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MacLaury, Robert Ethan, Ph.D.

University of California, Berkley, 1986

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Color in Mesoamerica, Vol I:
A Theory of Composite Categorization

By

Robert Ethan MacLaury

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DISSERTATION

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Chairman Date

Paul Kay ..... 15 May 1986

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.....

Color in Mesoamerica, Vol. I: A Theory of Composite Categorization

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Robert Ethan MacLaury

Abstract

Color in Mesoamerica, Vol. I: A Theory of Composite Categorization

Robert E. MacLaury

The following concerns the purest imaginable examples of red, yellow, green, blue, white, and black. Many indigenous languages of Mesoamerica categorize two or three of these pure colors under a single name, for example, green-with-blue, red-with-yellow, or black-with-green-with-blue. The broad groupings are known as "composite color categories." They involve diverse internal compositions, semantic relationships, and phases of change, some of which are heretofore unreported. An assortment of findings have resulted from improved measurement and from refinement of descriptive method.

The central thesis is that these observations, as well as older ones, are most exhaustively explained and united by hypotheses that are built up from a few perceptual and cognitive axioms; *perception and cognition are equally critical to this kind of categorization.* The hypotheses constitute a unified theory to the extent that they share axioms. The theory accounts for data more thoroughly than do theories of color categorization that emphasize perception, such as Rosch's prototype and family resemblances or Kay and McDaniel's adoption of fuzzy-set logic. Conversely, the proposed theory reinforces Berlin and Kay's hypothesis of universal color-category evolution, and it incorporates works by McDaniel and by Zollinger that relate color ethnography to the findings of R. De Valois and his co-workers in visual physiology.

Cognition is treated in terms of coordinates, reference bodies, and continuous frames of reference, three tenets of relativity physics: (1) cognitive coordinates of reciprocally related, mutable strengths are combined with invariant perceptual coordinates (2) to compose a category as a vantage from one or more standpoints; (3) category

composition varies through a continuum of sizes and organizations according to the strengths of cognitive coordinates and choices of perceptual coordinates.

This volume is the first of two that address data collected from 900 speakers of 116 Mesoamerican languages.

Brent Berlin, Chairman

For

Moisés Romero Castillo

and

Eunice V. Pike

Acknowledgments

I profoundly thank the people and institutions who made my dissertation possible: The 116 investigators who contributed fieldwork and data to the Mesoamerican Color Survey (MCS) and World Color Survey (WCS) are listed with their institutions and languages in Table 1.1. Data of any figure in Chapters III-IX are attributed to particular sources through the table. Institutional directors and coordinators who authorized and mobilized collaboration are: Leonardo Manrique Castañeda, Jefe del Departamento de Lingüística, Instituto Nacional de Antropología e Historia, Mexico; William R. Merrifield, International Coordinator of the Summer Institute of Linguistics; Gordon Alsop and Donald Stewart, Directors, Summer Institute of Linguistics, Mexico (SIL-M); Michael Lind, Field Coordinator, SIL-M; Stephen Echerd and Matt Ulrich, Directors, Summer Institute of Linguistics, Central America; Narciso Cojtí, Director, Proyecto Lingüístico "Francisco Marroquín." Russell De Valois, Karen De Valois, and Nancy Coletta patiently answered questions regarding visual physiology. Terrance Kaufman drafted an up-to-date account of ProtoMayan color terms. Lynn Kalmar and Jorge Raul de Moral Mena translated the promotional circular and instruction on field methods to Spanish. Willett Kempton wrote a key computer program. Tim Knab and Luís Marcial Corzo provided tactical assistance in Mexico City and San Cristóbal de las Casas. Brent Berlin, Paul Kay, and William R. Merrifield lent Munsell materials and data to the MCS from the WCS. Brent Berlin, Paul Kay, Haruo Aoki, Richard Sun, and Heinrich Zollinger contributed theoretical discussion and manuscript criticism. Ann Gover proofread the final draft. Richard Gringeri and Simon Cassidy also spotted errors. The Fulbright-Hays fellowship program sponsored the project during 1979. Responsibility for any aspect of the dissertation rests with me, Robert E. MacLaury.

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Chapter I

Introduction

1.0. Preface

Many indigenous languages of Mesoamerica categorize two or three pure colors under a single name, such as green-with-blue, red-with-yellow, or black-with-green-with-blue. The broad groupings are known as "composite color categories." They involve diverse internal compositions, semantic relations, and phases of change, some of which are heretofore unreported.

The central thesis of this study is that all such observations of composite color categorization are most exhaustively explained and united by hypotheses that are built up from a few perceptual and cognitive axioms; *perception and cognition are equally critical to this kind of categorization.* The various hypotheses constitute a unified theory to the extent that they share axioms. The theory addresses the assortment of findings that have resulted from improved measurement and from refinement of descriptive method.

The axioms and their chapter-by-chapter application is outlined in Chapter II, and the overview is re-expressed in Chapter X as a summary of observations and hypotheses.

The present study of composite categories is entitled "Volume I," because it is half of a comprehensive account of color categorization in Mesoamerican languages. A subsequent study, to appear as "Volume II," will be based on the same collection of data. But it will concern primary, derived, and residual categories. The two subjects are naturally divided, because a different set of axioms is required to explain each. This

chapter provides background regarding the genesis of the current project, collaborators and languages, a map of the latter, the Munsell color solid and stimulus materials, the psychological color solid, the CIE chromaticity chart and tristimulus values, equipment design and its history, and the prior development theory concerning color categorization in particular and categorization beyond the domain of color.

1.1. The Mesoamerican Color Survey

The central thesis was conceived after much of the data had been collected and their analysis was under way. The original goal of the project was to reconstruct color categorization in Mesoamerican proto-languages, such as ProtoOtomanguean, ProtoMayan, and ProtoMixeZoquean, and it was to trace the descent of the proto-systems to their contemporary forms. It was surmised that prolonged contact between precolumbian cultures in Mesoamerica had occasioned color categories to evolve in the same manner among each of them; reconstructions of various proto-systems would provide a diachronic test of Berlin and Kay's hypothesis of universal color-category evolution. It was vaguely projected that the planned undertaking might yield some insight into the means and mechanisms by which areal diffusion effected the evolution of color categorization. Since the literature reported that most contemporary Mesoamerican languages name five native color categories -- white, black, red, yellow, and green-with-blue -- it was of particular concern to identify the linguistic group that originated the widely diffused five-category system.

In pursuit of that scheme, a data-collecting project was drafted. First, lexical data regarding color categories was to be assembled from published sources, unpublished manuscripts, private card files, and archives. Second -- and eventually with a substantial consequence -- arrangements were made with missionary linguists and academics to conduct about 40 original investigations among speakers of genetically diverse languages throughout Mesoamerica. The field studies were to supplement the lexical data and to

enable examination of points that might have been overlooked by the available works. The collected sample was to be further enlarged by 16 investigations conducted in Mesoamerican languages under the World Color Survey, a distinct but complementary project.[1]

The substantial consequence was that the field studies, once in progress, revealed that the goal was misguided. The effects of areal diffusion did not appear in the data, and the published sources had given no clue of the actual situation: In some Mesoamerican languages, the color domain was not partitioned into the expected five categories, but only into three or four; nevertheless, color categories, their internal compositions, and the words used to name them bore relationships of unanticipated variety and complexity, many of which had not been reported in literature pertaining to Mesoamerican languages or to others.

The historical and areal concerns were largely replaced with a focus on color-category composition, relationships, and semantics. The project of collecting original data was expanded to include twice the investigations that were slated at the outset. After this change, the study coalesced into its final design and objectives, those stated in the preface.

1.2. Data Collection

Mesoamerican Color Survey (MCS) is the area-specific counterpart of the World Color Survey (WCS). The two surveys provide an overview of color categorization from regional and global perspectives. During the MCS, data collection proceeded as follows:

Collaboration was sought from individuals who had knowledge of a native Mesoamerican language and rapport with its speakers. Eighty missionary linguists, academic linguists and anthropologists, and native-speaker linguists offered to contribute to the project by collecting data in as many languages. The offers were expressed as formal

[1]The World Color Survey was conducted by members of the Summer Institute of Linguistics in the Americas, Asia, Africa, Australia, the Philippines, and New Guinea under NSF Grant BNS 76-14153 to Brent Berlin, Paul Kay, and William Merrifield. It produced interviews of 2500 individuals in 100 languages.

letters. In exchange, each was to receive the loan of a 330-chip set of Munsell stimulus materials, other equipment, and consultation on interview methods; and the result of each investigation was to be published as a collaborative article under the authorship of the project participant.

The letters of support were attached to a grant proposal; and the grant was to pay for the some 80 sets of Munsell stimulus materials, an item that otherwise was beyond the reach of available funds. However, the grant was denied. The World Color Survey, which was nearing completion during 1979, rescued the Mesoamerican Color Survey by lending used equipment and surplus materials. After a slow start, the Mesoamerican Color Survey survived and flourished. It was carried out in Mexico, Guatemala, and Honduras during 1978-81 on a shoestring budget.

As a result of the Mesoamerican Color Survey and the World Color Survey, the total corpus of data -- to be called "the Mesoamerican sample" -- is as follows:

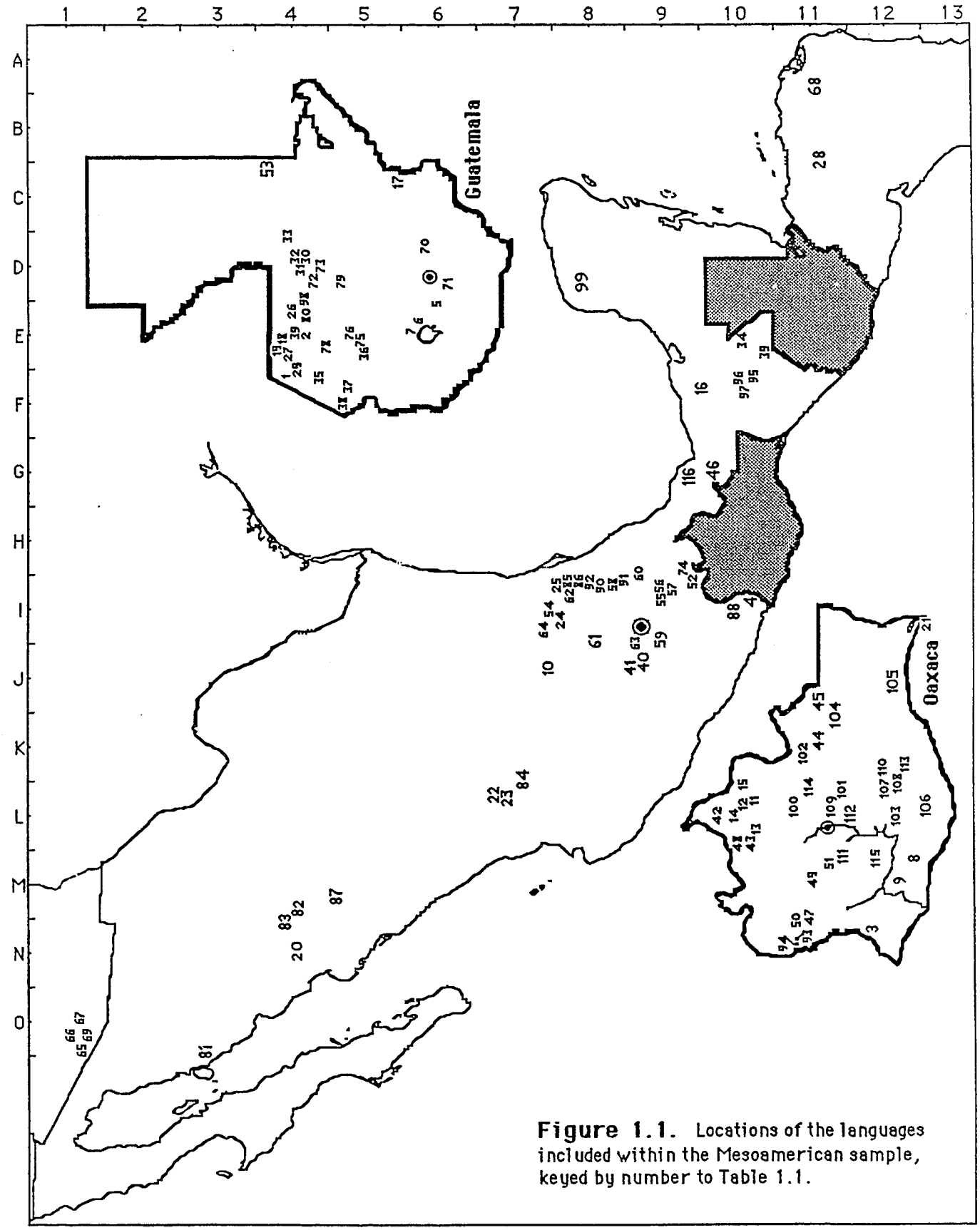


Figure 1.1. Locations of the languages included within the Mesoamerican sample, keyed by number to Table 1.1.

Table 1.1[2]

The Mesoamerican Sample

	Language	Location	Key To Figure 1.1	Survey	Collaborator & Institution	Number Of Individuals Interviewed	Naming Elicitations	Mapping Elicitations
1.	Acatec	San Miguel Acatán	F4	MCS	José Juan Andrés, PLFM; Arvid Westfall, SIL-CA	19	19	19
2.	Aguacatec	Aguacatán	E4	WCS MCS	Harry McArthur, SIL-CA	35 -	35 0	0 5
3.	Amuzgo	San Pedro Amuzgos	N12	"	Susana Cuevas, INAH	5	5	4
4.	Amuzgo	Xochistlahuaca	I10	WCS MCS	Amy Bauernschmidt, SIL-M	25 -	25 1	0 1
5.	Cakchiquel	Santa María de Jesús	E6	"	Stephan Stewart, U. de San Carlos	12	12	12
6.	Cakchiquel	Patzún	"	" WCS	" Débora Ruyán & Joann Munson, SIL-CA	10 30	10 30	8 0
7.	Cakchiquel	Tecpan	"	MCS	Wenceslao Tucubal S., PLFM	13	13	13
8.	Chatino	Santo Reyes Nopala	M12	"	Allen Lachmann, SIL-M	1	1	1
9.	Chatino	San Miguel Panixtlahuaca	"	"	none	1	1	1
10.	Chichimeca Jonaz	San Luís de la Paz	J8	"	"	1	1	1
11.	Chinantec	San Juan Lealao	L10	"	James Rupp, SIL-M	1	1	1

[2] Table 1.1 lists sources of data and acknowledges collaborators and their institutions. Abbreviations: SIL-M, SIL-CA, and SIL-NA = the Summer Institute of Linguistics of Mexico, Central America, and North America, CEM-UNAM and IIA-UNAM = *Centro de Estudios Mayas* and *Instituto de Investigaciones Antropológicas* of the *Universidad Nacional Autónoma de México*, INAH = *Instituto Nacional de Antropología e Historia*, U de SC = *Universidad de San Carlos*, PLFM = *Proyecto Lingüístico "Francisco Marroquín,"* SMU = Southern Methodist University, UCB and UCLA = the University of California at Berkeley and at Los Angeles. Figure 1.1 relates Table 1.1 to the map.

12.	Chinantec	San Juan Palantla	"	WCS	Allen & Patricia Anderson, SIL-M	25	25	0
13.	Chinantec	Tepetotutla	"	MCS	David Westley, SIL-M	11	11	11
14.	Chinantec	Tlacoatzíntepec	"	"	Mabell Lewis, SIL-M	1	1	1
15.	Chinantec	Tuxtepec	"	"	Leo Skinner, SIL-M	1	1	1
16.	Chontal de Tabasco	Mesamán	F10	"	Jorge Raul de Moral Mena, CEM-UNAM	1	1	1
17.	Chortí	Jocotán	C5	"	Vitalino Perez, PLFM	5	5	4
18.	Chuj	San Mateo Ixtatán	E4	"	none	1	1	1
19.	Chuj	San Sabastián Coatán	"	"	Mateo Felipe Diego, PLFM	11	11	11
20.	Guarajío	Los Alamos	N4	WCS MCS	Ron & Sharon Stolzfuz, SIL-M	25 -	25 1	0 1
21.	Huave	San Mateo del Mar	I13	WCS	Glenn & Emily Stairs, SIL-M	25	25	0
22.	Huichol	Santa Catarina	L7	MCS	Glenn Gardener, UNAM	1	1	1
23.	Huichol	San Sabastián	"	"	Dennis Holt, UCLA	4	4	3
24.	Huastec	Huehuetlán	I8	"	María Angel Ochoa Peralta, INAH; Daniel Wilcox, SMU	10	10	10
25.	Huastec	Tantoyuca	"	" WCS	M. A. Ochoa P., INAH; James & Mary Walker, SIL-M	4 25	4 25	3 0
26.	Ixíl	Chajúl	E4	MCS	Dwight Jewett, SIL-CA	1	1	0
27.	Jácaltec	Jacaltenango	"	"	Baltazar Hurtado Diaz, PLFM	10	10	10
28.	Jicaque	Montaña de la Flor	B11	WCS MCS	Ron & Lynn Dennis, SIL-CA	10 0	10 0	0 5
29.	Kanjobal	Santa Eulalia	F4	"	Juan Diego Diego, PLFM	6	6	5
30.	K'ekchí	Carchá	D4	"	Stephan Stewart, U de SC	1	1	1
31.	K'ekchí	Cobán	"	"	"	3	3	0
32.	K'ekchí	Chamelco	"	"	"	1	1	1
33.	K'ekchí	Lanquín	"	"	Pedro Tiul, PLFM	10	10	6
34.	Lacandón	Naja'	E10	"	Robert Bruce, INAH	6	6	0
35.	Mam	San Ildefonso Ixtahuacán	F4	"	Juan Ortíz Dominguez, PLFM	11	11	11

36.	Mam	San Juan Ostuncalco	E5	"	David Scotchmer	2	2	1
37.	Mam	Tacaná	F5	"	Tom Godfrey, SIL-CA	5	5	2
38.	Mam	Tectitlán	"	"	Eleanor Beach, SIL-CA	7	7	4
39.	Mam	Todos Santos	E10	"	Richard Reimer, SIL-CA	1	1	0
40.	Matlatzinca	San Francisco Oxtotilpan	J9	"	Roberto Escalante, INAH	3	3	1
41.	Mazahua	Nineteen locations	"	WCS	Donald & Shirley Stewart, SIL-M	25	25	0
42.	Mazatec	Jalapa de Diaz	L10	MCS	Terry & Judy Schram, SIL-M	1	1	0
43.	Mazatec	Chiquihuitlán	"	WCS	Carole Jamieson, SIL-M	25	25	0
44.	Mixe (Coatlán)	Santiago Isquintepec	K11	MCS	Searle Hooshagan, SIL-M	6	6	6
45.	Mixe	San Juan Guichicovi	J11	"	Norman Nordell, SIL-M	1	1	1
46.	Mixe	Sayula de A.	G10	"	Roberto Escalante, INAH	1	1	1
47.	Mixtec	San Esteban Atatlahuca	M11	"	Betty Forshaw, SIL-M	1	1	1
48.	Mixtec	San Juan Coatzospan	L10	"	Priscilla Small, SIL-M	5	5	3
49.	Mixtec	San Juan Diuxí	M11	"	Joy Oram, SIL-M	17	17	14
50.	Mixtec	Santo Tomás Ocotepec	N11	"	Betty Forshaw, SIL-M	20	20	13
51.	Mixtec	Santa María Peñoles	M11	WSC	John & Margaret Daly, SIL-M	25	25	0
52.	Mixtec	Xayacatlán	I9	MCS	Kenneth Wistrand, SIL-M	1	1	0
53.	Mopán Maya	San Luís Petén	C4	"	Matt & Rosemary Ulrich, SIL-CA	10	10	0
54.	Nahuatl	Coxcatlán	I8	"	none	1	1	1
55.	Nahuatl	Santa Buena-ventura	I9	"	Tim Knab, IIA-UNAM	10	10	10
56.	Nahuatl	Santa María Tonantzintla	"	"	"	8	13	5
57.	Nahuatl	San Pedro Tonantzintla	"	"	"	3	6	3

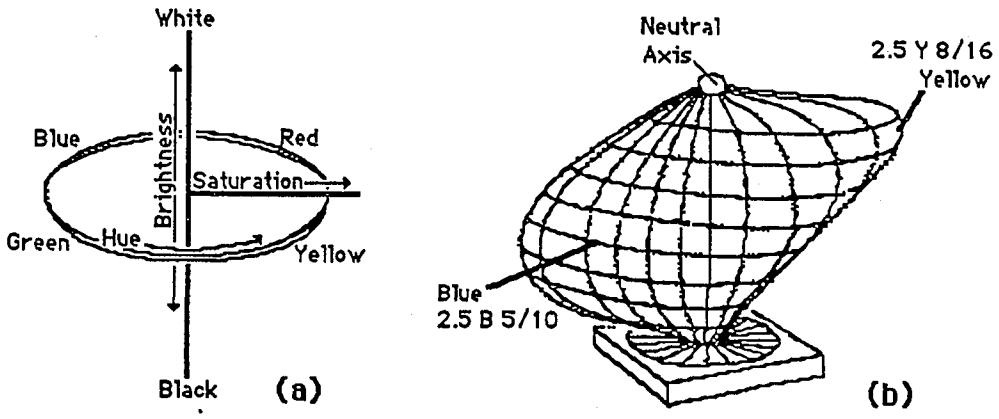
58.	Nahautl	Tlaxpanaloya	I8	WCS	Earl Brockway, SIL-M	6	6	0
59.	Ocuiltec	Santa Lucía	I9	MCS	none	2	2	1
60.	Otomí	Ixtenco	"	"	"	1	1	1
61.	Otomí	Valle del Mezquitál	I8	"	Donald & Isabelle Sinclaire, SIL-M	3	3	3
62.	Otomí	San Antonio El Grande	"	"	Katherine Voigtlaner & Artemisa Echegoyen, SIL-M	16	16	1
63.	Otomí	Santiago Tilapa	I9	"	Sergio Vivanco, INAH	1	1	0
64.	Pame	Santa María Acapulco	I7	"	Lorna Gibson, SIL-M	1	1	1
65.	Papago	O'odham	O1	WCS	Dean & Lucille Saxton, SIL-NA	7	7	0
66.	Papago	Ko-loodi	"	"	"	4	4	0
67.	Papago	Totogwuañ	"	"	"	9	9	0
68.	Paya	Pueblo Nuevo Subírana	A11	"	Steven and Pamela Echerd, SIL-CA	25	25	0
69.	Pima	O'odham	O1	"	D. & S. Saxton, SIL-NA	5	5	0
70.	Pocomám	San Luís Jilotepeque	D6	MCS	Thomas Smith-Stark, Tulane	1	1	0
71.	Pocomám	Palín	"	"	Otto Schumann, CEM-UNAM	1	1	0
72.	Pocomchí	San Cristóbal Alta Verapaz	D4	"	Ted & Gloria Engles, SIL-CA	3	2	3
73.	Pocomchí	Tactíc	"	"	Stephan Stewart, U de SC	1	1	0
74.	Popoloca	San Felipe Otlaltepec	H9	"	Ann Williams, SIL-M	2	2	0
75.	Quiché	Chiquimula	E5	"	Gaspar Pú Tzunux, PLFM	10	10	10
76.	Quiché	Momostenango (Xequemeyá)	"	"	Pedro Sanic Chanchavac, PLFM	11	11	11
77.	Quiché	Santa Catarina Ixtahuacán	"	"	Manuel Isidro Choxtum, PLFM	11	11	11
78.	Quiché	Sipacapa	E4	"	Susan Hoiland, SIL-CA	10	10	0
79.	Rabinal Achí	San Miguel Chicaj	D5	"	Rodrigo & Carol Barrera, SIL-CA	5	5	5
80.	Sacapultec	Sacapulas	E4	"	Jack DuBois, UCLA	5	5	5
81.	Seri	Desemboque	O3	WCS	Beckie Moser, SIL-M	25	25	0

82.	Tarahumara (Central)	Samachique, Rojogochi	M4	"	Don Burgess, SIL-M	9	9	0
83.	Tarahumara (Western)	Rocoroibo, Huicochi	N4	" MCS	Don Burgess; Willett Kempton, UCB	6 -	6 1	0 1
84.	Tepecano	Atzqueltán	L7	"	Dennis Holt, UCLA	1	1	0
85.	Tepehua	Tierra Colorado	I8	"	James Watters, SIL-M	1	1	1
86.	Tepehua	Huehuetla	"	"	Susan Edgar, SIL-M	7	7	7
87.	Tepehuán (Northern)	Baborigami	M5	"	Burt Bascom, SIL-M	12	12	11
88.	Tlapanec	Malinaltepec,	I10	WCS	Mark Weathers, SIL-M	25	25	0
89.	Tojolabal	Santa Margarita Agua Azul	E10	MCS	Jorge Raul de Moral Mena, CEM-UNAM	3	3	0
90.	Totonac (Nanacatlán)	Zapotitlán de M., Tetela de O.	I8	"	Betty Aschmann, SIL-M	10	10	10
91.	Totonac	San A. Zacatlán, Tlayehualancingo	I9	"	Antonia Espinoza & Blanca Garcia, U. Veracruzana	1	1	0
92.	Totonac	Xicotepec, Apapantilla	I8	"	Ruth Bishop, SIL-M	1	1	0
93.	Trique	San Andrés Chicahuaxtla	N11	"	Claud & Alice Good, Franconian Missions Society	11	11	0
94.	Trique	San Juan Copala	"	"	Bruce & Barbara Hollenbeck, SIL-M	3	3	0
95.	Tzeltal	Amatenango del Valle	F10	"	none	3	3	3
96.	Tzeltal	San Alonso Tenejapa	"	"	"	9	9	9
97.	Tzotzil	Navenchauc	"	"	"	6	6	6
98.	Uspantec	Las Pacayas	D4	"	Stanley & Margot McMillen, SIL-CA	11	10	11
99.	Yucatec	Yaxtzaba?	D8	"	William Pulte, SMU	1	1	1
100.	Zapotec	Atepec	L10	"	Neil Nellis, SIL-M	3	3	1
101.	Zapotec	San Baltasar Chichicapan	L11	"	Joseph & Mary Benton, SIL-M	14	14	8
102.	Zapotec	Santiago Choapan	K11	"	Larry Lymann, SIL-M	1	1	0
103.	Zapotec	Santa C. Cuixtla	L12	"	Jane Ruegsegger	2	2	1

104.	Zapotec	Guevea de Humbolt	K11	"	Barbara Morse, SIL-M	1	1	1
105.	Zapotec	Juchitán	J12	"	María Villalobos, SIL-M	5	5	3
106.	Zapotec	San Augustín Loxicha	L13	"	Jerry Gutierrez	2	2	1
107.	Zapotec	San Cristóbal Amatlán	L12	"	none	4	4	4
108.	Zapotec	Santo Domingo Amatlán	"	"	"	1	1	1
109.	Zapotec	San Juan Guelavía	L11	"	"	1	1	1
110.	Zapotec	San Juan Mixtepec	K12	"	Roger Reeck, SIL-M	10	10	10
111.	Zapotec	Santa María Lachixío	M11	"	Dave & Jan Persons, SIL-M	10	10	0
112.	Zapotec	Satiago Apostol	L12	"	Donald Olson, SIL-M	3	3	3
113.	Zapotec	San Pablo Ozolotepec	K12	"	Roger Reeck, SIL-M	1	1	1
114.	Zapotec	San Pedro Cajonos	L11	"	Don Nellis, SIL-M	1	1	0
115.	Zapotec	San Lorenzo Texmelucan	M12	WCS MCS	Chuck Spec, SIL-M	25 -	25 1	0 1
116.	Zoque	San Pedro Soteapan	G9	"	Roberto Escalante, INAH	1	1	1
					Totals:[3]	898	907	362

[3] The total number of naming elicitations is greater than the total number of individuals interviewed because some individuals were interviewed twice, marked as "-" when under different surveys.

1.3. Stimulus Materials



Figures 1.2a-b. The three dimensions (a) of the Munsell color solid (b).[4, 5]

Data were elicited during interviews in response to the Munsell color standards, 1976 issue. The complete system of 1600 Munsell colors is conceptually arranged as a three-dimensional "solid" in which each color is stepped off to an equal perceptual distance from its neighbors. The dimensions of the solid are: (1) **hue** -- the prismatic colors, such as red, yellow, green, blue, and violet; (2) **brightness** (also called "value" and "intensity") -- light-to-dark and white-grey-black; (3) **saturation** ("chroma" and "purity") -- the distance of a color from white-grey-black, its vividness. At maximum saturation, there are fewer perceptual steps between certain hues and the white-grey-black axis than there are between other hues and the axis. Figure 1.2b shows that yellow is perceptually closer in brightness to the white pole than is blue, but blue is closer to the grey axis than is yellow. Some hues, such as red, green, yellow, blue, purple, pink, and orange are distant from the axis. Others, such as brown, lavender, cream, and pastel colors are closer.

---

[4]Figures 1.2a-b are reproduced with changes by permission from *Webster's Third New International Dictionary* © 1986 by Merriam-Webster Inc., publisher of the Merriam-Webster ® Dictionaries.

[5]Colored depictions of the solid with technical explanation are found under "Color" in most encyclopedias and in *Webster's Third New International Dictionary*. See Newhall (1940), Newhall, Nickerson, and Judd (1943), Kelley and Gibson (1943), Granville, Nickerson, and Foss (1943), and Hurvich (1981: 270-98) for a detailed account.

Stimulus materials used by the WCS and MCS comprised 330 colors from the solid: the 320 that compose its outer, maximally saturated suface and 10 that compose its minimally saturated axis. The graph of Figure 1.3 schematicizes in two dimensions the axis and the surface of the solid. Each graph cell represents a different color. White, grey, and black are depicted at the left in the unnumbered column, the maximally saturated hues in columns 1-40. The number in each cell indicates the saturation level of its respective color, 0-16; heavy lines distinguish 2-6 and 8-16:

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
0	A																																								9.5
0	B	2	2	2	2	2	2	2	2	4	6	6	6	6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	9.0
0	C	6	6	6	6	6	6	8	14	16	14	12	12	12	4	10	8	8	6	6	6	6	4	4	4	4	4	4	4	6	6	4	4	4	4	6	6	6	6	6	6	8.0
0	D	8	8	10	10	10	14	14	14	12	12	12	12	12	6	10	10	10	8	8	8	8	8	6	6	6	6	6	8	8	8	6	6	6	6	8	8	10	10	8	8	7.0
0	E	12	12	12	14	16	12	14	12	10	10	10	10	10	8	12	12	10	10	10	10	8	8	8	8	8	8	8	10	10	10	8	8	8	8	10	10	10	12	12	12	6.0
0	F	14	14	14	16	14	12	10	10	8	8	8	8	8	10	10	12	12	10	10	10	10	8	8	8	8	8	8	10	12	12	10	10	10	10	10	12	12	12	14	14	5.0
0	G	14	14	14	14	10	8	8	6	6	6	6	6	6	12	8	8	10	10	10	10	8	8	8	6	6	8	8	10	10	12	12	10	10	10	10	12	12	12	12	14	4.0
0	H	10	10	12	10	8	6	6	6	4	4	4	4	4	10	6	6	8	8	8	8	6	6	6	6	6	6	6	8	10	10	12	10	10	10	10	10	10	10	10	10	3.0
0	I	8	8	8	6	4	4	4	2	2	2	2	2	2	4	4	4	4	6	6	6	4	4	4	4	4	4	6	6	6	8	10	8	8	8	6	6	8	8	8	8	2.0
0	J	2.5	5	7.5	10	5		10	5		10	5		10	5		10	5		10	5		10	5		10	5		10	5		10	5		10	5		10	5		10	1.0
		R				YR				Y				GY				G				BG				B				BP				P				RP		

Figure 1.3. Minimally and maximally saturated Munsell colors, those used as stimulus materials during the World Color Survey and Mesoamerican Color Survey.

Figure 1.3 further displays and relates two notations: (1) row-letters and column-numbers on the left and top; (2) Munsell specification on the right and bottom. In the discussion, only row-letters and column-numbers will be used. For example, the color of C9 (a vivid yellow) is saturated at level 16. The expression "C9" is simpler than referring to the color by Munsell symbols as "2.5 Y 8/16," which means 2.5 Y hue, 8/ brightness, and /16 saturation. The figure links the simplified notation to the internationally recognized standard.

The two-dimensional representation of the color-solid surface involves a distortion such that the perceptual distances between the colors in rows B-C and H-I are less than

between the colors of the same columns in rows D-G. The same distortion occurs on a flat map of the world (a Mercator projection) in which arctic and antarctic regions are enlarged. In rows A and J the pure white and pure black pole of the solid is represented by one graph cell, because just one color would extend through each row.

Figure 1.4a relates the two dimensional grid of Munsell colors to the eleven basic color terms of American English. These were elicited from a single individual who named the colors one-by-one during an interview (of the kind described in Chapter III). The subject also chose a best example or "focus" of each term. The figure provides the English-speaking reader with a reference against which to compare and interpret color categories of Mesoamerican languages (See Appendix I).

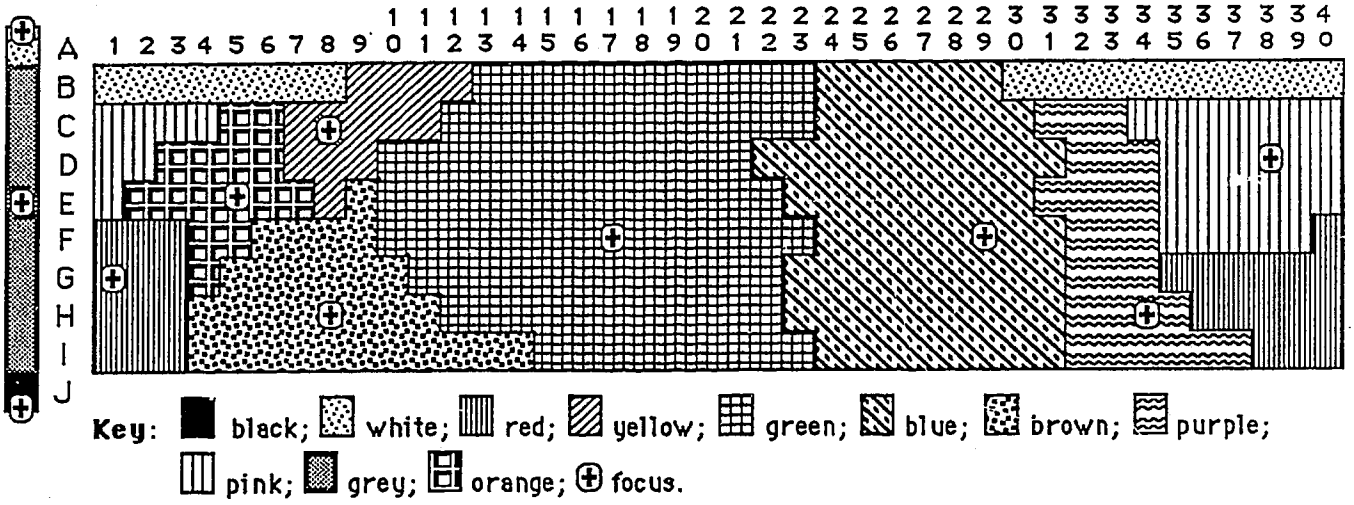


Figure 1.4a. Obverse display of color terms elicited from a speaker of American English, man, age 35, 1980.

Figure 1.4b is a "reverse" display of the same English speaker's data, opposed to the obverse in Figure 1.4a. Columns 1-20 and 21-40 are reversed as 21-40,1-20, which breaks the grid through bluish green but displays red and pink continuously. Since the grid

represents a spheroidal surface, any break is artificial. Obverse and reverse displays are used below.

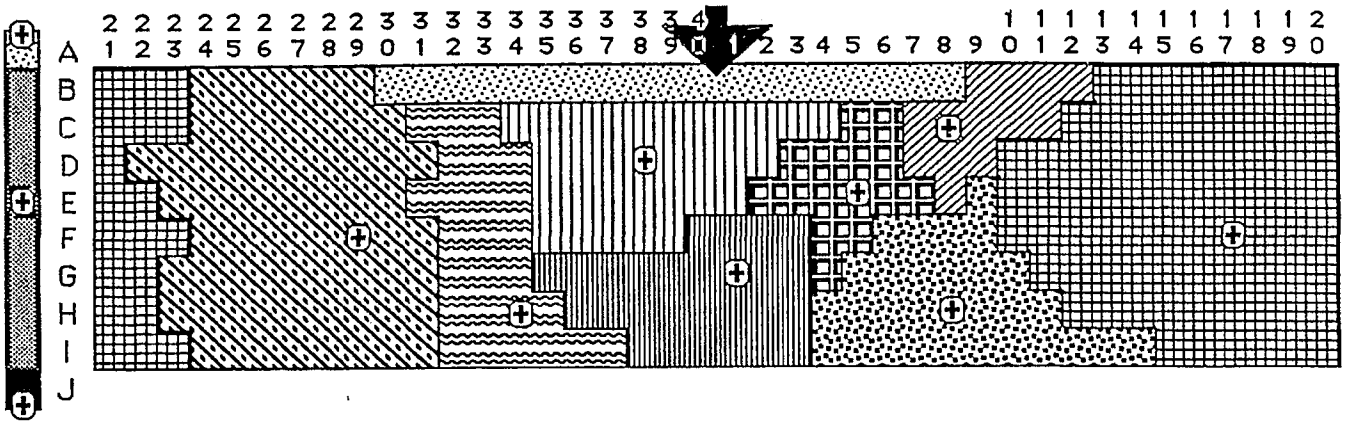


Figure 1.4b. Reverse display.

1.4. The Psychological Color Solid

The maximum levels of saturation within the Munsell color solid are those that are technically attainable with dyes; they are less than those that are theoretically visible. The latter are approximated with monochromatic light. The discernment of such light constitutes a second structure called "the psychological color solid" (Nickerson and Newhall 1943). The structures and surface values of the Munsell color solid and the psychological color solid are closely, but not simply, related. Figure 1.5 displays a simplified depiction of the saturation levels that compose the surface of the psychological solid:

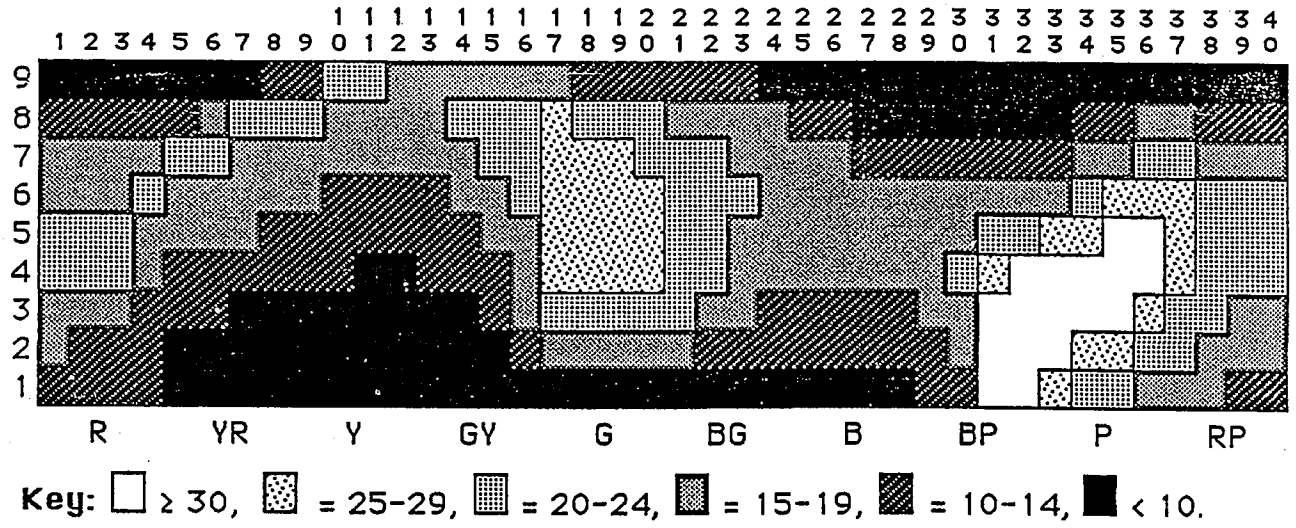


Figure 1.5. Maximum saturations within the psychological color solid.

The levels of Figure 1.5 are readily comparable with those of the Munsell solid in Figure 1.3.[6] The psychological solid is important to the present study because it represents all of the colors that people can see. It contributes to evidence of relative perceptual salience, as between green and blue or blue and purple.

1.5. Tristimulus Values and the 1931 CIE Chromaticity Chart

The *Commission Internationale de l'Eclairage* (CIE) has set various standards for the specification of color. In section 2.1.1.1., evidence in support of axiom #3 relies upon two of the standards, "tristimulus values" and the "1931 CIE Chromaticity Chart," which are briefly described:

[6] Nickerson and Newhall (1943) and Nickerson, Newhall, and Judd (1943) specified the psychological color solid and the Munsell color solid in terms of eleven levels of brightness, Ø-10, of which nine can be chromatic, 1-9. The nine appear in Figure 1.5 as a simplification of Nickerson and Newhall's Table 1 (*ibid.* 419). The commercial issues of Munsell colors, including the 1976 issue, are modified by reduction to ten brightness levels of which eight can be chromatic, as shown in Figure 1.3. Therefore, Figures 1.3 and 1.5 are comparable in regard to the relative positions of hues within the two dimensions of the 40-column framework, although the specification of brightness differs by one level between them.

Helmholtz (1896) showed that, when given three light sources of a single wavelength each (W_1, W_2, W_3), a fourth (W_x) could be added to any one of the three so as to match the mixture of the remaining two ($W_x + W_1 = W_2 + W_3$), providing that none of the three by itself will match the mixture of the two others. Any such three wavelengths are called "primaries." Their choice can be arbitrary if the provision is observed. Helmholtz chose red, green, and blue as primaries; printers use magenta, cyan, and yellow.

Wright (1928-29) conducted matching experiments with human subjects to empirically demonstrate the proportions of the primaries 650nm red, 530nm green, and 460nm blue that are required to match all spectral colors. Figure 1.6 shows an average of his data:

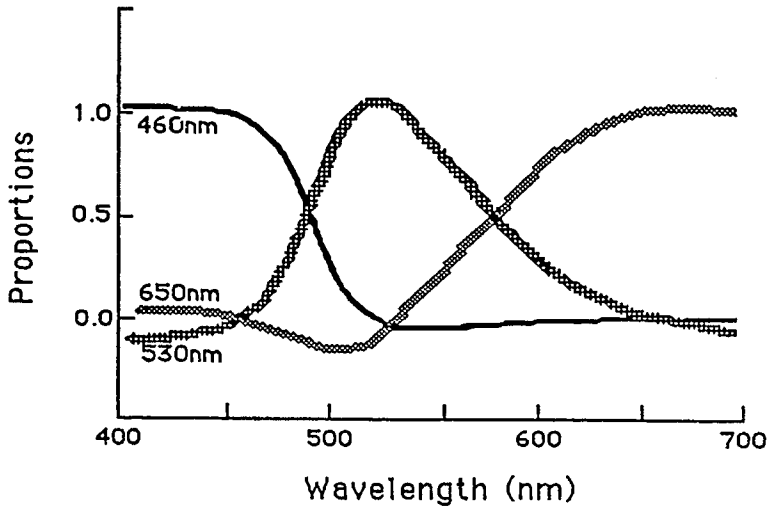


Figure 1.6. Wright's proportions of primaries for achieving color matches.

Negative values in these data indicate that one primary was added to a target sample to reduce saturation enough to enable its matching with the other two primaries. Wright devised a two-dimensional horseshoe-shaped chart of the "chromaticity space" that showed the amounts of each primary relative to the total of the three. One axis, C_1, represented amounts of red, and another axis, C_2, amounts of green. The third proportion,

C_3, was not shown in the two-dimensional chart, although it was derivable from C_1 and C_2.

In 1931, the CIE adopted Wright's horseshoe-shaped system as a means of describing colors by trichromatic composition, specifying a "standard observer" and a standard illuminant. To eliminate Wright's negative values and to attain other practical advantages, the CIE adopted primaries of 700, 546.1, and 435.8nm. Figure 1.7 displays the 1931 CIE chromaticity chart:

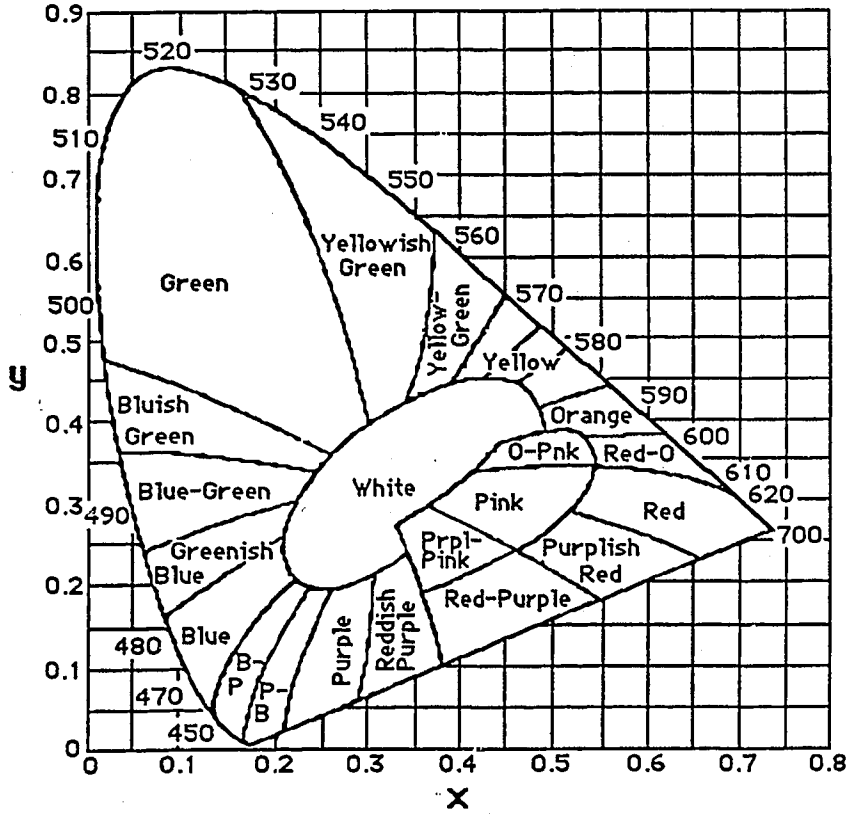


Figure 1.7. The 1931 CIE chromaticity chart. (Reproduced with changes by permission of the publisher from Sheppard [1968: 32, fig. 13] © 1968 by Elsevier Science Publishing Co., Inc.).

This figure includes Kelley's (1949) 22 "color designations" for ease of interpretation; Sheppard depicts the chart with a color plate as a frontispiece. The CIE replaced Wright's axes with a commensurable **Yxy** system, by which the tristimulus values of any color-match are expressed. Two values, **x** and **y**, are attributed to any point

of color within the prismatic parabola from coordinates of the chart; the third value, Y, is derived from the other two. For example, the tristimulus values of the Munsell color 2.5 Y 8/16 are Y = .4957, x = .4800, y = .5910.

The Munsell system and the matches obtained in the CIE chromaticity chart together constitute the means of specifying color in science and industry. The Munsell color solid differs from the CIE chart by including psychological spacing and luminance information. The relationship between the two systems is detailed by Newhall, Nickerson, and Judd (1943; see also Boynton 1979: 19, 97-158; Hurvich 1980: 270-97).

1.6. Descriptive Method and Measurement: Their History

The scholarly and scientific literature on the ethnography of color categorization spans 130 years (Gladstone 1858). In the finest tradition of nineteenth-century empiricism, the original color ethnographers paid meticulous attention to descriptive method. Then, as much as now, the primary concern was to collect data by systematic procedures and in reference to a widely accepted standard so that they would be communicable, comparable between languages, and replicable. Magnus (1880) conducted the first world-wide color survey by mailing instructions on methods and stimulus materials to missionaries and colonial officials; his materials consisted of Holmgren's wools, a standard developed by the Swedish physiologist Alarik Frithiof Holmgren for testing the color vision of Lapps. Rivers (1901), in addition to using the same yarn test, interviewed Torres Straits islanders with Lovibond's tintometer among an assortment of other fantastic devices. But after this period, the comparative investigation of color categorization waned for half a century as it yielded to a new-found interest in cultural relativism (Boas 1896).

Ray (1952, 1953) revived the cross-linguistic comparison of color categorization, using a darkroom and the light from a spectrogram as his replicable standard. However, during the interim of disinterest in color ethnography, the Munsell standards were developed (Munsell 1905; Nickerson, Newhall, and Judd 1943). Lenneberg and Roberts

(1956) introduced the use of the Munsell standards as the metric of color ethnography. They arranged the 320 maximally saturated colors as an array in spectral order, using this to elicit Zuni color categories. Their method consisted of (1) preparing, in advance of interviews, a complete-as-possible list of color terms from the language of study and (2) conducting interviews by asking individual speakers to outline with a grease pencil on an acetate overlay (a) the range of each term as it appeared in the array and (b) the "most typical example" or focus of each term. The procedure became known as "the acetate mapping method."

Berlin and Kay (1969) fully adopted the Munsell standards, as well as the acetate mapping method with both of its steps. As an improvement, they rephrased the "focus mapping task" so that a subject is asked to indicate the "best example" of each color term on the array, and they modified the array itself: They added a vertical column of 10 achromatic color chips that range from pure white through eight shades of grey to pure black, and they framed the entire array of maximally saturated colors along its lightest and darkest margin with a solid row of the pure white and the pure black color. The added rows reduced confusion during interviews. The modification has been called "the Berlin-and-Kay array."

The full use of Berlin and Kay's adoption of the acetate mapping method and modified array is exhibited by Dougherty (1975) and Berlin and Berlin (1975). Other investigators, during the same period, employed variations of the method, all using the Munsell standards (e.g., Heider 1972a; Heinrich 1974; Kuschel and Monberg 1974; Hage and Hawkes 1975).

Collier (1973; Collier et al. 1976) miniaturized the Munsell array by cutting out 1/4" discoidal chips with a paper punch. These are mounted in the familiar rows and columns on a neutral matte, but with a small space separating each from its neighbors. The result is a reduced expenditure of the costly Munsell materials, an array that is easier to store and to transport, and a visual effect by which interviewees can separately regard each chip as they inspect the array. The latter advantage, in particular, facilitates the mapping procedures that

were developed during the Mesoamerican Color Survey. It was found that the miniaturization does not hinder elicited response.

The World Color Survey and the Mesoamerican Color Survey used an array that combined Collier's miniaturization with Berlin and Kay's design. The WCS departed from the acetate mapping method by employing two procedures: (1) a separate naming of each of the 320 maximally saturated and 10 minimally saturated Munsell colors in a fixed random order and (2) identification of foci for each name volunteered during (1). The MCS expanded on this method by adding a newly elaborated direct mapping procedure and by recording all modifiers as well as non-lexical responses. The MCS methods are outlined under section 2.2.3. and described in Chapter III. The MCS further altered the Collier-Berlin-Kay design by adopting both an obverse and a reverse array, of the formats shown in Figures 1.4a-b. The option allowed focusing and mapping of any category on an array without distortion caused by the artificial break between columns. Both surveys organized raw data on a graph that represented the array (cf. Figures 1.4a-b), the WCS with a computer and the MCS by a manual method.

1.7. Theoretical Background

The analysis of Mesoamerican data addresses two related traditions of research and theory: one concerns *universal color-category evolution* and the other pertains to *category structure*, the internal organization of categories within any domain. The two developments are outlined here:

1.7.1. Universal Color-Category Evolution

This review begins with the development of ethnographic color theory after 1969, the year of Berlin and Kay's landmark publication. Nevertheless, the cross-cultural study of color began in the Nineteenth Century. This early work -- which is reviewed by Segall, Campbell, and Herskovits (1966), Berlin and Kay (1969: 134-49), and Dougherty (1975: 4-8) -- recognized the tendency of color categories to develop in a universal order. The

work also involves debate about whether differences between the color categorization of distinct peoples are culturally or physically conditioned.

Tichener (1916) produced the last work of the nineteenth-century tradition. After this, the investigation of color categorization was dominated by relativist preconceptions, which are reviewed by Berlin and Kay (*ibid.* 12, 159-60) and Dougherty (*ibid.* 6-8). These held that color is perceived as an unbroken continuum that is segmented arbitrarily by linguistically determined convention (Ray 1952, 1953; Whorf 1939, 1940; Conklin 1955). According to Ray, "There is no such thing as a natural division of the spectrum. Each culture has taken the spectral continuum and has divided it upon a basis which is quite arbitrary" (1952: 252). In this climate, color categorization became a maxim used in textbooks to exemplify the principle of linguistic relativity (e.g., Gleason 1961: 2-5). Berlin and Kay conceived of their initial work as a response to that doctrine.

1.7.1.1. Basic Color Terms

As part of the research that preceded their 1969 publication, Berlin and Kay examined compilations of color terms from 98 languages; 20 were collected with their modification of the acetate mapping method, and the remainder came from dictionaries, reports, and correspondence. The study resulted in an initial version of a complex hypothesis consisting of eight stipulations:

1. Among the color terms of any language, a particular subset can be distinguished as "basic color terms." These are taxonomically superordinate and not subordinate ("inclusive"), easily remembered and frequently used ("salient"), usually short and structurally simplex ("monolexemic"), and not confined in meaning to a limited class of referents ("non-context specific"). Moreover, basic color terms are widely shared, tend to designate only color, and are unlikely to have been recently borrowed from another language. A basic color term names a "basic color category."

2. The speakers of any language will focus their basic color categories on approximately the same colors. The tight clustering of foci will vary between languages no

more than within a language; "...foci of color categories are similar among totally unrelated languages" (Berlin and Kay 1969: 10). There are eleven focal colors.

3. Different languages name different numbers of the eleven focal colors with basic color terms; some languages name only two, some name all eleven, and others name an intermediate number. Commensurably, a language can employ from two to eleven basic color terms.

4. The number of basic color terms in a language predicts the foci that they name. The reliability of such predictions implies a seven-stage sequence through which basic color terms evolve in any language that elaborates them:

Table 1.2
Berlin and Kay's Original Evolutionary Sequence

I	II	IIIa-b	IV	V	VI	VII
white		green	green			purple
→	red →	*or* →	*and* →	blue →	brown →	pink
black		yellow	yellow			orange
			\——————grey——————/			

Grey and, perhaps, brown can be encoded "prematurely" in the sequence.

5. The stage of basic color-term evolution that is manifested by a particular language correlates loosely with the level of societal complexity that its speakers represent.

6. The universally invariant spectral locations of the eleven focal colors suggest a probable neurophysiological determinant, and the evolutionary sequence suggests the same.

7. A basic color term not only names a focus but extends semantically to some of the surrounding, less distinctive colors; a focus is only the "best" referent of a basic color term; for example, in Stage I, the white-focused term can extend to high-brightness colors, and the black-focused term can extend to low-brightness colors.

8. An illusion of cross-linguistic relativity is created by differences between the numbers of basic color terms that are used in distinct languages; and the illusion is reinforced by culturally prescribed differences among specifically the boundaries -- although not the foci -- of basic color terms. The illusion is enhanced, further, by the proliferation of many non-basic terms among the color vocabularies of specific languages.

The eight claims countered the doctrine of linguistic relativity by asserting that specifically in the color domain -- the purported exemplar of semantic arbitrariness -- perception determines language rather than the reverse. However, the evolutionary sequence together with its suggested relationship to societal complexity assumed the visage of nineteenth-century unilineal evolution. For sixty years, proponents of the moderately relativist Boasian view of culture -- the prevailing view that had spawned the off-shoot of linguistic determinism -- had sought to displace the ethnocentric unilineal concept. Hence, the reviews of Berlin and Kay's publication were abundant, in many cases vehemently partisan, in part misguided, and in part accurate and constructive (e.g., Wescott 1970; Hickerson 1971; Newcomer and Faris 1971; Merrifield 1971; Hill and Hill 1971; Snow 1971; Frish 1972; Hays et al. 1972; Mitsunobu 1972; Durbin 1972; Conklin 1973; Collier 1973). See also Tornay (1978) and Hickerson (1980).

The enduring results of Berlin and Kay's study prove the work to be a benchmark in semantic theory:

First, its four major tenets have withstood fifteen years of exacting scrutiny: (1) the concept of the "basic color term," (2) the universality of delimited areas of distinctive color that constitute perceptual reference points, (3) the composition of color-term meanings in relation to these points, (4) the universal order of color-category evolution.

Second, the anti-Whorfian critique not only remains in force, but has opened fresh avenues of research: Mounting evidence demonstrates that perceptual universals operate

synchronically and diachronically in semantics, and apparently some of them involve human neurophysiology (Rosch 1974). Berlin (1970) recognized the "universalist evolutionary approach to semantics." The approach seeks to identify the universals of organization and development within various semantic domains, among them color and folk taxonomy (cf. Berlin 1972; Berlin, Breedlove, and Raven 1973).

Third, along the lines of this approach and under the stimulus of Berlin and Kay's study, Rosch (a.k.a. Heider) began her research on "category structure" as a test of the concept of "focality" in color naming (Heider 1971, 1972a-b; Heider and Oliver 1972). This work, reviewed under section 1.7.2., has yielded principles that profoundly affect semantic and linguistic theory (cf. Lakoff 1986), such as the prototype, gradations of category membership, and the basic-level category.

In spite of the seminal character of Berlin and Kay's study, its initial findings have warranted revisions and improvements. Some were motivated by the constructive criticism of the early reviews; others were produced by research that was directly stimulated by the original work. It has been shown that: (1) focal colors are not named by basic color terms one-by-one in a temporal order, but rather, at any time, a color naming system partitions all colors that can be perceived; the number of basic categories predicts which colors will be categorized under one name and which colors will not; (2) particular languages themselves need not be characterized by a single evolutionary stage, but rather individual speakers can represent different stages; (3) the predominant target of investigation is color categories rather than color terms; (4) color categories, like categories in other domains, have internal organizations that can be represented by a formal model; (5) the model can incorporate findings from the field of visual physiology. In detail, the revisions and improvements are as follows:

1.7.1.2. Color Ethnography after 1969

Berlin and Kay's publication was followed by six field studies of color categorization in specific languages, each based on data elicited with the Munsell materials: Dugum Dani, Stage I (Heider 1972a); Bellonese, Stage II (Kuschel and Monberg 1974); Binumarien, Stage IIIb (Hage and Hawkes 1975); Aguaruna, Stages IIIa-V (Berlin and Berlin 1975); West Futunese, Stages IIIa-VII (Dougherty 1975); Eskimo, Stages IV-VII (Heinrich 1974). They showed that, at any evolutionary stage, a color naming system designates all perceivable colors and that some color categories encompass more than one pure or "focal" color. Berlin and Berlin (*ibid.*: 84-5) emphasized this revision in reference to a green-with-blue or "grue" category of Stage IV:

> Finally, these new data may now allow us to restate the evolutionary progression of the linguistic recognition of the eleven universal perceptual color foci in a way which expresses the relationship of foci to one another assuming an original dichotomy of light-warm vs. dark-cool: (1) At Stage I, the warm-light category, encompassing the universal foci of white, red, yellow, brown, orange, purple, and pink, is lexically opposed to a category comprised of the cool-dark foci, black, green, and blue. High brightness greys are included in the warm-light category, low brightness greys in dark-cool. Foci for both of these two primordial categories are fluid and unstable, though we may now speculate that red tends to dominate WARM-LIGHT and that black tends to dominate COOL-DARK. This position would be in keeping with Heider's results for the Dugum Dani. (2) At Stage II, WARM-LIGHT begins to separate into two linguistically distinct categories. The original term for WARM-LIGHT becomes more restricted to high-brightness chromatic hues with white becoming focal. A new term emerges and becomes firmly established in focal red with extensions into the chromatic warm hues. Black continues to become focal for COOL-DARK, though it is still floating at this time. (3) At Stage III, two possible developments may occur: The COOL-DARK category may divide (Stage IIIa), leading to the emergence of GRUE. The ancient unity of black, blue, and green may still be recognized, however, by the extension of black into these cool chromatic hues. Focal GRUE may be either blue or green.
>
> The WARM-LIGHT chromatic category dominated by focal red may divide (Stage IIIb) leading to the emergence of yellow. The cool-dark category in Stage IIIb systems remains essentially unchanged from that of Stage II. (4) At Stage IV, Stage IIIa systems will encode GRUE, the latter finding a focus, as before, in either blue or green. (5) At Stage V, undifferentiated GRUE will divide. The new category may encode either blue (if green was focal in the GRUE period) or green (if blue was focal in GRUE). (6) At Stage VI, focal brown will emerge from the WARM-LIGHT category. (7) At Stage VII, focal purple, pink, orange, and grey will become encoded in no particular order.

Features of the foregoing revision are: (1) the use of 'light-warm', 'dark-cool', 'warm', and 'grue' or 'cool' to name the categories that contain three and two pure or

"focal" colors; (2) the recognition of "floating" foci in early-stage systems; (3) the assignment of primacy to pure red over pure yellow within the warm category and to pure black over pure green or blue within the dark-cool category; (4) recognition of Stages IIIa and IIIb, that either the dark-cool category can divide before the warm category or vice versa; (5) recognition that the focus of certain early-stage categories, such as "grue" or cool, can be assigned to either but not to both of the pure colors contained therein; as such a category divides, a new category will encompass its non-focal pure color(s); (6) acknowledgment of data showing that the cool category can become highly salient before a less salient dark-cool category retracts to just pure black; cool is adjudged to be basic on the salience criterion, although it is encompassed by dark-cool.

Kay (1975: 260) summarizes these revisions by representing the same early-stage categories with capital letters:

Categories:	WHITE BLACK	RED	GRUE yellow	yellow GRUE	green *and* blue	brown	purple pink orange grey
Stages:	I	II	IIIa IIIb	IV	V	VI	VII

...Stage I consists of two basic categories: WHITE, which includes white, very light shades of all colors, all warm colors, and may have its focus in either white, red, or pink and BLACK which includes black, some very dark browns and purples, all but the lightest blues and greens, and which probably has a variable focus in black and in dark greens and blues. At stage II RED is marked by a basic color term and includes all warm colors with the focus in English focal red; this stage represents no departure from stage II as described in Berlin and Kay (1969) except that RED can be considered to have come out of WHITE rather than to have emerged in part from WHITE and in part from BLACK. At stage III either the yellow focus is accorded a basic term (IIIb) or the category GRUE is accorded a basic term (IIIa). In the latter case the focus may be either in blue or in green or perhaps in both, but there is no evidence that in any language the focus of GRUE is in what we would call 'blue-green'. At stage IV, stage IIIa systems add yellow and stage IIIb systems add GRUE, so that all stage IV systems contain terms for WHITE, BLACK, RED, GRUE, and yellow, with foci as described for stage III. Then at stage V, GRUE is split into green and blue. Stage VI and VII remain unchanged from Berlin and Kay (1969) with the following reservation.... the possibility mentioned by Berlin and Kay (1969: 45) that grey may appear as a wild card is supported by new data.

Dougherty (1975), after conducting fifty interviews with the acetate mapping method on the island of West Futuna, adds eight refinements to the hypothesis of color-category evolution:

1. Color-category evolution is stimulated by culture contact, in this case between an outlying island culture and the world at large. Yet the innovation of new categories is selective, progressing within the constraints of the universal sequence. Berlin and Berlin (1975: 83) corroborate this observation.

2. The process of division can occur simultaneously in warm and cool ("grue") categories, although the division will be more advanced in warm than in cool (p. 81). In their actual evolution, the stages are not initiated in a discretely segmented sequence within the system of an individual.

3. Some individuals place dual foci in the cool category, thus recognizing the focality of both pure green and pure blue (pp. 47-8, 56). Most of them represent Stage IV. Dual foci accompany other complexities: (a) as the cool category divides, different individuals confine the original "cool" term to opposite colors, green or blue; (b) some individuals maintain dual secondary categories of green and of blue. Futunese differs greatly from Aguaruna.

4. "Basic categories" and "secondary categories" are overtly distinguished as constructs that are related by superordination versus subordination within a perceptual hierarchy (pp. 92-111). Berlin and Kay (*ibid.*) did not use the term "secondary category."

5. Color modifiers -- such as 'dark', 'light', 'pure', and 'off-' -- are recognized as worthy of study (pp. 127-41; cf. Lakoff 1973; cf. Hersh and Caramazza 1976).

6. A separately named category that encompasses a broad range of desaturated colors, a "desaturation category," is recognized and defined as pertaining throughout an ample core of the color solid that exceeds the English notion of "grey" (pp. 118-26).

7. Dougherty (pp. 142-204) analyzes data concerning the acquisition of color categories by Futunese children, and she synthesizes her results with those of five other studies of color-category acquisition (McClure 1974; Harkness 1973; Karpf and Lutz 1975; Istomina 1960; Catlan and Mervis 1975). She finds that the phylogenetic and ontogenetic sequences are partially parallel.[7]

8. Together Dougherty (1975, 1977) and Kay (1975) synthesized observations by Dougherty (1975), Harkness (1973), Kuschel and Monberg (1974), Heinrich (1974), and Berlin and Berlin (1975). They noted that individual speakers of particular languages varied among evolutionary stages; although each individual system independently matched predictions of the evolutionary hypothesis, a language in itself might not be ascribed to a particular stage.[8] The observation had five consequences: (1) Findings of color ethnography were linked with those of sociolinguistics that relate variation to change (cf. Weinrich, Labov, and Herzog 1968). (2) Variation between stages is the rule rather than the exception within the domain of color categorization. (3) A compilation of color terms from a language constitutes only a rough test of the evolutionary hypothesis; it is more closely tested against data that are separately elicited from individual speakers of a language. (4) The recognition of substantial differences among individuals leads to an advance in data analysis: Color data can be analyzed as they are aggregated or summarized

[7]This promising line of research has not been further pursued by color ethnographers. Nine preliminary interviews based on simplified MCS methods conducted by Daniel Wilcox among children of English speakers in a Dallas, Texas pre-school reveal that some young subjects fully comingle 'red' and 'yellow' terms and 'green' and 'blue' terms, suggesting warm and cool categories of the kind used by adult speakers of Futunese, Aguaruna, Bellonese, Binumarien, Tzeltal, and many other languages. Dougherty and the researchers whose work she synthesizes used different methods with other results (See also Valentine 1914; Staples 1932; Suchman 1966; Fijalkow 1972; Bornstein 1975b; Catlan, Mervis, and Rosch 1975; Peoples and Teller 1975; Bornstein, Kessen, and Weiskopf 1976; E. G. Johnson 1977).

[8]Berlin, Kay, and Merrifield (1985) advance the statistical concept that many languages have a "basic stage," that which is shared by a plurality, if not a majority, of speakers. Berlin (personal communication) writes "We may speak of the 'basic stage' of language-X, as exemplified by the most commonly used terms and various levels of agreement. At least 80-85% of the languages in the WCS... have an interpretable basic stage at 30% level of agreement.... in spite of the extreme...variation." The WCS approach is to isolate the prevalent pattern as the object of explanation. The MCS approaches the same variation with several hypotheses, all based on the same axioms, that account for the way that each individual categorizes color. It attempts to develop a unified theory that explains all data regardless of how widely they vary from a mean.

across individuals (cf. Berlin and Berlin 1975, figs. 2-26; Berlin, Kay, and Merrifield 1985) or as they are manifested by separate individuals (cf. Burgess, Kempton, and MacLaury 1983, figs. 1 and 7 *vs.* figs. 2 and 4; MacLaury and Stewart 1984).

McDaniel (1972, 1974; Kay and McDaniel 1978) and Zollinger (1972, 1973, 1976) independently adopted Hering's (1874 [translation 1964]) abstract, nineteenth-century model of color-vision physiology as an explanation of some ethnographically observed universals. Hering stipulated that three pairs of color sensations each couple one "arousing" and one "non-arousing" color, namely red and green, yellow and blue, white and black. Each pair is produced by a different one of three processes in the visual pathway. Since each pair is produced by one process, its constituent arousing and non-arousing colors are located at disjunctive intervals on the spectrum; they cannot be perceptually combined or identically named; nor can their names qualify each other as, say, "reddish green" or "bluish yellow." Further, each of the six sensations consists of a point of pure color that is perceived when its respective process is active -- in its arousing or non-arousing state -- and the opponent processes are inactive. For example, pure yellow does not contain the faintest trace of either red or green. Combinations of processes produce off-colors, as off-red, dark blue, or greenish yellow, and they produce evenly blended perceptions, as orange, purple, chartreuse, or pink.

Wattenwyl and Zollinger (1978, 1979, 1981) used medium-brightness Munsell standards to collect data from diverse languages. These demonstrate the presence of distinct color categories throughout the sample that uniformly correspond to the six pure sensations that are predicted by the Hering model. Bornstein (1975; Bornstein, Kessen, and Weiskopf 1976) showed that infants who have not yet acquired language, nevertheless, respond differentially to the four chromatic hues; infant-response to white and black was not tested.

Prior to the research on visual physiology of the last two decades (e.g., De Valois, Abramov, and Jacobs 1966; De Valois and Jacobs 1968), the Hering model was assumed

to conflict with other attested processes of color perception. The Young-Helmholtz tri-receptor theory specified that three types of cones within the retina emit distinct wavelength-dependent responses, whose combination accounts for the perception of all color (cf. Hurvich and Jameson 1955). However, De Valois and his associates isolated the neurological analogue of Hering's opponent processes at a higher point in the optic system. Between the retina and this post-retinal point, the tripartite responses of the three-cone system are reorganized into both opponent and non-opponent processes. The four chromatic sensations -- red, green, yellow, and blue -- derive from two pairs of opponent processes, and the achromatic sensations -- white and black -- derive from non-opponent processes.

De Valois and co-workers used microelectrodes to monitor single neurons in the lateral geniculate nuclei (LGN) of macaque monkeys, a species whose color perception is like that of humans. They isolated two sets of opponent cells, each set consisting of two cell-types. The types of each set fire at a basal rate when not stimulated, but are excited and inhibited in response to the stimuli of opposite members of one pair of colors; the excitation of one type sends to the cerebral cortex the same information as the inhibition of the other, and vice versa. Thus the cells of one set, consisting of types +R-G and +G-R, are excited (+) and inhibited (-) in response to cone inputs triggered by the wavelengths that are associated with red and green; +R and -R indicate responses that will result in red perceptions, +G and -G result in green. The cells of the other set, types +Y-B and +B-Y, are likewise stimulated by cone inputs triggered by the yellow- and blue-associated wavelengths. The opponent processes of the two sets of cell-types are abstractly diagrammed in Figure 1.8:

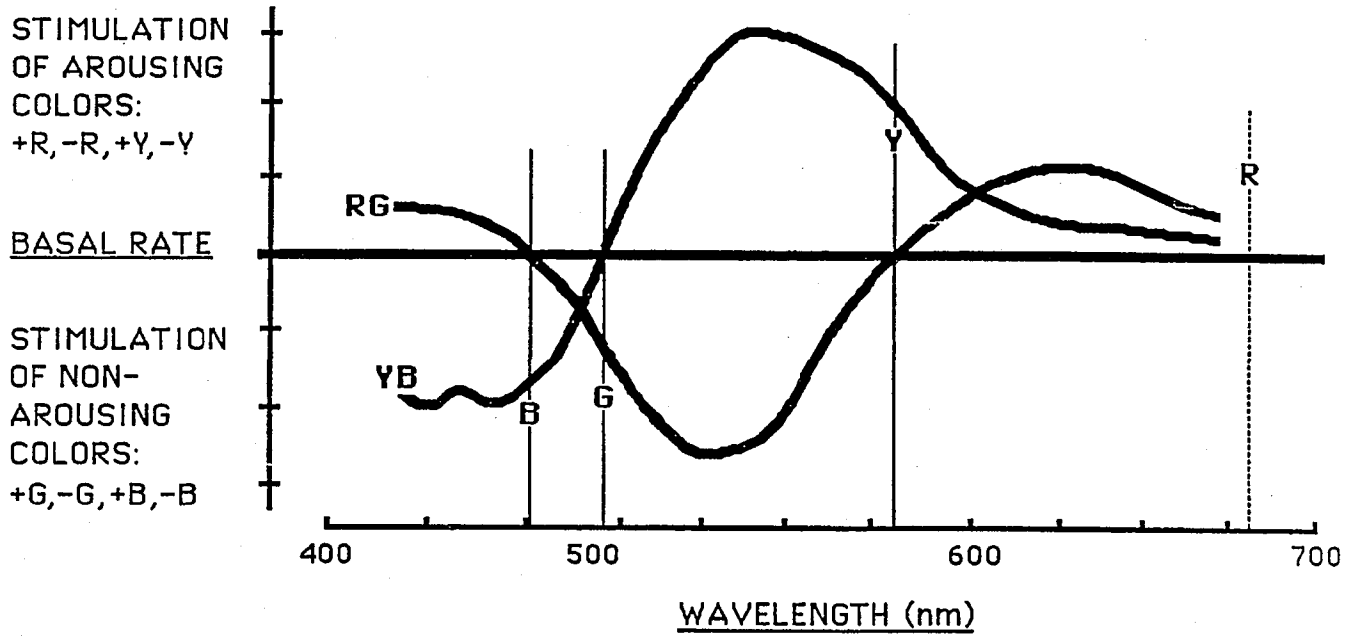


Figure 1.8. Opponent processes (reproduced from Wooten [1970] by permission of B. R. Wooten; cf. Kay and McDaniel 1978: fig. 5).

In Figure 1.8, the heavy horizontal line represents the basal firing rate, and the vertical scale represents increments of deviation from the basal rate that are provoked in each cell-type by particular wavelength stimuli. Wavelength is represented as a horizontal scale. The curves above and below the horizontal line depict the responses of cell-types that, in the cortex, will translate into oppositions between red, green, yellow, and blue; the curves do not differentiate excitation and inhibition. The vertical lines represent the four pure sensations, **B, G, Y, R**, which occur in response to wavelengths of 480, 510, 580, and 700nm. The vertical lines indicate that each of the four occurs when either cell-type of one set is stimulated and neither type of the other set is stimulated; the unstimulated set fires at the basal rate. The broken vertical line shows that pure red is extra-spectral and, thus, unperceivable; the purest perceivable red contains some yellow.[9]

[9] The color that is sometimes called "pure red" or "unique red" is only the purest red that humans can see. It is properly called "purest (perceivable) red" or "near-unique red."

De Valois and co-workers found that the macaque neural responses to white and black stimuli each involve different groups of cells and are, therefore, non-opponent. The sensations of pure white and pure black are stimulated by total reflectance and total non-reflectance, the presence and absence of reflected light:

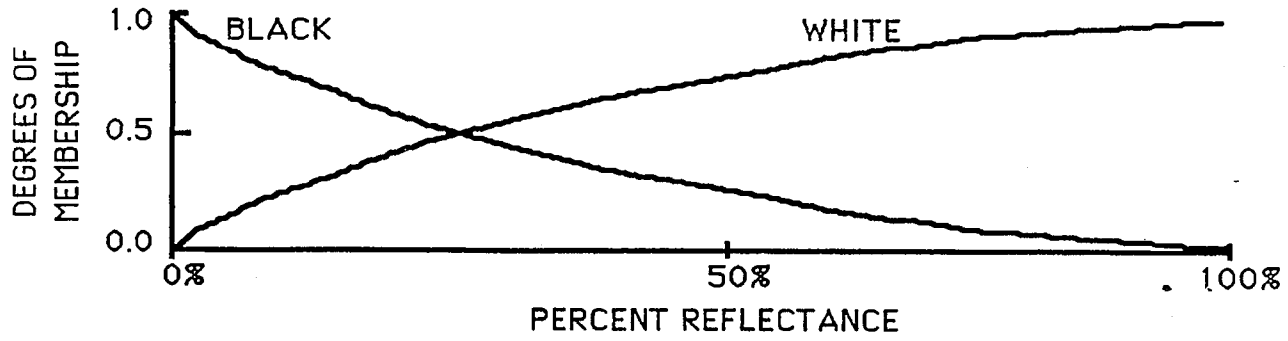


Figure 1.9. Non-opponent processes (reproduced from Kay and McDaniel [1978: fig. 7] by permission of the authors and the Linguistic Society of America).

McDaniel (1972, 1974) related the findings of De Valois and his colleagues to the observations of color ethnologists. He pointed out that the findings (1) suggest the physiological basis of the universally invariant pure sensations that constitute perceptual reference points of color categories, (2) explain why the colors within certain pairs, specifically red/green and yellow/blue, are never in any language encompassed by one category and identically named, (3) plot the outer-most margins of color categories at the pure colors of neighboring categories, and (4) allow for overlap and intergrading of categories between the pure colors. On these grounds, McDaniel made the original argument that any language, regardless of its stage of color-category evolution, will name all colors by encompassing each of the pure sensations within one or another of its categories; the evolution is always a progressive partitioning of the color space, never an encoding of previously unnamed pure colors one-by-one.

Kay and McDaniel (1975, 1978) modeled color categorization as three fuzzy-set logical operations on the six pure sensations. They derive their formalism from Zadeh's

(1965) "fuzzy-set theory," a calculus based on a decimal system that describes logical sets as graded in values of membership, as non-discrete, and as overlapping. It allows that some specific colors can have a degree of positive membership in more than one set, as, say, "red-orange" might be perceived to pertain to both the red category and the orange category. Thus, the fuzzy-set model accommodates such intuitively acceptable statements as, "Although mandarin red is a kind of red, it is not a very good red because it looks much like orange." Degrees of fuzzy-set membership range from 1.0 to 0.0. They are diagrammed as a bell-curve in Figure 1.10:

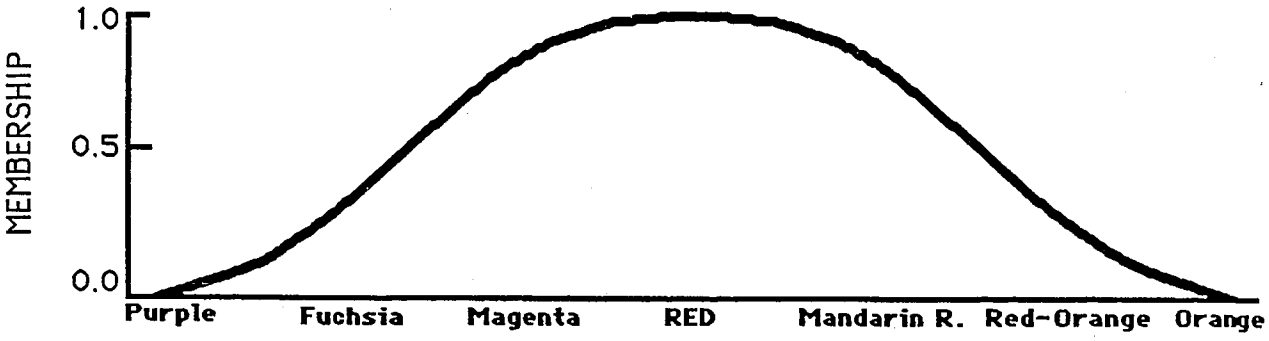


Figure 1.10. The fuzzy set of red in American English.

Kay and McDaniel's adaptation of the fuzzy-set model consists of eight parts:

1. Basic color categories are classed as three types -- "primary," "composite," and "derived" -- each of which is defined by a distinct fuzzy-set logical operation on the sensory reflexes of neural response to wavelength:

A *primary basic color category* contains just one of the six pure sensations. It is composed by what Kay and McDaniel call an "identity," a function whose input and output

are the same or, in other words, a one-to-one correspondence of a pure sensation and the category itself:

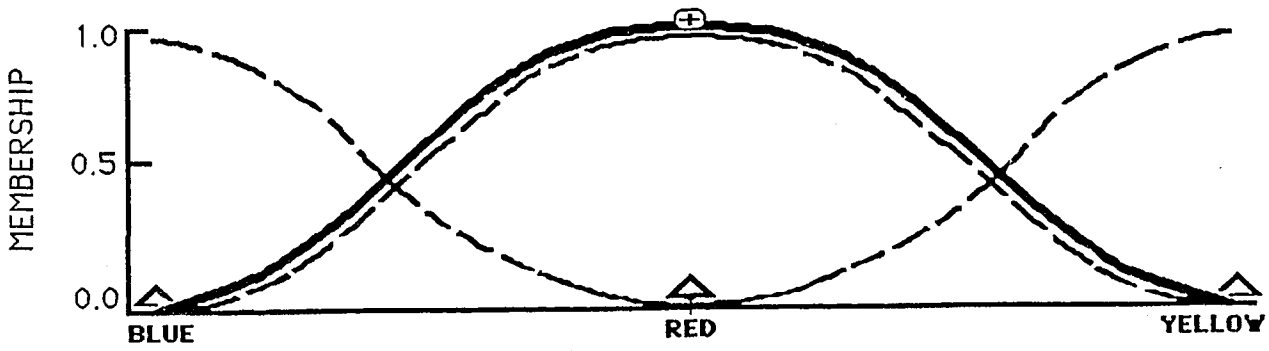


Figure 1.11. A primary basic color category.

In Figure 1.11, color perception is represented by a broken line and its categorization by a solid line. The pure or purest possible color sensations are represented as Δ. Maximum membership in, say, the primary basic red category occurs at the perception of purest red; values of membership gradually decrease toward the category margins as red intergrades with the perceptions of, for example, yellow and blue until the values reach a minimum of 0.0 at unique yellow and unique blue.[10]

A *composite basic color category* contains three or two of the six pure sensations. The most common composite categories are light-warm (white, red, yellow), dark-cool (black, green, blue), warm (red, yellow), and cool (green, blue). These are composed by the operation of fuzzy-set union, which is diagrammed in Figure 1.12 with the cool category as the exemplar:

[10]To simplify, Figure 1.11 represents the red category of a language that does not separately name categories of purple and orange. In English, the red category is not strictly a fuzzy-set identity; violet colors between maximum purple and blue cannot be called "red," even though they are perceived to contain a trace of red. That is, violet is not of the red category and cannot be named as such; nor can colors between maximum orange and unique yellow. See Figure 1.10.

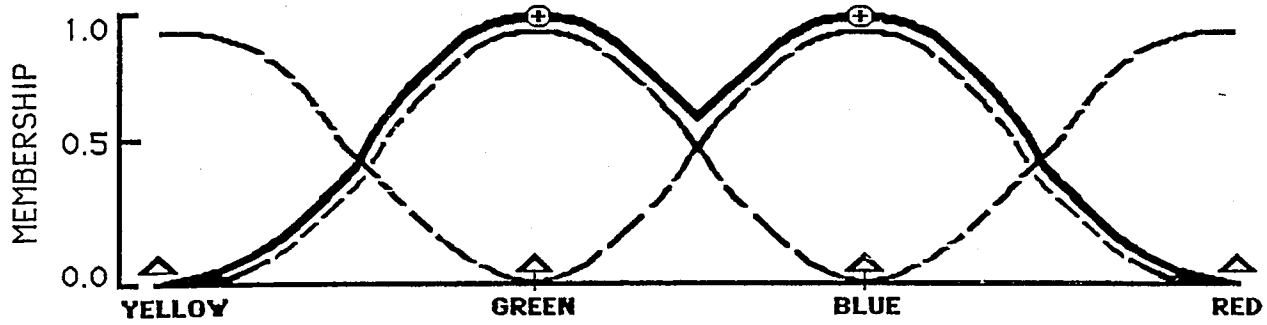


Figure 1.12. A composite basic color category.

According to this operation, a percept is a member of the cool category to the extent that it is ***either*** green ***or*** blue but not both green and blue. Maximum membership occurs at either green or blue, but the turquoise colors between green and blue are less than maximal members of the category; and the minimum value of membership occurs at the category margins where these approach other pure sensations, such as unique yellow and red.

The model, then, disallows highest membership between the pure sensations of any composite color category and, thus, is endowed with a bimodal contour in the case of warm and cool categories and with a trimodal contour in the case of light-warm and dark-cool categories; each pure color has a maximum membership value:

> ...In the experimental studies...(as B & K found for Tzeltal)...early-stage categories, including grue, are often multiply focused. In these studies, focal grue selections have often proved to be bimodal, being chosen from both focal blue and the focal green regions. But grue has never been found to be focused in the intermediate blue-green region... (Kay and McDaniel *ibid.*: 83).

Some of the data that Kay and McDaniel had at hand were: (1) Dougherty's (1975: 47-8, 56) observation that some Futunese speakers, most of them representing Stage IV, selected dual foci on both pure green and pure blue in a single cool category, (2) Berlin and Berlin's (1975: 72, fig. 9) observation that Aguaruna speakers, most of whom represent Stage IIIa, chose just one cool-category focus, almost always a blue, and (3) Berlin and Kay's (1969: 9-12) observation that 40 Tzeltal speakers each focused the cool category either in green or in blue but never in both and never between. Although Kay and McDaniel do not specifically address the prospect of dual foci, the bimodal model

predicts that a number of individuals of any sample would each focus any composite category on more than one of its constituent pure colors, as did some Futunese speakers. The differences between (1), (2), and (3) are not confronted.

A *derived basic color category* contains none of the pure sensations; rather, it consists of a blend or perceptual mixture of two pure colors without containing either color at its purest perception. Kay and McDaniel stipulate that the colors of derived categories are brown (yellow + black), purple (red + blue), pink (red + white), orange (red + yellow), and grey (white + black). The derived categories are composed by the operation of fuzzy-set intersection; however, Kay and McDaniel multiply the resultant values of membership by a factor of two:

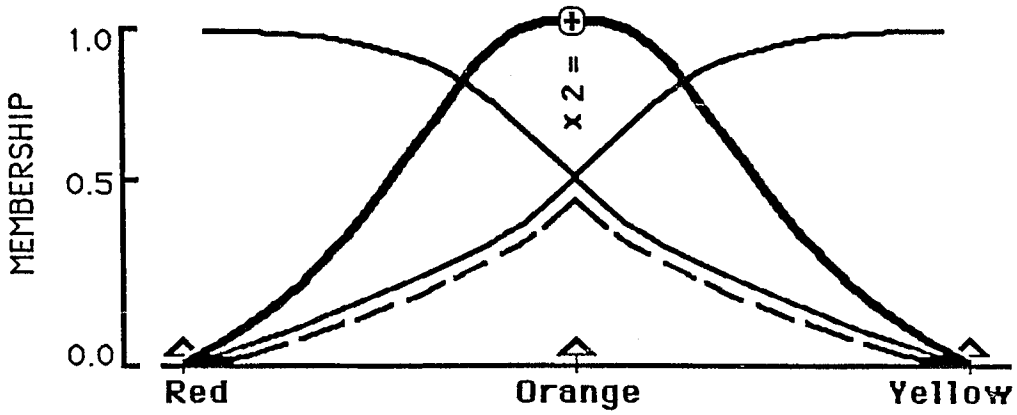


Figure 1.13. A derived basic color category.

The operation of fuzzy-set intersection entails that a color percept is a member of a derived category to the extent that it consists of both of the pure colors that compose the intersection; for example, in Figure 1.13, a percept is a member of the orange category to the extent that it is ***both*** red ***and*** yellow. Kay and McDaniel multiply this membership by two in order to represent the intuition that in a language, such as English, the highest membership value of any derived category is as high as that of any primary category; for example, an intense orange color is as distinctively 'orange' as is pure red or pure yellow

distinctively 'red' or 'yellow'. Also, the multiplication prevents subordination of a derived basic category by the neighboring primary categories whose pure sensations contribute to it.

The multiplication, in effect, distinguishes the cognition of a derived color category from the logic of its perceptual basis. Although Kay and McDaniel do not dwell on this distinction (cf. pp. 663-666), its implication is immense: *Color categorization need not mirror perception but rather can result from an interaction of perception and cognition.* Kay and McDaniel represent cognition to the extent that their model departs from the logical operations of Zadeh's fuzzy-set theory. Although color categories involve perceived fuzziness, they also involve cognition. But the latter is not captured by the straightforward application of fuzzy-set logical operations.

2. Kay and McDaniel's modification of fuzzy-set theory, thus, implies that (1) color categories are perceptually graded in reference to neurologically determined pure colors, and (2) at least some kinds of color categories are further shaped by cognition. Kay and McDaniel did not stipulate other cognitive processes in primary and composite categories; ample data were lacking at the time of their analysis. However, both implications (1-2) establish precedent for the central thesis of the present volume (cf. section 1.0., page 1).

3. The model generates fifteen possible basic color categories as the result of the three fuzzy-set operations: 1. light-warm, 2. dark-cool, 3. warm, 4. cool, 5. white, 6. red, 7. yellow, 8. black, 9. green, 10. blue, 11. brown, 12. purple, 13. orange, 14. pink, 15. grey. They are expressed according to the respective entailments as 1. white-or-red-or-yellow, 2. black-or-green-or-blue, 3. red-or-yellow, 4. green-or-blue, 5. white, 6. red, 7. yellow, 8. black, 9. green, 10. blue, 11. yellow-and-black, 12. red-and-blue, 13. red-and-yellow, 14. red-and-white, 15. black-and-white. Since the fuzzy-set intersection is modified, Kay and McDaniel express its entailment, that of 11.-15., as "+" rather than as "and."

4. Kay and McDaniel acknowledge linguists' reports of another composite category that contains yellow-or-green (cf. Kay 1975: 260-61). They also suggest that the fuzzy-set model might allow additional basic categories, such as chartreuse, maroon, and turquoise, which so far are unobserved; there is no specification of an inborn limit upon the the number of basic categories with which humans can distinguish color. They do not acknowledge further allowances of the model: categories encompassing all of white and green, yellow and green and white, black and red, yellow and red and black, or white and black; there is no suggestion of why these have never been observed. Nor do they stipulate that a category encompassing red and blue would never occur because the purest perceivable red contains yellow, the opponent color of blue.[11]

5. The fuzzy-set model integrates four major accounts: (1) McDaniel's (1972, 1974) and Zollinger's (1972, 1973, 1976, 1979) adoption of the Hering model; (2) the coupling of the Hering model with De Valois and co-workers' findings in visual physiology; (3) Rosch's concept of "category structure," reviewed under section 1.7.2., as gradations of family resemblance between category members and an exemplary prototype; (4) Sternheim and Boynton's (1966) experiments in perceptual psychology. This work showed that English-speaking subjects perceived derived categories to combine adjacent pure sensations, but they perceived the pure sensations to be unique.

6. The fuzzy-set model facilitates expression of the universal order of color-category evolution: Composite basic color categories first divide into primary basic color categories before derived basic categories emerge. In detail, light-warm divides into white

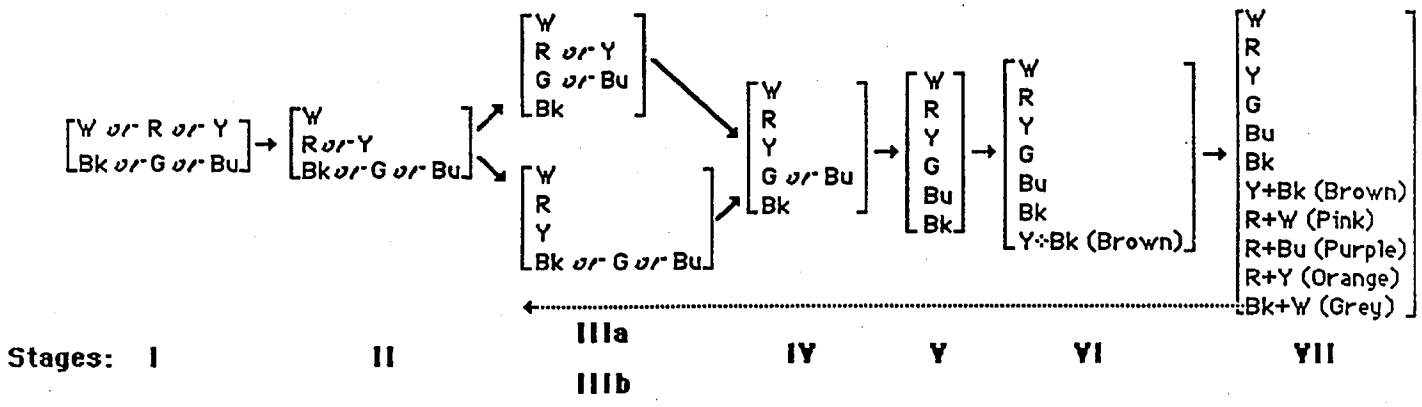
[11]A category encompassing yellow and green has been substantiated with Munsell colors among languages of the Pacific Northwest (MacLaury 1986, 1987); in that area, the category has been innovated at Stage IIIa by transferring a warm category from red to green on the pivot of a yellow focus, and at Stage IV by transferring a cool category from blue to yellow on the pivot of a green focus. Berlin and Berlin (1975: figs. 5-7) document a non-basic 'yellow, green' term in Aguaruna, which suggests an avenue by which such a category can enter a system from a stage earlier than IIIa. The MCS and WCS reveal a purple-focused category of blue and purple (MacLaury and Stewart 1984; Berlin, Kay, and Merrifield 1985). Both surveys have also turned up isolated uses of a white focused term that extends to black; however, in any language observed, the white-with-black usage coexists with a 'black' term. All speakers know a black-focused term or at least a dark-cool term, even though some name black with the white-focused term (cf. Figure 8.40e). Volume II of the MCS analysis reviews evidence of a "light blue" basic category, first entertained by Berlin and Kay (1969: 35-36).

and warm before dark-cool divides into black and cool; warm divides into red and yellow before cool divides into green and blue. Brown emerges before any of the other derived basic color categories, except sometimes grey; both brown and grey can emerge before all of the composite categories have divided, although none of the other three derived categories can so emerge. The other three evolve last and in any order among themselves. Kay and McDaniel omit from their depiction evolution of brown prior to Stage VI:

Table 1.3

The Revised Sequence As An Evolution Of Fuzzy Sets

(reproduced from Kay and McDaniel [*ibid.*, fig. 13] by permission of the authors and LSA)



7. The fuzzy-set model provides for the complete partition of the color space by any of the combinations of basic color categories that are allowable within the constraints of the universal evolutionary sequence; at any stage, every color is categorized and named.

8. The fuzzy-set model simultaneously accounts for category foci and boundaries and, thereby, supersedes the awkward requirement to separately address foci and boundaries that had encumbered earlier models of color categorization.

In sum, Kay and McDaniel made three major contributions: (1) They related a neurological model of color perception to ethnographic data. (2) They used the model as a basis for distinguishing different kinds of color categories. (3) They suggested that, at

least in the derived category, cognition and perception are not the same; but, nevertheless, perception and cognition conjointly compose categorization, at least in that context.

Burgess, Kempton, and MacLaury's (1983) study of Tarahumara color modifiers represents progress in the direction suggested by Kay and McDaniel. The study is the first exhibition of the descriptive and analytical methods attained during the Mesoamerican and World Color Surveys: evidence based on *correspondence* between direct mappings, modifier distributions, foci, and ranges of color-term roots; fine-grained quantification; a distinction between individual and aggregated data. The result of these methods shows that cognition and perception differ within composite and primary basic color categories in ways that are as substantial as that which Kay and McDaniel postulate for derived basic categories. Obligatory Tarahumara modifier usages and mapping data separately substantiate graded structure in composite and primary categories, but these and other data show that all such categories from a sample of 15 individuals are skewed to differing extents; the skewing increases in correlation with independent evidence of advancing category division. Although this account does not link category division and skewing to specific cognitive axioms, it indicates the need of an explanation along such lines. In this way, the Tarahumara modifier study is transitional between the groundwork established by Kay and McDaniel's fuzzy-set formulation and the central thesis of the present volume (cf. section 1.0., page 1).

Kay and McDaniel's (1978) analysis implicitly marks the limit to which an understanding of color categorization can advance without a large sample of data and without a more thorough descriptive method than acetate mapping. Apart from Burgess, Kempton, and MacLaury's forerunner of work that until now has been in the research stage, other highly focused studies have followed the flurry of breakthroughs produced during the mid-1970s. In the interim, research has progressed in the laboratory and the

field.[12] Under the World Color Survey and the Mesoamerican Color Survey, color categorization has been described more extensively than during any period within the 130 years of scientific interest in the topic. The analysis of the Mesoamerican data represents the first in a series of planned reports on the findings of the surveys.

1.7.2. Category Structure

The analysis of Mesoamerican data closely pertains to a theory that was developed by Rosch (a.k.a. Heider) and her associates in cognitive psychology. The research began with investigations of Berlin and Kay's claim concerning the universality of basic color-term foci. Its original intent was to further explore the question of semantic universals versus linguistic relativity. However, the constructs that accrued from this and subsequent work now compose a theory of categorization. Its unifying implication is that categories are internally structured according to principles that do not conform to the set theoretic concept that has pervaded the 2000-year development of Western thought. The theory includes the notions of the prototype, the perceptual or natural category, graded values of category-membership, family resemblances and complexivity, the basic level of categorization, and, recently, a retrenchment and research program that some have called "prototype effects (cf. Lakoff 1986)." The mainstay of Rosch's contribution is her replicable experimentation through which she tests a single hypothesis in numerous

[12]Other contributions involving original experiments or field work are: Cairo (1977); Caskey-Sirmons and Hickerson (1977); Bolton (1978); Ember (1978); Thomas, Curtis, and Bolton (1978); Bolton and Crisp (1979); Callaghan (1979); Forbes (1979); Lucy and Shweder (1979); Vallier (1979); Bolton, Curtis, and Thomas (1980); Kristol (1980a,b); Mervis and Roth (1981); Crawford (1982); Iijima, Wenning, and Zollinger (1982); Zimmer (1982); Sun (1983); Zollinger (1984); Kinkade (1986); Greenfeld (1987). Berlin and Kay (1969: 149-51) review Wijk's (1959) hypothesis that ethnic differences of color categorization are caused by the intensity and angle of sunlight at different latitudes. Bornstein's (1973, 1975) hypothesis -- that such differences in sun-light condition differences in intraoccular pigmentation that, in turn, cause latitudinal differences in color categorization -- can be matched against the discussion concerning the disadvantage of short wavelength cones, section 2.1.1.1. Bornstein does not explain why one vague and one distinctive percept, such as blue and green, would be more difficult to distinguish than two distinctive percepts, such as red and yellow.

paradigms, such as learning, recall and memory, matching, use of linguistic hedges, distance judgment, rating and ranking, reaction time, example production, and others.

Kempton (1981: 1-23) relates Rosch's concepts of family resemblances and the prototype to long-established semantic principles, such as taxonomy, paradigm, and distinctive features; these constituted major constructs of approaches that were pursued under the rubrics of "ethnoscience" and "cognitive anthropology" (cf. Tyler, ed. 1969) prior to Rosch's research. Lakoff (1986), in turn, applies Rosch's program concerning prototype effects to numerous "cognitive models" regarding semantics and linguistic syntax. He demonstrates the seminal extent to which Rosch's theory of categorization crosscuts the concerns of linguistics, philosophy, cognitive psychology, and anthropology.

1.7.2.1. Focal Colors

In her first series of experiments (Heider 1971, 1972a-b; Heider and Oliver 1972), Rosch demonstrated that the eleven "focal colors" that Berlin and Kay (*ibid.*) had stipulated to be universal were perceptually prior to their categorization in language. This finding superseded claims by Brown and Lenneberg (1954), who -- after observing correlations between codeability and memorability of colors -- asserted that codeability enhanced memory. Rosch showed that both codeability and memorability correlate with the extent to which a color is universally distinctive. Her experimentally derived evidence of maximally distinctive colors concurred with Berlin and Kay's claim of universal foci. It reinforced the argument against the strong version of the Whorfian view that language determines thought and perception.

In brief, Rosch's initial experiments consisted of naming, learning, matching, and both long- and short-term memory tasks. These were performed by speakers of different major languages, by three and four year-old English speaking children who had not fully developed color naming, and by individual speakers of Dani, a language of New Guinea, who during prior interviews named just two color categories: light-warm and dark-cool of

Berlin and Kay's Stage I. The Dani subjects were screened for their lack of secondary categories that might contain single pure colors.[13]

In sum, both Rosch's notion and Berlin and Kay's notion of "focal colors" embodies the view that the foci of color categories are universal and, hence, probably determined by visual physiology. As a matter of formal theory, neither Rosch nor Berlin and Kay distinguish such colors from those that individuals select as best examples of

[13]Rosch (Heider 1972a) accompanied her initial experiments regarding universal focal colors with a description of Dani color categorization *per se*. In addition to basic light-warm and dark-cool categories, some Dani speakers used combinations of other categories or terms: they were either red-focused, yellow-focused, and blue-focused secondary categories or minimally salient near-synonyms for light-warm and dark-cool. The foci of the light-warm and dark-cool categories, reproduced here (from Heider *ibid.*, Table 2), show foci that appear to "float" and that, consequently, do not fully conform to the contention of universal foci, that held by Berlin and Kay and by Rosch:

Table 2. Distribution of "best example" choices for *mili* and *mola*.

Brightness	*Hue*																			
	5R	10R	5YR	10YR	5Y	10Y	5GY	10GY	5G	10G	5BG	10BG	5B	10B	5PB	10PB	5P	10P	5RP	10RP
Distribution of mili *exemplars*																				
9/													1							
8/																				
7/																				
6/																				
5/																				
4/																				
3/											1	1			2					
2/							1	4	2	5	8	2	3	4	4	1				1
Distribution of mola *exemplars*																				
9/	1	2		2					1				1	1	1					3
8/																				
7/	1																			
6/	1																			
5/				1																7
4/	5		1														1	2		4
3/	1																2	1		1
2/																				

Note. -- Numbers represent the number of Dani informants who chose that chip as the best example of that colour name. Numbers do not equal 40 because some informants chose pure "black" or "white."

For an explanation of the pattern among Dani foci placements, see footnote 5, Chapter VII.

categories, even though Rosch reported *floating foci* and labelled them "best examples" (See footnote 13);[14] focus selections that deviate from "focal colors" are random.

1.7.2.2. The Perceptual Category

Rosch (1973a-b, 1974) contrasts the "perceptual category" and the "semantic category." Perceptual categories, such as those of color, shape, and facial expressions, "develop around perceptually salient natural prototypes." The structure of semantic categories, such as those of 'fruit', 'bird', 'science', 'sport', or 'vehicle', are non-perceptual; however, they are structured as are perceptual categories: "By structure is meant that categories possess a core meaning (or focal examples) and that instances of categories differ in the degree to which they fit the core meaning or are like the focal examples (1973a: 140)."

This contrast is based on the results of experiments that involved learning tasks among the Dani and that involved judgments by Americans concerning goodness of example in both superordinate and subordinate categories. The Dani were especially apt subjects because they did not have specific words for the "categories" of colors and shapes -- or, at least, the arrays of percepts -- that they were required to learn and to name with kinship or "sib" terms.

The notions of perceptual and semantic category do not involve a deliberate distinction between perception and cognition; and the "perceptual category" implies that its semantic structure is perceptual structure with no modifying intermediation of cognition. Cognition is not addressed in regard to semantic categories.

The construct of "core meaning"..."surrounded" by other category members of decreasing similarity to the core meaning is used interchangeably with "prototype," which Rosch introduces for the first time (1973a: 113):

[14]Berlin and Berlin (quotation on page 26) coined "floating foci" to describe Rosch's data.

1.7.2.3. The Prototype and Analogue Structure

Although the "prototype" was equated with "core meaning" in earlier work, the concept is further developed as a "cognitive reference point" to which other stimuli in a category are asymmetrically related (Rosch 1975a). That is, non-reference members of a category are judged to be more similar to reference members than the reverse. This is so, apparently, because the reverse comparison contradicts the asymmetrical direction in which the relationship between a non-referent stimulus and the prototypical referent is usually assessed. The asymmetry constitutes the analogue or graded structure of a category. Rosch supports this claim with the results of experiments that involve frames containing linguistic hedges or that require subjects to make spatial approximations to fixed stimuli. She demonstrates reference points of pure colors, line orientations, and decimal numbers.[15]

The view that a category is composed of a prototype and graded structure countermands the Aristotelian notion of a category as a discrete cell, which is fundamental to classical logic, syllogistic reasoning, Boolean set theory, and conventional views of disciplined thought. With this research (1975a), Rosch departs from an emphasis on experiments that involve the color domain and argumentation against linguistic relativity. Although some of her future work concerns color, much of it focuses on other domains to explore general principles of categorization. The shift away from countering relativism and toward formulating a universalist theory coincides with further conceptual advance:

1.7.2.4. Family Resemblances

Rosch and Mervis (1975) enhance the concepts of prototype and analogue structure with Wittgenstein's notion of "family resemblances." A prototype is the member of a

[15]The work on "reference points" foreshadows the concept of "vantage point," introduced in Chapter V of the present volume. Rosch (1975a: 546) writes, "...a landmark is a...reference point which people use to navigate through the environment...through cities.... It would not be surprising if judged distances between locations in a city and landmarks were asymmetrical... And people in everyday life may well navigate through those distances as if they were asymmetrical. If the use of reference points is a general cognitive strategy it should be applicable in many domains of human activity."

category with the most attributes in common with other members and least attributes in common with other categories; a non-prototypical member pertains to a category to the extent that it shares attributes with the prototype; distinct members of one category can share different sets of attributes with the prototype and, thus, need not resemble each other. The notion of family resemblances differs from "distinctive features," as no particular minimal set of attributes must be shared to constitute membership; membership is a matter of degree that depends on the number of attributes shared. Evidence of this principle consists of the results of six experiments that involve prototypicality ratings, negative attribute correlations, and learning and identification speeds.

Prototypes as bundles of attributes are viewed as "natural correlational structures of the environment," that is, perceptually salient and natural points of maximal contrast. This view is compatible with the "perceptual category"; under both concepts, category structure mirrors the way that the world is seen objectively; no cognitive intermediation is specified.

1.7.2.5. The Basic Level of Categorization

The notion of a basic level transfers the family-resemblances concept to heirarchically ordered domains (Rosch et al. 1976): the basic level within a taxonomy of categories is the most inclusive level on which prototypes possess significant attributes in common with non-prototypical members and share least attributes in common with the members of other categories; it is the highest, most inclusive level of maximum contrast. Above the basic level -- on the superordinate level -- prototypes share fewer attributes with category members and more attributes with members of other categories. Below the basic level, prototypes share much with each other via their subordination to the basic level. Rosch's taxonomic basic level corresponds with Berlin, Breedlove, and Raven's (1973) folk generic biological taxa, which is first to evolve and is simplest nomenclaturally (cf. Berlin 1972). The basic level seems to be that on which humans most easily perceive, distinguish, and conceptually manipulate their natural surroundings. The basic level of

categorization, like "category structure," mirrors the way that the world is seen straightway without intervention of cognition.

Rosch et al. (*ibid.*) do not relate "basic level of categorization" to Berlin and Kay's "basic color category." It is unresolved whether composite, primary, or derived basic color categories constitute the basic level.

In other publications, Rosch treats additional questions concerning the prototype, family resemblances, and the basic level of categorization (1975b-e; Catlin, Mervis and Rosch 1975; Rosch, Simpson, and Miller 1976; Mervis and Rosch 1981). Palmer, Rosch, and Chase (1981) introduce the concept of a "canonical perspective." Rosch (1983) further employs the prototype in accounts of situational logic and everyday reasoning, and she (1977) summarizes her work through 1976.

1.7.2.6. "Prototype Effects"

Rosch makes sparing use of the phrase "prototype effects" (e.g., 1978: 38, 1983: 74, 82), although the non-explanatory nature of the prototype and of analogue structure is extricable from lengthy passages of her later work (e.g., 1978: 38-43). Lakoff (1986) extensively uses the phrase in a discussion of the passages. In those, she disclaims misleading implications of her prior findings, six of which are especially relevant to the analysis of Mesoamerican color-category data: (1) Prototypicality and its correlation with category structure is neither a model nor a theory of category cognition..."cognitive representation." (2) Although prototypicality obviously has some place in such a model, it is not clear what the relationship is. (3) There are no prototypes, but only judgments of degree of prototypicality; there is not an entity or construct but rather a behavior. (4) Models of "process, representation, and learning" must be constrained by the known facts about prototypes. (5) Prototypes need not wholly depend on bundles of attributes that are perceived to inhere in the real world; they can depend, instead or in part, on systems of cultural knowledge, "culturally defined events in which objects serve as props."

(6) Category formation can involve laws of cognitive economy and can involve definition of categories within systems in terms of contrast with each other.

In short, Rosch concludes a magnificent block of work by recognizing that a theory of categorization must incorporate both perception and cognition. This proposal is the point of departure for the present account of data from Mesoamerica.

1.8. Summary

During the Nineteenth Century, some investigators posited evolutionary regularities among the diverse ways that exotic languages categorized color. But others proposed racial explanations. The new-found concept of natural selection was untested against linguistic and ethnographic observations, which encouraged many to classify races, languages, and cultures according to a unilineal scheme in which Western culture represented the pinnacle.

Relativism emerged with the Twentieth Century. Anthropologists rejected unilineal evolution in favor of cultural determinism. Some sound nineteenth-century work on color-category evolution was blindly jettisoned together with the indefensible and the ethnocentric. Since color categorization differed between cultures, it came to be regarded as a canonical example of the extent to which language and culture could shape world view.

In response to extreme relativism, Berlin and Kay argued that perception shaped color categorization, causing both synchronic and diachronic regularities. Rosch and others supported and expanded the work with the results of controlled experiments. With an eye toward countering relativism, they emphasized replicable measurement, neurology, and invariant perceptual universals. Kay and McDaniel followed suit with a model based on a derivative of classical logic.

However, the anti-relativist position was weighted so strongly toward perception and logic that cognition was not addressed. The following chapters continue the unbroken line of research by turning attention to the cognitive side of color categorization.

In brief, it is found that perception and cognition are equally important. Perception is invariant and, thereby, accounts for universals. Cognition is mutable and accounts for variation and change. Further, the treatment of cognition employs principles of relativity, such as reciprocally related coordinates, vantages, and continuous frames of reference. These, in turn, account for statistically significant correspondences among independently elicited data, within and between languages. However, the principles derive from the Specific and General Theories of Relativity regarding physics, according to which every event occurs in relation to a constant; they have nothing to do with the Whorfian notion of relativity, according to which conventions are arbitrary and unrelatable between cultures.

Chapter II

Extended Abstract

2.0. Preface

The central thesis of this work is that color categorization is as much cognitive as it is perceptual; observations that pertain to color categorization will be most thoroughly explained and united by hypotheses that are built up from a combination of cognitive and perceptual axioms. The axioms are outlined under section 2.1., the hypotheses under section 2.2.

2.1. Axioms

The hypotheses that are developed throughout Chapters IV-X of Volume I are based on just four axioms. Three concern perception, and one concerns cognition. However, the four are part of a larger set of five perceptual axioms and three cognitive axioms; the total of eight conjointly constitute the basis of a comprehensive theory of color categorization, which is developed throughout Volumes I and II. The four axioms that concern the present volume are listed in sections 2.1.1. and 2.1.2. together with those that pertain only to the second volume. Section 2.1.3. briefly acknowledges a relationship of "motives" to axioms. Section 2.1.4. isolates the four axioms that will be used immediately and describes how they tie together.

2.1.1. Perceptual Axioms

Color perception consists of sensation that is produced when the visual cortex responds to processes that have originated in the retina and optic nerve. Although other notions of perception include phenomenal interplay of sensation, cognition, and memory, this account regards perception as elemental sensory reflexes in the cortex of precortical events. Color perception includes the following, which is set forth as five axioms:

1. Normal humans sense six pure or almost pure colors; they are the purest examples imaginable of white, black, red, yellow, green, and blue. The six comprise fifteen possible pairs. Two pairs contain antagonistic colors: red/green, yellow/blue. Since yellow and blue are antagonistic and since the purest perceivable red is slightly yellowish, red and blue are antagonistic to that same slight degree.

2. The two pure sensations within each of the fifteen pairs are to some extent similar and to some extent distinct.

3. Similarity and distinctiveness differ in magnitude among each pair; for example, the colors within each antagonistic pair look very distinct, red and blue also look distinct, red and yellow look less distinct and more similar, and green and blue look more similar still.

4. The different pure sensations can intergrade or overlap with each other. The overlaps constitute blended colors, such as brown, purple, pink, orange, grey, and others.

5. Brown and purple each consist of an overlap of more pure sensations than pink, which in turn consists of more than orange and grey. Blends can be constituted by an overlap of two, three, or four pure sensations, each of which contributes by a different proportion.

There is one further assumption: *The five axioms apply universally.* Color perception is entirely determined by physiology. The physical mechanisms are shared throughout the human species. Consequently, the axioms pertain identically to all normal observers, allowing for a small range of non-anomalous variation. The sameness imposes strong

constraints on color categorization in every language and in every individual system. The constraints produce universals of color categorizing behavior.[1]

2.1.1.1. Evidence of Perceptual Axioms

The first three axioms will be used throughout Chapters IV-IX. They are supported to different extents by findings from visual physiology. Axiom #1 concerning the six pure sensations is consistent with the opponent process model and the research of R. De Valois and his co-workers, as is explained in section 1.7.1.2., Figure 1.8. Axiom #2 follows from axiom #3, but #3 requires evidence. This is available from two sources. The weakest source concerns the measurement of "discrimination distance" between pure colors. The strongest concerns the contributions of retinal photopigments to response of LGN cell-types, as is summarized by De Valois and De Valois (1975) and Ratliff (1976). However, this evidence bears specifically on deficient discrimination between green and blue. For the purposes of Chapters IV-IX, the findings afford a modified but very specific version of axiom #3: green and blue appear more similar to each other than do red and yellow or yellow and green.

But the research has yielded nothing concerning the relative perceptual distances between the other 12 of the 15 possible pairs of pure colors, notably those that include

[1]The physiological mechanisms of color vision are precortical and, hence, beyond the reach of feedback from, or modification by, activity within the cerebral cortex:

Photochemical reactions in the retina and neuronal firing in the lateral geniculate nuclei (LGN) transform distal stimuli of radiant energy to proximal stimuli. But both orders of stimuli originate prior to detection in the visual cortex and, hence, prior to sensation, conscious or unconscious. Even though neural signals fire within the body, they are as external to experience as are the wavelengths that initiated them.

Experiments with decorticalized monkeys emphasize the lack of reciprocity between the precortical mechanisms and cortically mediated sensation. Hull (1967) nullified the cortex of monkeys of all receptive activity by means of both anesthesia and cooling; yet she found that the cones and the LGN cells continued to respond in their normal manner to light of all wavelengths as it was directed on the retina; peripheral physiology automatically sent impules to an unreceptive cortex.

On reaching the cortex, neural response triggers reflexes that are detected as sensation. Again, the sensory reflexes are automatic and -- within a narrow tolerance of individual variation -- universal. The reflexes themselves constitute perception, although they derive directly from neural outputs that, in turn, are invariant transformations of events in the external world.

In this manner, the external world is directly sensed. Although color perception differs between, say, a frog, a cat, and a human, each perceives wavelength in the direct manner for which it is equipped. After perception has occurred, within a time span so short that it might be immeasurable, color perception and cognition interact.

either black or white or both. Since that part of axiom #3 remains unsupported, only the part regarding green/blue and red/yellow is used as a foundation for hypotheses. The following reviews (1) the weak evidence concerning the direct measurement of discrimination distance and (2) the strong evidence concerning retinal mechanisms:

1. Discrimination Distance. There is a way to measure relative similarity among pairs of pure colors, although it might not be reliable for the present purpose. Wyszecki and Stiles (1967: 450-501, esp. Table 6.3) construe color differences as a combination of differences in brightness and in "chromaticness," hue and saturation at one level of brightness. These are expressed in terms of "just noticeable differences" or JNDs. A JND is the smallest difference that an individual can detect between two nearly identical colors. The methods of determining JNDs from paired comparisons is reviewed by Torgerson (1958). There are various scales and formulae for calculating the number of JNDs between distinct points of color. Wyszecki and Stiles (*ibid.* 460-61 [6.3.7.]) recommend the "1964 CIE-(U*V*W*) system." Kempton developed a computer program that uses the system to calculate discrimination distances as the number of JNDs between any two colors within all but the lightest and darkest levels of the Munsell solid.[2] Each Munsell color is specifiable by its tristimulus values, which are provided by Newhall, Nickerson and Judd (1943) and by Wyszecki and Stiles (*ibid.* 488-500).[3] The discrimination distance between almost any two Munsell colors is obtained with Kempton's program by entering the tristimulus values for each color. This was done for four specific color chips among those that were used during the Mesoamerican interviews, the four that most approximate the purest sensations of red, yellow, green, and blue.[4] Each of the four

[2]Willett Kempton's program is called DISCRIM.DIST, and sometimes DD. It is stored on a full dump tape labelled "Semantics," 22 October 1980, at the Quantitative Anthropology Laboratory, University of California at Berkeley.

[3]The tristimulus values of a color are the relative amounts of three primaries, specified by the CIE, whose mixture will match it exactly. See section 1.5.

[4]The aggregate of focus choices from all color categories of the Mesoamerican sample show that these four colors were chosen with highest frequency among those that English speakers call 'red', 'yellow', 'green', and 'blue'.

is specified with its (a) English name, (b) row-letter/column-number, (c) Munsell symbols, (d) tristimulus values, Y, x, y: **1.** (a) red, (b) G2, (c) 5.0R4/14, (d) Y =.1200, x =.5734, y =.3057; **2.** (a) yellow, (b) C9, (c) 2.5Y8/16, (d) Y =.4957, x =.4800, y =.5910; **3.** (a) green, (b) F17, (c) 2.5G5/12, (d) Y =.1977, x =.2385, y =.5071; **4.** (a) blue, (b) F29, (c) 2.5PB5/12, (d) Y =.1977, x =.1793, y =.1894.

The discrimination distances obtained between the colors of the three non-antagonistic pairs support, at least, part of axiom #3: green/blue = **83.63**; red/yellow = **222.92**; yellow/green = **234.58**.[5] Red and blue are not antagonistic as are red/green and yellow/blue, but red/blue is considered with the full antagonisms because the purest perceivable red is yellowish:

The discrimination distances obtained between red and green and between red and blue are unpredictably close: red/green = **156.21**; red /blue = **123.62**; yellow/blue = **280.87**. That is, the distances do not conform to what might be inferred from the opponent process model, that colors of either antagonistic pair, as well as red/blue, would appear exceptionally distinct.

Although calculation of JNDs is accurate at close distance, it might be inaccurate at the distances assessed here. Moreover, distinct strategies of calculation would produce conflicting results, as would, for example, calculating distances over the surface of the solid versus calculating Euclidian distances through the solid. It is difficult to justify the use of the Munsell solid as opposed to the psychological solid (cf. section 1.4.), and it is difficult to justify using any particular level of saturation in either solid. Sun (1983) used a different formula to calculate Euclidian distances through the psychological solid between unique hues saturated to a theoretical maximum. He arrived at discrimination distances that are greater between green and blue than between red and yellow.

[5]These distances conform to the empirically established regularities of color-category evolution: Languages that use the cool category of green and blue are more numerous than languages that use the warm category of red and yellow; languages that use the yellow-with-green category are the rarest (MacLaury 1987). All languages that use a basic warm category also use either a basic cool or a basic dark-cool category. Regarding basic categories of two pure colors, the shorter the discrimination distance between the colors the more common will be the category among the world's languages.

2. Disadvantage of Short-Wavelength Cones. Strong evidence concerns the contribution of different cone-types to discrimination among paired colors; it indicates that green and blue are perceived to be more similar than any other chromatic pair. The discrimination of green and blue relies on a change in the output of short-wavelength cones. Yet this cone-type, in comparison to others, is slow to respond to stimuli, is peripherally distributed on the retina, and is sparse. The condition foreordains a paucity of neurologically conveyed information, which might weaken the ability to discriminate green and blue. The relationship of short-wavelength cones to discriminability of blue and green is outlined:

There are three types of cones, each containing a different kind of photopigment. Although each is sensitive to all wavelengths, each is maximally sensitive to a different wavelength. The three types are: "S-cones," whose pigment most readily absorbs short-wavelength photons; "M-cones," whose pigment most readily absorbs medium-wavelength photons; "L-cones," whose pigment most readily absorbs long-wavelength photons.

De Valois and De Valois (1975) note that any sensation -- whether it is visual, auditory, olfactory, gustatory, or somatic -- involves a neural response to a comparison of at least two inputs; a sensation never involves a direct, lineal connection between an external stimulus via one neuron to a cortical reflex. The comparison of inputs is fundamental to all sensory physiology, because it enables the distinction of quality from quantity.[6] For example, one +R-G cell in the LGN (lateral geniculate nuclei) is excited by a ratio of inputs from two different cone-types; it is the ratio itself that stimulates the LGN cell, not the amount of input. Since the ratio remains constant under normal variation of ambient daylight, an observer will sense the same red color regardless of the quantity of photons absorbed by the two cone-types.

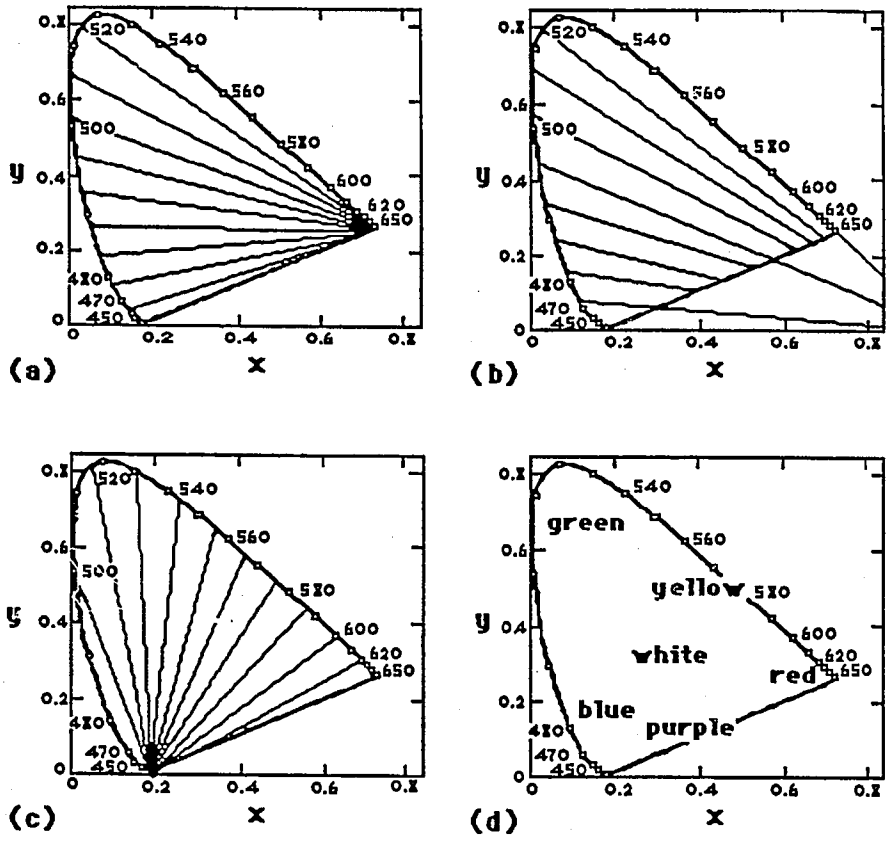
[6]Also the comparison of inputs is infinitely more efficient to differentiate minute grades of stimuli than would be a system that devoted a specialized set of neurons for the conveyance of each gradation of stimulus that might occur.

Each LGN cell-type is stimulated when it differences the activities of at least two cone-types. De Valois and De Valois (*ibid.*: 132, fig. 5) offer a model of interaction between the three cone-types and the six LGN cell-types, which is abstracted here: +L-M --> +R-G, +M-L --> +G-R, +L-S --> +Y-B, +S-L --> +B-Y, +L+M --> +W-Bk, -L-M --> +Bk-W. For example, +L-M --> +R-G means that the L-cones feed in an excitatory manner (+L) and the M-cones in an inhibitory manner (-M) into a +R-G cell. When the L- and M-cone inputs differ in magnitude such that the L-cone input is greatest, the cell excites (+R). Its excitation stimulates a sensation of red in the visual cortext. When the ratio differs such that the M-cone input is greatest, the cell inhibits (-G). Its inhibition stimulates a green sensation. The inputs of +M-L --> +G-R work in the opposite fashion. Response of each LGN cell-type is activated by a **ratio** of inputs from distinct cone-types.[7]

Ratliff (1976: 321-25) related retinal structure to the late evolution of a "blue term" in Berlin and Kay's original sequence of 1969. He observed that S-cones, unlike L- and M-cones, do not occur in the *fovea centralis*, a small but maximally sensitive pit at the retinal center where cones are concentrated. He also cited an unpublished model by Abramov and Levine, showing that S-cones are late to interact with other cone-types. Thus, "the blue end of the spectrum might exert weaker influence on the responses of the... opponent cells (322)." Ratliff's argument concerns the possible weakness of the blue percept *per se,* but it does not address the relative discriminability of green and blue versus that of red and yellow or of yellow and green. Why might normal observers have greater difficulty differentiating green and blue if green itself is not subject to the same disadvantage as blue?

[7]Hurvich (1981: 132, fig. 4) proposes a slightly different model of cone-to-cell interactions. The difference among models is not critical because the cone inputs have not been affirmed, especially the inputs into +B-Y and +Y-B cells. De Valois and De Valois (*ibid.* 131) observe that "...although most of the data suggest that the BY cells are differencing the outputs of the S and L cones.... It is conceivable...that both the S-L and S-M types of connections exist."

Evidence concerning the lesser discriminability of green and blue involves the "confusion lines" of color-deficient individuals that transcourse the 1931 CIE chromaticity chart (See section 1.5). Confusion lines connect colors within the chart that cannot be distinguished by individuals who suffer chromatic deficiency or partial "color blindness." These individuals are called "dichromats," because they lack one or another of the three photopigments while retaining the other two.



Figures 2.1a-d. Color-vision deficiencies exhibited by the chromaticity confusions within the 1931 CIE chromaticity chart of three kinds of dichromats: (a) protanopes; (b) deuteranopes; (c) tritanopes.

Source: Hurvich 1981: 294, Fig. 13. Figure 2.1d approximates information that is better conveyed by a color plate.

There are three kinds of dichromats, each of which lacks a different pigment: protanopes lack the L-pigment, deuteranopes lack the the M-pigment, and tritanopes lack the S-pigment. Accordingly, each is deprived of the ability to make a different set of color discriminations. Thus, the confusion lines of each kind of dichromat crosscut the CIE chromaticity chart from a different point of origin. Figures 2.1a-c show the crosscutting of the chart by protanopic, deuteranopic, and tritanopic confusion lines. In Figure 2.1d, rudimentary designations provide a rough idea of how the chart displays color.

The three sets of confusion lines evidence one critical principle: Discrimination between blue and green depends on change in excitation of S-cones, those containing the S-pigment; blue-and-green discrimination does not depend on changes in the excitation of M-cones or L-cones, because there is a constant ratio of M-cone and L-cone outputs over the blue-to-green range of color.

The evidence concerning dichromatic confusion lines combines with Ratliff's point about retinal structure: Since S-cones are sparse, slow to interact with LGN cells, and peripherally distributed in the retina, the S-cones are at a disadvantage as a mechanism that produces information to be used in the visual cortex for discriminating colors. Discrimination that depends on S-cone output, such as that between blue and green, would be less acute than that depending on L-cone and M-cone outputs, such as that between red and yellow or between yellow and green. This argument is based on the premise that the ability to discriminate is positively related to the amount of information received.

2.1.2. Cognitive Axioms

Cognition consists of the ways in which people modify their perceptions. There are, at least, three such modifications of color perception, each of which constitutes an axiom of cognition:

6a. An individual simultaneously attends to the perceived similarity and the perceived distinctiveness between any pair of the pure color sensations.

6b. The two attendances are mutable; for example, the attendance to similarity can weaken through time and the attendance to distinctiveness can gain strength.

6c. The attendances are reciprocally related; weakening of one will correspond to strengthening of the other.

7. Colors whose perceptual composition evokes indecision in identification and naming can be thought of and treated as a group apart from others, specifically because they are problematical.

8. Colors whose perceptual composition evokes indecision in identification and naming can be grouped together with a pure color or relatively simplex color in order to provide them with a more discernible point of reference.[8]

Axiom #6a-c is the mainspring of internal change and division among, at least, composite categories. Its engagement with perceptual axioms #^{s} 2-3 is discussed further under section 2.1.4. However, the reciprocal shift in strength between attendances to similarity and to distinctiveness will not occur without ***motivation***. Thus, before addressing the relationship between perceptual and cognitive axioms, section 2.1.3. devotes passing acknowledgment to this important aspect of color categorization. Without an account of motives, any theory of color categorization is incomplete. Unfortunately, the present accounts of motivation either do not cover all observations or have not been systematically tested:

2.1.3. Motives

Berlin and Kay (1969) addressed the question of motivation by proposing that the stages of basic-color term evolution roughly correlate with increments of societal complexity. Berlin and Berlin (1975) and Dougherty (1975) noted that color categories divide under the influence of culture contact; although loan words can be used to name

[8]Axioms #^{s} 7-8 are not used in Volume I, but in Volume II. Both axioms pertain mainly to complex blends of color and sometimes to blue. That the two contradict each other should be appreciated. The contradiction provokes unending cycles of change among the blue-with-purple, derived, and residual color categories of some languages.

new categories, they are innovated in the predicted order of evolution. Berlin and Kay observe further that the languages of some simple societies use more basic color categories than would be expected and, inversely, the languages of some complex societies use fewer than expected. For example, the Eskimo of the Arctic Circle and the Bushmen of the Kalahari Desert each name five salient color categories; but most of the languages of state-level societies in ancient Mesoamerica also named five, and, until recently, Mandarin Chinese named six. Parallel situations are evident throughout the data from contemporary Mesoamerica. Here, in particular, certain languages of small villages that are located in regions of poor farmland far from urban centers tend to name appreciably more color categories than do languages of some large towns that occupy fertile farmland within a hour's bus ride by paved road to a state capital.

Certainly something -- call it "X" -- motivates individuals to innovate color categories or, more generally, to increase attendance to distinctiveness and reciprocally decrease attendance to similarity. Societal complexity and culture contact have been proposed as possible instigators, although some observations are left unexplained. In the same spirit of speculation, yet another proposal is feasible: Color-category evolution is motivated by exposure to novelty rather than by societal complexity or culture contact *per se,* although such complexity or contact would induce novelty.

Novelty is motivational because it forces individuals to attend more to distinctiveness as a general strategy of sorting out and comprehending a world that differs from one day to the next. A society need not be complex in order to experience novelty as a daily event. Hardships and economic disadvantage can expose the members of a simple society to uncertainties that demand close attention to detail and frequent innovation. Therefore, marginal peoples who must shift for a livelihood and/or migrate outside of their territory will use many salient color categories, even though their society is small, remote, monolingual, and culturally cohesive. Conversely, people of large agricultural towns

whose daily lives are routine and predictable will use fewer color categories, even though they might live within the orbit of a metropolitan capital.

It must be stressed that all such conjecture concerning motives is precisely that. Yet the question of motives is very important and, therefore, cannot be ignored.

2.1.4. Engagement of Axioms

In review, three perceptual axioms (1-3) and one three-faceted cognitive axiom (6a-c) provide the basis for all that follows in Chapters IV-X. In brief, the axioms are: (1) people perceive six purest-possible colors, fifteen potential pairs; (2) the members of each pair are to an extent similar and to an extent distinct; (3) each pair differs in these extents; (6a-c) an individual attends simultaneously to similarity and to distinctiveness, and he can reciprocally shift the strengths of each attendance. Evidence from visual physiology supports axiom (1) and supports part of axiom (3): green and blue appear more similar than other paired colors, such as red and yellow.

From this simple point of departure, many observations can be accounted for and interrelated. For example, it is predictable that a category containing relatively distinct colors, such as red and yellow, will always divide before a category containing relatively similar colors, such as green and blue. Further, the antagonistic and semi-antagonistic colors of the opponent process model, such pairs as red/green, yellow/blue, and red/blue, will never in any language be categorized under one name. Berlin and Kay have recorded exactly these observations and have integrated them into an evolutionary hypothesis.

Specifically the stipulated axioms of perception and cognition are capable of engaging with each other in a manner that can explain change: to extents that are reciprocal, the perception of similarity is cognitively suppressed while the perception of distinctiveness is foregrounded; although perception is invariant, cognition is mutable. It is this *capacity of engagement* that makes the axioms useful for addressing the dynamics of categorization, such as the instigation and order of category evolution, category

division, compositional change and semantic change within a category, and many kinds of variation between individuals.

2.2. Chapter Abstracts

The following abstracts sketch the contents, organization, and findings of Chapters I, III-X. They contribute a condensed overview of the central thesis and its step-by-step development.

2.2.1. Chapter I: Introduction

This chapter first provides a general orientation, a history of the project, and a list of collaborators, languages surveyed, and a map. Its subsequent sections review the development of descriptive method, stimulus materials, the psychological color solid, and the development of theory concerning both color categorization in particular and categorization in general.

2.2.2. Chapter II: Extended Abstract

2.2.3. Chapter III: Descriptive Method

Equipment is described in Chapter I, including the loose color chips and two arrays. Each native speaker was interviewed separately and in privacy whenever possible, or at least without interjection from onlookers. A complete interview consisted of three independent procedures:

1. Naming. Each individual named all 330 color chips, one-by-one, in a fixed random order. This yielded color-term roots and modifiers of roots, as well as hesitations, alternatives, and null responses. Elicitation was prefaced by an instruction to use any word for as many colors as seemed appropriate and to decline to designate colors that were difficult to name.

2. Focus Selection. Each individual was shown the arrays and asked to pinpoint the "best example" of each root that he or she had volunteered while naming chips.

This resulted in a focus for each term. The obverse array was used to elicit the foci of words pertaining to dark and cool colors, the reverse array for light and warm colors.

3. Mapping. For each term volunteered, an individual was asked to indicate its range on an array by placing a grain of rice on each color that could be named by that term. Some mappings progressed in steps, punctuated by spontaneous pauses at which the subject stopped mapping as if finished. At each pause, the subject was asked in a positive phrase to "map more of X-term." Some mappings proceeded through several steps until the subject insisted that the term applied to no other colors. Each step was separately recorded as row-letters/column-numbers. The objective was to elicit a complete mapping rather than to encourage steps. But the tendency of some individuals to pause and then to respond to a further request produced additional data: mapping steps as well as a full mapping. Obverse and reverse arrays were used according to the category being mapped. After a subject declared each mapping complete, the rice was swept from the array before the next mapping commenced. Separate categories of adjacent hues were widely segregated in the mapping sequence.

An interview lasted 2-1/2 hours on the average. Data were organized by encoding them on graphs of the format shown in Figures 1.4a-b. The benefit of eliciting data by independent procedures was that each result could be checked for accuracy or otherwise interpreted against the others. The most reliable interpretation of data addressed the correspondences between them, not any one order of data by itself. The use of 330 color chips added a critical numerical variable to correspondences; for that reason, the full array was indispensable.

Some readers might ask whether the mapping elicitation, with its prompts, would produce distorted or misleading data, and similar queries might pertain to the other elicitations. Such questions are answered by the correspondences among independently elicited data that are summarized numerically in Tables 6.1 and 8.1, Chapters VI and VIII. A flawed method could not produce statistics at those levels of significance.

2.2.4. Chapter IV: Basic Categorization

This chapter is also introductory in the sense that it familiarizes the reader with (1) a genre of data and (2) a strategy of analysis that considers both statistics derived from a sample of speakers and categorization by single individuals. The chapter is more than introductory in the sense that it unites the concepts of the "basic color category" and the "basic level of categorization," whose relationship previously had been undefined.

The chapter introduces data that would appear recalcitrant at best or inaccurate at worst: the mapping of a term covers many more colors than its naming range. For example, some Tzeltal speakers used their black-focused term mainly to name dark colors and they used it to name a few blues, but they mapped the term throughout black, green, and blue. Other speakers both applied and mapped the term only on black and very dark colors. Yet each of the former group used the cool-focused term about 35 times less than did any within the latter group. The numerical correspondence implies that all of the data are accurate.

The correspondence requires an explanation, which is suggested by one of the axioms that are listed in section 2.1.: The Tzeltal speakers who mapped the black-focused term throughout black, green, and blue attended more to similarity and less to distinctiveness than did those who confined the mapping to dark colors. Conversely, those of the latter group, who attended more to distinctiveness, named the cool category more times than did any among the former group; they attached greater importance to the finer division of black versus green-with-blue.

Thus, so far, it is shown that data consist not only of naming ranges, foci, and mappings, but of correspondence between them. The correspondence is consistent with an axiom.

The chapter demonstrates, further, how the same axiom is used to address theoretical problems: Rosch defined the "basic level of categorization" in two ways, one of

which was *ease of use;* it is easiest to categorize on the basic level in contexts that do not call for exceptional generalization or specificity, for example, "car" rather than "vehicle" or "Ford." But mainly she defined the basic level objectively as "the categories that best mirror the correlational structure of the environment." Berlin and Kay defined a "basic color term" -- and thereby the "basic color category" that it names -- with operational criteria, such as superordination and salience. But the two concepts have remained unconnected, because it has seemed necessary to specify whether composite, primary, or derived basic color categories constituted Rosch's basic level.

Moreover, some of the Tzeltal data appear to challenge the usefulness of Berlin and Kay's criterial definition of the basic color category, because the superordinate dark-cool category is salient only in black; the cool category is subordinate but salient throughout its range. Some Tzeltal name the cool category more saliently than others, but even those who subordinate the cool category name it with a fair degree of salience. Berlin and Kay's criteria of superordination and salience are split between two levels of categorization rather than applying to the same category.

The axiom of reciprocal attendances provides a way out of both dilemmas: First, perceived color constitutes a hierarchy of potentially higher and lower orders of inclusion; that is, colors can be categorized in a broad group of, say, black-with-green-with-blue, or they can be categorized in narrower groups of, say, black versus green-with-blue or of black versus green versus blue. Second, different individuals find it easiest to categorize on different levels of the perceptual hierarchy; the basic level of categorization is not invariantly fixed at one perceptual level. The easiest or basic level is established for an individual by the particular balance that he maintains between the attendances to similarity and distinctiveness. Third, as distinctiveness gains strength and similarity loses strength, the basic level of categorization moves through the perceptual hierarchy toward greater differentiation and specificity. Fourth, the movement is smooth and continuous. The smooth movement of the basic level is determined by the reciprocity of the two

attendances. The reciprocal shift in strengths prevents abrupt jumps in movement from one level of the perceptual hierarchy to the next. Finally, since the movement is smooth and not saltant (advancing by leaps), the basic level of categorization can, at any time, be at a point ***between*** two perceptual levels. When this is the case, Berlin and Kay's definitional criteria of a basic color term will be shared between the perceptual levels; a superordinate category can be less salient than a subordinate category.

As might be anticipated, an individual will not bed down for the night at one evolutionary stage and awaken in the morning at the next stage; the movement of basic categorization between perceptual levels occurs gradually and smoothly whenever an individual so changes in the course of a lifetime. "Basic categorization" expresses the idea that there is no disunity between any "basic color category" and the "basic level." The two concepts are linked by recognizing that the basic level is mobile. Its mobility, as well as its smooth trajectory, is afforded by the mutability and reciprocity of two cognitions. Although Berlin and Kay's criteria can be shared between two categories, there is good reason for it. The incongruity does not justify altering, tampering with, or assigning priorities to the criteria.

In review, two mutually inextricable facets of one axiom each accounts for a separate observation: (1) The shift between the strengths of two cognitions explains why a broad mapping of the black-focused term corresponds with a small cool-focused naming range, and, vice versa, why a narrow mapping of the black-focused term correponds with a large cool-focused naming range. (2) The reciprocity that inheres in the same shift explains why the criteria of basic categorization are, in some cases, split between perceptual levels. The axiom enables a view of category-evolution in which the basic level moves through a perceptual hierarchy toward greater specificity; basic color categorization and the basic level of categorization are one and the same on any perceptual level or between any two of them. The power of the axiom is suggested by its capacity to explain and tie together two observations and, in the process, to improve theory.

The chapter goes on to explore data from Tzotzil speakers who name four levels of a perceptual hierarchy, three of them saliently.

2.2.5. Chapter V: Coextensive Semantic Ranges.

This chapter introduces *coextensivity*, a cognitive composition of a category that is formed when an individual assumes two or more vantages of the same colors. Hard evidence of this composition is that individuals name the category with a different term from each vantage. The terms have coextensive semantic ranges but distinct foci. The evidence that a category is composed of vantages has profound implications for a theory of categorization. However, these are addressed in succeeding chapters.

The purpose of Chapter V is to introduce coextensivity as simply as possible while avoiding a reductionistic account. In this interest, the chapter does not emphasize the cognitive constitution of coextensive vantages but, instead, features their semantic side. Coextensive semantic ranges exhibit a type of semantic relationship that differs qualitatively from any other, although its uniqueness has not been recognized heretofore.

Coextensivity is introduced with (1) a data-oriented enumeration of its characteristics and (2) a demonstration of its relationship to other semantic types, such as *near-synonymy*, *inclusion* and *complementation*. Yet the exposition of both (1) and (2) involves unavoidable complications, and each produces implications for theory that are analyzed in the present chapter:

The enumeration of characteristics is complicated by their occurrence in distinct perceptual environments, such as the warm category and the cool category, where they are manifested differently. Nine characteristics are described as they occur in each category, and the descriptions are tabulated and contrasted in parallel columns, Table 5.1. Chapter V substantiates only characteristics 1-7; 8-9 are included to complete the description within one table, and they are cross-referenced to sections of later chapters. In general, the

contrast shows that the naming ranges, mappings, and foci of coextensive vantages in the warm category are juxtaposed more dichotomously than in the cool category.

This difference matches the evidence from visual physiology that pure red and pure yellow are perceived to be more distinct from each other, and that pure green and pure blue are perceived to be more similar. The difference further matches Berlin and Kay's evolutionary stipulation that red and yellow will be separately categorized before green and blue. It appears that the perceptual universal explains both the order of evolution and the difference between coextensive characteristics in the warm and the cool category.

Finally, it is shown that coextensivity is one segment of a continuum of semantic types. The continuum ranges from near-synonymy, through three variants of coextensivity, through inclusion, to complementation. Within both the warm and the cool category, the types evolve through the continuum as the attendance to similarity weakens and the attendance to distinctiveness gains strength reciprocally. The reciprocity of the two attendances explains *both* the evolutionary order of ideal semantic types *and* the occurrence of types in data that are intermediate to the ideals. The types evolve within a category as augmentation of the attendance to distinctiveness provokes gradual change in cognitive composition; the change culminates with full division of the category.

Chapter V concentrates on the difference between near-synonymy and coextensivity, because this difference is least obvious. The differences among coextensivity, inclusion, and complementation are addressed in Chapter VII.

Chapter V shows that semantic evolution along the continuum is unbroken, just as Chapter IV has shown that evolution of basic color categorization smoothly progresses through the levels of a perceptual hierarchy. Both evolutions are propelled by the reciprocal shift in strength between the attendance to similarity and the attendance to

distinctiveness. The reciprocal nature of the relationship between the two cognitions prevents discontinuous jumps between semantic types and between basic stages.

In sum, Chapter V introduces coextensive category composition, and it ties together the following observations: (1) the smooth evolution of semantic types and of basic stages; (2) the order in which the warm and the cool category evolve, differences between coextensive characteristics in these environments, and physiological evidence that green and blue are perceived to be more similar than red and yellow.

2.2.6. Chapter VI: Variants of Coextensivity

This chapter analyzes three variants of coextensivity in the warm category: *dominant-recessive*, *balanced*, and *polarized*. The three types constitute a short evolutionary continuum, although the balanced and polarized variants seldom occur; dominant-recessive coextensivity is by far the most common of the three, although in some cases it is "weak" or partially balanced.

In spite of the minority of partial cases, dominant-recessive coextensivity is characterized by strong numerical correspondences: a *dominant coextensive vantage* manifests (1) a naming range of many responses, (2) a mapping that covers many colors, (3) mapping steps of a large average size, and (4) a centralized focus, that is, one placed between the unique hues; a *recessive coextensive vantage* manifests (1) a naming range of fewer responses, (2) a mapping that covers fewer colors, (3) mapping steps of smaller average size, and (4) a focus that is less centralized, placed on a unique hue, or polarized. The correspondences are expressed in Table 6.1 for each individual whose data was complete enough to allow assessment of the four characteristics. The statistics are strong, because they show a consistent pattern across four columns of paired numbers, each depicting an independent datum.

The main task of this chapter is to explain the tabularized correspondences. In brief, this is done by developing the fundamental tenet of coextensivity: a category is

cognitively composed from vantages. The development forces a redefinition of categorization and a freshly formulated theory of the same. The formulation departs from prior theories.

In detail, a vantage is always taken from a particular position or, in the terminology of physics, a "reference body consisting of coordinates." In physical experience, a vantage point is constituted by coordinates of three dimensions and time, as $K = x, y, z, t$ or $K' = x', y', z', t'$. In a color category that is coextensively composed, a vantage point is constituted by one perceptual coordinate and, at least, one cognitive coordinate, that is, by one unique hue and by, at least, one of the two attendances to similarity and to distinctiveness.

The coordination of a unique hue with the attendance to similarity entails that a coextensive vantage will be copiously named, broadly mapped, mapped with large average steps, and centrally focused. The coordination of a unique hue with the attendance to distinctiveness entails that a coextensive vantage will be sparsely named, sparingly mapped, mapped with small average steps, and focused at a polarized position, on a unique hue, or less centrally. The projected correspondences constitute a prediction and, consequently, a means to test the hypothesis of vantages and coordinates. In Table 6.1, the correspondences are numerically overwhelming.

The numbers provide strong evidence that a coextensively composed color category consists of vantages that, in turn, are each taken from a position that is constituted by a linkage of opposite perceptual and cognitive coordinates. The hypothesis has four corollaries:

1. A category of the kind treated here is a coordination of cognition and perception; the cognitive coordinates constitute the category as much as do the perceptions that are encompassed by it. Thus, both kinds of coordinates will conjointly shape categorizing behavior.

2. In order to link a cognition (e.g., an attendance to similarity or to distinctiveness) with a perception (e.g., unique hue), an individual must treat his own cognitions *as though* they existed physically. The ability to treat something that is non-substantive *as though* it were substantive is fundamental to this kind of categorization.

3. A category is composed from a vantage by treating a cognition *as though* it were a thing. And, by the same efficient act, the category itself is treated *as though* it were a thing. The vantage point endows the category with a fixed position where the categorizer stands and looks on, as if viewing a valley from a hilltop or a room from a point within it. Color categories of the kind studied here, like any physical object or event, necessarily involve this order of embodiment.

4. Like any physical object or event, a category assumes a distinct size and composition when envisioned from different positions. From its dominant vantage point, a category is large and evenly proportioned; but from its recessive vantage point, it is small and skewed. This case parallels Einstein's classic example of an object that falls from a moving railway carriage: from the train its trajectory is straight, but from the ground its trajectory is parabolic.

In Chapter VIII, other statistics are presented that suggest that any color category is composed from a vantage point, even one that does not involve coextensivity. Such a category is composed of a single vantage. Most color categories are of the single-vantage type.

However, the importance of the *vantage* principle to categorization is most readily demonstrated against the columns of paired correspondences that derive only from coextensive vantages, Table 6.1. After having established the principle with such strong statistics, it is further tested against correspondences among data from single-vantage categories.

2.2.7. Chapter VII: Semantic Types and Category Division

This chapter continues the analysis of semantic types. As Chapters V-VI concentrated on the early end of the evolutionary continuum, the present chapter concentrates on the late end. It analyzes the transformation of (1) coextensivity to inclusion and of (2) inclusion to complementation. The analysis emphasizes the relationship of semantic evolution to category division. The relationship was as relevant to earlier discussion as it is here; however, prior chapters primarily explored other topics, leaving the tie between category division and semantics for the present.

The analysis shows that the transformation from coextensivity to inclusion assumes different forms in the warm category and cool category. This difference is one of those that are listed in Table 5.1 of Chapter V, but not substantiated there; like the other differences, it is determined by distinct perceptual distance between the pertinent unique hues. Although the data are minimal, further differences characterize the transformation of coextensivity to inclusion in the dark-cool category and, perhaps, in the light-warm category. The differences require separate treatment of the division process within each environment:

In the warm category, coextensivity transforms to inclusion when the recessive vantage retracts to the extent that it encompasses just one unique hue. Each vantage then composes a separate category: one superordinate warm category of two unique hues and one subordinate category of a single unique hue. In some languages, the superordinate warm category is yellow-focused and the subordinate category is red; other languages show the mirror image: a red-focused superordinate and a yellow subordinate category. Speakers of single languages agree on a pattern, but mirror-image relationships of inclusion differentiate closely related languages. Such mirror-image patterns descend from a prior state of dominant-recessive coextensivity in both languages. Coextensivity differs from inclusion in that speakers of one language can vary in their assignment of dominance (and, inversely, of recessiveness) to unique red or to unique yellow.

As inclusion becomes established in the warm category, the dominant-recessive pattern of foci is replaced with the absence of pattern. The focus of the superordinate warm category is commonly polarized, whereas the focus of a dominant coextensive vantage never is polarized.

Among warm colors, inclusion transforms to complementation by the retraction of the superordinate warm category to the extent that it encompasses only one unique hue. The entire change from dominant-recessive coextensivity, through inclusion, to complementation is an orderly process of, first, one retraction and, later, another. The semantic ranges that once pertained to coextensive vantages pull apart in opposite directions, and the split is accompanied by abundant polarization of foci and of first mapping steps.

All such characteristics of semantic change during category division directly show that an increasing attendance to distinctiveness propels the process.

In the cool category, by contrast, the transformation of coextensivity to inclusion appears disorderly: As an individual category divides, the naming range of a particular coextensive term will be confined to one side of the category, but its mapping will be confined to the opposite side and its focus to either side; the data pertaining to the opposite coextensive term can show the same kind of mismatching, but with a mirror-image pattern. The net impression is one of chaos. The impression is compounded as different speakers mismatch data with opposite patterns.

However, the confinement of data to one side of a dividing cool category is the result of an enhanced attendance to distinctiveness: to divide the category, this attendance must be strong enough to overbalance the inherently strong perceptual similarity of green and blue; here the contention between cognition and perception becomes greater than it does among warm colors.

The mismatching of data is a consequence of the same "crossover effect" that characterizes coextensivity in relatively stable cool categories: since green and blue are

inherently similar, it is more difficult and less consequential to consistently identify a particular coextensive term with a particular vantage. The crossover effect is introduced under Table 5.1 as a trait of coextensivity in, specifically, the cool category; it persists as the category divides.

In the dark-cool category, coextensivity is now rare. Where it survives, it involves polarization of the "cool" focus; the "black" focus is routinely placed on the blackest color in almost all black-focused vantages and categories. An earlier period of widely recurrent coextensivity in the dark-cool category is suggested by mirror-image relationships of inclusion in closely related Mesoamerican languages. Some languages superordinate a cool-focused dark-cool category and subordinate a black-focused category; others superordinate a black-focused dark-cool category and subordinate a cool category.

In the dark-cool category, inclusion transforms to complementation as the superordinate category retracts toward its focus. The process is difficult to detect in data, and it involves indecision during elicitation and disagreement between naming ranges and mappings.

The remnants of a few light-warm categories are exemplified, but they are so rare that little can be generalized. Throughout the world, the few light-warm categories that have been observed are lexically complex and involve more than one term, usually several. The reconstruction of the ProtoOtomanguean light-warm category postulates that it was named with at least five nearly synonymous terms (See Appendix II).

A composite category evolves from a state of relative internal stability toward eventual division as the strengths of two cognitions reciprocally shift. The shift establishes preconditions along a continuum for the development of different kinds of cognitive composition; some kinds involve two vantages of one category and others involve two hierarchically related categories consisting of one vantage each. However, two points must be stressed: (1) None of the preconditions determine that a composition of two vantages or

of two categories will develop. (2) When such a composition does develop, it need not be directly named. For either of these reasons, a category can be named with just one word throughout its evolution from a relatively stable state to a full division.

Nevertheless, a category will be named with two or more words only in response to one or another cognitive composition within the evolutionary continuum. The semantic relationship between the words will be dictated by the composition. As the attendance to distinctiveness increases, so does the likelihood that a composition will develop that involves at least two vantages or two categories. And the likelihood increases that the composition will be named directly with at least two words.

In the warm category, semantic relationships tend to emerge early on the continuum and to evolve through its full gamut. But the cool category is often named throughout its internal evolution with only a single word. Like the other semantic differences between the warm and the cool category, this evolutionary difference is consistent with the greater perceptual distance between red and yellow and the lesser distance between green and blue.

2.2.8. Chapter VIII: Skewing

This chapter presents statistics which suggest that the cool category always is composed from a vantage, even when it is named with just one term and not composed of coextensive vantages. The adoption of a vantage is intrinsic to color categorization itself, not only to coextensivity. The data of this chapter pertains primarily to cool categories that are not coextensively composed.

Skewing is the assignment of highest membership to one side of a composite color category. All cool categories are at least slightly skewed, including secondary cool categories that are not substantially dividing. Thus, skewing is not a consequence of division. Nevertheless, as a category divides, its skewing becomes increasingly pronounced.

The immediate objective of this chapter is to test a three-part hypothesis of skewing, composition, and division regarding categories that do not involve coextensivity: (1) All

such cool categories are skewed, because all are composed from a vantage point. The vantage point is fixed on one side or the other of any category. (2) The vantage point is constituted by a linkage of one perceptual coordinate -- a unique hue -- and two cognitive coordinates, that is, the attendances to similarity and to distinctiveness. As the latter attendance gains strength and the former weakens, the composition of a category skews to an extreme; high values of membership retract toward the vantage point, leaving low values on the far side of the category. (3) The cool category will fully divide when a further increase in the attendance to distinctiveness reduces the low values to zero.

The three-part hypothesis has three corresponding classes of entailment: (1) Any cool category that is composed of one vantage will not be dual focused, and it will not contain dual secondary categories of green and of blue. Further, its focus will be placed on one side or the other of column 23, that of true turquoise, but not on the column. This manifestation of skewing will match others in a mapping and a naming range.
(2) Centralized foci will correspond with "continuous" mappings, and foci that are placed on a unique hue or polarized will correspond with "disjunctive" mappings. In other words, an individual who attends strongly to similarity will place the cool-category focus between the unique hues where it will represent all cool colors as equally as possible -- although not on column 23 -- and he will map green, turquoise, and blue with one continuous first step; but an individual who attends strongly to distinctiveness will polarize a focus or place it on a unique hue so that it will mark contrast of one side of the category against the other, and he will follow suit by mapping green, turquoise, and blue with separate or disjunctive steps. (3) After division, the historical "cool" term will name the unique hue that had been included in the vantage point prior to division. The other unique hue will be named with a newly innovated term, although it might remain unnamed for a period.

The statistics concerning (1), (2), and (3) support the three-part hypothesis of skewing, composition, and division.

Another major statistic shows that more than three times as many cool categories of the Mesoamerican sample are skewed toward green than toward blue. Further, skewing toward green is more frequent among cool categories that evidence a strong attendance to distinctiveness: a greater percentage of basic cool categories are skewed toward green than secondary categories, and a greater percentage of disjunctively mapped cool categories than continuously mapped categories are skewed toward green. It follows that, as the attendance to distinctiveness increases, the vantage of a cool category must shift from its blue side to its green side if not originally skewed toward green. A tentative explanation is this:

It is fully demonstrated that green is perceptually more salient than blue. As the attendance to distinctiveness increases, the ***difference*** in salience between green and blue becomes more important to the categorizer. Then the most salient percept is incorporated into the vantage point while the least salient is abandoned as a possibility.

Transference is the shift of a vantage point from blue to green. An individual who is undergoing transference maintains coextensive vantages while naming each with the same term. Such individuals demonstrate the covert coextensivity by mismatching a focus and a first mapping step or by placing dual foci. Such mismatching recurs among members of a community where transference is in process, but it does not recur where the process is absent. When cool-category foci are aggregated across all speakers of certain languages, the aggregate shows a pattern in green and in blue that is identical to that which characterizes dominant-recessive coextensivity. The resemblance suggests that these speakers place foci in either green or blue because they too are undergoing transference. Usually, the covert coextensivity that accompanies transference is discontinued when the process is complete.

Transference is discouraged by the presence of a yellow-with-green category. Languages that use it will always skew the cool category toward blue. When each vantage of a coextensive pair is separately named and one name is older than the other, there is a

chance that the oldest name will designate the vantage that is skewed toward blue; after category division, it will name only blue. An example is seen in Numic languages (Nicholas 1980: Table 2). Such occurrences obviate arguments against the putative universality of transference that could be inferred from historical data.

In passing, a few other important attributes of skewing are noted. For example, when a secondary category develops, it will emerge almost always on the low-membership side of a single-vantage category. Secondary categories on the focal side of the cool category are very rare. A few single-vantage cool categories retract toward dark colors rather than toward one unique hue as they approach a division. In these categories, it appears that the vantage point incorporates a second perceptual coordinate on the brightness dimension, specifically darkness.

The chapter closes with a review of prior observations concerning the cool category in Aguaruna, Eskimo, Navaho, Tzeltal, West Futunese, and Tarahumara. It lists the reasons that the model which postulates cognitive and perceptual coordinates should replace the fuzzy-set union model of composite color categorization.

2.2.9. Chapter IX: Complex Composition

This chapter reviews the cool categories whose compositions are the most complex of the Mesoamerican sample. The precondition for all of the complexities is *covert coextensivity,* a coextensive cognitive composition whose vantages are named with the same word. Covert coextensivity, like transference, is evidenced by recurrent mismatching of data among members of one community, such as mismatching of a focus and first mapping step. It is not always possible to distinguish covert coextensivity that is temporarily maintained during transference and that which is maintained over generations. However, only the latter produces complex composition.

In addition to coextensivity itself, the major aspects of complex composition are dual foci, dual secondary categories of green and of blue, and disappearance of the original 'cool' term as the secondary categories become basic and their names gain salience.

Dual foci are actually the single foci of distinct coextensive vantages. This account is important, because dual foci were cited in support of the fuzzy-set union model of composite color categorization.

It is shown in Chapter VIII that secondary categories are almost never innovated on the high-membership side of a single-vantage cool category, but they are commonly found on the low-membership side. In a coextensively composed cool category, a secondary category can emerge on both sides, probably because each pertains to the low-membership side of the vantage that is skewed toward the opposite side. (In terminology of vantages, "high-" and "low membership" could be replaced with "close" and "distant.")

A separate section is devoted to modifier coextensivity, which is accompanied by the same complex characteristics that coincides with covert coextensivity and with coextensivity whose vantages are separately named.

Finally, rare examples of coextensivity on the axis of dark-versus-light are compared. This coextensivity is complex because its vantage points incorporate a second pair of perceptual coordinates, extremes of brightness. Specifically a coordinate of darkness has been used to compose a few single-vantage cool categories; and the same coordinate is used commonly in the composition of the basic green and the basic blue category. Primary basic categories are the first topic of Volume II.

2.2.10. Chapter X: Conclusion

The conclusion summarizes the findings that are abstracted in sections 2.2.3-9., but in a format that is arranged by hypotheses rather than by chapters. *A fundamental contribution is that any color category is composed of one or more vantages, each of which is taken from a standpoint of perceptual and cognitive coordinates. A category transforms through*

a gamut of composition as the cognitve coordinates change strength reciprocally. The continuum of composition sets preconditions for the evolution of semantic relationships, of which there are four ideal types. Since these and other hypotheses are built up from the same axioms, they conjointly compose a theory of color categorization. The conclusion enumerates observations that correlate with the theory and, thereby, are explained and brought together.

The reciprocity of coordinates, their assemblage as vantage points, and the continuous range of possible vantages are in close keeping with tenets of relativity physics. The likeness might not be accidental: human categorization probably emerged on the foundation of a primordial ability to cope with objects, motion, space, and time. The accomplishment is contingent on the ability to treat intangibles as things, including one's own cognitions. The composition of a category as a vantage point of cognitive and perceptual coordinates differs minimally from the way that any species maintains awareness of its physical position in reference to three perpendiculars and relative motion.

Chapter III

Descriptive Method

3.0. Preface

This chapter expands the outline of descriptive method (cf. section 2.2.3.), describes equipment design, and introduces further graphics conventions. Since subsequent chapters proceed with extensive reference to data, it is essential to explain how the data were collected and how they are presented.

3.1. Equipment

Stimulus materials and the history of equipment design are treated under sections 1.2 and 1.6. The design includes loose swatches or "color chips" of 10 minimally saturated and 320 maximally saturated Munsell colors and obverse and reverse arrays of the same (cf. Figures 1.4a-b).[1] The loose chips are numbered in a fixed random order and fitted, with the arrays and a film canister, into a box. The canister contains rice grains for

[1]Each loose swatch of pigmented, cast-coated paper is cut to a 1.2 x 1.6cm rectangle, mounted on a 2.5 x 2.5cm neutral matte, and encased in a 4.0 x 6.0cm lamination of clear acetate. An array consists of a 35.5 x 12.7 x 0.1cm matte of neutral cardboard to which 330 discoidal chips (plus the extra rows of 40 white and 40 black chips), cut with a 1/4" punch, are affixed in their spectral order and aligned 1/16" apart, horizontally and vertically. The matte is printed in advance with row letters, column numbers, and 1/4" asterisks to guide the alignment. Each array is encased between two rectangles of plexiglass, which are kept from contact with the array by a gasket and secured with neutral tape. The mass production of equipment sets for an ethnographic color survey is a tedious topic that is best reserved for a manual or video tape. Even the box has been meticulously designed by trial-and-error through three models and is prescribed to the centimeter. The total design is efficient and costeffective to assemble and easy to carry; the lamination achieves a hermetic seal that totally resists dust, humidity, mold, and moisture, and it completely arrests the process of chemical outgassing from the chip itself. The outgassing had obscured with a residue the glass in an experimental model that encased chips in photographic slide binders.

mapping elicitations. Other equipment consists of numbered sheets, graphs, carbon paper, paper clamps, and graphite and colored pencils, for recording and organizing data in the field.

3.2. Methods in Brief

The fundamental methodological strategy of the Mesoamerican survey was to collect data from single informants and to analyze separately the result of each interview. Color naming within any particular community was investigated by conducting multiple interviews: several individuals were interviewed separately by the same procedures; the result of each interview was analyzed by itself; the separate analyses were compared, aggregated, or otherwise prepared for further analysis.

In broad outline, methods were composed of three phases: (1) elicitation, (2) organization, and (3) analysis. There are, further, some graphics conventions for presenting color-category data in a black-and-white medium.

Elicitation of data consists of three independently executed procedures: (1) the naming elicitation in which color chips are named one-by-one; (2) the focus elicitation in which a best example of each name is selected; (3) the mapping elicitation in which the range of each name is demonstrated. The naming elicitation produces the names of colors, their modifiers, and non-linguistic data, such as hesitations and null responses. The focus elicitation yields foci, that is, an individual's opinion concerning the best example of each name. The mapping elicitation provides an indication of the ranges of named categories, their relationships, and, often, their internal ordering. The benefit of eliciting data by independent procedures is that the result of one procedure can be checked for accuracy and otherwise interpreted against the results of the others.

Organization involves transferring raw data to graphs that represent the Munsell array. In this form, they can be easily seen, counted, and compared. Naming data, focus data, and mapping data are organized according to separate procedures and notation.

Analysis consists of comparing data from one individual to test their accuracy and to accumulate evidence in support of an interpretation. Evidence consists of quantitative correspondences; and it consists of correspondences between behaviors, such as a focus, a particular mapping step, and a modifier usage. An interpretation amounts to a model of the way an individual cognitively orders his color categories. Statistical analysis is achieved by aggregating specific kinds of data, such as foci or null responses, across the results of many interviews.

3.3. Methods at Length

This section fills in the foregoing outline with detail. Each procedure of elicitation, organization, and analysis is exemplified with the results of an interview of a Guarajío speaker, to be referred to as "Guarajío speaker #1." Graphics conventions are explained as they are introduced throughout the examples.

3.3.1. Bookkeeping

Each individual who was interviewed was assigned a number, for example, Guarajío speaker #1. Every sheet of raw and organized data pertaining to that individual bore the number, as well as the name of the language, the place where the individual learned it, and the date of recording; and, on sheets of raw data, page numbers indicated the order of recording.

3.3.2. Demographics

Demographic data were collected from each individual as part of the interview, for example, name, approximate age, sex, origin, other languages spoken partially and fluently, parents' origin and languages, schooling, travel, occupation, and so forth. This

was best accomplished during a recess in the middle of an interview, after enough rapport was established to ask such questions and to roughly assess bilingual ability in Spanish.

3.3.3. Preliminaries

A full interview -- naming, focus, and mapping elicitations -- lasted an average of 2-1/2 hours. Some interviews were completed in two sessions, first the naming and focus elicitations and later the mapping. Only one informant at a time was interviewed. On-lookers were always asked not to interject, comment, or react.

Lighting conditions cannot be totally controlled in the field. Interviews were conducted out of doors in natural daylight after sunrise and before sunset in the shade at the edge of direct sunlight, or they were conducted indoors with the informant's back to a window or open door. A few interviews that were impossible to conduct during the day were conducted under a 100 watt white incandescent bulb. Critics have emphasized the putative biasing effect of ambient light on the results of color interviews (e.g., Cairo 1977). However, controlled experiments show that the eye is remarkably flexible in its capacity to repeat the same minute color discriminations under a variety of dark and bright daylight conditions.[2] The usual gamut of passing clouds and of differing exposures to indirect sunlight during the day has no biasing effect on human color categorization.

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[2]"...in the usual run of events, our world of colored objects changes very little with considerable changes in illumination."...

"The visual system has the remarkable property that it can function efficiently over a very wide range of illuminations. It functions well at very low levels of illumination as well as at high ones. The eye sees dimly illuminated objects because the visual system adapts. When light is imaged on the retina, the pupillary aperture through which it passes widens at low light levels and allows more light to enter the eye, but the major increase in sensitivity comes about mainly because the rods are more active at low illuminations and they contain the sensitive rhodopsin photopigment, which is increasingly reconstituted the longer the rods are protected from bleaching light levels... The eye not only dark-adapts to increase its sensitivity, it also light-adapts to enable it to function more efficiently at moderate light levels and to protect itself from overstimulation by extremely bright lights. The cone system is operative at higher illumination levels. The eye's sensitivity to light can thus decrease or increase depending on illumination conditions."

"The visual system not only adapts to different light levels, it also adapts to color. **Color adaptation** refers to changes in the eye's sensitivity when it is exposed to chromatic light stimulation. Here the changes in sensitivity tend to compensate for the spectral quality of the light rather than for changes in its overall level" (Hurvich 1981: 195).

Also, section 2.1.1.1., item 2., explains why color perceptions are responses to ratios of cone-type inputs, not responses to quantities of photons. Although such quantities vary during daylight, the ratios remain constant. This is a major reason that color discrimination is unaffected throughout the day by changes in amount of light.

Most interviews were conducted in the native language by a fluent speaker or with the aid of an interpreter, although a few were conducted with only a sheet of prepared phrases. The interview itself required minimum dialogue. Use of Spanish was avoided as much as possible, as experience showed that it could influence a choice of words.

3.3.4. Elicitation Procedures

3.3.4.1. Naming

At the beginning of an interview, the interviewer and the informant sat facing each other with the box of Munsell materials between them. The interviewer displayed the array and said, "I'll ask you to name all of these colors. All the colors under this glass are also in the box. Notice that many colors look almost the same, but none are identical. You will name the colors one-by-one as I take them from the box. I will show you only one at a time. You may use the same word for many different colors. You may decline to name colors that are difficult to name. It is better to decline to name than to delay. There are 330 colors here, and if you take minutes to name each, we'll be at it until tomorrow night." The array was then turned face down or hidden.

An informant named each of the 330 loose color chips, one-by-one, in their fixed random order.[3] The interviewer recorded the data on correspondingly numbered sheets, including roots and any and all modifiers. Care was taken to observe variant pronunciations and to record them. No datum was dismissed as trivial during an elicitation. A system of notation was developed for efficiently recording hesitations, null responses, changes of mind, afterthoughts, alternatives, dubatives, reportatives, false starts, and other non-linguistic data.

[3]Individuals who hestitated to name chips were told that they were not being tested, everyone names color diffcrently, all are correct, and there are no wrong anwers.

In Table 3.1, naming responses 1-10...330 that were collected during the interview of Guarajío speaker #1 are reproduced from a sheet of raw data. They include a variant pronunciation in item 1. and a hesitation in 5.

Table 3.1

Unorganized Naming Data

1. soyomuriame	7. ka·we si·yoname
2. teesa si·yoname	8. setamuriame
3. sehtaname	9. warosaherame
4. ohčoname	10. ka·we siyoname
5. - siyoname	:
6. wa·rosa	330: tosapočame

3.3.4.2. Focus Selection

After the naming elicitation, the interviewer prepared a list of every distinct lexical root that was volunteered by the informant in response to the 330 loose color chips. The list included even the roots that were used only once or twice; and it included all phonological variants of any root, even when the variation was not previously observed to be meaningful. Interviewers were cautioned to take their time while composing the list, since it was very easy to overlook forms. The list was used for both focus elicitation and mapping.

The interviewer had determined in advance how to ask for a "best example." A focus was elicited for each itemized lexeme by asking the informant to indicate on the array the best example of the term. Focus selections were recorded as row-letter/column-number intersections next to the respective item on the list. The interviewer attempted to request foci of (1) terms with broad meanings first and with restricted meanings last and (2) terms with similar meanings at widely spaced intervals in the elicitation sequence. The informant worked with a blunt, neutral pointer (A penpoint stains the plexiglass.).

During the interview of Guarajío speaker #1, the list was compiled and foci elicited as shown in Table 3.2.[4] (See footnote 13., page 109)

Table 3.2

Lexeme List And Foci

SECTION I	SECTION II
siyóname -- G17	siyomúriame -- F25
sehtáname -- H40	sa·wáieme -- D9
ohčóname -- J } all	sehtamúrame -- E6
tosáname -- A } all	warósaherame -- E6
sa·wáeme -- C8	tosawíčame -- C33
wa·rósa -- D35	sehtapóčame -- E38
čokorá -- E8	ohčomúrame -- I32
wetapáeme -- E11,F0	sawamúrame -- C10
	siyomúrame -- F17

3.3.4.3. Mapping

The objective of a mapping elicitation was to induce an informant to map on the array the entire, fully extended range of each listed color name. An informant executed a mapping of a named color category by placing grains, such as rice or lentils, on the discoidal chips of the array in response to verbal requests, such as "Put a grain on every disk that you can call 'X-color term'."

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[4] This list deviates from the prescription of listing only roots. In Guarajío, native color-term roots are modified with obligatory suffixes, and an unmodified root sounds unnatural. Six native roots modified with *-name* or *-eme* are first listed as "Section I" with two loan words from Spanish *barroso* and *chocolate* that occurred unmodified.

During the naming elicitation, Guarajío speaker #1 mostly volunteered terms modified with *-name* or *-eme*. On this weak evidence, the interviewer proceeded as though each lexeme that was so modified could name any part of the category to which it referred and that, further, its focus would be that of the entire category. The assumption was affirmed during the mapping elicitation. But in the event that he was wrong, the interviewer listed the other combinations of roots and suffixed modifiers that had appeared in the naming data. These are listed with their foci under "Section II."

Countless complications of this kind can arise during an elicitation. Any of the three elicitation procedures -- naming, foci, and mapping -- can require innovation. Nevertheless, participants in the MCS were pointedly asked not to deviate from the three procedures unless innovation was essential to deal with an attribute of a particular language, such as the obligatory suffixes of Guarajío color-term roots.

3.3.4.3.1. Preparation

The interviewer composed a "mapping order" by listing all of the roots volunteered during the naming elicitation in the order in which he intended to map them. The terms to be mapped on the reverse array -- those with white and warm ranges -- were encircled as a reminder. These measures guarded against omissions and lack of planning during the elicitation. The mapping order was composed according to two guidelines: (1) Categories that were adjacent on the array, such as red and yellow, should not be mapped in sequence; categories that were far apart, such as red and green, should be mapped in sequence. This reduced the chance that an informant would adapt a mapping to his memory of a prior mapping. (2) The terms that were likely to have the broadest ranges were mapped before those whose ranges were likely to be encompassed by the broader terms. This reduced the chance that an informant would curtail what otherwise would have been a broad mapping to accommodate what he remembered of the prior, restricted mapping in the same area of color. Table 3.3 displays the mapping order that was used during the interview of Guarajío speaker #1.[5]

Table 3.3

Mapping Order

1. sehtáname	5. tohsáname
2. siyóname	6. wa·rósa
3. sa·wáeme	7. wetapáeme
4. ohčóname	8. čókora

[5]The mapping order of Table 3.3 is problematical, because guidelines (1) and (2) conflict in these data: terms 6-8 are all encompassed by the range of term 3, as was eventually verified for, at least, terms 6 and 8 by the mappings themselves. The unsatisfactory solution was to to place terms 6-8 at the end of the mapping order, giving priority to guideline (2) over (1). It would have been better to initiate the mapping order with term 3 and to disperse the mappings of terms 6-8 at separate intervals throughout the rest of the order. Perhaps as a consequence of the shortsighted planning, Guarajío speaker #1 did not map term 7 about the area where he mapped terms 6 and 8, although he had used all three terms to name that area.

Before the elicitation, the interviewer prepared a list of requests, called "mapping directives." These were used to systematically coax an informant to map colors. The directives were phrased in the informants' language, preferably with the aid of a native assistant. The directives had to convey the interviewer's wishes in a way that seemed natural and idiomatic to informants. Table 3.4 displays the mapping directives that were used during the interview of Guarajío speaker #1.[6]

Table 3.4

Mapping Directives

1. piiripi arosi yachase yoma (X-color term)
   "Put rice on all the (X-color term)."

2. yachase epeche... yooma _____.
   "Put on more... all _____."

3. toina _____?
   "Are there any _____ left?"

4. in tun epeche?
   "Are there more?"

5. kawe unatepa.
   "Think well."

6. yachasa epeche... teesa _____.
   "Put on more... very little _____."

7. yoomahu?
   "Is that all?"

[6] Other interviews employed directives that were more positive than those of Table 3.4. The table contains *questions*, which can prove ineffective with a lazy or impatient informant who might answer negatively to shorten the interview. It is safest to phrase directives that imply that more colors remain to be mapped, as "Put rice on those that are left," rather than "Are there any left?" Usually, directives were phased like these: (1) Put one grain on each color that under any circumstance you can name "X." (2) Do more that you can name "X." (3) Do the "X" that are left. (4) Do those that you can sometimes name "X." (5) Do those that you can still name "X," even though you would rather give them another name.

3.3.4.3.2. Elicitation

The interviewer explained that the informant will place one grain on each color chip of the array that he can name with a certain color word, that they will repeat the procedure for several words. The interviewer began to elicit the mapping of the first term in the mapping order by reading the first directive on the list of mapping directives. As the informant started to place grains on the array, the interviewer recorded the row-letter and column-number of the very first grain or group of grains that the informant placed. After the informant stopped mapping, the interviewer recorded by row-letters and column-numbers the entire group of chips that the informant had covered with grains. Then the interviewer read another directive and recorded it by number. In response, the informant might have mapped further, or he might have declared that the mapping was complete.

Usually, a mapping of a named category proceeded in steps, punctuated by natural pauses at which the informant stopped mapping as though finished. The interviewer recorded each mapping-step at the pause; then he encouraged the informant to continue mapping by reading another one of the mapping directives. The interviewer continued to record and to encourage the mapping in this manner until, after various steps, the informant firmly insisted that no additional color chips could be designated by the category name. After the informant declined to map a color term further in response to three consecutive directives, the interviewer terminated the mapping of the word.

The interviewer always initiated a mapping with the first, most sweeping directive on the list; but then he could deliver out of sequence, repeat, skip, or combine the subsequent directives in whatever fashion appeared to most effectively encourage the informant to map the category to its maximum extension. Toward this end, the interviewer could phrase new directives during the interview and add them to the bottom of the list.

Table 3.5 displays raw mapping data from Guarajío speaker #1 as they were recorded during his interview. These illustrate the procedures and notation of mapping:

Table 3.5

Unorganized Mapping Data

sehtáname First grain: G 2

Step I (1 + yo·ma)
F 38-40, 1-4
G-H 35-40, 1-4

Step II (2)
E 1-4 /sehtamúriame/
C 1-5 /sehtamúrame/
D 1-5 /sehtapóčame/

Step III (3)
G 5 /very good red/
I 37-40, 1-5 (whatever)

Step IV (4)
D 35-40
E 36-40
C 35-40

Step V (5) > Ø
(6 + tisa sehtáname)
E 33-35
F 33-37
I 33-38

Step VI (spontaneous)
C-D 33-34

Step VII (4 + 5) > Ø
Ø (6) > Ø
(7) > Ø

siyóname First grain: F 17

Step I (1)
C 16-21 /ka·we siyóname/
D 16-24
E 15-24
F-H 15-23

Step II (2)
C 15-28
D 14-30
E-F 13-31
G-H 14-31

Step III (6)
C 29-30
D 31

Step IV (6)
F 12
G12-13

Step V (4) > Ø
(5) > Ø
Ø (6) > Ø

Of the eight mappings of color terms that were completed by Guarajío speaker #1 (cf. Table 3.3), two appear as examples in Table 3.5: mappings of *sehtáname* and *siyóname*. They are discussed out of their mapping order:

Among the data under *siyóname,* the "first grain" is recorded at F 17. This is the row-letter/column-number intersection of the chip on which the informant began to map the term. Under "Step I," other row-letters and column-numbers are recorded: C 16-21, D 16-24, E 15-24, F-H 15-23. These represent additional chips on which the informant plotted his initial mapping, before he paused as if finished. At the right of "Step I," a "1" appears in parentheses and a Guarajío phrase, *"ka·we siyóname,"* appears in slashes. The "1" in parentheses is the number of the mapping directive that the interviewer used to coax the informant to begin to map. The Guarajío phrase in slashes is a comment that the informant volunteered as he mapped this first step, "a very good *siyóname.*" Throughout the progress of the mapping, the interviewer's and the informant's statements were recorded and distinguished by this convention of parentheses and slashes. Since many of the interviewer's statements had been prepared in advance as a list of mapping directives, they could be quickly recorded by number.

Under "Step II" of *siyóname,* a second portion of the mapping was recorded. Accordingly, the number of the mapping directive appears to the right in parentheses. This happens to be "2." Under "Step III" and "Step IV" another directive, "6," was used to prompt both steps. This illustrates two important aspects of the mapping procedure: (1) the mapping directives can be administered in any order that the interviewer thinks will be effective, and (2) the numbers of the mapping directives and the numbers of the steps need not correspond. For this reason, the steps are indicated by Roman numerals and the directives by Arabic numerals. The distinct conventions emphasize that the numbers of steps and the numbers of directives bear no fixed, predetermined relationship within a mapping.

Under "Step V" of *siyóname,* the interviewer coaxed the informant with three different directives. As each failed in succession to evoke a mapping, each is marked with "Ø" to its right. The interviewer did not change the step number when a directive did not evoke a further mapping; rather, he used another directive under the same step, then he tried yet another. After three directives resulted in a refusal to map further, the mapping of *siyóname* was terminated. The termination was marked as ▨.

Among the data under *sehtáname,* additional conventions are illustrated: Under "Step V," directive "5" failed to evoke a mapping, and this is marked as "Ø." Another directive, "6," is combined with an extemporaneous directive, one that was not prepared on the list of mapping directives. The renderings of both directives are enclosed by the same parentheses. In any mapping elicitation, the interviewer can combine directives at his discretion.

Under "Step VI" of *sehtáname,* "spontaneous" is noted in curly brackets, and parentheses are not used. The informant, after completing Step V and pausing, spontaneously proceeded to map Step VI without receiving a directive from the interviewer. "Spontaneous" is noted in curly brackets, because this comment was uttered neither by the interviewer nor by the informant as part of their interaction. Rather, "spontaneous" is a meta-comment or notation about the informant's performance. In any mapping elicitation, all such observations were distinguished from oral communication between interviewer and informant by framing them in curly brackets.

Under "Step VII" of *sehtáname,* two directives from the prepared list, "4 + 5," were used in combination, and this failed to produce a mapping. Under "Step II," the informant made a separate comment as he mapped each of three rows. Under "Step III," a brief dialogue is reported in English translation, although the dialogue occurred in Guarajío.

In general, the examples of Table 3.5 show that the mapping conventions are sufficiently flexible to record any kind of data, and yet they record efficiently and in a way that can be read by someone who did not witness the interview.

3.3.4.3.3. General Provisions

Four provisions were observed throughout all mapping elicitations:

1. After a mapping of a color term was terminated, the grains were removed from the array before the mapping of the next term began.

2. The interviewer did not make statements that drew the informant's attention to some small, particular area of the array. For example, the mapping directives did not contain color words that were more specific than a category name.[7]

3. The interviewer did not point to the array during a mapping or otherwise make gestures that suggested to the informant where on the array to map.

4. Exception to provisions (2) and (3) were made under three conditions: (a) an informant's final mapping of the range of a color term was much smaller in extension than his use of the term during the naming elicitation; (b) at the beginning of an elicitation an informant was uncertain about what to do; (c) after a mapping had been terminated on the basis of oral directives, the interviewer could administer a final check by pointing to areas around the perimeter of the mapping and asking, "What about these?"

When the interviewer influenced a mapping, either verbally or in gesture, the interference was indicated by drawing a circle around the resultant data.

3.3.4.3.4. Strategy And Objectives

1. The purpose of a prepared list of mapping directives is to have on hand idiomatic requests in the field language, and it is to expedite recording of what is said during an interview. The purpose *is not* to interview each informant with exactly the same sequence

[7] In Table 3.5 under "Step V" of the mapping of *sehtáname*, this provision is violated by use of the Guarajío color modifier *tísa-*, 'a little bit.' The provision is similarly violated in Table 3.4 within mapping directive 6, which contains the color modifier *teesa-*.

of requests. Providing that the interviewer keeps a record of what he and the informant said, the interviewer can adapt his use of directives to the personality of the informant and to the immediate concerns of the task. The mapping procedure is predicated on the view that scientific rigor is not enhanced by imposing exactly the same sequence of statements on different informants. Since each individual is in some way different than others, the individual himself brings an uncontrolled variable into the elicitation that precludes attainment of rigor through a uniform delivery of directives. Rather, rigor and replicability in mapping color categories are maximized by applying the same strategy to the administration of all interviews: the same equipment is used, each informant is requested to perform the same physical tasks, idiomatic native language is used, interference by use of gesture and color modifiers occurs within prescribed guidelines, and each informant -- with language that the interviewer deems appropriate for that person -- is coaxed to map each category until he firmly refuses to map further.

2. The object of a mapping is to demonstrate the extent of a category; it *is not* to elicit mapping steps. A fully mapped range of just one step is an analyzable datum. Nevertheless, people tend to map a category completely only in response to repeated requests, which produces yet another kind of data: steps, in addition to a range.

3.3.5. Organization Of Data

Raw data were organized on graphs that represented the Munsell array. In the Mesoamerican Color Survey, this was done by hand rather than by computer. Ideally, the manual organization was done in the field so that further questions could be brought to light and resolved while informants were accessible. Eventually, all data had to be organized in order to analyze them.

3.3.5.1. Naming Ranges

Naming data were any of the words and reactions volunteered in response to the fixed randomized sequence of 330 loose color chips. Naming data from each informant

were derandomized and organized in their spectral relationship by encoding them on 330-cell graphs that represented the Munsell array. First, all the responses were copied on a large graph of seven 8-1/2 x 11" segments whose cells were ample enough to accommodate the data.[8] Then, roots were keyed to single-letter symbols and recopied to a small graph of one sheet; modifiers were likewise keyed and recopied to a separate small graph.

The distribution of the letter symbol for one root on the small graph represented the "naming range" of that root. Each naming range was outlined in dark ink on the graph. Then, the naming-range outlines were transposed with the aid of carbon paper to the graph containing symbols for modifiers. This displayed the relationship of modifiers to the naming ranges of roots. The relationship of each particular modifier to naming ranges could be extracted in isolation by passing just the outlines and all cases of the symbol for that modifier to yet another graph, again with carbon paper.

To enhance graphics display, letter-symbols of roots were changed to textures of shading, which filled each naming-range outline with a continuous visual effect; but, in most diagrams, modifiers were still represented by letter-symbols, although sometimes by shading or by a combination of symbols and shading. Figures 3.1a-2 display the roots and one of the modifiers that were elicited from Guarajío speaker #1:

[8]The copying, which took about an hour for the data from one informant, was facilitated by a datum number in each graph cell that linked the cell to a numbered datum on the sheets of 330 randomized responses. All notation was transferred from sheets to graph. Graph cells were also identified with row letters and column numbers, which allowed commentary pertaining to any data to be footnoted in a space below the graph. Participants in the MCS were provided with a pamphlet that detailed other conventions of the copying process. Data were further transferred from a large graph to a small graph in reference to row-letters and column-numbers only.

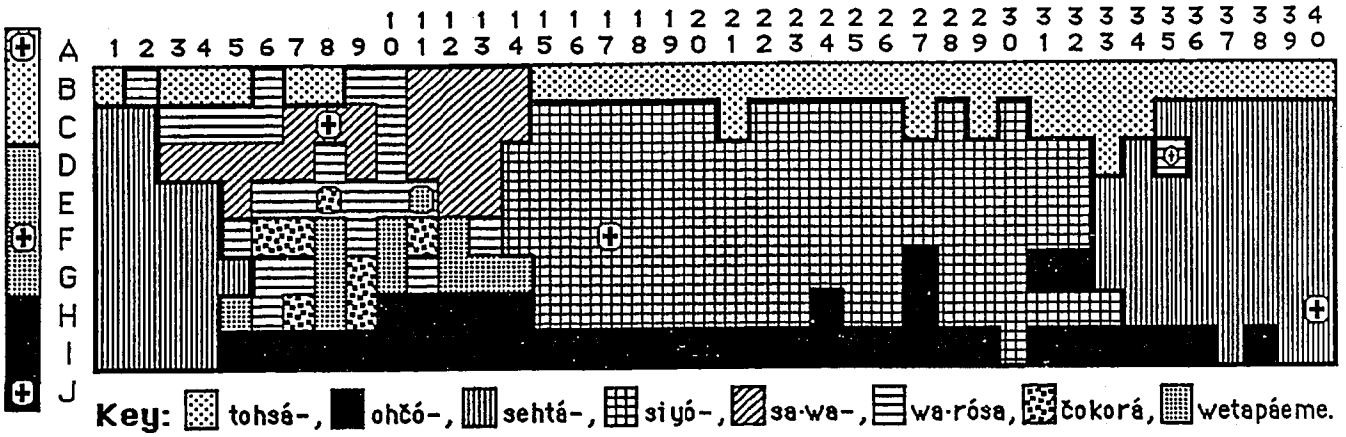


Figure 3.1a. Obverse display, naming ranges of roots and foci; Guarajío, speaker #1, Alamos, man, age 35, 1979. (Compare with Figures 1.4a-b, pages 14-15, or with Appendix I.)

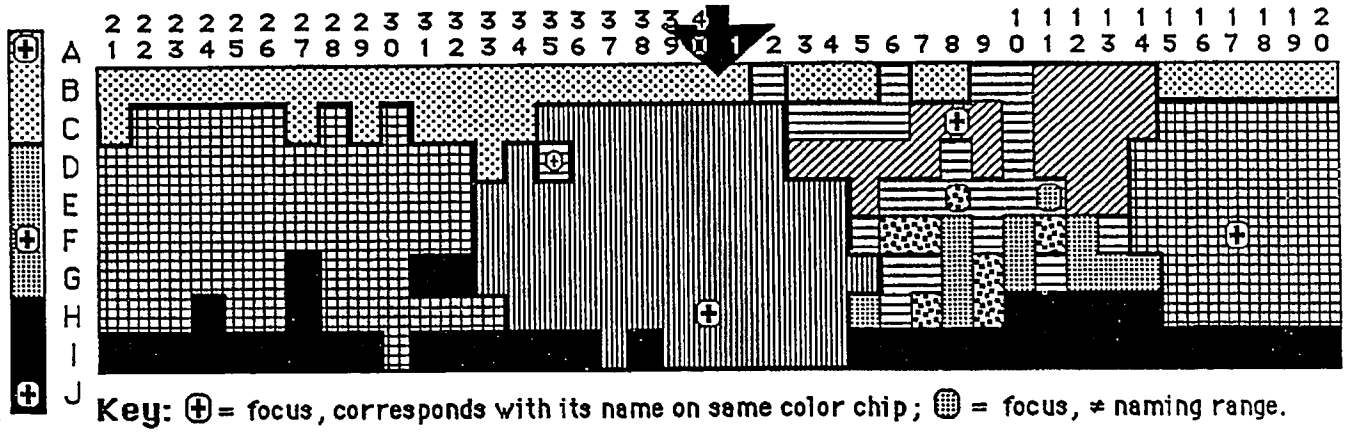


Figure 3.1b. Reverse display.

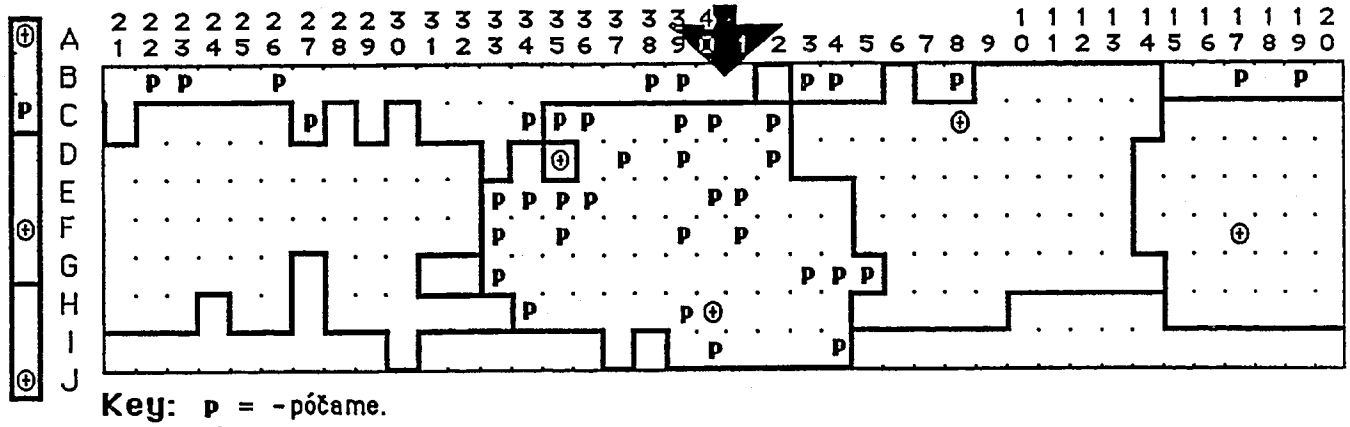


Figure 3.2. The distribution of every use of one Guarajío color-modifier suffix in relation to naming-range outlines of roots.

Figures 3.1a-b show two unusual features. One regards foci and is discussed under section 3.3.5.2. The other is the mixture of four terms throughout yellow and brown colors of columns 4-13. The range of one of them will be demonstrated by mapping data under section 3.3.5.3. Figure 3.2 shows the distribution of just one suffixed modifier among the several that could have been been shown; this particular modifier qualifies only the red-focused and white-focused roots.

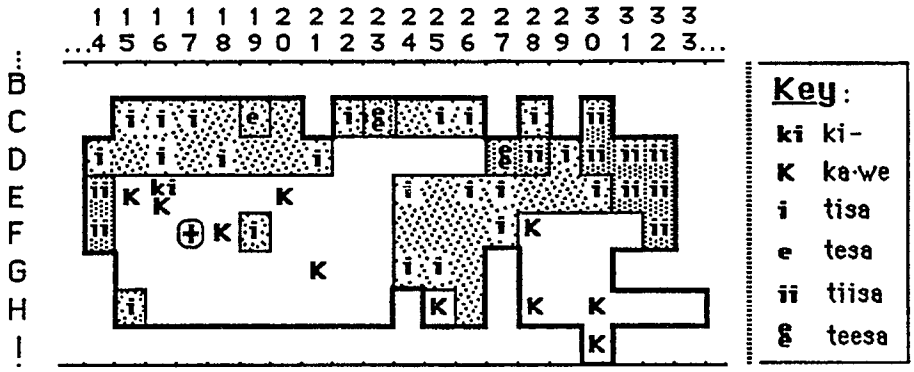


Figure 3.3. The distributions of one modifier prefix and five unbound preposed modifiers within the naming range of Guarajío *siyó-* (cf. Figure 3.1a).

Figure 3.3 demonstrates three graphics conventions: (1) Only one category is displayed; the irrelevant portions of the Munsell grid are deleted, in this case from both ends. (2) General distributions of different groups of modifiers -- those with short vowels versus those with long -- are visually contrasted with distinct qualities of shading; particular usages are indicated with letter symbols. The symbols of a third group are displayed against an unshaded background. (3) The naming-range outline of the root and the lines separating modifiers are of different widths. The latter lines, whose placement is somewhat arbitrary, enhance the visualization of the figure and, further below (cf. Figures 3.8a-c), facilitate the comparison of the modifier distributions with mapping steps.

3.3.5.2. Foci

Foci are organized on the graphs with both color-term roots and modifiers. In Figures 3.1a-b, foci occur in two ways: (1) In seven cases, the color chip that was selected as the focus of a term during the focus elicitation was also named with that term during the naming elicitation (e.g., H40, C8, F17, D35, FØ, AØ, and JØ).[9] These are marked with an oval containing a cross. (2) In two cases, the focus of a term was selected on a chip that was named with another term (e.g., E8 and E11). These are marked with an oval containing the shading that elsewhere symbolizes the naming range of the focused term.

As a further complication, one term was focused on two disjunctive colors, at FØ and E11.

3.3.5.3. Mappings

Figure 3.4a represents with herringbone lines the mapping of the term *siyóname*. The lines intersect the graph-cells that correspond to color chips on which the informant placed rice grains. Each line is framed and segmented with numbers. The numbers mark the edges of the steps by which the informant progressively mapped the category, and they indicate the order in which the steps were volunteered.[10] Since single steps were mapped on more than one row or on discontinuous segments within a row, the same step-numbers appear on different rows and frame discontinuous segments within a row. The earliest step on a row is bracketed at both of its edges by its number, the lowest on the row; each later step on the row is numbered at its outer edge only:

---

[9] "Ø" refers to the unnumbered, achromatic column of the array.

[10] Figures 3.4a-b can be compared with the raw mapping data of *siyóname* in Table 3.5. Each mapping step in both the organized and the raw data corresponds to the same row-letter/column-number intersections.

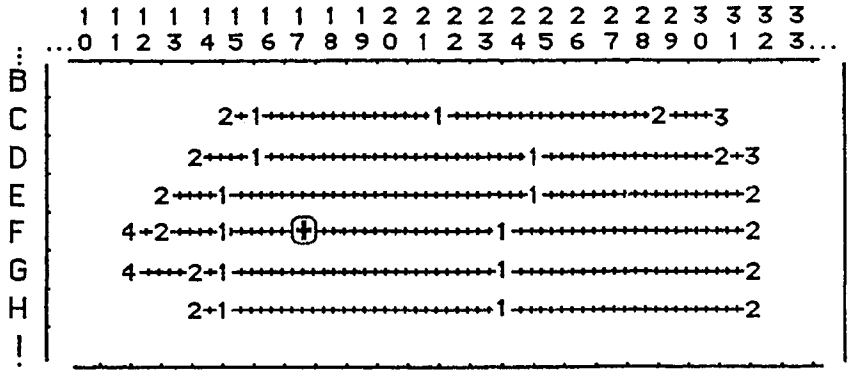


Figure 3.4a. A four-step mapping of Guarajío *siyóname.*

Figure 3.4b depicts the same mapping in a different style:

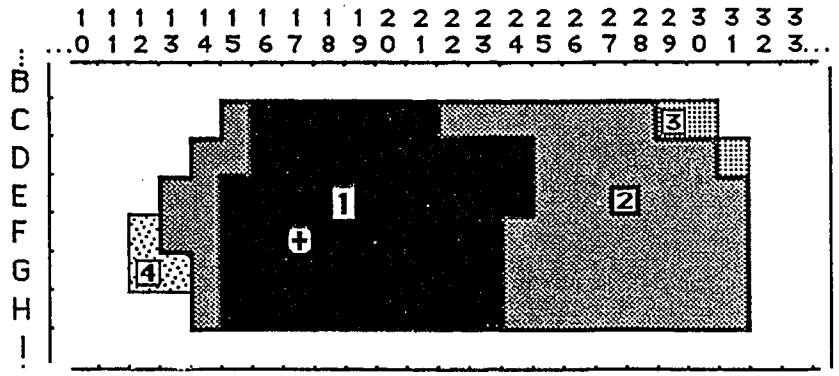


Figure 3.4b. Mapping steps depicted with shading.

Both styles of presenting a mapping have advantages, and both will be used in subsequent chapters. Figure 3.4b is easiest to see, but the style of Figure 3.4a allows different mappings to overlap in one diagram:

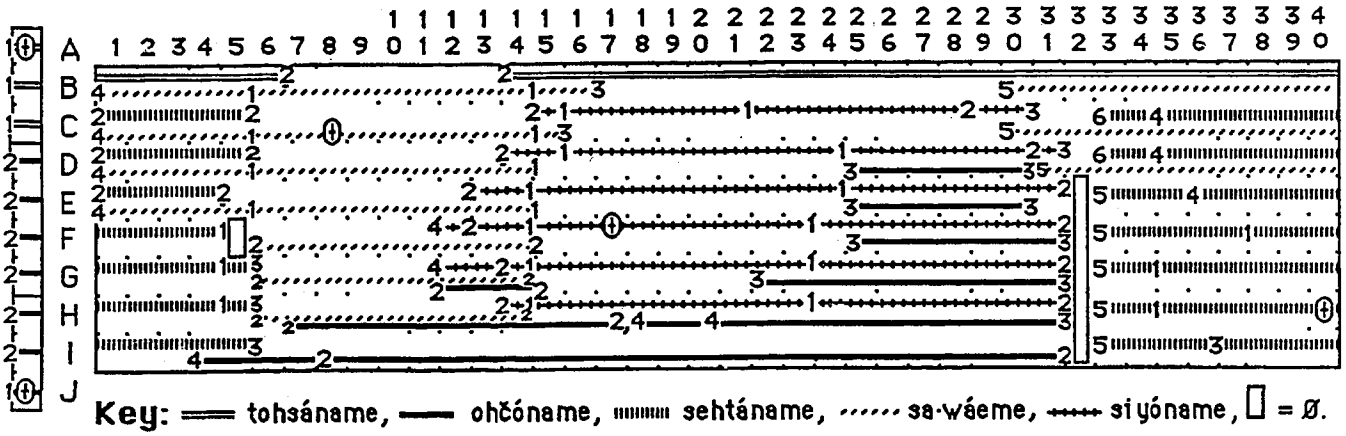


Figure 3.5a. A Guarajío speaker's mappings of basic color categories, speaker #1

Figure 3.5a demonstrates the overcrowded result of displaying the mappings of five categories in one diagram. This limitation of graphics is circumvented in most subsequent figures by combining a minimum of mappings in any display, or by supplementing crowded displays with other figures that show less. In spite of its busy appearance, Figure 3.5a shows (1) one individual's full system of basic color categories and (2) their overlapping ranges. The figure further shows that speaker #1 did not map some colors, those whose graph cells are enclosed by rectangles (e.g., F5, E-I 32). It shows that the range of the yellow-focused term (C8) extends throughout the yellow and brown colors of columns 5-14, those that were named with a mixture of four different words during the naming elicitation (cf. Figures 3.1a-b);[11] the mapping data demonstrate that the basic color-category system is simpler than would be evident from the naming data alone.

Section 3.3.6. presents single diagrams that combine mapping data and naming-range outlines. However, such combinations become even more overcrowded than do diagrams of just mappings by themselves when more than three categories are represented. Figure 3.5b exemplifies the unproductive effect of exceeding the three-category limit when combining mappings and outlines:

[11] The mappings of the other three words are discussed in Volume II.

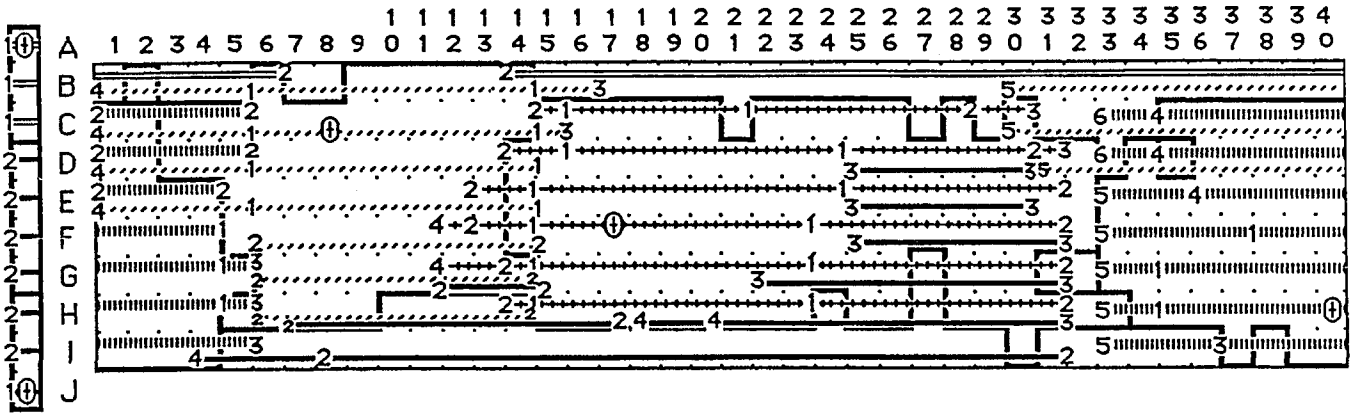


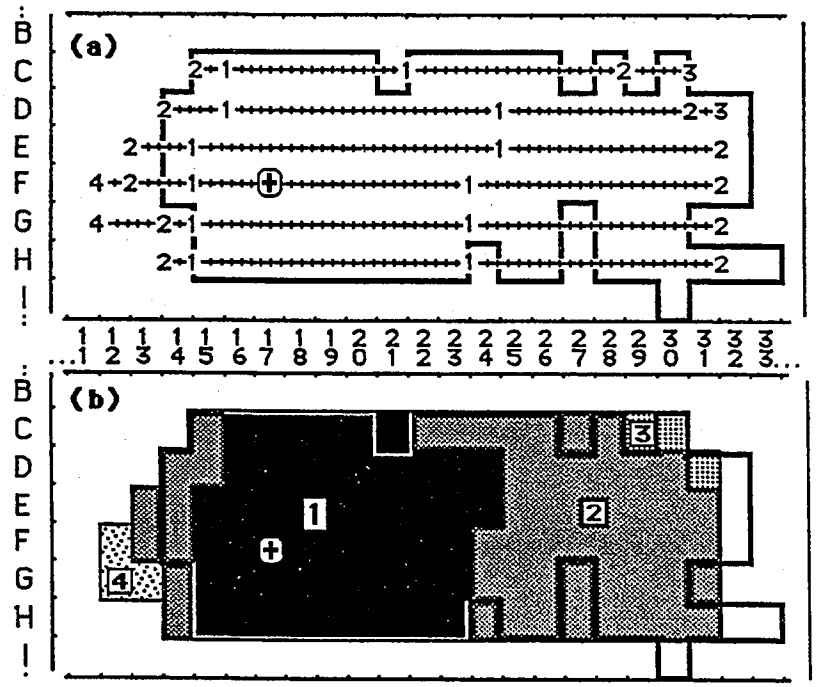
Figure 3.5b. The mappings of Figure 3.5a superimposed on the naming-range outlines of Figure 3.1a.

3.3.6. Analysis

Data from each informant were separately analyzed prior to conducting further analyses of data from groups of individuals. An analysis of data from one informant constituted a hypothesis of the way in which that individual cognitively organized the color domain. The hypothesis was supported by multiple correspondences between naming ranges, foci, the ranges of mappings, modifier distributions, and mapping steps. The analysis was carried out by comparing the different data and identifying correspondences. The following demonstrates how such a hypothesis of individual color cognition was constructed from the data volunteered by Guarajío speaker #1. For brevity, the demonstration concentrates on the analysis of black-focused and green-focused categories and their overlap throughout blue colors:

3.3.6.1. Correspondence among Naming Ranges and Mappings

Figure 3.5b exhibits correspondence between naming ranges and mappings throughout the domain. Figures 3.6a-b extract the same correspondence within the green-focused category:



Figures 3.6a-b. The correspondence between the naming range and mapping of *siyóname* represented in two styles, (a) and (b).

Figures 3.6a-b show that the first mapping step and the naming range fail to match only at C21, whereas the second step and the naming range fail to correspond at H24, C27, G-H27, and G31. If column 23 is taken to represent the universal divide between perceptions of green and blue,[12] the green-focused category was named 50 times on the green side of the column and 47 times on the blue side; the category was mapped throughout 58 color chips on its green side and 47 on its blue side. The quantitative biases in naming and mapping correspond with each other, and they correspond with placement of the focus and of the first mapping step on green.

[12] Kay and Kempton (1981) established on the basis of experiments with speakers of English and Japanese that column 23 of the maximally saturated Munsell array, 1976 issue, is the divide between green and blue for both groups.

These correspondences support the hypothesis that the Guarajío speaker cognitively organizes the green-focused category with unequal values of membership that favor green over blue.

3.3.6.2. Correspondence among Mappings

Further correspondences corroborate the hypothesis. Figure 3.7a displays the relationship between the mappings of the green-focused and black-focused categories:

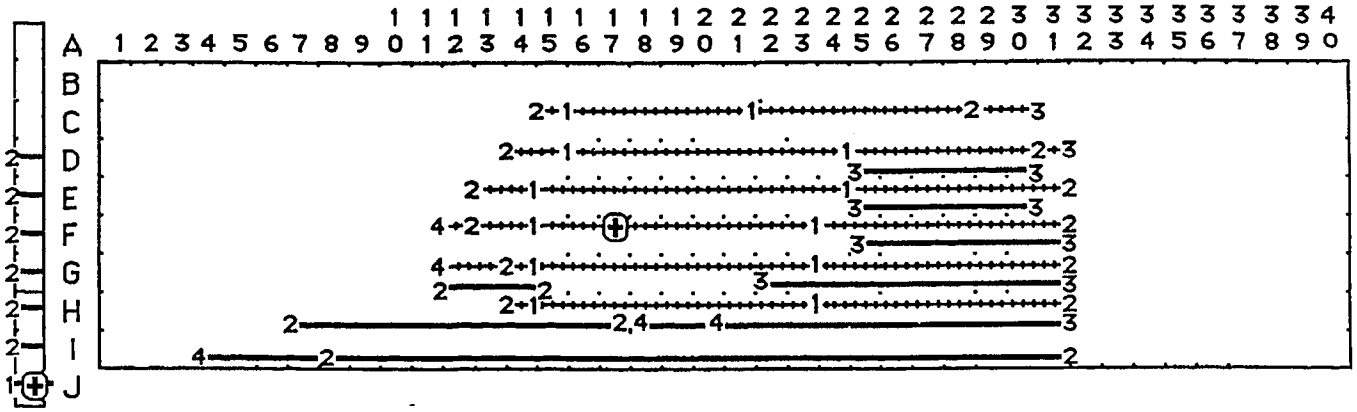
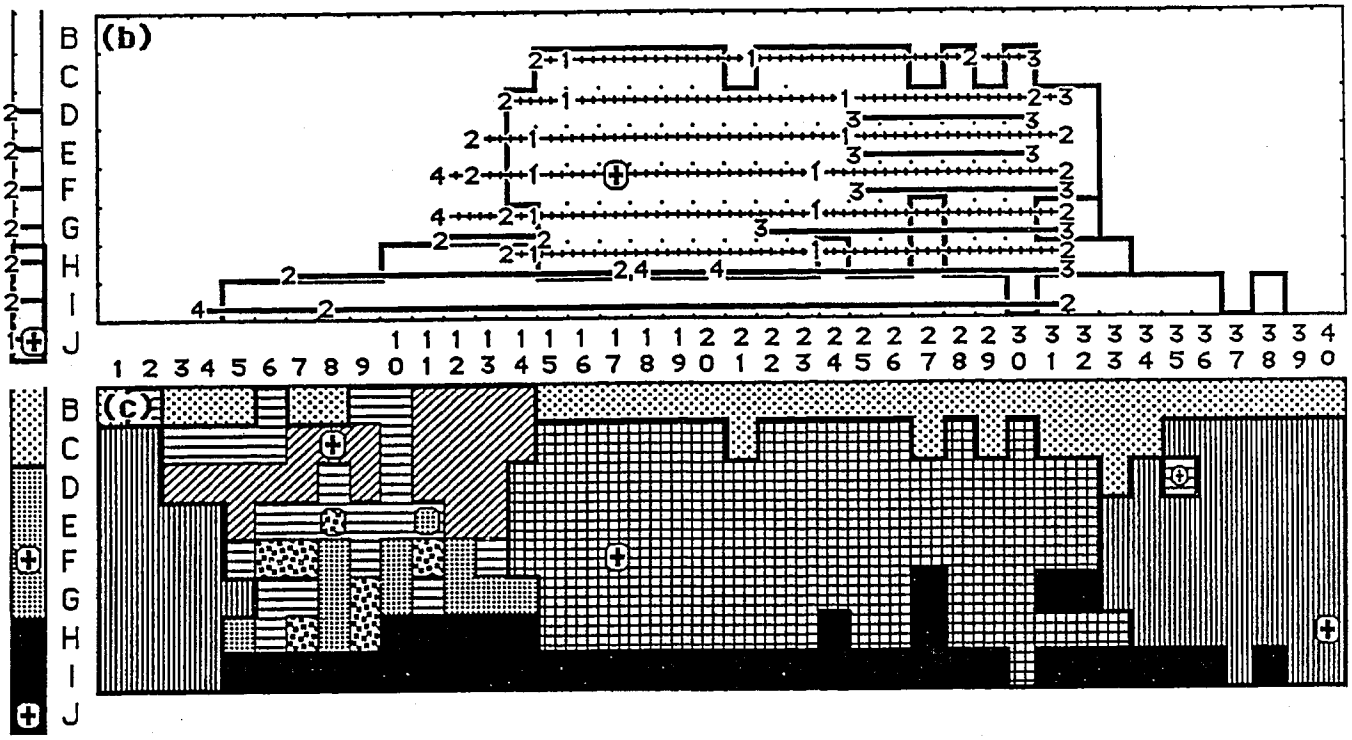


Figure 3.7a. One individual's mappings of *siyóname* and *ohčóname,* speaker #1.

Figure 3.7a shows that the second step of one mapping corresponds with the third step of the other throughout blue colors; the second step of the mapping of the green-focused category and the third step of the mapping of the black-focused category correspond. Each category overlaps with the other at its area of moderately low membership, and each does not significantly overlap at its area of highest membership. Blue colors -- including unique blue -- are categorized from *two perspectives,* one that is green-focused and another that is black-focused.

Figures 3.7b-c show a further correspondence between the overlap of mappings and an interspersal of naming ranges:



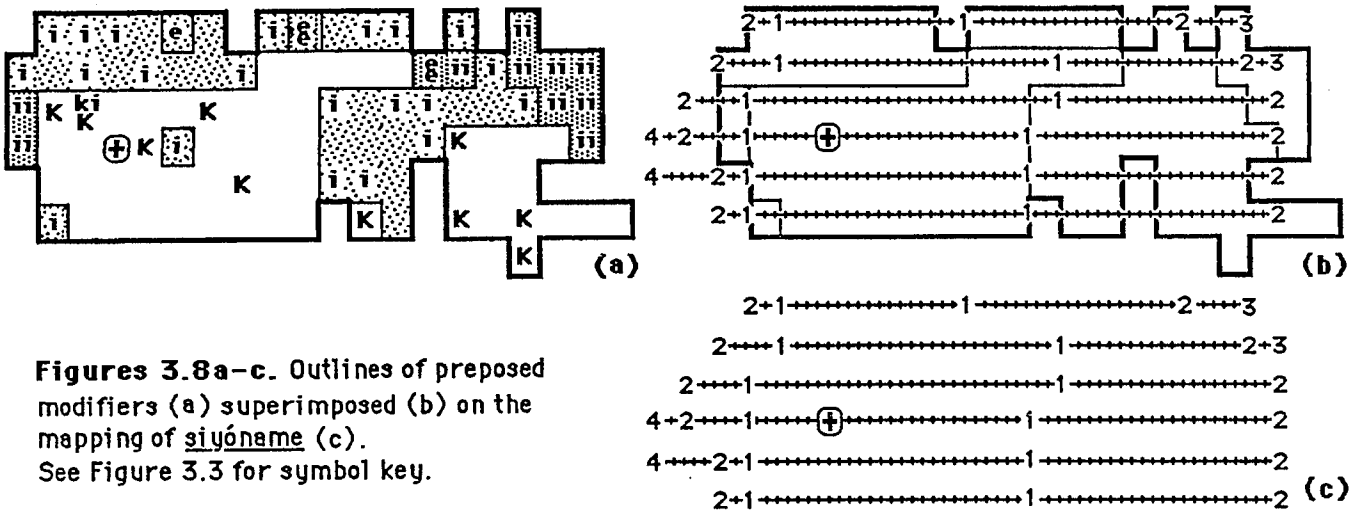
Figures 3.7b-c. Mappings of *siyóname* and *ohčóname* superimposed on naming-range outlines (b) and naming ranges (c).

Figures 3.7b-c show that the third mapping step of the black-focused category in blue colors corresponds with an extension of the black-focused naming range at H24, G-H27, G31-32.

The correspondence among mappings fits together with all of those among naming ranges and mappings. The three-way agreement contributes further to the hypothesis of individual cognition: Speaker #1 categorizes blue colors from two perspectives by including them in low- membership areas of separately focused categories.

3.3.6.3. Correspondence among Modifiers and Mappings

Figures 3.8a-c combine earlier figures (3.3-4a) to show correspondence among the preposed modifiers of the root *siyó-* and the mapping of *siyóname:*

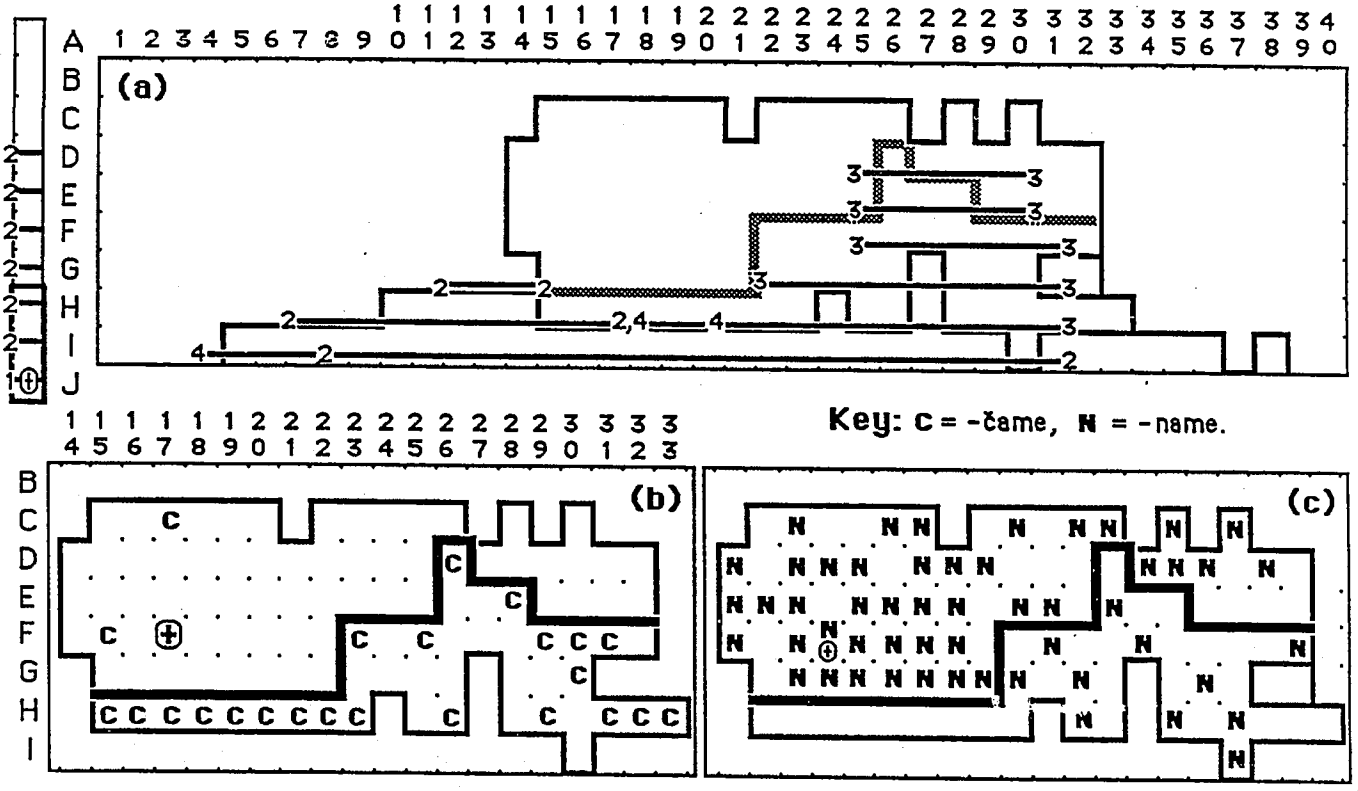


Figures 3.8a-c. Outlines of preposed modifiers (a) superimposed (b) on the mapping of siyóname (c).
See Figure 3.3 for symbol key.

In Figure 3.8a, diminutive modifiers meaning "a little" are shaded and augmentative modifiers meaning "very good" are unshaded. Figure 3.8b shows that the diminutive modifiers tend to correspond to the second and third mapping steps and to the edges of the mapping; the augmentative modifiers correspond to the green focal region of the first mapping step and to the bluest colors of the second mapping step. However, an equal number of augmentative modifiers occur on the green and the blue sides of the perceptual divide at column 23 (cf. Figures 3.7b-c and footnote 11); and this distribution does not correspond to the attested lower membership of blue colors in the category. The non-correspondence indicates the need of another interview and further tests, such as a mapping elicitation of specifically *ka we siyóname.* A possible correspondence is the one prefixation of *ki-* to an augmentative modifier on exclusively the high-membership side of the category. The prefix might semantically intensify the augmentative value of the modifier, but this

minuscule datum was overlooked during the interview and its meaning was not investigated.

Figures 3.9a-b show a correspondence between a suffixed modifier, *-čame,* of the root *siyó-* and the overlap of green-focused and black-focused category mappings:



Figures 3.9a-c. Correspondence of the mapping of *ohčóname* with usages of *siyóčame* (a) and complementary distributions of *-čame* (b) and of *-name* (c) within the naming range of *siyó-*.

The data of Figures 3.9a-b indicate that the informant used the suffixed modifier, *-čame,* to specify colors of the green-focused category that either were peripheral (e.g., F15 and C17) or that were also members of the black-focused category. The informant not

only mapped the overlap of two categories with late steps, but he named it differently. He named it as he did peripheral colors, *siyóčame*.

3.3.6.4. Correspondence among Modifiers

Figures 3.9b-c display complementary distributions of different modifier suffixes in the green-focused category. The complementation constitutes a kind of correspondence. Whereas *-čame* designates the area of overlap and low membership, *-name* predominantly designates the green colors of highest membership that correspond to the focus and first mapping step; however, *-name* is used less frequently but regularly to name colors of lower membership throughout the margins and the blue half of the category.

The distribution of *-name* is consistent with its meaning as the general designation of the whole category, properly called *siyóname*. Speaker #1 was most inclined to use the term for the whole category under the specific stimulus of colors about its focus; he tended to associate the whole with its most typical part.[13]

3.4. Final Remarks

The correspondences among independently elicited data sustain a hypothesis that Guarajío speaker #1 cognitively organizes green-focused and black-focused categories with unequal values of membership in each. Highest membership occurs about category foci; lowest membership occurs at category margins and in blue colors, throughout which the categories overlap. The blue colors are categorized from the perspectives of both foci.

---

[13] "It would be surprising if the best examples of categories were not highly associated with the category name, and it is not surprising that best examples of categories elicit the category name as a superordinate more frequently than do peripheral examples" (Rosch 1973a: 139). The focus of *siyóname* at G17 was elicited during the WCS interview in Alamos, a year prior to the MCS interview in Ixmiquilpan. During the latter, *siyóname* was focused at E25. The WCS focus was used in this demonstration of method, because it agrees with the other data in the simplest way. Mixture of data between results of different interviews is inadmissible for purposes of a real analysis.

The WCS focus agrees with Rosch's statement. Speaker #1 might have placed the MCS focus on a central turquoise (E25) because it equally represents the application of *siyóname* to all colors of the cool category; during that interview, he focused *siyomúrame* at G17. At the time of the MCS interview, speaker #1 was involved in a linguistic workshop outside of Guarajío territory; his analytically oriented employment might have inspired him to consider additional contingencies as he focused.

The analysis calls up further questions that might be resolved during another interview of Guarajío speaker #1. For example, it would aid the analysis to elicit separate mappings of specialized forms, such as *ka·we siyóname* and *siyóčame,* and to establish the meaning of *ki-*.

The methods are intended to allow a spiralling feedback between analysis and further interviews on progressively more penetrating levels of inquiry. Since no part of the elicitations or the data organization depends on cumbersome equipment or electricity, analyses can proceed while informants are on hand for reconsultation and specific tests. In practice, much data of the Mesoamerican Color Survey were extracted from single interviews and analyzed away from the field, although approximately 100 individuals were reconsulted and a few were interviewed by both the MCS and the WCS. Almost every analysis stood by itself without further field work.

Chapter IV

Basic Categorization

4.0. Preface

This chapter addresses data whose significance is far from obvious, and it develops their theoretical implications. In the process, the chapter provides a conscious and deliberate demonstration of the approach to hypothesis-building that will characterize the analysis of Mesoamerican data throughout this volume and the next. In the first capacity this chapter moves ahead with the primary aim of contributing to theory, and in the second it continues the introduction to method from the prior chapter. The discussion proceeds by undertaking four objectives (**1.-4.**), three in section 4.1 and the last in section 4.2.:

1. The first intent is to introduce a genre of correspondence between data that might challenge casual assumptions of how data should match each other. The aim, further, is to show how the accuracy of such data is substantiated. Since data of subsequent chapters manifest the same order of unexpected correspondence, it is crucial to present a thorough account at the outset:

A naming range can be much smaller than its mapping, even though neither set of data is in error. For example, some Tenejapa Tzeltal speakers used their black-focused term mainly to name dark colors and they used it to name a few blues, but they mapped the term throughout black, green, and blue in the configuration of a dark-cool category. The same speakers each mapped a cool-focused term throughout green and blue, and each used the term about 95 times to name the same colors. In short, a dark-cool category of low

salience encompassed a cool category of high salience, the appraisal of "salience" being based on the number of times a term is used relative to the size of its mapping.[1]

A second group of Tzeltal speakers, on the average younger than the first, mapped the black-focused term on only dark colors and mapped the cool-focused term in green and blue; each speaker used the latter name about 135 times. In short, they maintained separate

---

[1]Berlin and Kay (1969:5-7) define the basic color term by four major (I-Iv) and four subsidiary (v-vIII) criteria:

> Every language has an indefinitely large number of expressions that denote the sensation of color. Note, for example, the following English expressions: (a) *crimson*, (b) *scarlet*, (c) *blond*, (d) *blue-green*, (e) *bluish*, (f) *lemon-colored*, (g) *salmon-colored*, (h) *the color of the rust on my aunt's old Chevrolet*. But psychologists, linguists, and anthropologists have long operated with a concept of basic color term, or basic color word, which excludes forms such as (a)-(h) and includes forms like *black*, *white*, *red*, and *green*. However, the expression basic color term does not have a unique operational definition. We used the following procedure for the determination of basic color terms. Ideally, each basic color term should exhibit the following four characteristics:
>
> **(I)** It is *monolexemic;* that is, its meaning is not predictable from the meaning of its parts (cf. Conklin 1962). This criterion eliminates...(e)-(h) and perhaps also (d).
>
> **(II)** Its signification is not included in that of any other color term. This criterion eliminates examples (a) and (b), which are both kinds of red for most speakers of English.
>
> **(III)** Its application must not be restricted to a narrow class of objects. This criterion eliminates example (c) which may be predicated only of hair, complexion, and furniture.
>
> **(Iv)** It must be psychologically salient for informants. Indices of psychological salience include, among others, (1) a tendency to occur at the beginning of elicited lists of color terms, (2) stability of reference across informants and across occasions of use, and (3) occurrence in the idiolects of all informants. This criterion eliminates all the examples (a)-(h), most particularly (h).
>
> These criteria (i-iv) suffice in nearly all cases to determine the basic color terms in a given language. The few doubtful cases that arise are handled by the following subsidiary criteria:
>
> **(v)** The doubtful form should have the same distributional potential as the previously established basic terms. For example, in English, allowing the suffix *-ish*, for example *reddish*, *whitish*, and *greenish* are English words, but **aquaish* and **chartreusish* are not.
>
> **(vI)** Color terms that are also the name of an object characteristically having that color are suspect, for example, *gold*, *silver*, and *ash*. This subsidiary criterion would exclude *orange* in English, *if* it were a doubtful case of the basic criteria (i-iv).
>
> **(vII)** Recent foreign loan words may be suspect.
>
> **(vIII)** In cases where lexemic status is difficult to assess [see criterion (i)], morphological complexity is given some weight as a secondary criterion. The English term *blue-green* might be eliminated by this criterion.

During the pilot phase of the MCS, elicitation of "salience lists," of the kind specified as (Iv) (1), accompanied each interview; but the practice was abandoned: often the lists radically contradicted other data, and no objective way could be found for admitting or excluding such lists as primary evidence of salience; either all of them had to be used, or none of them. Others who have worked with salience lists report different results (e.g., Bolton, Curtis, and Thomas 1980).

The Tenejapa Tzeltal naming frequencies of the cool category could give the misimpression that an absolute numerical index can be used as a measurement of salience in the color categories of any language. But, to the contrary, the Mesoamerican data show that the naming frequency of the cool category differs between languages when the category is unequivocally basic for all speakers interviewed. The frequency

(Continued next page.)

black and cool categories and named the latter with higher salience than did those of the first group.

The key observation is that the broad black-focused mappings of the first group *corresponded* with fewer uses of the cool term than did the narrow black-focused

(Continued from prior page.) varies from a low of 80 uses of the category-name by an individual Jacaltec speaker to a high of 177 by a Cakchiquel speaker (cf. Figures 8.32a-33d). The Jacaltec speaker named a basic cool category fewer times than any of the Tenejapa Tzeltal speakers. Of the three Amatenango Tzeltal speakers who were interviewed, one named the cool category 132 times and two named it 105 and 113 times; the latter two mapped a black-focused dark-cool category and the former did not. The latter numbers are higher than the average of 94 among the Tenejapa Tzeltal speakers who mapped the dark-cool category.

Hays et al. (1972) propose additional indices of salience:

> Eleven focal colors are named by basic color terms in many languages. The most salient colors (black, white, and perhaps red) are named in all languages; the least salient of the set are named in fewer languages. Salience correlates with earliness of introduction, as measured by a scale of social evolution; with brevity of expression, as measured by phonemic length of basic terms; with frequency of use, as measured by frequency of basic color terms in literary languages; and with frequency of mention in ethnographic literature. None of these correlations are established in the pioneer study of Berlin and Kay (1969)... The first two were documented in Narol (1970) and Durbin (1972); the last two are documented here.

Hays et al. define salience in perceptual terms rather than in linguistic or cognitive terms:

> By salience of colors we mean those colors which are notable for their prominence and conspicuousness, and thus attract attention. Salient colors "leap out"...from French *salire* "to leap," and we define it in this traditional way.

The following comments are in order: (1) Unlike the cognitive and linguistic indices of salience, a perceptual index is not testable under most ethnographic field situations; at least, Hays et al. have not developed a test. (2) Hays et al., without independent justification, assign perceptual foci to a scale of salience, then they equate the scale with Berlin and Kay's evolutionary sequence. But Berlin and Kay do not explain the universals of color-term evolution by relative perceptual salience. (3) Hays et al. note that the shortness of a term might correspond with its age or frequency of use; and salience, in many cases, might be related to age and frequency. However, a given number of phonemes indexes nothing in any particular instance. (4) Hays et al. cite frequency of use as a corollary of salience. This index is adopted in the present analysis, specifically in regard to results of the naming elicitation. (5) The present study does not use Hays et al.'s index of "frequency of mention in ethnographic literature," although it appears that Berlin and Kay (1969: 32-33) themselves have used this index to assess the salience of color terms in Mayan languages (See footnote 2).

This chapter concentrates on the criteria of *superordination* (ii) and *salience* (iv), because these are manifested throughout the Mesoamerican data in ways that contribute most to theory. Berlin and Kay's stipulations (i and iii) that basic color terms are *monolexemic* and *non-context-specific* are also manifested in the sample, but their theoretical import is less striking:

Kaufman (1976: 962-3) identifies a historical tendency throughout many Mesoamerican languages (e.g., "Type A") to use words of one or few morphemes, and he lists the tendency as a diagnostic of the linguistic area. As a result of the tendency, many color terms in Mesoamerican languages are not only monolexemic but also monosyllabic, regardless of whether they are basic. Aztec color terms, however, are exceptionally pertinent to the "monolexemic" criterion (cf. Hill and Hill 1970; Molina: 1571): Most Aztec color terms are etymologically transparent, usually consisting of a reduplicated natural-object term
(Continued next page.)

mappings of the second group. The numerical correspondence of independently elicited data substantiated that all data from both groups were accurate, even though the maintenance of a dark-cool category by speakers of the first group was not superficially apparent from the way that they named color.[2]

2. The next purpose is to demonstrate how perceptual and cognitive axioms are combined in a manner that leads to a hypothetical explanation: The Tzeltal speakers who mapped the black-focused term throughout black, green, and blue attended more to similarity and less to distinctiveness than did those who confined its mapping just to dark colors. Conversely, those of the latter group limited the black-focused mapping because they attended more to distinctiveness; each of them named the cool category more times than did any among the former group, because each attached greater importance to the finer division of black versus green-with-blue.[3]

(Continued from prior page.) combined with a modifier suffix, as in *λiλ-tik* (soot > black), *istak* (snow > white), *čičil-tik* (chili pepper > red), *kos-tik* (? > yellow), *šošo-tik* (leaf > green, blue). In this case, the monolexemic criterion must be interpreted to mean the simplest construction applied to color.

Some context-specific color terms pertaining to foods, soils, weather, and animals were collected adventitiously during the Mesoamerican survey. Some individuals were inclined to name color chips with these words, at least at low salience. Context-specificity is a variable quality; terms can become non-context-specific as the variation shifts (cf. Kuschel and Monberg 1974).

[2]This demonstrates the reason for collecting data with 330 color chips rather than with a time-saving half set of 165 (cf. Heider 1972b; footnote 13, Chapter I, page 44).

Non-obvious attributes of the variation among Tenejapa Tzeltal color categories did not emerge in earlier elicitations: Berlin and Kay (1969: 32-33) report the results of acetate mappings that establish the range of the Tenejapa Tzeltal black-focused term at unique blue, but the acetate-mapping method did not detect the range of the term throughout green. The difference between Berlin and Kay's results and those shown in Figures 4.1a-4c can be attributed to the distinct methods by which the data were collected.

Berlin and Kay (32-33) classify "the twenty-six Mayan languages of Mexico and Guatemala" as Stage IV. The classification is based on the acetate mappings collected from Tzeltal speakers and, probably, on the five color-term cognates that are reported over-and-again throughout Mayan languages (cf. Meyers 1962: 382, 396-7). If the latter criterion was used, it would be much like Hays et al.'s (1972) criterion of "frequency of mention in ethnographic literature." Had the acetate-mapping method enabled Berlin and Kay to detect the dark-cool range of the Tzeltal black-focused category, they might have classified the language as an earlier stage than IV.

[3]It is possible that Tzeltal speakers are unaware of their differences in color categorization. The distinct extents to which they attend to similarity and to distinctiveness might lock each into a particular view and set of expectations that discourages recognition of such differences. Berlin and Berlin
(Continued next page)

In sum, all of the Tzeltal speakers behold the same perceptual hierarchy in which black-with-green-with-blue constitutes a more inclusive grouping than does black versus green-with-blue. The perceptual hierarchy is invariant. Yet some speakers categorize these colors on the more inclusive level and others on the more specific level, because they differ in cognition. Although perception is invariant, cognition is mutable. Since perceptual axioms cannot account for variation and change, the cognitive axiom is unavoidable.

3. Next, the chapter demonstrates how the engagement of perceptual and cognitive axioms is useful in addressing dilemmas of theory:

First, some of the data from Tzeltal present an incongruity among Berlin and Kay's criteria of a "basic color category," namely *superordination* and *salience* (See footnote 1, ii and iv.). The speakers who maintain the dark-cool category split the criteria between two hierarchically related categories such that the superordinate dark-cool category is less salient than the cool category that it encompasses.

Second, Berlin and Kay's "basic color category" and Rosch's "basic level of categorization" have not been unified as concepts. Rosch defined the basic-level as a perceptual construct, as "maximal correlational structures of the environment" (See section 1.7.2.5.). The perceptual definition appeared to fix the basic level of color categorization at a particular but unspecified tier of the perceptual hierarchy; but it was impossible to specify, for example, whether the dark-cool category, the cool category, or the black, green and blue categories constituted the basic level. Rosch further stipulated that the basic level, wherever it might be, would be the easiest to use.

The first dilemma regarding split criteria is resolved by the cognitive axiom: the attendances to similarity and to distinctiveness shift strengths reciprocally. This means that

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(Continued from prior page.) (1975: 86, note 9) report the reactions of young Aguaruna speakers on witnessing older relatives map seemingly familiar color terms on the Munsell array. Individuals who are unaware of their differences cannot instigate change by copying a prestigious variant (cf. Weinreich, Labov, and Herzog 1968; Kay 1975; Section 1.7.1.2., page 29). Section 2.1.3. (page 60) outlines proposed motives of cognitive change in color categorization. They involve attempts by individuals to adopt wherewithal to cope with increasing complexity or novelty of surroundings. None involve a hypothesis of social copying and prestige motive; variation always accompanies change but is not part of its cause.

individuals who maintain the strengths at different balances will find it easiest to categorize at different perceptual levels. Further, as the balance shifts in favor of distinctiveness, the *reciprocity* of strengths determines that basic categorization will move from a general level to the next most specific level *smoothly* and *continuously*, not by discrete increments or jumps. Therefore, at any time, certain individuals will situate basic categorization between perceptual levels. From that situation, the criteria of basic categorization will be split between vertically related categories.

The basic color category and the basic level of categorization are united by recognizing that basic categorization is as much cognitive as it is perceptual. For this reason, it is mobile rather than fixed. Since cognition is a reciprocity of attendances, basic categorization moves between perceptual levels continuously rather than by disjunctive leaps.

Although Rosch's concept is radically altered, Berlin and Kay's concept is reconciled with what otherwise would amount to an inexplicable incongruity. The alternative to this emendation would be to add arbitrarily baggage to the criterial definition of a basic color category, such as assigning highest priority to salience. The present proposal can be assessed against other ways of addressing the same problems:

Berlin and Berlin (1975: 72-74, 83-84, figs. 9-15) note that some Aguaruna speakers manifest the same split of criteria between dark-cool and cool categories as is found in Tzeltal; but they favor the salience criteria, as implied by their classification of these speakers as Stage IIIa. B. Berlin (personal communication) further suggests that the basic level of color categorization might consist of the eleven categories used by many of world's major languages, such as English. Languages evolve basic color categories as

they strive to "achieve" this level as a long-range perceptual target.[4] Thus, the perceptual definition of the basic level is preserved at the expense of complicating the definition of the basic color category and by further proposing that change progresses toward a distant goal.

Such issues need not be resolved on the basis of circumscribed data, such as those from Aguaruna and Tzeltal. The rival hypotheses can be appraised in view of how each articulates with yet other hypotheses within the framework of a theory. For example, the notion that change in basic categorization is continuous between perceptual levels is consistent with other findings: In Chapters V-VIII it is shown that semantic relationships manifest a continuum of types within a category as it divides by progressive phases; the continuous evolution of basic color categories and the continuous evolution of semantic types are both propelled by the same shift between reciprocal strengths of the attendances to similarity and to distinctiveness.

4. The final objective stands apart from the first three. It is to display a unique case in which the axiom of cognitive reciprocity might have been suspended, although the suspension is probably unstable and temporary. The exceptional data are from Navenchauc Tzotzil, a neighbor of Tzeltal. The circumstance of Navenchauc itself is exceptional, because the village directly abuts the Panamerican Highway. Construction of that major artery some thirty years ago abruptly plunged the formerly isolated settlement into the twentieth-century mainstream. Yet its inhabitants, especially women, preserve indigenous dress, monolingualism, and traditional ways. The residents of Navenchauc have maintained what is old while assimilating what is new.

[4]Berlin, Breedlove, and Raven (1973: 224-25) recognize continuous movement of the basic level of folk biological categorization: "Some specific taxa in question appear to be achieving generic status." They describe it as though the taxa move 'up', while the present analysis of color categorization implies that the basic level moves 'down'. The figures of speech refer to the same movement, although from different perspectives. The present analysis departs from what has long been observed only by hypothesizing how the movement is "achieved" and why it is necessarily continuous.

It appears that under this condition, the reciprocity of strengths between the two attendances has been broken or, at least, altered. Individuals attend strongly both to similarity and to distinctiveness.[5] The evidence from color categorization is two-fold: (1) The present chapter will discuss data from five young women who simultaneously and saliently named four perceptual levels. It is impossible to identify one basic level among them. Data from the other 115 languages in the Mesoamerican sample show separate naming of no more than two levels, as in Tzeltal; and one level is always more salient than the other. (2) Chapter VI shows that the same Tzotzil speakers fully map the warm category, but with 9 to 14 small steps. Speakers of other languages who use the warm category usually map it with 1 to 3 large steps.

It is important to show that, in a rare case, a people might collectively depart from the cognitive axiom. But when they do, unusual patterns result in more than one order of data. The construct of "basic categorization" cannot be applied as it can in other instances. It depends on the reciprocity of the two attendances.

4.1. Variation In Tzeltal

Nine Tzeltal speakers were interviewed at Paraje Nabil, an outlying hamlet of San Alonso Tenejapa. Seven yielded data that are suitable for this analysis, and two used exceptional systems that are analyzed elsewhere (cf. Figures 6.26a-c; Volume II). The seven comprise two groups:

The first group consisted of four monolingual individuals, ages 60, 90, 60, and 65±. Each mapped a black-focused category throughout black, green, and blue in the configuration of a dark-cool category, and they named the category at high salience in dark

[5]Iijima, Wenning, and Zollinger (1982: figs. 1-3) make a similar observation of differences between the color categories of three populations of Japanese speakers, two in semi-rural and urban Japan and one in Germany. The latter group attempted to maintain Japanese language and culture while adapting to its foreign surroundings. That group placed the maxima of distinct color categories, such as green and blue, farther apart on the Munsell array than did the two groups in Japan. The greater differentiation of maxima indicates stronger attendance to distinctiveness. But the group in Germany also used a broader range for each category. Broader category ranges indicate stronger attendance to similarity.

colors, brown, and purple, at low salience in blue, and at exceptionally low salience in green. Each also named and mapped a cool category. Although the dark-cool category was superordinate and the cool category subordinate, they named the cool category at higher salience than the dark-cool category througout green and blue. Each named the cool category 89, 85, 100, and 100 times respectively, an average of 94 uses of the category-name. See Figures 4.1a-4c.

The second group consisted of three individuals, ages 70, 75, and 34. The former two were monolingual, and the latter was bilingual Tzeltal-Spanish and had lived in San Cristóbal de las Casas for 15 years. Each named and mapped the black-focused category only in dark colors, purple, and brown, and each named and mapped the cool category only in green and blue. Each named the cool category 141, 122, and 143 times respectively, an average of 135. See Figures 4.5a-7c.

The data show that the dark-cool mappings of the black-focused category correspond with lower naming salience of the cool category; the limited dark mappings of the black-focused category correspond with higher naming salience of the cool category. The correspondences indicate that all of the data are accurate.

One further correspondence is evident, although it is easier to assess impressionistically than by quantification: The individuals of the first group tended to intermix terms more readily than did those of the second group. Compare, for example, the naming ranges of speakers #4 and #5 of Figures 4.4a and 4.5a.

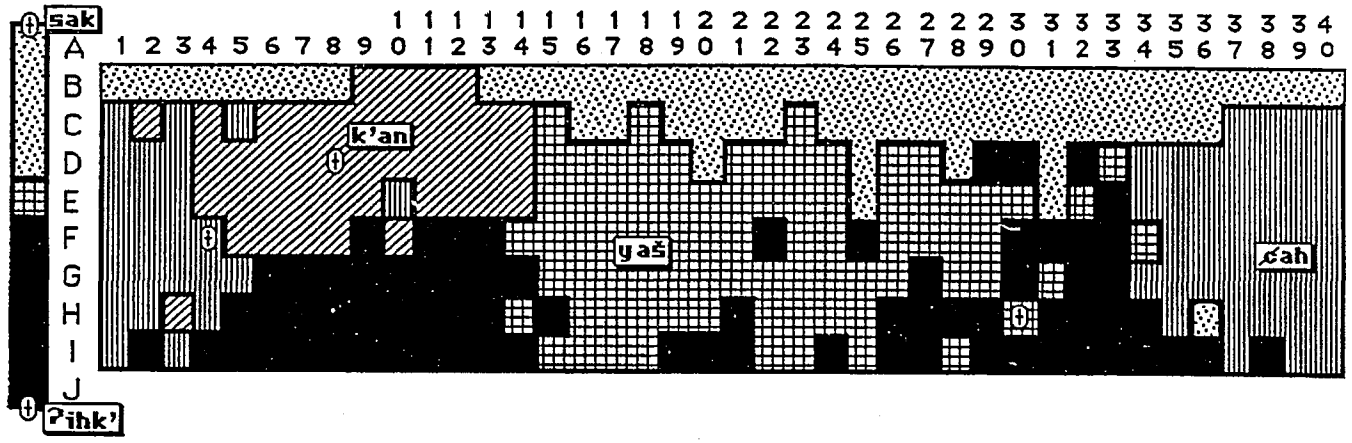
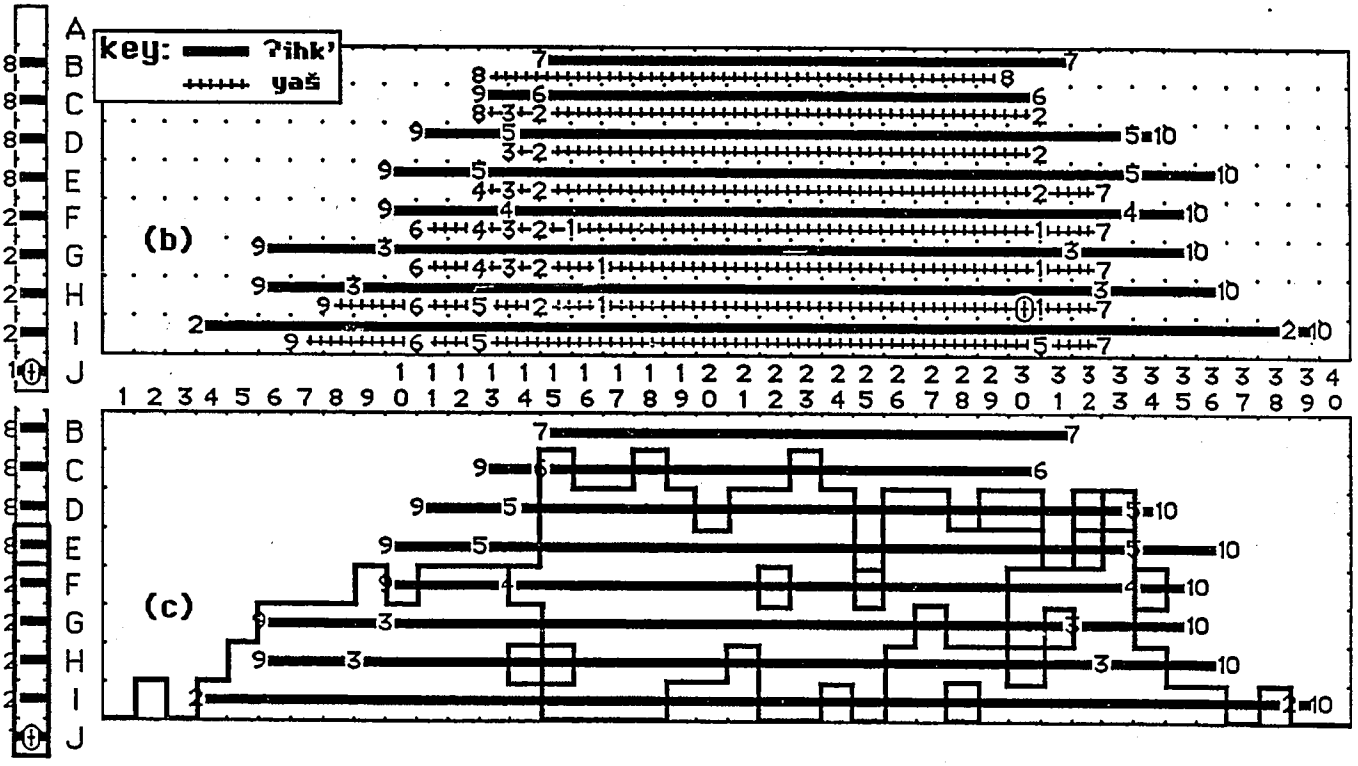


Figure 4.1a. Naming ranges, Tzeltal, San Alonso Tenejapa, speaker #1, woman, age 60, 1980. Key applies to Figures 4.2a, 4.3a, 4.4a, 4.5a, 4.6a, and 4.7a.



Figures 4.1b-c. Mappings (b) from cool and dark-cool categories of speaker #1 with (c) naming-range outlines superimposed from Figure 4.1a. Key applies through Figure 4.7c.

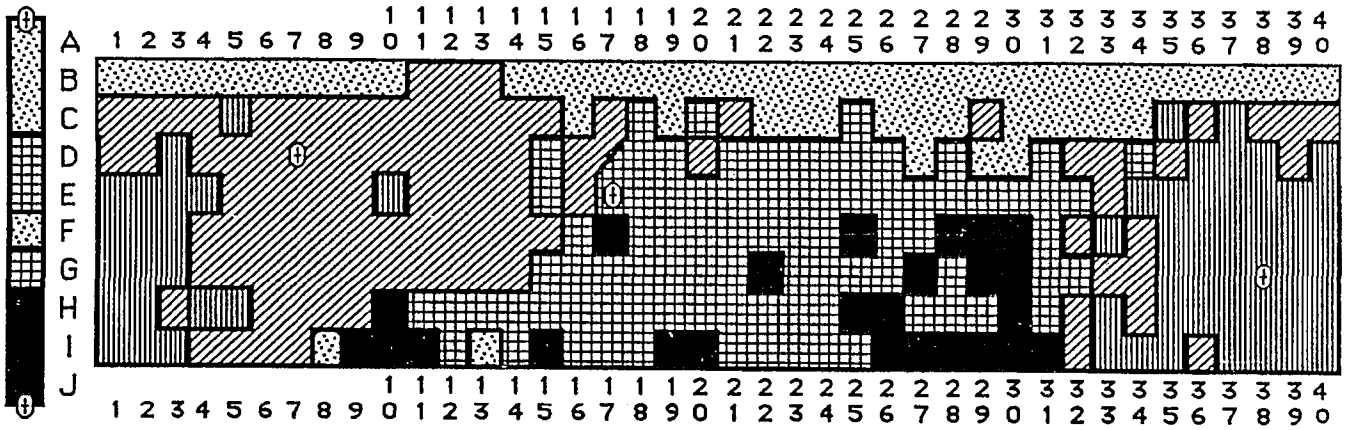
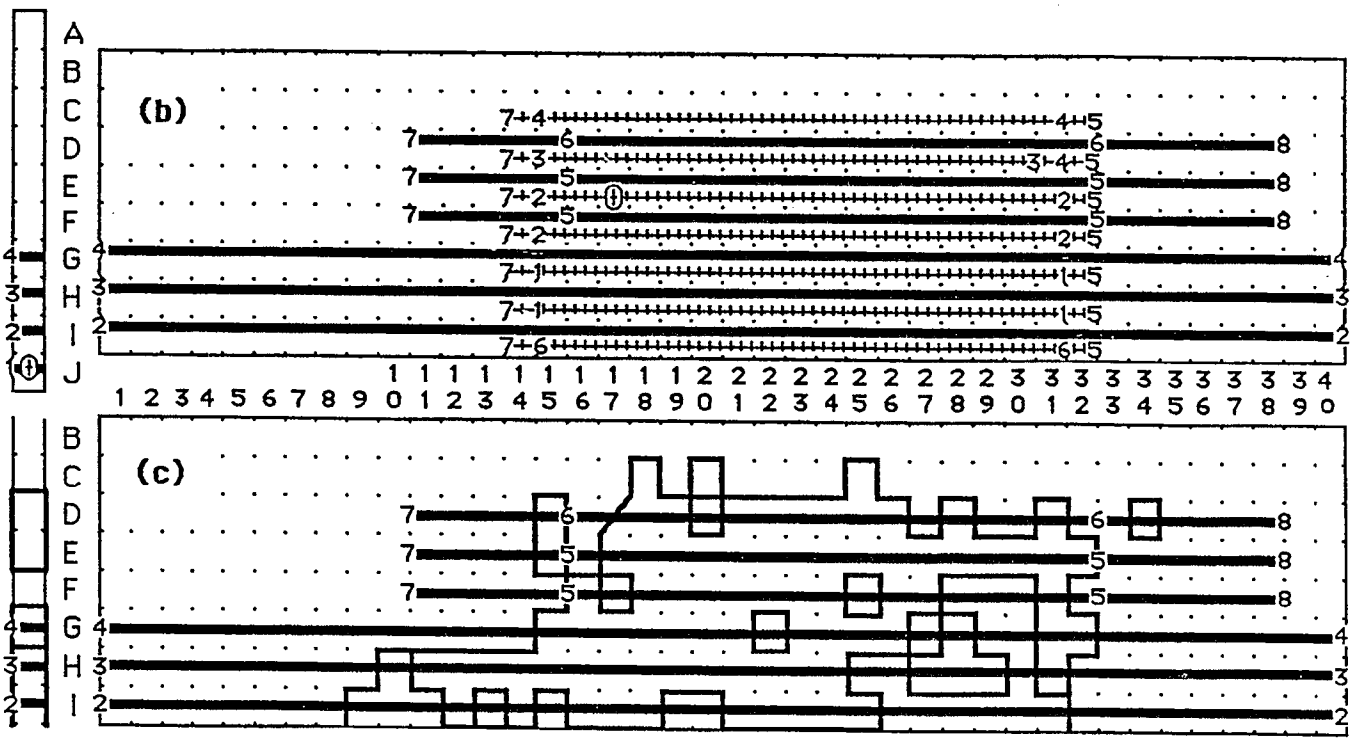


Figure 4.2a. Naming ranges, Tenejapa Tzeltal, speaker #2, man, age 90, 1980.



Figures 4.2b-c. Mappings (b) from cool and dark-cool categories of speaker #2 with (c) naming-range outlines superimposed from Figure 4.2a.

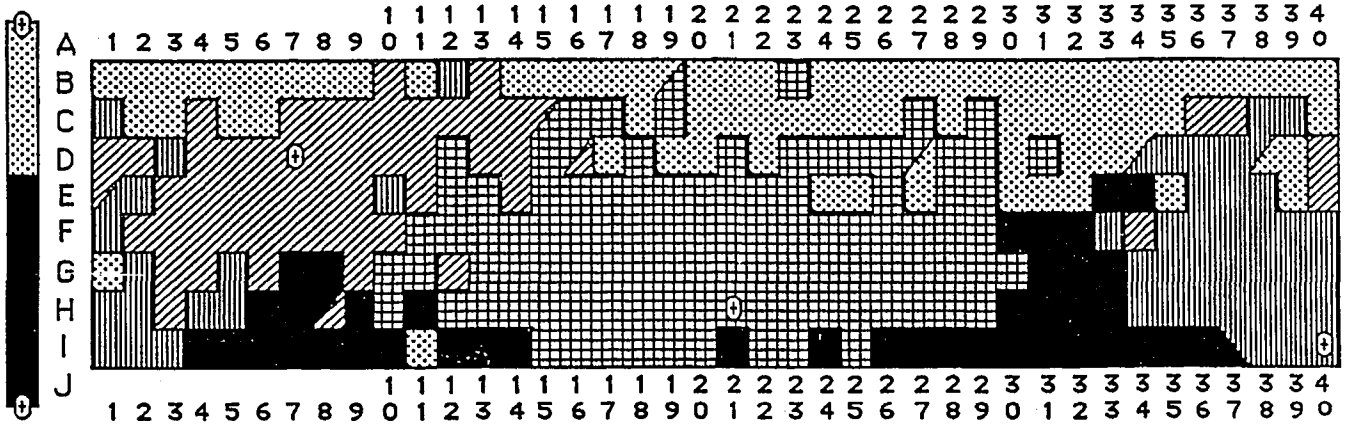
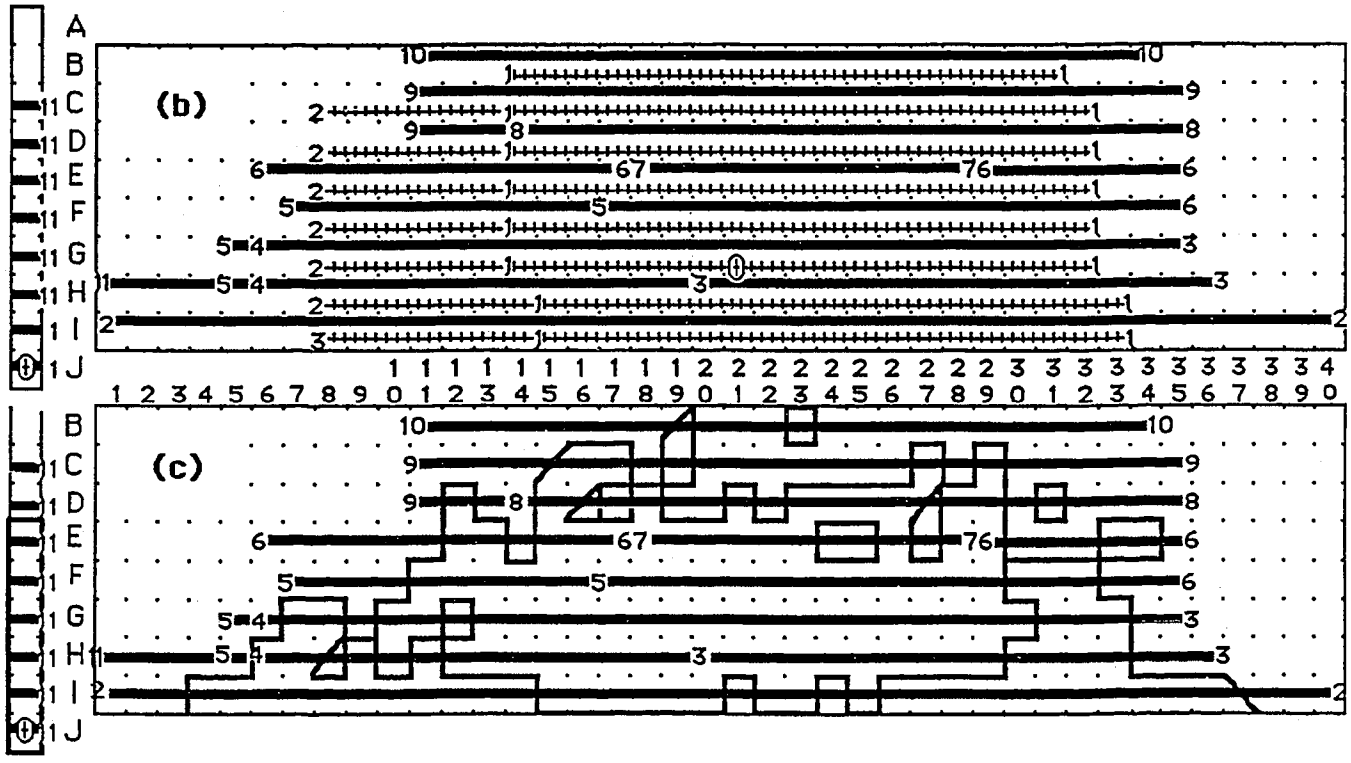


Figure 4.3a. Naming ranges, Tenejapa Tzeltal, speaker #3, woman, age 60, 1980.



Figures 4.3b-c. Mappings (b) from cool and dark-cool categories of speaker #3 with (c) naming-range outlines superimposed from Figure 4.3a.

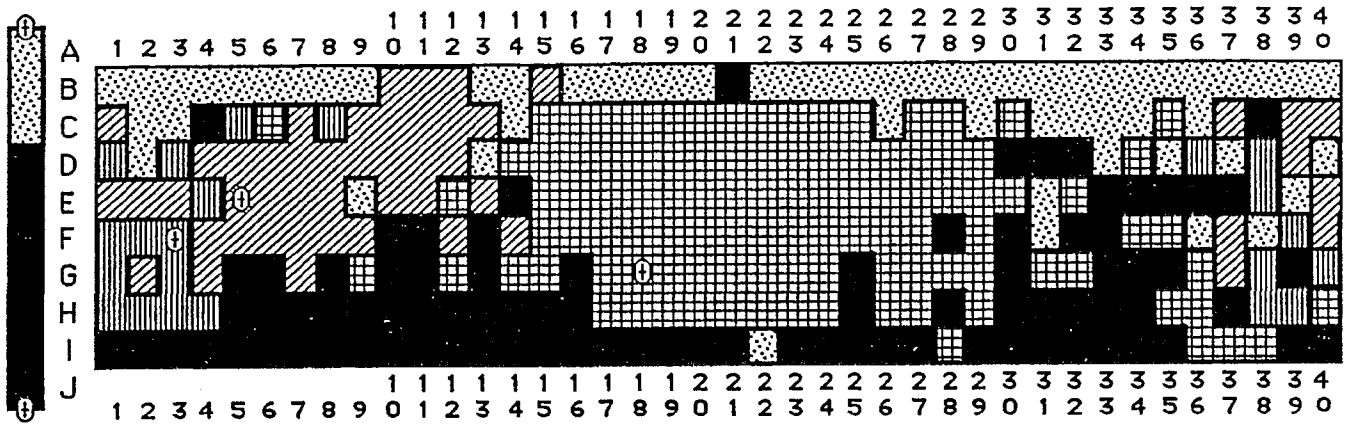


Figure 4.4a. Naming data, Tenejapa Tzeltal, speaker #4, man, age 65+, 1980.

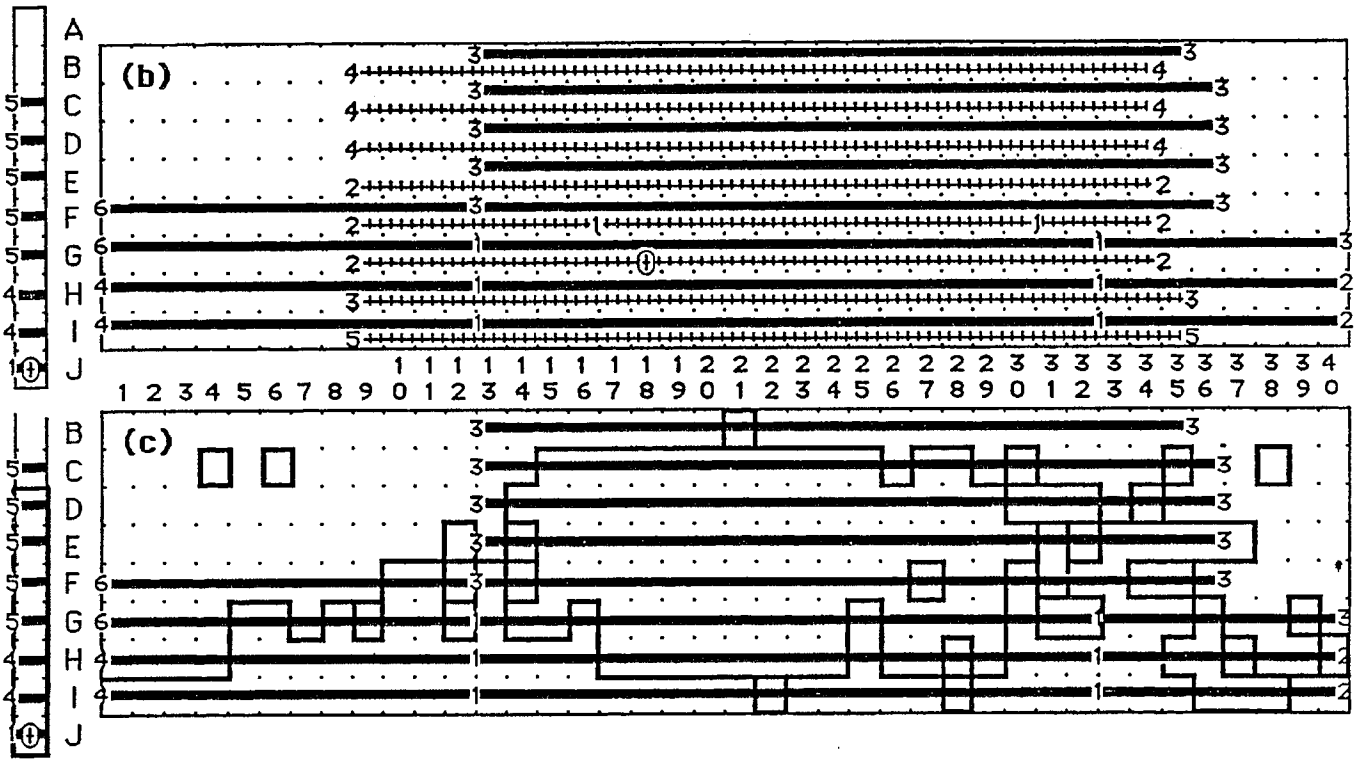


Figure 4.4b-c. Mappings (b) from cool and dark-cool categories of speaker #4 with (c) naming-range outlines superimposed from Figure 4.4a.

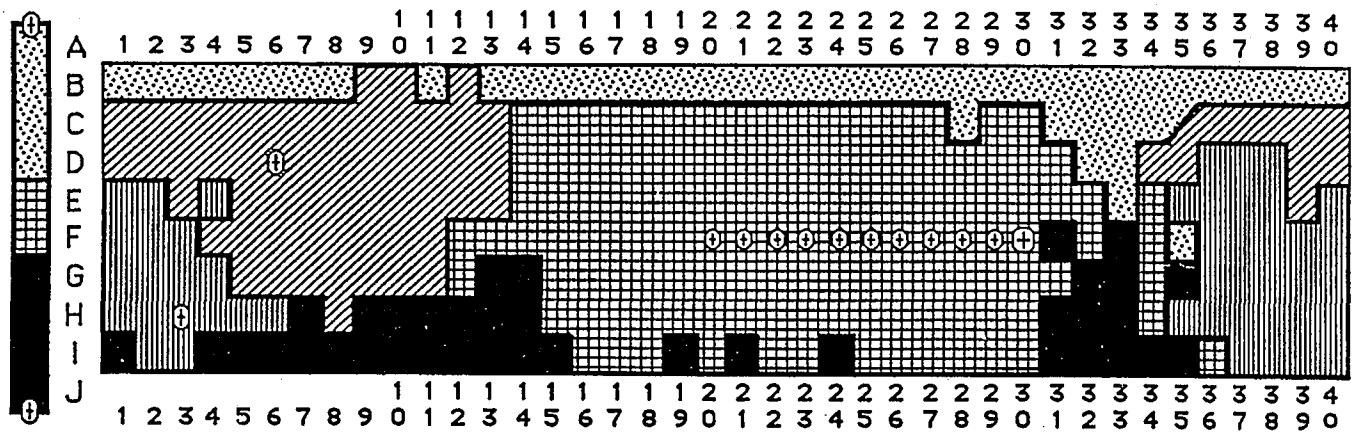
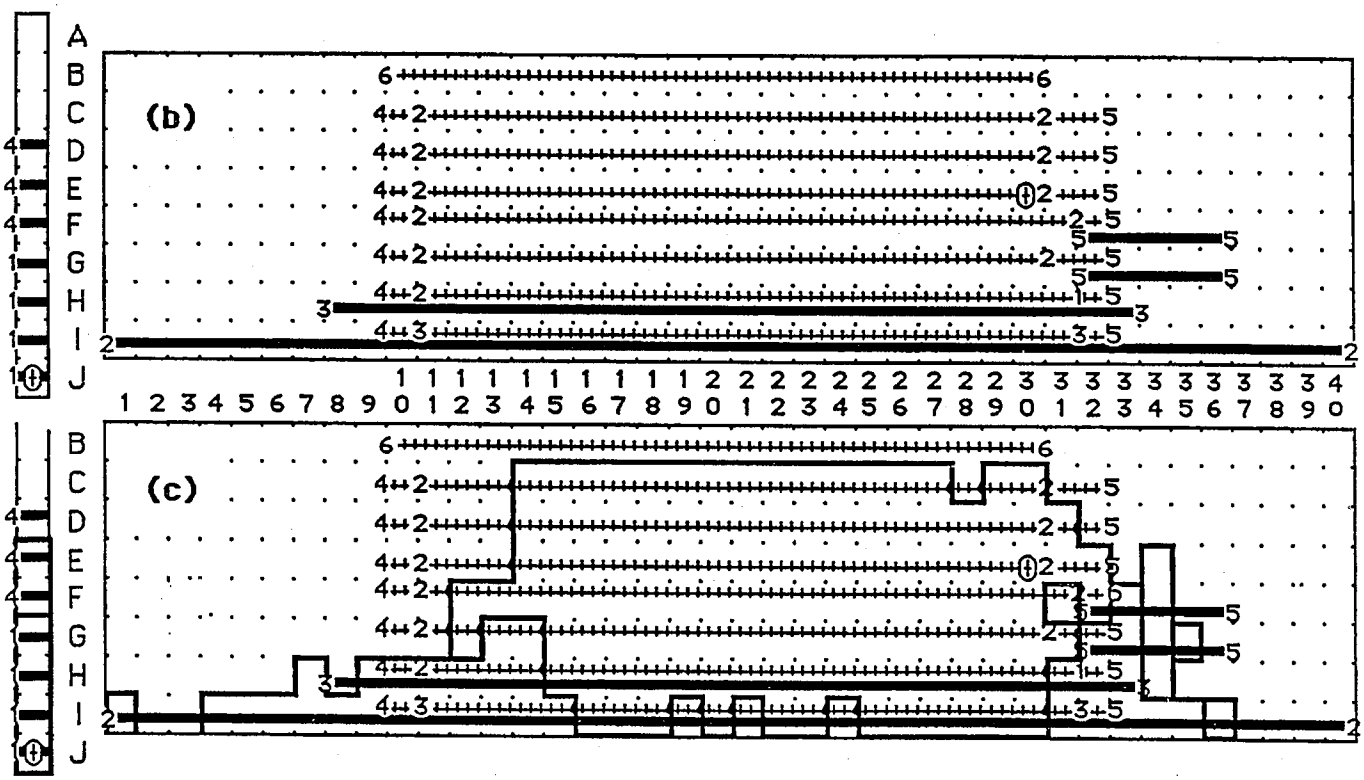


Figure 4.5a. Naming ranges, Tenejapa Tzeltal, speaker #5, man, age 75, 1980. The cool category is broadly focused through E20-30 with a preference at E30.



Figures 4.5b-c. Mappings (b) from the cool and black categories of speaker #5 with (c) naming-range outlines superimposed from Figure 4.5a.

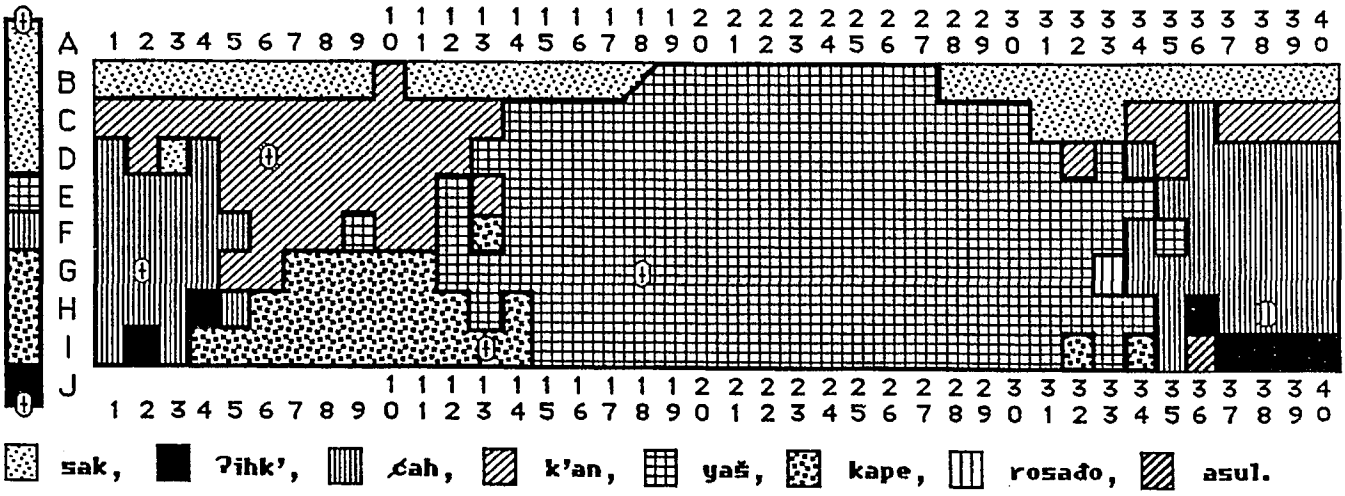
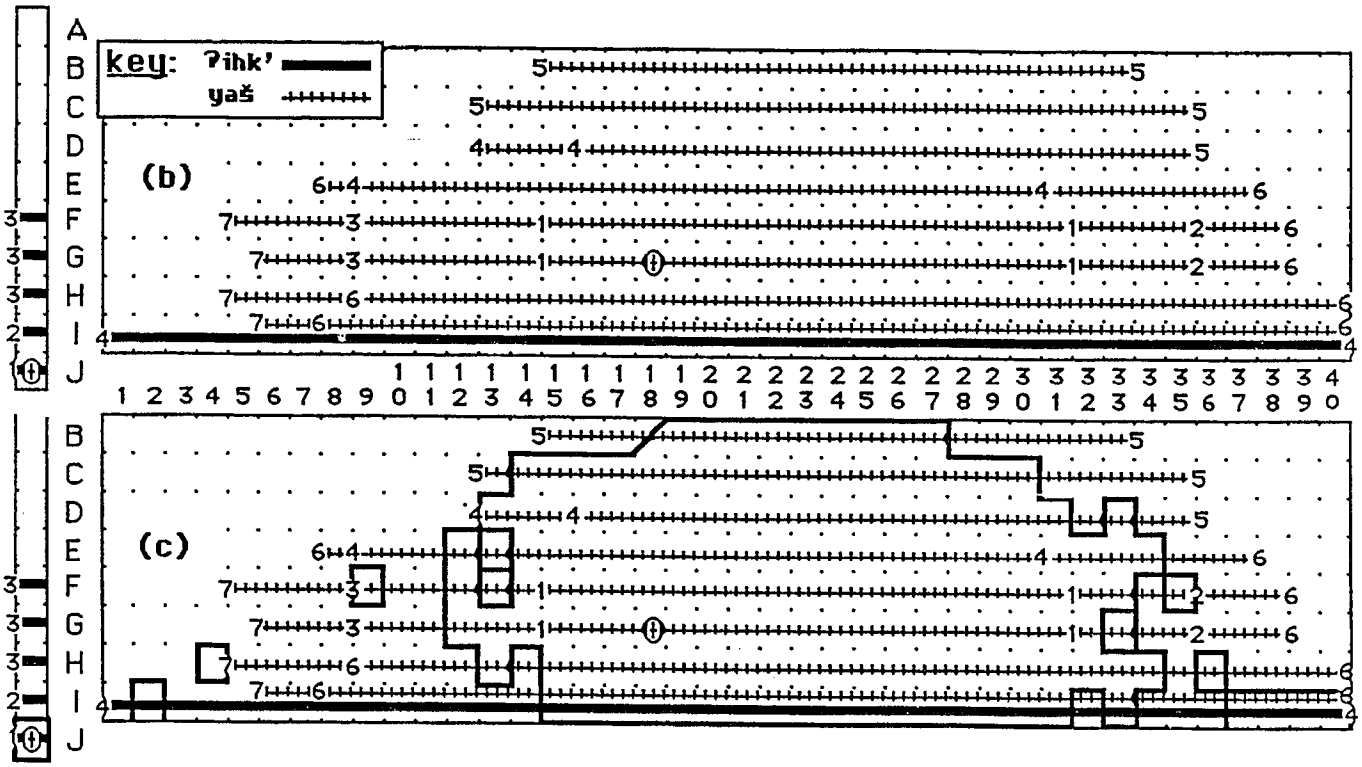


Figure 4.6a. Naming ranges, Tenejapa Tzeltal, speaker #5, woman, age 70, 1980.



Figures 4.6b-c. Mappings (b) from the cool and black categories of speaker #6 with (c) naming-range outlines superimposed from Figure 4.6a.

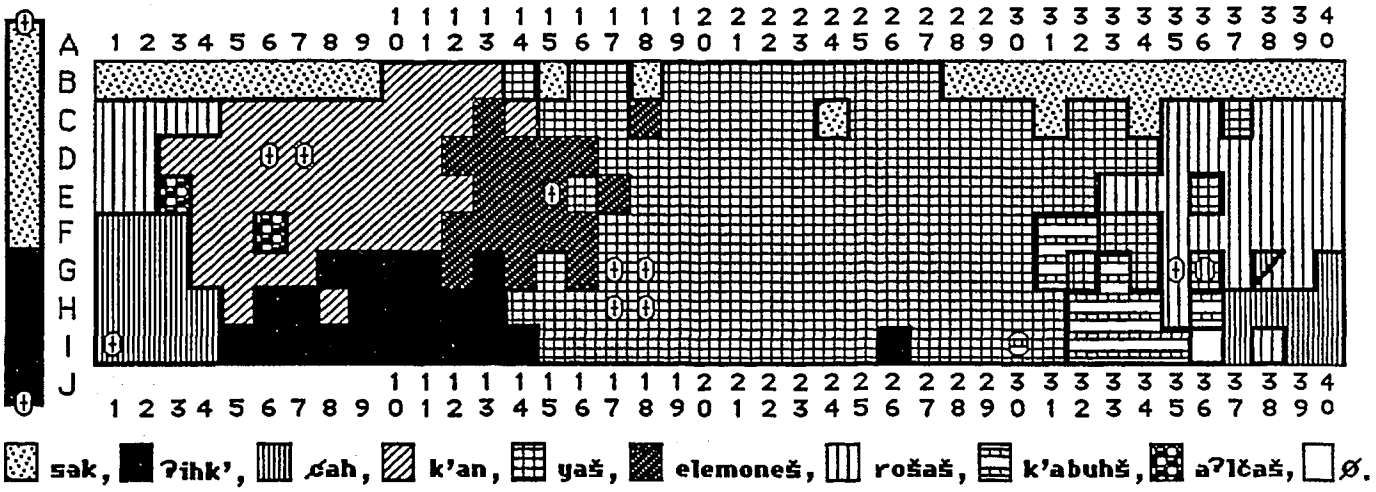
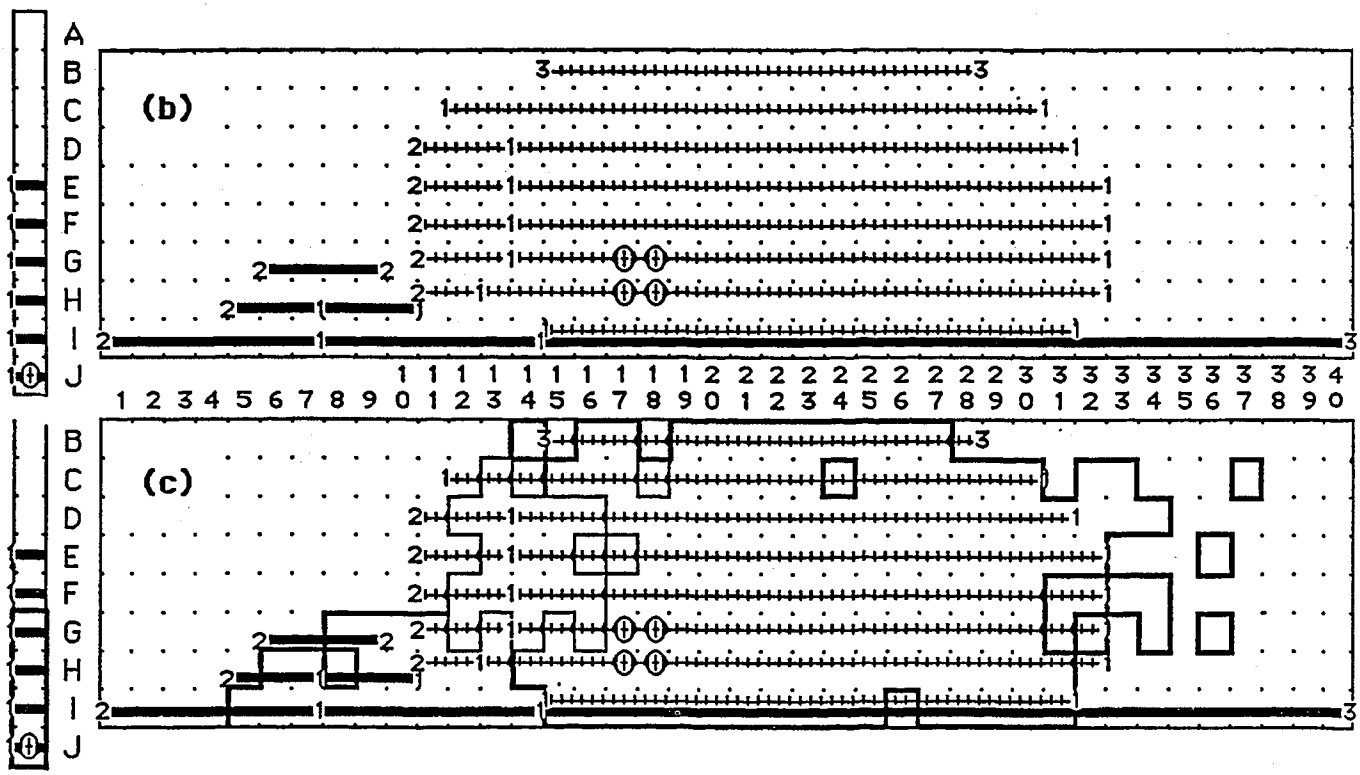


Figure 4.7a. Naming ranges, Tenejapa Tzeltal, speaker #7, woman, age 34, 1980.



Figures 4.7b-c. Mappings (b) from the cool and black categories of speaker #7 with (c) naming-range outlines superimposed from Figure 4.7a.

The main difference between the two groups of Tzeltal speakers is cognitive.

Those of the first group attend more strongly to similarity. Thus, they maintain a dark-cool

range of the black-focused category, they name the subordinate cool category fewer times, and they place less importance upon using color words distinctively. The latter practice lends the misimpression of sloppy, careless usage.[6] Those of the second group attend more strongly to distinctiveness. Thus, they limit the black-focused category only to dark colors and separate it from cool colors, they name the cool category more times, and they choose their words with less intermixture.

The data of the first group, Figures 4.1a-4c, exhibit the dilemma that is introduced in section 4.0.: Berlin and Kay's criteria of a basic color category, *superordination* and *salience*, are divided between two heirarchically related categories. As hypothesized in that section, the split criteria result from intermedial situation of the basic level of categorization. As the attendance to similarity and to distinctiveness shift strengths reciprocally, the basic level moves smoothly through the perceptual hierarchy toward greater specificity. Its intermediacy is a natural and expected consequence of continuous movement. The splitting of criteria is predictable.

4.2. Salience on Multiple Levels in Tzotzil

Thirty years ago, the Tzotzil-speaking village of Navenchauc was catapulted into the Twentieth Century (cf. section 4.0., page 117). In that milieu, some individuals -- young women in particular -- appear to attend strongly to both similarity and distinctiveness; a generation has suspended the reciprocity of strengths between the attendances, although the suspension is probably temporary and unstable.

Data from five interviews show that the young women maintained the dark-cool category at low salience, but they named at high salience six categories on two or three levels of increasing specificity under the dark-cool category. Other data show that four of

[6]The misimpression of sloppiness would derive from the assumption that individuals directly categorize perception, and do so more or less accurately. However, the very notion of accuracy varies according to the strengths at which an individual attends to similarity and to distinctiveness.

the Tzotzil speakers executed broad mappings of the warm category, but three did so with 9 to 14 small steps (cf. Figures 6.5a-f and 6.15a-16c). The evidence of broad categories, such as dark-cool and warm, indicated a strong attendance to similarity. But the deep hierarchy of saliently named categories and the many small mapping steps indicated a strong attendance to distinctiveness. The younger Tzotzil speakers were the only ones of the Mesoamerican sample who manifested such a correspondence, and they manifested it collectively. Just one older woman was interviewed, age 50; she named two perceptual levels, only one of them saliently (cf. Figures 7.29c-d).

Since all but the most inclusive category of a four-tier hierarchy was saliently named, it is impossible to identify the basic level of categorization. Although the two most specific levels were named with loan words, they were nevertheless salient, agreed upon between speakers, and under competent control. It appears that in this rare case, in which the reciprocity of attendances has been collectively placed in abeyance, theoretical constructs such as the "basic color category" and "the basic level" do not meaningfully apply. The constructs are germane to only the majority of languages, whose speakers maintain reciprocity between the two cognitions. The Tzotzil data are important because: (1) they show that the cognitive axiom of reciprocal attendances can be broken for, at least, a temporary and unstable period; (2) they imply that concepts, such as basic categorization, depend on the reciprocity; without it, the concepts do not correlate with data in a telling manner.

The five younger women were between ages 16-27. The youngest of them provided the data of Figures 4.8-13c. She claimed to have completed six grades of Spanish-instructed school in Navenchauc, and she was semi-bilingual and semi-literate. Since only the very youngest had been educated, the hierarchy of categories probably was not learned in school. The other four women were entirely monolingual.

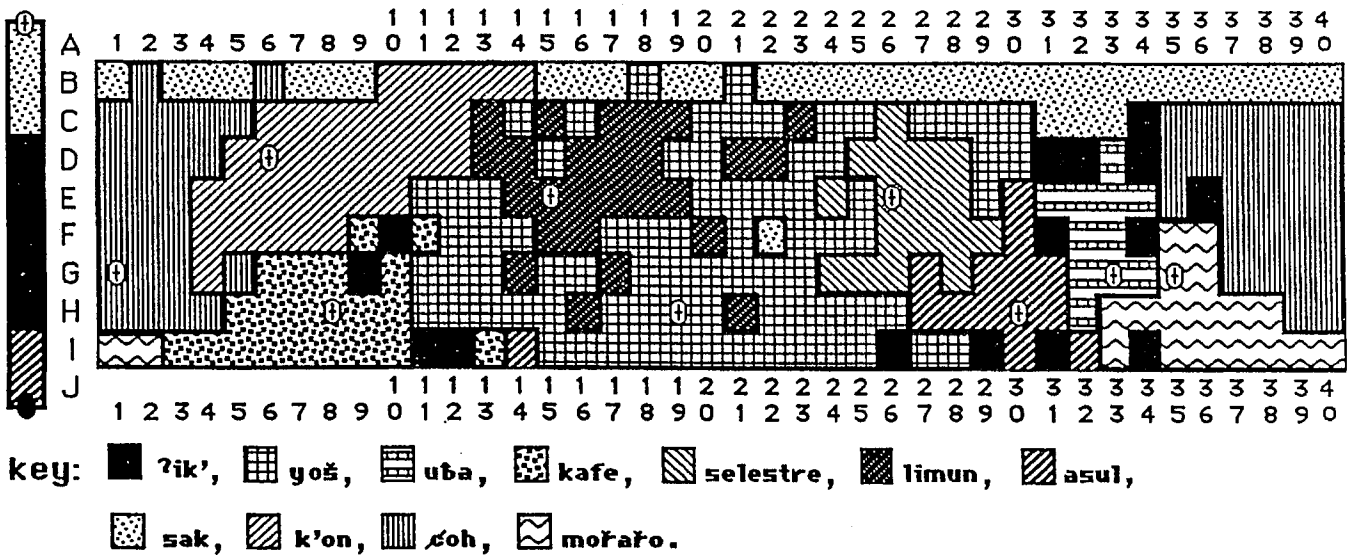


Figure 4.8. Naming ranges, Tzotzil, Navenchauc, speaker #1, woman, age 16, 1981.

Figure 4.8 shows that the Tzotzil speaker named eleven color categories, ten of which were moderately or highly salient. The least salient category, that focused in black at JØ, was designated with a sparse but widely distributed naming range (e.g., G9, I26, C34); the range and its focus did not correspond.

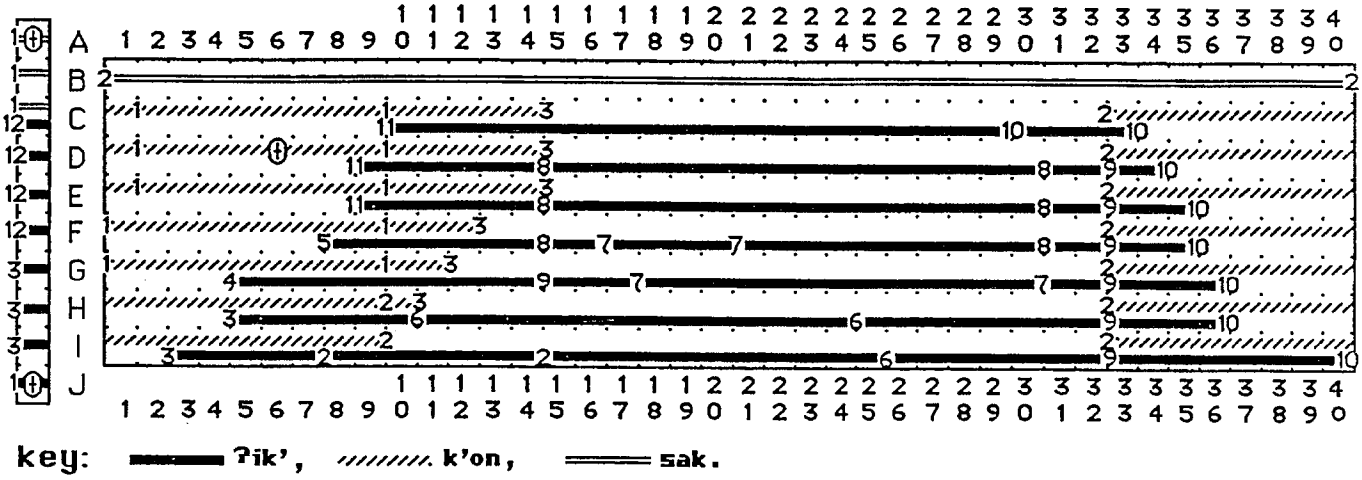


Figure 4.9. Mappings of black-, white-, and yellow-focused categories.

Figure 4.9 shows the mappings of three of the eleven categories that were named in Figure 4.8, including the minimally salient black-focused category. The three in themselves are broad enough to cover all colors in the configuration of a Stage-II system. Although the black-focused category is minimally salient, it encompasses six categories that are more salient than itself. (The warm category, unlike those of some of the other speakers, is mapped in just three steps.)

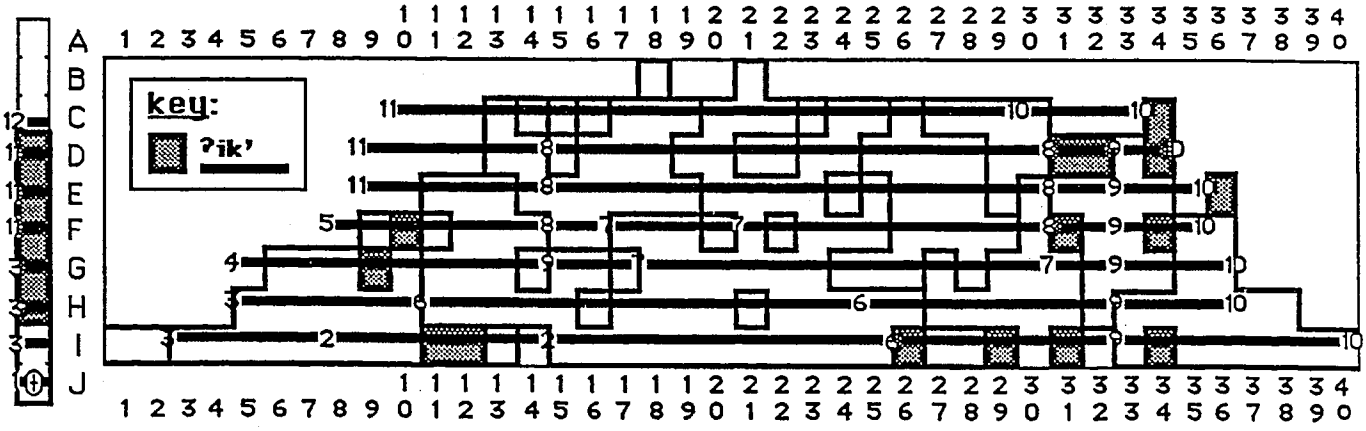
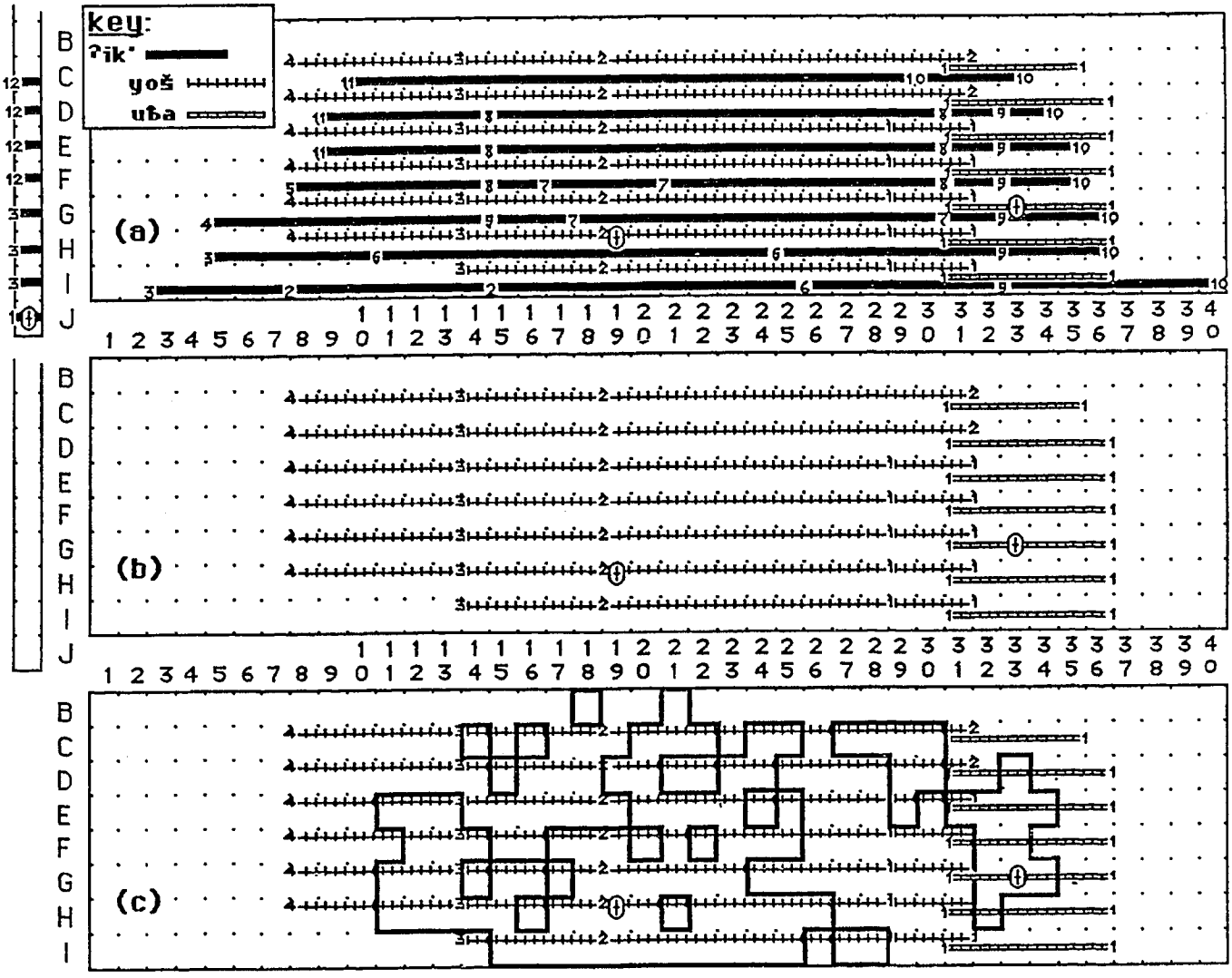


Figure 4.10. Mapping of the black-focused category with naming-range outlines from Figure 4.8.

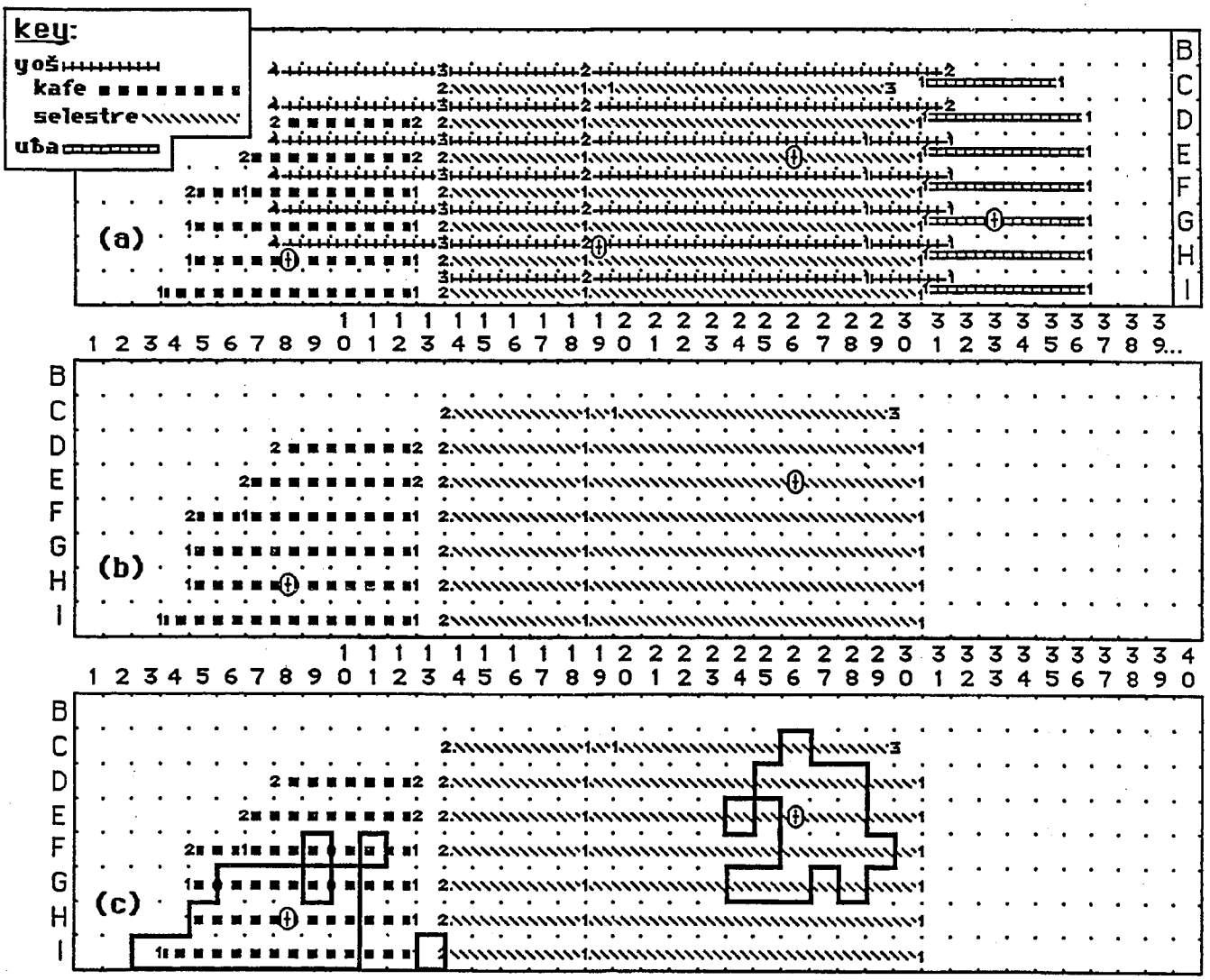
Figure 4.10 displays the naming-range outlines of the six categories superimposed on the mapping of the black-focused category. The naming range of the latter is shaded.

Figures 4.11a-13c demonstrate four levels of hierarchical inclusion in order of the most general to the most specific:



Figures 4.11a-c. Mappings of black-, cool-, and purple-focused categories with cool and purple naming-range outlines superimposed from Figure 4.8.

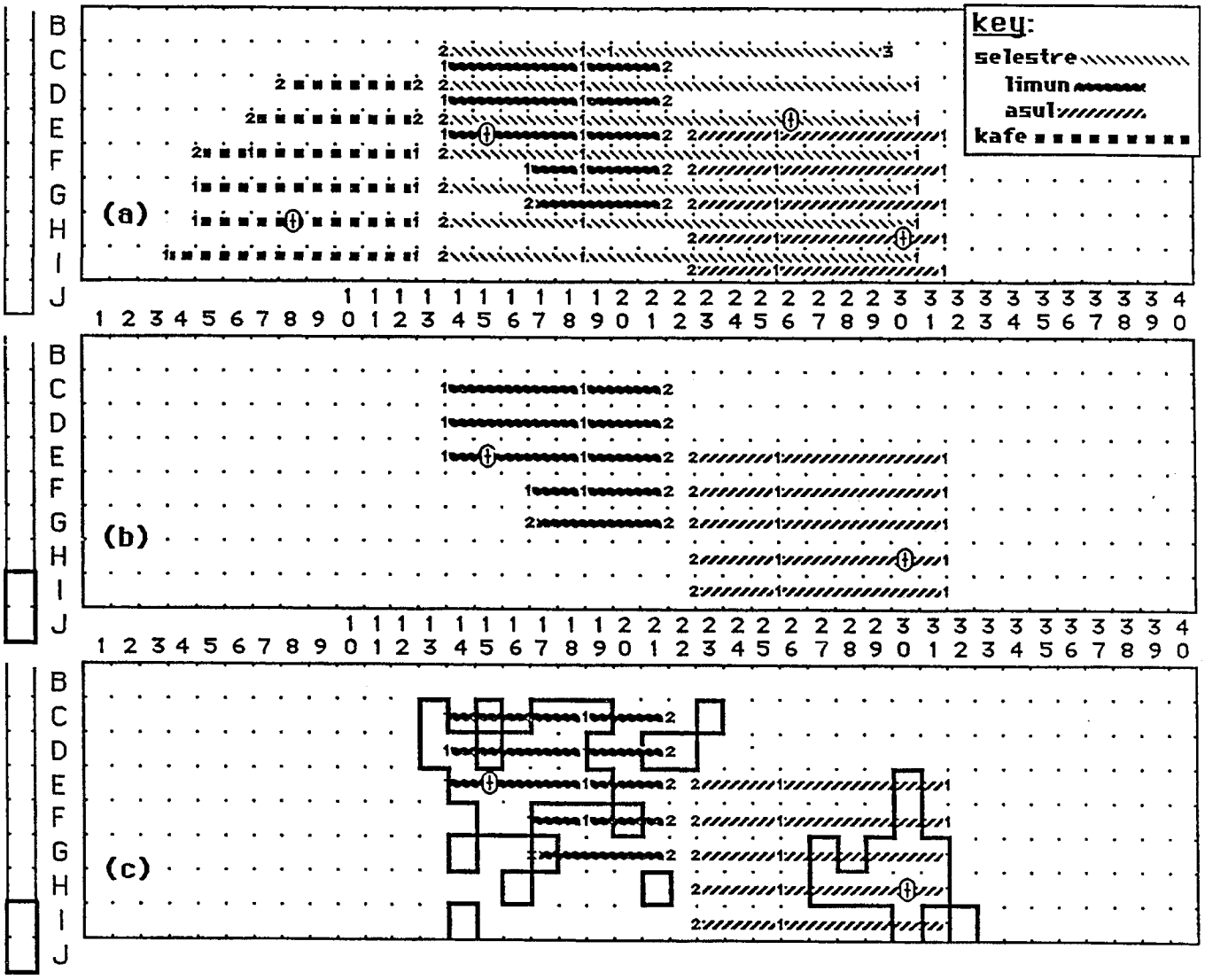
Figures 4.11a-c display the relationship between mappings of black-, cool-, and purple-focused categories and between the latter two and their naming ranges. The latter, focused at H19 and G33, constitute the second level of inclusion within the hierarchy of categories.



Figures 4.12a-c. Mappings of cool-, purple-, brown-, and light blue-focused categories with brown and light blue naming-range outlines superimposed.

Figures 4.12a-c display the relationships between mappings of the cool-, purple-, brown-, and light blue-focused categories and between the mappings and naming ranges of the latter two. The latter two, focused at H8 and E26, constitute the third level of inclusion. The light blue-focused category (E26) has a cool range like that focused at H19, but it is less extensive.[7]

[7]This relationship between ranges might be one of "coextensivity" rather than of inclusion.



Figures 4.13a-c. Mappings of brown-, light blue-, chartreuse-, and blue-focused categories with chartreuse- and blue-focused naming-range outlines superimposed.

Figures 4.13a-c display the relationship between mappings of brown-, light blue-chartreuse-, and blue-focused categories and between the latter two and their naming ranges. The latter, focused at E15 and H30, constitute the fourth and most specific level.

Figure 4.14 abstractly diagrams the hierarchy of four levels that are substantiated by data from the Tzotzil speaker:

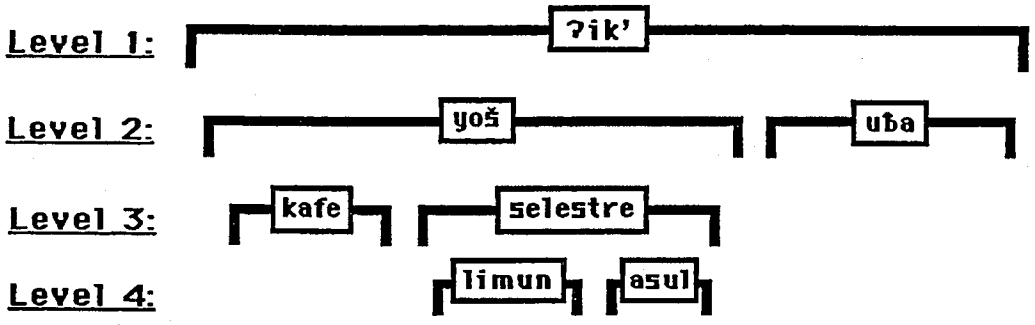
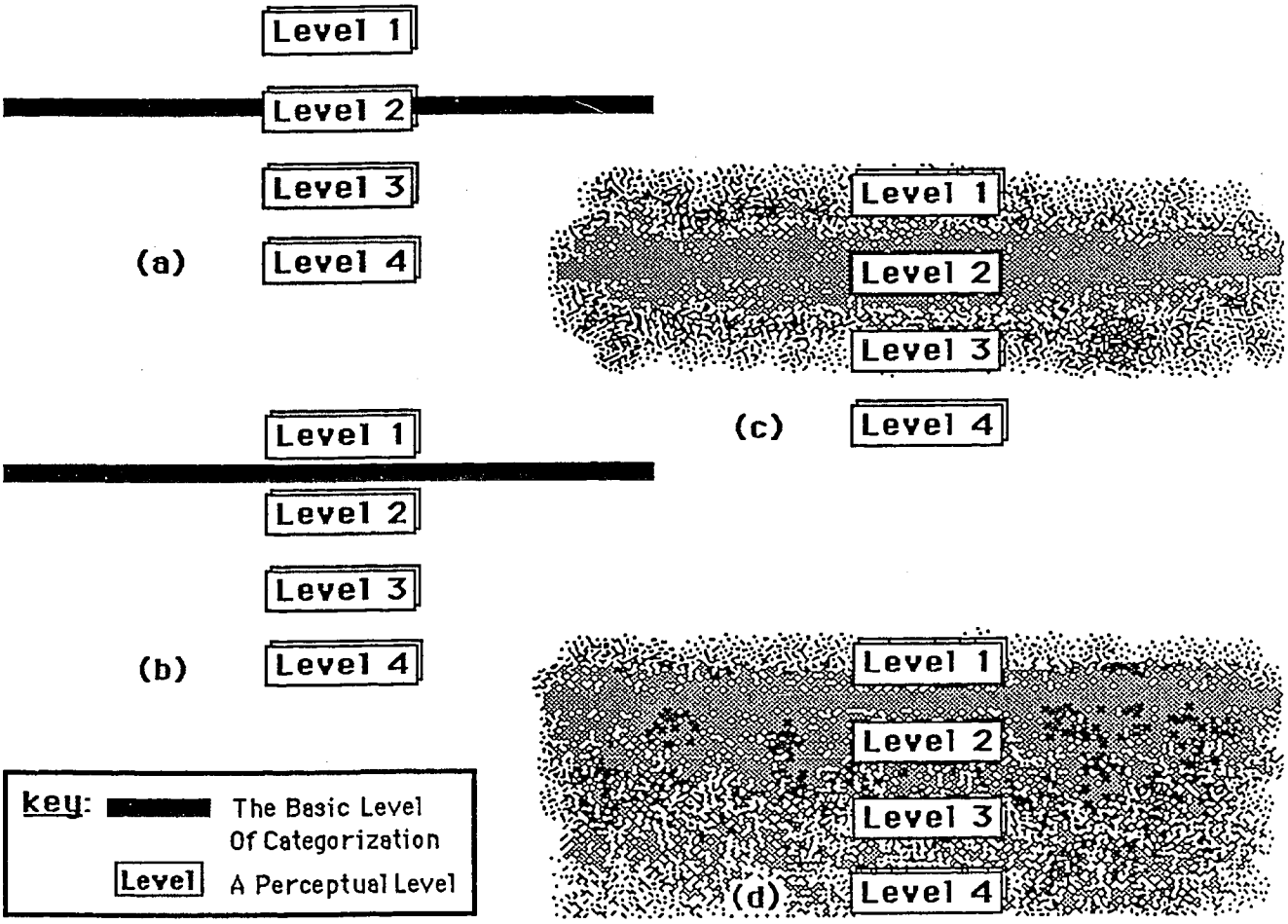


Figure 4.14. Hierarchically ordered Tzotzil color categories.

The data of Figures 4.8a-13c demonstrate that naming salience remains strong throughout the three more specific levels of the hierarchy; categories are salient on all levels but the highest. The non-correspondence of superordination and relative salience throughout the hierarchy poses an obstacle to identifying basic categories according to definitive criteria. The basic level of categorization cannot be established reliably. The inapplicability of these concepts is a consequence of a very unusual suspension of the reciprocity between the attendences to similarity and to distinctiveness. At least two independent lines of data indicate that both cognitions are strongly maintained.

4.3. Summary

Figures 4.15a-d diagram distinct relationships of basic categorization to the perceptual hierarchy. Figure 4.15a shows the relationship that was maintained by the second group of Tzeltal speakers, who fully separated the black-focused and cool-focused categories. Figure 4.15b shows that which was maintained by the first group of Tzeltal speakers, who used a non-salient dark-cool category and a moderately salient cool



Figures 4.15a-d. Relationships of basic categorization to the perceptual hierarchy.

category. Basic categorization is situated between perceptual levels, because the reciprocity of strengths among cognitions fosters smooth transition from one level to the

next as the strengths shift. Figures 4.15c-d represent two speculations concerning the relationship of basic categorization to the perceptual hierarchy in Tzotzil. Basic categorization is dispersed across two or three levels, if the concept applies in any way to this unusual case. The cognitive reciprocity appears to have been temporarily suspended.

The foregoing account warrants three conclusions:

1. Rosch's basic level of categorization is as much cognitive as it is perceptual. Reciprocally shifting attendances to similarity and to distinctivenss smoothly and continuously move the basic level through a fixed perceptual hierarchy toward greater specificity and differentiation. The smooth movement, in some individual cases, situates basic categorization between perceptual levels. In that situation, Berlin and Kay's operational criteria of a basic color category will be split between two hierarchically related categories. Since the situation is predictable and natural, it does not justify changing the criteria or assigning priority to salience. Rosch's concept and Berlin and Kay's concept are united under this hypothesis.

2. Since the perceptual hierachy is universal and invariant while cognition is mutable, a cognitive axiom is indispensable to a theory of variation and change among basic color categories.

3. Under very rare conditions, the cognitive axiom can be broken. Speakers of a language will suspend the reciprocity between strengths of two cognitions, although the suspension probably will be temporary and unstable. In such a case, it will be impossibe to relate data to the concepts "basic level" and "basic color category." But nothing short of genetic mutation can break a perceptual axiom.[8]

[8]An alternative account to the suspention of a cognitive axiom might be possible. It requires recognition of both non-social and social motives of color category-evolution (cf. footnote 3, page 114). This interpretation of Tzeltal and Tzotzil data is outlined in Chapter VI, footnote 3, after presentation of further data in Chapter V. In brief, the Tzotzil maintain an archaic Stage-II system at low salience as a conservative emblem of group identity. In spite of this maintenance, cognition has evolved toward strong attendance to distinctiveness; the latter encourages small mapping steps and salient taxonomic depth.

Chapter V

Coextensive Semantic Ranges

5.0. Preface

This chapter introduces coextensive semantic ranges. *Semantic coextensivity* denotes a relationship between two (or, rarely, more) terms that are focused in reference to markedly different colors within a category but whose ranges of meaning coextend throughout the category; such a category is regarded from (at least) two *vantages*, and it is named differently from each.[1] *Coextensivity* differs from other semantic relationships, such as *near-synonymy, inclusion,* and *complementation.* Although some investigators have described coextensivity in passing,[2] none have pointedly acknowledged it as a semantic relationship that differs from any other, none have addressed or studied it as a subject in itself, and none have pursued its importance to theory. The revised descriptive method

[1]In ordinary usage, a *vantage* is a view that is taken from a commanding position. In this discussion, a *vantage* is a view of a category that is taken from the position of one of its unique hues (or one of its non-unique colors). This definition will suffice for the present chapter, although the data of Figures 5.1a-9c show that a coextensive range is seldom focused precisely on a unique hue but only in reference to it. In Chapter VI, it is demonstrated that a coextensive vantage is not merely taken from the position of a unique hue (or other strong color), but it is also taken from the position of, at least, one of the two attendances. Thus, a coextensive vantage is taken "in reference to" a unique hue and "in reference to" an attendance, but from a "position" or vantage point that is constituted by a coordination of both.

[2]Merrifield (1971: 264), discussing Amuzgo color terms, notes that "The two terms for green have different foci but the same range." Hage and Hawkes (1975: 297) describe coextensivity in Binumarien cool and dark-cool categories:

> In this scheme, if two categories have the same range but differ in focus they are regarded as the same category. Thus if focal GREEN covers GREEN and BLUE and focal BLUE covers BLUE and GREEN, they are both BLUE-GREEN or in Berlin's term GRUE... Similarly, if focal BLUE covers BLUE, GREEN, and BLACK, and focal BLACK covers BLACK, GREEN, and BLUE they are both BLACK or the "dark-cool" category...

reveals that coextensivity occurs commonly in diverse Mesoamerican languages and in all kinds of color categories.[3]

Coextensivity involves more than just an unexplored semantic relationship: (1) it is characterized differently in distinct perceptual environments, and (2) it is linked to other types of semantic relationship in specific ways and for particular reasons. A minimal but non-reductionistic introduction to coextensivity requires a description of both contingencies (**1-2.**):

1. Coextensivity typifies the warm category, but in the cool category it occurs less often than not; and, in the warm category, coextensivity exhibits more dichotomous characteristics than in the cool category. The differences corroborate the evidence from visual physiology that red and yellow appear more distinct than green and blue. *The same engagement of perceptual and cognitive axioms that explains why the warm category divides before the cool category in universal evolutionary order also explains the differences shown by coextensivity in those environments.*

2. Semantic relationships, such as near-synonymy, coextensivity, inclusion, and complementation, are not discrete types but segments of a continuum. At one extreme, strong attendance to similarity can produce near-synonymy, and at the other extreme strong attendance to distinctiveness produces complementation; midway on the continuum a closer equilibrium of the two attendances can produce coextensivity; farther along, increased attendance to distinctiveness occasions inclusion. *The same interaction of perception and cognition that causes the continuous evolution of basic color categories also causes evolution along a continuum from one semantic type to another within a particular category as it progressively divides.*

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[3]It is unknown whether coextensivity occurs outside of the color domain. Berlin, Boster, and O'Neill (1981: 103, fig. 3), in the domain of folk ornithology, show aggregated applications of different Aguaruna names across eight woodpecker species. The aggregates suggest coextensivity, although individual data are not shown. As they mention, their data would reveal more if they had asked subjects to apply each name to an array of birds (their skins) in addition to showing each bird and requesting its name. The former, if it is ever conducted, should resemble the mapping elicitation of multiple prompts that is used to determine color-category ranges.

The further purpose of this chapter is to begin to relate coextensivity to widely applicable hypotheses of color categorization: Both (**1.**) and (**2.**) are explainable on the basis of the same perceptual and cognitive axioms that were set forth in Chapter II and used in Chapter IV. The explanations integrate coextensivity into the larger body of theory.

The chapter introduces coextensivity by describing it in different environments, by relating it to other semantic types, and by accounting for such observations on the basis of particular axioms. But the introduction does not exhaust the implications of coextensivity:

To maintain simplicity, the semantic side of coextensivity is emphasized throughout the present chapter. However, coextensivity is a *cognitive composition* that is produced when an individual composes a category by assuming two (or more) vantages of his perceptions. Chapters VI-IX will develop the theoretical relevance of *coextensive vantages*, that the adoption of at least one *vantage* is essential to categorization. The present substantiation of overtly named coextensive vantages is the first step toward elaboration of theory in that direction.

A final point is immediately evident: *Semantic coextensivity is inexplicable solely in terms of perceptual axioms, because vantages do not inhere in neural response to wavelength. It is the observer who assumes distinct vantages of his perceptions and names them differently from each. Explanation of the latter requires a cognitive axiom.*

This argument is of the same force as that regarding the inability of invariant perception to account for division of categories. Both coextensivity and category division constitute strong but separate arguments for incorporating cognition into a theory of categorization.

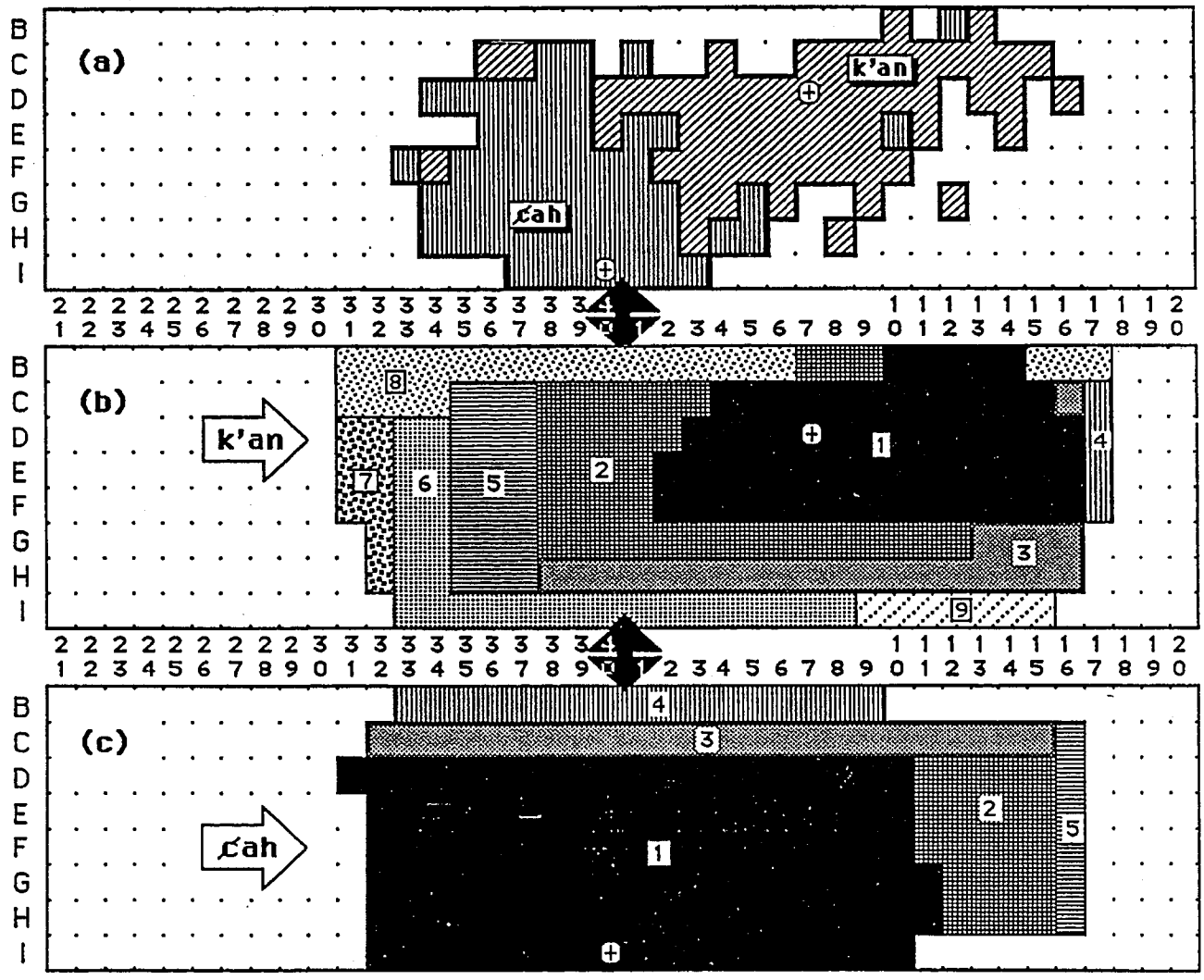
5.1. Characteristics of Coextensivity

Semantic coextensivity is introduced by comparing its manifestations in the warm and the cool category. Although fundamental properties characterize coextensivity

wherever it occurs, differences between coextensivity in the warm and in the cool category appear to be physiologically conditioned. The differences agree with the evidence from visual physiology that red and yellow appear more distinct than green and blue (axiom #3).

5.1.1. Coextensivity in the Warm Category

Figures 5.1a-c display naming ranges and mappings that attest to coextensivity in the warm category of a Tenejapa Tzeltal speaker (same speaker as in Figures 4.3a-c, 6.13):



Figures 5.1a-c. Naming ranges (a) and mappings (b-c), Tenejapa Tzeltal, woman, age 60,1980.

The data from Tzeltal exemplify four fundamental characteristics of coextensive semantic ranges within the warm category: (1) one category is named with two terms; (2) each term is focused in reference to a different unique hue; (3) the mapping of each term encompasses the focus of the opposite term; (4) the mappings of the two terms substantially overlap throughout the category; for example, the mappings of Figures 5.1b-c overlap throughout 212 colors or 88% of the 250 colors mapped for both terms. The four fundamental characteristics vary across individual systems, which is a major topic of Chapter VI and accordingly featured in its title.

Two other characteristics (5-6) vary even more than the fundamental four, although they are quite common. (5) *Mappings that progress in opposite directions:* In Figure 5.1b, the first mapping step includes the yellowest colors and the subsequent steps progress throughout reds, pinks, and purples; in Figure 5.1c, the first mapping step includes the reds, pinks, and purples and the subsequent steps progress throughout the yellows. The converse mappings further demonstrate the strong relationship of each coextensive range to an opposite unique hue. As will be shown in Chapter VI, characteristic (5) varies in that one of the two ranges can be mapped with a first step that covers both unique hues; the reasons are given in that chapter. Nevertheless, coextensivity differs from near-synonymy, in which the mapping of each range covers both unique hues in a first step (cf. Figures 5.10b-c). (6) *Intermixture of terms:* Figure 5.1a shows slight intermixture at B12, C36-7, E10, and F34. Either coextensive term can designate any color within the category, even though the naming range of each might be concentrated around its focus and around the pure color to which it is primarily related. Characteristic (6) varies to an extreme at which some individuals show no intermixture, although their mappings and other data affirm that they relate terms coextensively (cf. Figures 5.4a-d). Other individuals vary to the opposite extreme, as is attested by the next figure:

Figure 5.2 displays naming data from an Aguacatec speaker that blatantly exhibit the intermixture of coextensive terms:

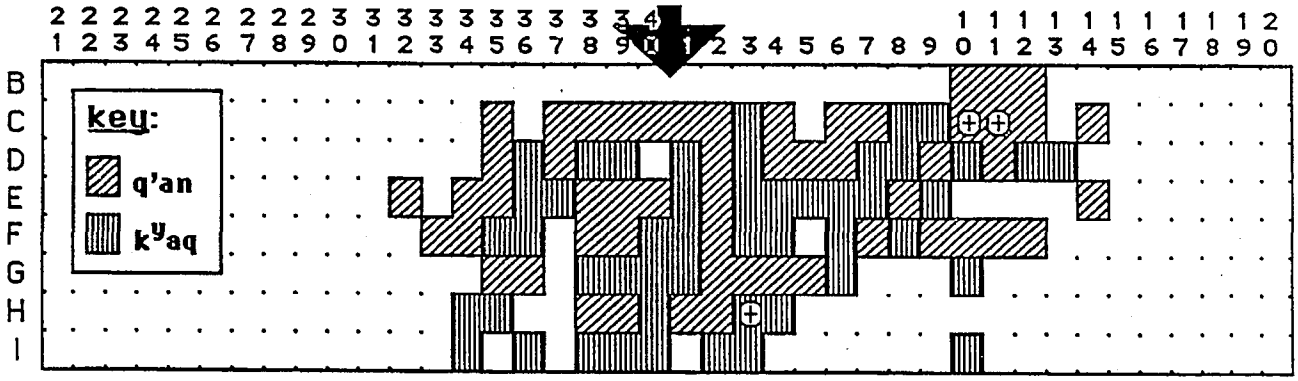


Figure 5.2. Naming ranges, Aguacatec, Aguacatán, man, age 84, 1978.

The Aguacatec speaker focused each term near one of the unique hues, located at about G1-2 and C8-9; yet he used each term to name colors near and beyond the opposite unique hue.

The Aguacatec speaker exhibits another characteristic of coextensivity, (7) *polarized foci:* he selected foci at H3 and C10-11 on the outermost side of the unique hues, G1-2 and C8-9. In this case, the foci are *mutually polarized;* he placed each between a unique hue and the category margin, as though he were emphasizing the distinction between the coextensive ranges. In Figure 5.1a, the Tzeltal speaker also exhibits polarization, but only of one focus at I40. Polarization also varies, as will be elaborated in Chapter VI.

Figure 5.3 displays data from a Tlapanec speaker that exemplify an extreme case of mutually polarized foci:

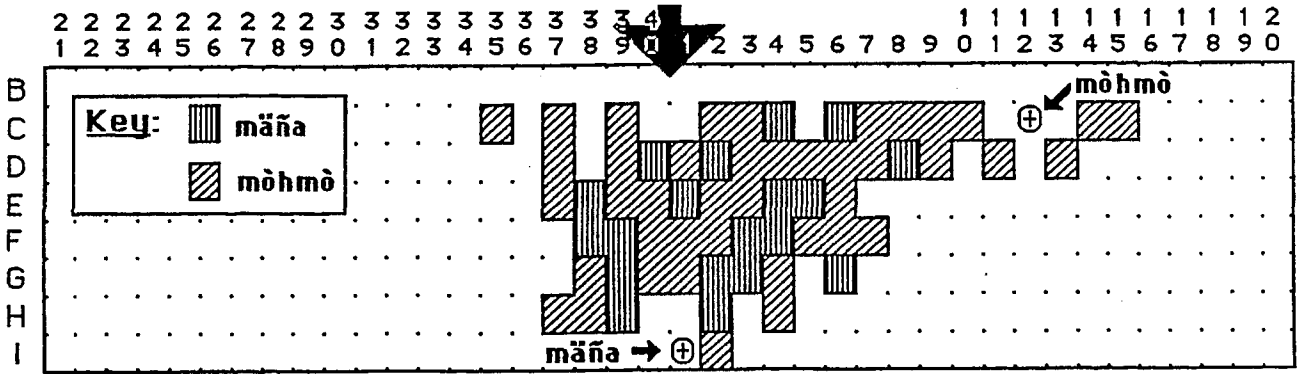
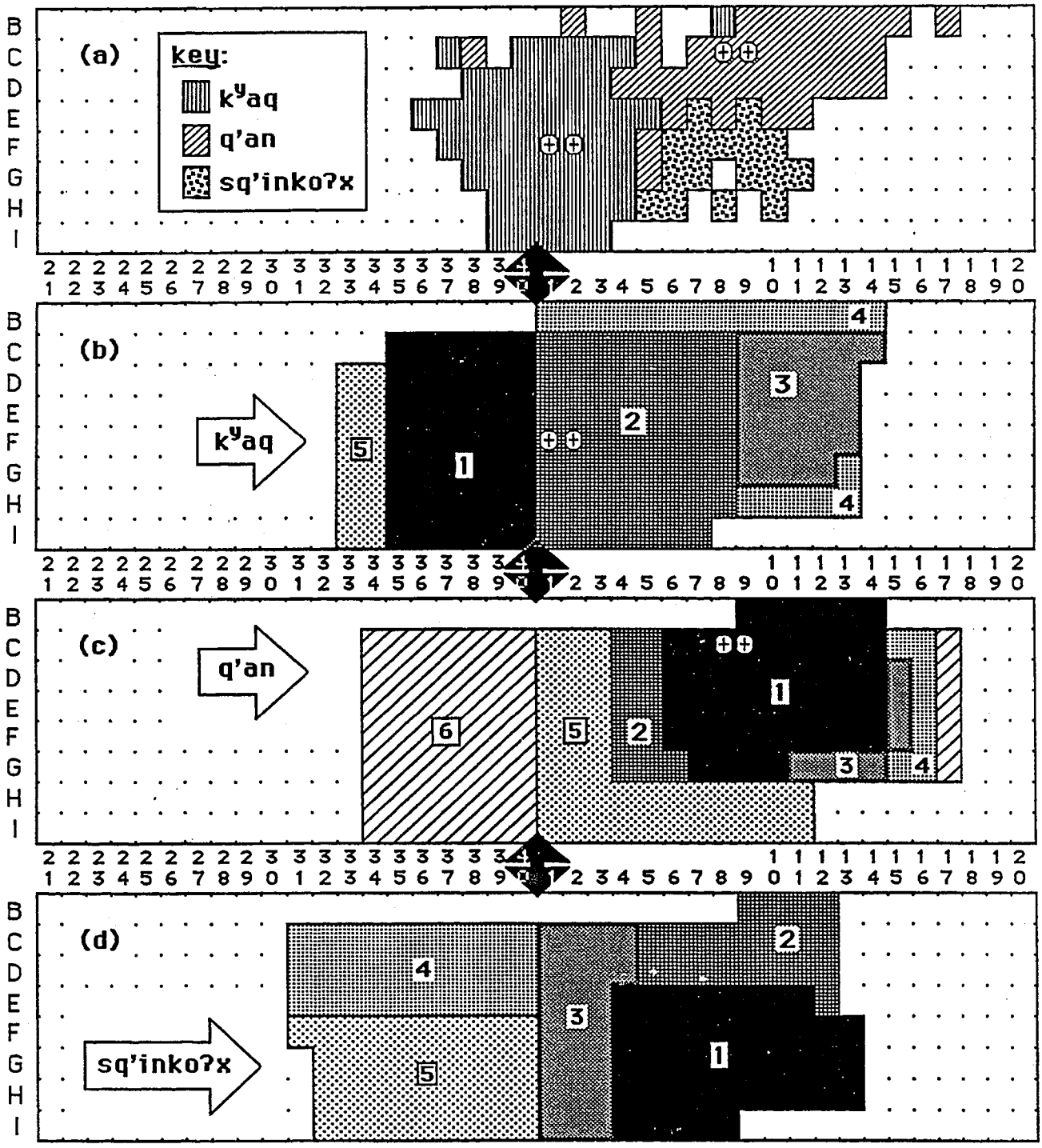


Figure 5.3. Naming ranges and foci, Tlapanec, Malinaltepec, man, age 22, 1978.

The Tlapanec speaker has selected foci at positions (I1 and C12) that are polarized beyond the margins of his coextensive naming ranges. Tlapanec speakers tend to focus the term *mäña* in reference to purest red and *mòhmò* in reference to pure yellow (cf. Figures 6.17b, 6.24, 7.19b).

Figures 5.4a-d show that another Aguacatec speaker composes the warm category from three separately named coextensive vantages, which are red-focused, yellow-focused, and "brown-oriented". The focus of the latter was inadvertently omitted during elicitation. The mapping of each term was started with a first step around its focus or at brown, and each mapping progressed by steps in a direction that is converse to the directions of the other two mappings. The two more frequently used names descend from ProtoMayan, and the sparsely used name of the "brown-oriented" range is a relatively recent innovation within just Aguacatec:

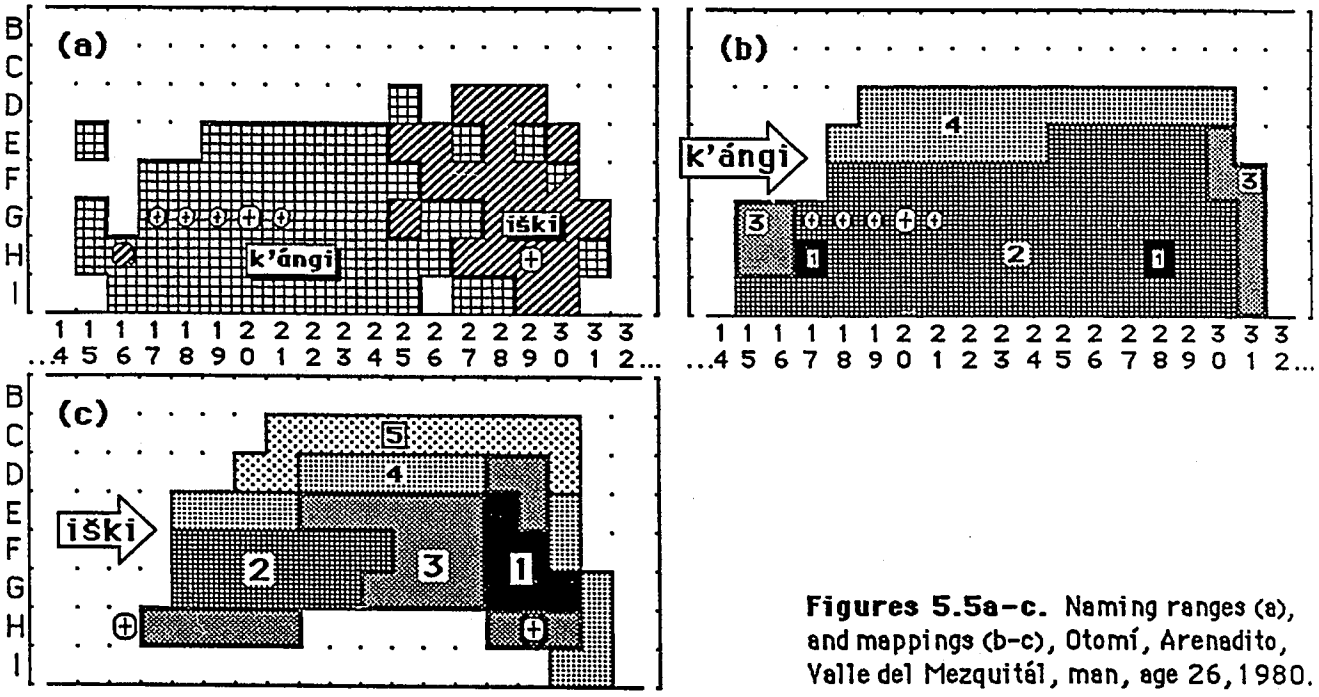


Figures 5.4a-d. Naming ranges (a) and mappings (b-d), Aguacatec, Aguacatán, woman, age 41, naming 1978, mapping 1980; triple coextensivity.

5.1.2. Coextensivity in the Cool Category

The fundamental attributes (1-7) that characterize coextensivity in the warm category also pertain in the cool category, but in a less dichotomous fashion. (1) In the cool category, coextensive ranges are often named with two terms. However, it will be shown in Chapter IX that coextensive ranges in a single cool category both can be named with the same term; such cases are common enough to warrant the appellation "covert coextensivity," and they are substantiated by various lines of evidence (cf. section 9.1). The evidence is sufficiently complex to justify postponing discussion and exemplification of covert coextensivity until that chapter, thus keeping the present chapter free of distracting detours. (2) When the cool category is named with two coextensive terms, each term tends to be related to one unique hue; but the relationship can be weak. Thus, at least one of the coextensive terms can be focused in a dual manner in separate reference to both of the unique hues (cf. Figure 5.6). Or, for the same weakness, both terms can be focused in reference to just one of the unique hues (cf. Figures 5.7a-c). The weakness is manifest in further characteristics: (3-4) The mapping of each coextensive term covers both unique hues, but this is often done with the first mapping step. (5) The first step can be disjunctively applied to pure green and pure blue while leaving turquoise colors for a subsequent step (cf. Figures 5.5b); or the first step can be applied continuously to both pure colors as well as to the colors between them (cf. Figures 5.9a-c). In either event, the pure colors are mapped in a single performance. (6) An extensive intermixture of coextensive terms is more common in the cool category than in the warm category (cf. Figures 5.8a-c), and the confinement of a coextensive term to just part of the cool category is rare (cf. Figure 5.5a). (7) The foci of a coextensively named cool category are less likely to be polarized than those of a warm category; and when such polarization occurs, it is seldom manifested to the extreme seen in the warm category (cf. Figures 5.5a-9a, esp. 5.8a-c).

Figures 5.5a-13 exemplify the characteristics (1-7) of coextensivity in cool categories with data from seven speakers of six languages:



Figures 5.5a-c. Naming ranges (a), and mappings (b-c), Otomí, Arenadito, Valle del Mezquitál, man, age 26, 1980.

Figures 5.5a-c display naming ranges and mappings of coextensive terms within the cool category of an Otomí speaker. One term is broadly green-focused with a preference at G20, and the other is dual-focused at H16 and H29. The data exhibit all characteristics (1-7) of coextensivity in the cool category, except (6) the intermixture of terms: The dual-focused term is confined to blue colors in the vicinity of its first mapping step, Figure 5.5c. The second step of this mapping is disjunctively applied to greens, and the third step fills the disjunction in turquoise colors between steps 1 and 2; the forth and fifth steps cover marginal colors. In Figure 5.5b, the mapping of the green-focused term is also disjunctive, with its first step occurring on single colors at H17 and H28. The second step is continuous through green, blue, and turquoise, encompassing the first step; and the third and fourth steps are marginal.

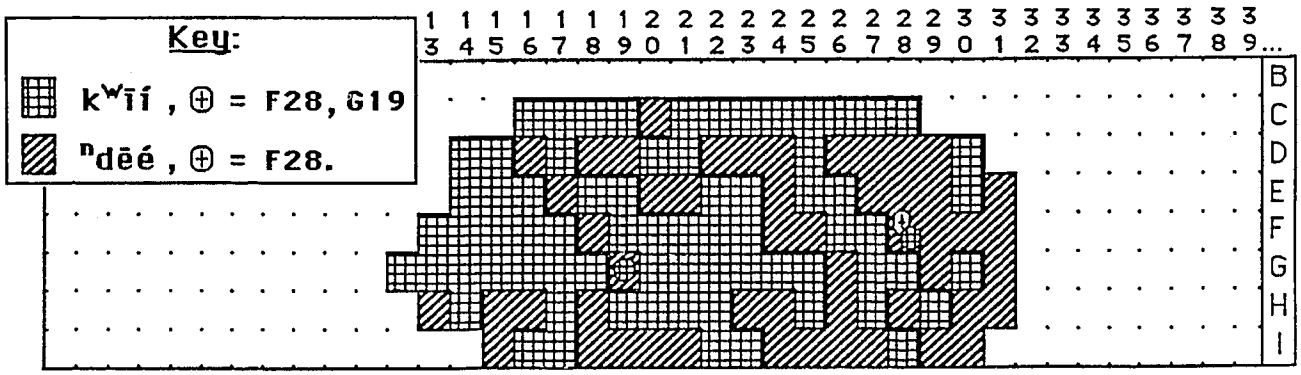
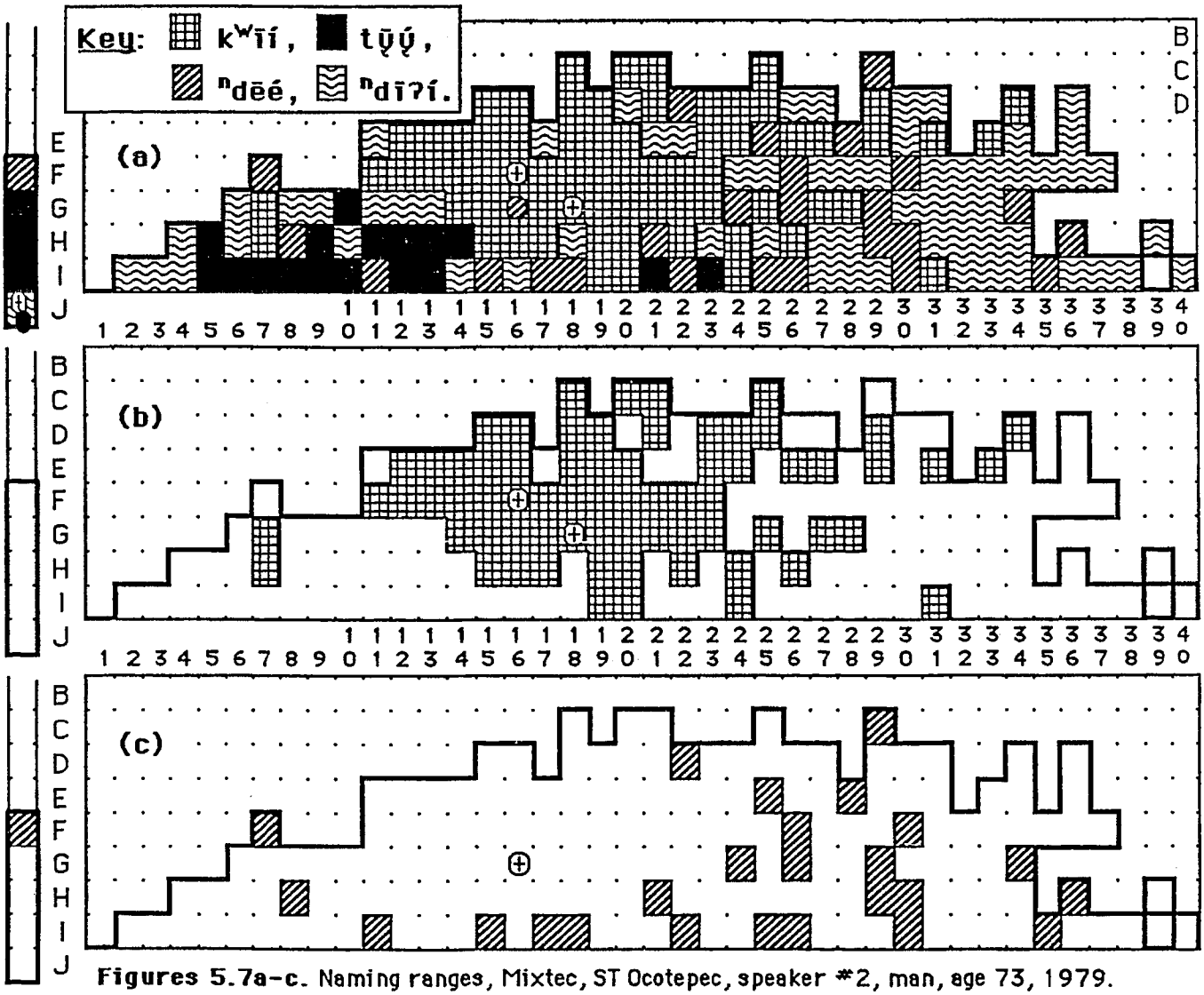


Figure 5.6. Naming ranges, Mixtec, Santo Tomás Ocotepec, speaker #1, man, age 75±, 1979.

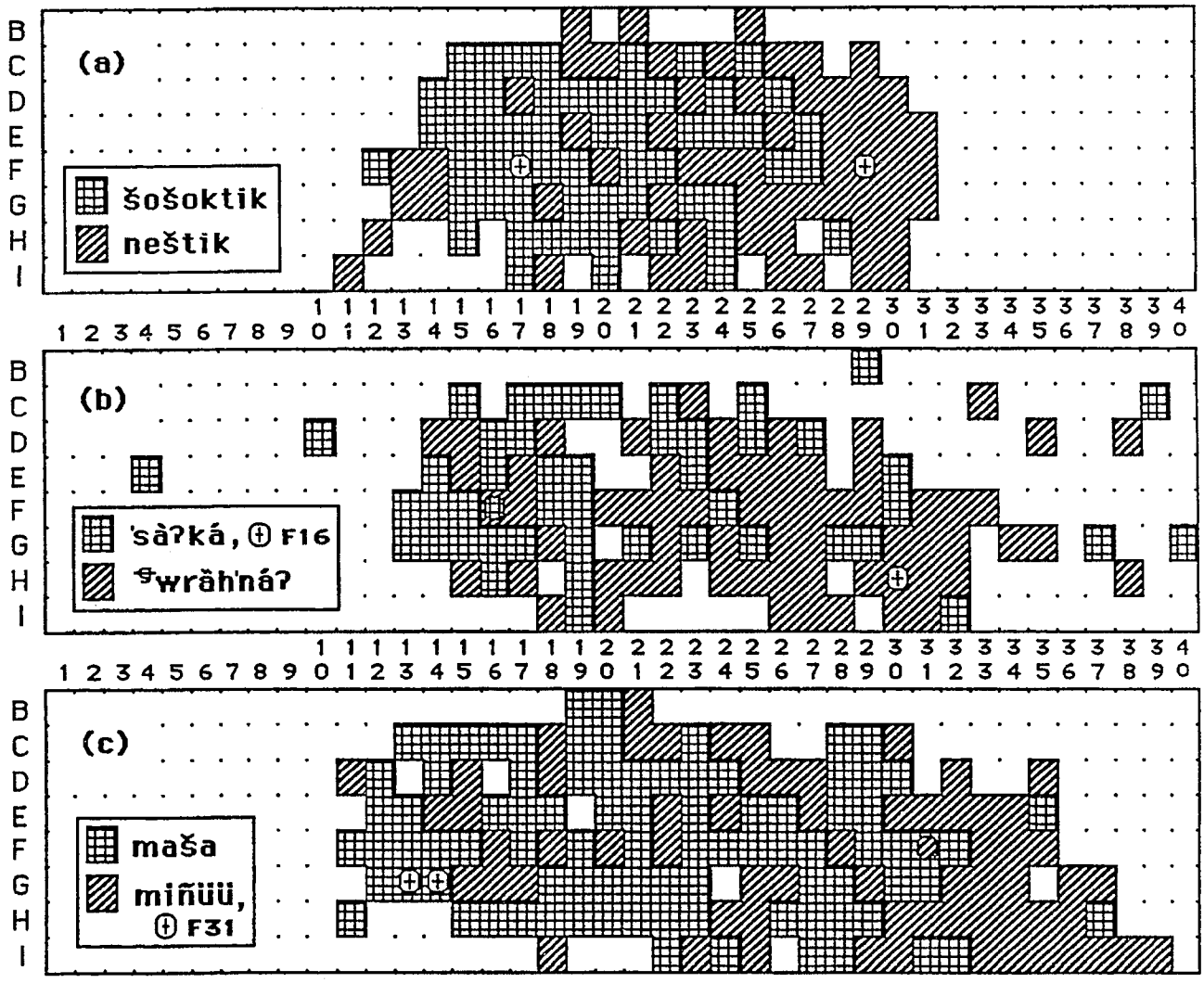


Figures 5.7a-c. Naming ranges, Mixtec, ST Ocotepec, speaker #2, man, age 73, 1979.

In Figure 5.6, coextensive naming ranges from the cool category of Mixtec speaker #1 are intermixed (6), unlike the naming ranges of the Otomí speaker (cf. Figure 5.5a). But like the Otomí speaker, the Mixtec speaker focused one coextensive term on dual colors, G19 and F28. Both of these colors are named with the other term, whose single focus is also placed on F28.

In Figures 5.7a-c, Mixtec speaker #2 focused both coextensive ranges only in green. Figure 5.7a displays the intermixed naming ranges of a black-focused 'dark-cool' basic term (JØ), a 'black' secondary term (JØ), and two coextensive terms that name a secondary cool category (F16/G18, G16). This rare incidence of cool-category coextensivity on the secondary level occurred in a social milieu that encouraged differentiation: In Ocotepec, speakers #1 and #2 were the only two among a sample of 20 who maintained the cool category, both having adopted coextensivity. Figures 5.7b-c isolate speaker #2's usage of each coextensive term, one concentrated in green and the other in blue. The latter mismatches its focus, G16.

Figures 5.8a-c display coextensive naming ranges in the cool category of a Nahuatl, a Paya, and a Tlapanec speaker. Each polarizes foci to a different degree. The Nahuatl speaker shows no polarization, focusing on unique green at F17 and unique blue at F29. The Paya speaker shows slight polarization of foci, F16 and H30. The Tlapanec speakers shows the most extreme polarization of foci seen among any of the coextensive cool-category terms in the Mesoamerican sample, G13-14 and F31. Most Tlapanec speakers use the former term to name the cool category and the latter to name the blue-with-purple category:



Figures 5.8a-c. Naming data: (a) Nahuatl, Tlaxpanaloya, man, age 35, 1978; (b) Paya, Pueblo Nuevo Subírana, man, age 23, 1977; (c) Tlapanec, Malinaltepec, man, age 30, 1978.

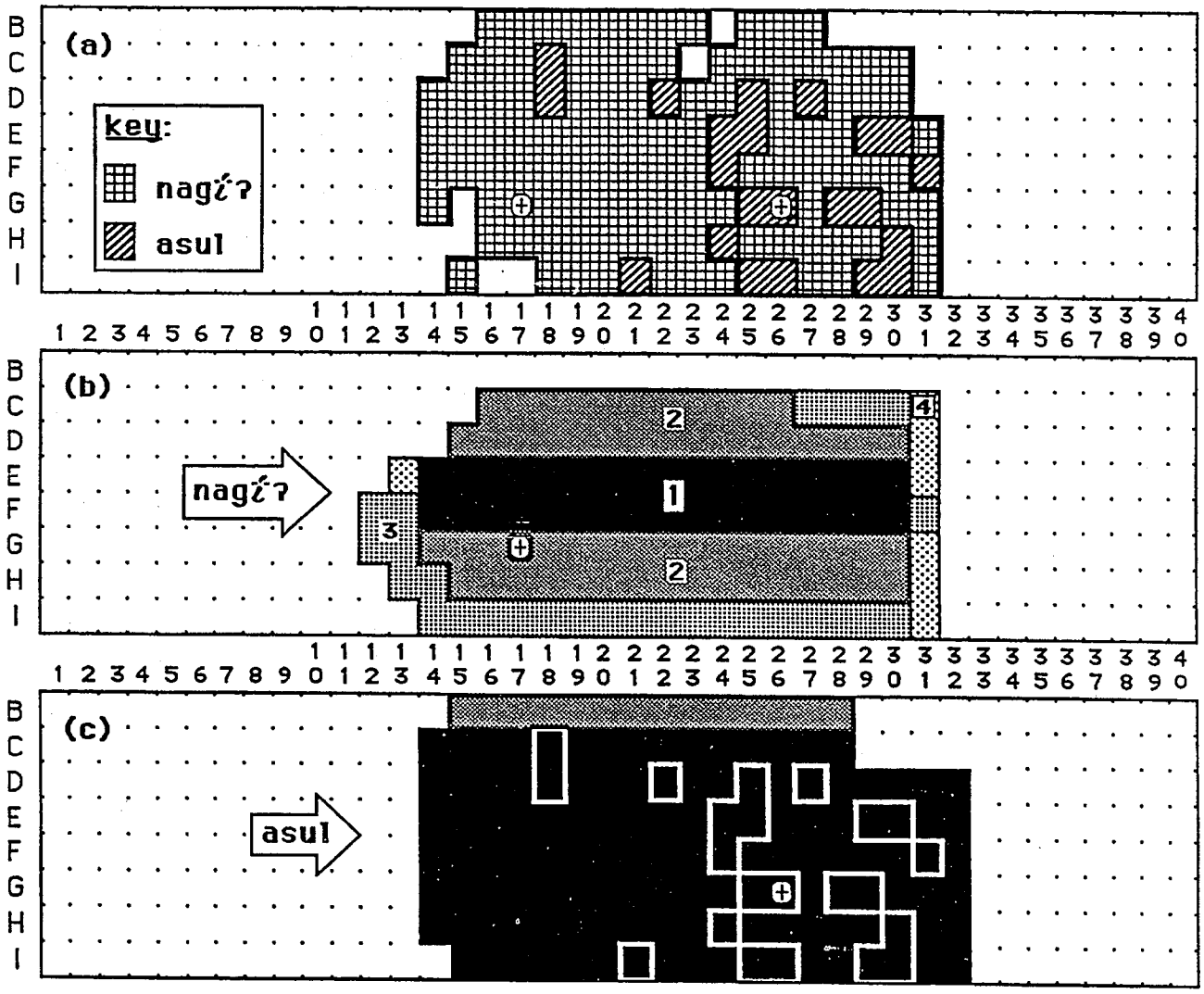


Figure 5.9a-c. Naming ranges (a) and mappings (b-c), Zapotec, Santiago Apostol, man, age 57, 1980.

Figures 5.9a-c show the coextensive ranges of a native term and a loan term in the cool category of a Zapotec speaker.[4] The native term is more salient than the loan term. Yet each is mapped continuously, with a single mapping step covering green and blue. Coextensivity can pertain as readily to a loan word as to a native word.

[4]This Zapotec speaker of Santiago Apostol, speaker #1, is the contemporary of speakers #2 and #3, whose categories are depicted in Figures 5.12a-13c. The three speakers show that relationships of coextensivity (#1), inclusion (#2), and complementation (#3) between green-focused and blue-focused terms are maintained by members of one generation in a small community.

5.1.3. Coextensivity in Two Environments: A Comparison

The foregoing describes seven characteristics of semantic coextensivity in the environments of the warm category and the cool category. Table 5.1 compares these seven characteristics plus two others in summary form:

Table 5.1

COEXTENSIVITY IN THE WARM CATEGORY	COEXTENSIVITY IN THE COOL CATEGORY
1. Each vantage that composes one category is always named with a different root.	1. Each vantage that composes one category can be named with a different root; or both vantages can be named with the same root (cf. Chapter IX, section 9.1.). Such can be differentiated by modifers of the root (cf. section 9.2).
2. Each term is focused in reference to a different unique hue; each vantage is taken in reference to a different unique hue. In a category that is constituted by more vantages than there are unique hues, the additional vantages are taken in reference to a complex color, such as brown; and each additional range is focused in reference to such (cf. Figures 5.4a-d).	2. Each term is often focused in reference to a different unique hue, although the reference is weak. The weakness enables at least one of a pair of coextensive terms to be applied from two vantages and, consequently, to be dual-focused in reference to both unique hues. Or, for the same reason, both terms can be focused in reference to the same unique hue (cf. Figures 5.6-7c).
3. The mapping of each range encompasses the focus of the opposite range(s).	3. Ditto.
4. The mappings of the two (or more) ranges substantially overlap throughout the category.	4. Ditto.
5. A range is likely to be mapped such that the first step is placed in the vicinity of one unique hue and the other unique hue is mapped by a subsequent step as the mapping progresses in the direction of the distant-most margin of the category. The mapping of the second range is likely to progress in similar fashion, but from an opposite starting point and in the converse direction (cf. Figures 5.1a-c). Rarely, one range will be mapped over both unique hues by one step (cf. Figures 6.3a-c, 6.7a-8c, 6.10a-c). In no event will both ranges be mapped over both unique hues, respectively, by the first step of each mapping (cf. Figures 5.10b-c).	5. A range is likely to be mapped such that the first step is placed on both unique hues, *either* disjunctively on green and blue with turquoise colors left to be mapped by subsequent steps *or* continuously throughout green, turquoise, and blue. In either case, both unique hues are treated with one performance during the mapping of each range (cf. Figures 5.5b, 5.9a-c). A mapping of one range over the unique hues by separate steps is exceptional (cf. Figure 5.5a).

6. The name of any range can be applied throughout the category (cf. Figure 5.1a), although the extensive intermixture of coextensive terms occurs in about one in ten cases (cf. Figures 5.2-3). A prevailing confinement of each term to the vicinity of opposite unique hues is common (cf. Figure 5.4a).	6. The name of any range is used with slight preference in the vicinity of one unique hue, although extensive intermixture of terms occurs in about one in two cases (Figures 5.8a-c). A prevailing confinement of each term to the vicinity of opposite unique hues is rare (cf. Figure 5.5c).
7. Foci are often polarized to a position between a unique hue and the category margin (cf. Figure 5.1a). Foci of opposite ranges can both be polarized in apparent opposition to each other (cf. Figure 5.2). In extreme cases, mutually polarized foci are placed on opposite peripheries outside of their naming ranges (cf. Figure 5.3).	7. Foci are sometimes polarized, although seldom to an extreme (cf. Figures 5.8a-c). Rarely, the foci of both ranges are polarized to peripheral positions that are virtually adjacent or the same rather than opposite (cf. Figure 5.11a). Such seems to result from the weakness of association of a range with a particular vantage, as detailed under 2 (above).
8. Coextensivity exhibits a continuum of variants, whose ideal forms are called *dominant-recessive*, *balanced*, and *mutually polarized*. The forms coincide with phases of category division (cf. Chapter VI).	8. Coextensivity exhibits different forms, which might relate to category division. But inconsistencies that result from the weak tie between particular ranges and vantages impede the identification of variants (cf. Figures 6.27a-c).
9. During advancing category division, each coextensive range retracts toward its own polarized focus and away from the focus of the opposite range. The coincidence of a term, its mapping, and its focus is unequivocal. Data from different individuals coincide in like ways (cf. section 7.I.).	9. During advancing category division, a term, its mapping and/or its focus can be confined to opposite sides of a category. Data pertaining to the other term can similarly mismatch, but in an inverse pattern. Different individuals exhibit such patterns that are scrambled in reverse manners (cf. Figure 7.2).

Of the nine characteristics (1-9) of coextensivity that are compared in Table 5.1, seven (1-7) have been exemplified and discussed in conjunction with Figures 5.1a-9c, partially or fully. Remaining aspects of 1-7, as well as 8-9, are exposited in subsequent sections and chapters, as is noted in the table.

All characteristics, except (3-4), differ between the warm category and the cool category. Each difference has the same implication: *Red and yellow appear more distinct than green and blue; ethnographic evidence and physiological evidence corroborate each other* (cf. section 2.1.).

The following discusses each difference, characteristic-by-characteristic, and it outlines the reasons that each difference has the same implication:

1. The greater the perceived distinctiveness of two (or more) colors, the more likely it is that (a) they will be regarded from more than one vantage and that (b) they will be named with a different word from each vantage. Coextensive vantages in the cool category that each are named with the same word are discussed under section 9.1.; substantiation of such coextensive vantages requires different lines of evidence than does substantiation of overtly named vantages.

2. It is easier and more consequential to avoid interchanging words between vantages that are associated with distinct colors; it is more difficult and less consequential to avoid the interchange when the colors are similar. This assumes that the vantages that are taken in reference to particular colors remain stable; only their names are interchanged. The interchange allows that one coextensive term can be focused in reference to more than one pure color (cf. Figures 5.5a and 5.6), and it allows that two coextensive terms can be focused in reference to the same pure color (cf. Figures 5.5a, 5.6, and 5.7a-c). The interchange also involves much more, which is discussed and exemplifed in section 7.2. The various manifestations of interchange are called "crossover effects." They characterize coextensivity in the cool category only.

3-4. These characteristics are useful indicators of coextensivity, but by themselves they also typify near-synonymy. Coextensivity and near synonymy are further differentiated by other characteristics, as outlined in section 5.2 under Figures 5.10a-c.

5-6. Individuals will be inclined to treat distinct colors with separate performances and similar colors with a single performance. The mappings described in the table under 5. reflect this inclination. However, the dominant range of dominant-recessive coextensivity in the warm category can also be mapped on both unique hues in a first and single step (cf. section 6.1., Figures 6.3a-c, 6.7a-8c, 6.10a-c). Dominant-recessive coextensivity occurs when the attendance to similarity is strong. Moreover, the mapping of a cool-

category term in Figure 5.5b covers the unique hues in two steps rather than in one; in Figure 5.5a, the naming range of the same term is confined to just blue. Characteristics 5-6 are prevailing tendencies only. The intermixture of cool-category terms (cf. Figures 5.6-8c) is enhanced directly by the similarity of green and blue, and the intermixture might be further enhanced by the "crossover" or interchangeability of words between vantages (See characteristic 2).

7. Polarization marks contrast between colors that are perceived to be distinct or, at least, thought of as distinct; a focus is selected on the edge of a category so that it strongly expresses a distinction between the colors of one part of the category versus those of other parts. Centralization is an expression of similarity; a focus is selected between the unique hues of a category so that it represents as closely and equally as possible all of its colors. That the foci of the warm category are more frequently polarized and polarized to a greater extreme suggests that distinctiveness is more apparent between red and yellow than between blue and green. However, dominant-recessive coextensivity involves both strong centralization and polarization. This pattern is explained in Chapter VI, section 6.1.

8. The dominant-recessive form of coextensivity is more discernible in the warm category because the distinctiveness of red and yellow discourages the crossover effect. In the cool category, the crossover intermixes the characteristics of dominant and recessive ranges more than in the warm category. In the cool-category, division is precipitated by an attendance to distinctiveness that is strong enough, at least, to equal the strength of the immanently strong perception of similarity. The equalization at elevated strengths provokes a conflict between perception and cognition, which causes indecision about whether both coextensive terms name one composite category or whether each names a separate primary category. In response, the naming range of one term can be confined to just one side of the category and the term can be mapped on just one side; however, the naming range and mapping can be "crossed over" to opposite sides such that they mismatch each other. The naming range and mapping of the second coextensive term can likewise mismatch, but with

a crossover pattern that is the mirror-image of that which pertains to the first. The complexities become further involved when individual variation is considered. Such data are discussed and exemplified in section 7.2., Figures 7.21a-25d.

9. The extreme polarization that characterizes advancing division of the warm-category is encouraged by the inherently strong perception of distinctiveness between red and yellow (cf. section 7.1). Conversely, the crossed over mismatchings that characterize advancing cool-category division result from a clash between strong perception of similarity and an attendance to distinctiveness that has been enhanced to an equal strength, as discussed under 8.

The foregoing enumerates all of the ethnographic evidence that conforms to the axiom that *red and yellow are perceived to be more distinct than green and blue.* At this juncture, the analysis has run ahead of itself, because "covert coextensivity," "crossover," "dominant-recessive," and characteristics 8-9 are exemplified and discussed in later chapters. All characteristics are contrasted here in order to completely summarize the description of coextensivity in one table. Characteristics 1-7 are sufficient to illustrate the conformity of observations to the axiom.

The engagement of the perceptual axiom with the cognitive attendances to similarity and to distinctiveness accounts for the differences between coextensivity in the warm category and the cool category. The same engagement of perception and cognition determines that the warm category will divide before the cool category in evolutionary order.

5.2. Coextensivity in Relation to Other Semantic Types

The reciprocity of strength between attendances to similarity and to distinctiveness entails a continuum along which clear semantic types and intermediate blends of types are related to each other. At one extreme, strong attendance to similarity and weak attendance to distinctiveness produce near-synonymy. At the other extreme, strong attendance to

distinctiveness and weak attendance to similarity produce complementation. Between the extremes, a closer equilibrium of the attendances produces coextensivity, with small shifts in the equilibrium producing dominant-recessive, balanced, and mutually polarized coextensivity. A greater shift toward distinctiveness produces inclusion. The types evolve within a category as it divides.[5]

The following compares near-synonymy and coextensivity, and it exhibits data that suggest a blend of these types. Minimum attention is devoted to inclusion and complementation. The continuous relationship between coextensivity, inclusion, and complementation is exemplified and fully discussed in Chapter VII. The objective here is only to show that the continuum exists, not to describe it in detail or to develop all of its implications. However, near-synonymy is treated in the present section as thoroughly as possible; the Mesoamerican sample yields only one clear example of near-synonymy within a composite category:[6]

Figures 5.10a-c display the example of near-synonymy. A Jicaque speaker named all colors with only three terms, a conservative practice. In consistency with this, she named the warm category with one term throughout, focused in red at G3. The other nine Jicaque speakers who were interviewed at Montaña de la Flor used yellow-focused *lu* as well as red-focused *he* (cf. section 8.4.4., Figures 8.39a-40a-f). Yet the present speaker, after using just the latter term to name red and yellow colors, focused and mapped both terms on request, as shown in the figures. Her knowledge exceeded her usage during the naming elicitation.

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[5]Hage and Hawkes (1975: 298-99) describe the same semantic evolution and recognize its relationship to basic-category evolution: "An examination of individual protocols reveals...steps in the transition of one phase to the next.... one group...had a stable focus...but not bounded GRUE, i.e., the GRUE category matched the dark-cool or BLACK category in range [*Coextensivity*]. (Informant 1 lacks even a GRUE focus [*Near-Synonymy*].) A second group...has a bounded GRUE, which is subordinate to a large BLACK category [*Inclusion*]. A third group...has a bounded GRUE which contrasts with a restricted or "shrunken" BLACK [*Complementation*].... a more advanced system results from a redefinition of the taxonomic relations between old categories rather than the...sudden introduction of a new category." [Words in square brackets added.]

[6]The Mesoamerican sample yields more examples of near-synonymy among primary basic color categories, which are treated in Volume II.

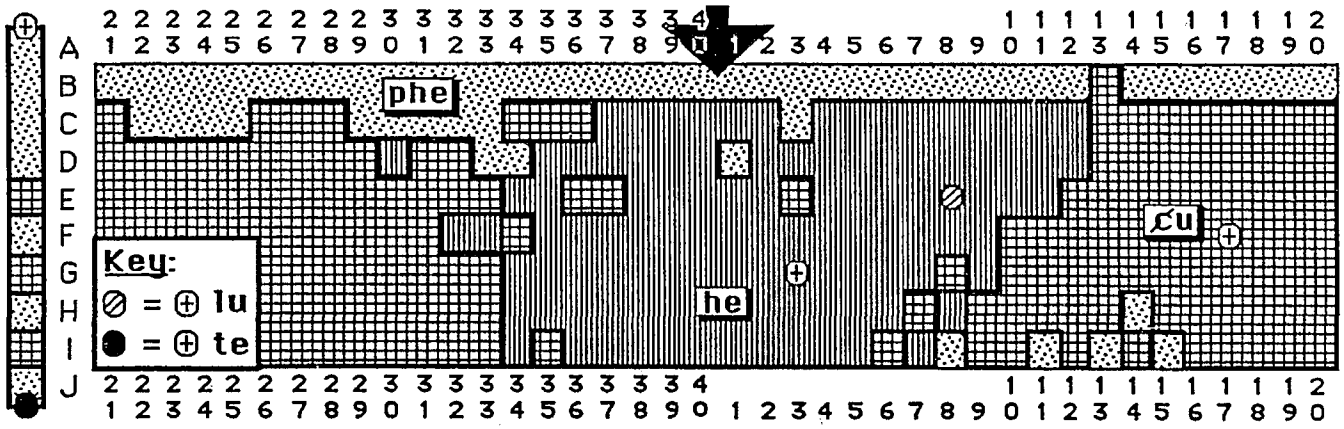
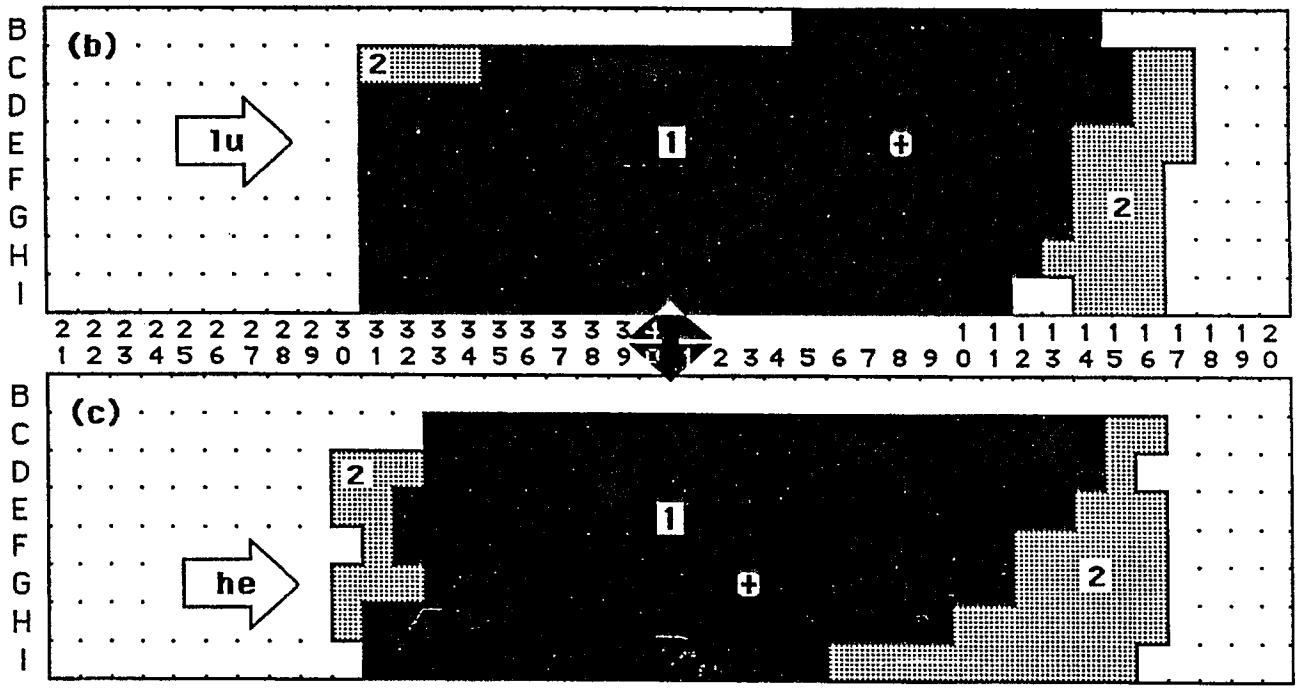


Figure 5.10a. Naming ranges, Jicaque, Montaña de la Flor, woman, age 25±, 1977.

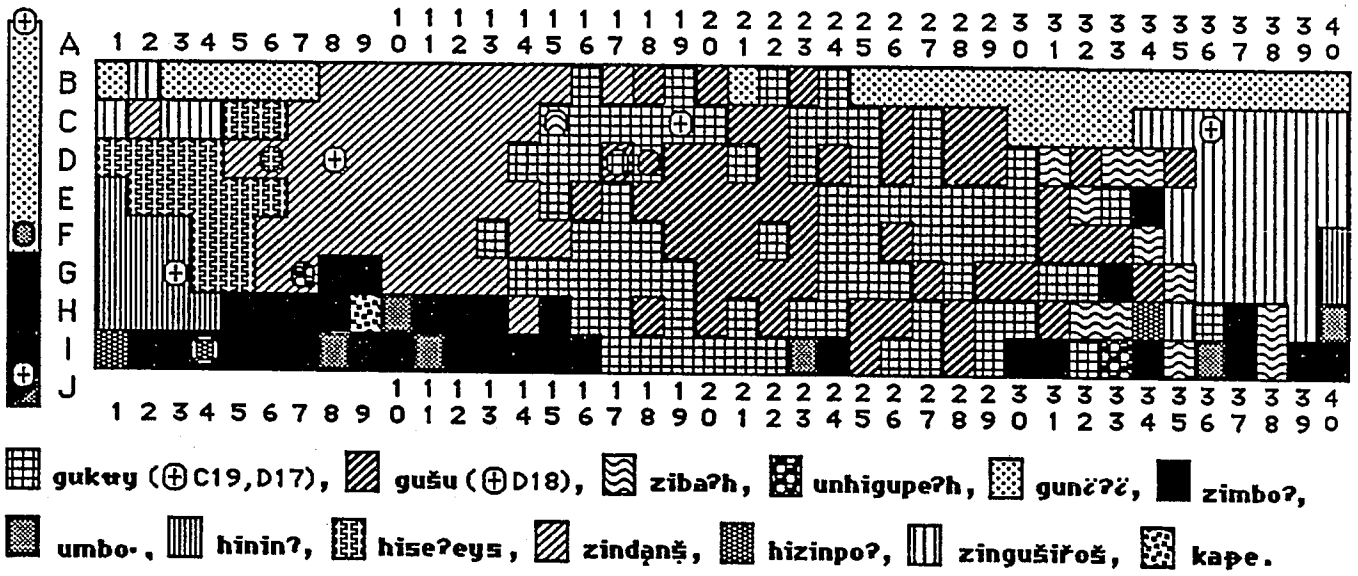


Figures 5.10b-c. Mappings, same speaker as in Figure 5.10a, 1981.

In the Jicaque data, the distinction between near-synonymy and coextensivity is clear. The speaker assumed two vantages of the warm category, and she linked each to a

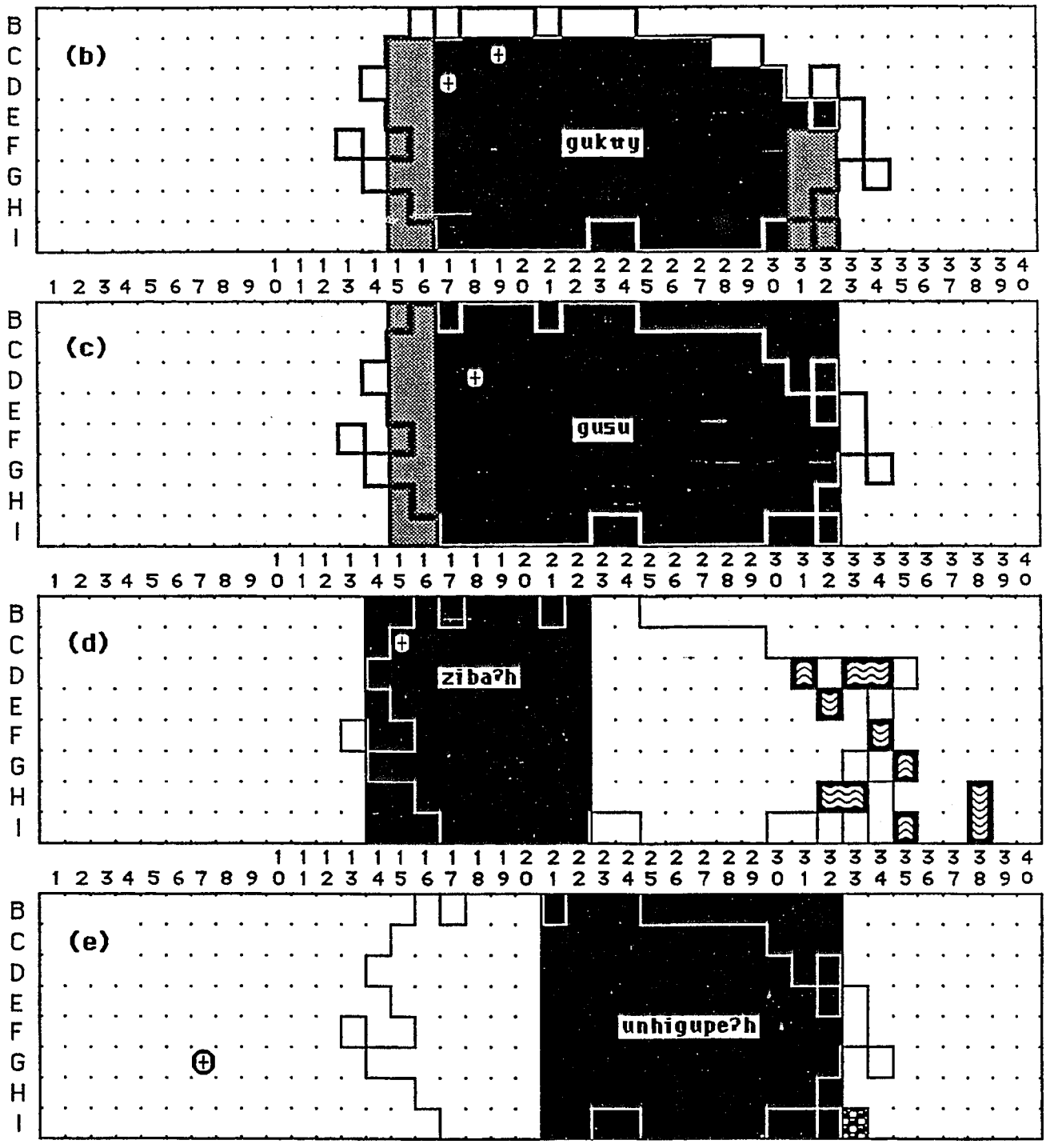
separate focus and a different word. But the foci are closer together than those seen in the coextensive ranges of Figures 5.1a-4d. And in contrast to the Tzeltal and Aguacatec speakers of Figures 5.1a-c and 5.4a-d, the Jicaque speaker mapped the two terms much alike; the first mapping step of each covers most of the reds and yellows, *including both unique hues*. These characteristics of near-synonymy correspond to her designation of all warm colors with just one name. Since each term had almost the same meaning to this speaker, it might have mattered little to her which term she used during the interview.

Figures 5.11a-e display data from a cool category in which characteristics of coextensivity and near-synonymy appear to merge:



Figures 5.11a. Naming ranges, Chichimeca Jonáz, Misión de las Chichimecas, San Luís de la Paz, woman, age 73, 1981.

In Figure 5.11a, two major terms designate the cool category. Various characteristics that are shown in this figure and in Figures 5.11b-e suggest that the two terms might be coextensive rather than synonymous: For example, both are focused in the same polarized vicinity at C19, D17, and D18, which is consistent with characteristic 2 of Table 5.1; in the cool category, the interchangeability of terms between vantages allows



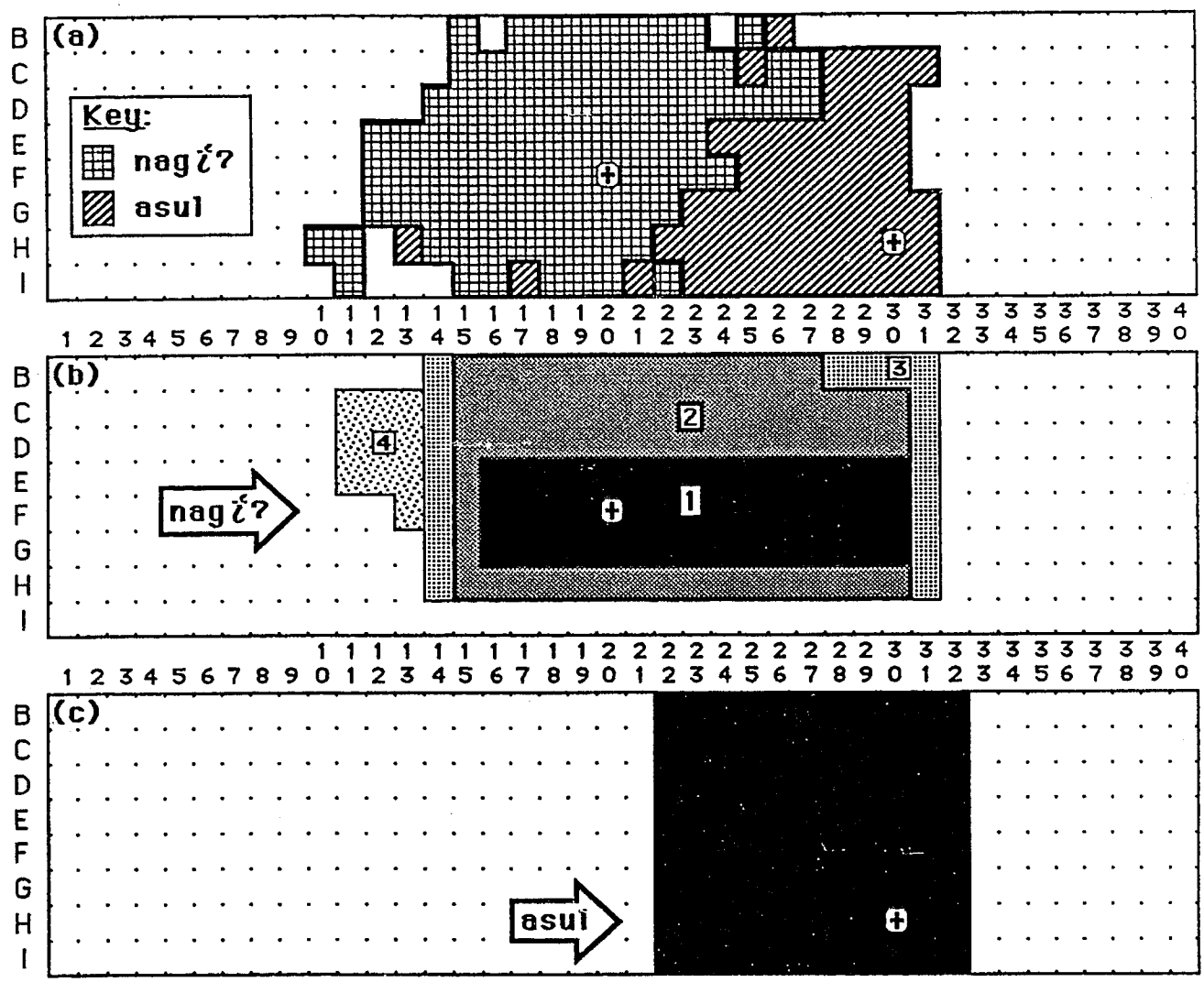
Figures 5.11b-e. Mappings, same speaker as in Figure 5.11a, 1981.

that two terms might be polarized at the same position. In other aspects, synonymous characteristics of the terms are blatant: Both terms are applied with almost equal evenness throughout the cool category. That is, one term (C19, D17) is used 37 times to name colors on the green side of column 23, 3 times to name colors in column 23, and 36 times to name colors on the blue side of that column;[7] the other term (D18) is used 22, 4, and 24 times, respectively. Moreover, Figures 5.11b-c show that each term is mapped continuously throughout the category; the mappings fail to correspond on only 24 of the 136 colors that they cover.

However, characteristics of other terms further suggest coextensivity: *ziba?h* is applied to purple colors in columns 31-38, but it is focused at C15 in the same polarized vicinity as the two major names of the category (C19, D17; D18); Figure 5.11d shows that the mapping of *ziba?h* corresponds to its focus rather than its naming range. Similarly, Figures 5.11a and 5.11e show that another term, *unhigupe?h,* is used once at I33, mapped throughout cool colors of columns 21-32, and focused at G7 in extreme polarized opposition to its mapping and minimally salient naming range. The mappings of the two minor terms are executed on opposite sides of the cool category, suggesting distinct vantages. Although these latter data appear erratic when considered by themselves, they corroborate the evidence concerning polarized foci of the two major terms. All evidence collectively suggests that the Chichimeca Jonáz speaker composes the cool category from coextensive vantages, at least incipiently; but characteristics of coextensivity and near-synonymy are merged.

Figures 5.12a-13c show examples of inclusion and complementation among the green-focused and blue-focused terms of two Zapotec speakers from Santiago Apostol, speakers #2 and #3. In Figure 5.9a-c, Zapotec speaker #1, who is also from that small community, demonstrated a coextensive relationship between the same terms:

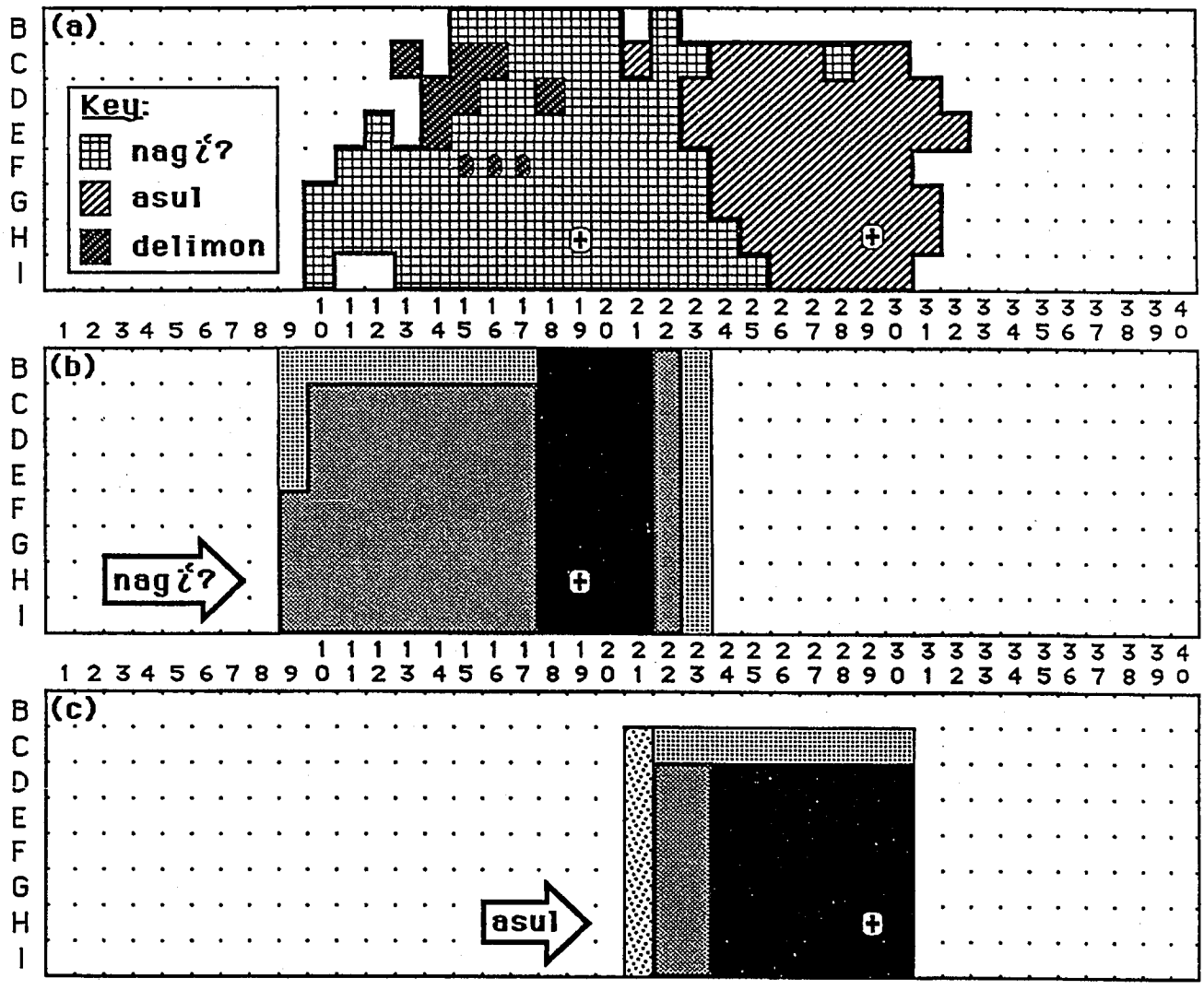
[7]Kay and Kempton (1981) provide evidence that column 23 is the universal perceptual divide between green, focused at G17, and blue, focused at F29.



Figures 5.12a-c. Naming ranges (a) and mappings (b-c), Zapotec, Santiago Apostol, speaker #2, man, age 61, 1980.

In Figure 5.12a, speaker #2 extended the blue-focused naming range beyond its mapping to H13 and I17, which suggests that he maintained a semantic relationship that was intermedial to coextensivity and inclusion; however, no sign of coextensivity appeared in his blue-focused mapping of Figure 5.12c. In Figure 5.13a, speaker #3 volunteered a stray usage of his green-focused term at C28, suggesting an intermedial relationship to

inclusion and complementation; however, again, the intermediacy is not evident in the green-focused mapping of Figure 5.13b:



Figures 5.13a-c. Naming ranges (a) and mappings (b-c), Zapotec, Santiago Apostol, speaker #3, man, age 63, 1980.

5.3. Semantic Evolution in Two Environments

It should be emphasized that evolution of semantic relationships is not obligatory; as a category divides, it can be named with just one term throughout the process.

The cognitive shift between the strengths of the two attendances does not determine that semantic types will develop. Rather, any particular balance between the strengths establishes a *precondition* for the development of the particular semantic type that is commensurable with that balance. Whenever an individual first names one category with more than one word, the words will assume the relationship that reflects the prevailing balance of strengths.

The continuum, then, is one of cognitive preconditions that constrain semantic relationships; it is not a semantic continuum *per se*. Since the continuum consists of preconditions for semantic types, evolution of actual types need not begin at the earliest segment of the continuum but can begin at any point, including a very late point.

It is more likely that semantic evolution will begin early on the continuum in the warm category than in the cool category. In the latter, the second term is commonly introduced at the segment of the continuum that determines inclusion; this is the first semantic type to emerge. In rare cases, the cool category fully divides without the introduction of a second term; thus, one of the two unique hues remains unnamed for a period (cf. Figures 8.5a, 8.7a, 9.6a-d). In other words, after the cool category had divided completely, complementation emerges as the first relationship between two terms in the environment of green and blue.

The following statistics are excluded from Table 5.1, because they concern the entire continuum of semantic evolution rather than just the segment that determines coextensivity. However, like the characteristics listed in the table, these too conform to the axiom that red and yellow appear more distinct than green and blue: Of the 59 warm categories in the Mesoamerican sample, 58 are named with at least two words, which bear a relationship of near-synonymy, coextensivity, or inclusion (See Chapter VI, footnote 2.).

Only the Jicaque speaker of Figures 5.10a-c named the warm category with one word, although she too maintained near-synonymy in the sense that she demonstrated her knowledge of a second word (cf. Figure 5.10b). The count of semantic types within the 59 warm categories is: 1 near-synonymy, 30 coextensivity, 28 inclusion.[8] Of the 589 cool categories of the sample, 367 are named with just one term with no overwhelming independent evidence of near-synonymy or of "covert coextensivity (cf. 9.2.)." The count of semantic types within the 589 cool categories is: 367 simple use of one name, 1 near-synonymy, 104 overt coextensivity or strongly attested covert coextensivity, 117 inclusion. The percentages compare as follows, **warm/cool**: simple use of one name .0000/.6230; near-synonymy .0169/.0017; coextensivity .5084/.1765; inclusion .4745/.1986.

The reciprocal shift between cognitions establishes a continuum of preconditions for the development of semantic types. Semantic types always evolve in the warm category and tend to begin the evolution early on the continuum; semantic types evolve in the cool category less often than not, and they tend to begin the evolution late on the continuum.

5.4. Summary

Coextensivity is a unique type of semantic relationship. It is characterized by nine traits that, as a complex, distinguish it from three other types. The characteristics differ between the warm category and the cool category in a way that is consistent with the perceptual axiom that red and yellow appear more distinct than green and blue. The engagement of that axiom with the attendances to similarity and to distinctiveness explains both the evolutionary order of the warm and the cool category and the distinct manifestation of coextensivity in each.

Coextensivity is a segment of a continuum of ideal types through which semantic relationships evolve from near-synonymy, to coextensivity, to inclusion, to

[8]Cases that are indeterminate are classed as inclusion; when only naming data are available, coextensivity might not be apparent, even though it is in use. See Chapter VI, footnote 2.

complementation. The evolution is propelled by the reciprocal shift in strength between the attendances to similarity and to distinctiveness. The precondition for the emergence of each type is established by a different balance of strengths. Since the relationship between strengths is reciprocal, the semantic evolution is continuous, allowing the development of types that are intermediate to the ideals.

The same reciprocal shift of strengths advances the evolution of basic categories through an invariant perceptual hierarchy, as discussed in Chapter IV. For this reason, both the evolution of basic color categories and the evolution of semantic types progresses continuously rather than by disjunctive leaps.

The engagement of perceptual and cognitive axioms further accounts for differences in the way that the evolution of semantic types occurs in the warm and cool categories. In the warm category, the evolution always occurs and it tends to begin early. In the cool category, the evolution may not occur and, when it does, it tends to begin late.

Each range of a coextensively named category manifests a separate vantage of the perceptions that the category encompasses. The vantages are adopted by the observer and are, therefore, cognitive. They do not inhere in neural response. Coextensive vantages and category division constitute separate arguments that composite color categorization is as much cognitive as it is perceptual. A theory of this topic requires axioms of both kinds.

Finally, this introduction to coextensivity has maintained simplicity by emphasizing semantics and ignoring cognitive composition. It has discussed only seven characteristics of coextensivity while postponing treatment of others until later chapters. And it has exemplified the continuum of semantic types in a cursory manner. Only the data regarding near-synonymy is covered fully, because they are minimally represented by the sample. In contrast, Chapters VI and VII cover the evolution of coextensivity, inclusion, and complementation in detail. Chapter VI tests a hypothesis that coextensive vantages are constituted from specific perceptual and cognitive coordinates, and it develops implications of the test-results for a theory of category composition and internal change.

Chapter VI

Variants of Coextensivity

6.0. Preface

This chapter tests the hypothesis that coextensively related terms name a category from different *vantages*; a category that is so named is *composed* of vantages. Like a vantage that is taken of the physical world, each vantage of a coextensively composed category is taken from a particular *position* or *vantage point*. And, like such a position in physical space and time, each vantage point of a coextensively composed category is constituted by *coordinates*.

In physics, the coordinates that constitute a vantage point are derived from some reference body of three perpendicular dimensions and time, and the temporal coordinate is a function of relative motion: $K = x, y, z, t;\ K' = x', y', z', t'$. A single event or object will differ when viewed from distinct vantage points, K or K'. Thus, in Einstein's classic example, the trajectory of an object that falls from a moving railway carriage is straight when viewed from the train but parabolic when viewed from the ground.

In a coextensively composed color category, the equivalent coordinates are the perceptions and cognitions of an individual. A particular vantage point is constituted by a coordination of one unique hue and the attendance to similarity; another vantage point is constituted by a coordination of the opposite unique hue and the attendance to distinctiveness. The category will assume a different size and composition when regarded from each vantage.

The size and composition of each vantage is made up of four independent and quantifiable characteristics that are mutually predictable. The predictability enables a test of

the foregoing hypothesis against numerical data. For reasons that will be detailed in section 6.1, incorporation of the attendance to similarity in a vantage point entails that a category will be (1) centrally focused, (2) copiously named, and (3) broadly mapped with (4) large mapping steps; incorporation of the attendance to distinctiveness in a vantage point entails that a category will be (1) focused less centrally, (2) sparsely named, and (3) narrowly mapped with (4) small steps. The four different characteristics of each set will correspond within one vantage of a coextensive pair. *In a sample of well described coextensively composed categories, the four characteristics of each set will correspond within a particular coextensive range at a frequency that is overwhelmingly greater than chance.*

The statistical evidence that coextensively named categories are composed of vantages has implications for theory. Some of them concern the difference between the present notion of categorization and Rosch's theory of natural prototypes and family resemblances. Others concern the parallel between the use of perceptual and cognitive coordinates in category composition and the use of spatial and temporal coordinates in the apprehension of the physical world. It will be argued that the parallel is not coincidental. These and other implications are detailed in section 6.5.

The same axiom that, in Chapters IV-V, provides for an explanation of continuous evolution of basic color categories and of semantic types further provides the coordinates that account for correspondence among characteristics (1-4) of size and composition within coextensive ranges. The axiom unites hypotheses that concern both continuous evolution and composition of categories from vantages.

The title of this chapter refers to the variant extent to which the four characteristics correspond. Each measure of correspondence defines a different type of coextensivity. *Strong dominant-recessive coextensivity* involves a complete correspondence: the four characteristics of the attendance to similarity correspond in the *dominant vantage* and the characteristics of the attendance to distinctiveness correspond in the *recessive vantage.*

The former is called "dominant" because it is broad and symmetrical, and the latter is called "recessive" because it is skewed and retracted toward its focus and, in many cases, polarized. *Weak dominant-recessive coextensivity* involves correspondence of just three characteristics. *Balanced coextensivity* involves no correspondence; the characteristics of the different sets are mixed two-for-two among the vantages. *Mutually polarized coextensivity* is balanced coextensivity with mutually polarized foci as well as other signs of exceptionally strong opposition between vantages.

The types of coextensivity constitute a short evolutionary continuum in which dominant-recessive coextensivity is closest to near-synonymy and mutually polarized coextensivity is closest to inclusion. The continuum of coextensive variants is part of the longer continuum of semantic types, introduced in Chapter V. Accordingly, dominant-recessive coextensivity requires the strongest attendance to similarity, and mutually polarized coextensivity requires the strongest attendance to distinctiveness. In the middle of the short continuum, the two attendances approach equal strength. At that point, some individuals find it difficult or inconsequential to consistently attach each attendance to an opposite unique hue, which occasions a "crossover effect" and balanced coextensivity.

Strong dominant-recessive coextensivity is, by far, the most common variant; its frequency of occurrence is followed at a distant second place by weak dominant-recessive coextensivity. Balanced and mutually polarized coextensivity are rare; they never occur during the internal evolution of most coextensively composed categories. Usually, dominant-recessive coextensivity evolves directly into a relationship of inclusion when the recessive range retracts toward its focus to an extent that it no longer pertains to the opposite unique hue.

6.1. Coextensive Vantages: A Test

This section tests the hypothesis that coextensive terms name a category from vantages that are constituted by perceptual and cognitive coordinates. In composite categories of two vantages, the perceptual coordinates are the unique hues; the cognitive coordinates are the attendances to similarity and to distinctiveness. Rare cases of triple coextensivity are considered in section 6.2.

The test is conducted on the basis of the 20 warm categories of the Mesoamerican sample in which coextensive ranges are represented by naming data, mappings, and foci.[1] For this test, the warm category is more suitable than the cool category because it is less susceptible to crossover effects, as discussed in Table 5.1, item 2 (Also see section 7.2.). The test hinges on the prediction that the warm category will assume a distinct size and composition when regarded from vantage points that incorporate opposite cognitions. The prediction is refined by analyzing size and composition into independent and quantifiable characteristics. There are five characteristics in total. Four of them will always occur, and they will be modified accordingly by each cognitive coordinate. Thus, in each vantage, the characteristics will assume distinctive, numerically expressable forms and the forms will correspond with each other to a significant extent. The hypothesis of vantages and coordinates specifically predicts the coorespondence.

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[1]In addition to these twenty, 10 cases of warm-category coextensivity are substantiated by naming data alone; mappings were not collected. The total of 30 are treated in this chapter. In Chapter VII, 15 additional warm categories are substantiated and analyzed; all suggest inclusion. There is no evidence that any of the fifteen are coextensively composed, although some might be. A warm category showing near-synonymy appears in Figures 5.10a-c.

In Nahuatl of Santa Buenaventura and Santa María Tonanzintla, 13 red-focused warm categories are substantiated. All encompass a yellow-focused category and none are coextensive. In the data from Santa Buenaventura, 10 are called *λapalin;* this word has replaced the warm range of *čičiltik,* which presently designates only red. In the data from Santa María Tonanzintla, the remaining three warm categories are named with both of the two words, which share one focus. See Volume II.

The inventory of warm categories of the Mesoamerican sample, thus, totals 59; one shows near-synonymy, 30 are coextensively composed beyond a doubt, and 28 are composed by inclusion.

The following describes the characteristics (1-5b) and enumerates the reasons that they should correspond:

The attendance to similarity entails, generally, that colors of a category will be viewed as *strongly associated* with each other, of relatively *equal membership*, and separated by *minimal psychological distance*. The attendance to distinctiveness entails, generally, that the colors of a category will be viewed as *weakly associated*, of precipitously *unequal membership*, and separated by *maximal psychological distance*. The entailments will have five independent manifestations among the ways that the coextensive vantages of a category are named, focused, and mapped. Four of them (1-4) will always occur:

1. Relative focus placement. The attendance to similarity will be manifested by a centralized focus or, at least, a focus that is placed closer to the middle point between the unique hues than is the focus of the opposite range. A centralized focus reflects strong association and equal membership among colors by its placement at a position that represents as closely and as equally as possible all colors throughout.

The attendance to distinctiveness will be manifested by a focus that is placed on a unique hue, polarized, or, at least, less centralized than that of the opposite range. Such a focus closely represents only the colors in its immediate vicinity *in contrast* to other colors within the category. Contrast is markedly expressed by polarization. This reflects weak association and unequal membership among colors.

2. Relative number of colors to be named. A broad naming range that designates many colors throughout a category manifests the attendance to similarity. The range is strongly and relatively evenly associated with all colors as an undivided group. Conversely, a sparse naming range that designates mainly colors about its focus and few colors throughout the category manifests the attendance to distinctiveness. The range is strongly associated with only some colors and weakly associated with others; the former group is contrasted against the latter.

3. Relative number of colors to be mapped. A mapping that covers many colors throughout a category manifests the attendance to similarity because a strong association between colors minimizes the psychological distance between them and, thereby, encourages the incorporation of a maximal number of colors into a single group. Conversely, a mapping that covers few colors manifests an attendance to distinctiveness because a weak association between colors increases the psychological distance between them and, thereby, encourages a minimal grouping of colors; the few colors that are strongly associated are mapped as a contrastive set against those that are left unmapped.

4. Relative average number of colors per mapping step. This characteristic consists of the total number of colors mapped in a range divided by the number of steps in which the mapping was achieved. Single mapping steps that cover many colors manifest the attendance to similarity because they demonstrate a strong association between colors and a view that the colors belong together. Single mapping steps that cover few colors manifest the attendance to distinctiveness because they demonstrate a weak association between the colors and a view that the colors belong in small groups that are differentiated from each other on a contracted scale.

5. Relative modifier count and modifer distribution. (5a) *Count:* The attendance to similarity is indicated by a frequent use of maximal or augmentative modifiers relative to an infrequent use of minimal or diminutive modifiers to qualify the name of a range; such usages show a strong identification of colors throughout the range with its focus. The attendance to distinctiveness is indicated by a frequent use of minimal or diminutive modifiers relative to an infrequent use of maximal or augmentative modifiers to qualify the name of a range; such usages show a weak identification of colors throughout the range with the focus, a differentiation of the focus and the rest of the range.
(5b) *Distribution:* The attendance to similarity is indicated by the use of the name of one range to qualify the name of the other range; such qualification overtly marks a recognition

of likeness between colors that are named with different roots. Conversely, the attendance to distinctiveness is less likely to be expressed in this way.

Characteristics 5a-b cannot be used as a diagnostic to perform a test throughout a sample of categories from different individuals, because not all individuals volunteer modifiers during the naming elicitation.

It should be asked whether any of the characteristics are interdependent. For example, would 3 and 4 be interdependent? Probably not, since a large mapping can be attained as easily in many small mapping steps as in a few large ones (cf. Figures 5.1b-c, 6.15a-16c), and a relatively small mapping can consist of one relatively large step (cf. Figure 6.14b).[2]

Table 6.1 shows the extent to which characteristics 1-4 correspond within the coextensive ranges of 20 individual warm categories. Eleven of the categories (#s1-11.) show a full correspondence. Another seven categories (#s12-18.) fail to correspond by one characteristic, while they show correspondence among the remaining three. In just one category (#19.) the characterisitics are evenly intermixed, two-for-two, between coextensive ranges; and in another category (#20.) intermixture is combined with mutually polarized foci. Among the 18 that show strong or weak correspondence, there are 72 (4 x18) pairs of characteristics that are predicted to correspond, and 65 of them or 90% meet the prediction. Among all 20 categories, there are 80 pairs of characteristics predicted to correspond, and 81% of them do.

[2]Readers who maintain that any certain pair of characteristics are interdependent can discard one of them. The test is sufficiently robust to do without a variable or two. Likewise, if the data from any 10 of speakers #s 1-20 were arbitrarily rejected, the test-results would still be significant. All of the data are displayed in the figures that are listed in Table 6.1. so that the reader can make a personal judgement and calculate the test-results accordingly.

Table 6.1
Correspondence Among Characteristics

INFORMANT	VANTAGE COLOR D	VANTAGE COLOR R	COLORS NAMED D	COLORS NAMED R	FOCUS D	FOCUS R	COLORS MAPPED D	COLORS MAPPED R	AVERAGE PER STEP D	AVERAGE PER STEP R	FIGURES
1. TTzel.	Yellow	Red	66	46	C (D6)	P (H3)	155	138	39	28	6.1a-c
2. TTzel.	Yellow	Red	59	28	C (F4-5)	P (I2-3)	158	81	17	9	6.2a-c
3. TTzel.	Yellow	Red	48	21	+C (E6)	-C (F3)	168	160	168	80	6.3a-c
4. TTzel.	Red	Yellow	63	42	+C (F4)	-C (D8)	188	63	27	13	6.4a-c
5. Jacal.	Red	Yellow	66	39	C (F4)	UH (C8)	158	59	40	15	7.1a-c
6. Tzotz.	Red	Yellow	75 (28+47)	40	C (E5)	UH (C8)	132	112	19	12	6.5a-f
7. Uspan.	Yellow	Red	79	35	C (C8-9<F4)	UH (G2)	109	27	27	14	6.6a-c
8. Uspan.	Red	Yellow	67	65	C (G4)	P (C14,16)	150	140	38	35	6.7a-c
9. Aguac.	Red	Yellow	49	37	C (F1-2)	UH (C8-9)	214	162	43	27	5.4a-d
10. ATzel.	Yellow	Red	59	43	+C (F5)	-C (F2,39)	155	144	155	72	6.8a-c
11. ATzel.	Red	Yellow	77	47	C (F1,E2)	UH (C8)	248	99	50	25	6.9a-c

(Continued next page)

*12.	TTzel.	Yellow	Red	*45*	*53*	C (D6)	UH (G2)	160	73	40	36	6.11a-c
*13.	ATzel.	Red	Yellow	73	36	*P* (G39)	UH (C8)	170	164	43	27	6.10a-c
*14.	TTzel.	Yellow	Red	93	60	C (D7)	P (G38)	*134*	*144*	67	36	6.12a-c
*15.	Aguac.	Yellow	Red	77	38	C (D7)	UH (G2)	163	104	*27*	*104*	6.14a-c
*16.	Tzotz.	Yellow	Red	62	52	C (E4)	UH (G2)	141	84	*13*	*14*	6.15a-c
*17.	Tzotz.	Yellow	Red	54	40	C (E4,D9)	P (G40)	145	117	*10*	*24*	6.16a-c
*18.	TTzel.	Yellow	Red	56	51	C (D7)	P (I40)	210	187	*23*	*37*	5.1a-c 6.13
1-18., Totals:				1168	773			2958	2058	30	25	
		Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	
**19.	Tzotz.	Yellow	Red	*32*	*52*	*C* (D6)	*UH* (G1)	*140*	*114*	*46*	*57*	6.20a-c
**20.	Aguac.	Yellow	Red	*54*	*49*	*P* (C10-11)	*P* (H3)	*35*	*106*	*12*	*21*	5.2; 6.22a-b

Key: D = dominant vantage, one that is taken from a position of the attendance to similarity; R = recessive vantage, one that is taken from the position of the attendance to distinctiveness; Ø = balanced vantage; **VANTAGE COLOR** = the color, yellow or red, from which a coextensive vantage was taken; **COLORS NAMED** = the number of times that each vantage, dominant and recessive, was named during elicitation; (28+47) = 28 basic and 47 secondary terms (See 6.). **FOCUS** = the color(s) chosen as a focus (foci) for each vantage. In the columns under **FOCUS** are: **C** = centralized; **+C** = the most centralized focus, and **-C** = the least centralized focus, as, for example, in data-set 3. the focus at E6 is at a distance of two rows of the Munsell array from unique yellow at C 8-9 whereas the focus at F3 is one row distant from unique red at G1-2; **UH** = unique hue, C8-9 and G1-2; **P** = polarized; (C8-9<F4) = F4 was preferred as a focus over C8-9, but was chosen last (See 7.). **COLORS MAPPED** = the number of colors covered by the mapping of a vantage; **AVERAGE PER STEP** = the average number of colors covered by the step(s) of a mapping (= COLORS MAPPED + NUMBER OF STEPS that constitute a mapping; in each category, these are: 1. D=4/R=5, 2. 9/9, 3. 1/2, 4. 7/5, 5. 4/4, 6. 7/9, 7. 4/2, 8. 4/4, 9. 5/6, 10. 1/2, 11. 5/4, 12. 4/6, 13. 6/1, 14. 14/5, 15. 9/5, 16. 11/6, 17. 2/4, 18. 4/2, 19. 3/2, 20. 5/3); *italics plus underlining* = a characteristic that does not correspond within its vantage with, at least, two others; * = a set of data that contains one non-correspondence; ** = two non-correspondences; TTzel. = Tenejapa Tzeltal, ATzel. = Amatenango Tzeltal, Jacal. = Jacaltec, Tzotz. = Navenchauc Tzotzil, Uspan. = Uspantec, Aguac. = Aguacatec.
(See page 174-a for a simplification of Table 6.1.)

Simplification of Table 6.1: An Isolation of Its Essential Pattern

Informant I.D.	Vantage Color		Number of Colors Named		Centrality of Focus		Number of Colors Mapped		Average Number of Colors Per Mapping Step	
	D	R	D	R	D	R	D	R	D	R
1.	Y	R	+	−	+	−	+	−	+	−
2.	Y	R	+	−	+	−	+	−	+	−
3.	Y	R	+	−	+	−	+	−	+	−
4.	R	Y	+	−	+	−	+	−	+	−
5.	R	Y	+	−	+	−	+	−	+	−
6.	R	Y	+	−	+	−	+	−	+	−
7.	Y	R	+	−	+	−	+	−	+	−
8.	R	Y	+	−	+	−	+	−	+	−
9.	R	Y	+	−	+	−	+	−	+	−
10.	Y	R	+	−	+	−	+	−	+	−
11.	R	Y	+	−	+	−	+	−	+	−
12.	Y	R	[−]	[+]	+	−	+	−	+	−
13.	R	Y	+	−	[−]	[+]	+	−	+	−
14.	Y	R	+	−	+	−	[−]	[+]	+	−
15.	Y	R	+	−	+	−	+	−	[−]	[+]
16.	Y	R	+	−	+	−	+	−	[−]	[+]
17.	Y	R	+	−	+	−	+	−	[−]	[+]
18.	Y	R	+	−	+	−	+	−	[−]	[+]
	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
19.	Y	R	[−]	[+]	[+]	[−]	[+]	[−]	[−]	[+]
20.	Y	R	[+]	[−]	[+]	[−]	[−]	[+]	[−]	[+]

Key: **D** dominant range, **R** recessive range, **Ø** balanced range, Y yellow, R red, + most, − least, [ ] non-correspondence.

The non-correspondences are the expected result of reciprocal shift of strength between the attendances to similarity and to distinctiveness. As the shift brings the strengths of the two attendances to a near parity, it becomes difficult or inconsequential for some individuals to consistently attach each cognition to an opposite unique hue. As the parity is approached, some crossover will occur. However, the data of Table 6.1 yield a surprise: no more than 19% of the characteristics have crossed over, even under the harshest interpretation of the data. If speakers #^{S}19-20 are excluded from consideration, the crossover of characteristics is 10%.

The four degrees of correspondence represent distinct variants of coextensivity, segments of an evolutionary continuum: #^{S}1-11 show strong dominant-recessive coextensivity, #^{S}12-18 show weak dominant-recessive coextensivity, #19 shows balanced coextensivity, and #20 shows mutually polarized coextensivity.

The table reveals, further, that different speakers of single languages link the same unique hue with opposite attendances and, inversely, couple the same attendance with opposite unique hues. Compare, for example, #^{S}1-3 with 4, 6 with 16-17, 7 with 8, 10 with 11 and 13, and 9 with 15. *The lack of pattern is critical to the test-result, because it demonstrates that correspondence is not determined by perception and its physiological base.* Moreover, it shows that particular linkages of perceptual and cognitive coordinates need not be established by shared convention. Nevertheless, six of the seven Tenejapa Tzelatal speakers (#^{S}1-3, 12, 14, and 18 versus #4) coordinated the attendance to similarity with unique yellow, suggesting a culturally prescribed preference within that community.

The following subsections (5.1.1.-5.1.3.) exemplify individual manifestations of characteristics 1-5b, including counts and distributions of modifier usages that a few individuals volunteered (cf. Figures 5.5f and 5.13):

6.1.1. Strong Dominant-Recessive Coextensivity

The coextensive vantages of the following eleven categories (cf. Table 6.1, #s 1-11) show full correspondence among the four characteristics:

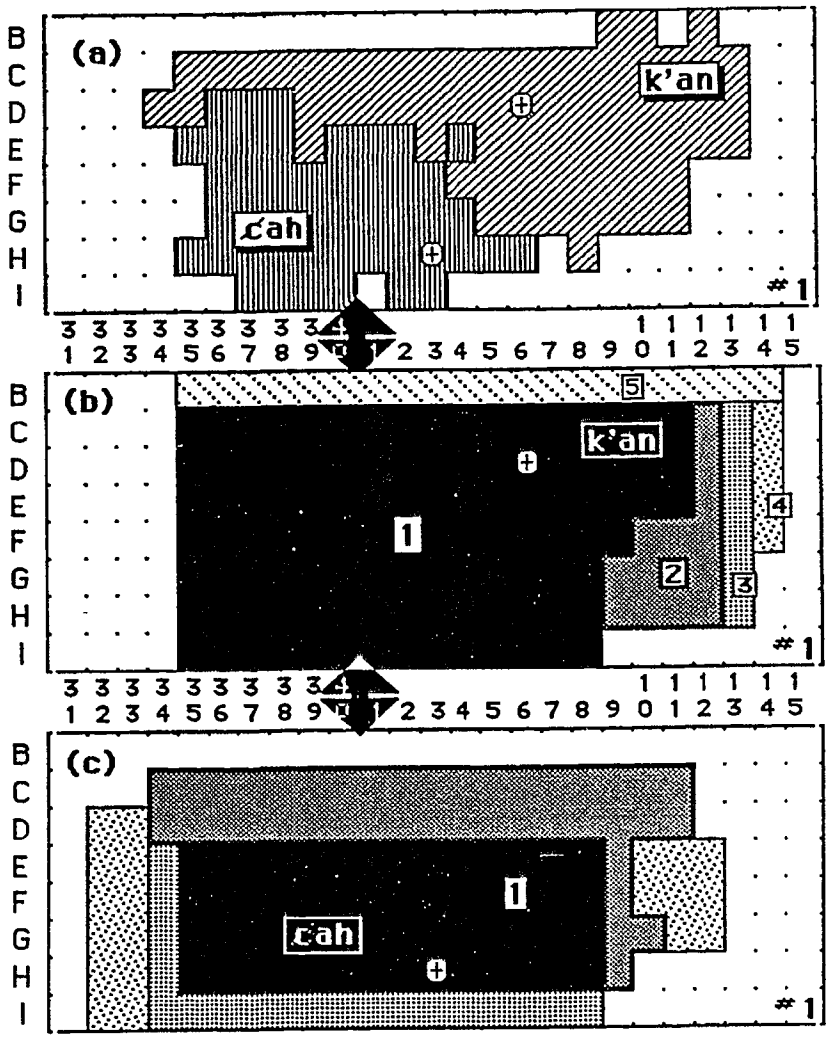
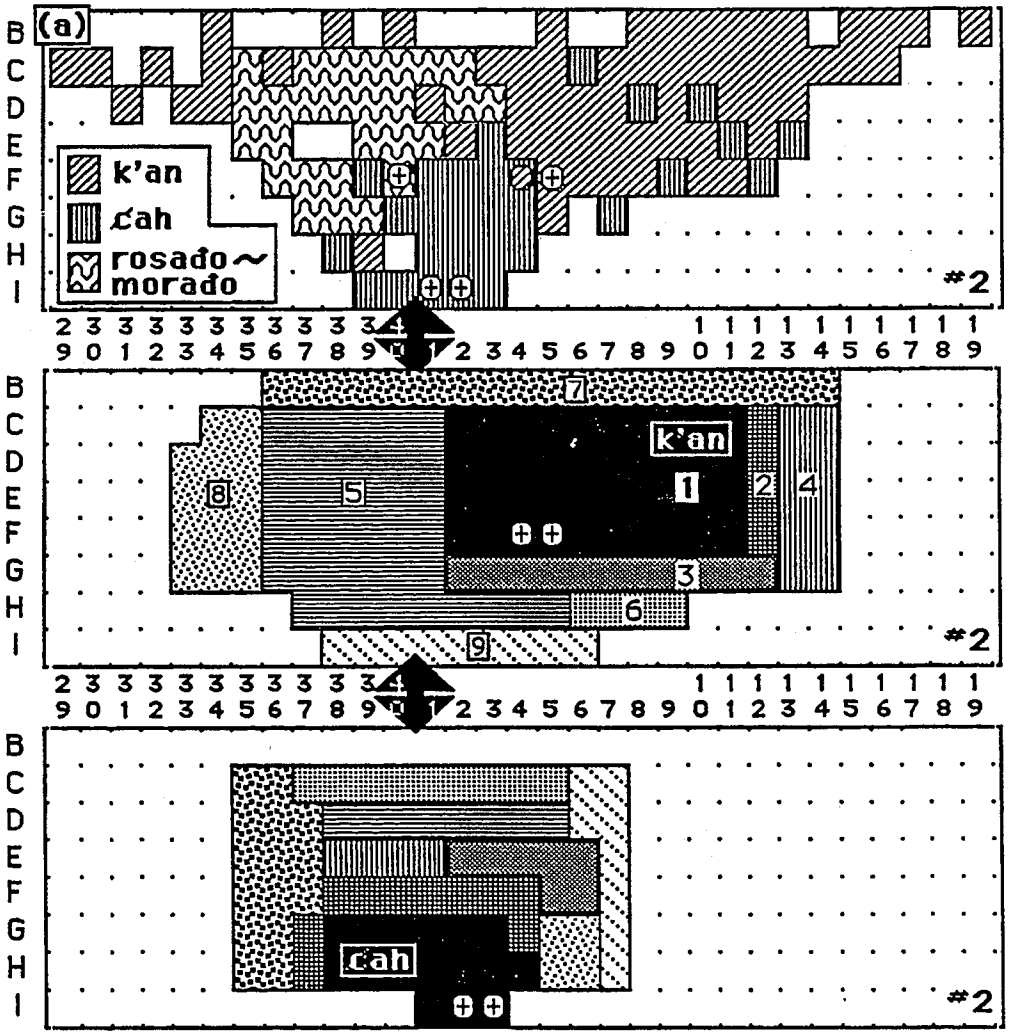


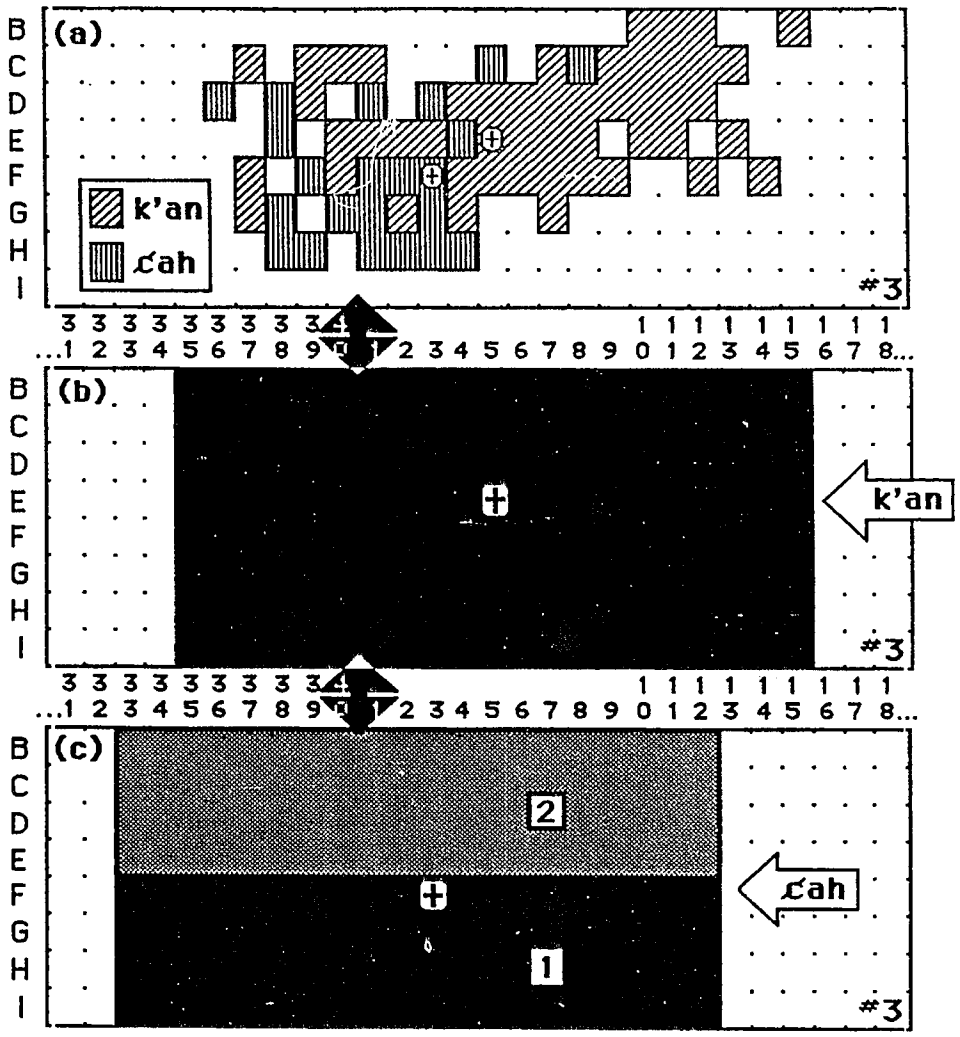
Figure 6.1a-c. Speaker #1 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tzeltal, San Alonso Tenejapa, man, age 75, 1980 (same speaker as in Figures 4.5a-c).

The dominant and recessive naming ranges of Figure 6.1a are not intermixed and, thus, give no clue that speaker #1 maintains a coextensively composed warm category. Evidence consists of the mappings and of their likeness to the others from Tenejapa.



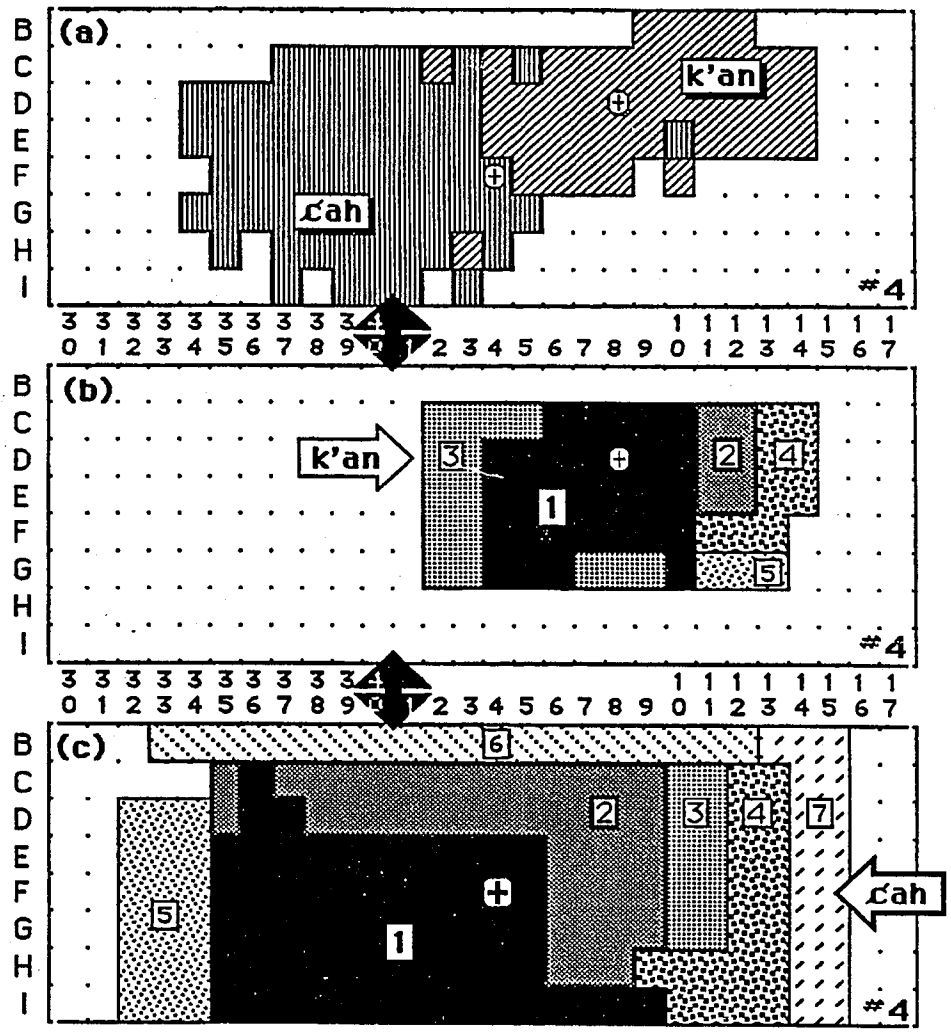
Figures 6.2a-c. Speaker #2 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tenejapa Tzeltal, woman, age 36, 1980 (same speaker as in Figures 6.26a-c, page 204).

The recessive naming range of Figure 6.2a extends to yellow at D8, D10, E11, E13, F9, and F12, although the mapping of this vantage was curtailed short of these yellows. The use of two intermixed secondary loan words reduces the number of both dominant and the recessive naming responses, 59 versus 28. Counting all uses of the loan words as part of the recessive naming range would increase its size to 55. Speaker #2 mapped both ranges in converse directions, and she mapped them over fewer colors and with more steps than did speaker #1. Speaker #2 is half the age of speaker #1.



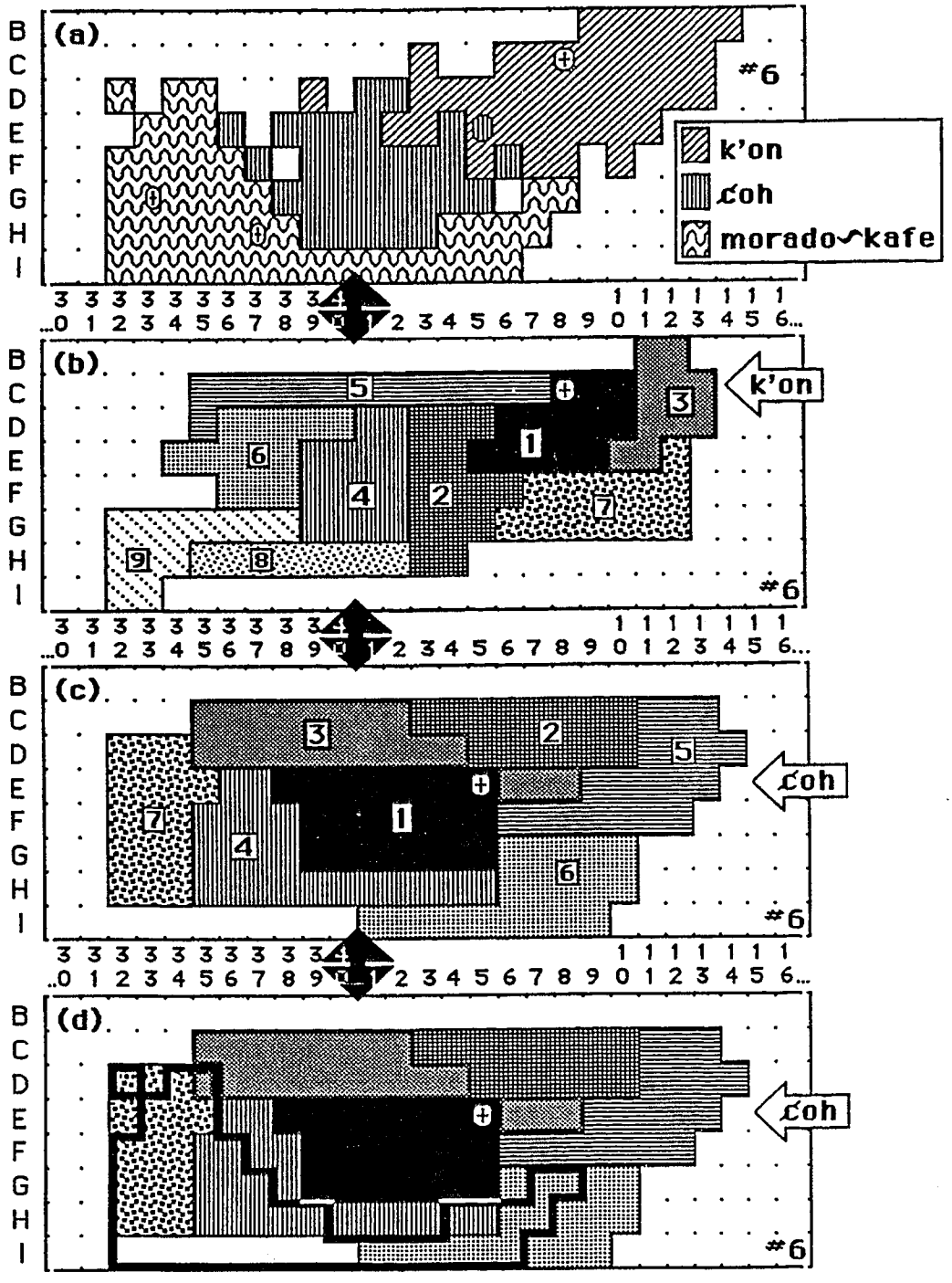
Figures 6.3a-c. Speaker #3 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tenejapa Tzeltal, man, age 65+, 1980 (same speaker as in Figures 4.4a-b).

Figures 6.3a-c show coextensive naming ranges and mappings that differ substantially in size. Mapping of the dominant range was rendered in one step, and mapping of the recessive range was rendered in two steps. Both ranges are focused in a centralized position, although the dominant-range focus is the most centralized; this focus, at E5, is two rows darker than unique yellow at C8-9, whereas the recessive-range focus, at F3, is one row lighter than unique red at G1-2. Each range is focused almost perfectly on center in relation to its mapping.



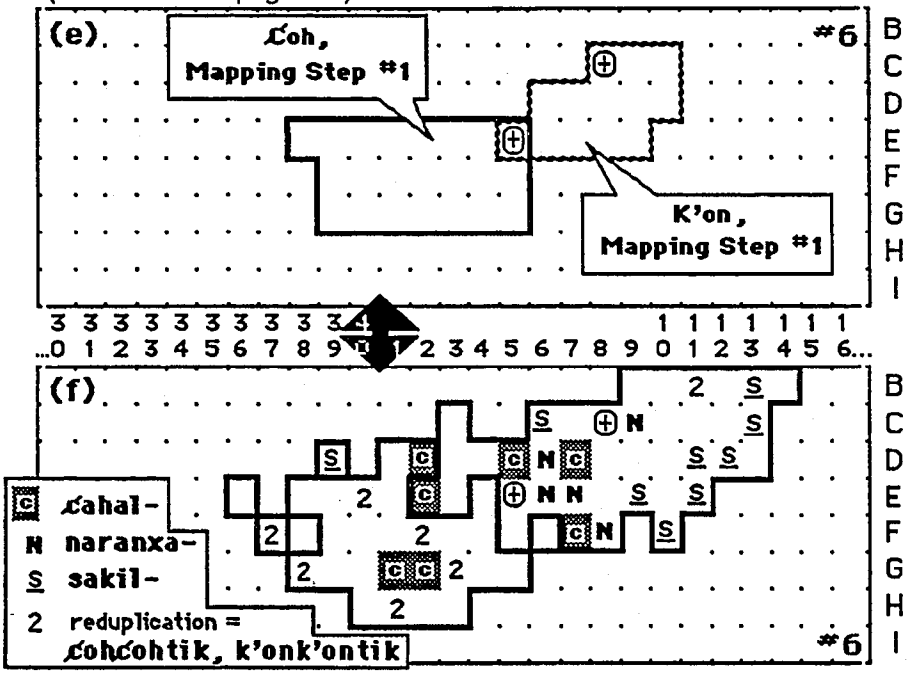
Figures 6.4a-c. Speaker #4 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tenejapa Tzeltal, woman, age 60, 1980 (same speaker as in Figures 4.1a-c).

Chapter VII addresses the continuous relationship between *dominant-recessive coextensivity* and *inclusion*. The coextensive ranges of Figures 6.4a-c are extremely dominant and recessive. Yet the recessive range is named at H3 outside of its mapping and on the far side of the dominant-range focus, its mapping covers unique red at G2, and its focus is centralized at D8 slightly less than the dominant-range focus at F4. Speaker #5 (cf. Figures 7.9a-c) exhibits further development of coextensivity toward inclusion during category division.



(continued on page 181)

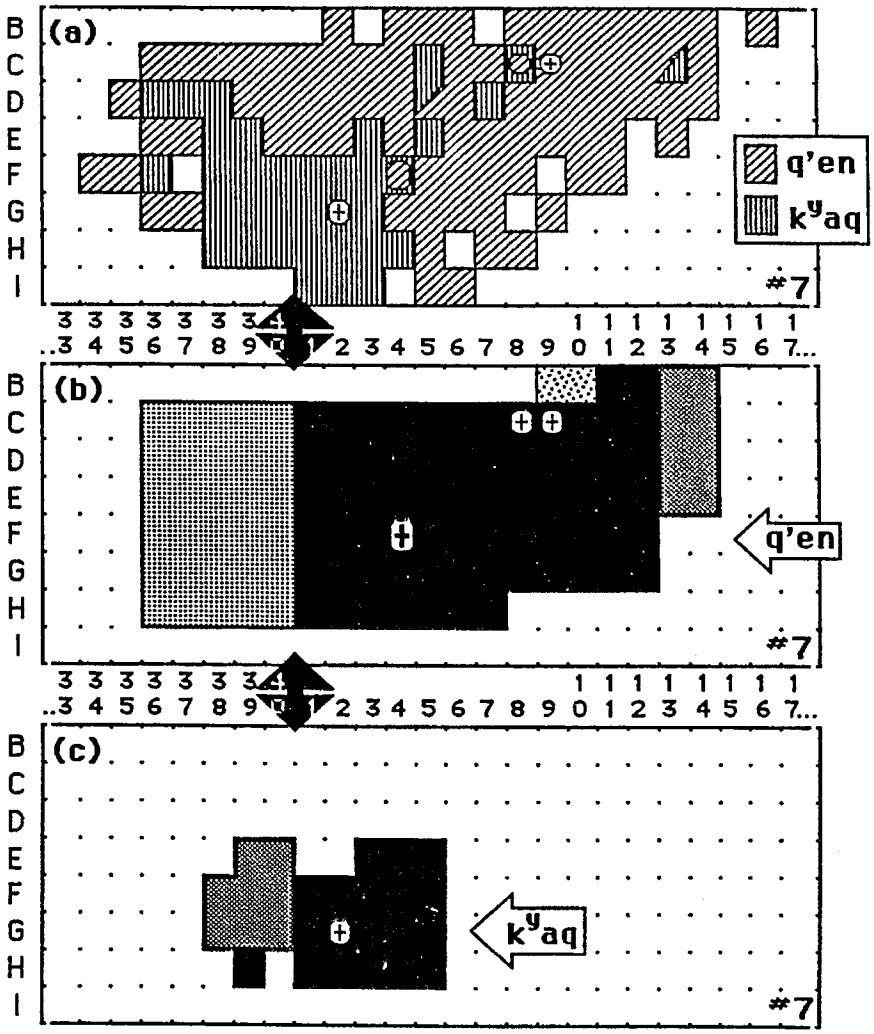
(continued from page 180)



Figures 6.5a-f. Speaker #6 (cf. Table 6.1), naming ranges (a), mappings (b-e), and modifiers (f), Tzotzil, Navenchauc, woman, age 19, 1981.

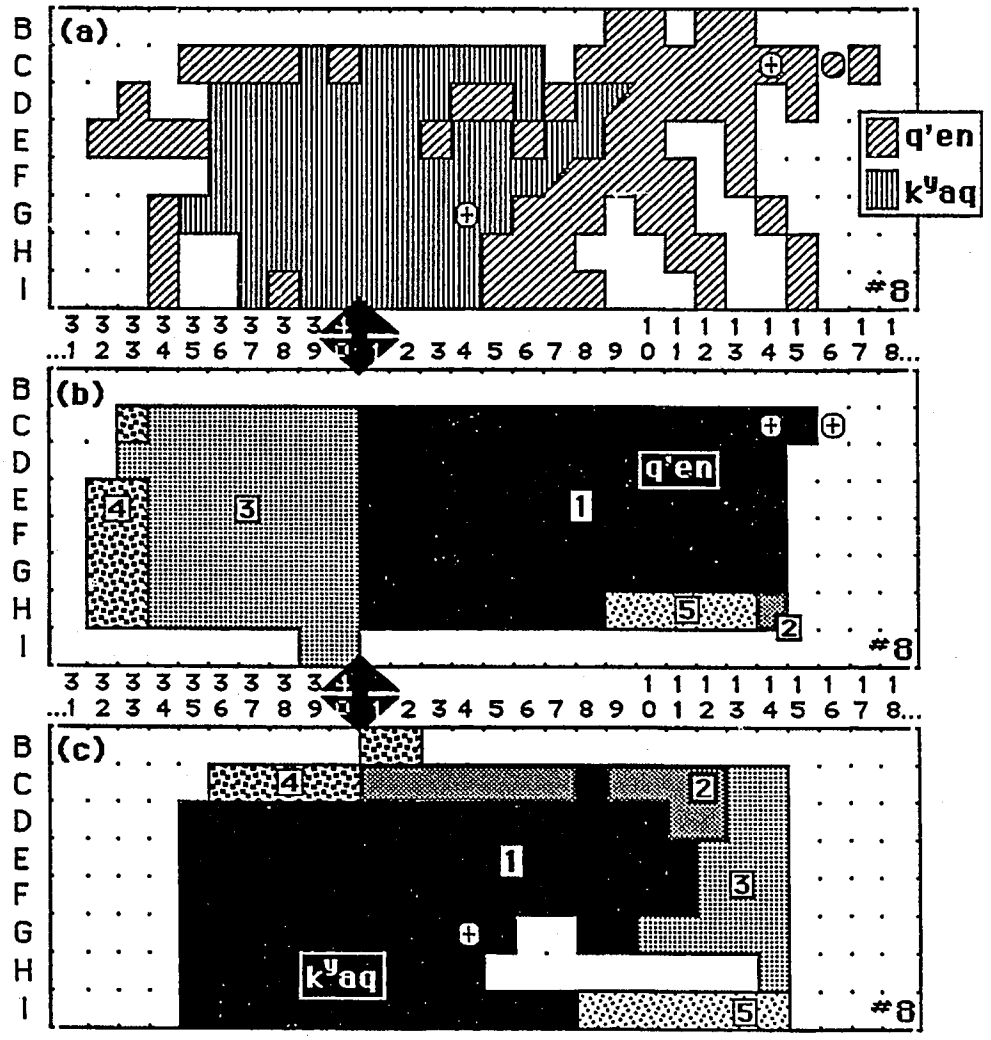
Figures 6.5a-d show that speaker #6 named the dominant range with 28 uses of the basic term and 47 intermixed uses of two secondary terms, 75 total (cf. Table 6.1); Figure 6.5d relates the dominant-range mapping and the secondary naming range. Perhaps to mark contrast against the secondary category, speaker #6 focused the dominant range at E5, which corresponds to the upper right of its first mapping step. However, Figure 6.5e shows that E5 represents the one color shared by the first steps of both mappings; the dominant-range focus was strategically placed on the only central color that represents the maximal membership of both ranges.

Figure 6.5f shows that each range is designated by a distinct pair of maximal and minimal modifiers. Those of the recessive range qualify only the name of that range, whereas those of the dominant range qualify the names of both ranges (See characteristic 5b, page 171). The dominant-range maximal modifier, *ʧahal*, embodies the archaic form of the root, **ʧah* (>*ʧoh*); its counterpart in the recessive range is a loan word, *naranxa-*.



Figures 6.6a-c. Speaker #7 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Uspantec, Las Pacayas, woman, age 70+, 1979.

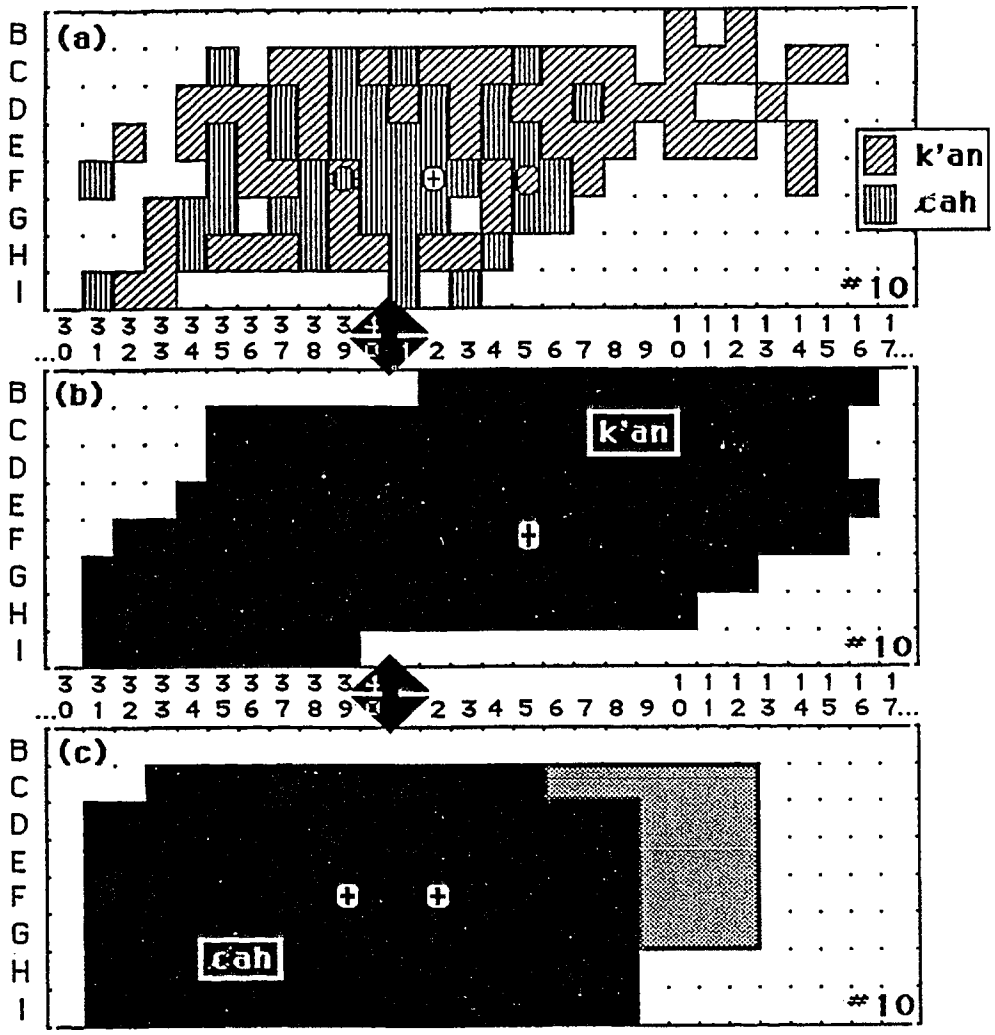
Figures 6.6a-c show coextensive ranges that are extremely dominant and recessive. The mapping of the recessive range does not extend to some colors that are designated with its name, such as those at C8 and C13; these usages, in turn, are the only evidence of coextensivity. Speaker #7 focused the dominant range first at C8-9 and second at F4, while explaining that she preferred the focus at F4. She placed the latter closer to purest red than to pure yellow, perhaps to mark contrast against her preliminary choice at the yellow unique hue.



Figures 6.7a-c. Speaker #8 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Uspantec, Las Pacayas, man, age 74, 1979.

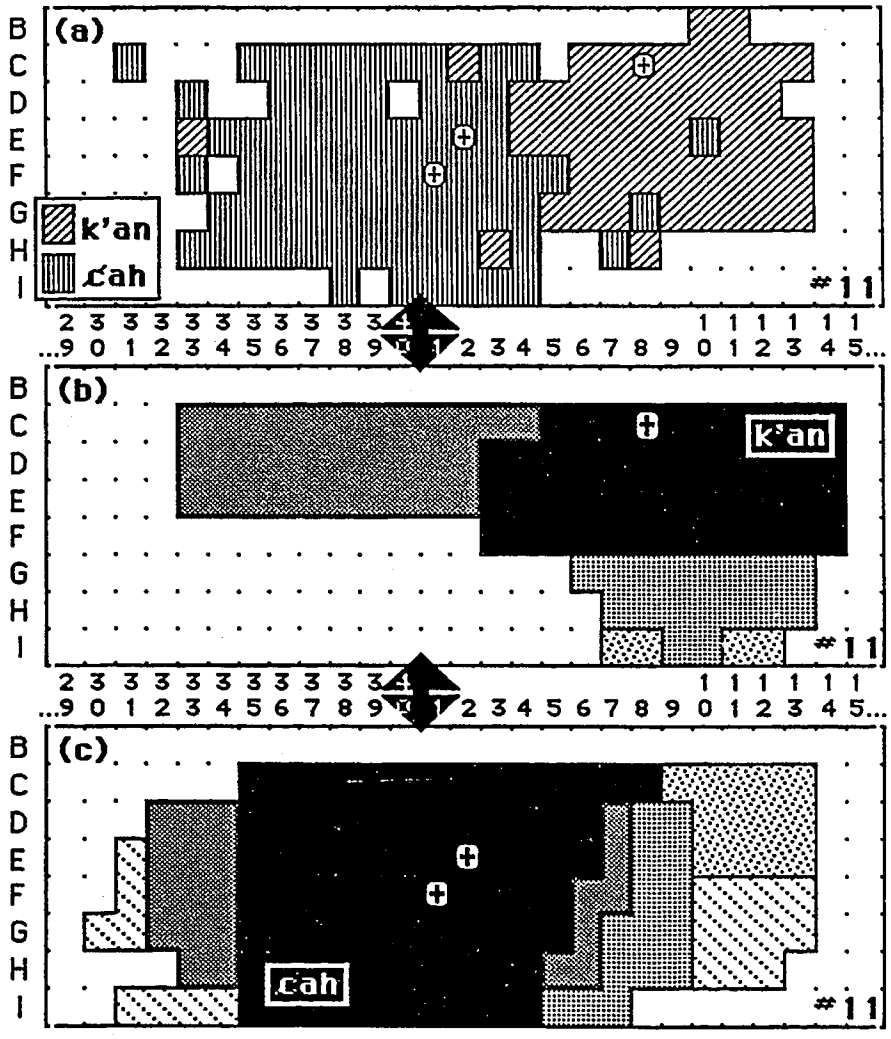
Figures 6.7a-c show dominant-recessive coextensive ranges that approach "neutrality"; the reciprocal cognitions are almost of equal strength. Table 6.1 shows that the red-focused range (G4) consistently maintains a negligible numerical edge; its focus is centralized by just two columns and by no levels of brightness. The nearly neutral coextensivity of speaker #8 contrasts with the blatant dominant-recessive coextensivity of speaker #7. Speaker #8 is exceptional in that he maintains full correpondence despite the apparent near-equality of strength between the two cognitions.

Figures 5.4a-d (page 144) display triple coextensivity of speaker #9: vantages from red, yellow, and brown. Table 6.1 quantifies dominant red and recessive yellow vantages. Yellow and brown vantages intermix characteristics: ***colors named*** 37/16, ***focl*** UH/not recorded, ***colors mapped*** 162/160, ***average per step*** 2Z / 32. (See section 6.2.)



Figures 6.8a-c. Speaker #10 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tzeltal, Amatenango del Valle, woman, age 85±, 1981.

In Figures 6.8a-c, speaker #10 ambivalently focused the recessive range, F39 and F2. She mapped the dominant range in one step and focused it closer to red than to yellow.

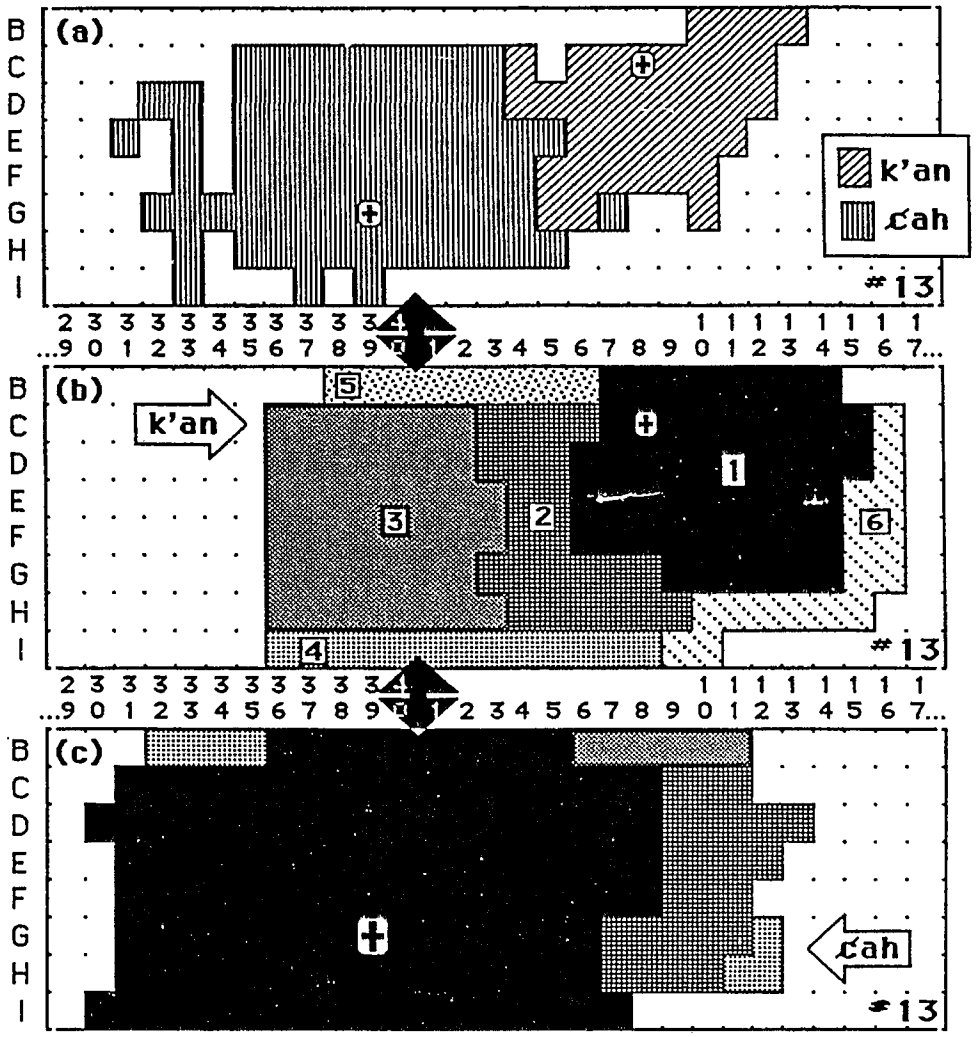


Figures 6.9a-c. Speaker #11 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tzeltal, Amatenango del Valle, woman, age 80 ±, 1981.

The data of Figures 6.9a-c weakly evidence coextensivity: one naming response at H3 indicates that speaker #11 extends the recessive range beyond the colors that she covered with its mapping. She might be retracting this range toward its focus during category division, a process further treated in Chapter VII. The ranges of speaker #11 contrast with those of speaker #10 (cf. Figures 6.8a-c), who named with *k'an* a centrally focused dominant range that she mapped in a single, extensive step. The two speakers have resided as neighbors since young adulthood.

6.1.2. Weak Dominant-Recessive Coextensivity

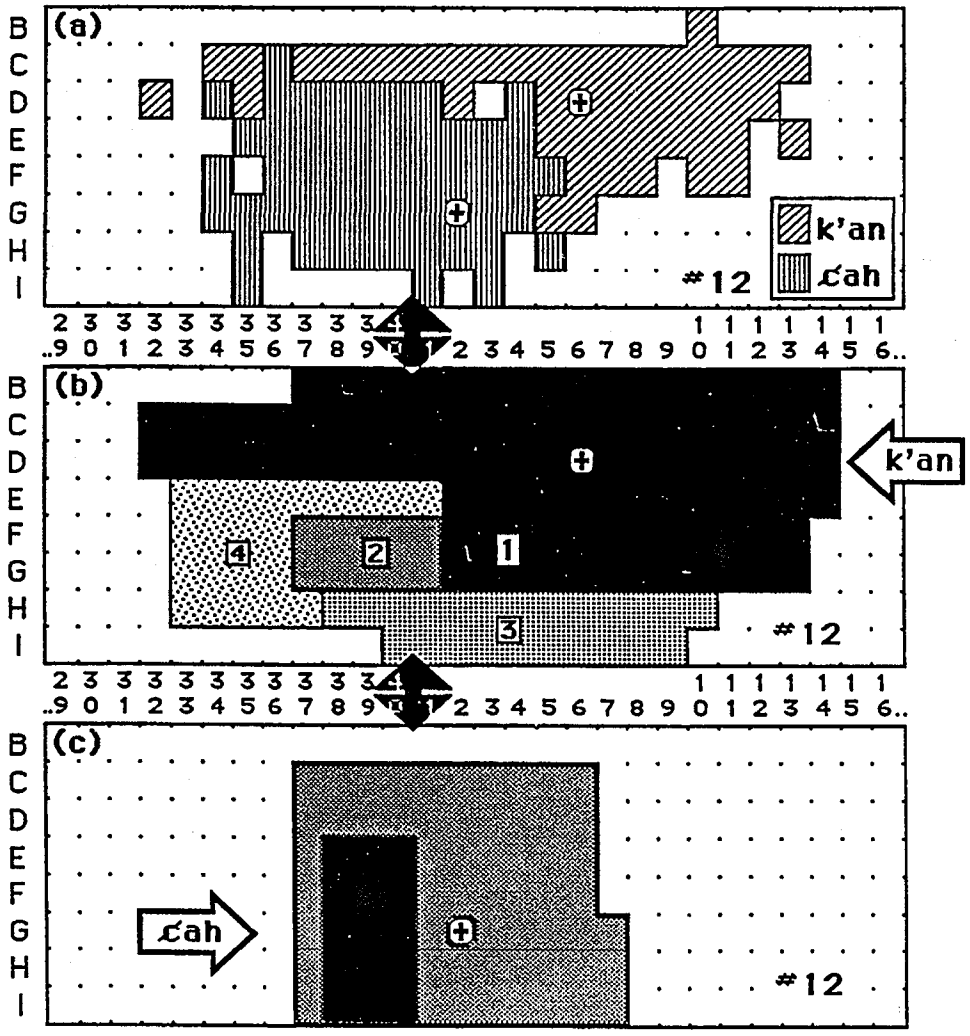
The coextensive vantages of the following seven categories (cf. Table 6.1, #S 12-18.) show correspondence among three of the four characteristics. The categories are presented so that individuals are sequenced by language rather than by speaker-number:



Figures 6.10a-c. Speaker #13 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tzeltal, Amatenango del Valle, woman, age 45, 1981.

In Figures 6.10a-c, speaker #13 -- also a neighbor of speakers #S 10-11, but younger -- betrays no trace of coextensivity in her use of names, although her mappings

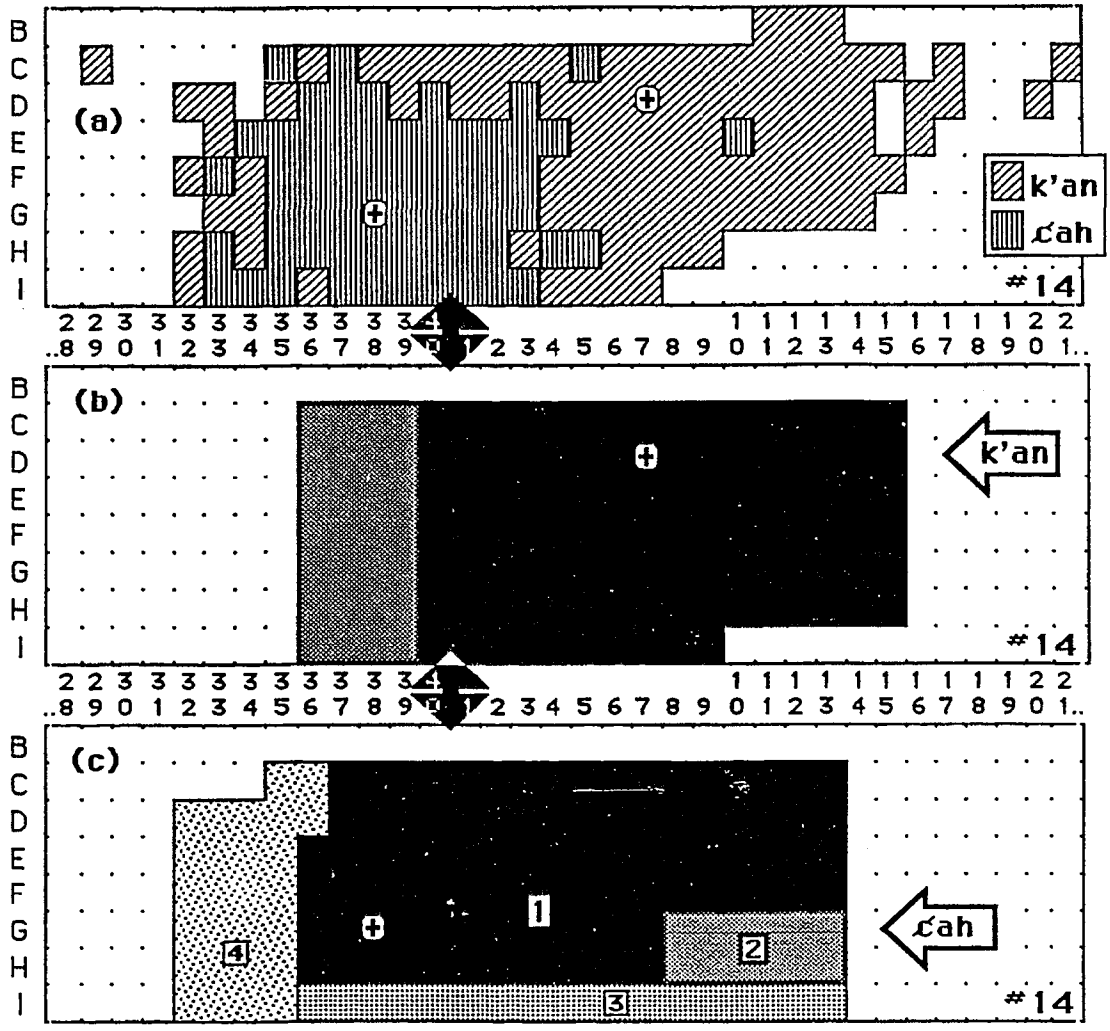
show the relationship. Her dominant-range focus is polarized at G39 but coincides with the center of the first mapping step.



Figures 6.11a-c. Speaker #12 (cf. Table 6.1), Naming ranges (a) and mappings (b-c), Tzeltal, San Alonzo Tenejapa, woman, age 70, 1980 (same speaker as in Figures 4.6a-c).

In Figures 6.11a-c, speaker #12 has named the dominant range, *k'an*, with fewer responses than she has named the recessive range, 45 versus 53. The focus and the first mapping step of the recessive range do not coincide. Its second step encompasses the dominant-range focus at D6, but barely so. This is the weakest evidence of coextensivity

among the sample of Table 6.1. The woman's daughter provided an example of inclusion (cf. Figures 7.1a-c).



Figures 6.12a-c. Speaker #14 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tenejapa Tzeltal, man, age 90, 1980 (same speaker as in Figures 4.2a-c).

In Figures 6.12a-c, speaker #14 has mapped the dominant range, *k'an*, over 10 fewer colors than the recessive range, 134 versus 144. The dominant naming range and its mapping do not correspond in purple colors of columns 32-35 and in chartreuse colors of columns 16-17. Each first mapping-step covers both unique hues, a characteristic of near-synonymy. Speaker #14 is the oldest who was interviewed in Tenejapa.

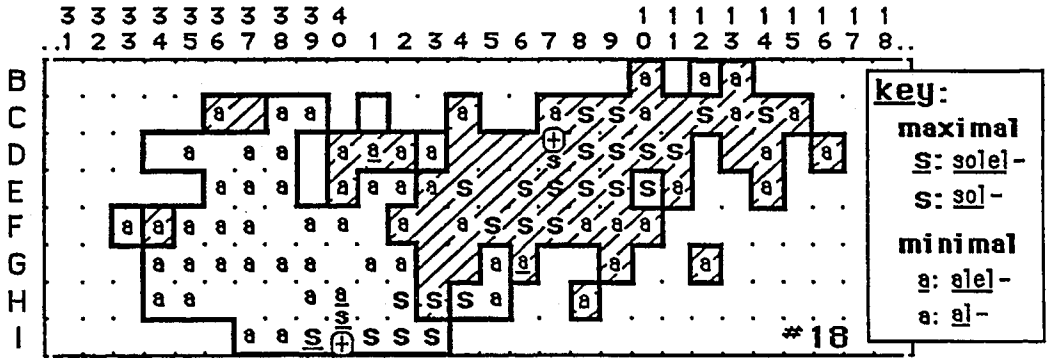
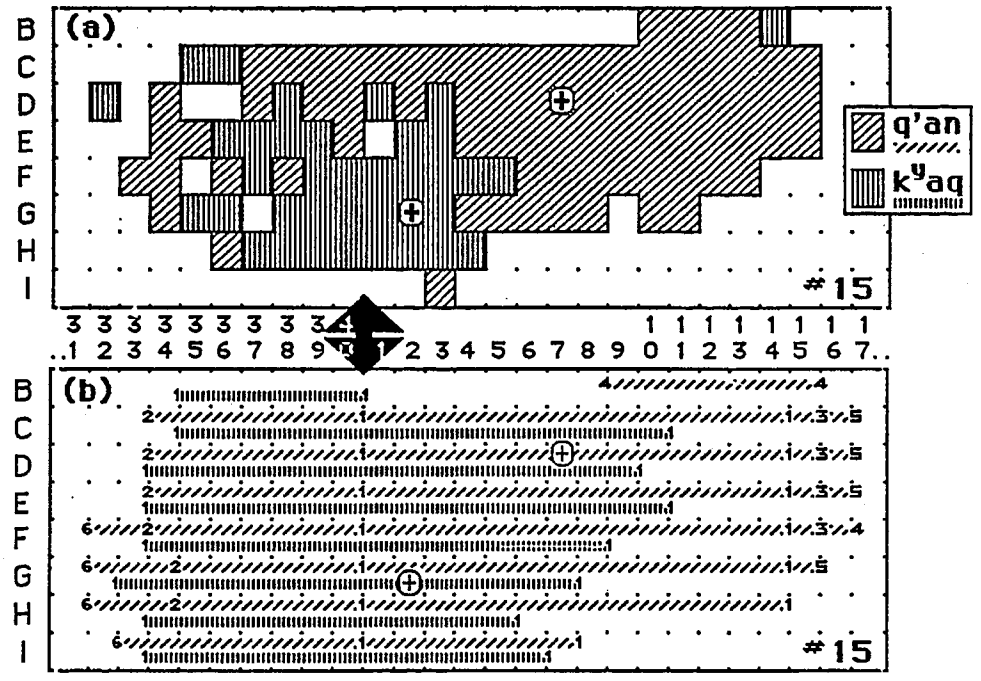


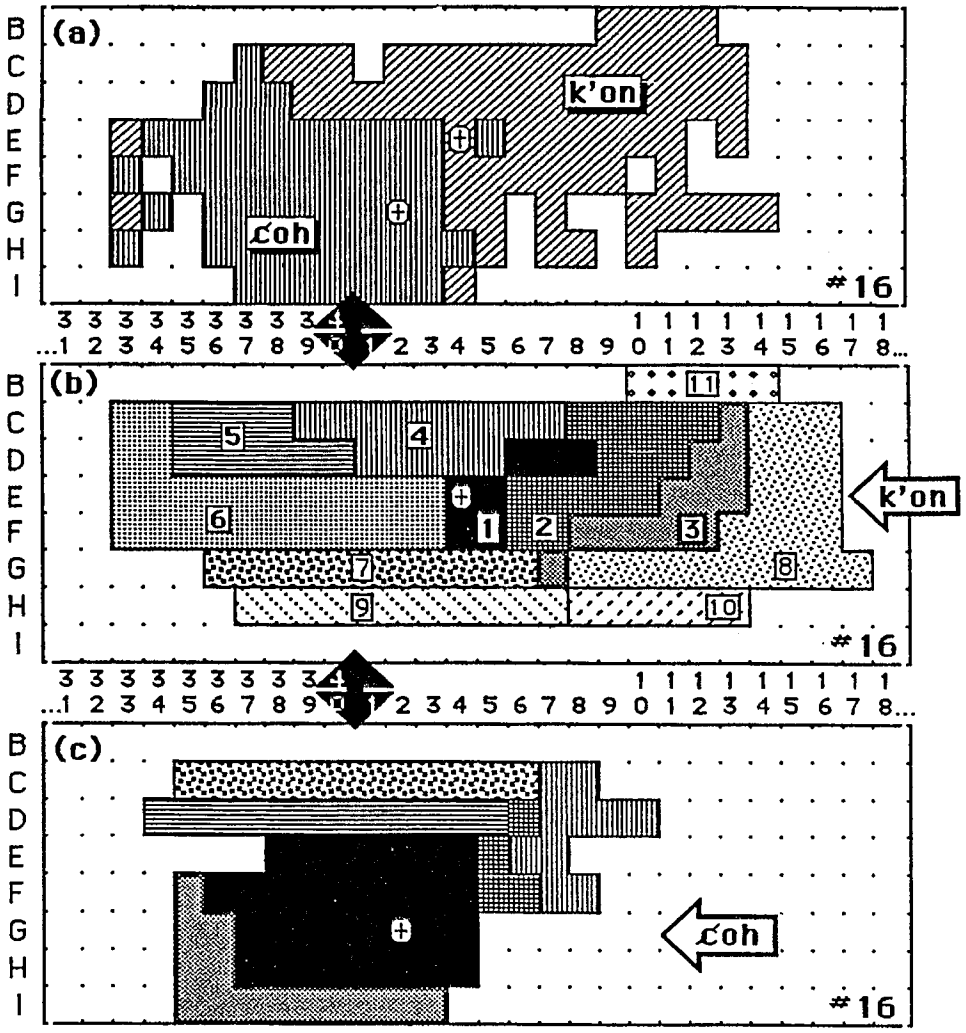
Figure 6.13. Speaker #18 (cf. Table 6.1), modifiers, Tenejapa Tzeltal, woman, age 60, 1980 (same speaker as in Figures 4.3a-c). See Figures 5.1a-c for naming ranges and mappings.

In Figure 6.13, counts of maximal modifiers *versus* minimal modifiers show ratios of 17:27 and 8:34 in the dominant range (shaded) and the recessive range respectively. See characteristic 5a., page 171. Compare the *counts* of this figure with the modifier *distributions* of Figure 6.5f, page 181.



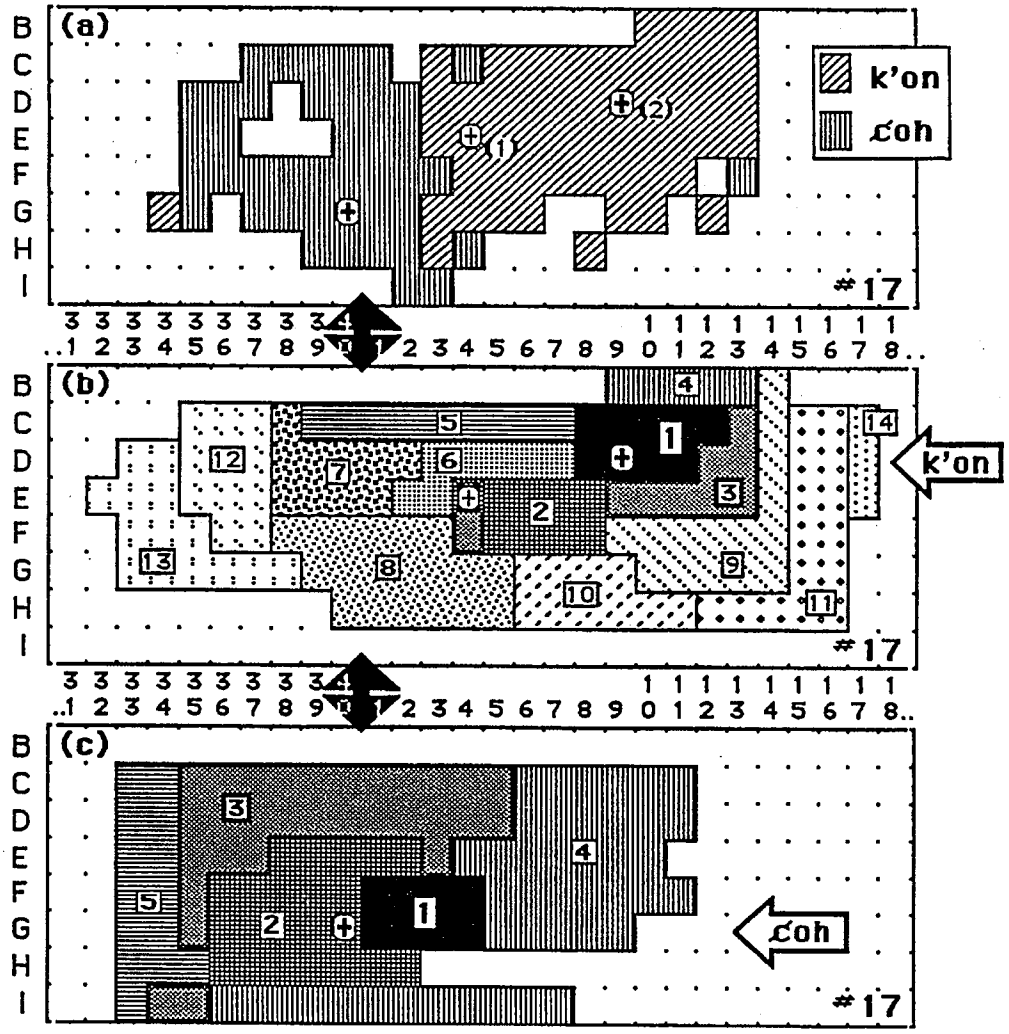
Figures 6.14a-b. Speaker #15 (cf. Table 6.1), naming ranges (a) and mappings (b), Aguacatec, Aguacatán, man, (a) age 58, 1978, (b) age 60, 1980. Comment follows on page 190.

Figure 6.14b (page 189) shows the only single-step mapping of a *recessive* warm-category range within the sample of Table 6.1. Figures 6.3b and 6.8b (pages 178 and 184) show that speakers #3 and #10 both mapped a *dominant* warm-category range in a single step.



Figures 6.15a-c. Speaker #16 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tzotzil, Navenchauc, woman, age 50, 1981.

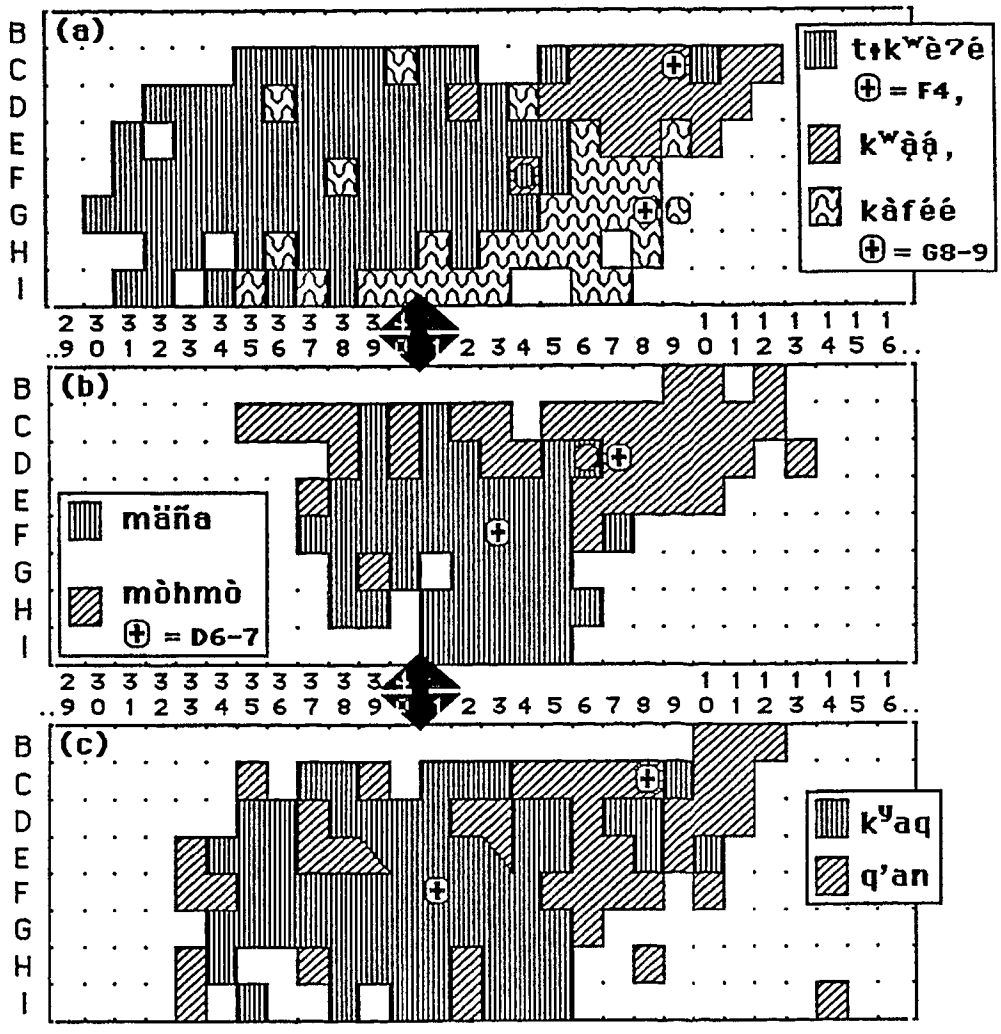
Figures 6.15b shows that speaker #16 mapped the dominant range with 11 steps, an unusually high number. However, speaker #17 exceeded that performance with 14 steps:



Figures 6.16a-c. Speaker #17 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Tzotzil, Navenchauc, woman, age 26, 1981.

Speaker #17 focused her dominant range twice, with her final choice matching the first mapping step. Three of the four Tzotzil speakers (#S6, 16, and 17) who mapped the yellow-focused range throughout warm colors did so in 9 or more steps, suggesting a shared linkage of differentiation with the yellow vantage (cf. Figures 6.5b, 6.15b). Of the four, #S16 and 17 show correspondence among just 3 of the 4 dominant-recessive characteristics reviewed in Table 6.1, and #19 evidences the only case in the sample of fully balanced coextensivity (cf. Figures 6.20a-c).

Before moving on to examine the fully balanced coextensivity of speaker #19 in section 6.1.3., five of the seven attestable cases of dominant-recessive coextensivity that remain to be reviewed in the Mesoamerican sample are displayed. These remaining cases are attested by only naming data and foci. The five languages of Table 6.1 all happen to be Mayan. Figures 6.17a-19 demonstrate coextensivity in the warm categories of three Otomangean languages as well (Also see Figures 7.18a, 8.40d, and 9.20a):



Figures 6.17a-c. Naming ranges and foci from (a) Peñoles Mixtec, woman, age 50+, 1978, (b) Malinaltepec Tlapanec, man, age 50, 1978, (c) Tacaná Mam, woman, age 60, 1979.

Figures 6.18-19 exhibit two cases of warm-category coextensivity that are exceptional:

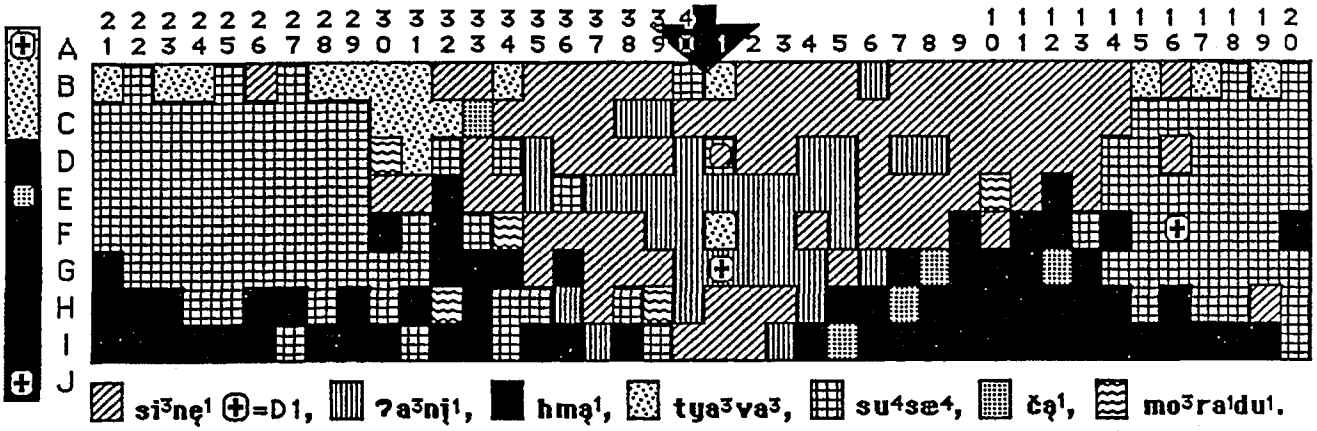


Figure 6.18. Naming ranges and foci, Chiquihuitlán Mazatec, man, age 45, 1977.

The Mazatec speaker shows an unusual form: the dominant range is focused in pink at D1 and its naming is exceptionally broad (e.g., E30, D16), surrounding the uses of the recessive name. Possibly, the unusual characteristics are occasioned by the inclusion of this warm category in the light-warm category of a Stage-I system, even though the Mazatec speaker names color with seven terms. The white-focused naming response at F1, in bright red, suggests an extension of the white-focused range to warm colors; the intermixture of terms is shown elsewhere (cf. Figure 4.4a) to accompany early-stage categorization. The dominant-range focus at D1 is triangulated at equal distance from pure white, yellow, and red, as foci are characteristically placed in the light-warm category (cf. Rosch's Dani data, Chapter I, footnote 13, page 44).

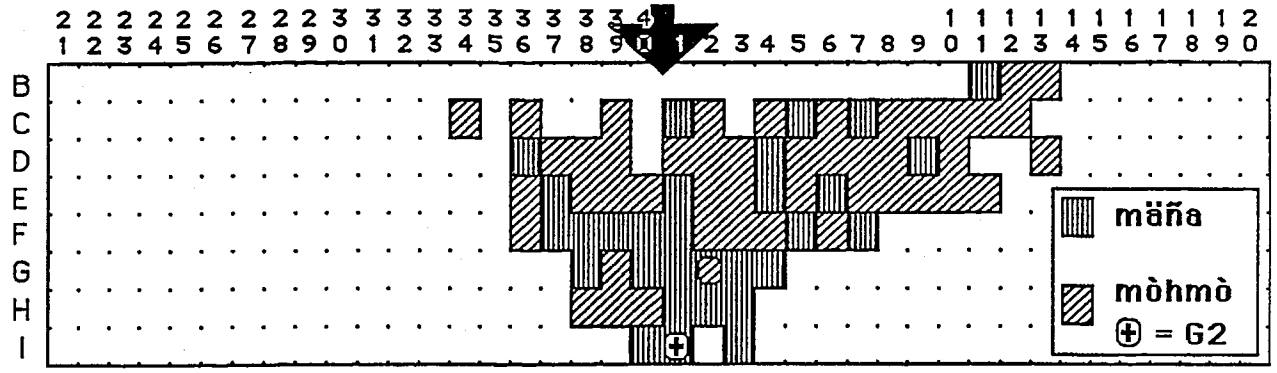


Figure 6.19. Naming ranges and foci, Malinaltepec Tlapanec, man, age 30, 1978.

The Tlapanec speaker of Figure 6.19 (page 193) also shows an unusual focus placement: *mòhmò*, which is usually focused in reference to yellow (cf. Figure 6.17b), is focused on pure red at G2; the focus of the other range is polarized at I1. The focus at G2 might be a more extreme manifestation of behavior shown by other individuals, such as the Uspantec speaker of Figures 6.6a-b (page 182), who focused close to pure red a coextensive term that other Uspantec focused near or on unique yellow. It was recorded that the Uspantec speaker underwent a decision-making conflict prior to her final choice of a focus at a centralized position; the final focus near red might have been placed in compensatory contrast to her first choice at unique yellow. For the Tlapanec speaker, behavior prior to a final choice was not recorded.

6.1.3. Balanced Coextensivity

Fully balanced coextensivity is rare. Chapter VII will show that most individuals divide the warm category, first, by retracting the recessive range and, last, by retracting the dominant range; usually, dominant-recessive coextensivity evolves directly into inclusion without an intermediate phase of balance.

However, a minority of individuals equally divide the four dominant characteristics among both coextensive vantages of the warm category, and they do the same with the recessive characteristics. The crossover of characteristics is most likely to occur when the attendances to similarity and distinctiveness reach a near-parity of strength; as an individual approaches the parity, he finds it increasingly difficult or inconsequential to distinguish the two attendances and to consistently keep each linked with a separate vantage.

Some individuals, such as speaker #8, showed that they were adept at maintaining the separation, even when the parity was almost perfect; but others were less able or less inclined, such as speakers #S12-20 (cf. Table 6.1 and supporting figures). Speakers #S12-18 -- who show correspondence among three of the four characteristics -- represent a partial transformation of dominant-recessive coextensivity toward a state of balance. Only

one individual in the sample of 20, speaker #19, exhibits a complete intermixture, two-for-two, of the four dominant and recessive characteristics between two coextensive vantages:

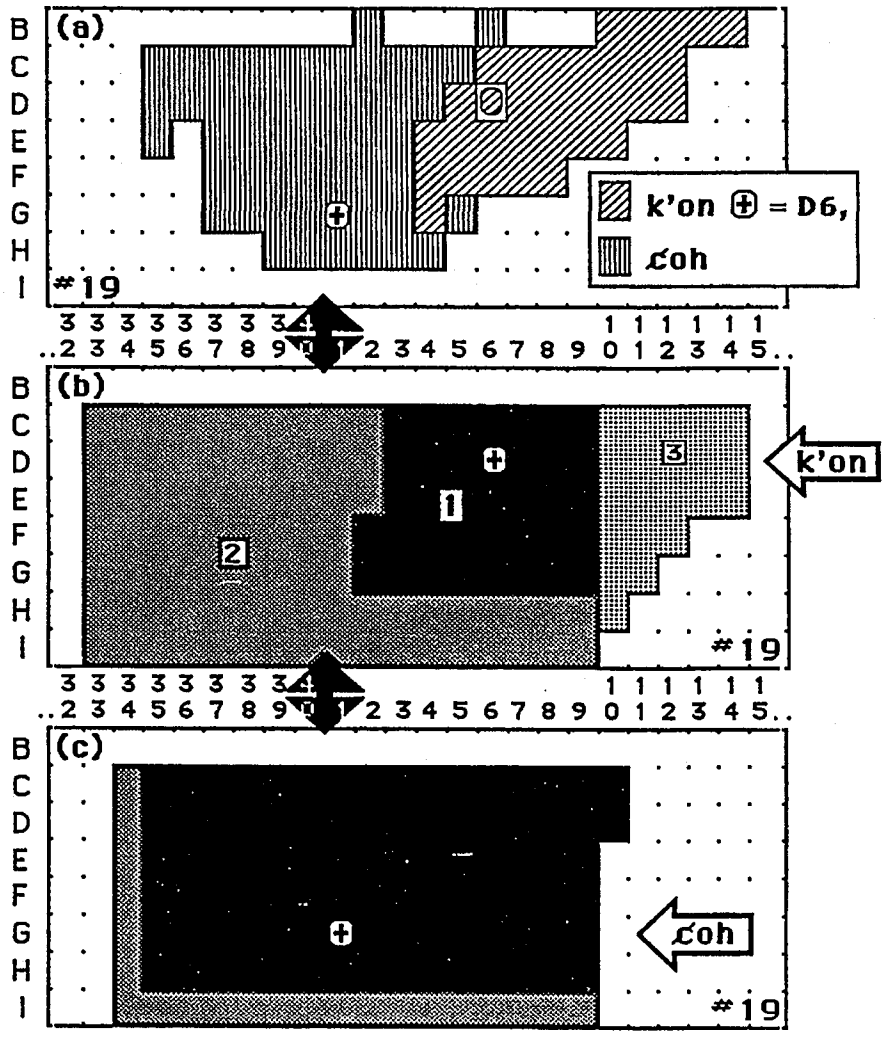


Figure 6.20a-c. Speaker #19 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Navenchauc Tzotzil, woman, age 16, 1981 (same speaker as in Figures 4.8-14, pp. 129-34).

Speaker #19 ascribed dominance in *mapping size* and *focus placement* to the "yellow" vantage and ascribed dominance in *naming* and in *average-size-of-mapping-steps* to the "red" vantage (cf. Table 6.1).

It is a remarkable coincidence that this same individual, speaker #19, demonstrated the greatest taxonomic depth in color categorization among any found in the Mesoamerican sample, the rare case of four levels detailed in Figures 4.8-14. Speaker #19 achieved this depth by maintaining a dark-cool category while, nevertheless, saliently naming all orders of composite, primary, and derived categories under the dark-cool superordinate. The taxonomy itself might evidence strong attendance to both similarity and distinctiveness, a "suspension of the cognitive axiom (cf. Chapter IV, sections 4.2 and 4.3 [item 3.])."

Of the other five Navenchauc Tzotzil speakers of the sample, four saliently named categories of dark and cool colors on either three or four perceptual levels. In correspondence, two of them, speakers #S 16 and 17, composed the warm category with weak dominant-recessive coextensivity; speakers #S 6, 16, and 17 mapped the dominant vantage in 9, 11, and 14 steps respectively, numbers that were not even closely matched by speakers of other languages. The only case of balanced coextensivity among the warm categories of the sample occurred in that context. See sections 4.0. (item 4.) and 4.2.[3]

[3]In Chapter IV, footnote 3, a non-social motive of change is proposed: Individuals are simultaneously but separately motivated by growing exposure to novelty to attend more to distinctiveness. Thus, each individual becomes more disposed to differentiate color linguistically. Labov, however, proposes a social motive of linguistic change: "The sound changes usually originated with a restricted subgroup...when the separate identity of this group had been weakened by internal or external presures. The linguistic form which began to shift was often a marker of regional status (1972: 178)." The non-social motive and the social motive might conjointly explain differences between ways that color categories change in distinct languages, for example, (1) Tzotzil and (2) Tzeltal:

1. Speakers of Navenchauc Tzotzil maintain a conservative Stage-II variant as an emblem of social identity under external pressure, even though the pressure has fostered strong attendance to distinctiveness. The cognitive balance between attendances to similarity and to distinctiveness has shifted *ahead* of the archaic Stage-II system, which is preserved as an emblem in spite of cognition. Cognition is manifested by low salience of superordinate categories, their small and numerous mapping steps, extraordinary taxonomic depth at high salience, and weak coextensivity.

2. Among the Tenejapa Tzeltal of Paraje Nabil, the cognitive balance is *behind* the socially sanctioned system of five color categories, Stage IV. Many individuals attend to similarity to an extent that they are comfortable with only three categories. They adopt five terms to imitate the favored variant, but they relate some terms coextensively or by inclusion. This practice -- which gives rise to the evolution of semantic types -- might have began among the ancient Mayan, when a theocratic elite advocated a five-category color-direction cosmology to a peasantry (See Appendix II, section 1., pages 4-5, regarding Mesoamerican color cosmology).

The particular reciprocity of cognitions that characterizes most individuals of a community can be either (1) ahead or (2) behind an emblematic variant of color categorization. Conservative or progessive placement of the emblem differently affects color-category evolution.

Further note: In Chapter IV it is proposed that the cognitive axiom was suspended by the Navenchauc Tzotzil. Recognition of non-social *and* social motives might modify that proposal.

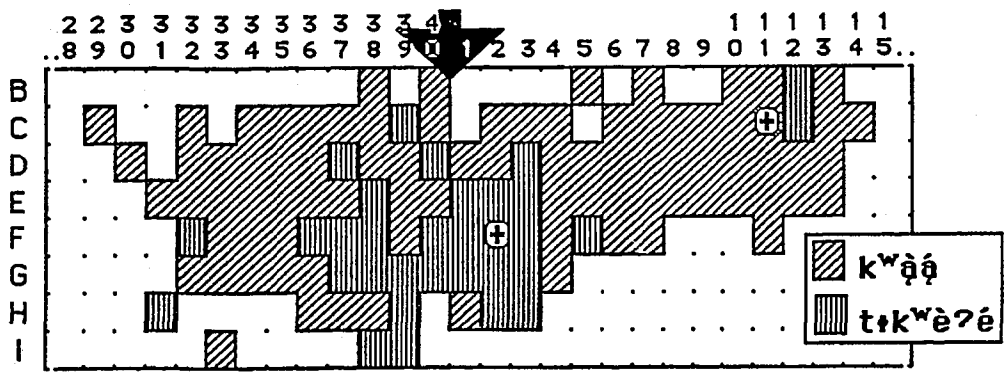


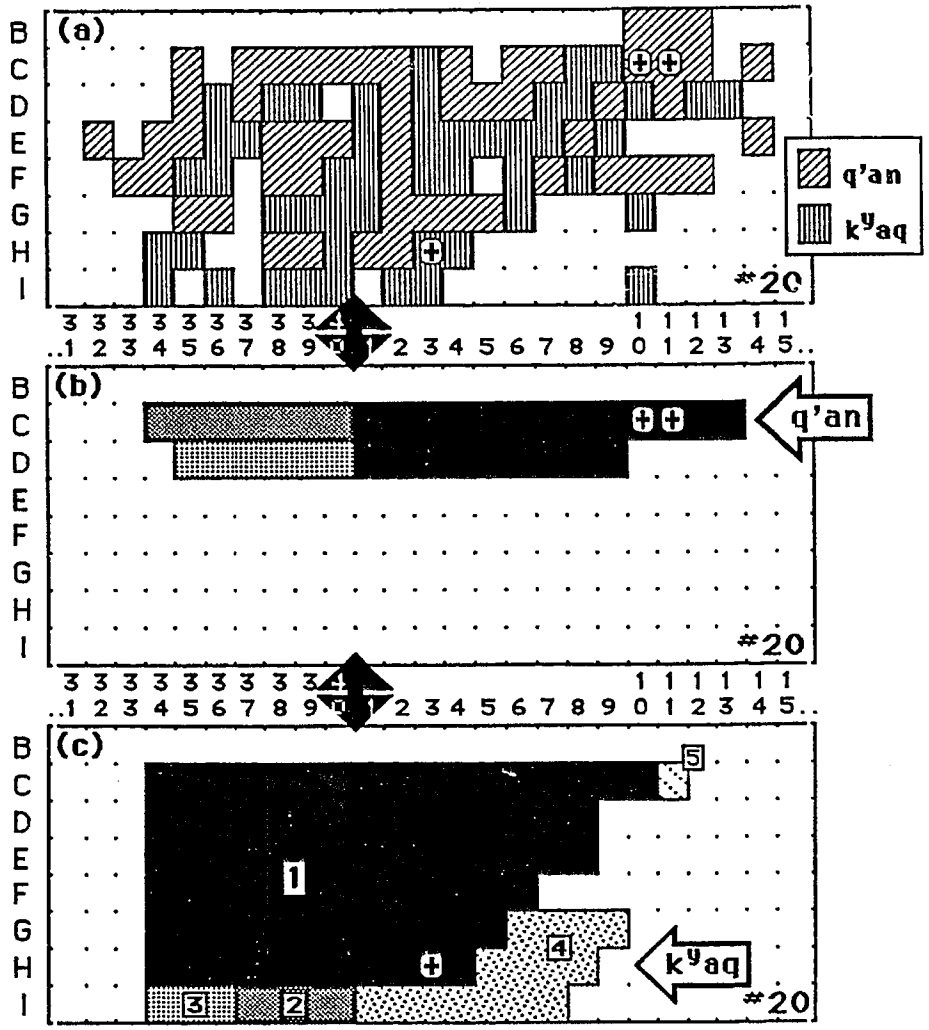
Figure 6.21. Naming ranges and foci, Peñoles Mixtec, man, age 27, 1978.

Mappings were not elicited from the Peñoles Mixtec speaker. Yet the dominant naming range is focused in a polarized position at C11, and the recessive naming range is focused in a centralized position at F2. Recessive naming responses at B-C12 evidence coextensivity. The data sugest a balance, at least to the extent that can be inferred without mapping data.

6.1.4. Mutually Polarized Coextensivity

Mutually polarized coextensivity is balanced coextensivity in which the focus of each vantage is polarized. The mutual polarization manifests a strong attendance to distinctiveness and an attendance to similarity that is correspondingly weak, that is, not strong enough to determine that one vantage will be centrally focused. The strong attendance to distinctiveness can be manifested in other ways as well. Like balanced coextensivity, mutually polarized coextensivity is rare. A warm category need not develop polarized foci in both vantages as it divides.

Speaker #20 (cf. Table 6.1) shows non-correspondence of the four dominant-recessive characteristics plus mutually polarized foci at H3 and C10-11:



Figures 6.22a-c. Speaker #20 (cf. Table 6.1), naming ranges (a) and mappings (b-c), Aguacatec, Aguacatán, man, (a) age 87, 1978, (b-c) age 89, 1980 (Figure 6.22a repeats 5.2).

In Figures 6.22a-c, the extent to which speaker #20 attended to distinctiveness is apparent: He mapped the yellow-focused vantage in three steps on only rows C-D, curtailing the mapping short of the remaining part of his yellow-focused naming range throughout rows E-H. Instead of mapping the colors that are included in this vantage, *he mapped the distinctiveness of the vantage.* That is, as he mapped, he attributed greatest

importance to the attendance to distinctiveness while largely ignoring the perceptual contents of the category.[4]

The mutually polarized coextensivity of speaker #20 involves a curtailed mapping, non-correspondence of dominant-recessive characteristics, and mutually polarized foci. In this sense, it differs from the weak dominant-recessive coextensivity of speaker #13, Figures 6.10a-c, page 186 (cf. Table 6.1): Speaker #13 polarized one focus but placed the other on a unique hue, a mitigated case of mutual polarization; however, (1) she showed correspondence among three other dominant-recessive characteristics and (2) she mapped both vantages throughout the two unique hues. Speaker #20 did neither (1) nor (2).

Figure 6.23 shows another mitigated case of mutually polarized foci: A Tlapanec speaker placed one focus on the unique hue at C8-9 and the other in a diffuse but polarized position at H-I1-3. In Figure 5.3 (page 143), another Tlapanec speaker polarized warm-category foci to extremes at C12 and I1.

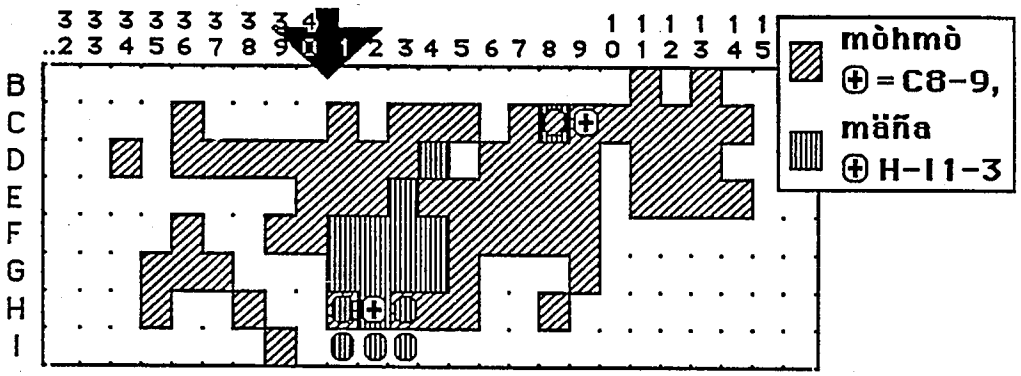


Figure 6.23. Naming ranges and foci, Tlapanec, Malinaltepec, woman, age 60, 1978.

[4]During the mapping procedure of the interview, Speaker #20, after mapping the cool category, mapped *kʸaq*, then other categories, and then *q'an*. He steadfastly refused to map *q'an* beyond rows C-D in spite of extensive use of mapping directives by the interviewer.

6.2. Triple Coextensive Vantages

The Mesoamerican sample yields two clear cases of triple coextensivity in the warm category, from an Aguacatec and a Mixtec speaker (cf. Figures 5.4a-d and 6.17a, pages 144 and 192). The Aguacatec speaker assigns dominance to the red-focused range, recessiveness to the yellow-focused range, and pronounced recessiveness to the "brown-oriented" range (whose focus was not elicited). The Mixtec speaker makes the assignment in the order of red-focused, brown-focused, and yellow-focused ranges, which differs from the Aguacatec speaker.

How can two reciprocal cognitions be separately coordinated with three perceptions of purest red, unique yellow, and exemplary brown?

An answer might lie in the *relativity* of the attendances to similarity and to distinctiveness. The Aguacatec speaker views red and yellow as similar from her red-focused vantage relative to the way she views the same colors from her yellow-focused vantage. But she views red and yellow as similar from her yellow-focused vantage relative to the way she views these colors from her "brown-oriented" vantage. An equivalent statement can be extended to the Mixtec speaker, allowing for his difference from the Aguacatec speaker.

The attendances to similarity and to distinctiveness are relative as well as reciprocal.

6.3. Perceptual Constraints

Section 6.1. has demonstrated that cognition profoundly determines the composition of the warm category. The data of Figure 6.24 demonstrate that perception determines category composition to an equal extent:

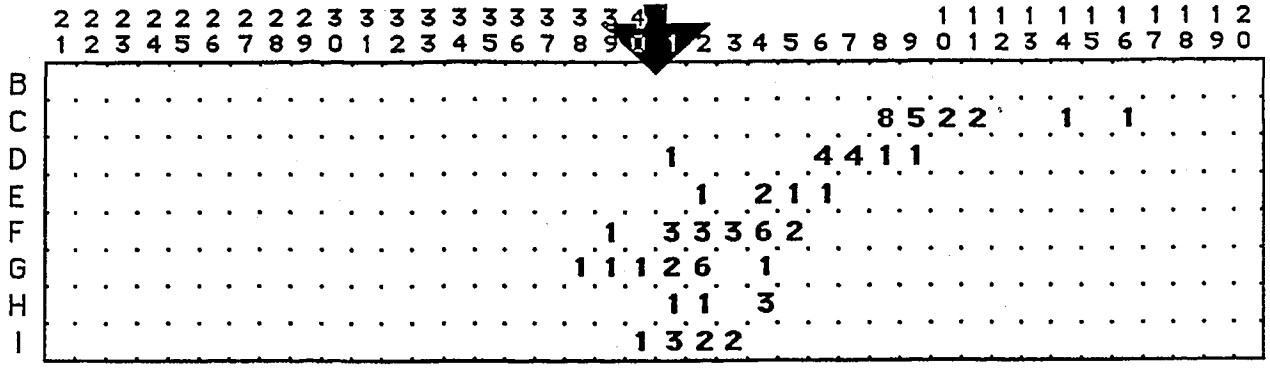


Figure 6.24. Colors chosen as foci for "red" and "yellow" vantages of the 30 warm categories in which coextensivity is attestable.

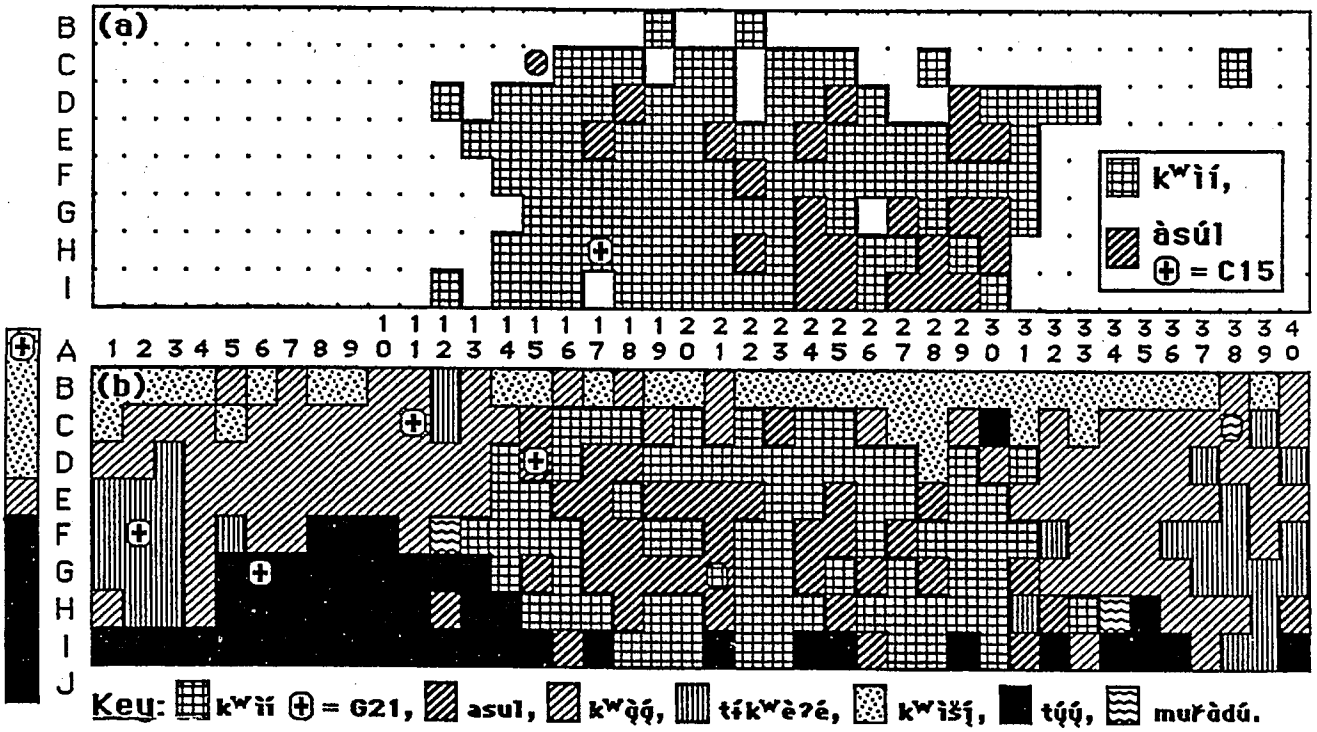
The figure displays the distribution of all foci that 30 different individuals selected for both the "red" and the "yellow" vantages of the 30 warm categories that are attested to be coextensively composed (cf. footnote 1, page 169). The numbers in the figure represent the number of times that each color of the Munsell array was chosen as a focus. The total is 79 rather than 60, because some individuals chose more than one color when focusing. Any focus that covered more than two adjacent colors is omitted from the figure. The foci show the highest concentration on and between the unique hues (G1-2 and C8-9), especially at G2, C8, and F4. Their distribution concentrates along an axis that intersects both unique hues and that extends somewhat beyond each.

The constraining effect of the unique hues is evident. Although foci placements are readily centralized and polarized as a result of cognition, most of the foci are placed within a narrow gamut whose limits are determined by perception and its physiological base.

6.4. Coextensive Variants In The Cool Category

The cool category, like the warm category, can be composed of dominant-recessive, balanced, or mutually polarized coextensive vantages. These variations are not unique to the warm category, but typify coextensivity in any environment. However, the three forms are modified by the perceptual similarity of unique green and unique blue; the variants of coextensivity differ between the cool and the warm category in the nine ways specified in Table 5.1. Most important, (1) coextensive terms tend to be more readily intermixed throughout the cool category, (2) a centralized dominant-range focus and a polarized recessive-range focus commonly occur on the same side of the cool category, and (3) the dominant-recessive characteristics are more readily "crossed over" between vantages in the cool cateogry. The latter (3) fosters weak dominant-recessive coextensivity and balanced coextensivity, and it tends to reduce the incidence of strong dominant-recessive coextensivity.

Figures 6.25a-b (page 203) display dominant-recessive coextensivity in the cool categories of two Mixtec speakers. Mappings were not collected. In each category, the dominant vantage is named with a native term and the recessive vantage with a loan term. In Figure 6.25a, the Diuxí Mixtec speaker focused the dominant vantage at H17, the column of unique green; and, on the same side of the category, he polarized the focus of the recessive vantage at C15. In Figure 6.25b, the Peñoles Mixtec speaker also focused



Figures 6.25a-b. Naming data and foci: (a) Diuxí Mixtec, man, age 18, 1978; (b) Peñoles Mixtec, man, age 27, 1978.

both vantages on one side of the category, polarizing the recessive-range focus at D15 and centralizing the dominant-range focus at G21.

The Peñoles Mixtec speaker coextensively composed both the cool category and the warm category (See Figure 6.21, page 197, for a reverse display of the same data.). The two dominant and recessive characteristics that are ascertainable from these data -- size of naming ranges and position of foci -- correspond within the vantages of the cool category but do not so correspond in the warm-category vantages. The incomplete data suggest that coextensivity of the cool category is dominant-recessive and that coextensivity of the warm category is balanced, at least to the extent that can be determined from naming data alone.

Figures 6.26a-c (page 204) display dominant-recessive coextensivity in both the cool category and the warm category of a Tenejapa Tzeltal speaker:

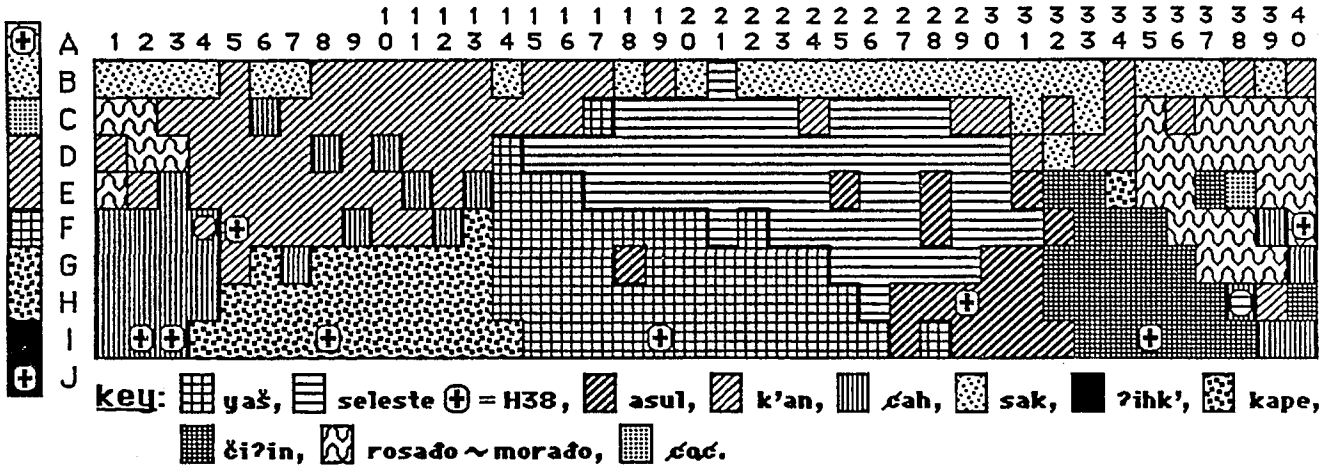
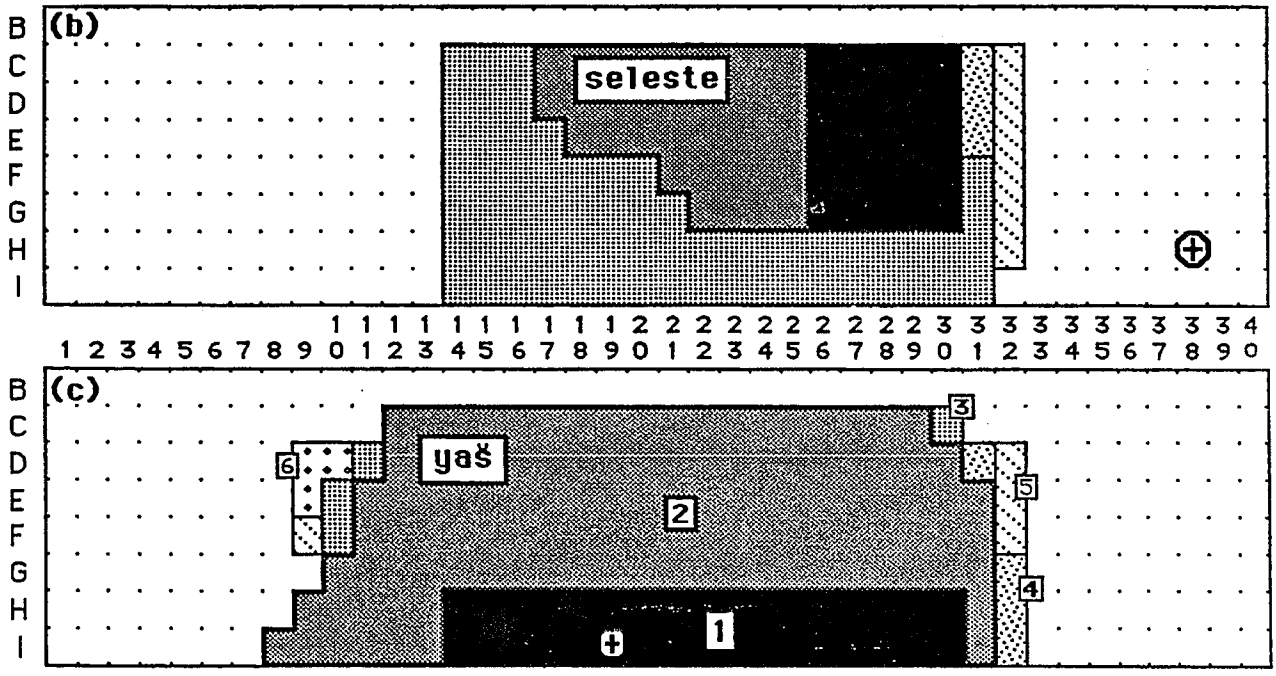


Figure 6.26a. Naming ranges and foci, Tenejapa Tzeltal, woman, age 37, 1980 (speaker #2, cf. Table 6.1; see Figures 6.2a-c for a reverse display of the warm category).



Figures 6.26b-c. Mappings and foci, same speaker as in Figure 6.26a.

In this cool category, the dominant range is centrally focused at I19 and mapped over 163 colors with an average mapping-step size of 27 colors; the recessive-range focus

is polarized to an extreme at H38 and mapped over 113 colors with an average mapping-step size of 23 colors. The sizes of the naming ranges do not correspond with the other three characteristics: the dominant range is designated 48 times and the recessive range 54 times. It is unlikely that this cool category is well along in the division process, because the warm category itself is intact; the warm category is observed always to divide first in data from around the world. Yet the warm category of this Tzeltal speaker shows correspondence among all four of the dominant and recessive characteristics (cf. speaker #2, Table 6.1), but the cool category shows correspondence among just three. The weaker correspondence within the cool category -- even though it is purportedly the least advanced of the two categories in the division process -- exemplifies the tendency to interchange dominant-recessive characteristics between coextensive vantages in the environment of green and blue.[5]

6.4. Conclusions

Each term of a coextensive pair names the same perceptions of color from a different vantage. The coextensive vantages compose a category of the perceptions. Each vantage is taken from a distinct position or vantage point. A vantage of a coextensively composed category is a coordination of (1) one unique hue and (2) one attendance, either to similarity or to distinctiveness. The same cognitive axiom that provides for the account of continuous evolution among basic color categories and semantic types further provides the cognitive coordinates of coextensive vantages. Both perception and cognition determine the composition of a coextensively composed category.

[5]The Tzeltal cool category embodies a further feature: The coextensive vantages are juxtaposed between dark and light colors; the first mapping step of the dominant range is on and below row H, and the first and second mapping steps of the recessive range are above row H. In the warm category, the dark-versus-light contrast is incidental to the positions of unique red and unique yellow at distinct levels of brightness. But in the cool category, unique green at F17 and unique blue at F29 are on the same brightness level. Thus, the marking of contrast between coextensive vantages on the brightness dimension is optional. Among the some 589 cool categories of the Mesoamerican sample, three others clearly exploit this option (cf. Figures 9.36a-38c).

Such a category assumes a different size and composition when regarded from its distinct vantages. The different cognitive coordinates determine measureable, quantifiable differences in the centralization of a focus, size of a naming range, size of a mapping, and average size of mapping steps. And the cognitive coordinates determine that the four orders of independent numerical data will correspond within a vantage: the attendance to similarity will entail higher numbers and a more centralized focus than will the attendance to distinctiveness. This prediction affords the statistical test of the hypothesis of vantages and coordinates, Table 6.1.

The four columns of paired numbers in that table provide strong evidence of the pertinence of the vantage principle to categorization. For that reason, the numbers are presented prior to discussion of other statistics that concern categories that are not coextensively composed, Table 8.1. Chapter VIII develops evidence that the adoption of vantages is more than an artifact of coextensivity. Rather, any composite color category is composed from at least one vantage. A vantage is inherent to any and all such categorization.

The notion that any composite category is composed from at least one vantage has the following implications for theory:

1. Categorization is accomplished on the basis of a primal ability: to treat something intangible as though it were tangible, including one's own cognitions. With this ability, an individual can constitute a vantage point by coupling reciprocally related cognitions to one unique hue; and he can separate each cognition from the other such as to couple them with opposite unique hues of a coextensively composed category. The primal ability is the same that is used to accomplish other forms of behavior that are both unique and critical to the human species. For example, metaphor is also a treatment of something intangible as though it were tangible (cf. Lakoff and Johnson 1980).

2. When cognitions and perceptions are treated like things in order to compose a category from a vantage point, the category itself is treated as though it existed physically: the vantage point endows the category with a fixed position in which the categorizer stands and looks on. The standpoint is inherent to the category; that is, it is part of the category by virtue of the way that the category is composed. The inherence of a standpoint means that categorization involves the same order of embodiment as does the direct observation of physical objects and events.

A category differs from concrete events and objects specifically and only in that some of its coordinates are cognitive rather than dimensional and temporal. Human beings have accomplished categorization by creating an abstraction that, nevertheless, is as similar to concrete experience as it can be.

3. From different standpoints, a category assumes compositions of different sizes and distinct degrees of skewing, just as physical objects and events differ when observed from different standpoints.

4. The present theory is consistent with the more conservative of two phylogenetic accounts: At some point in hominid evolution, early humans set themselves apart from other animals by developing unique abilities, such as categorization. They might have done this by (1) slightly altering behavior that all higher animals engage in, namely, the apprehension of objects and events from vantage points composed of coordinates. Or they might have done this by (2) innovating categorization *in vacuo*, with no antecedents. The latter possibility (2) is radical if not outlandish, but the former (1) is conservative: categorization is accomplished by treating cognition in the same manner that all creatures treat physical dimensions. The accomplishment is dependent on the primal ability to treat non-things as things.

The concept that a color category is a vantage differs from Rosch's notion that a color category is composed of "family resemblances" to a "natural prototype" (cf. sections 1.7.2.1-4.). A color percept is a member of a category to the degree that it shares attributes

with a prototypical percept. In the domain of color, prototypes are unique hues, other pure colors, or, presumably, exemplary complex colors. The assessment of prototypicality and of shared attributes is perceptual. Color categories are "perceptual categories." Foci and values of membership that do not match perception are manifestations of randomness or error. There is no provision that would predict or explain correspondences, such as those shown in Table 6.1 or Table 8.1.

Under the present theory, natural prototypes do not exist. The placement of a focus, the size of a category, and the distribution of membership values are determined by coordinates of perception and cognition. The coordinates constitute one, two, or more standpoints from which a category is composed as a vantage. Category composition varies through a continuum of types because cognitive coordinates are of mutable strength.

Finally, the specific way that perceptual and cognitive coordinates are combined to compose coextensive vantages has not been determined empirically. According to the present proposal, an individual constitutes a vantage point in reference to one unique hue and one attendance; and he constitutes another vantage point in reference to the opposite unique hue and opposite attendance. He maintains reciprocity of the attendances by counterpoising them within the category from opposite vantage points. There are other possibilities that would fit the hypothesis of vantages and coordinates, although this one is the simplest.

Chapter VII

Semantic Types and Category Division

7.0. Preface

This chapter makes no major claims beyond those that were set forth in Chapters IV-VI. Its main intent is to elaborate evidence that has already been cited concerning the evolution of semantic relationships from coextensivity, through inclusion, to complementation. As the prior chapters treated the early half of the semantic continuum, this chapter treats the late half. Further, the chapter emphasizes that semantic evolution and the on-going division of a category are inseparable. They occur simultaneously as the attendences to similarity and to distinctiveness shift reciprocally in strength.

Nevertheless, although the chapter features data, it offers a few refinements of theory (1-5) as well as mentioning issues that presently cannot be resolved (6-7):

1. As the division of a category progresses, the coextensive relationship transforms into one of inclusion between a superordinate and a subordinate category. As has been touched upon in Table 5.1, items 2., 8., and 9., the change takes different forms within the warm and the cool category.

In the warm category, the recessive vantage retracts toward its focus and becomes a subordinate category; the dominant vantage remains as it was, but becomes a superordinate warm category. A polarized focus commonly characterizes one or both categories, especially the superordinate one. Later the superordinate category too retracts towards its focus, resulting in two primary basic categories that are related by complementation. The process advances in that order, and it involves predictable correspondence between naming

ranges, mappings, and foci. It is typified by polarization of foci and of first mapping steps. Since the perceptual difference between red and yellow is immanently strong, an increasing attendance to distinctiveness propels the division of the warm category without a perceptual impediment.

In the cool category, strong perception of similarity forestalls full division; and it continually fosters the crossover effect, even as the cognitive attendance to distinctiveness augments. To cause full division, the strength of the cognition must supersede that of perceived similarity. But before the cognition is enhanced to that extreme, it becomes strong enough to encourage the confinement of naming ranges and mappings just to green or to blue. The confinement of data and the crossover effect co-occur in an undivided category. In combination, they produce a mismatching of naming ranges and mappings: One coextensive term names just green but is mapped in just blue, and the other names just blue but is mapped in just green; either term is focused anywhere. Different speakers vary in the colors that they name and map with a given term. The variation creates an impression of chaos. In the cool category, as in the warm category, coextensivity evolves into inclusion, but the transition can appear disorderly.

The engagement of perceptual and cognitive axioms provides for an explanation of a seemingly chaotic manifestation of change in the cool category, and it provides for an explanation of the difference between that and the orderly appearance of change in the warm category.

2. Data from the dark-cool category show that coextensivity, inclusion, and complementation evolve in this environment much as the types evolve in the warm category (cf. footnote 5, Chapter V, page 156). There are some unique manifestations, as there are in the warm and the cool category (cf. Table 5.1), which are probably determined by the three-way perceptual distance between black, green, and blue. In the dark-cool category, as in the other composite categories, inclusion develops as a recessive vantage is retracted toward its focus.

3. In both the warm category and the dark-cool category, a recessive vantage can be focused in reference to any of the unique hues. Thus, the retraction of the recessive vantage can occur in any direction and, consequently, the resultant relationship of inclusion between a superordinate and subordinate category can assume either of two patterns: a red-focused warm category can include a yellow category or a yellow-focused warm category can include a red category; a black-focused dark-cool category can include a cool cateogry or a cool-focused dark-cool category can include a black category. *No particular focus is primal in the evolution of the warm category or the dark-cool category.* Sections 8.4.9. and 8.5.1. discuss how the cool category differs in this regard.

4. The sparse evidence of the light-warm category is described. The rare examples are lexically complex, and they are attested by corespondence between mapping data, white-focused terms that name red, and warm-category foci that are "triangulated" in pink at equal distance from red, yellow, and white (cf. footnote 13, Chapter I, page 44).

5. The data regarding transition from coextensivity to inclusion provide an inferential argument that the warm category assumes different sizes when viewed from distinct vantages. At some point during the retraction of a recessive vantage toward its focus, a size differential must develop between it and the dominant vantage.

6. Substantial evidence justifies the recognition of "contrast," a semantic type that is intermediatal to inclusion and complementation. The relationship involves separate categories whose ranges pertain to only one unique hue but whose foci are mutually polarized or are juxtaposed in centralized-to-polarized opposition. This differs from complementation, in which the compositions of separate categories are not defined in relation to each other. For the present, the juxtaposition is simply regarded as a transition on the continuum between inclusion and complementation. Eventually, however, a formal difference between semantic types might be worked out in a way that would specify different uses of coordinates, that is, different ways in which they are combined. The

question will be considered in Volume II when relationships between primary basic categories are analyzed.

7. Provisionally, there might be at least three ways in which perceptual and cognitive coordinates are combined to constitute vantage points: (1) each of two cognitive attendances is linked with an opposite unique hue of a perceptual pair, such as red and yellow; (2) both attendances are linked with each unique hue of a pair or, simply, with one unique hue; (3) one attendance is linked with two perceptions consisting of one unique hue and a dimension of brightness. The first (1) would pertain to a coextensively composed category, the second (2) would pertain to categories related by inclusion or to any composite category that is composed of just one vantage, and the third (3) would pertain to complementary primary basic categories. In Chapter VIII, Figure 8.28b, it is shown that basic green and blue categories tend to be focused at two levels of brightness darker than the cool category; the attendance to similarity is discontinued (or diminished) as a coordinate, and it is replaced (or buttressed) with one of brightness. Near-synonymy might involve a linkage of each attendance with a different coodinate from the brightness dimension (4), a fourth combination. Such is consistent with the emphasis on brightness that characterizes early-stage categorization. Intermediate semantic types might involve different kinds of linkages between coodinates within each vantage; for example, a type between near-synonymy and coextensivity might involve one vantage composed of a coordination of the attendance to similarity and an extreme of brightness and another vantage composed of a coordination of the attendance to distinctiveness and a unique hue. *Contrast* is not worked into the nascent scheme, although that hypothetical type too might involve more than one way of linking coordinates; the type, therefore, would be intermediate. A developed scheme might further specify distinct ways that coordinates are related to each other between vantage points. If ideal semantic types (1-4) could be defined in terms of distinct coordinates and coordinate-combinations, it would not conflict with the empirically observed continuum of semantic evolution or the axioms that explain it.

7.1. The Warm Category

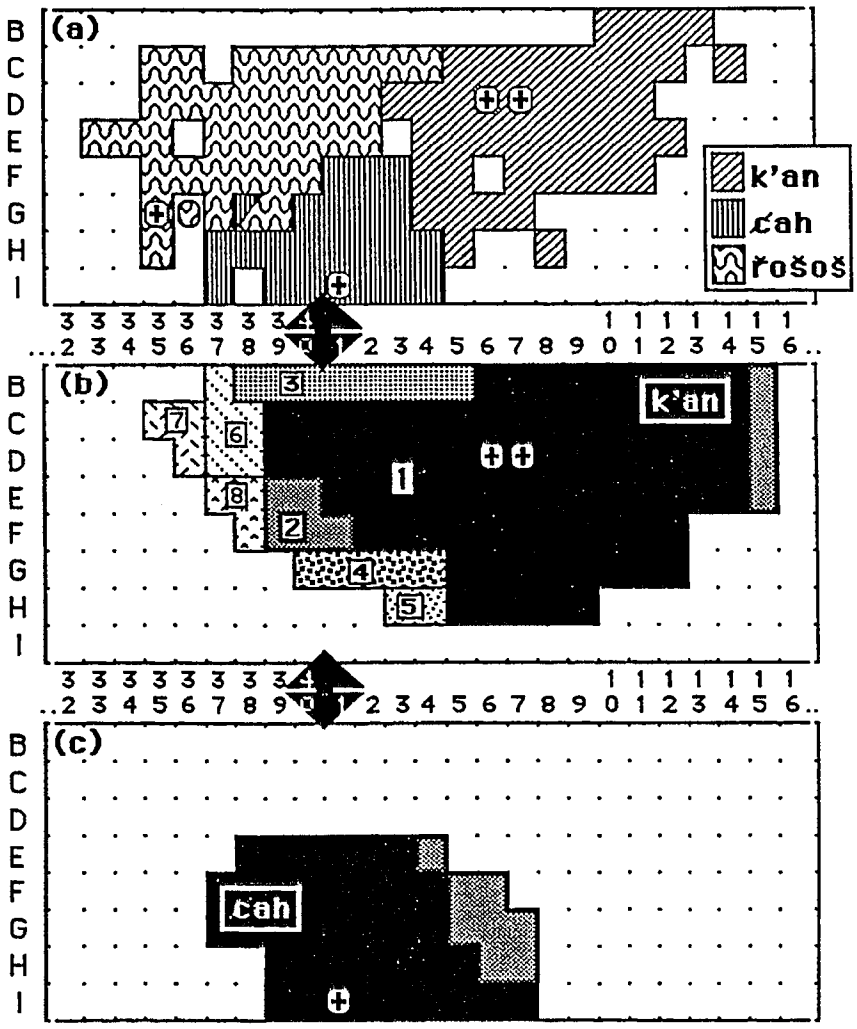
This section examines data regarding individual warm categories from twelve languages. The data indicate that (1) inclusion develops from coextensivity, (2) centralized and polarized foci placements of superordinate and subordiante categories are unpredictable, (3) speakers of any language agree upon which category is superordinate, whether it is yellow-focused or red-focused, and (4) complementation develops from inclusion.

7.1.1. Superordination in Reference to Yellow

Figures 7.1a-c (page 214) display a superordinate warm category, focused at D6-7 in reference to yellow, and a subordinate red category that is focused at I1.

The Tenejapa Tzeltal speaker came from a community in which warm-category coextensivity abounds (cf. Table 6.1). She was the youngest speaker and the only Tzeltal-Spanish bilingual of the sample, and she had lived for 15 years outside of Tenejapa in San Cristóbal de las Casas, an urban center. Hardly by coincidence, she was the only Tzeltal speaker of the sample whose warm category was not coextensively composed. *This relationship of inclusion is the next phase of semantic development beyond an earlier phase of coextensivity.* The warm categories of her mother and father appear in Figures 6.11a-12c, pages 187-88.

In Figures 7.1b-c, the warm range of the superordinate term is evidenced by its mapping at purest red, G1-2, and at unique yellow, C8-9. The subordination of the red-focused term is suggested by the confinement of both its naming range and mapping to rows E-I. Other characteristics resemble those of weak dominant-recessive coextensivity: ***colors named*** 44/22; ***focus*** centralized/polarized; ***colors mapped*** 114/46; ***average per step*** *14* /*23* .



Figures 7.1a-c. Naming ranges (a) and mappings (b-c), Tzeltal, Tenejapa, woman, age 34, 1980 (same speaker as in Figures 4.7a-c).

Figures 7.2a-c (page 215) show that an Acatec speaker focused a superordinate warm category on unique yellow at C8-9. The subordinate red category is focused twice, with the first choice in a centralized position at F2 and the final choice polarized at F40 in agreement with the first mapping step. The polarization pertains to both the final focus and to the mapping, which makes the inclusion of the red category by the warm category appear to be incomplete. Only the fourth mapping step of the superordinate category pertains to

red at G1-2. This, with the polarization, indicates a strong attendance to distinctiveness. None of the final foci placements are centralized, as would be characteristic of dominant-recessive coextensivity:

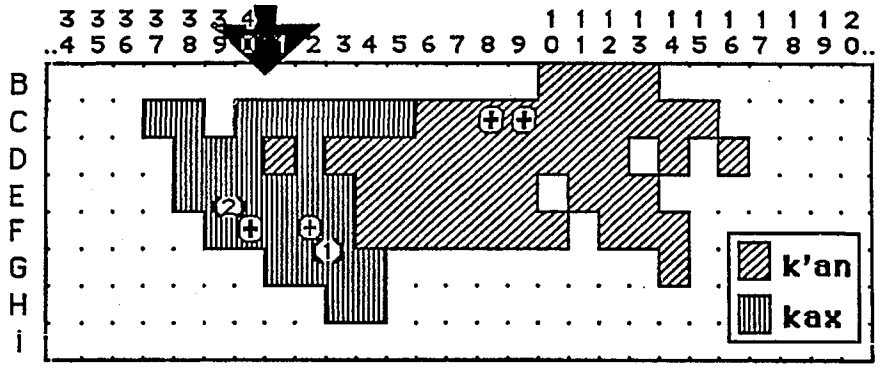
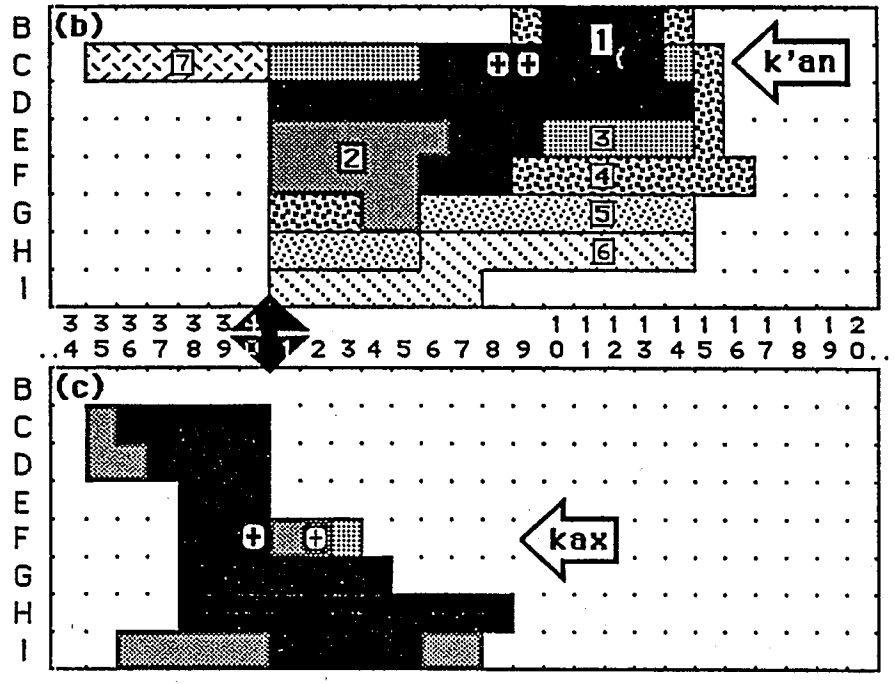


Figure 7.2a. Naming ranges, Acatec, Coya', San Miguel Acatán, man, age 32, 1980.



Figures 7.2b-c. Mappings, same speaker as in Figure 7.2a.

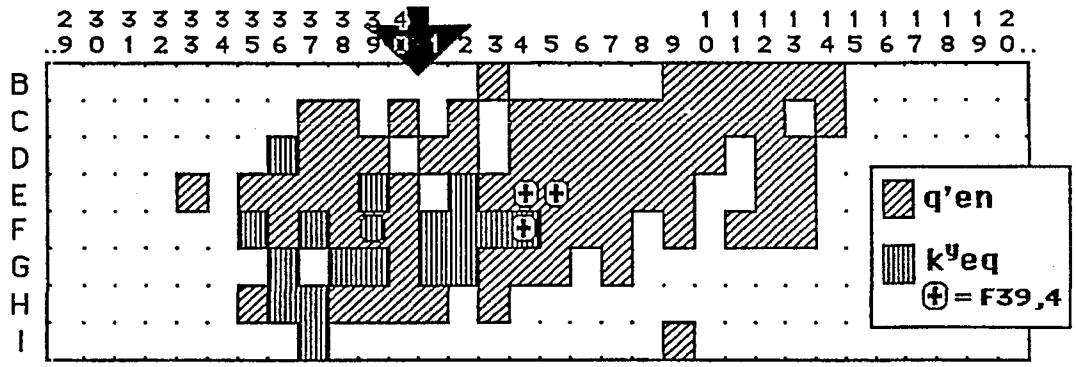


Figure 7.3. Naming ranges and foci, Quiché, Sipacapa, woman, age 60, 1978.

In Figure 7.3, a Sipacapa Quiché speaker -- like the Acatec speaker of Figures 7.2a-c -- ambivalently centralized and polarized foci of the subordinate red category, F4 and F39.

Figures 7.4a-c (page 217) display naming ranges and mappings from an Aguacatec speaker. The superordinate warm category is focused in reference to yellow in a polarized position at C12, and the subordinate category is focused on purest red at G2. These foci,

like those of the Acatec speaker, are not placed in the pattern that characterizes dominant-recessive coextensivity:

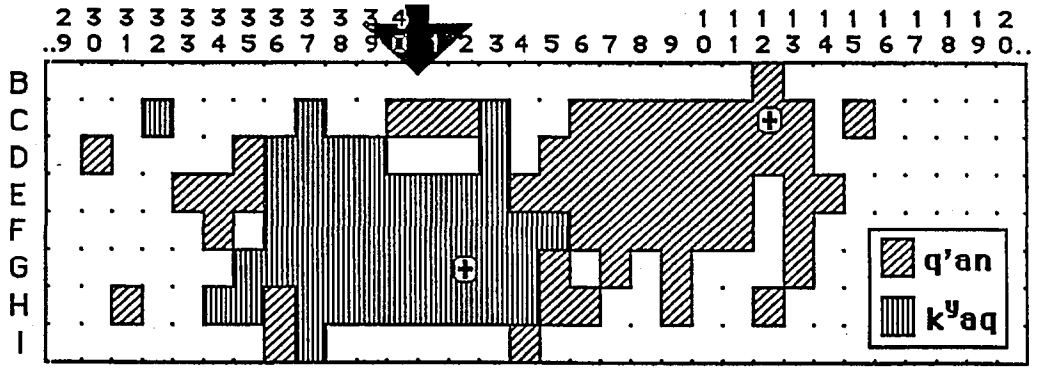
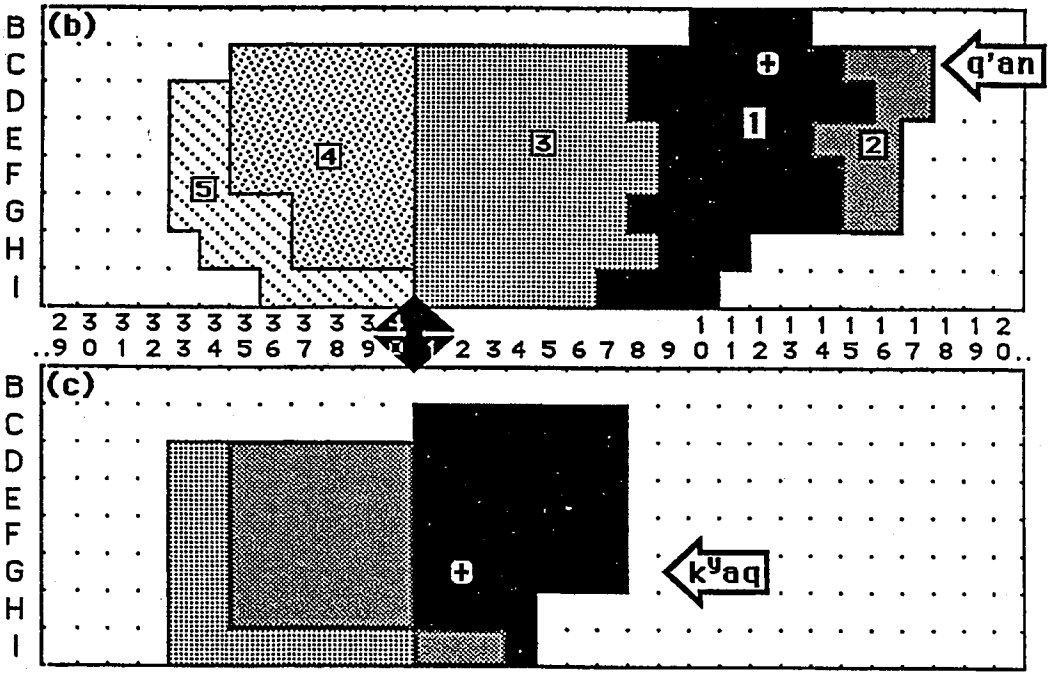
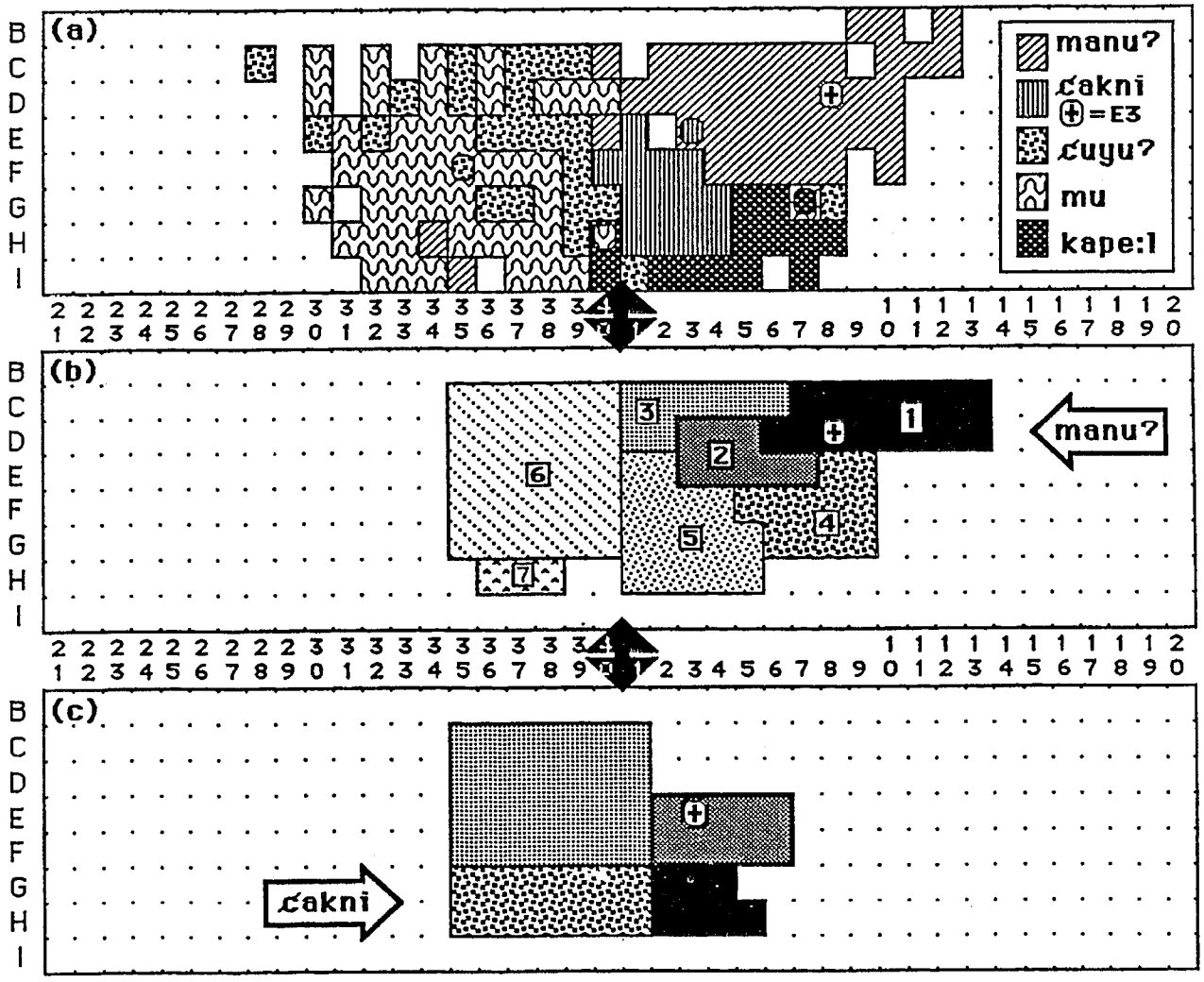


Figure 7.4a. Naming ranges, Aguacatec, Aguacatán, man, age 79, 1978.

In Figure 7.4b, the mapping of the superordinate category is the second one that was rendered by this Aguacatec speaker. It corresponds to almost all colors of the superordinate naming range, such as those at E33, C40, and I36. His first mapping of the same category did not extend toward red beyond column 4, suggesting a strong attendance to distinctiveness:

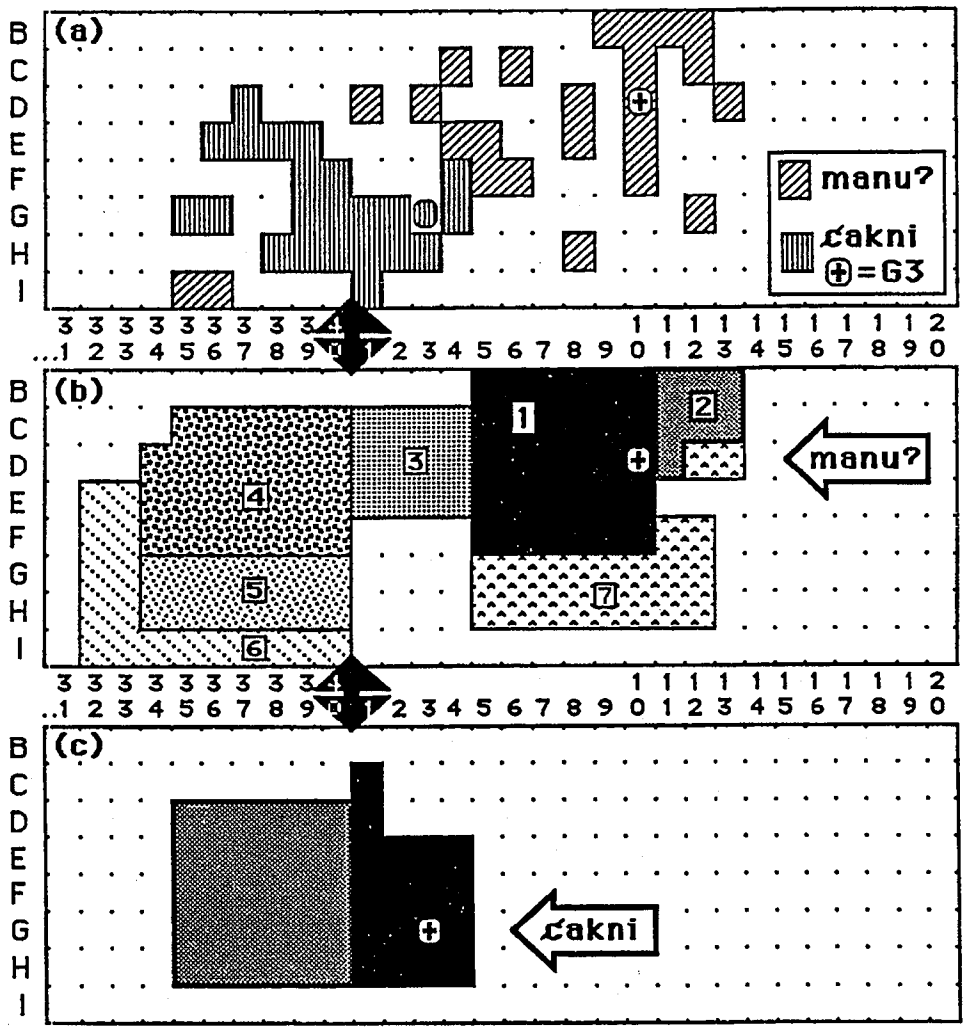


Figures 7.4b-c. Mappings, same speaker as in Figure 7.4a, 1980.



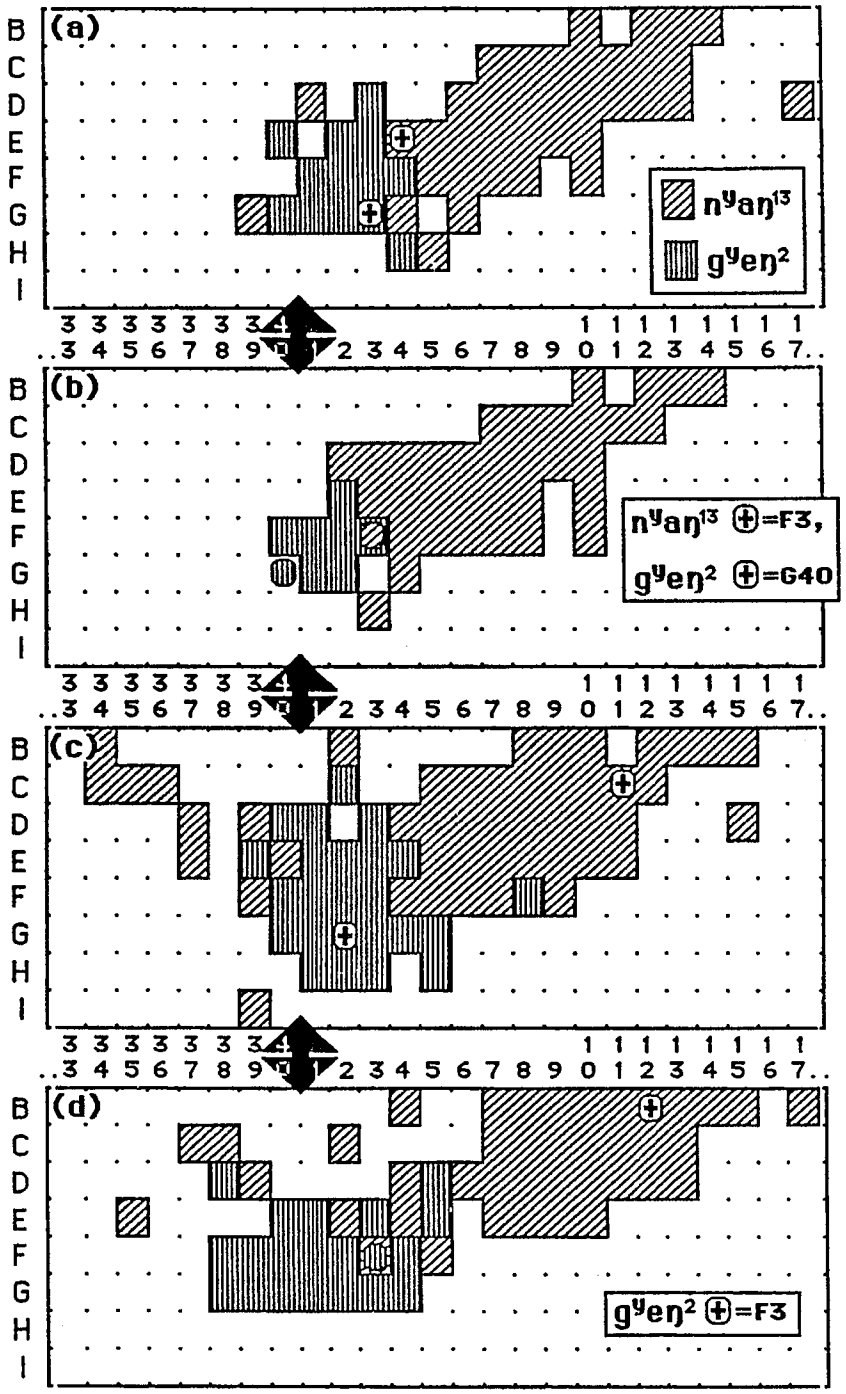
Figures 7.5a-c. Naming ranges (a) and mappings (b-c), Huastec, Huehuetlán, woman, age 75±, 1980.

In Figures 7.5a-c, a Huehuetlán Huastec speaker centrally focused the subordinate red category at E3 in correspondence with its second mapping step. The unlikely placement might mark contrast against a complex of abutting categories, those focused at F35, H40, and G7.



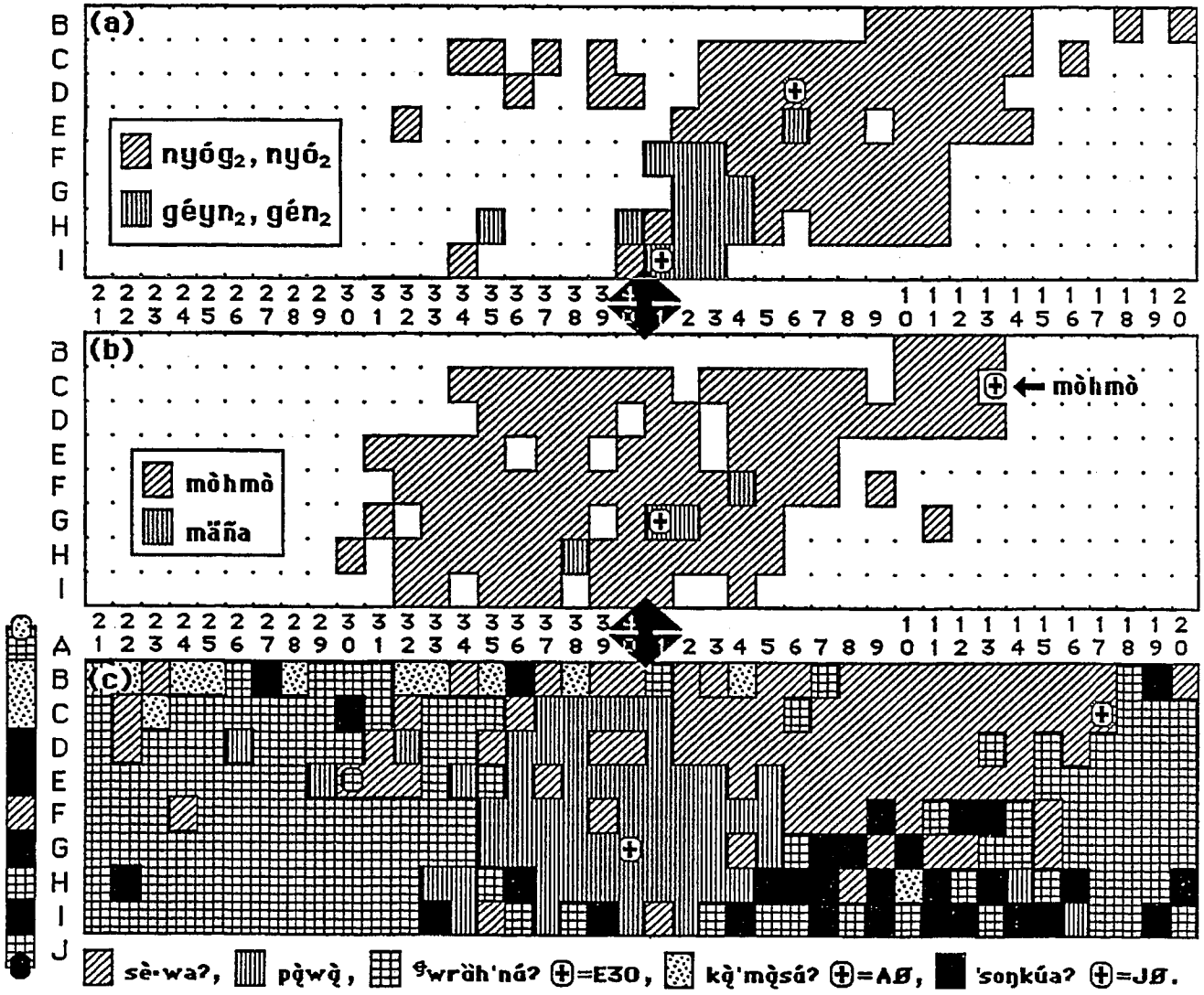
Figures 7.6a-c. Naming ranges (a) and mappings (b-c), Huastec, Huehuetlán, man, age 49, 1979.

During the naming elicitation, the Huastec speaker of Figures 7.6a-c named only the first 165 color chips. His pattern of focus placement at D10 and G3 is unlike that which typifies dominant-recessive coextensivity. His mapping of the superordinate range surrounds but does not cover pure red at F-H 1-4, which, in turn, matches the first step of the subordinate-category mapping. This implies that he strongly attended to distinctiveness and that he was approaching a full division of his warm category.



Figures 7.7a-d. Naming ranges and foci, Chinantec, San Juan Palantla, 1978, four women, ages: (a) 52, (b) 59, (c) 27, and (d) 39. Comment on page 221.

In Figures 7.7a-d (page 220), older (a-b) and younger (c-d) Chinantec speakers, respectively, centralized and polarized the focus of the superordinate category, E4 and F3 *vs.* C11 and B12.



Figures 7.8a-c. Naming ranges and foci: (a) Chinantec, Tepetotutla, man, age 69, 1979; (b) Tlapanec, Malinaltepec, woman, age 50, 1978; (c) Paya, Pueblo Nuevo Subirana, man, age 40, 1977.

In Figures 7.8a-c, the Chinantec speaker (a) used a pattern of naming ranges and foci among apparent superordinate and subordinate categories that is like that of dominant-

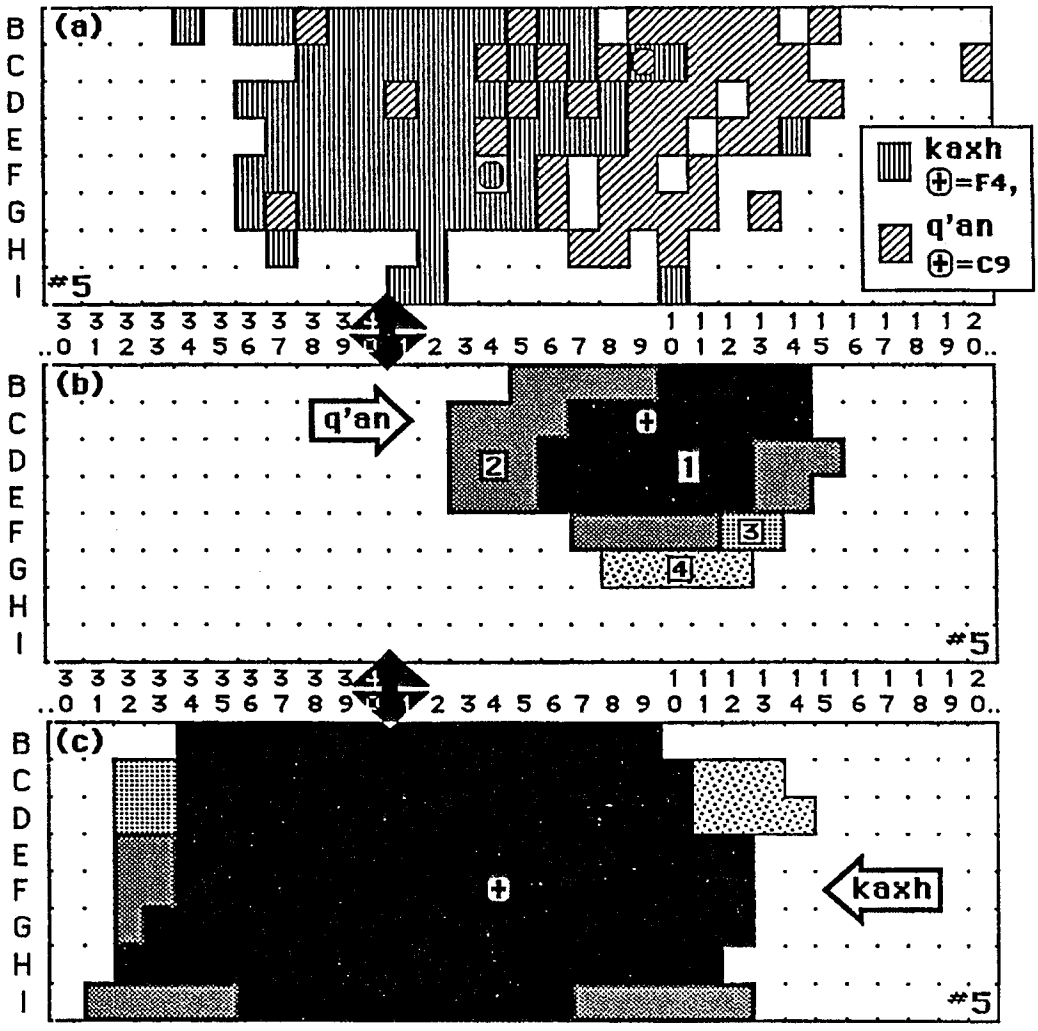
recessive coextensivity. In contrast, the Tlapanec speaker (b) radically departed from that pattern by focusing the superordinate category with extreme polarization at C13; yet she named the superordinate category 103 times and the subordinate category 4 times. The Paya speaker (c) mutually polarized foci, G40 for the subordinate and C17 for the superordinate category. Column 17 at middle brightness contains unique green (cf. Figure 7.30, page 253, C17 dark-cool category focus). A relationship of inclusion cannot be reliably affirmed in any system without mapping data. The Paya speaker's uses of black-focused and cool-focused terms suggest coextensivity in a dark-cool category, and the intermixture of all terms elsewhere typifies early-stage systems (cf. Figures 4.4a and 6.18). The very broad range of the polarized superordinate category also hints of an early stage. However, the strong attendance to similarity that occasions early-stage categorization would be incongruous with a relationship of inclusion in the warm category, since the latter requires substantial attendance to distinctiveness. Data from other Paya speakers are among the most conservative of the Mesoamerican sample (cf. Figures 7.32 and 7.34).

This section has reviewed all data of the Mesoamerican sample that substantiate -- or that appear to manifest -- a superordinate warm category that is focused in reference to yellow. In some instances, the relationship of inclusion can be shown to have descended from an earlier coextensive relationship. Some of the data from individual superordinate categories show evidence of a strong attendance to distinctiveness, especially those regarding polarization. All speakers who could be shown to use a superordinate warm category in certain languages, such as Huastec and Chinantec, consistently focused it in reference to yellow. But in the languages discussed under the next section, speakers focused a superordinate warm category in reference to red with equal consistency.

7.1.2. Superordination In Reference To Red

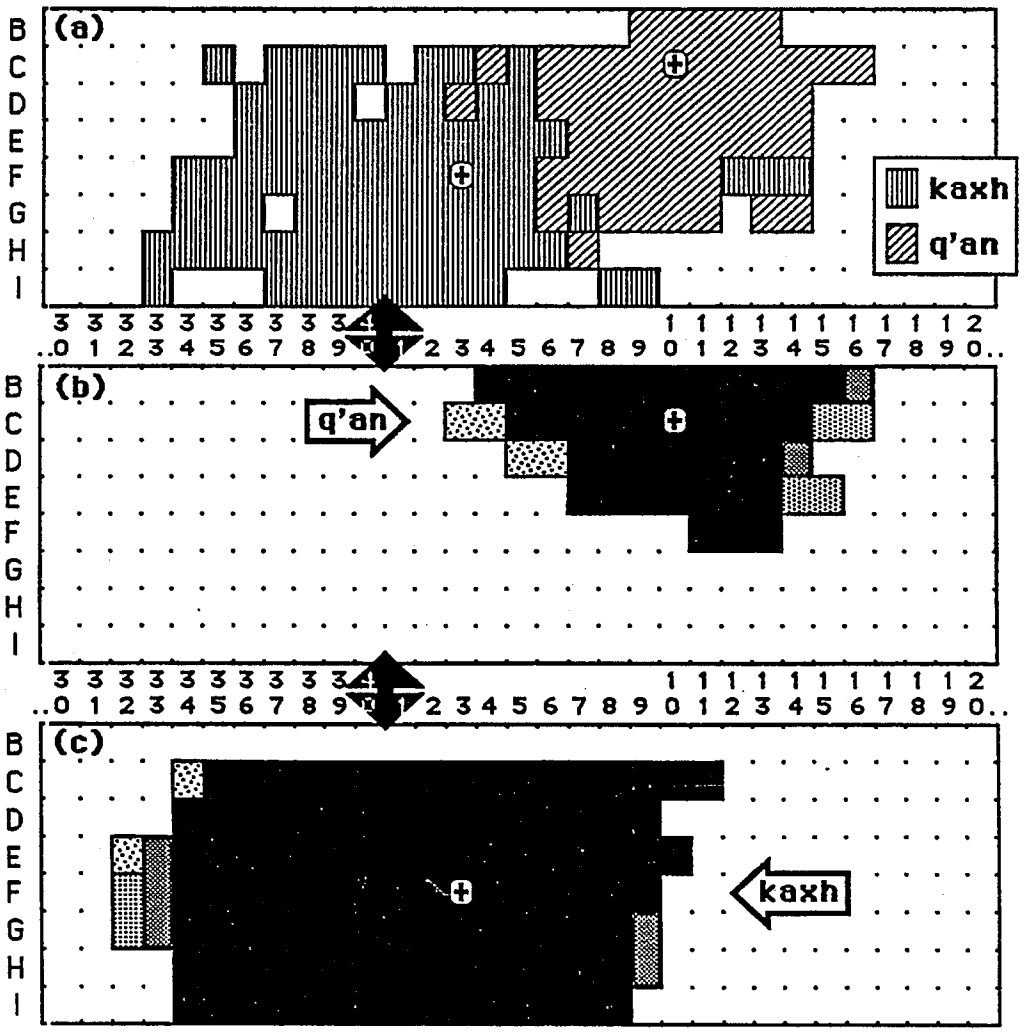
Characteristics seen throughout Figures 7.1a-8c are equally prevalent among superordinate warm categories that are focused in reference to red. As dominant-recessive coextensivity transforms to a relationship of inclusion, polarization becomes increasingly evident in the warm category: the "red" focus of the superordinate category as well might be polarized as centralized; the "yellow" subordinate-category naming range and mapping might be polarized to the extent that they cover very green colors.

Figures 7.9a-12c (pages 224-28) demonstrate subtly manifested phases of divison among warm categories of five Jacaltec speakers, including dominant-recessive coextensivity, superordination of the red-focused category, and complementation. The five suggest a continuum of development:



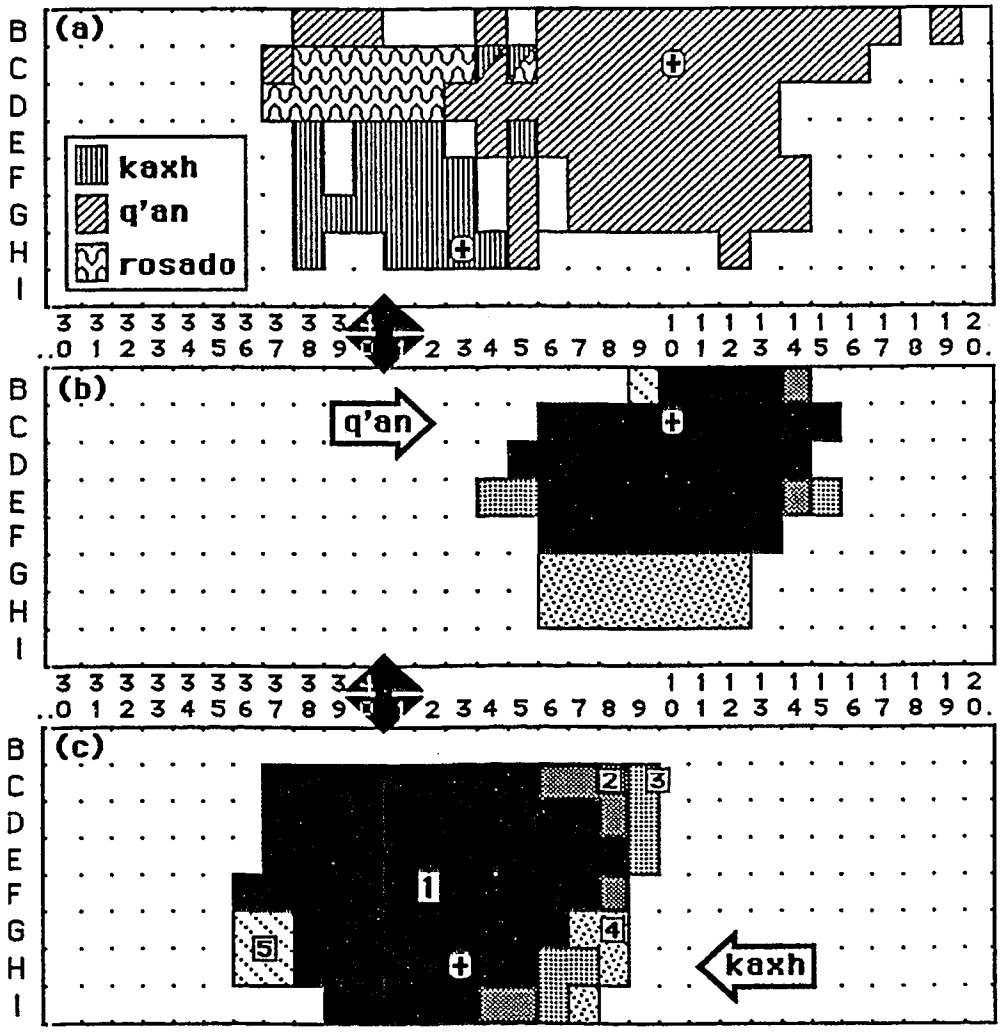
Figures 7.9a-c. Naming ranges (a) and mappings (b-c), speaker #5 (cf. Table 6.1), Jacaltec, Jacaltenango, woman, age 50, 1980.

The Jacaltec speaker of Figures 7.9a-c demonstrated coextensivity with naming responses at G37, E4, and C8-9. The dominant-recessive relationship is well advanced toward transformation to *inclusion* by retraction of the recessive vantage, focused on unique yellow at C9.



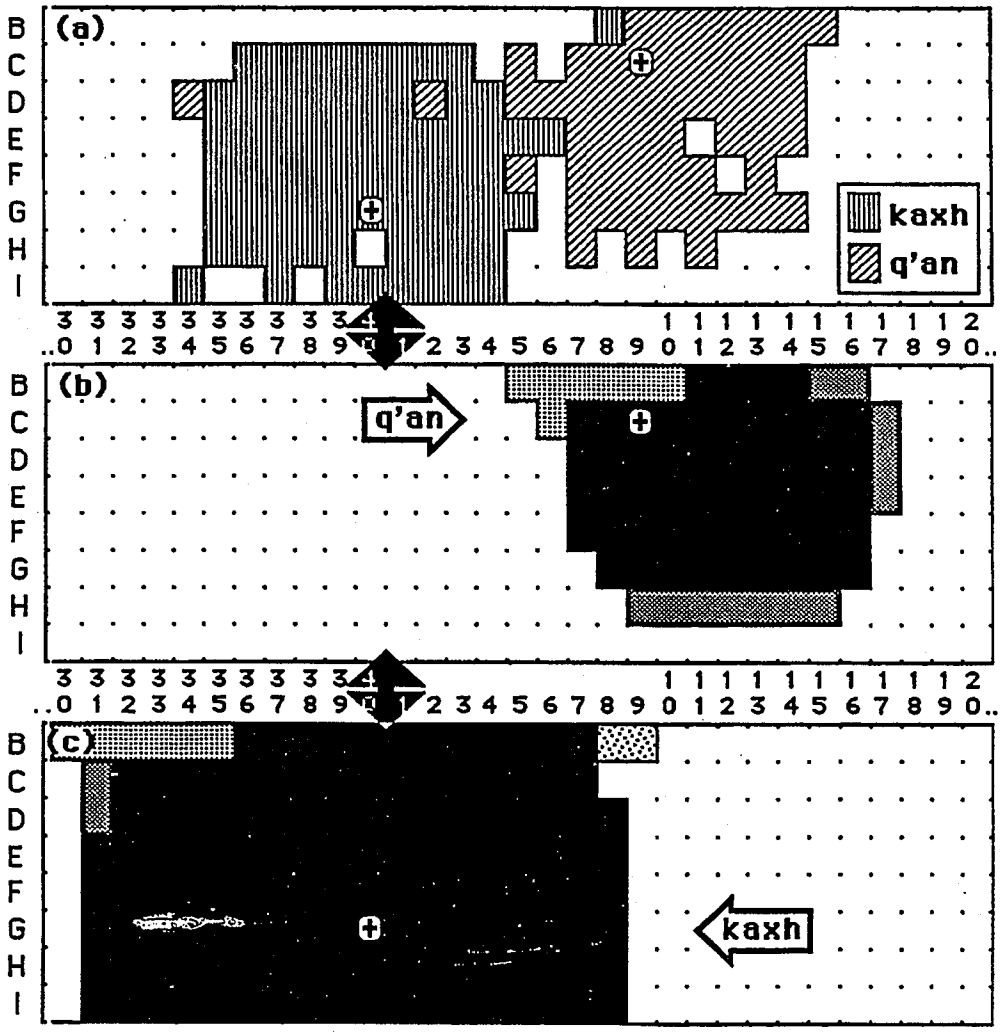
Figures 7.10a-c. Naming ranges (a) and mappings (b-c), Jacaltec, Jacaltenango, woman, age 86, 1980.

The Jacaltec speaker of Figures 7.10a-c showed no evidence of coextensivity. The mapping of the superordinate category, centrally focused at F3, scarcely covers unique yellow, C8-9. In contrast, the subordinate category shows polarization in its mapping to column 16 and its focus at C10.



Figures 7.11a-c. Naming ranges (a) and mappings (b-c), Jacaltec, Jacaltenango, man, age 37, 1980.

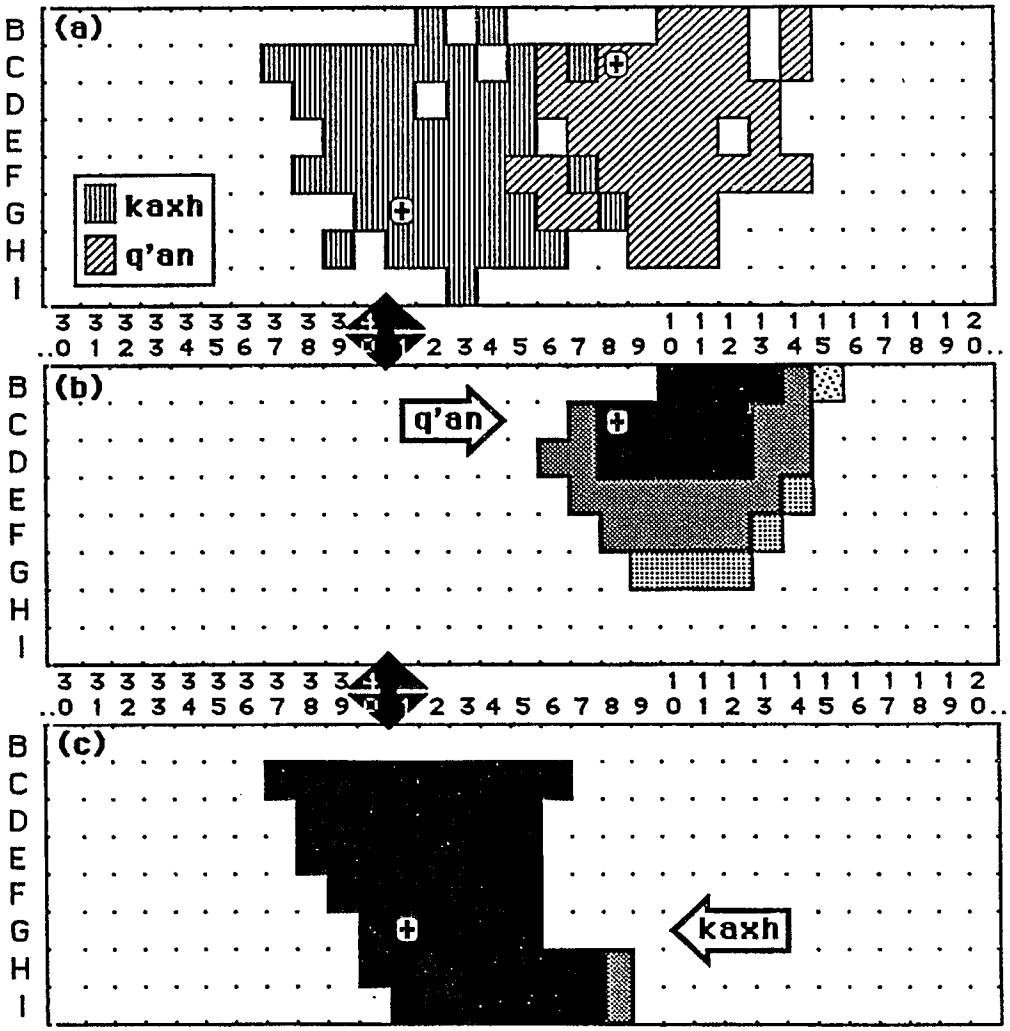
The Jacaltec speaker of Figures 7.11a-c showed further retraction of the superordinate category; only its second and third mapping steps cover unique yellow, C8-9. Moreover, the foci of *both* the superordinate *and* the subordinate category are polarized at H3 and C10.



Figures 7.12a-c. Naming ranges (a) and mappings (b-c), Jacaltec, Jacaltenango, woman, age 42, 1980.

The Jacaltec speaker of Figures 7.12a-c had barely accomplished the transformation from *inclusion* to *complementation*. Her mapping of the red category stops just short of unique yellow, C8-9. The red-category focus is polarized at G40, although the yellow-category focus is on the unique hue at C9.

The Jacaltec speaker of Figures 7.13a-c (page 228) showed fully developed *complementation*. The mappings of the red and yellow categories cover no colors in

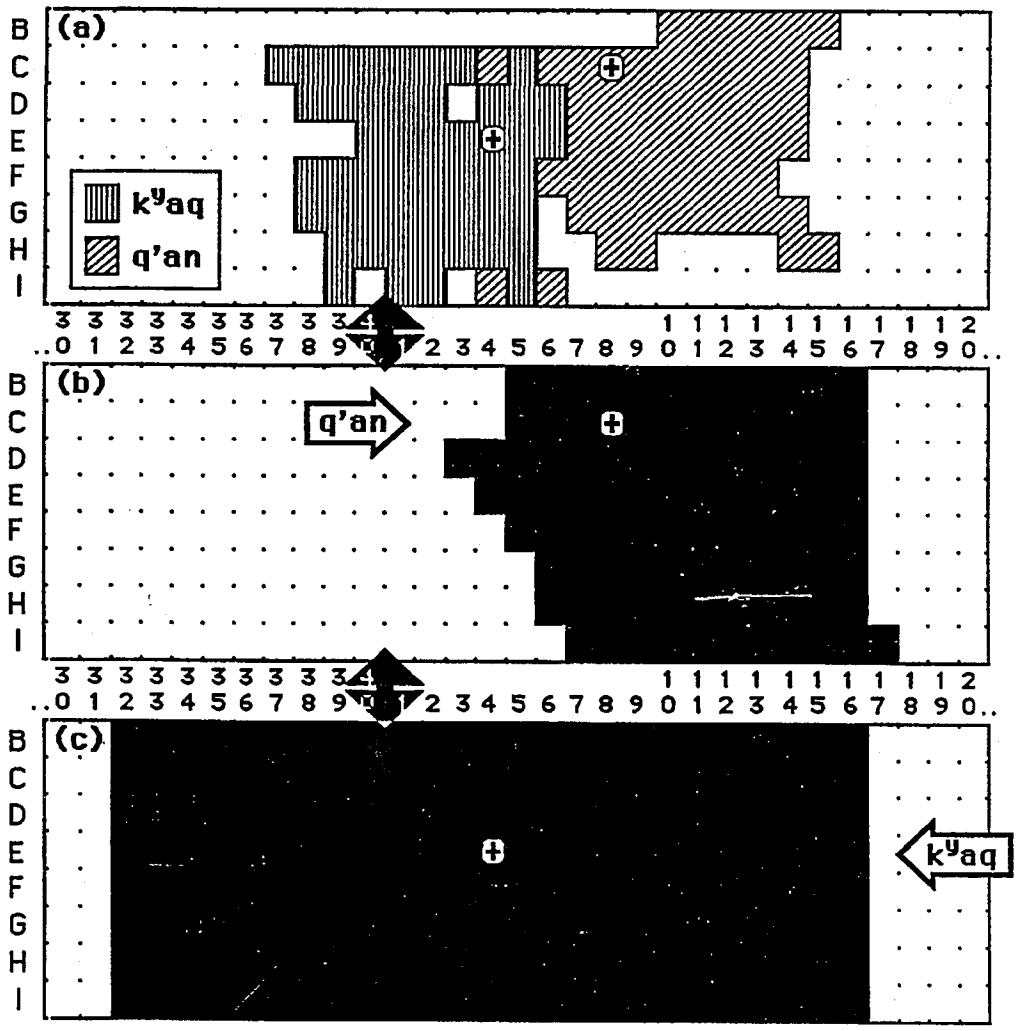


Figures 7.13a-c. Naming ranges (a) and mappings (b-c), Jacaltec, Jacaltenango, man, age 43, 1980.

common, and each is focused on a unique hue, G1 and C8.

The data from five Jacaltec speakers suggest an evolution of semantic types from dominant-recessive coextensivity, through inclusion, to complementation. In the middle phases, the correspondences that characterize dominant-recessive coextensivity give way to unpredictable polarization of foci in either the superordinate or the subordinate category, or in both.

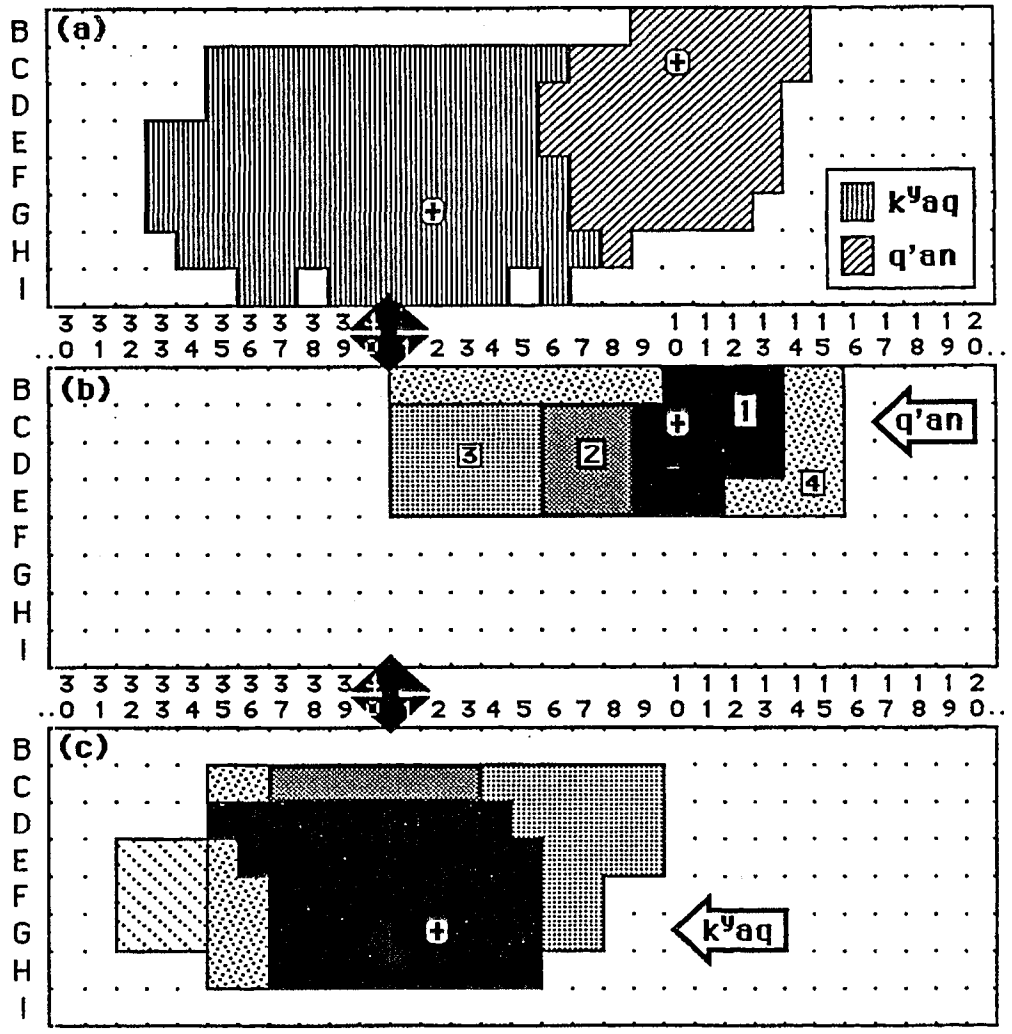
Figures 7.14a-19d exemplify further the relationship of inclusion between a superordinate warm category that is focused in reference to red and a subordinate yellow category. All cases involve polarization of at least one focus -- extreme polarization, in some cases -- except that of Figures 7.14a-c:



Figures 7.14a-c. Naming ranges (a) and mappings (b-c), Mam (Teco), Tichumel, Tectitlán, woman, age 50, 1980.

In Figures 7.14a-c, a Tectitlán Mam speaker appears to have used a superordinate category with a centralized focus at E4 and a subordinate category focused on unique yellow at C8. There is no evidence of coextensivity, although the completion of each

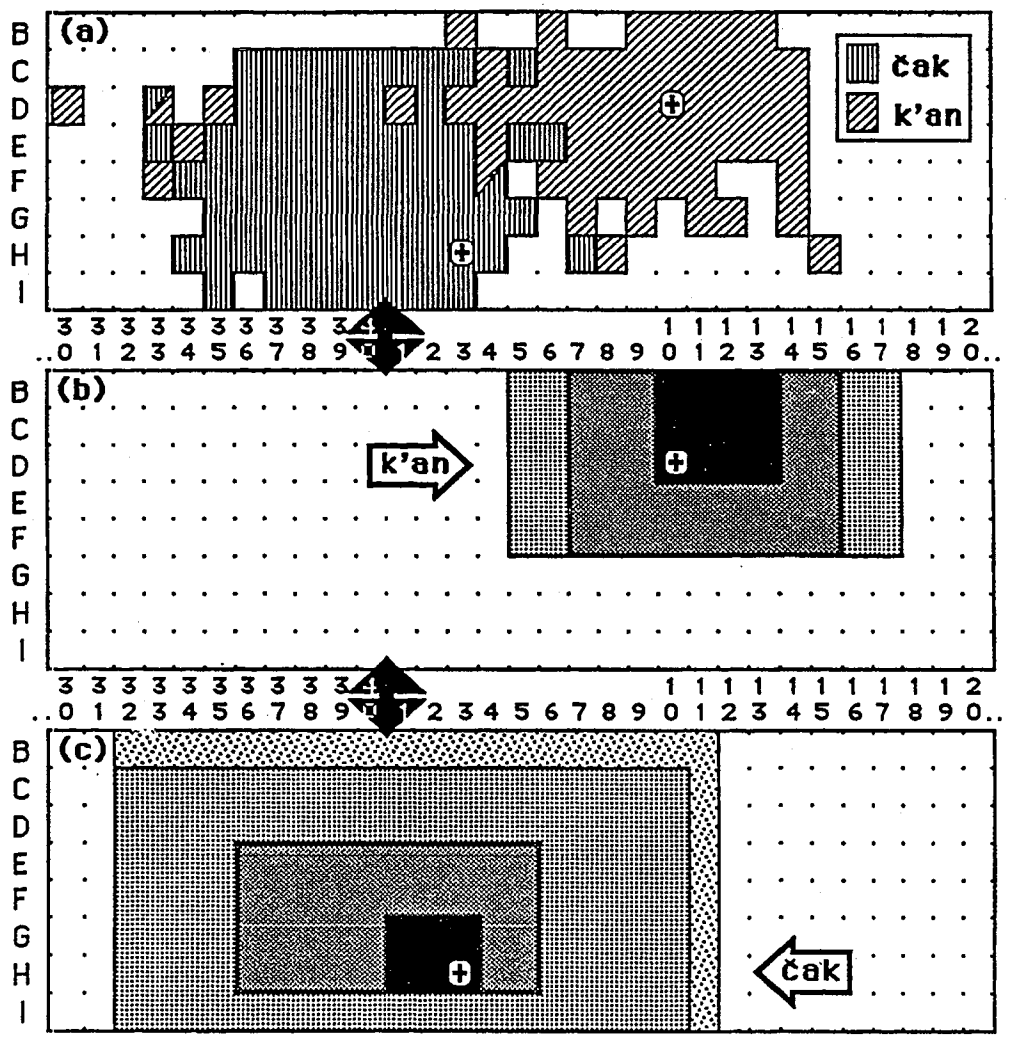
mapping in just one step is unusual; it hints that the yellow-focused term might not have been fully mapped.



Figures 7.15a-c. Naming ranges (a) and mappings (b-c), Mam, San Ildefonso Ixtahuacán, woman, age 56, 1980.

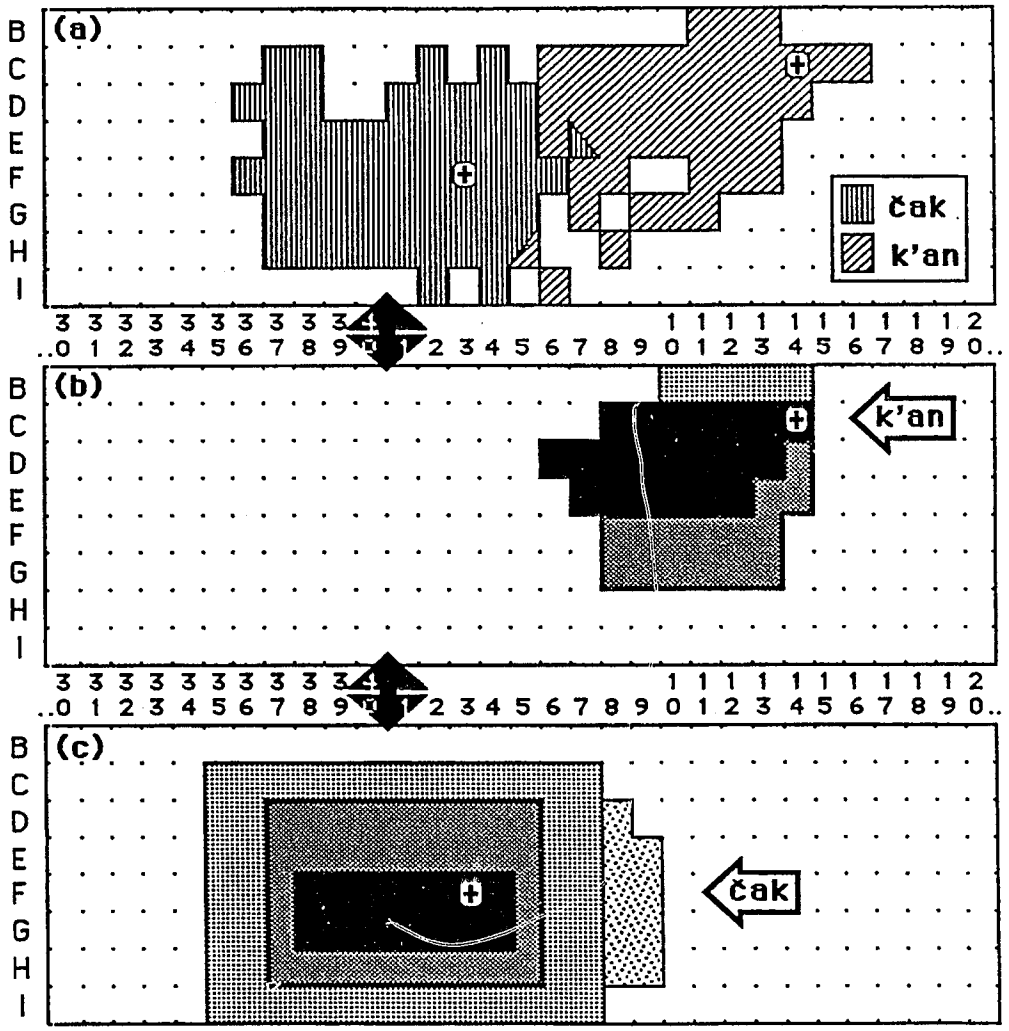
In Figures 7.15a-c, a San Ildefonso Ixtahaucán Mam speaker has mapped the red-focused superordinate category through unique yellow, C8-9; and she has polarized both the focus and the first mapping step of the subordinate yellow category.

Figures 7.16a-17c display data from two Chuj speakers that contrast a late phase of *inclusion* against an early phase of *complementation.* Both sets exhibit polarization:



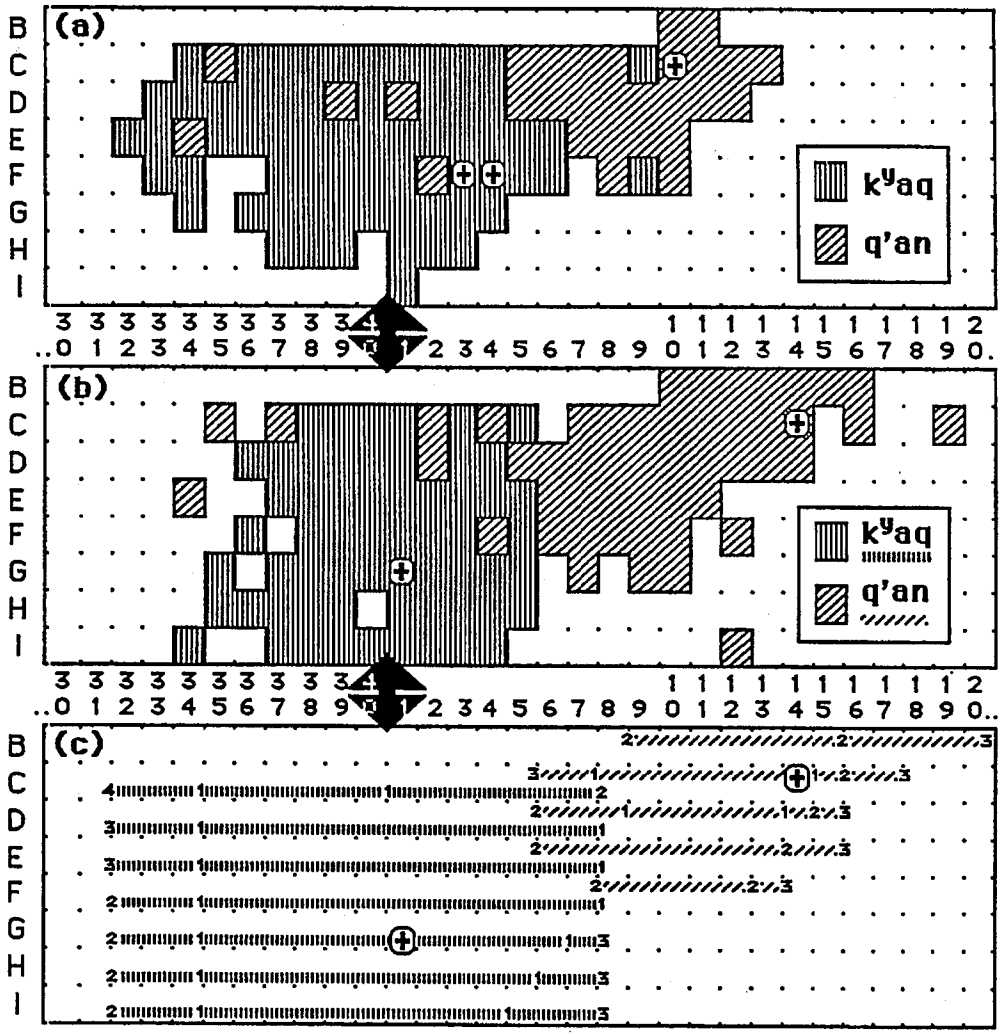
Figures 7.16a-c. Naming ranges (a) and mappings (b-c), Chuj, San Sabastián Coatán, man, age 30, 1980.

In Figures 7.16a-c, a Chuj speaker showed a relationship of inclusion that involves mutually polarized foci and a polarized first mapping step of the subordinate yellow category.



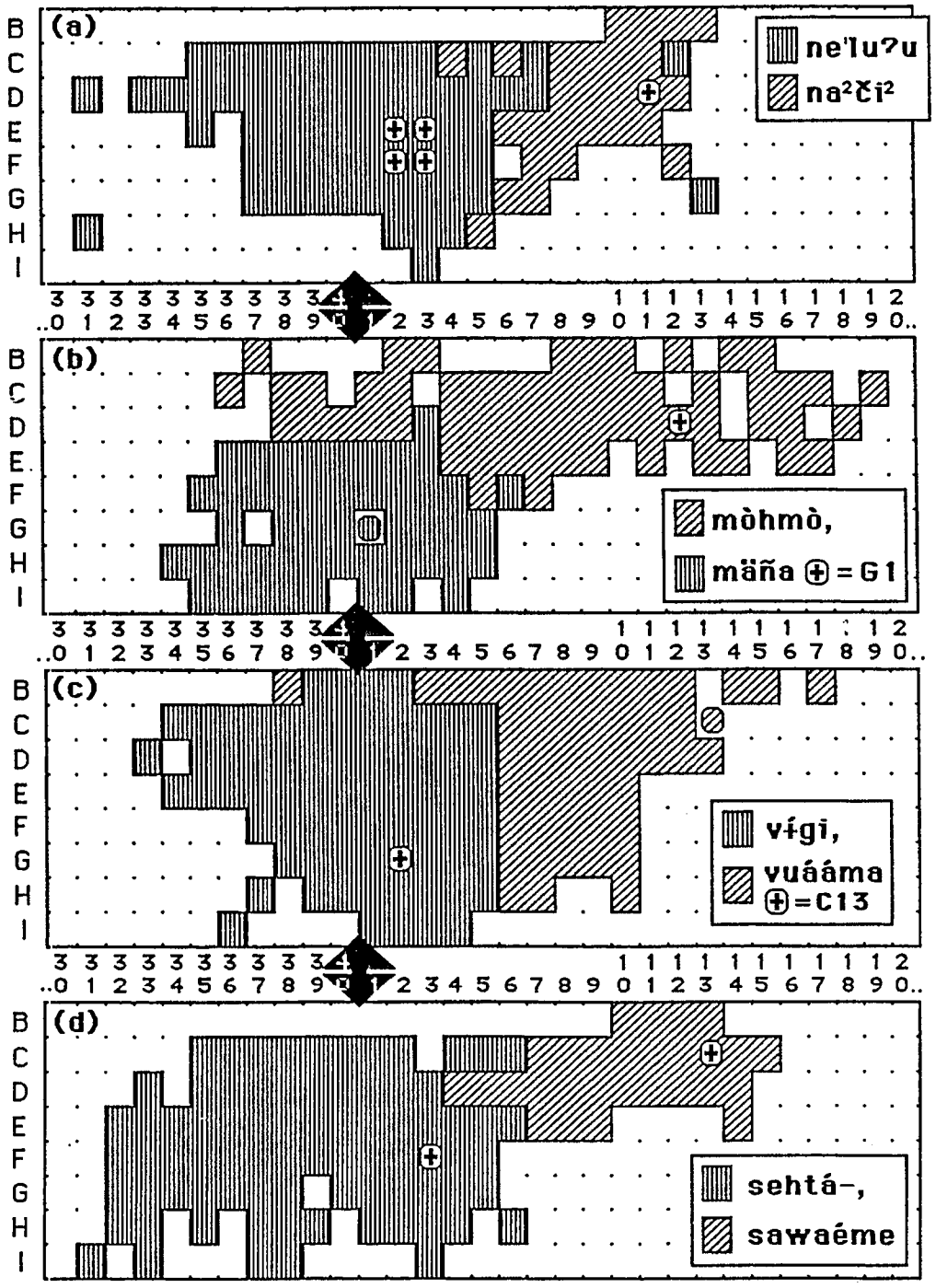
Figures 7.17a-c. Naming ranges (a) and mappings (b-c), Chuj, San Sabastián Coatán, man, age 70, 1980.

In Figures 7.17a-c, a second Chuj speaker showed a relationship of complementation between the red-focused and yellow-focused categories. He mapped the red category only to C7, short of unique yellow at C8-9. However, he strongly polarized both the mapping and the focus of the yellow category. The polarization suggests that complementation was at an early phase. The exaggeration of differences that accompanied category division was maintained just after the division had been completed.



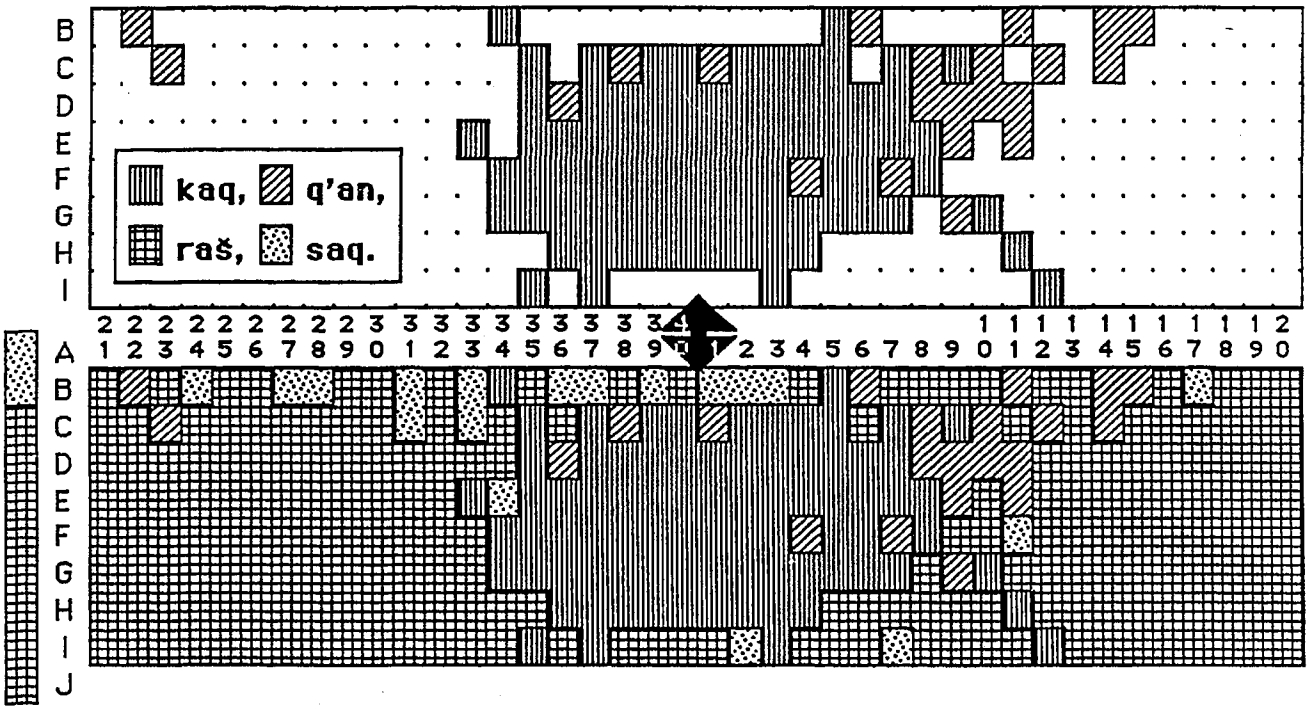
Figures 7.18a-c. Naming ranges (a-b) and mappings (c) Aguacatec, Aguacatán, (a) woman, age 20, 1978, (b-c) man, (b) age 19, 1978, (c) 1980.

In Figure 7.18a, naming ranges of an Aguacatec speaker suggest coextensivity; a dominant-range focus is centralized at F3-4 and a recessive-range focus is polarized at C10. In Figures 7.18b-c, a second speaker demonstrated a relationship of complementation; the yellow-category focus is extremely polarized at C14. In Figures 7.18a and 5.4a-d, Aguactec speakers of ages 20 and 41 assigned dominance to the red-focused range; in Figures 7.4a-c and 6.14a-b, speakers of ages 60 and 74 assigned the same in reference to yellow.



Figures 7.19a-d. Naming ranges and foci; (a) Zapotec, Santa María Lachixío, woman, age 60±, 1979; (b) Tlapanec, Malinaltepec, woman, age 45, 1978; (c) Northern Tepehuán, woman, age 31, 1981; (d) Guarajío, woman, age 20, 1978. Comment on page 235.

In Figures 7.19a-d (page 234), speakers of two Otomanguean (a-b) and two UtoAztecan (c-d) languages have shown extreme polarization of the yellow category, in either a relationship of inclusion (a) or apparent complementation (b-d).



Figures 7.20a-b. Naming ranges, K'ekchí, Lanquín, man, age 50, 1980.

Figures 7.20a-b display just the naming ranges of a K'ekchí speaker; foci were not elicited and mappings were curtailed. The K'ekchí speaker named all colors with only four terms, but in ranges that are exceptionally broad in comparison to most of those from Mayan languages in the Mesoamerican sample. The ranges suggest that *kaq* named a superordinate warm category; the naming range of a yellow category is polarized, subordinate, and sparser than that of any other yellow-focused range in the sample from a Mayan-language speaker.

A major characteristic of inclusion is polarization, which is caused by a stronger attendance to distinctiveness than that which fosters coextensivity. The polarization that characterizes inclusion differs from the coextensive pattern of polarization, in which the

focus of the recessive vantage is polarized while the focus of the dominant vantage is centralized (cf. Table 6.1). Figures 7.1a-7.19a display 24 cases of inclusion, 12 of which manifest the pattern of foci that is typical of coextensivity and 12 of which do not. Some of the former might be coextensive (cf. Figures 7.14a-c), although naming ranges and mappings do not reveal it. Of the latter, three show mutually polarized foci (cf. Figures 7.8c, 7.11a, 7.16a), and 9 show one focus on a unique hue and another that is polarized either moderately (cf. Figures 7.2, 7.3, 7.6, 7.15a) or extremely (Figures 7.4a-b, 7.7c, 7.7d, 7.8b, 7.12a).

There is one unusual case of a superordinate warm category whose focus is extremely centalized (cf. Figures 7.7b). For the present, this and the less pronounced cases of the same pattern are unexplained (cf. Figures 7.3, 7.7a, 7.19a). In section 7.0 under item 7., a notion is addressed that eventually might provide an explanation: the vantages of the four ideal semantic types might be constituted by distinct combinations of coordinates; intermediate types might involve different combinations within each vantage. The cases of inclusion that show a centralized focus of the superordinate category might be intermediate in this way: the coordinates of the superordinate category are combined as are those of a dominant coextensive vantage, that is, the attendance to similarity with a unique hue; the coordinates of the subordinate category are combined as they usually are in a single-vantage category, that is, both attendances with one unique hue.

A semantic relationship of "contrast" might be intermediate to inclusion and complementation; for example, Figures 7.2a-8c, 7.10a-12c, 7.15a-17c, 7.18b-20d. See section 7.0., item 6., for discussion.

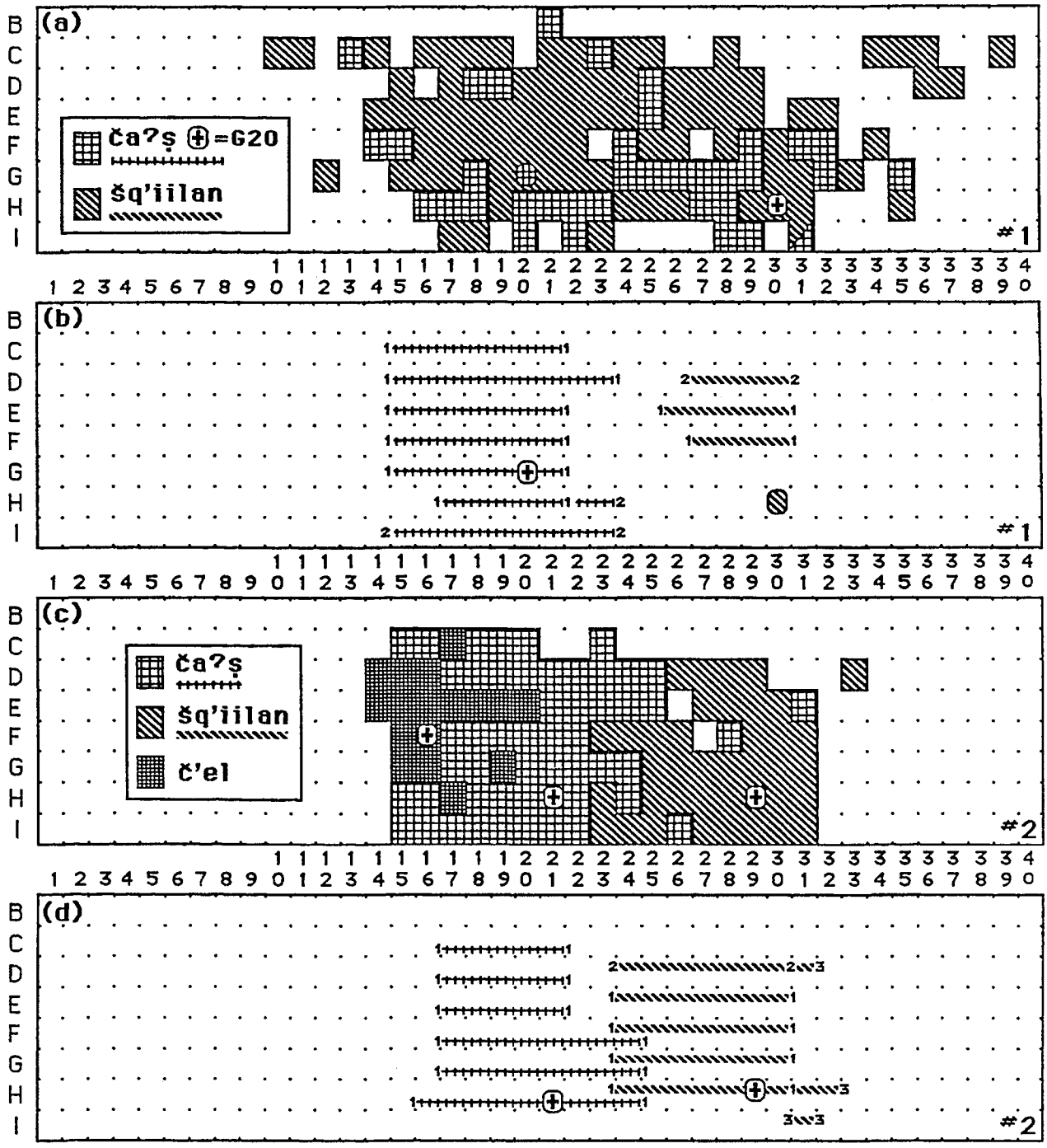
7.2. The Cool Category: A Case of "Crossover"

During division of the cool category, the coextensive relationship assumes a different form than it does during division of the warm category. When the warm category divides, one or both of the coextensive vantages become polarized; then they retract toward their foci one-after-the-other and pull apart in opposite directions. But when the cool category divides, the following can occur: (1) the naming range and/or mapping of each coextensive term is confined to just one side of the category, to green or to blue. (2) The naming range and the mapping of one term can be confined to opposite sides of the category, and its focus can apply to either side. (3) The naming range, mapping, and/or focus of the opposite term also can be mismatched, and this mismatching can occur in a pattern that is the inverse of that pertaining to the first term. For example, one term might be applied to green and mapped on blue, while the other is applied to blue and mapped on green; their foci might be placed anywhere. The result is a double mismatching of naming ranges and mappings that is crossed over between vantages.

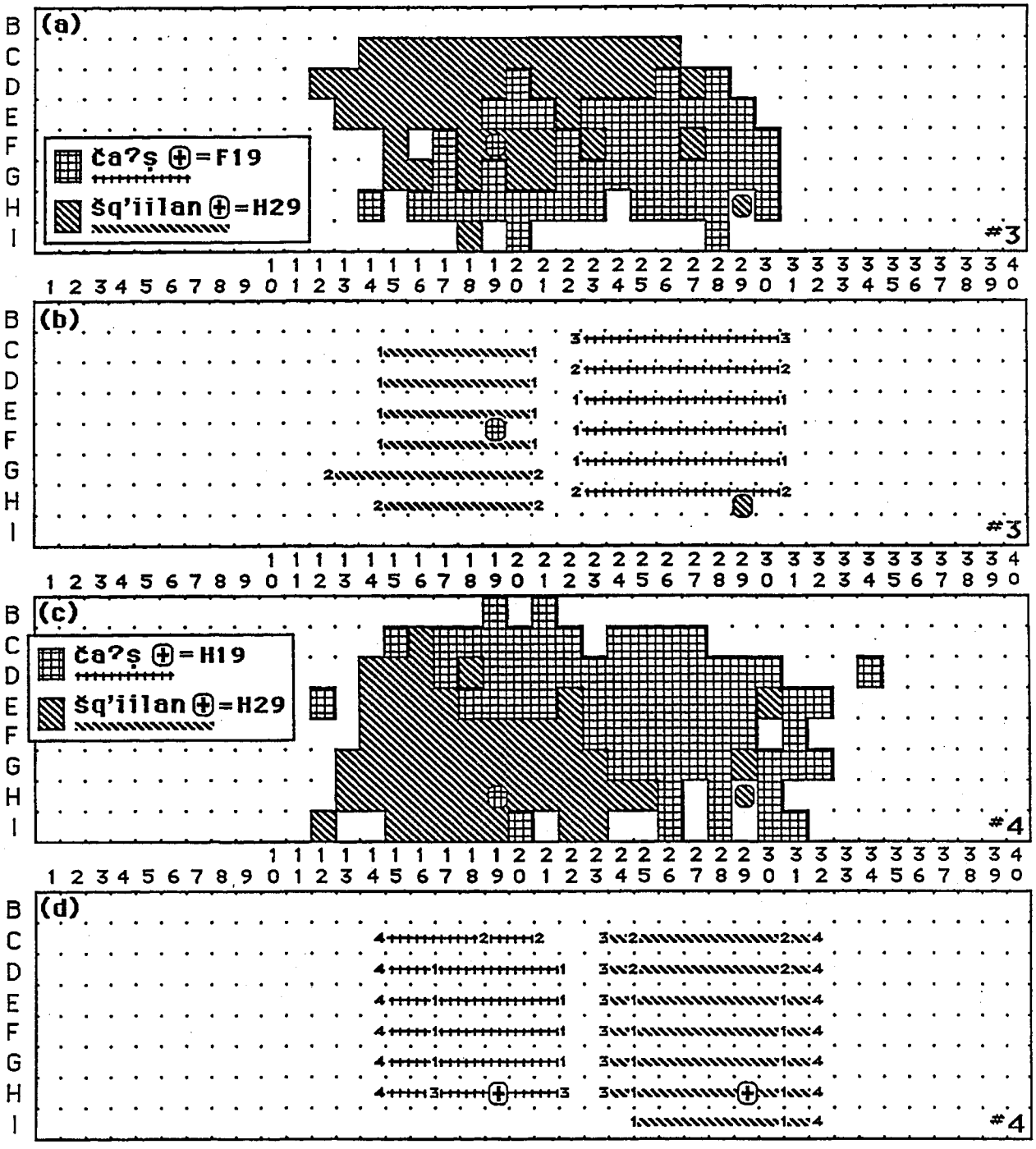
The double crossover of data appears chaotic. It differs markedly from the orderly progression of polarization that typifies the division of the warm category.

Figures 7.21a-7.25c (pages 238-42) display naming ranges, mappings, and foci from ten speakers of San Ildefonso Ixtahuacán Mam. All were younger than age 50 and all used separate red and yellow categories. At least nine of them coextensively composed the cool category. The confinement of naming ranges and mappings to the green or blue side of the cool category itself implies that each speaker attended strongly to the distinctiveness of these colors. It also suggests that the cool category was dividing throughout the generation of speakers younger than age 50.

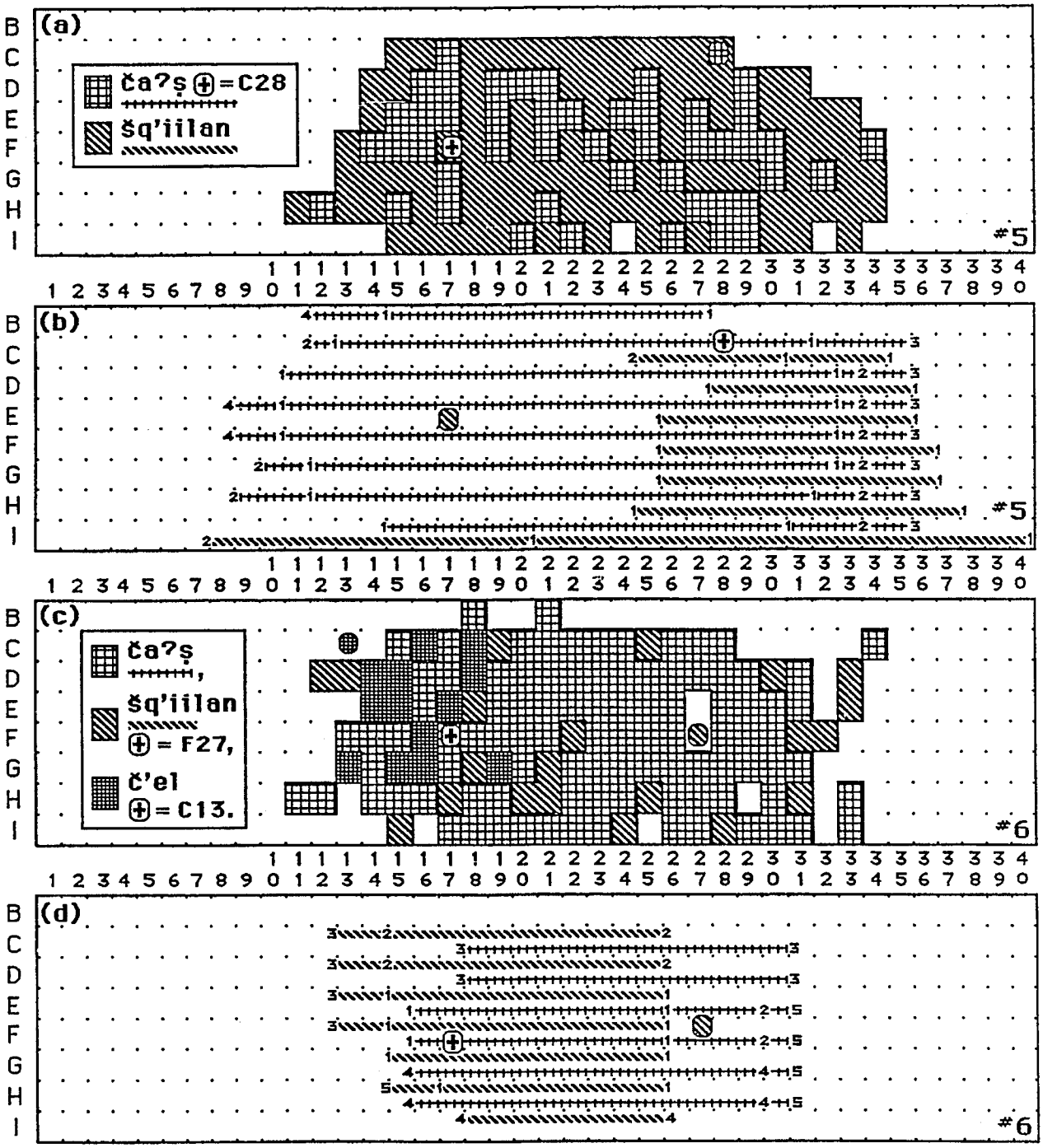
In Figures 7.21a (page 238), Mam speaker #1 demonstrated coextensivity with his use of intermixed naming ranges. But in Figure 7.21b, he mapped each range on an opposite side of the cool category. These mappings clearly exemplify the tendency to



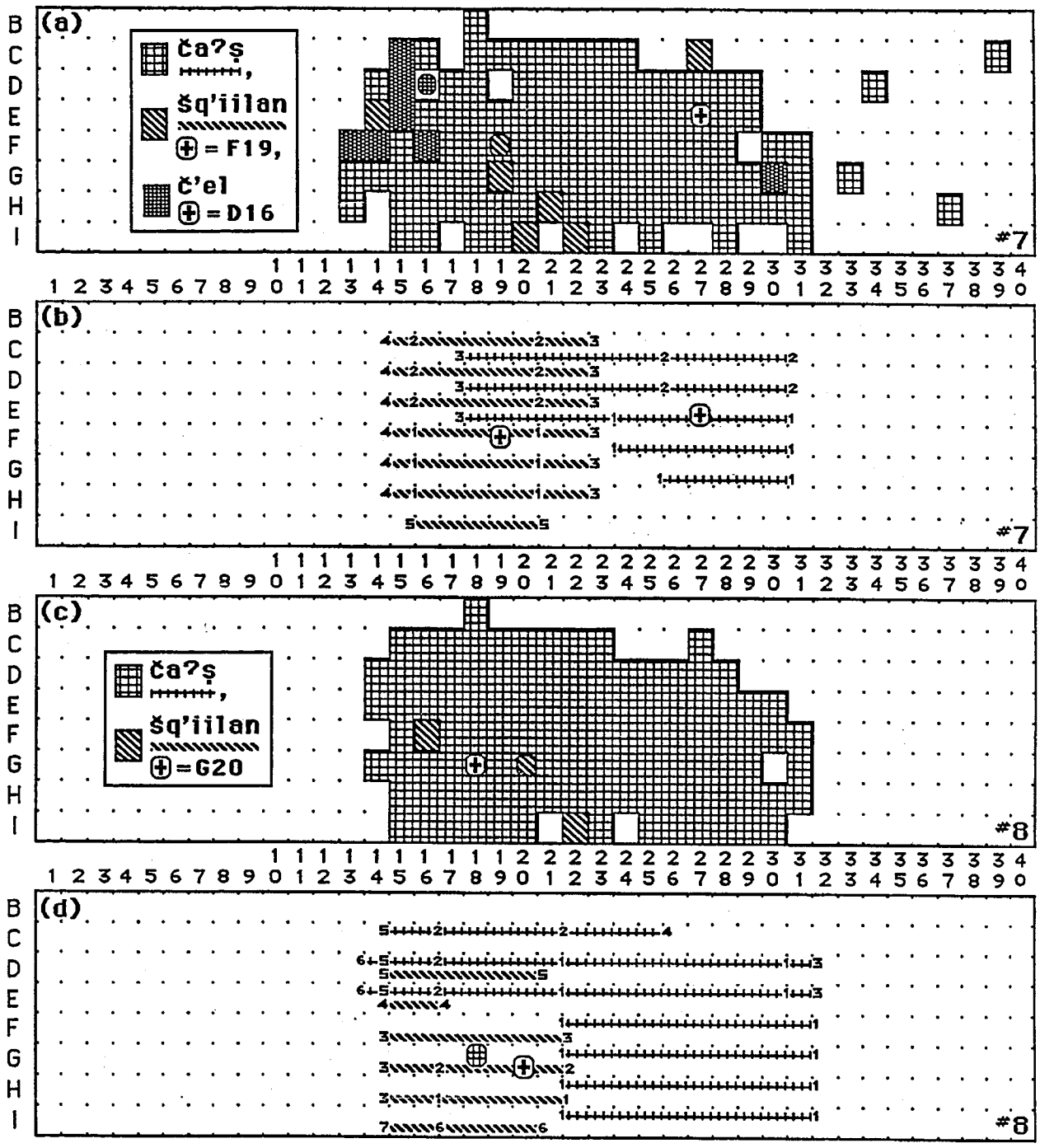
Figures 7.21a-d. Naming ranges (a, c) and mappings (b, d), Mam, San Ildefonso Ixtahuacán, 1980; (a-b) speaker #1, man, age 48, (c-d) speaker #2, man, age 40.



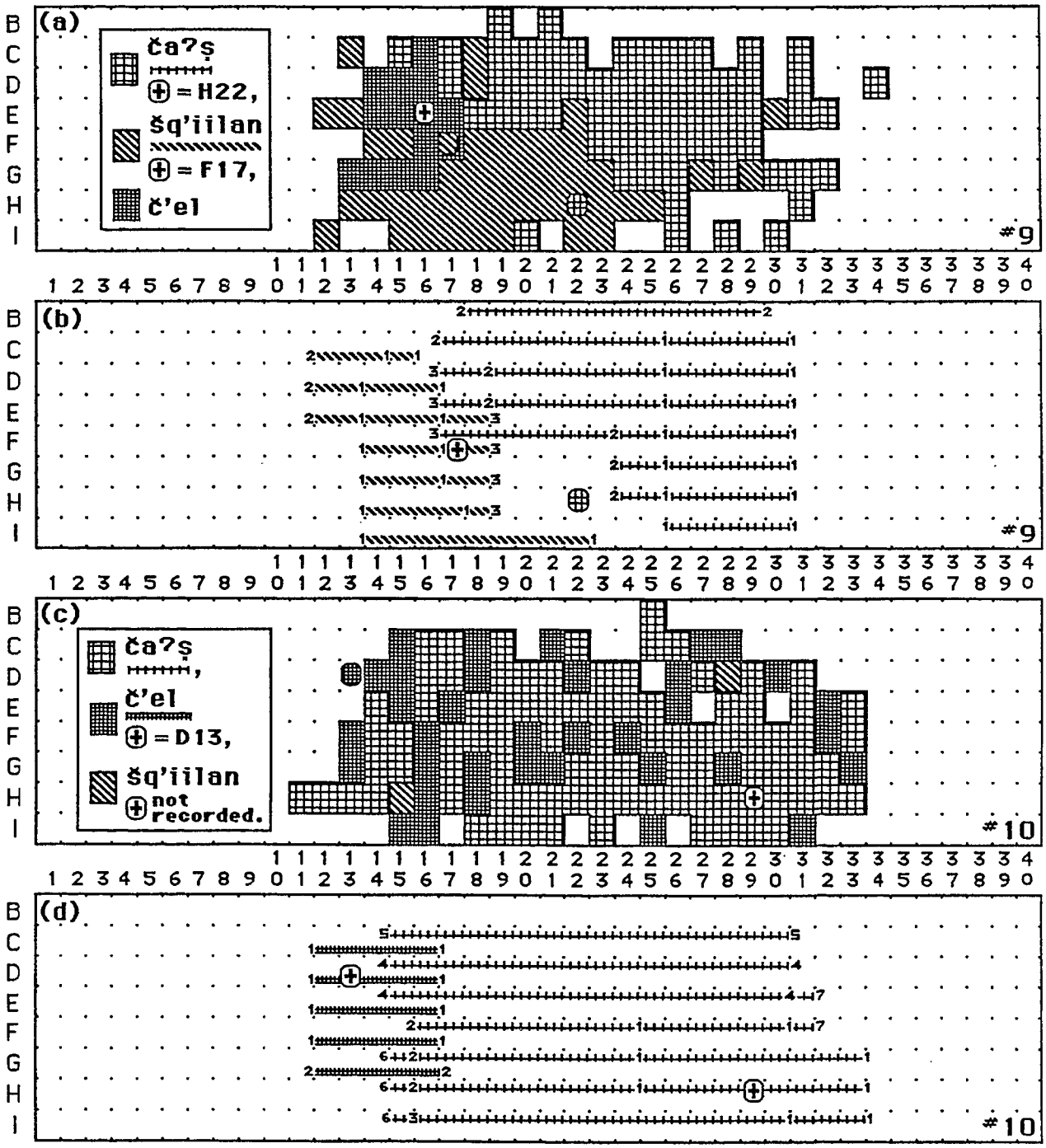
Figures 7.22a-d. Naming ranges (a, c) and mappings (b, d), Mam, San Ildefonso Ixtahuacán, men, 1980; (a-b) speaker #3, age 38, (c-d) speaker #4, age 48.



Figures 7.23a-d. Naming ranges (a, c) and mappings (b, d), Mam, San Ildefonso Ixtahuacán, men, 1980; (a-b) speaker #5, age 42, (c-d) speaker #6, age 35.



Figures 7.24a-d. Naming ranges (a, c) and mappings (c, d), Mam, San Ildefonso Ixtahuacán, 1980; (a-b) speaker #7, woman, age 49, (c-d) speaker #8, man, age 26.



Figures 7.25a-d. Naming ranges (a, c) and mappings (b, d), Mam, San Ildefonso Ixtahuacán, women, 1980; (a-b) speaker #9, age 32, (c-d) speaker #10, age 29.

confine data concerning a coextensive range to one side of a category, even though naming ranges of the same individual attest beyond a doubt that coextensivity was maintained.

In Figures 7.21c-d, Mam speaker #2 predominantly confined both naming ranges and mappings to opposite sides of the cool category, confining those of *čaʔṣ* to green and those of *šq'iilan* to blue. The mappings and foci of speakers #1 and #2 are much alike. In Figure 7.21c, uses of *čaʔṣ* at D31, F28, and I26 are the only evidence that speaker #2 maintained the cool category. The data suggest *inclusion* rather than coextensivity. Their major implication derives from their comparison with the data of speakers #3 and #4:

Figures 7.22a-d show that speakers #3 and #4 predominantly applied *čaʔṣ* to blue and *šq'iilan* to green. This pattern of naming is the opposite of that used by speaker #2, Figure 7.21c. Yet speakers #s1, 2, 3, and 4 focused the two words in almost the same way.

Figures 7.22a-d also show that speakers #3 and #4 differed from each other. In Figure 7.22a-b, speaker #3 matched the predominant naming range of each term with its mapping, *šq'iilan* in green and *čaʔṣ* in blue. The mappings and naming ranges mismatch the foci. However, in Figures 7.22c-d speaker #4 applied the naming range of *šq'iilan* to green, but he mapped and focused the term in blue; he applied the naming range of *čaʔṣ* to blue, but he mapped and focused the term in green.

Speakers #3 and #4 showed, in various combinations, a crossed over mismatching between the three orders of data. The mismatching is seen, further, as a disagreement between individuals; for example, speaker #2 differed from speaker #3, and speaker #3 differed from speaker #4. Mismatching of independently elicited data both within and between individual performances accompanied the tendency to confine to opposite sides of the cool category data concerning, specifically, coextensive vantages.

In Figures 7.23a-d, the naming ranges of speakers #5 and #6 further demonstrate coextensivity. Speaker #5 confined the mapping of *šq'iilan* to blue and focused the term in

green at E17. Speaker #6 confined the mapping of *šq'iilan* to green and focused the term in blue at F27. Both mapped *ča?ṣ* throughout green and blue, although speaker #5 focused *ča?ṣ* in a polarized position in blue at C28 and speaker #6 focused *ča?ṣ* on unique green at F17. Again, two individuals exhibited opposite patterns of confining to one side of the cool category data concerning coextensive ranges.

In Figures 7.24a-d, the naming ranges of speaker #7 show little evidence of coextensivity and those of speaker #8 show none. Their mappings roughly agree with each other. However, speaker #7 focused *ča?ṣ* in blue at E27 and speaker #8 focused the term in green at G18. Both mapped *šq'iilan* on the opposite side of the category as did speakers #S 2-5, but on the same side as did speakers #S 1 and 6. The mismatching between individuals suggests that speakers #S 7 and 8 also maintained coextensivity, even though their naming ranges do not show it.

In Figures 7.25a-d, speakers #S 9 and 10 evidence coextensivity in their naming ranges. Speaker #9 mapped and focused the two terms in a pattern similar to that shown by speaker #8. Speaker #10 showed a probable case of triple coextensivity, with uses of *šq'iilan* at just H15 and D28 and uses of *ča?ṣ* and *č'el* throughout the cool category. However, the mapping and focus at D13 of the latter term is polarized and confined specifically to chartreuse shades of green. The tendency to confine data pertains to any name of the cool category whose range is coextensive, that is, to coextensivity *per se* and not just to the ranges of *ča?ṣ* and *šq'iilan.*

The speakers of San Ildefonso Ixtahuacán Mam presented the only case in the Mesoamerican sample where members of a community both (a) widely share coextensivity in the cool category and (b) name each vantage with a different root. Furthermore, the tendency of different individuals to confine one or more orders of data to green or to blue suggests that most members of the current generation were dividing the cool category. Their data provide a rare and isolated opportunity to examine the effects of category

division on coextensivity within specifically the environment of green and blue. The data indicate the following (1-3):

(1) Crossing over and mismatching of data among individual responses and between speakers indicate that, at least, nine speakers associated each of the two terms with both sides of the cool category; almost all shared the coextensivity. This semantic relationship is overtly and independently demonstrated by the naming ranges of speakers #S1, 3-7, and 9-10.

(2) Confinement of data to one side of the cool category demonstrates a tendency to strongly differentiate blue and green. This tendency was also widely shared. It differs from cases in other communities where both coextensive ranges of a cool category were mapped thoughout unique green and unique blue with one or two mapping steps (cf. Figures 5.5b-c, 5.9b-c, 5.11b-c, 6.26b-c).

(3) Polarization is relatively rare; in strong form it occurred once at C28, speaker #5, Figures 7.23a-b. In weak form it occurred at H30, speaker #1, Figures 7.21a-b, and it occurred at D13 in chartreuse, speaker #10, Figures 7.25c-d, in association with a term that speakers #S 2, 6, and 9 used to name just chartreuse.

The contrast between seemingly chaotic data in the cool category and orderly data in the warm category during their respective divisions might be explained as follows:

Unique green and unique blue are preceived to be more alike than any other pair of unique hues. Consequently, the division of these colors into separate categories requires an exceptionally strong attendance to distinctiveness. *To divide the cool category, the inherently strong perception of similarity and the attendance to distinctiveness must contend at an enhanced strength.* Prior to category-division, the strength of the perception and of the cognition will be greater than those that pertain among red and yellow during division of the warm category.

The strong perception of similarity encourages an individual to maintain the cool category, it encourages continuation of the crossover effect, and it discourages

polarization. The strong attendance to distinctiveness encourages confinement of naming ranges and mappings just to green or to blue. The combination of crossover and confinement results in seemingly erratic mismatching of data and its inter-speaker variation.[1]

7.3 The Dark-Cool Category

Coextensively composed dark-cool categories are rare in the Mesoamerican sample. However, mirror-image relationships of inclusion among related languages -- like those seen in the warm category (sections 7.1.1-2.) -- suggest that coextensivity in the dark-cool category was once widely recurrent.[2] As in the warm category, a coextensively composed dark-cool category divides by, first, the retraction of one coextensive range and, later, the retraction of the other. In the interim, a relationship of inclusion prevails.

Although the data are sparse, a few cases suggest inconclusively that polarization of foci within dividing dark-cool categories is, perhaps, more common than among dividing cool categories. The final retraction of the superordinate dark-cool category is characterized by ambivalence: some individuals show the superordination in a naming range but not in a mapping, and others show it in a mapping but not in a naming range; naming ranges and mappings seldom agree. The final phase of retraction itself is hardly noticeable; it can be difficult to distinguish data that indicate a superordinate dark-cool category from data that support a relationship of complementation between a black category and a cool category.

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[1]Like the Tzotzil speaking village of Navenchauc (cf. section 4.2), San Ildefonso Ixtahuacán is adjacent to the Panamerican highway, built 30 years ago. And like the Tzotzil speakers, the Mam speakers were abruptly thrust into intensive contact with the world at large. Change in San Ildefonso might have occurred rapidly thereafter. The extent to which individuals mismatch data and disagree on a pattern might, in part, result from a pace of innovation that has disallowed the time to reach firm consensus.

Figures 9.1a-b display data from the cool category of an eleventh San Ildefonso Mam speaker who is six years older than any of the other ten. These data also evidence coextensivity, but the vantages are covert rather than overtly named with two terms.

[2]Hage and Hawkes (1975: 297), quoted in footnote 2, Chapter V, substantiate that coextensivity is maintained in the dark-cool category of Binumarien, a language of New Guinea.

The only two attestable cases in the Mesoamerican sample of coextensivity in the dark-cool category are displayed in Figure 7.8c (page 221) and Figure 7.26 by data from speakers of Paya and Tacaná Mam respectively. Both intermixed cool-focused and black-focused naming ranges and both placed the cool focus in a slightly polarized position on E30 at medium-high brightness, as though it were chosen in exaggerated opposition to the opposite focus on pure black. Both speakers accompanied the coextensively composed dark-cool category with a warm category, one of which involves a relationship of inclusion and the other coextensivity:

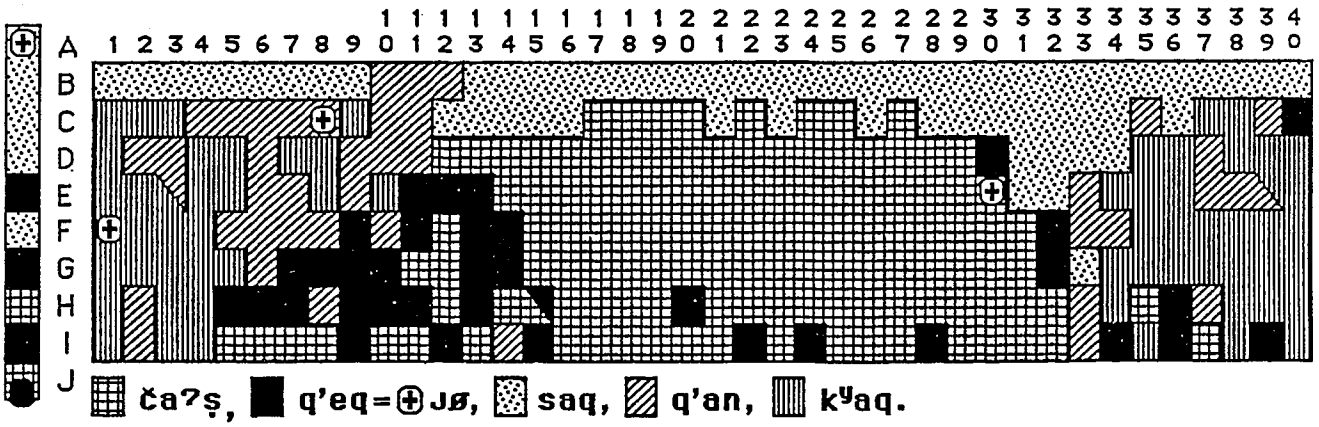
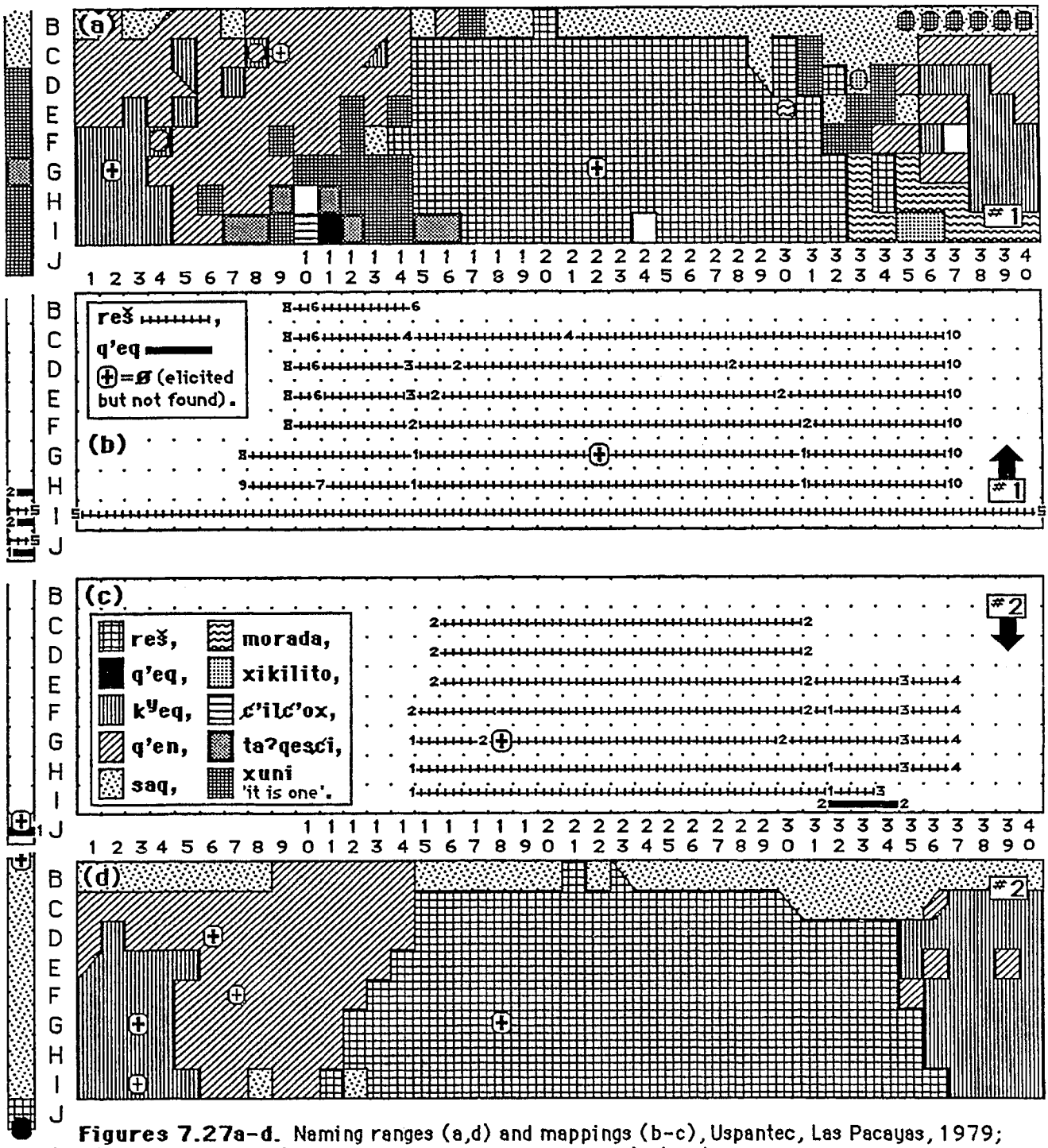


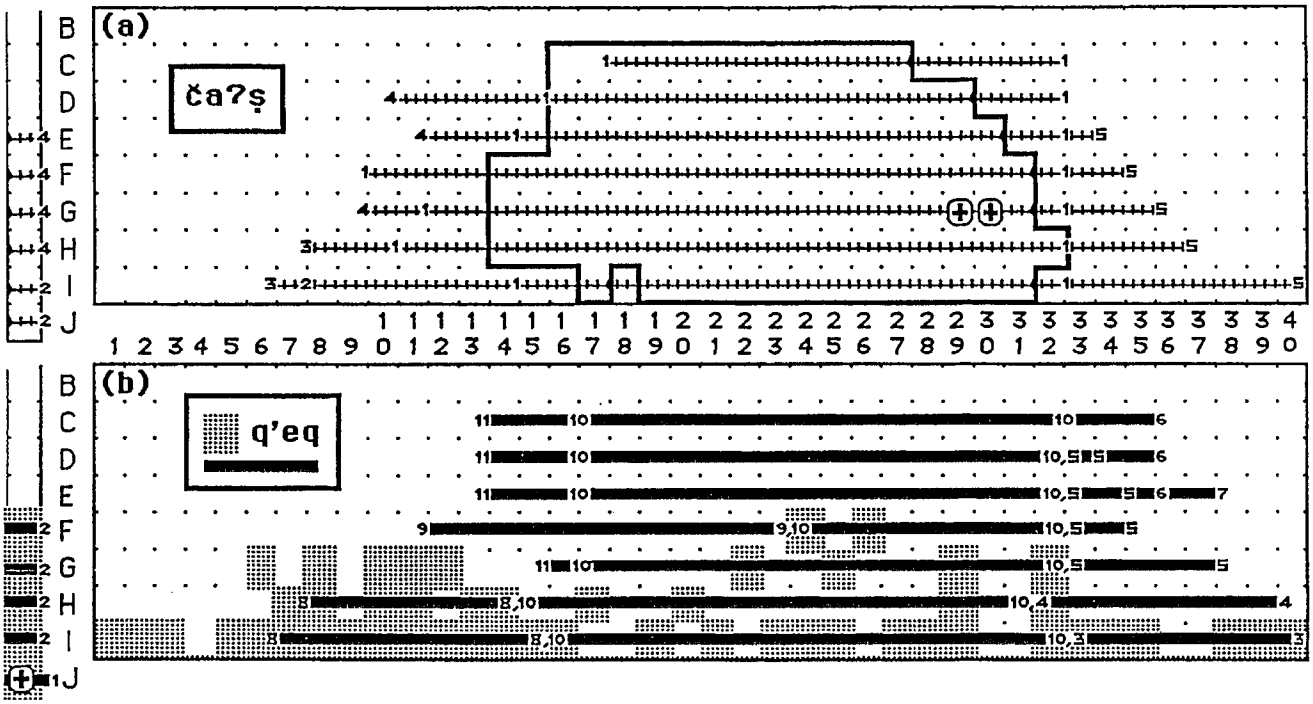
Figure 7.26. Naming ranges and foci, Mam, Tacaná, woman, age 60, 1979 (same speaker as in Figure 6.17c, reverse display).

The attested coextensivity in the dark-cool category is probably the predecessor of mirror-image patterns of inclusion: speakers of some languages included the cool category within the range of a black-focused dark-cool category; speakers of other languages included a black category within the range of a cool-focused dark-cool category. The mirror-image relationship is found among genetically related languages, such as Tzeltal Mayan and Uspantec Mayan. In section 4.1., the data of Figures 4.1a-4c document the way that four Tzeltal speakers related a superordinate black-focused dark-cool category and a subordinate cool category. Figures 7.27a-d (page 248) display the way that Uspantec speakers related a superordinate cool-focused dark-cool category and a subordinate black category:



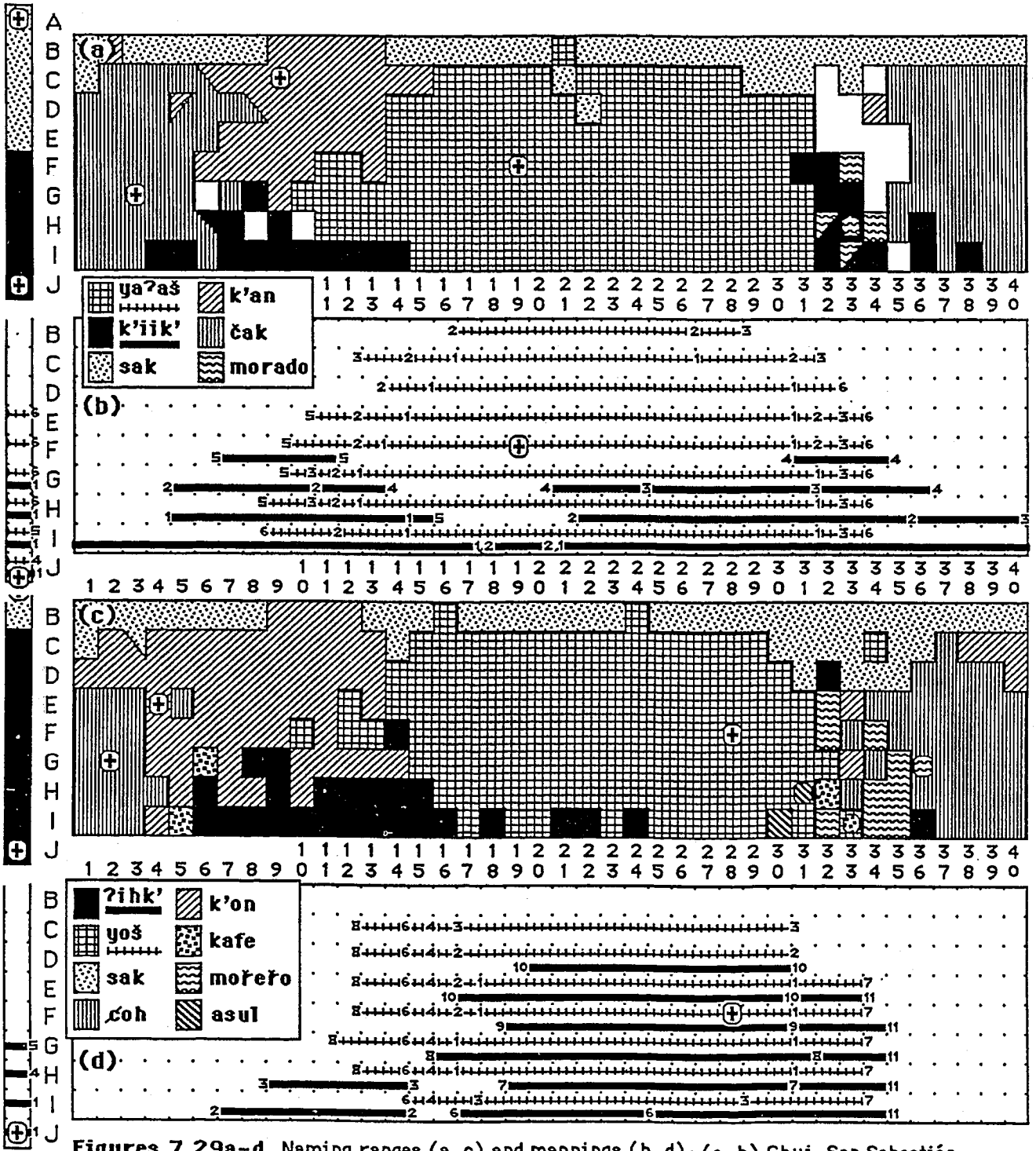
Figures 7.27a-d. Naming ranges (a,d) and mappings (b-c), Uspantec, Las Pacayas, 1979; (a-b) woman, age 70+ (same speaker as in Figures 6.6a-c), (c-d) man, age 58.

Eleven Uspantec speakers were interviewed in Las Pacayas, ages 30 to 80. Five of them -- ages 35, 60, 65, 78, and 80 -- mapped the cool-focused category throughout pure black of row J on the Munsell array, as did the woman of Figures 7.27a-b. Two of them -- ages 58 and 74 -- extended the cool-focused naming range to row J, as did the man of Figures 7.27c-d. Four of them -- ages 30, 35, 40, and 50 -- showed no evidence of a dark-cool category in naming ranges or mappings. None of the eleven demonstrated a dark-cool category in both naming ranges and mappings. The seven who showed some evidence of the cool-focused dark-cool category were older than age 58, except one at age 35. The four who showed no evidence were age 50 or younger. The sharing of the cool-focused dark-cool category by some Uspantec speakers is substantiated by recurrent evidence from 7 out of 11 independently conducted interviews and by the correspondence of these data with age.



Figures 7.28a-b. Naming ranges and mappings, Aguacatec, Aguacatán, men, 1978, 1980; (a) age 60 (same speaker as in Figures 6.14a-b), (b) age 79 (same speaker as in Figures 7.3a-c).

Figures 7.28a-b display mapping data with the naming range (a) in outline or (b) shaded from two Aguacatec speakers, who each maintained a dark-cool category. However, they showed a mirror-image pattern: one (a) named the dark-cool category with *čaʔṣ*, focused in blue at G29-30; the other (b) named the category with *q'eq*, focused at JØ in black. The words *čaʔṣ* and *q'eq* are cognates of terms that progressive speakers throughout Mayan languages use to name just the cool cateogry and just the black category respectively. This is the only case in the Mesoamerican sample in which individuals of one community showed the mirror-image pattern between dark-cool categories.



Figures 7.29a-d. Naming ranges (a, c) and mappings (b, d); (a-b) Chuj, San Sabastián Coatán, man, age 42, 1980, (c-d) Tzotzil, Navenchauc, woman, age 50, 1981.

Figures 7.29a-d (page 251) show cases of possible mirror-image relationships in which a dark-cool category is difficult to substantiate. In Figure 7.29a-b, a Chuj speaker mapped a cool-focused dark-cool category, but did not apply the 'cool' naming range to black. Unlike the Uspantec speakers (cf. Figures 7.27a-d), the Chuj speaker is the only individual who mapped a dark-cool category among the 11 who were interviewed in his community, San Sabastián Coatán. In Figures 7.29c-d, a Navenchauc Tzotzil speaker mapped a black-focused category in 10 steps to row D of the Munsell array, but not to rows C and B as did the Tzeltal speakers (cf. Figures 4.1a-4c). It appears that the Tzotzil speaker was in a final phase of retracting the superordinate dark-cool category toward its black focus. Other individuals from the same community, as in Figures 4.8-11a, also demonstrated a black-focused dark-cool category of low salience.

The data of Figures 7.29a-d reflect the indefinite character of the final phase of retraction during division of the dark-cool category. The superordinate range of the dark-cool category can retract without polarization.

Figures 7.30-32 (page 253) display three further cases of naming ranges that suggest a cool-focused dark-cool category:

In Figure 7.30, a Peñoles Mixtec speaker polarized the focus of the dark-cool category at C17. The polarization suggests coextensivity, although it is not evidenced by the black-focused naming range. The naming ranges of the warm category show a rare case of triple coextensivity (cf. Figure 6.17a); the Mixtec speaker had a penchant for that particular semantic relationship, at least among warm colors. Most Mixtec speakers used the cool-focused term to name only green and blue (cf. Figures 5.6-7c and 6.25a-b).

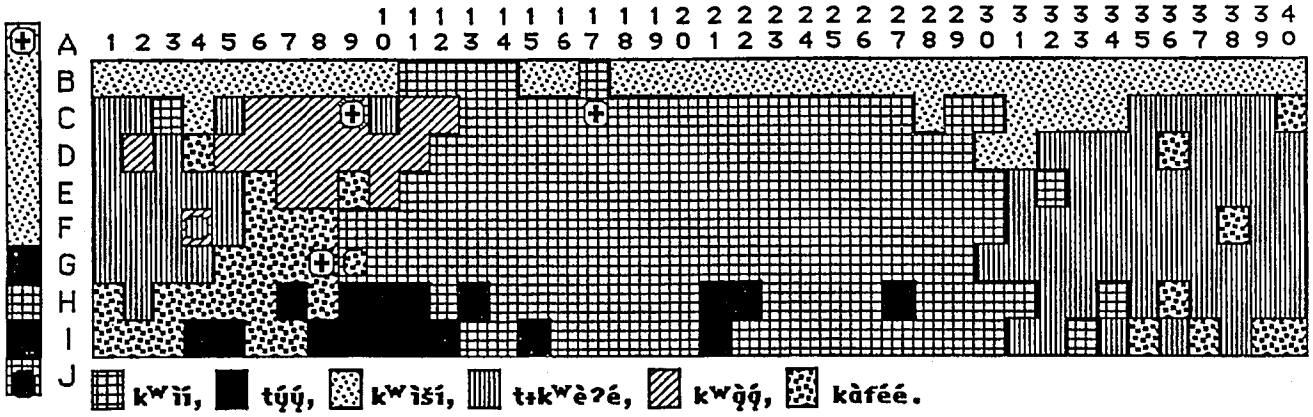


Figure 7.30. Naming ranges and foci, Mixtec, Peñoles, woman, age 50+, 1978 (same speaker as in Figure 6.17a).

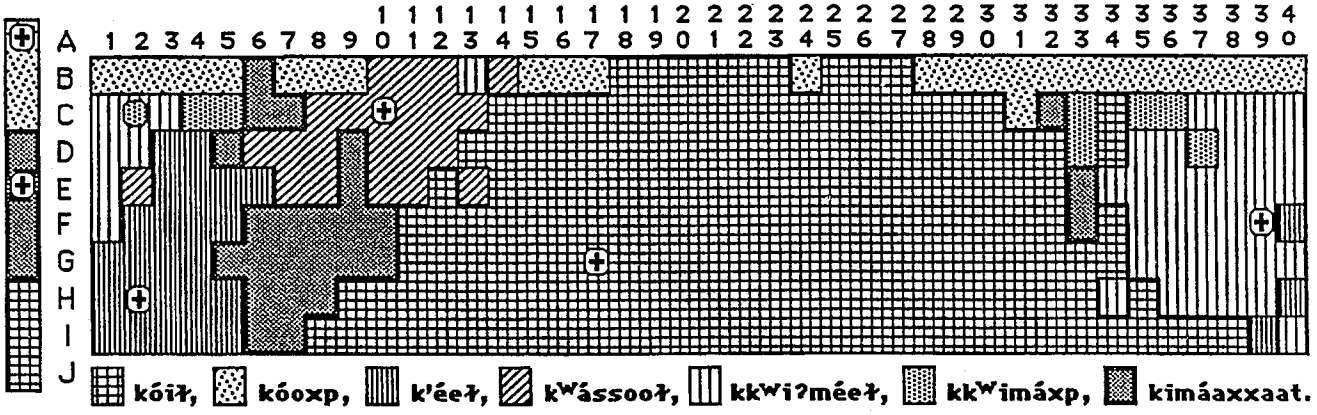


Figure 7.31. Naming ranges and foci, Seri, Desemboque, Woman, age 25, 1978.

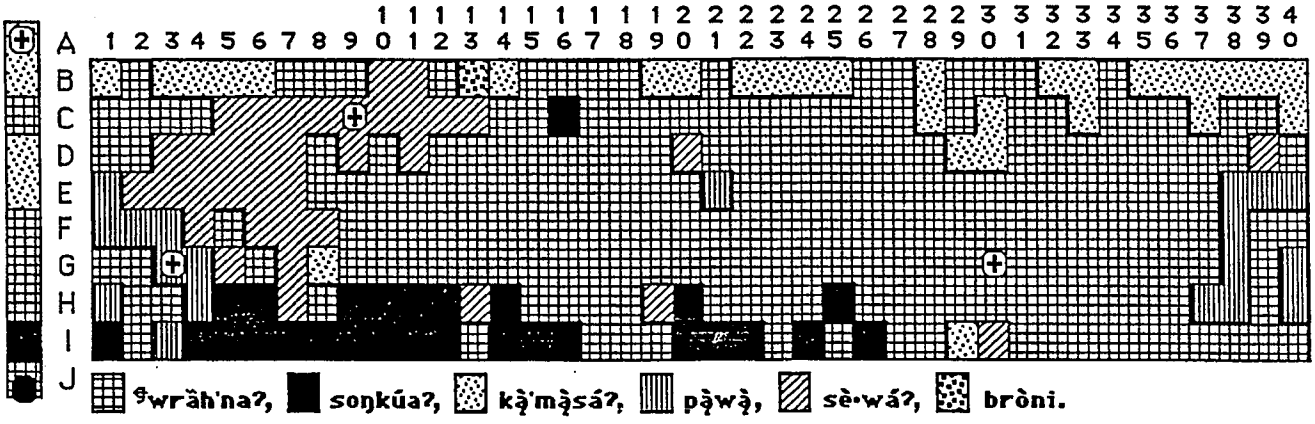


Figure 7.32. Naming ranges and foci, Paya, Pueblo Nuevo Subírana, woman, age 22, 1977.

In Figure 7.31, a Seri speaker used an exceptionally broad dark-cool naming range, but focused it at F17 on unique green. She did not use a black-focused term.

In Figure 7.32, a Paya speaker used an even broader dark-cool naming range, focusing it at G30 in blue. An isolated black-focused usage at C16 suggests coextensivity, as shown by another Paya speaker, Figure 7.8c. The intermixture of naming ranges is consistent with a strong attendance to similarity, although lack of mapping data prevents identification of a stage.[3]

The naming ranges of Figures 7.30-32 can be compared with the cool-focused dark-cool naming range of the K'ekchí speaker of Figures 7.20b (page 235) and the black-focused dark-cool naming ranges of the Santo Tomás Mixtec speaker of Figure 5.7a-c (page 147) and the Mazatec speaker of Figure 6.18 (page 193). Figures 7.30 and 5.7a-c contrast more examples of mirror-image inclusion.

7.4. The Light-Warm Category

There is no strong evidence of a light-warm category in the Mesoamerican sample. There is weak evidence in five widely dispersed cases from as many languages. The color categories of ProtoOtomanguean have been reconstructed as Stage I from contemporary meanings within cognate sets: Trique *ga*^{3}*¢i*^{54} 'white', Zapotec *nagáči* 'yellow', Ixcatec *ka*^{1}*¢e*^{3} 'red' (cf. Appendix II). But presently the light-warm category has all but disappeared throughout Mesoamerica.

However, the ProtoOtomanguean reconstruction indicates that even on that early horizon speakers named color with at least six terms; the naming ranges of

[3]The dark-cool category of some early-stage systems shows residual characteristics: Its name can apply to any color that is perceptually mixed rather than pure, which results in a naming range of vast size. This was done by the Paya speakers of Figures 7.8c, 7.32, and 7.34 and, slightly, by the K'ekchí and Jicaque speakers of Figures 7.20b and 8.40e. Others, such as those of Figures 7.30-31, 7.33b, and 7.35a, showed no residuality of the dark-cool category. Some individuals might regard the dark-cool colors as residual vis-à-vis light and warm colors.

The type of category that is only residual includes grey, brown, lavender, beige, and little else (cf. Figure 7.31, focus EØ; Dougherty 1975: 118-26; Greenfeld 1987).

ProtoOtomanguean color words were as involved as those used today. Individuals who name color with many terms, nevertheless, might categorize at an early stage. Some of the following naming ranges and mappings suggest such a situation:[4, 5]

A possible Stage-I system is suggested by the foci and naming ranges of the Mazatec speaker of Figure 6.18 (page 193). A warm-category focus is uncharacteristically centralized in pink at D1, and a white-focused naming response designates bright red at F1.

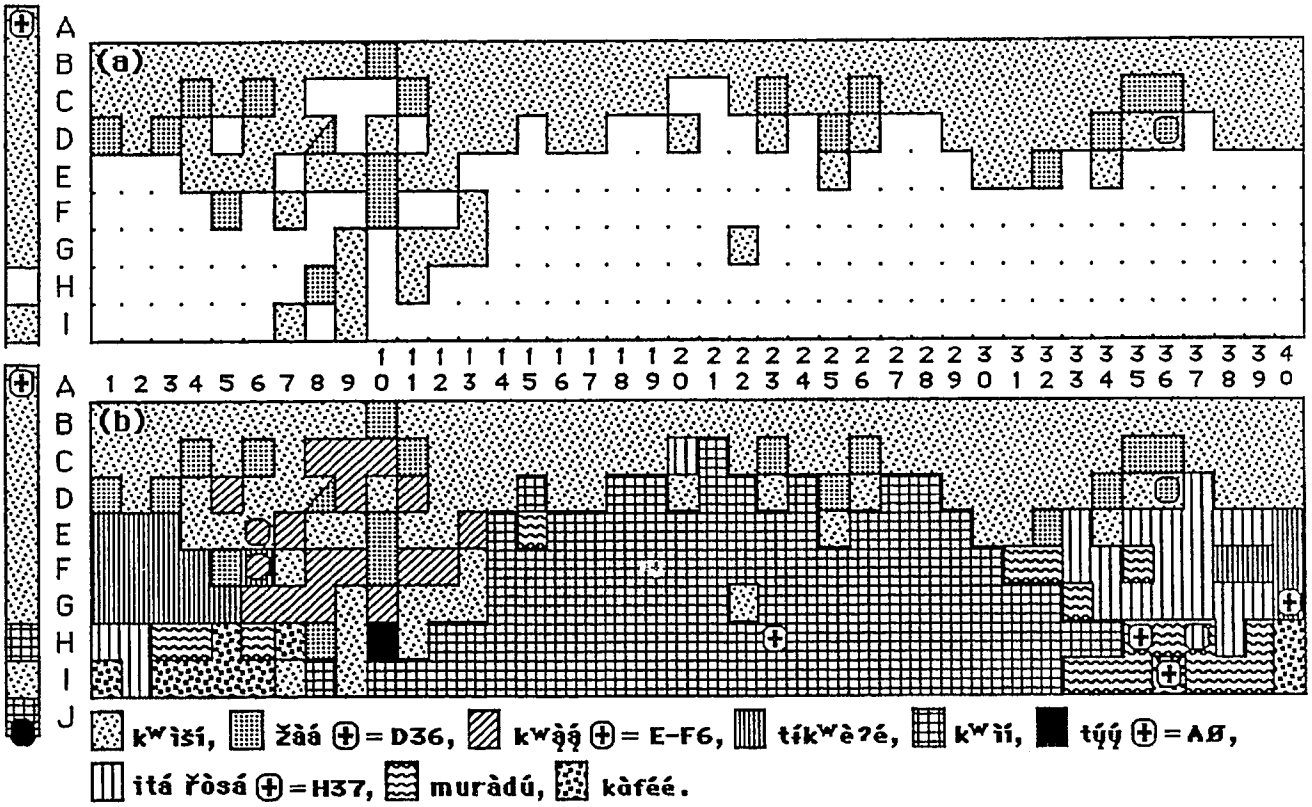
In Figures 7.33a-b (page 256), a Mixtec speaker intermixed white-focused (AØ) and pink-focused (D36) naming ranges throughout pastels, yellows, and browns. Loan words are focused in a polarized cluster at H35, H37, and I36, and their naming ranges designate dark colors versus others in a contrast of brightness. The "yellow" focus is centralized at E-F6 and the "red" focus is polarized at G40. The focus of the dark-cool category is centralized at H23:

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[4]Hage and Hawkes's (1975: 290) data concerning early-stage color categorization in Binumarien of New Guinea show the use of 2, 4, and 6 terms to name white, red, and yellow respectively.

[5]Rosch's data demonstrate Stage-I color categorization in Dugum Dani of New Guinea (cf. footnote 13, Chapter I, page 44). She (Heider 1972a) notes that the Dani use five color terms, of which three are secondary (or, perhaps, recessive). In her figures, she depicted the aggregated naming ranges of the dark-cool category but did not depict the aggregated naming ranges of the light-warm category. Assuming that the omission was not an oversight, probably the data were withheld because they would mislead: a prodigious use of secondary (or recessive) red-focused and yellow-focused words would attenuate the naming range of the light-warm category to an extent that would lead skeptics to disbelieve that such a category could exist. The same problem pertains to the demonstration of the light-warm category in Mesoamerican data. Rosch's main evidence is the aggregate of 40 light-warm category foci in red, pink, yellow, and white, which is more convincing than the sparse data from Mesoamerica.

Rosch's diagrams of foci in the dark-cool category and the light-warm category show a significant difference in pattern. In the light-warm category, a few foci are centralized, that is, triangulated in pink colors between pure red, pure yellow, and pure white; many are polarized at the extreme of red or white. In the dark-cool category, more foci are centralized and fewer are polarized; a cluster of foci is triangulated in dark turquoise colors between pure green, pure blue, and pure black. The difference in pattern is predictable on the basis of two axioms (1-2) and an attendant process (a): (1) Berlin and Kay (*ibid.*) stipulate that the light-warm category always divides before the dark-cool category. (2) A color category divides as the attendance to distinctiveness increases and the attendance to similarity decreases reciprocally; (a) this shift causes a focus to migrate from a centralized to a polarized position. Thus, as Rosch described, in a Stage-I system more foci of individual light-warm categories would be polarized and more foci of dark-cool categories would be centralized.



Figures 7.33a-b. Naming ranges and foci, Mixtec, Peñoles, man, age 72, 1978.

In Figure 7.34, a Paya speaker intermixed white-focused (AØ) naming ranges throughout warm colors, for example, H33, H36, I1, G5, G8, F36, F8-9. Broad naming

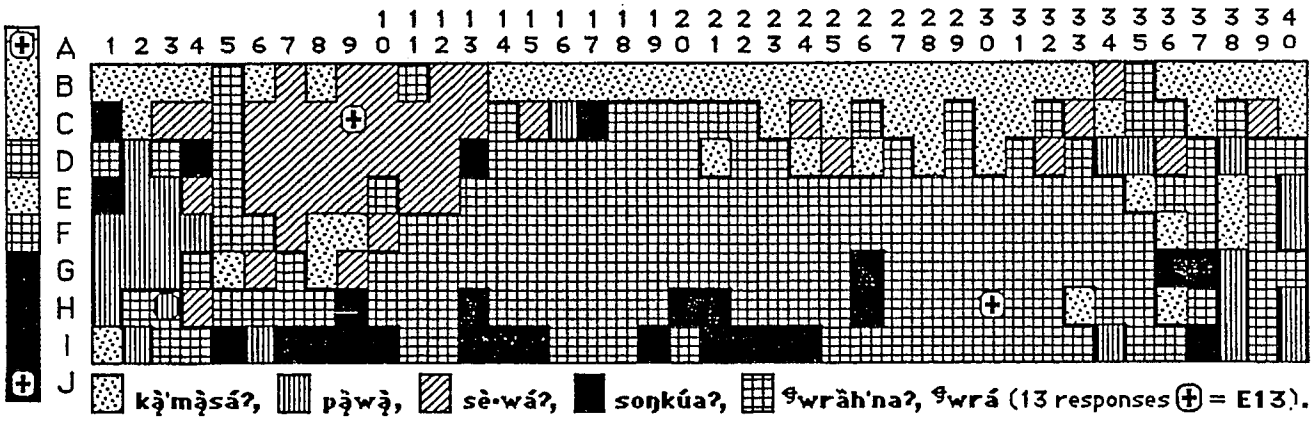
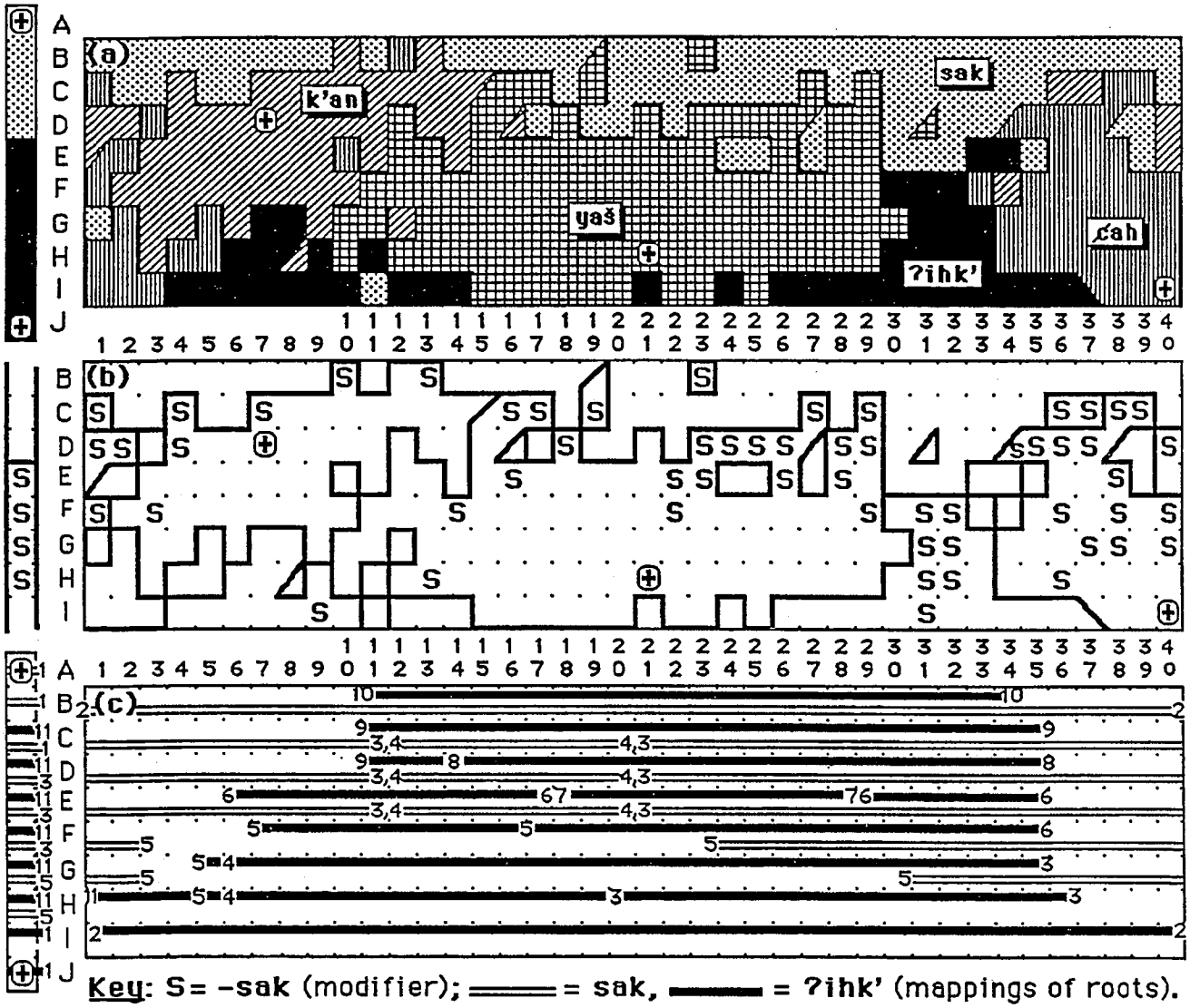


Figure 7.34. Naming ranges and foci, Paya, Pueblo Nuevo Subírana, man, age 33, 1977.

ranges and intermixture of terms suggest early-stage categorization, as they do among other Paya speakers (cf. Figures 7.8c and 7.32, pages 221 and 253).

In Figures 7.35a-c, a Tzeltal speaker (a) named purest red at G1 with the white-focused term, (b) used this term as a modifier throughout light and warm colors, and (c) mapped the white-focused and the black-focused categories in the configuration of Stage I throughout all but 10 of the 330 colors on the Munsell array:



Figures 7.35a-c. Naming ranges (a), modifier (b), and mappings (c), Tzeltal, San Alonso Tenejapa, woman, age 60, 1980 (same speaker as in Figures 4.3a-c, 5.1a-c, and 6.13).

Figure 7.36 displays the mappings of white-focused and black-focused categories of a Jicaque speaker, whose naming ranges appear in Figure 5.10a and 8.40e (page 157 and 313). This speaker did not name the black-focused category during elicitation. Her naming ranges are among the most conservative of the Mesoamerican sample:

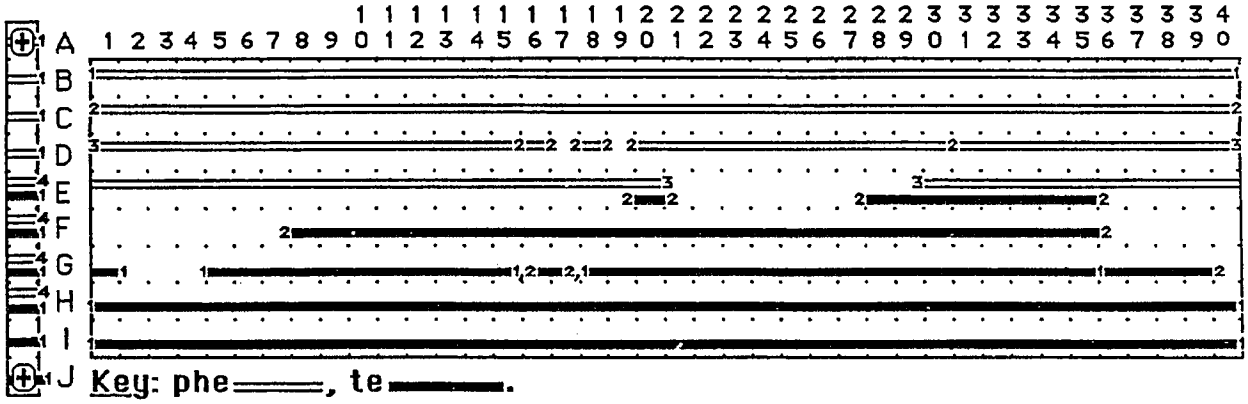


Figure 7.36. Mappings, Jicaque, Montaña de la Flor, woman, age 25±, 1981 (same speaker as in Figures 5.10a-c and 8.40e).

Since few data substantiate the persistence of the light-warm category in Mesoamerica, little can be generalized about its cognitive composition or the phases of its division. The putative light-warm categories shown here (cf. Figures 6.18, 7.33a-36), that reconstructed for ProtoOtomanguean (Appendix II), and those described by Heider (1972a) are lexically complex. A simplex light-warm category has never been reported.

7.5. Conclusions

Semantic evolution and category division are simultaneous and inseparable consequences of the reciprocal shift in strength that occurs between the attendances to similarity and to distinctiveness as the latter augments and the former diminishes.

The data of sections 7.1-3. exemplify specific characteristics of coextensivity, inclusion, and complementation that accompany the division of the warm, cool, and dark-cool category. Some of these characteristics regarding specifically coextensivity are listed in Table 5.1 under items 2, 8, and 9.

As the warm category divides, coextensive vantages retract toward their foci, first the recessive and later the dominant vantage. The first retraction changes coextensivity to a relationship of inclusion between a subordinate category of one unique hue and a superordinate warm category. The second retraction changes the inclusion to a relationship of complementation between primary basic red and yellow categories. Throughout these changes, the foci of the categories are usually related to each other by either mutual polarization or centralized-to-polarized juxtaposition; however, the relationship of foci is unpredictable in any category. Inclusion and complementation show early and late variants, each requiring a stronger attendance to distinctiveness than the one that proceeds it. Late variants of inclusion and early variants of complementation might be redefined as "contrast," although this distinction remains to be worked out formally. The division of the warm category appears to be an orderly process; as it transpires, naming ranges, mappings, and foci closely correspond, and data regarding opposite vantages or categories are typically polarized.

Most cool categories are composed from one vantage and named with one term. Their division is treated in Chapter VIII. However, some cool categories are composed coextensively. In these, the naming range, focus, and mapping of any one coextensive vantage can "cross over"; for example, the naming range might predominate in blue while the focus and first mapping step correspond in green. As the cool category divides, the crossing over of data persists. But as a further result of increased attendance to distinctiveness, such data can be confined entirely to just blue or just green. The crossing over and the confinement, when combined, produce mismatching of data. Naming ranges and mappings appear wholly erratic when crossover and confinement involve both coextensive terms, and the appearance is compounded by inter-speaker variation.

The different manifestations of coextensivity in the warm and the cool category are shaped by the perceptual distances between red and yellow and between green and blue. Since red and yellow appear to be relatively distinct, their cognitive differentiation can

progress with little impediment. But a strong perception of similarity between green and blue counters the cognitive differentiation, until a point is reached at which perception and cognition contend at enhanced strength: In accordance with a strong attendance to distinctiveness, data are confined to just one color within the cool category. In accordance with the strong perception of similarity, the category is left intact and the crossover effect is perpetuated.

The crossover effect in the cool category discourages the development of strong variants of semantic types, more so than in the warm category.

In the warm category, the entire gamut of semantic types is likely to evolve. But in the cool category, an exclusive use of one term is likely to prevail throughout its division. Coextensivity is rare, and near-synonymy is even rarer. Inclusion can be the first semantic type that develops after the use of just one term. It develops in the late phase of category division, after the attendance to distinctiveness has become too strong to foster coextensivity.

The explanation of semantic difference during division of the warm and the cool category requires the same engagement of perceptual and cognitive axioms that provide a basis for the hypotheses of continuous evolution and of vantages.

The dark-cool category evolves semantically much as does the warm category. Among the few dark-cool categories of the Mesoamerican sample, polarized foci are proportionately common. However, after inclusion has developed and the superordinate range begins to retract, the transition from inclusion to complementation is barely detectable in data. The naming range and mapping of the superordinate category seldom match each other around the focus of the subordinate category, whether the focus is green, blue, or black. Data from Tzotzil and Uspantec substantiate the transition with various kinds of correspondence among responses of multiple individuals.

During evolution of composite categories, no particular foci are primal. In any coextensively composed category, the dominant range and the recessive range can be focused in reference to either of the unique hues, providing that each range is focused in reference to an opposite unique hue. The same option applies to superordinate and subordinate categories that are related by inclusion. The optionality precludes the primacy of a red-focused warm category or a black-focused dark-cool cateogry during evolution. As composite categories evolve, the warm category as well can be yellow-focused and the dark-cool category cool-focused. The optionality leads to development of mirror-image relationships of inclusion among color categories of related languages.

In the cool category, mirror-image relationships of inclusion will seldom develop, for reasons discussed under sections 8.4.9. and 8.5.1.

The paucity of data concerning the light-warm category leaves little room for comment. However, both the ProtoOtomanguean reconstruction (Appendix II) and the ethnographic data from Dugum Dani (Heider 1972a) show that Stage-I categorization is lexically complex. In the Mesoamerican sample, such complexity might mask the use of the light-warm category in certain languages, such as Paya. Speakers of this language amplified and intermixed naming ranges to an extent that suggests early-stage categorization, but the absence of mapping data hinders identification of a specific stage.

Chapter VIII

Skewing

8.0. Preface

This chapter reviews evidence that the cool category is a vantage, a view that is taken from one particular position. *Categorization and the adoption of a vantage are one and the same.* Although the data presented here concern exclusively the cool category, the principle applies to any color category regardless of whether it contains three, two, one, or no unique hues.

The notion that categorization necessarily involves adopting a vantage was introduced in Chapters V-VI, mainly in reference to warm categories. In the environment of red and yellow, two vantages are taken, and each is separately named. But in the environment of green and blue, the cool category is usually composed by taking just one vantage and only one term is used to name it.

It is not surprising that a single principle would pertain to the formation of all color categories; it is improbable that some categories would be composed of two vantages while others would be composed of none. Particular color categories differ in regard to this principle only by the number of vantages that compose each. The categorization of cool colors is fundamentally like the categorization of warm colors, in the sense that all color categorization is achieved by adopting at least one vantage.

The data of this chapter concern only cool categories that are named with one term and that are not composed by coextensive vantages. All such categories are "skewed," at least, to a minimal extent, and some are skewed greatly. Greater skewing accompanies

advanced phases of category division.[1] "Skewing" means that any non-coextensive cool category (1) will have only one focus and (2) that the focus will be placed either on the green side or on the blue side of turquoise, that is, on either side of column 23 of the Munsell array, although seldom on that column.[2] In categories whose division is well underway, the skewing is manifested further by correspondences between the focal side of the category and (3) the most frequent use of the category name, (4) the most frequent use of maximal or augmentative modifiers and the least frequent use of minimal or diminutive modifiers (cf. Burgess, Kempton, and MacLaury *ibid.*), and (5) the first mapping step.

The analysis of skewing leads to a unified three-part hypothesis of (1) skewing, (2) composition, and (3) division of color categories:

1. Skewing. The simplest interpretation of skewing is that all individuals compose the cool category as though they were assuming a vantage of green and blue from one particular position. *The establishment of a vantage point on any side of the cool category produces the effects (1-5) of a skew toward that side.* This account is the same as that expressed in section 6.4., item 2: People treat a category as though it were substantive, as if they were standing next to it or on it. Thus, at least one such vantage is attributed to any color category.

2. Composition. Any vantage point is derived from a reference body of coordinates, whether it concerns a physical object, an event, a space, or a category. In the case of a category that is composed from just one vantage, the position is constituted by a coordination of both the attendance to similarity and the attendance to distinctiveness with one unique hue. Different strength is assigned to each attendance.

3. Category Division. The strengths can shift reciprocally over time; as the attendance to distinctiveness increases, the attendance to similarity decreases. The shift

[1]The effect of "skewing" in the cool category and its relationship to category division was originally reported by Burgess, Kempton, and MacLaury (1983).

[2]Kay and Kempton (1981), on the basis of experiments with English and Japanese speakers, specify column 23 to be the universal perceptual divide between green and blue.

causes change throughout the category in the distribution of values of membership, which leads ultimately to the division of the category.

The three-part hypothesis matches three orders of entailments that would characterize data concerning, specifically, cool categories that are composed from just one vantage:

1. Since skewing is inseparable from categorization, (a) few cool categories will be focused in column 23 of true turquoise and (b) few, if any, categories will be focused in a dual manner on separate colors in reference to both unique green and unique blue.

2. Since the attendances to similarity and to distinctiveness both constitute the same vantage point and since their strengths are reciprocal, a change in the strengths will cause specific correspondences among different data, such as naming ranges, foci, and mappings:

For example, a strong attendance to similarity will encourage a continuous mapping and a centralized focus;[3] this is because unique hues that are viewed as similar will be mapped during a single performance, and a focus will be selected on a central color that represents all members of the category as closely as possible. In essence, similar entities will be given the same treatment and will be grouped together. A strong attendance to distinctiveness will encourage a disjunctive mapping and a focus that is placed on one unique hue or that is polarized at a position between one unique hue and the category-margin; unique hues that are viewed as distinct will be mapped during separate performances, and the focus will be selected on a color that marks a contrast of one side of the category against the other. Distinct entities will be given different treatments, separated, and contrasted.

3. Since category division is provoked by strong attendance to distinctiveness and since this produces extreme skewing, (a) a category will divide by a retraction of its range

[3]"Continuous" and "disjunctive" mappings are exemplified in subsequent figures. A continuous mapping covers both unique hues and turquoise with its first step; a disjunctive mapping does not.

toward one side of the category and away from the other, and (b) full division will result in the application of the historical "cool" term to just one unique hue. The other unique hue will be named by a newly innovated term or, for a period, will remain unnamed.

In the quantitative section of this chapter, section 8.3., entailments (1-3) are matched against statistics from the 589 individual cool categories of the Mesoamerican sample. Tests of the three-part hypothesis are entirely of this numerical kind.

Sections 8.1., 8.2., and 8.4. are more exhibitory than substantiative. Sections 8.1. and 8.2. show how continuous and disjunctive mappings correlate with different placements of foci, and how skewing can occur in the direction of either green or blue. Section 8.4. complements the statistics of section 8.3. with exemplification featuring individuals and small samples from single languages.

Section 8.5. compares the findings and conclusions of this analysis of skewing against published accounts of the cool category from Aguaruna, Eskimo, Tzeltal, Futunese, and Tarahumara. Special attention is given to Kay and McDaniel's (1978) fuzzy-set union.[4]

8.1. Degree of Skewing

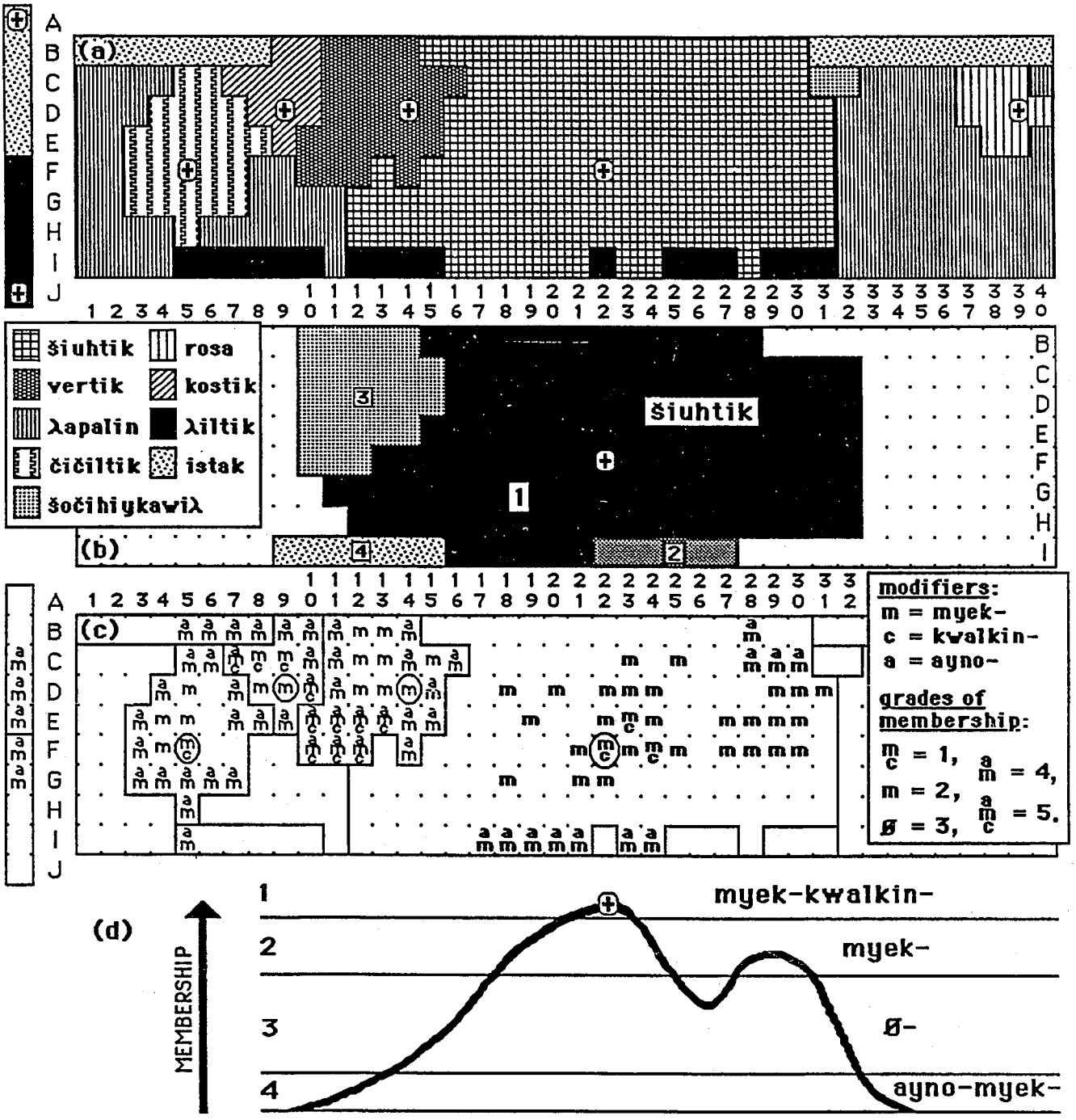
Different individuals manifest distinct degrees of skewing, which vary from slight to great. Individuals who slightly skew the cool category tend to focus it between the unique hues, although they focus it to one side or to the other of maximal turquoise in column 23; and they tend to map the category with a *continuous* first step, that is, one that covers both of the unique hues and turquoise. Individuals who greatly skew the cool category tend to focus it on one of the unique hues, or they focus it in a polarized position between a unique hue and the category-margin. They tend to map the category with a

[4]Kay and McDaniel (1978) introduced concepts to ethnographic color theory that are indispensable to the present discussion: (1) the notion that neurologically determined unique hues provide invariant perceptual reference points; (2) depiction of uneven membership values as curves, such as those used in Figures 8.1-13; (3) the clear separation of composite, primary, and derived color categories.

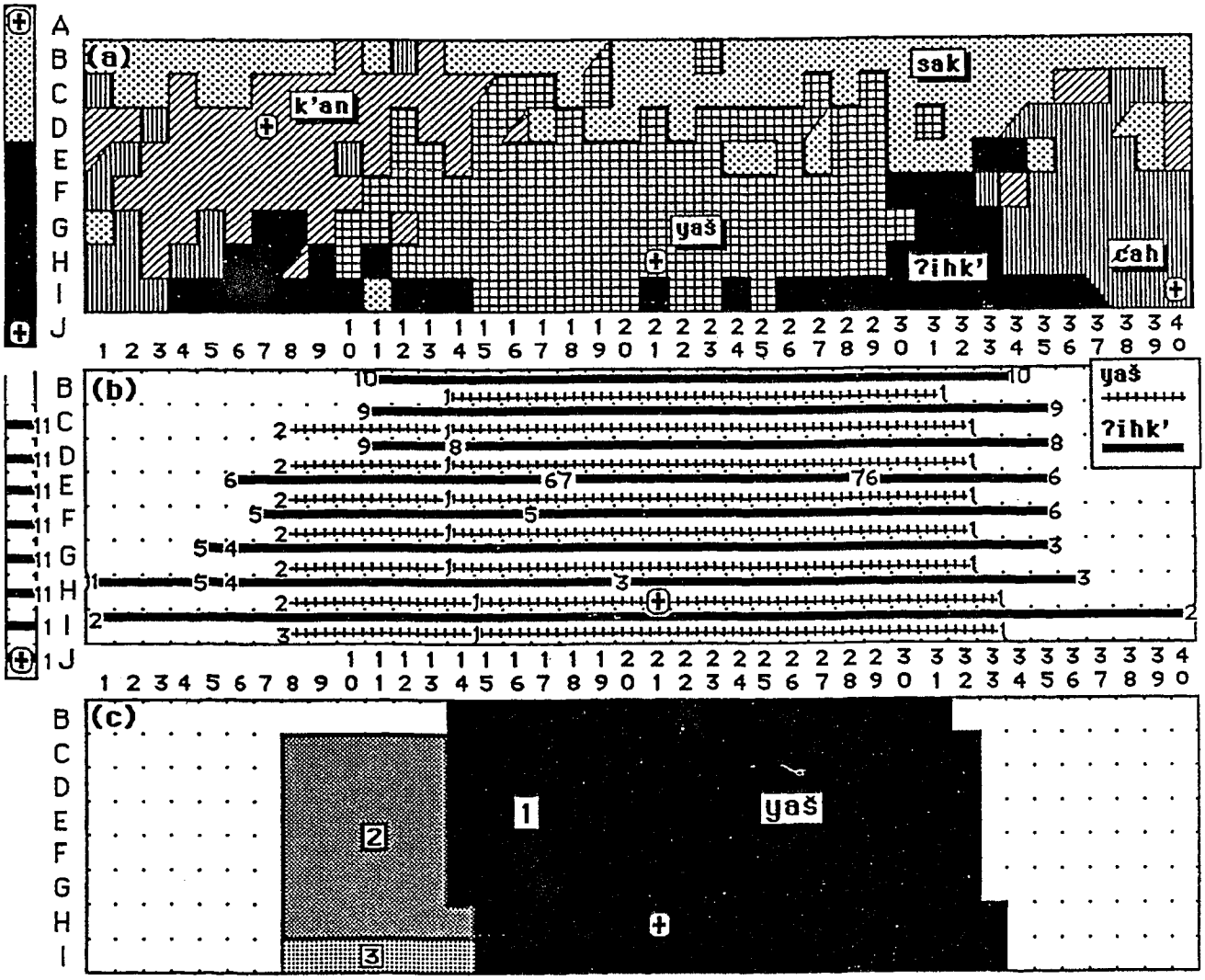
disjunctive first mapping step. That is, (1) the first mapping step covers only one unique hue; or (2) the first step covers both unique hues but not the turquoise colors between them, and it covers more colors around one unique hue than around the other. In short -- as will be developed in section 8.3. -- continuous mappings correspond with centralized foci and disjunctive mappings correspond with foci that are placed on a unique hue or that are polarized. However, a focus is almost never completely centralized in column 23.

Figures 8.1a-11 exemplify distinct degrees of skewing within the cool categories of eleven individuals who represent ten languages. Further, the figures show particular instances of the correspondence between a continuous mapping and a centralized focus and between a disjunctive mapping and a focus that is on a unique hue or polarized. To simplify this presentation, the examples of Figures 8.1a-11 all are skewed in one direction, toward green:

Figures 8.1a-d show that a Nahuatl speaker has mapped the cool category continuously in one step over unique green at F17 and unique blue at F29; and he has focused the category at F22 between the unique hues and on just one column to the green side of maximal turquoise in column 23. This evidence of slight skewing toward green is corroborated by the distribution of modifiers in Figure 8.1c: Maximal modifiers are clustered at the focus; medium-grade modifiers are bimodally distributed in one large, centralized cluster around the maximal modifiers and in one small cluster around unique blue; minimal modifiers are peripherally placed. In Figure 8.1d, a curve represents the approximate gradation of membership values that is suggested by the correspondence between the focus and the modifier distribution. The curve directly depicts the focus and the distribution of maximal and medium-grade modifiers, although its depiction of minimal modifiers is abstract: The latter occur in just two peripheral clusters; they do not occur around the entire periphery of the category, as a literal reading of the curve would suggest.



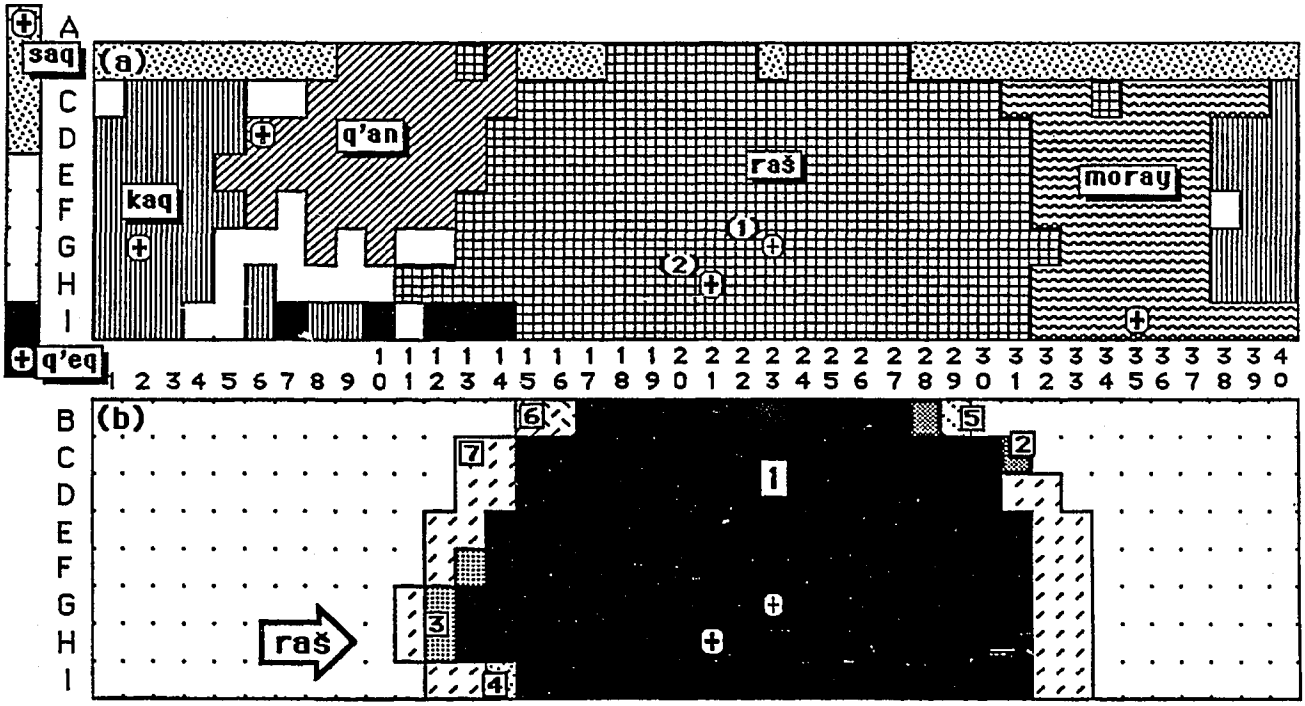
Figures 8.1a–d. Naming ranges (a), mapping (b), modifiers (c), and abstract depiction of membership gradation within šiuhtik (d); Santa Buenaventura Nahuatl, man, age 32, 1979.



Figures 8.2a-d. Naming ranges (a) and mappings (b-c); Tenejapa Tzeltal, woman, age 60, 1980 (Same speaker as in Figures 4.3a-c).

Figures 8.2a-c represent the naming range, mapping, and focus of a secondary cool category, one that is encompassed by the range of a black-focused dark-cool category. The cool category is continuously mapped and centrally focused at H21, although the focus indicates a slight skewing toward green. The cool category is slightly skewed even though it is secondary and, therefore, not substantially undergoing a division. These data, and others like them, indicate that skewing is not a consequence of category division, but rather

it is an inherent quality of any cool category. As the category divides, its skewing is enhanced; however, skewing is not caused by division.



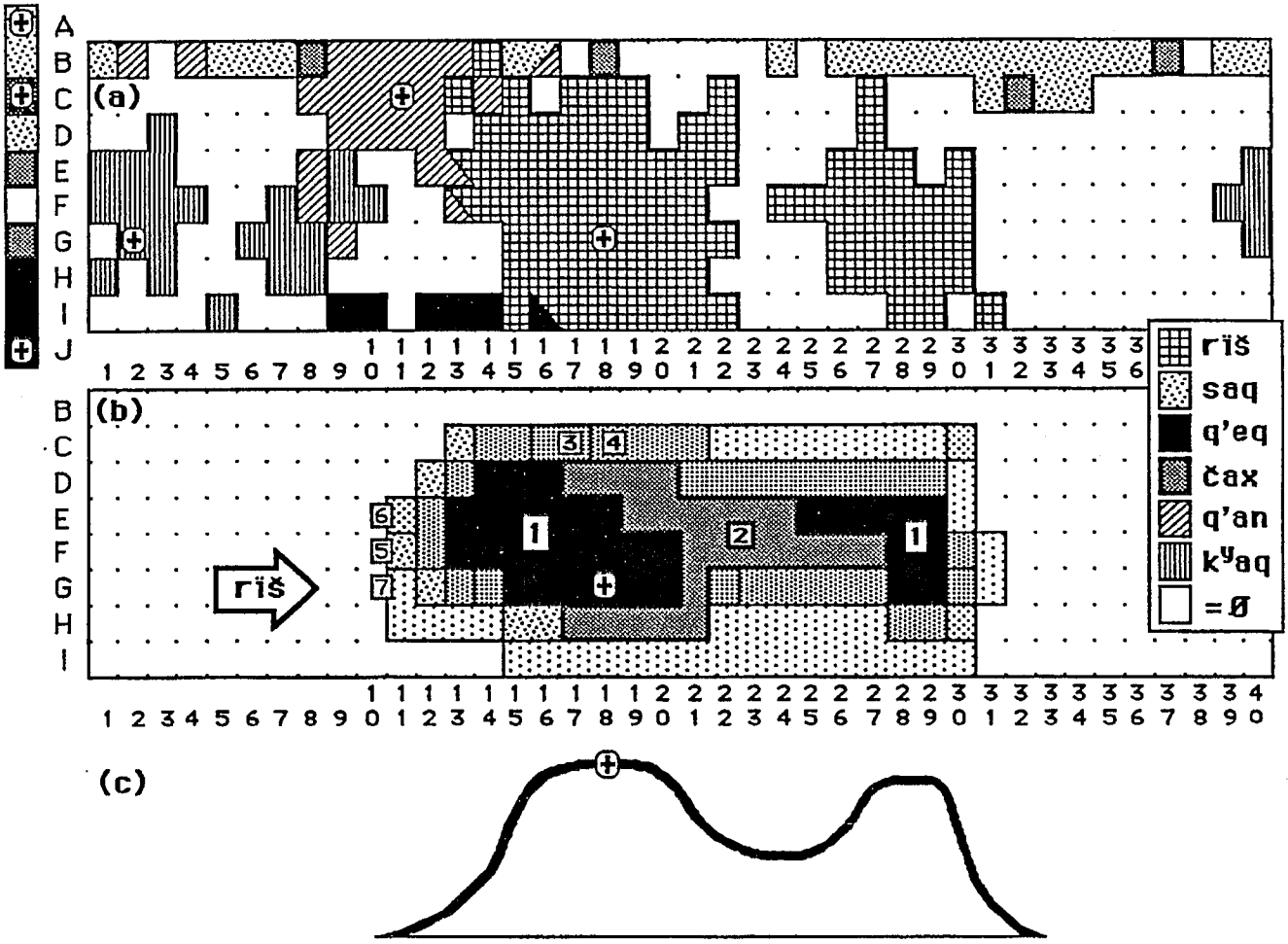
Figures 8.3a-b. Naming ranges (a) and mapping (b); K'ekchí, Lanquín, man, age 30, 1980.

In Figures 8.3a-b, a K'ekchí speaker continuously mapped and centrally focused the cool category. First he focused it in column 23 on maximal turquoise, but he immediately reconsidered and placed his final choice at H21 with a slight skewing toward green. His reconsideration suggests that he had a preference to skew his focus selection, and that its final placement represents an assessment of options.

Figures 8.4a-5c show data from two Tecpan Cakchiquel speakers, who both declined to name several colors during the interview. They differ in the way that each assigns values of membership within the cool category:

In Figures 8.4a-b, speaker #1 disjunctively named and disjunctively mapped the cool category, and he focused it with slight centralization on G18 just one column to the inside of unique green in column 17. In the mapping, the first step is applied to both

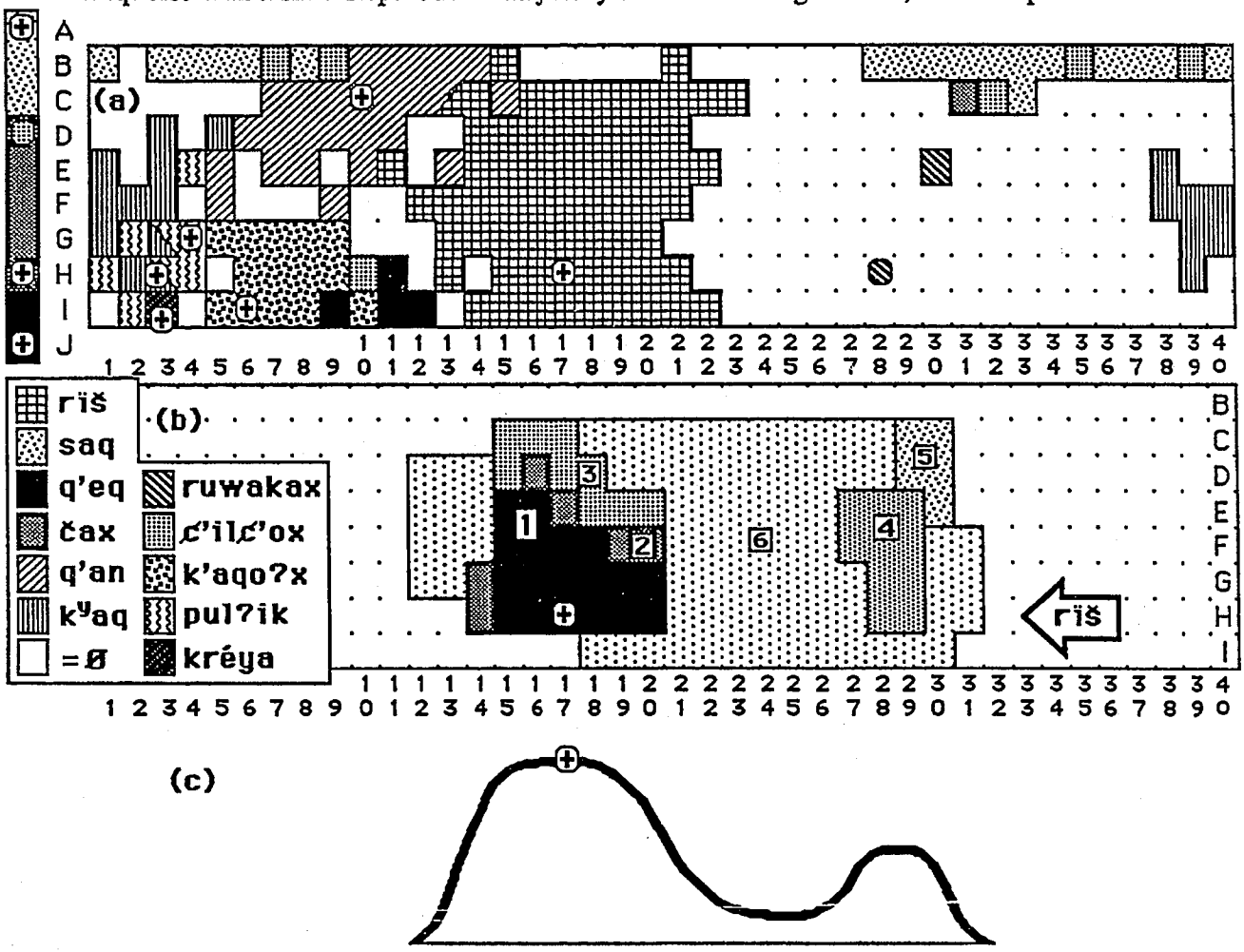
unique green and to unique blue, although turquoise colors are covered by the second step. In Figure 8.4c, a curve represents a likely gradation of membership values, with the value of green higher than that of blue: the focus, the largest half of the naming range, and the largest half of the first mapping step correspond in green.



Figures 8.4a-c. Naming ranges (a), mapping (b), and depiction of membership values (c); speaker #1, Cakchiquel, Panajabal, Tecpan, man, age 27, 1980.

In Figures 8.5a-b, speaker #2 names fewer colors than speaker #1, but uses more terms; speaker #2 declined to name all of the blues, except one light blue at D30 with a word for 'sky'. He mapped the cool category disjunctively, and he focused the category on H17 in the column of unique green in correspondence with the first mapping step.

Unlike speaker #1, speaker #2 mapped unique blue only with a fourth step while covering turquoise with a sixth step. Such data justify the curve of Figure 8.5c, which depicts two

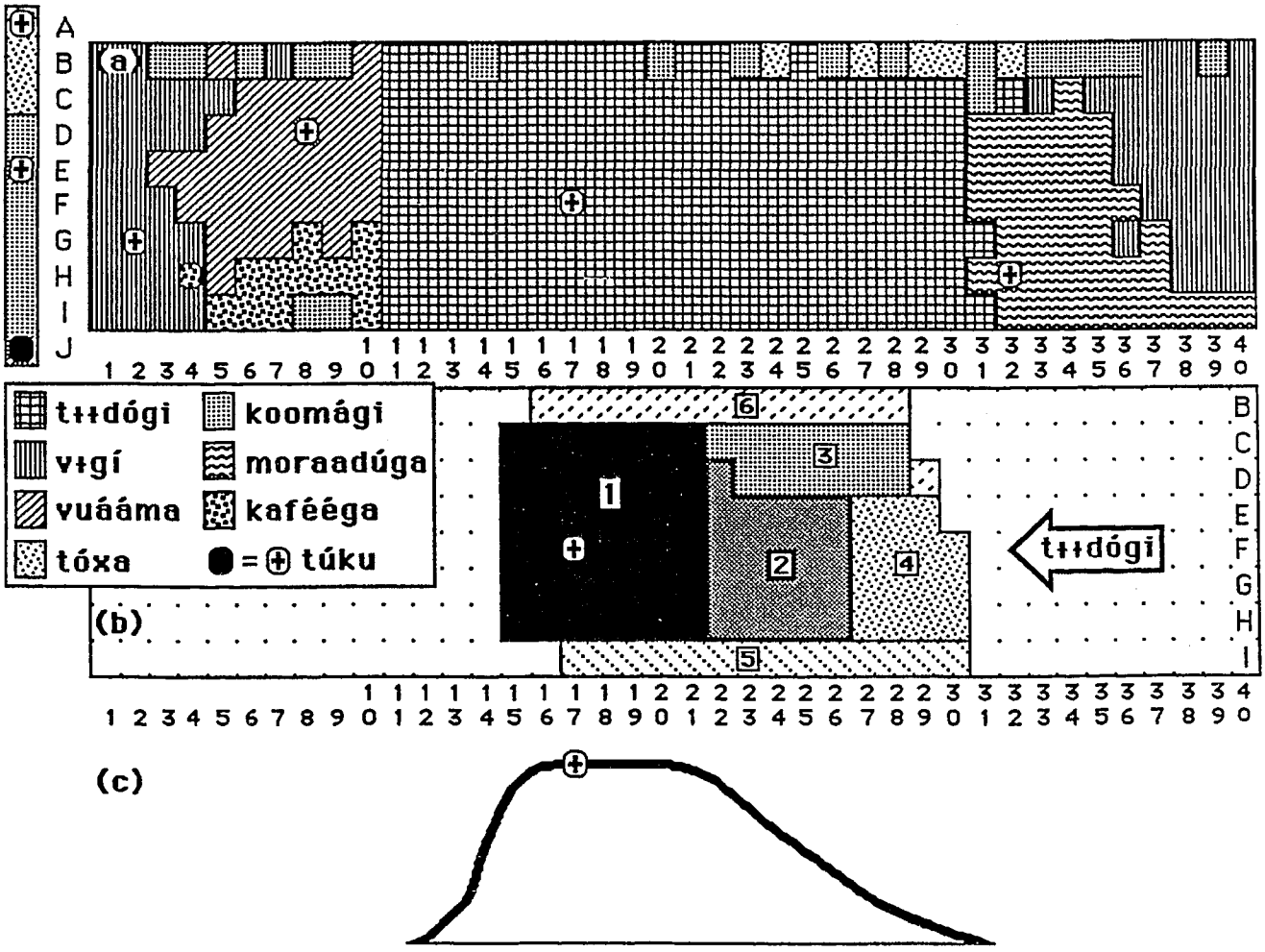


Figures 8.5a-c. Naming ranges (a), mapping (b), and depiction of membership values (c); speaker #1, Cakchiquel, Panajabal, Tecpan, man, age 34, 1980.

apexes of membership value, one in green and the other in blue, with the value in green the highest. The pronounced skewing of speaker #2 corresponds to his focus in column 17, whereas the lesser skewing of speaker #1 corresponds to his slightly centralized focus in column 18.

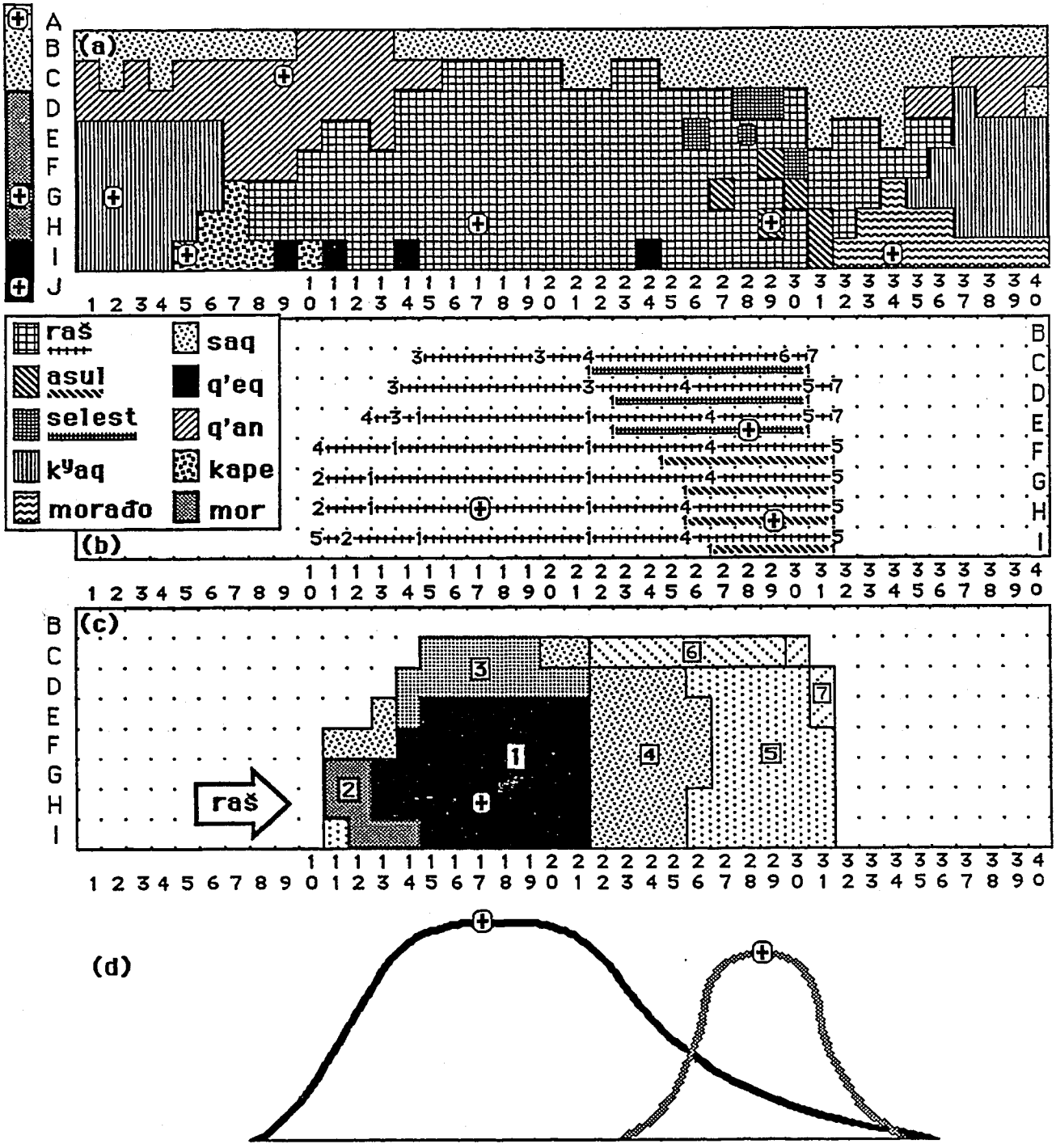
In Figures 8.6a-b, a Northern Tepehuán speaker focused the cool category on unique green of F17 and mapped the category disjunctively. However, unlike Cakchiquel

speakers #1 and #2, the Northern Tepehuán speaker mapped green first, turquoise second and third, and unique blue fourth. Thus, the curve of Figure 8.6c shows just one apex of membership, with values declining steadily from green, across turquoise, through blue.



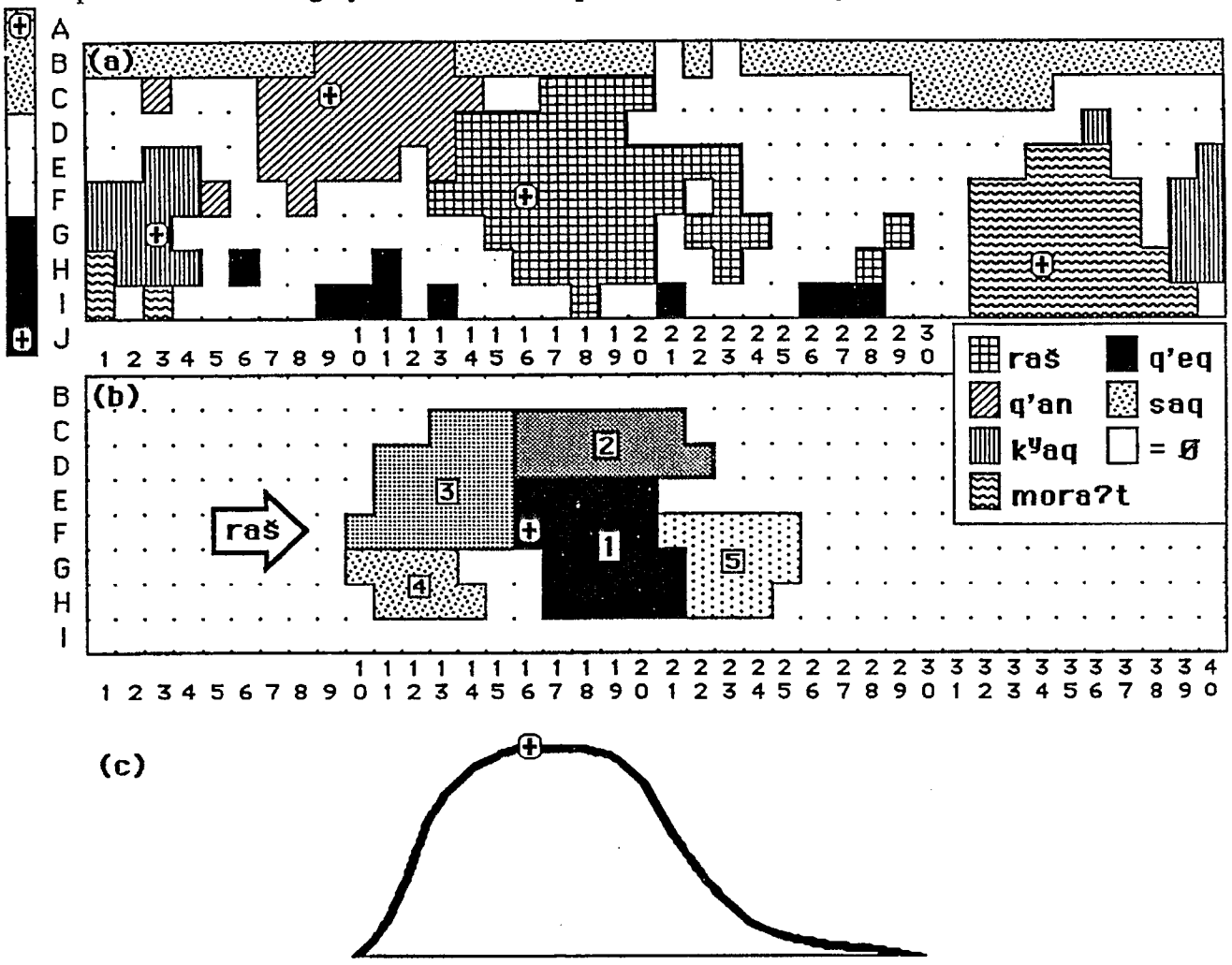
Figures 8.6a-c. Naming ranges (a), Mapping (b), and depiction of membership values (c); Northern Tepehuán, Baborigame, woman, age 50, 1981.

The mappings from the two Cakchiquel speakers and the Northern Tepehuán speaker all are disjunctive, but the disjunctions assume different configurations; the differences suggest distinct degrees of skewing within the cool category.



Figures 8.7a-d. Naming ranges (a), mappings (b-c), and curves depicting membership gradations within raš suggested by naming salience and mappings (d); Quiché, Momostenango, man, age 29, 1980.

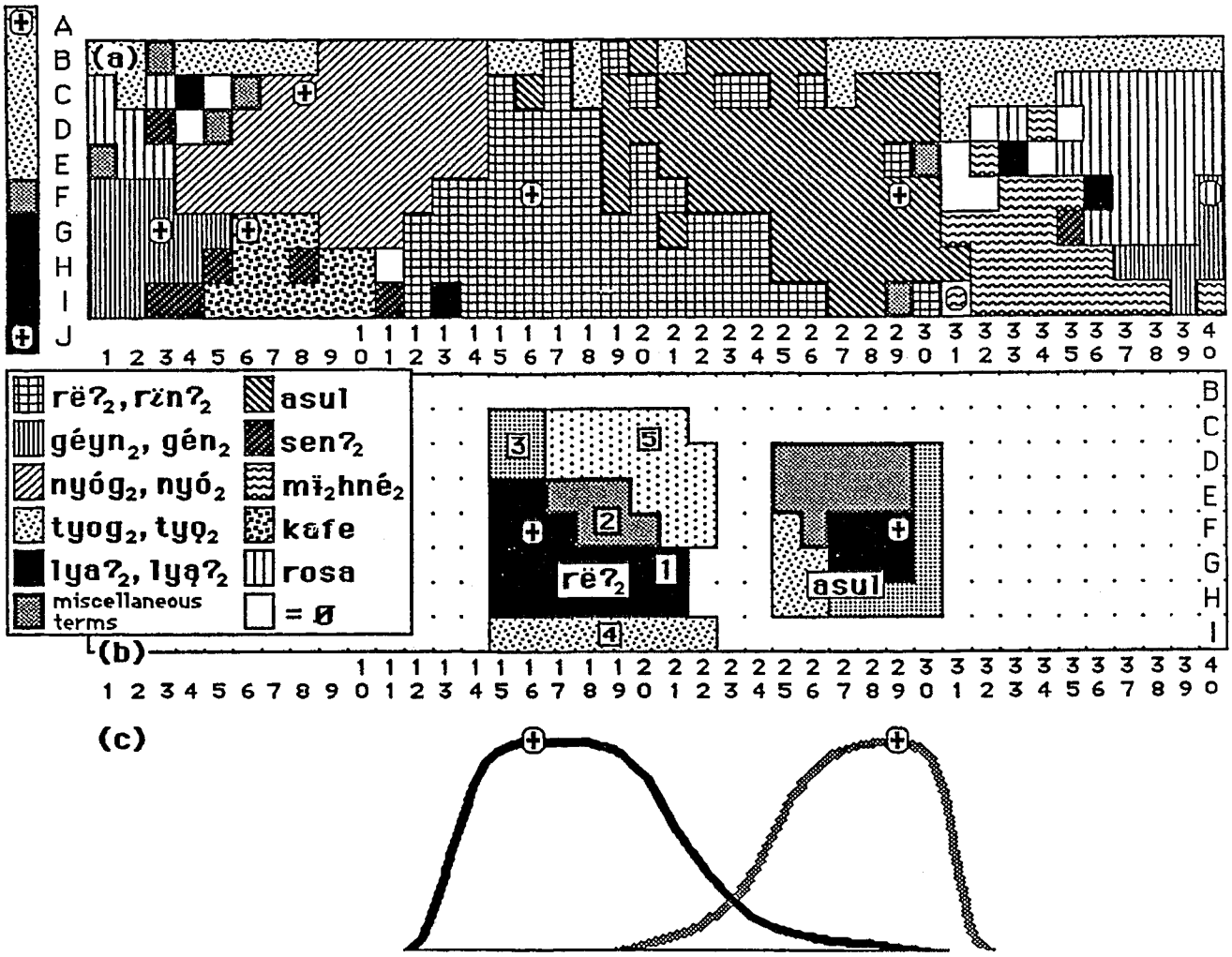
In Figures 8.7a-c, a Momostenango Quiché speaker focused the cool category in the column of unique green; and, like the Northern Tepehuán speaker, he mapped the category from green, across turquoise, through blue, in steadily declining steps. The Quiché speaker differs from the Northern Tepehuán speaker by his use of minimally salient secondary categories of blue colors that correspond to the latest mapping steps of the cool category. In Figure 8.7d, the dark and light curves depict one secondary category in the part of the cool category where membership values decline through blue.



Figures 8.8a-c. Naming ranges (a), mapping (b), and curve depicting membership values (c); Quiché, Santa María Chiquimula, man, age 38, 1980.

In Figures 8.8a-b (page 274), a Chiquimula Quiché speaker demonstrated a cool category with just two naming responses in columns 28 and 29; the mapping did not extend to these columns. The sparse evidence suggests that this speaker maintained the cool category in blue at the minimal value of membership, one that is lower than that maintained by the Northern Tepehuán speaker or Momostenango Quiché speaker. Correspondingly, the Chiquimula Quiché speaker slightly polarized the cool-category focus at F16, one column to the outside of unique green; the polarized focus suggests that the speaker had stressed the difference between the two sides of the highly skewed category. In Figure 8.8c, the curve depicts a precipitous decline of membership values through blue.

In Figures 8.9a-b (page 276), a Tepetotutla Chinantec speaker, like the Chiquimula Quiché speaker, showed scant evidence of the cool category among blue colors; and, correspondingly, she too polarized the cool-category focus at F16. But unlike the Chiquimula Quiché speaker, the Chinantec speaker named a secondary blue category; unlike the Momostenango Quiché speaker's minimally salient blue categories, this blue category is maximally salient and not surrounded on its purple margin by the naming range of the cool category. In Figure 8.9c, the dark and light curves depict a steep decline of membership value through blue and its relationship to the salient secondary category:



Figures 8.9a-c. Naming ranges (a), mappings (b), and curve depicting membership values (c); Chinantec, Tepetotutla, man, age 31, 1979.

Figures 8.10-11 show naming ranges of a Tepecano speaker and a Santiago Tilapa Otomí speaker.[5] Their cool categories are much like those of the Chiquimula Quiché and the Chinantec speaker, except that the foci are more polarized. Since mapping data were not collected, membership curves are omitted; however, such curves would depict even greater skewing than those of Figures 8.8c and 8.9c.

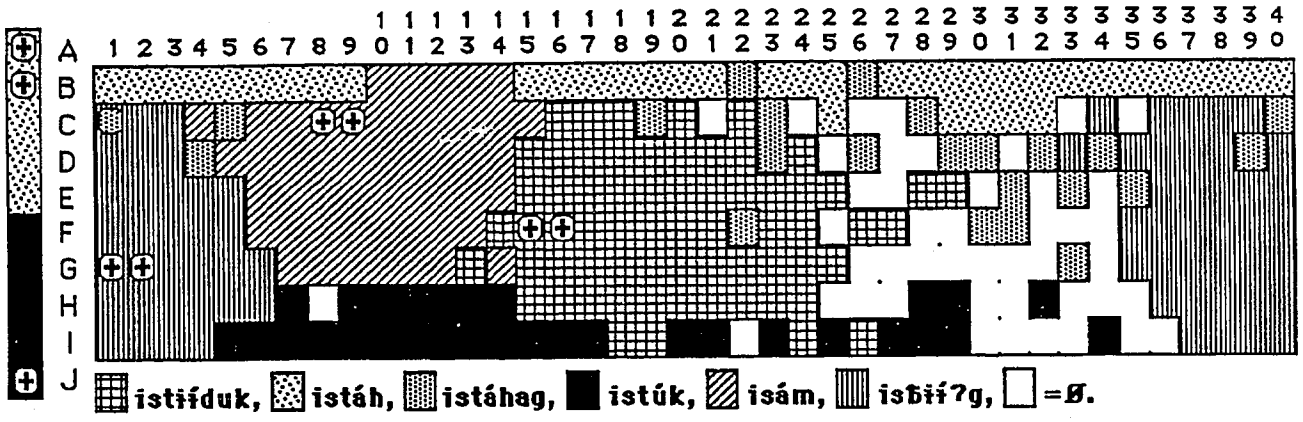


Figure 8.10. Naming ranges and foci; Tepecano, Atzqueltán, man, age 84, 1979.

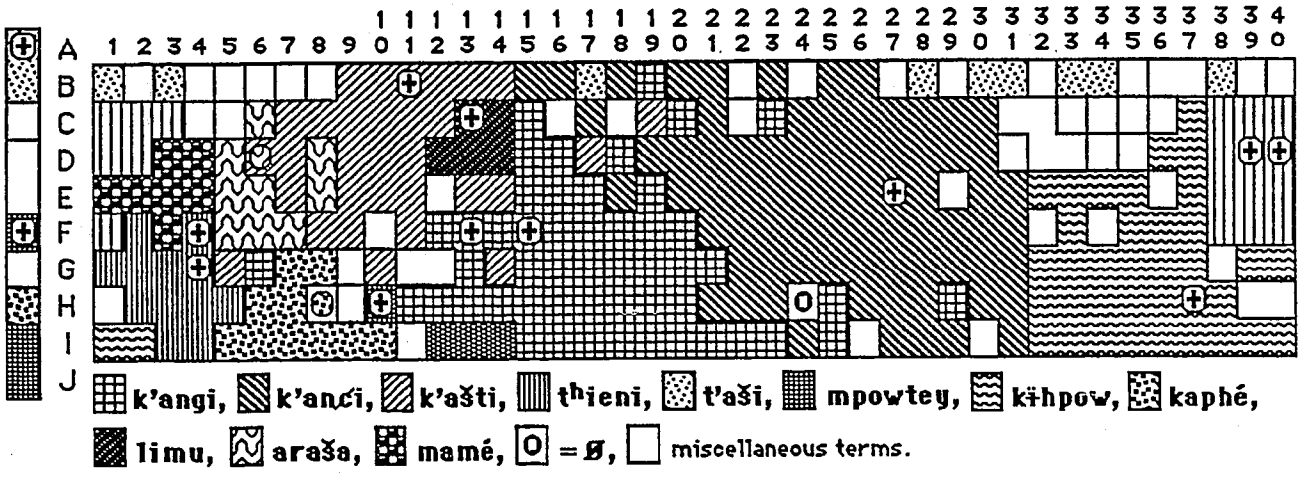
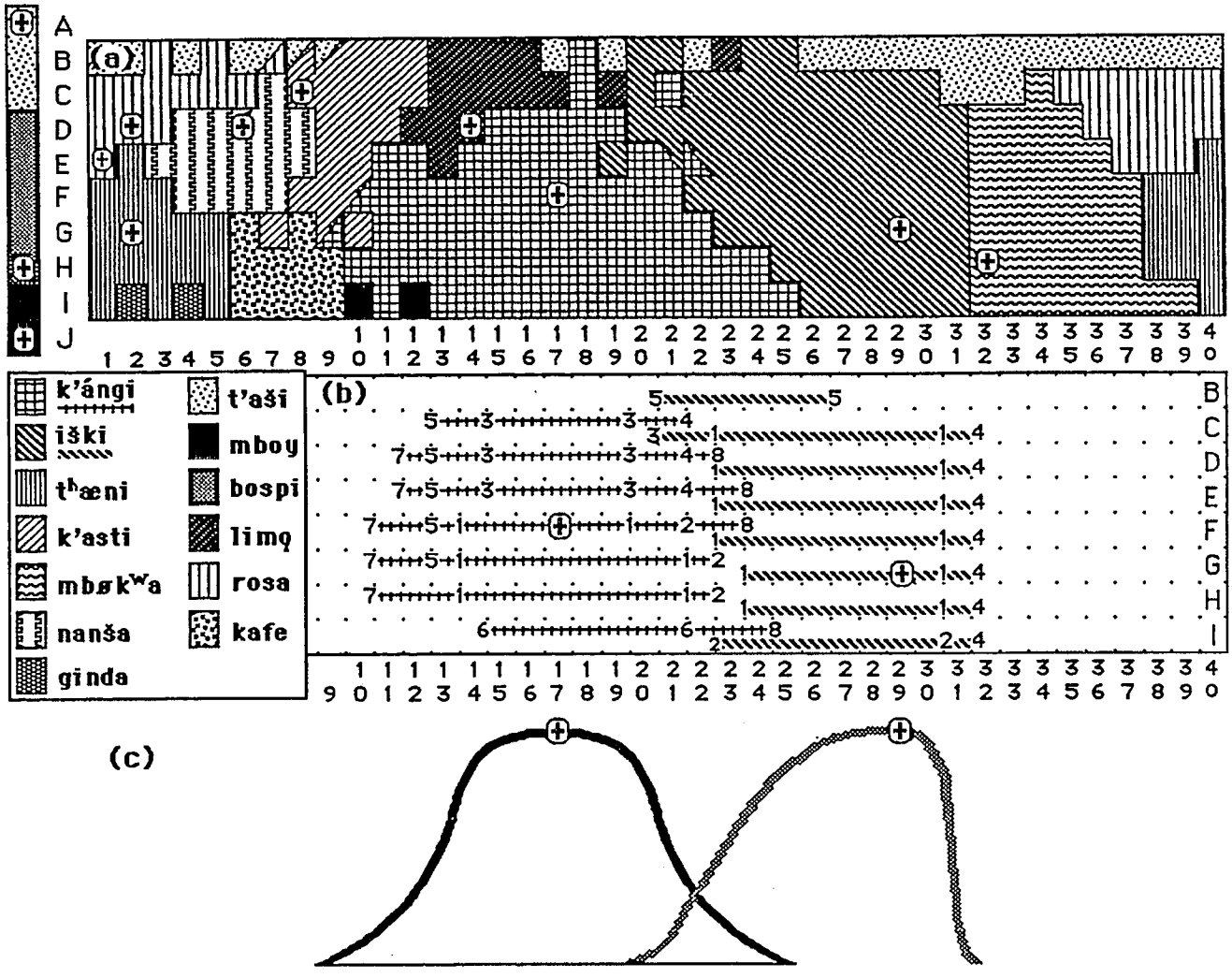


Figure 8.11. Naming ranges and foci; Otomí, Santiago Tilapa, woman, age 48, 1979.

In Figures 8.12a-b, a Mezquitál Otomí speaker used a green category and a blue category, each focused in the column of its unique hue. Other Otomí speakers use the

[5]Naming data and foci were collected by Dennis Holt from Lino de la Rosa Escobedo, the last living Tepecano speaker. Holt arranged a subsequent interview for mapping and other topics and waited three days, but Mr. Escobedo could not be found again.

'green' term, *k'ángi*, to name the cool category (cf. Figures 5.5a-b and 8.11), which implies that this green category developed from a skewing toward green of a historical cool category through the process suggested by Figures 8.1a-11. The Mezquitál Otomí speaker represents the culmination of that process in a full division of green and blue. Individuals of the Mesoamerican sample who show this full division *all* do not focus the green category and the blue category in the columns of their unique hues, and all would not reflect exactly the same curves as are depicted by Figure 8.12c.



Figures 8.12a-c. Naming ranges (a), mappings (b), and curves depicting membership values; Otomí, Valle del Mezquitál, Julián Villa Grande, woman, age 33, 1981.

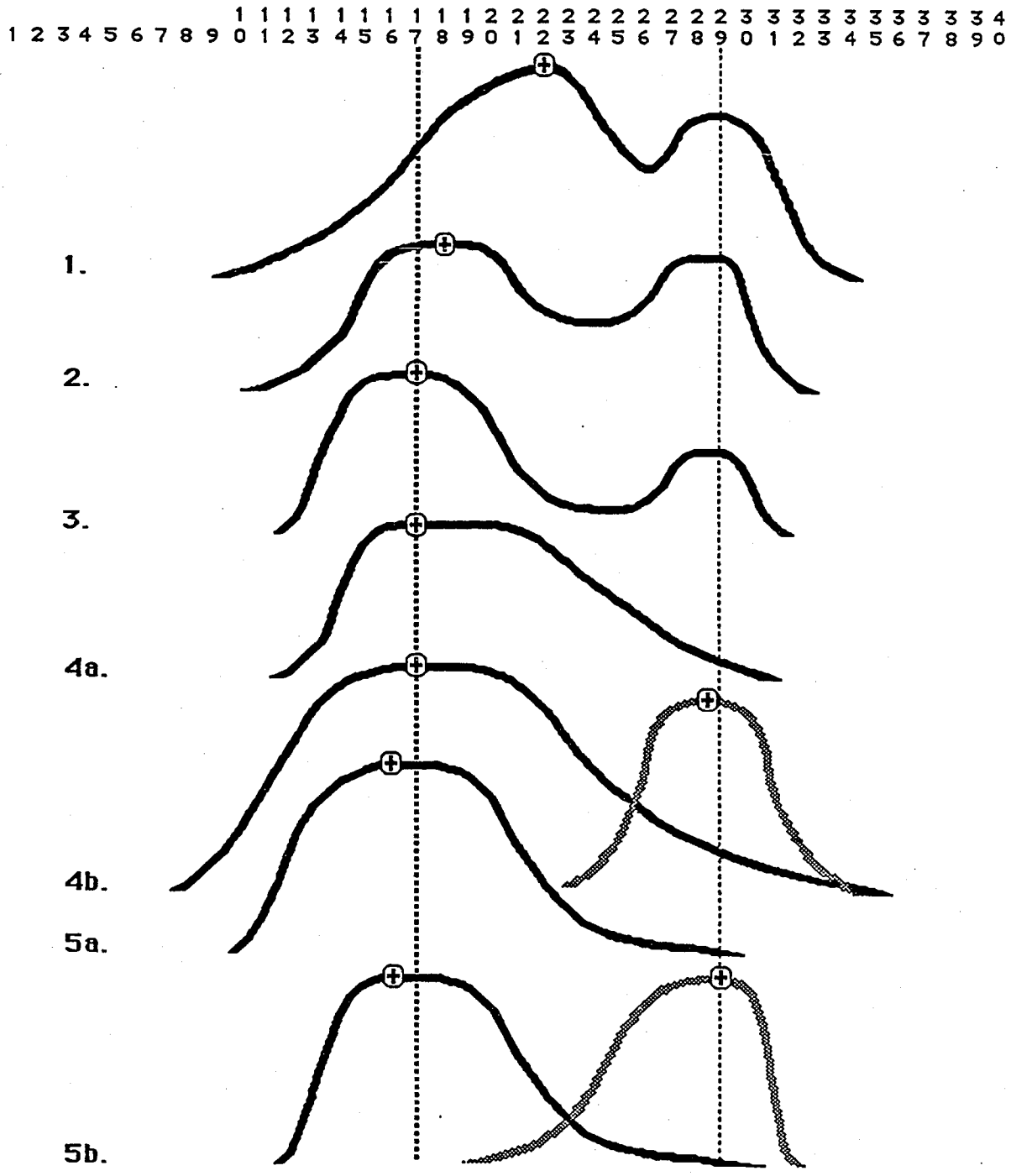


Figure 8.13. Curves depicting relationships of foci and membership values to the unique hues of Munsell-array columns 17 and 29 through five phases (1-5b) of skewing toward green.

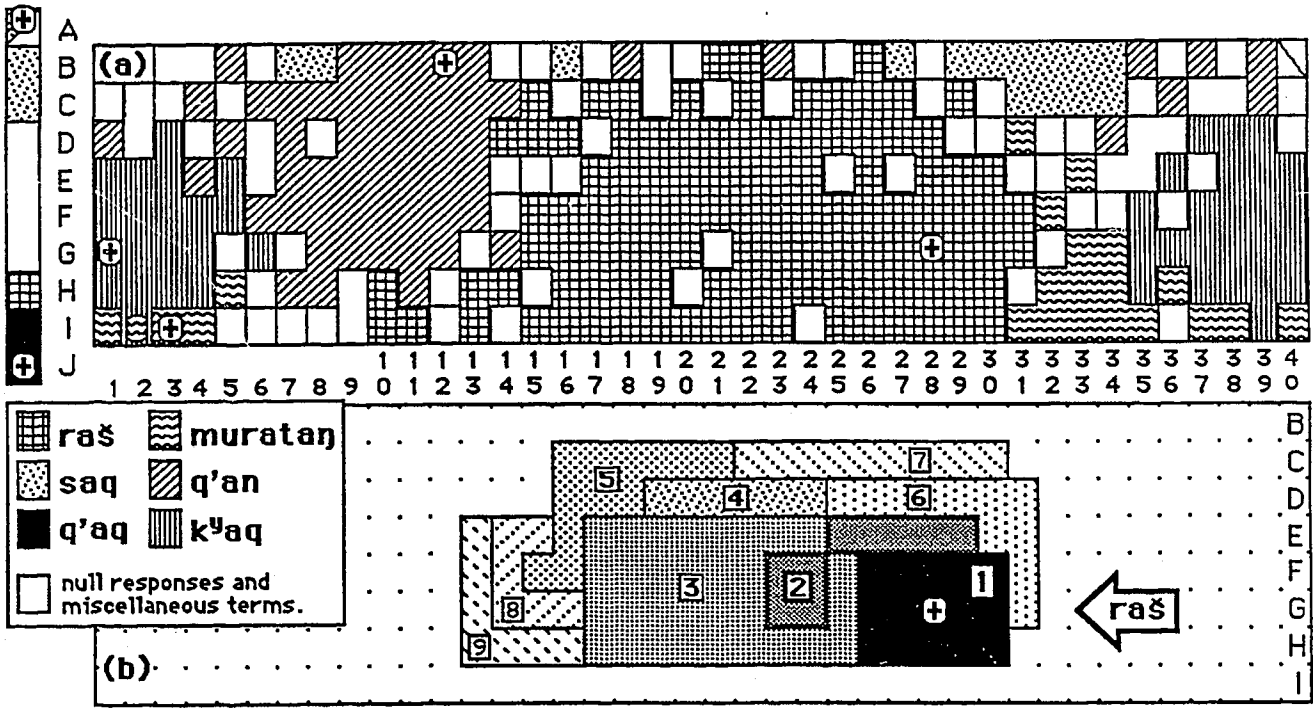
Figure 8.13 displays the curves of membership values from Figures 8.1d, 8.4c, 8.5c, 8.6c, 8.7d, 8.8c, and 8.9c. Vertical broken lines represent column 17 of unique green and column 29 of unique blue. Differences among the curves suggest a process of change by which the cool category becomes increasingly skewed as the attendance to distinctiveness is augmented; the process results in the complete division of the cool category into a basic green and a basic blue category (cf. Fig. 8.12c). As the process transpires, the focus moves from a centralized position, to a unique hue, to a polarized position; the value of membership remains high on the focal side of the category but diminishes to zero on the other side. Most important, the cool category is always skewed to some extent, even when it is "stable" and encompassed by a dark-cool category (cf. Fig. 8.2b); the cool category is always focused in reference to just one unique hue, and the focal side of the category always has a higher value of membership than the opposite side.

The theoretical importance of skewing and its relationship to category change is addressed in the concluding section, 8.5. The immediate intent is only to exemplify segments of the total process of change. In section 8.3., statistics are developed that demonstrate the correlation between continuous mappings and centralized foci and between disjuntive mappings and foci that are either on a unique hue or polarized. These correlations, not the examples of Figures 8.1a-12b, provide evidence that skewing involves particular regularities that pertain across Mesoamerican languages. The correlations, further, constitute one of the empirical bases for the three-part hypothesis.

8.2. Direction of Skewing

The examples of Figures 8.1a-12b all are skewed toward green. However, many individuals of the Mesoamerican sample skew the cool category toward blue. The skewing toward blue involves the same correlation between mapping pattern and foci placement that is exemplified in the foregoing figures. The curves of Figure 8.13, without alteration, could be horizontally inverted such that they represented degrees of skewing toward blue, instead of toward green.

Figures 8.14a-16 exemplify degrees to which the cool category has been skewed toward blue. The exemplification is not as complete as that of Figures 8.1a-12b, because the purpose only is to substantiate that skewing in the direction of blue occurs much in the same way as it does in the direction of green:



Figures 8.14a-b. Naming ranges (a) and mapping (b); Sacapultec, San Juan Sacapulas, man, age 78, 1980.

In Figures 8.14a-b, a Sacapultec speaker has named, focused and mapped a cool category with skewing toward blue. The focus is slightly centralized in column 28, one column to the inside of column 29 which contains unique blue.

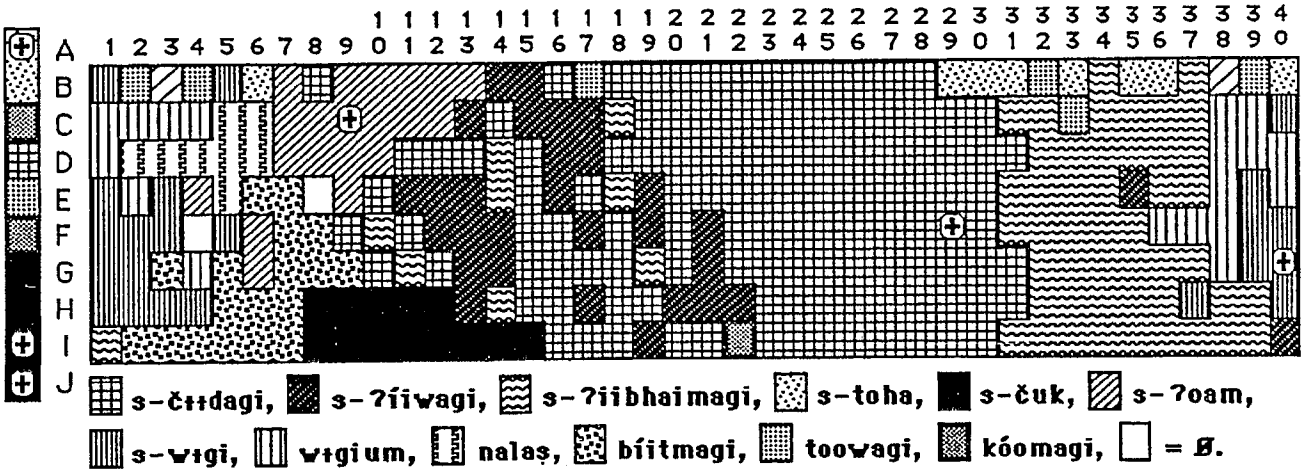


Figure 8.15. Naming ranges and foci; Pima, Gila River, woman, age 62, 1978.

Figure 8.15 displays naming ranges and foci from a Pima speaker; mappings were not collected. Skewing toward blue of the cool category is accompanied by a moderately salient secondary category, *s-ʔíiwagi,* among greens. The cool-category focus was placed on unique blue at F29; the focus of the green category was not elicited.

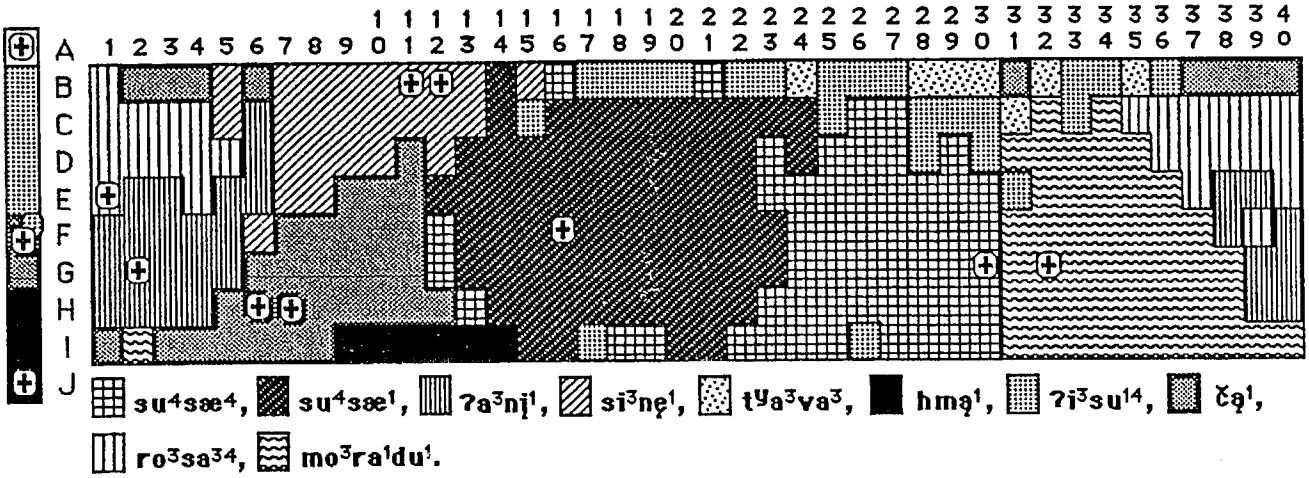


Figure 8.16. Naming ranges and foci; Mazatec, Chiquihuitlán, man, age 40, 1977.

In Figure 8.16, a Mazatec speaker has named a highly salient, secondary green category and has slightly polarized the cool-category focus at G30 one column to the outside of the column containing unique blue. The focus of the secondary green category is also polarized to the same slight degree at F16. The 'green' term, *su⁴sæ¹,* is derived by a change of pitch from the 'cool' term, *su⁴sæ⁴.*

8.3. Quantification

This section sets forth statistical correlations that substantiate the tendencies that are exemplified in sections 8.1. and 8.2.: (1) continuous mapping of the cool category corresponds with a centralized focus and disjunctive mapping corresponds with a focus that is either in the column of a unique hue or polarized; (2) three times as many individuals skew the cool category toward green than toward blue.

The statistics are embedded in a broader array of numbers that characterize the cool category within the Mesoamerican sample. All of the numbers are listed here:

Among the 898 individuals of the Mesoamerican sample, 589 used the cool category and 309 did not, a ratio of 1.52-to-1.[6] Of the 589, 478 composed the cool category from only one vantage and 102 composed it from two or more coextensive vantages, a ratio of of 4.69-to-1. Another 9 individuals constituted doubtful cases of coextensivity and, thus, are not counted in either class. Of the 589, 527 individuals focused the cool category on no more than two adjacent colors, 23 focused it on more than two adjacent colors, and, by oversight and error, 39 were not asked to focus the category during the interview.[7] Of the 527, 429 composed the category from one vantage and 98 composed it coextensively. Of the 23, all composed the category from one vantage. Of the 39, 35 composed it from one vantage and 4 composed it coextensively. Of the 102 who composed the cool category coextensively, 44 named each vantage with a different root, 10 named two or three vantages with the same root but differentiated them with modifiers, and 48 used the same term for both (or all) vantages without distinguishing them on any level.

Thirty-two individuals who used the cool category included it within the range of a black-focused dark-cool category; 30 of them composed the secondary cool category from

[6]The cool category was identified in data by either (1) a naming range that pertained both to column 18 and to column 28 or (2) a mapping that covered both unique green at F17 and unique blue at F29 or both (1) and (2). Generally, the mapping of a term is expected to be broader than its naming range.

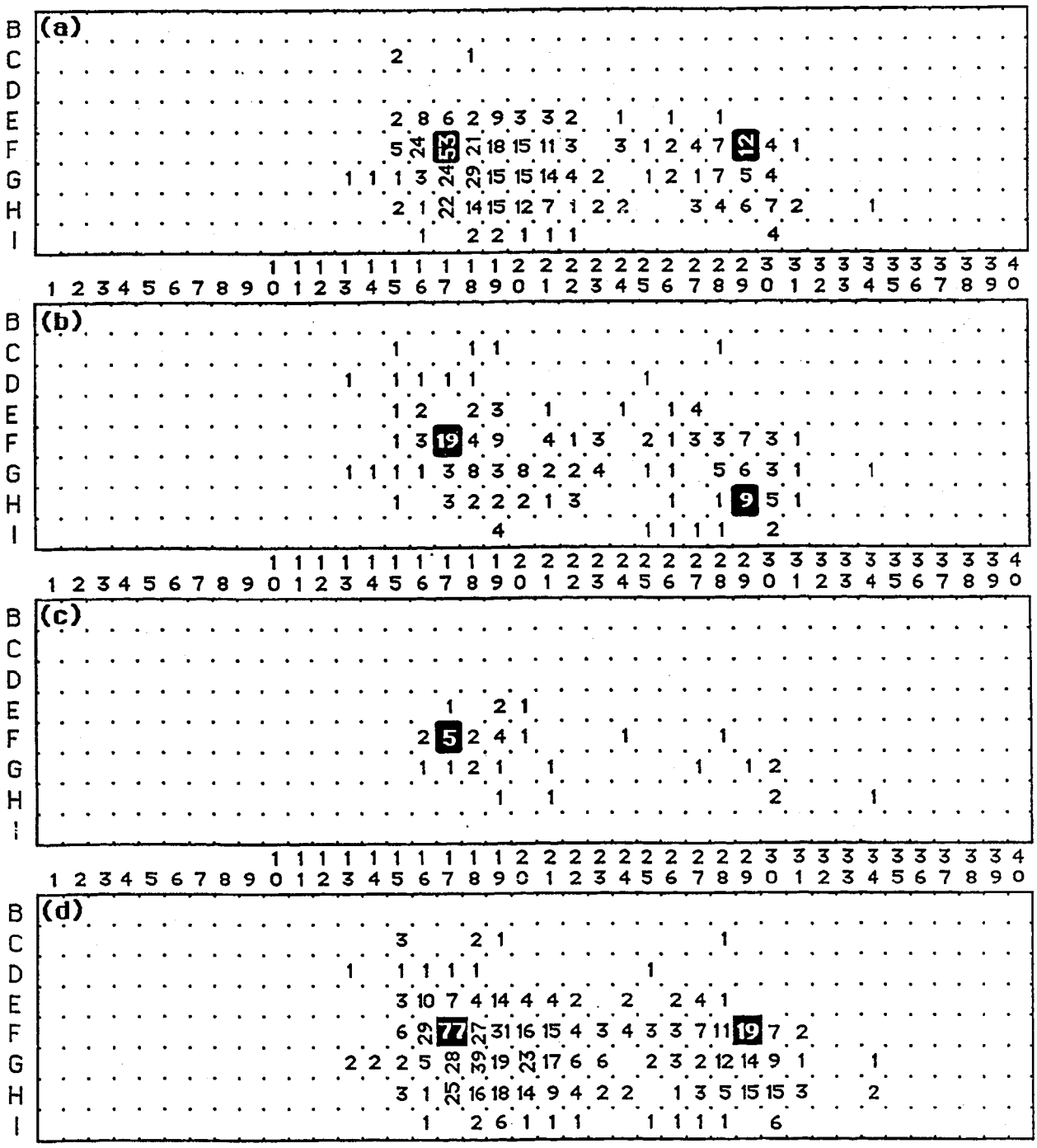
[7]When an individual extended a focus over many colors but expressed a preference for one or two of them, only the preferred color(s) was counted, as in Figures 4.5a and 5.5a-b.

one vantage, and 2 composed it coextensively. Both of the 2 separately named each vantage.

Mappings were collected from 260 of the 589 individuals who used the cool category. Of the 260 mappings, 33 are not used in calculations: 5 are of categories that were focused on more than two adjacent colors, and 28 are not accompanied by a focus. Of the remaining 227 mappings, 151 are of categories composed of one vantage and 76 regard categories that are coextensively composed. Of the 151, 81 are disjunctive and 70 are continuous. Of the 76 individuals who demonstrated coextensivity, 29 named each coextensive vantage with a separate root, 10 differentiated each vantage with a different modifier of the same root, and 37 named both vantages with one term without any differentiation. Each term of the 29 coextensive pairs was separately mapped, and most of the modifications were separately mapped in the 10 cases.

Implications of the foregoing numbers are developed in conjunction with Figures 8.17a-28b:

Some statistics bear on the **direction of skewing**. Figures 8.17a-d display the number of times each color of the Munsell array was chosen as a focus for different classes of cool categories. The figures aggregate only the individual choices that occurred on one color, on two adjacent colors, or on non-adjacent colors; the 23 choices that covered three or more adjacent colors are omitted. Figure 8.17a shows the aggregate of foci chosen for the 399 basic cool categories for which there was no evidence of a coextensive composition. Figure 8.17b shows the aggregate for the 98 secondary and basic coextensively composed categories, both those named with two terms and those named with one. Many of the latter were focused on only one color, which is one of the reasons that there was not an equal number of choices on either side of column 23. Figure 8.17c shows the aggregate for the 30 secondary categories that were not coextensively composed.



Figures 8.17a-d. Aggregates of cool-category foci: (a) basic categories composed from one vantage, (b) basic and secondary coextensively composed categories, (c) secondary categories composed from one vantage, (d) all categories (a-c).

Figure 8.17d combines all of the choices from Figures 8.17a-c and, thus, represents all of the focus-choices of no more than two adjacent colors that were recorded in the Mesoamerican sample. A plurality of 77 individuals favored as a focus the color of F17 on the green side of the cool category, and on the blue side 19 favored the color of F29. In each figure the most popular choice on either side of the category is marked against a dark background.

Figures 8.18-21 display with bar graphs the same data as in Figures 8.17a-d. The bars depict for each column the percentage of the total number of selections that was placed in that column; a selection is one individual's designation of a color as a focus, and such a designation of two adjacent colors constitutes two selections. For this reason, the total number of selections and the number of categories represented by each figure differ. The number of selections per column appears at the bottom of each, and the percentage of the total that is constituted by the number appears over each bar.

Figures 8.18-21 reveal a major preference among speakers of Mesoamerican languages for the direction of skewing: *At least three times as many individuals focused the cool category on green than on blue.* On either side of column 23, the numbers are: in Figure 8.18, 80.68% versus 18.38% or 4.39-to-1 for single-vantage basic categories; in Figure 8.19, 52.65% versus 37.21% or 1.54-to-1 for coextensively composed categories; in Figure 8.20, 74.26% versus 22.82% or 3.25-to-1 for single-vantage secondary categories; in Figure 8.21, 73.95% versus 24.26% or 3.05-to-1 for all of the categories.

In Figure 8.19, the ratio is least, because this aggregate contains the foci of 44 categories that are composed of separately named coextensive vantages; in many cases, the vantages were focused on opposite sides of a category. Moreover, coextensively composed categories whose vantages bear the same name tend to show ample variation in focus selection among speakers of one language, perhaps as a result of the "crossover effect." Nevertheless, more greens than blues were chosen as the foci of coextensively composed cool categories. Even these categories manifest the preference of a green focus.

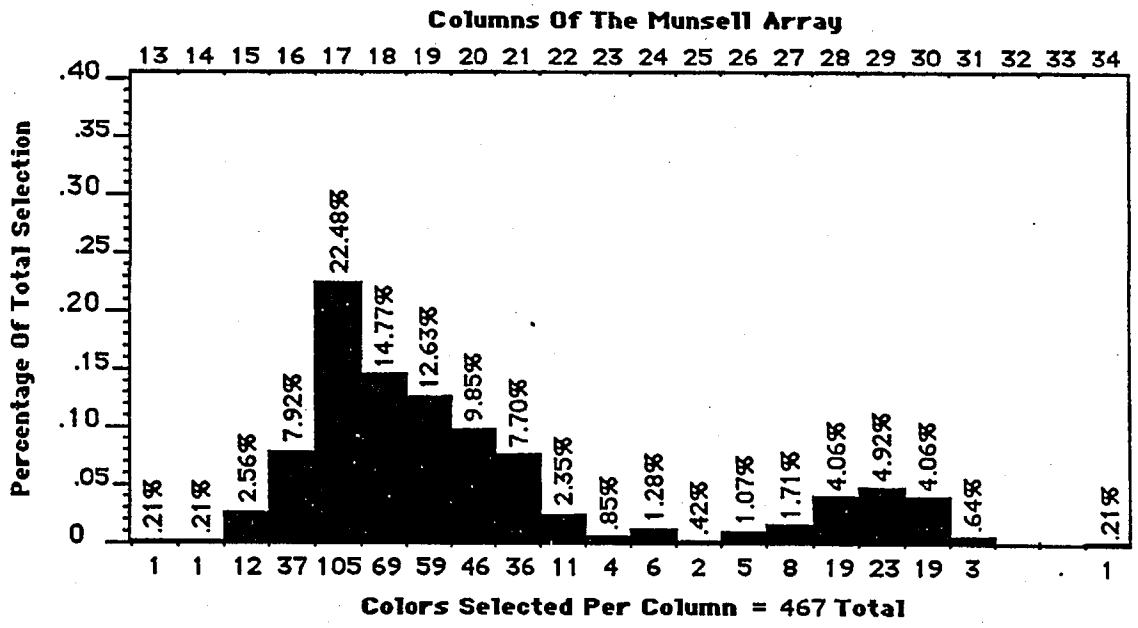


Figure 8.18. Aggregated foci of basic cool categories composed from one vantage, those of Figure 8.17a.

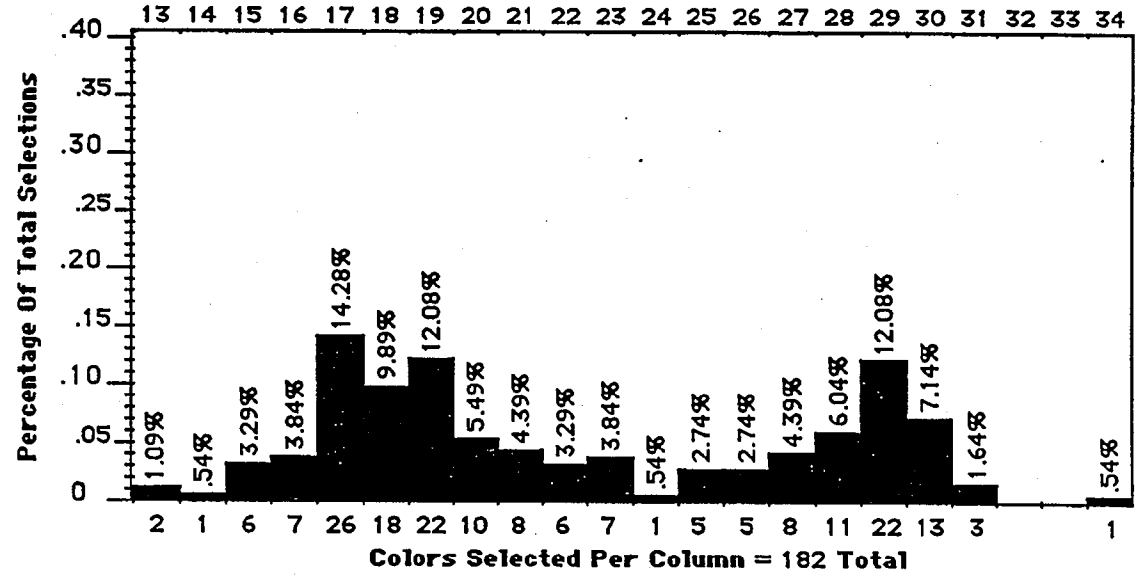


Figure 8.19. Aggregated foci of basic and secondary coextensively composed cool categories, those of Figure 8.17b.

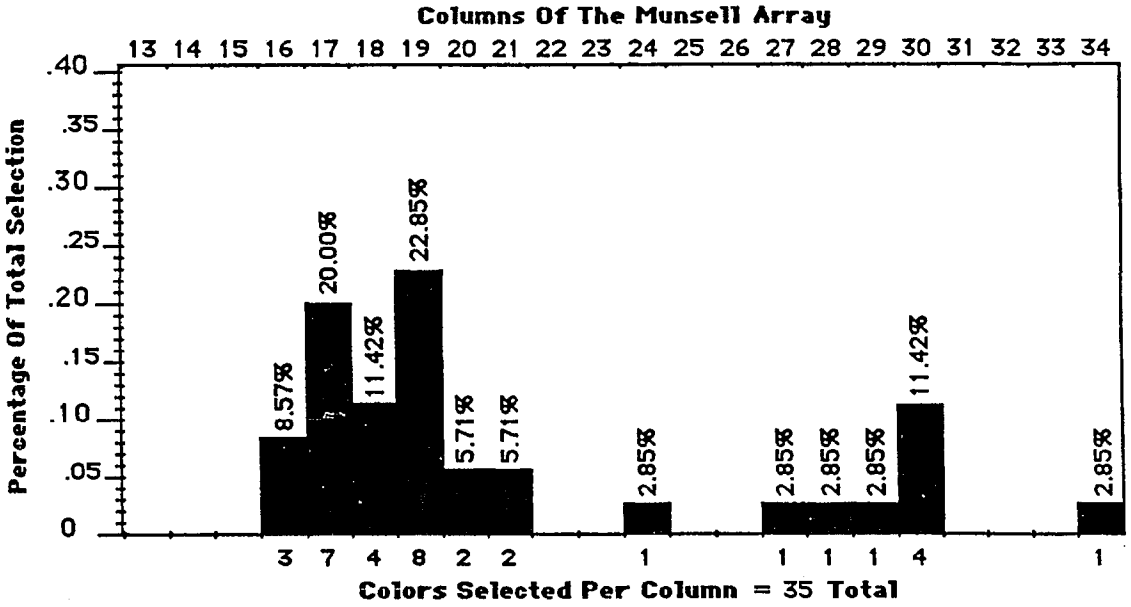


Figure 8.20. Aggregated foci of secondary cool categories composed from one vantage, those of Figure 8.17c.

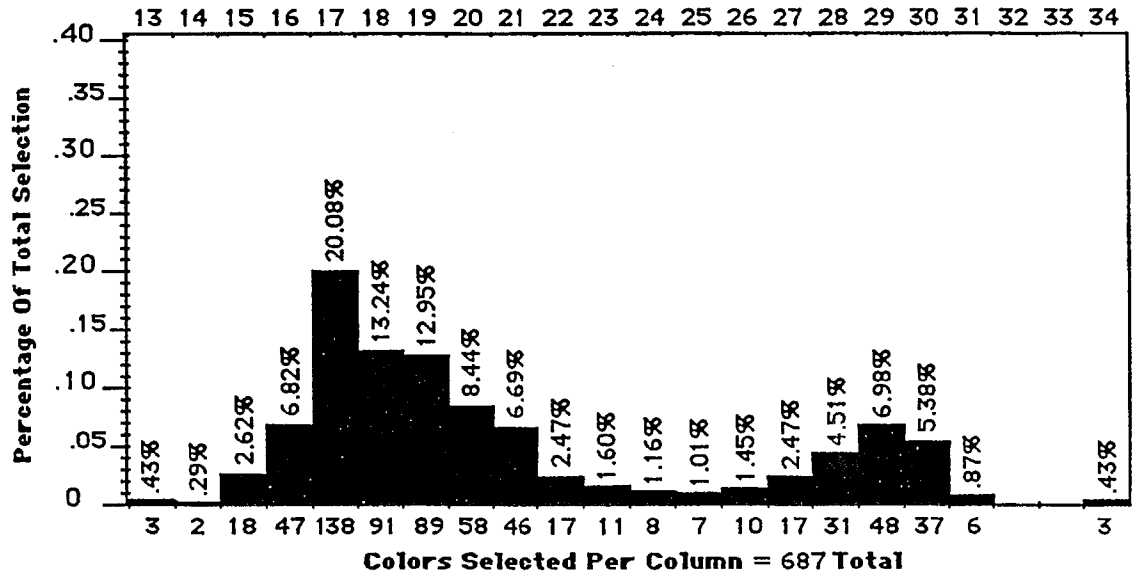


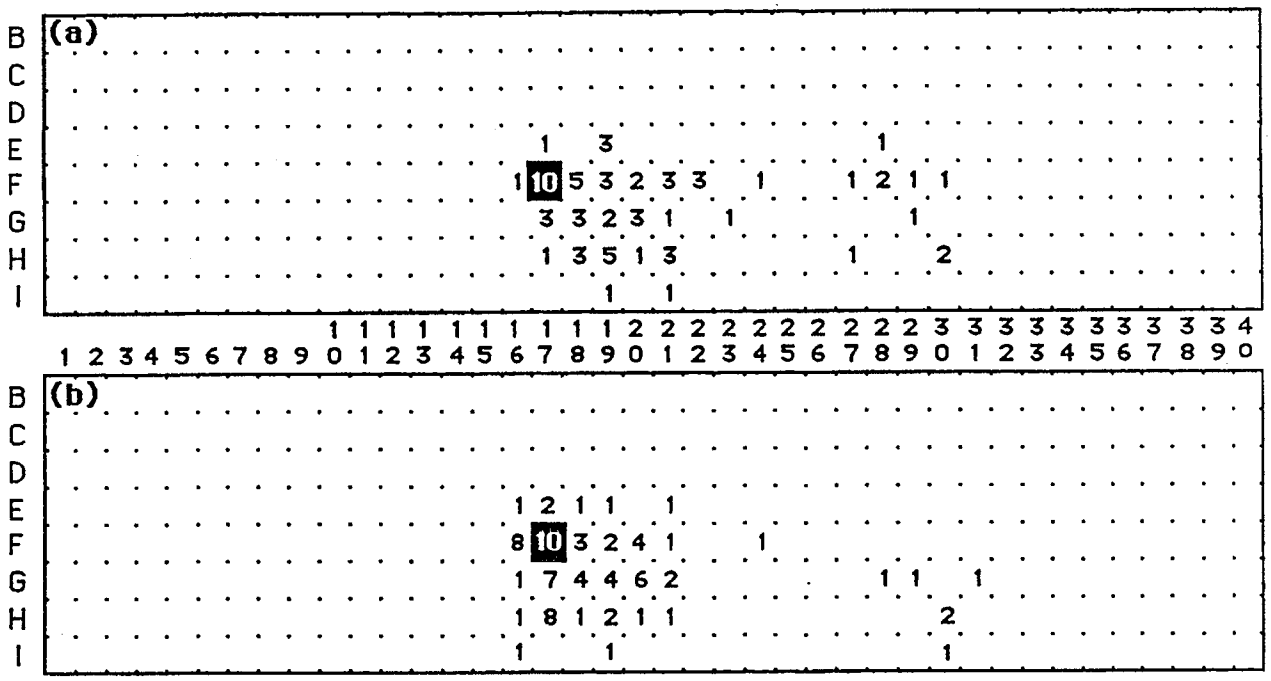
Figure 8.21. Aggregated foci of all cool categories, those of Figure 8.17d; focal aggregates of this figure and prior figures exclude selections of more than two adjacent colors.

The ratio is less for the secondary cool categories of Figure 8.20 than for the basic cool categories of Figure 8.18. The difference implies that the attainment of basic status -- or the greater attendance to distinctiveness that occasions basic status -- encouraged skewing specifically toward green.

The ratio among the total aggregate in Figure 8.21 is less than that among the aggregate of exclusively single-vantage basic categories in Figure 8.18, because the total incorporates the reduced ratios of coextensively composed categories and of secondary categories, those seen in Figures 8.19 and 8.20.

An additional set of statistics bears upon the **degree of skewing**. These show that continuous mappings correspond with centralized foci -- that is, foci that are placed between the columns of unique green and unique blue -- and that disjunctive mappings correspond with foci that are placed in the column of a unique hue or placed in a polarized position between such a column and the category-margin. The correlations coincide with the sequence of development that is summarized in Figure 8.13, and they support the three-part hypothesis of (1) skewing, (2) composition, and (3) division that would account for the sequence. As specified in section 8.0., entailments of the second part (2) of the hypothesis would lead us to expect the correspondence between mapping pattern and foci placement that is evident in the following data:

Figures 8.22a-24 display all foci in the Mesoamerican sample of cool categories that were both composed from just one vantage and mapped. The display excludes the foci of categories that were coextensively composed and/or that were not mapped, and it excludes foci of more than two adjacent colors. All mappings were either continuous or disjunctive in the manner exhibited by Figures 8.1a-3c versus 8.4a-9b, 8.14b.



Figures 8.22a-b. Aggregated foci of cool categories that were mapped (a) continuously and (b) disjunctively.

Figure 8.22a aggregates the foci of single-vantage cool categories that were continuously mapped, and Figure 8.22b aggregates the foci of single-vantage cool categories that were disjunctively mapped.

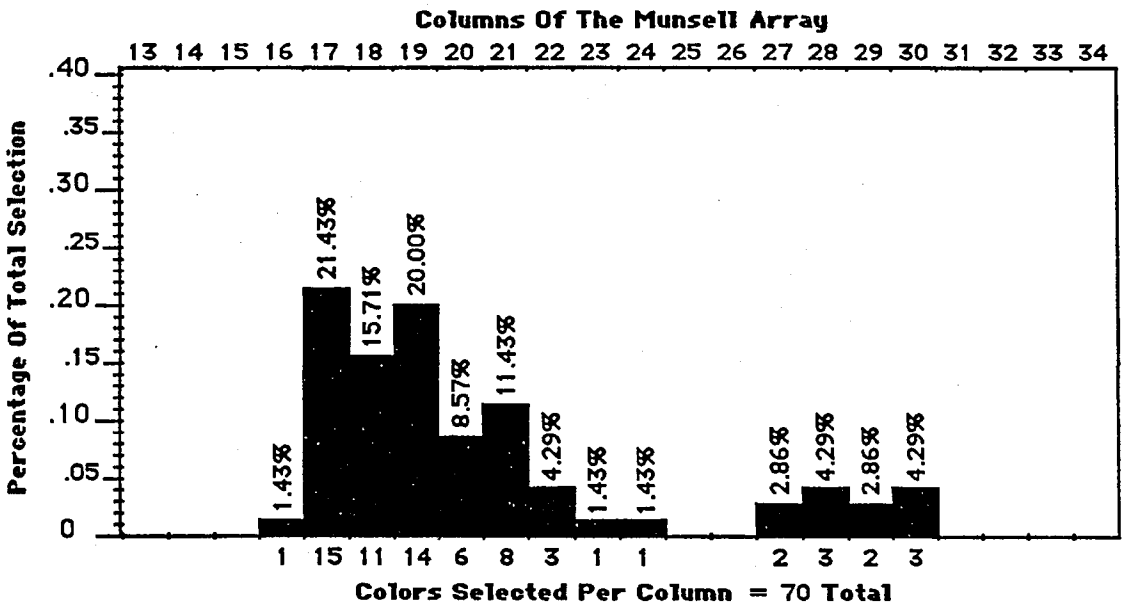


Figure 8.23. Aggregated foci of cool categories that were mapped continuously, those of Figure 8.22a.

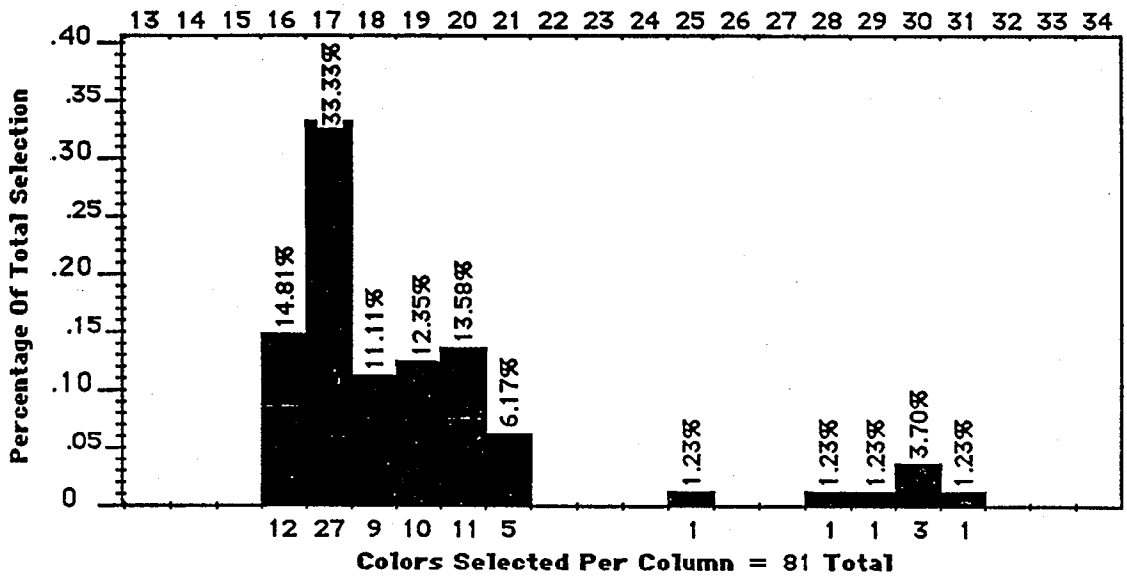


Figure 8.24. Aggregated foci of cool categories that were mapped disjunctively, those of Figure 8.22b.

Figures 8.23 and 8.24 provide bar graphs that show the percentage of total foci in each column of the Munsell array.

The foci of categories that were continuously mapped were selected at the following ratio: *69.94% between column 17 of unique green and column 29 of unique blue; 30.06% within these columns or outside of them on marginal colors.* The foci of categories that were disjunctively mapped were selected at a different ratio: *45.70% between the unique-hue columns; 54.30% within or outside.*

As a further tendency, the figures show that the continuous mappings correspond to a more even distribution of foci on the green and blue sides of column 23: continuous mappings, 81.86% green versus 15.73% blue; disjunctive mappings, 91.35% green versus 8.62% blue. The difference between ratios corroborates that which prevails among the secondary and basic single-vantage categories of Figures 8.20 and 8.18.

Foci tend to migrate away from the center of the cool category and toward its unique hues and its margins as the attendance to distinctiveness is enhanced and as the category approaches a full division.

If the migration were active, the correspondence of foci with unique hues and marginal colors would be exceptionally strong after the cool category had divided completely. That is, among basic categories of just green or just blue, the correspondence would pertain even more strongly than it does among disjunctively mapped cool categories. Figures 8.25-28b display data that show this correspondence:

In Figure 8.25, for purposes of comparison, the total aggregate of cool category foci of Figure 8.21 is artificially divided such that the focus selections of green colors in columns 13-23 and the selections of blue colors in columns 25-34 are separately summed to different totals; the percentage of selections is calculated for each column against only the total that pertains to it. This provision enables an unimpeded visual comparison between the data of Figure 8.21 and those of Figure 8.26. The latter figure displays the percentage of focus selections for each column against the total number of selections for all individual uses of the basic green category and of the basic blue category within the Mesoamerican

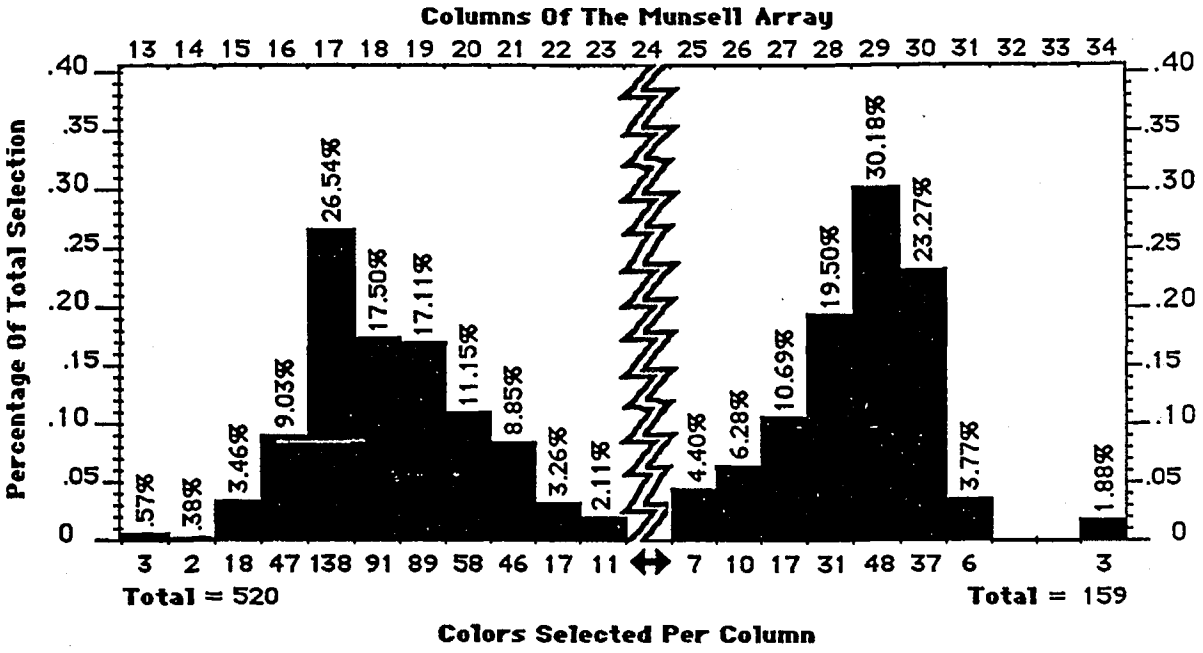


Figure 8.25. The same aggregate of all cool-category foci as in Figure 8.21, but with percentages calculated from separate totals on either side of column 24 to facilitate comparison with Figure 8.26.

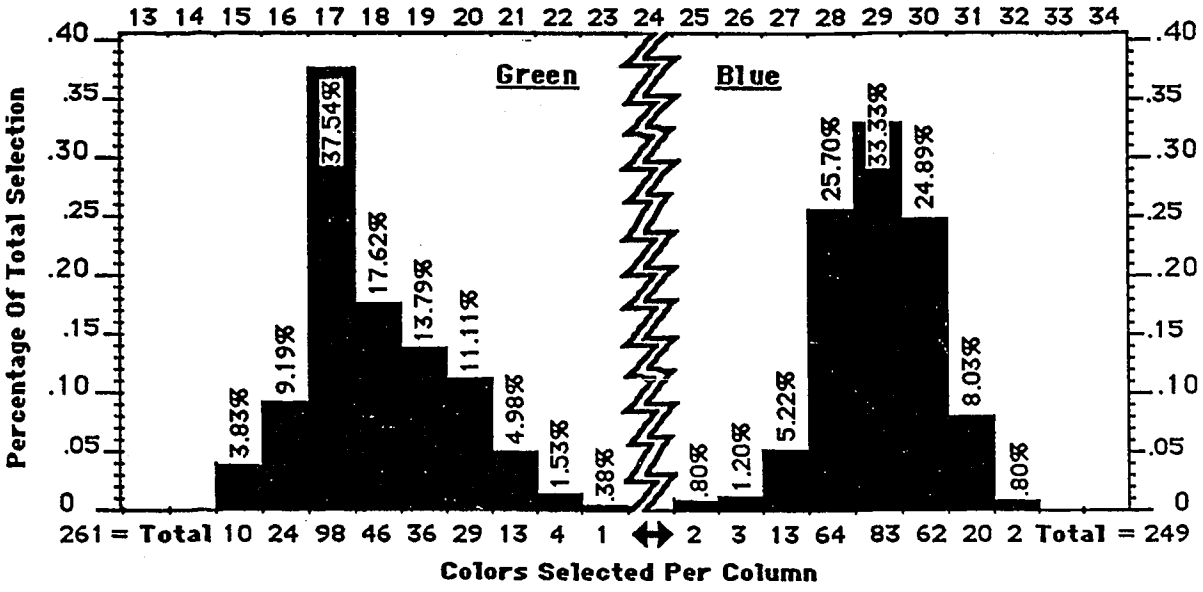


Figure 8.26. Separate aggregates of foci of the basic green category and the basic blue category, those of Figure 8.28b, with percentages calculated separately for each aggregate. Since neither category was focused in column 24, division occurs there instead of column 23.

sample. The total for the green category and for the blue category are naturally distinct, because the two categories are separate.

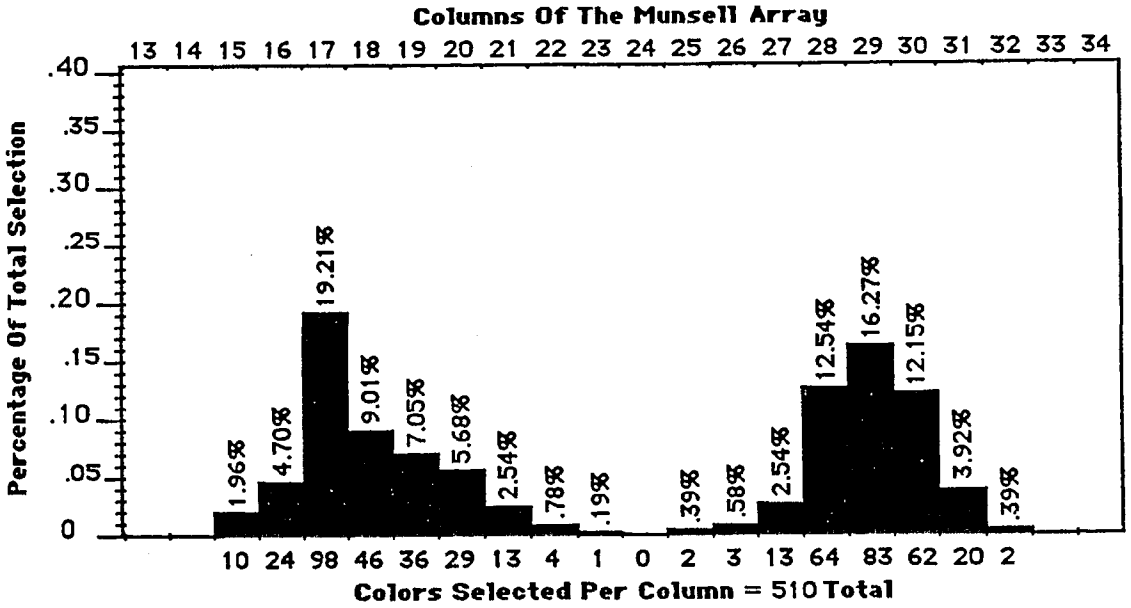


Figure 8.27. An artificial aggregate of foci of both the basic green and basic blue category, those of Figure 8.26, with percentages calculated from one total to facilitate comparison with Figure 8.21.

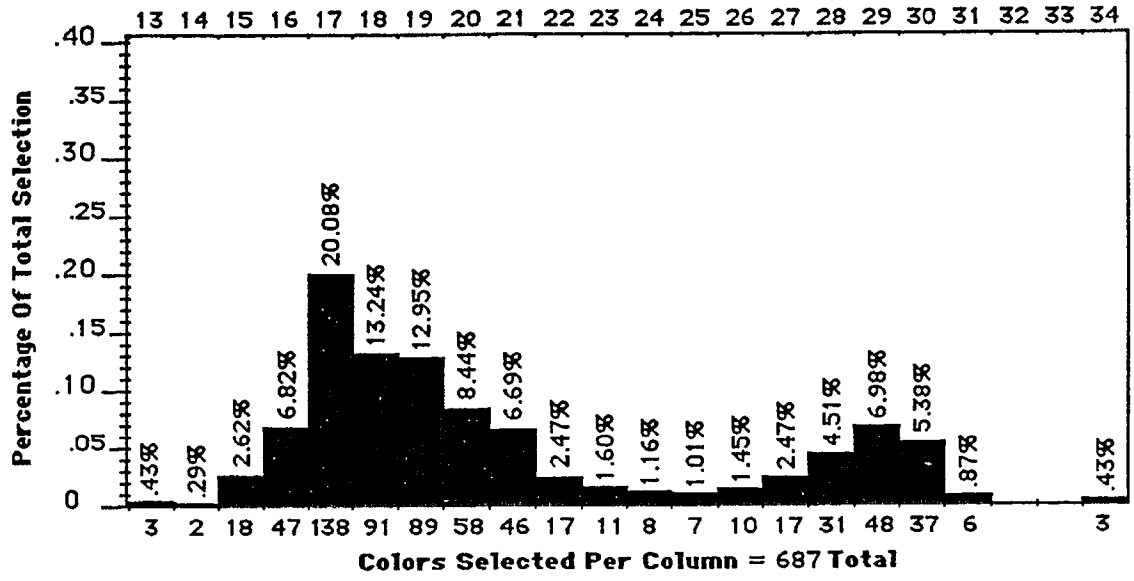


Figure 8.21. Aggregated foci of all cool categories reproduced from original figure, page 288.

Figure 8.27 adopts the opposite strategy: the focus selections for the basic green and basic blue category are artificially summed to one total throughout all columns, as

would be done for focal selections within the cool category. This facilitates visual comparision and numerical comparison between the distribution of aggregated cool-category foci in Figures 8.18-21,23-24 and that of the basic green and basic blue category.

Percentages from Figures 8.23-24 and 8.27 are summarized and compared in Table 8.1:

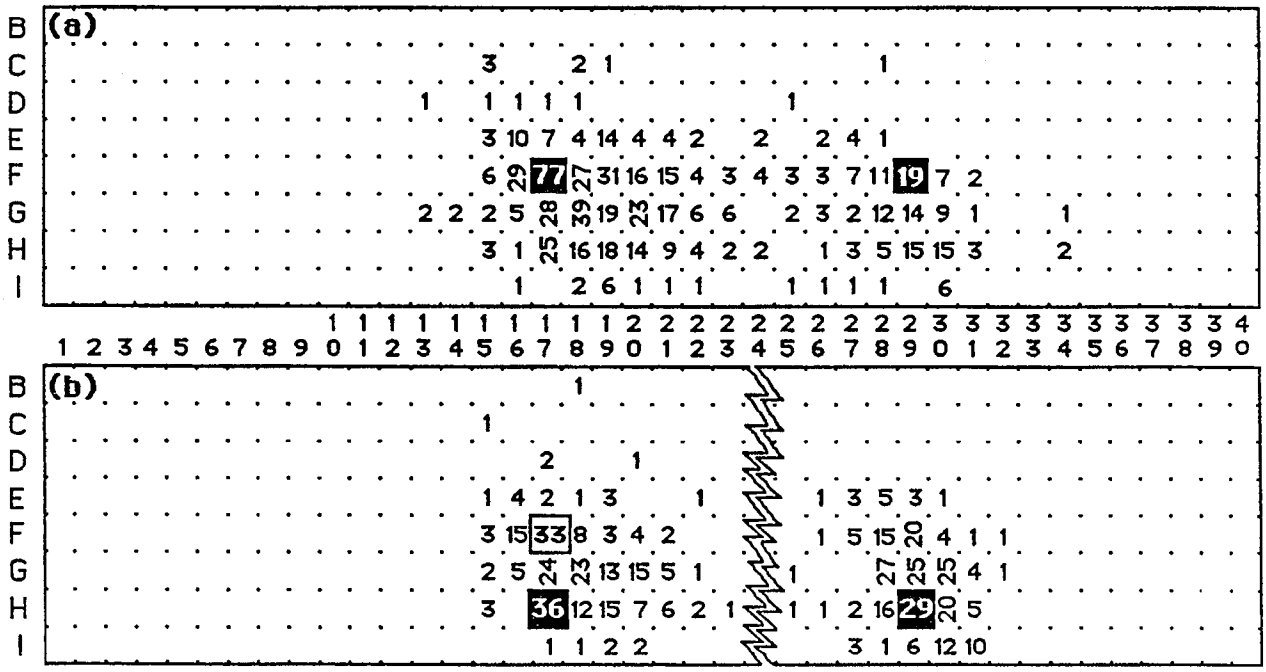
Table 8.1

	Green		Blue	Totals
CONTINUOUS MAPPINGS, FIG. 8.23				
Polarized	1.48		4.29	5.77
Unique Hues (UH)	21.43		2.86	24.29
Polarized + UH	22.91		7.15	30.06
Between UH		69.94		69.94
DISJUNCTIVE MAPPINGS, FIG. 8.24				
Polarized	14.81		4.93	19.74
Unique Hues	33.33		1.23	34.56
Polarized + UH	48.14		6.16	54.30
Between UH		45.70		45.70
BASIC GREEN AND BASIC BLUE, FIG. 8.27				
Polarized	6.66		16.46	23.12
Unique Hues	19.21		16.27	35.48
Polarized + UH	25.87		32.73	58.60
Between UH		41.30		41.30

Table 8.1 shows how the distribution of focus selections vary among cool categories that are continuously mapped, cool categories that are disjunctively mapped, and the artificially constituted aggregate from the basic green and the basic blue category. Polarized selections outside of columns 17 and 29 increase across the three classes of aggregate. Selections within the unique-hue columns 17 and 29 also increase. Correspondingly, selections between the unique-hue columns decrease.

Matching statistics from the total aggregate of cool-category foci in Figure 8.21 are intermediate to those from continuously mapped cool categories and disjunctively mapped cool categories: polarized total = 16.84, unique-hue total = 27.06, polarized + unique-hue total = 43.90, between-unique-hues total = 56.10.

A final statistic involves the distribution of focus selections in relation to levels of brightness. Figures 8.28a-b compare the distribution of foci within the total aggregate from the cool-category with distributions within the separate aggregates from the basic green category and the basic cool category. Figure 8.28b displays the latter, and Figure 8.28a is repeated from Figure 8.17d:



Figures 8.28a-b. Aggregates of foci of (a) all cool categories, those of Figure 8.17d, and (b) the basic green category and the basic blue category.

The figures show that the foci of the cool category tend to be lighter than those of the basic green and basic blue category. For example, in the cool category the plurality of selections among green colors and blue colors occurs at F17 and F29, whereas in the

green category and the blue category the plurality of selections are two levels of brightness darker at H17 and H29.[8]

[8]The darker foci of the basic green and the basic blue category are addressed in Volume II. The foci are darker than those of the cool category by two levels of brightness, because one of the cognitive coordinates was replaced by a second perceptual coordinate as the cool category divided and as green and blue assumed a relationship of complementation. That is, the attendance to similarity was discontinued as a coordinate while a coordinate on the brightness dimension was adopted in its stead. Darkness was adopted rather than lightness because black is closer in perceptual distance to unique green and to unique blue than is white. The result is a vantage point that is constituted by coordinates of one unique hue, darkness, and the attendance to distinctiveness, that is, two perceptions and one cognition. The attendance to similarity was discontinued as a coordinate because, after category division -- that is, after the attendance to distinctiveness was strengthened to an extreme -- similarity was reciprocally diminished such that it no longer pertained to the relationship between unique green and unique blue. The attendance to similarity was replaced with a second perceptual coordinate because people are predisposed to constitute any vantage point with at least three coordinates; in physical space, any higher organism reckons its position in reference to three perpendiculars, which might set the lower limit for the number of coordinates that human beings will use to compose the vantage of a category without suffering a sense of disorientation or dissonance.

Figure 8.28b shows a bimodal concentration of foci at dark green of H17 and unique green of F17. The maximal concentration of blue foci is only dark, not bimodal.

In specifically green some individuals do not automatically adopt the brightness coordinate; they might still maintain the attendance to similarity, even though by outward appearance they have divided green and blue into separate basic categories. Some might continue to maintain the cool category, although naming ranges and mappings do not show it. Or they might represent the situations suggested in section 7.0 under items 6 and 7: a relationship is maintained that is intermedial to inclusion and complemention; although the range of the green-focused category is empirically noted to pertain only to green, the vantage is still constituted by the kind of linkage among coordinates that characterizes a relationship of inclusion.

The absence of the bimodal focus concentration in blue is explicable by a concept that is introduced in section 8.4.9., "transference." In section 8.5.1. and in Chapter IX, it is argued that under most conditions a cool category is skewed toward green rather than blue before final division. The vantage from green assumes the characteristics of a dominant or superordinate vantage. In such a vantage, the attendance to similarity is stronger than in a recessive or subordinate vantage, and hence that cognition is more resistant to replacement by a perceptual coordinate from the brightness dimension.

Section 9.3 addresses the rare use of the brightness coordinate in the cool category before the attendance to similarity is "discontinued" (cf. Figures 8.33a-b and 8.34a-d). This suggests that the attendance to similarity is never discontinued but rather diminished greatly. As it diminishes, different individuals feel compelled to bolster the vantage with a second perceptual coordinate, some sooner than others. A few adopt the brightness coordinate early, before the cool category divides; others forestall the adoption, even after division.

Foci collected by Caskey-Sirmons and Hickerson (1977: figs. 1a-2b,4a-5b) from monolingual and bilingual speakers of five Asian languages show that the bilinguals tend to concentrate green and blue foci on more widely separated and darker colors. The bilinguals were more cosmopolitan and, likely, inclined to attend more strongly to distinctiveness. These data corroborate those of Figure 8.28b. Caskey-Sirmons and Hickerson propose that the bilinguals placed foci so as to copy the foci of English speakers. The present hypothesis stipulates that both the Asian bilinguals and the English speakers attend to distinctiveness at the same strength, but neither group copies an external ideal.

Iijima, Wenning, and Zollinger (1982: figs. 1-4) compiled lexical response curves for Japanese speakers in semi-rural, urban, and urban-foreign settings. The curves show an equivalent progressive separation of green and blue maximal usages. Japanese was unusual in the sense that its now-extinct "cool" category was skewed toward blue rather than green, as discussed in section 8.5.1.1. Commensurately, the Japanese response curves are bimodal in blue, as are the green foci of Figure 8.28b. If follow-up studies of Japanese were conducted, individuals who contribute, respectively, to the inner and outer maxima of the bimodal curve in blue might volunteer lighter and darker blue-category foci.

In sum, more than three times as many speakers of Mesoamerican languages skew the cool category toward green than toward blue. A higher percentage of basic cool categories than secondary cool categories are skewed toward green, and the statistic is repeated between disjunctively mapped and continuously mapped cool categories. Correspondence between distinct mapping patterns and focus placements support the three-part hypothesis of (1) skewing, (2) composition, and (3) division that is exemplified by the curves (1-5b) of Figure 8.13. The hypothesis is further reinforced by the distribution of foci within the artificially constituted aggregate from the basic green and the basic blue category. As an aside, the foci of the latter two categories tend to be darker than those of the cool category.

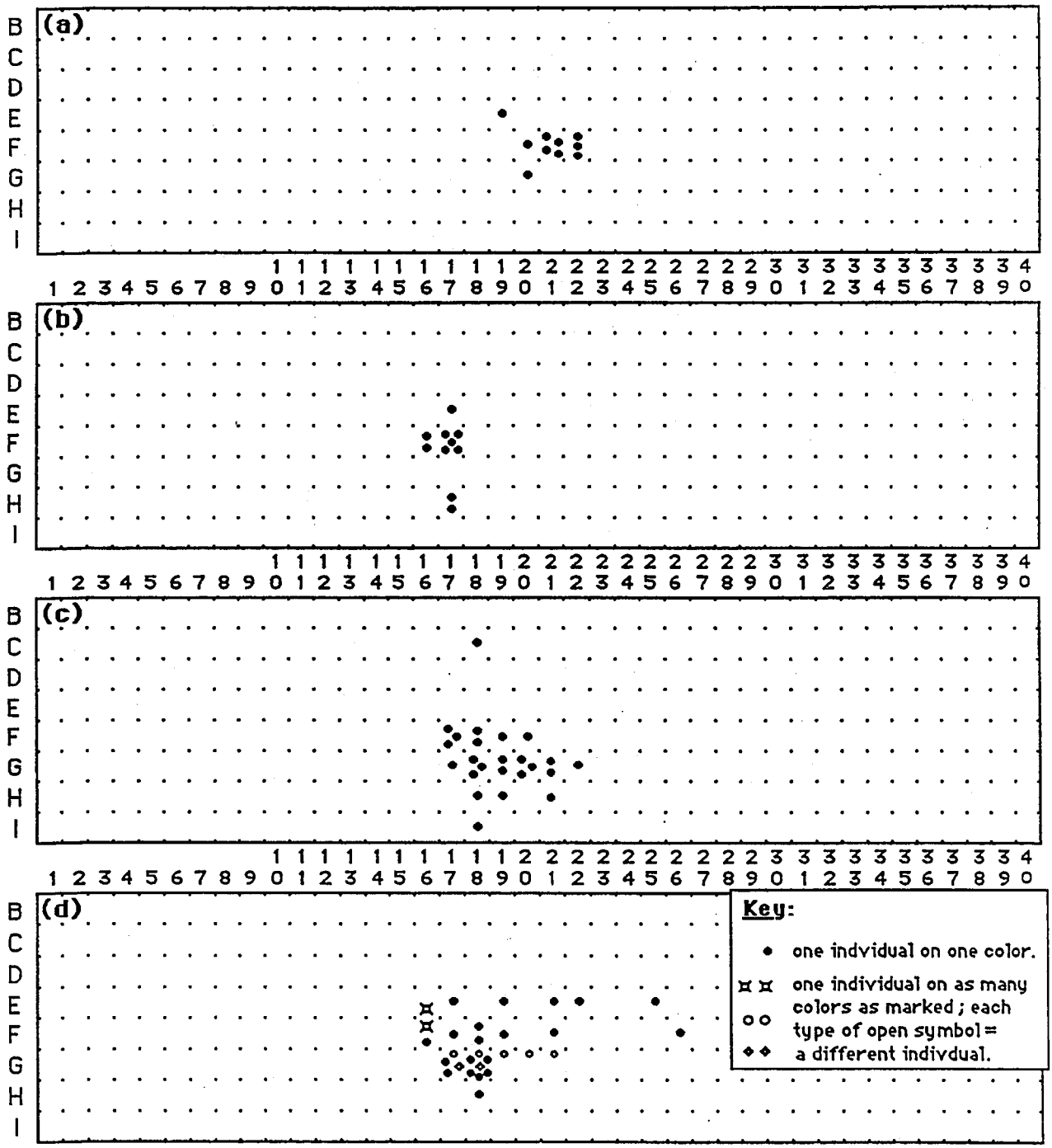
The statistics have implications for theory, which are developed in the concluding section.

8.4. Case Studies of Skewing

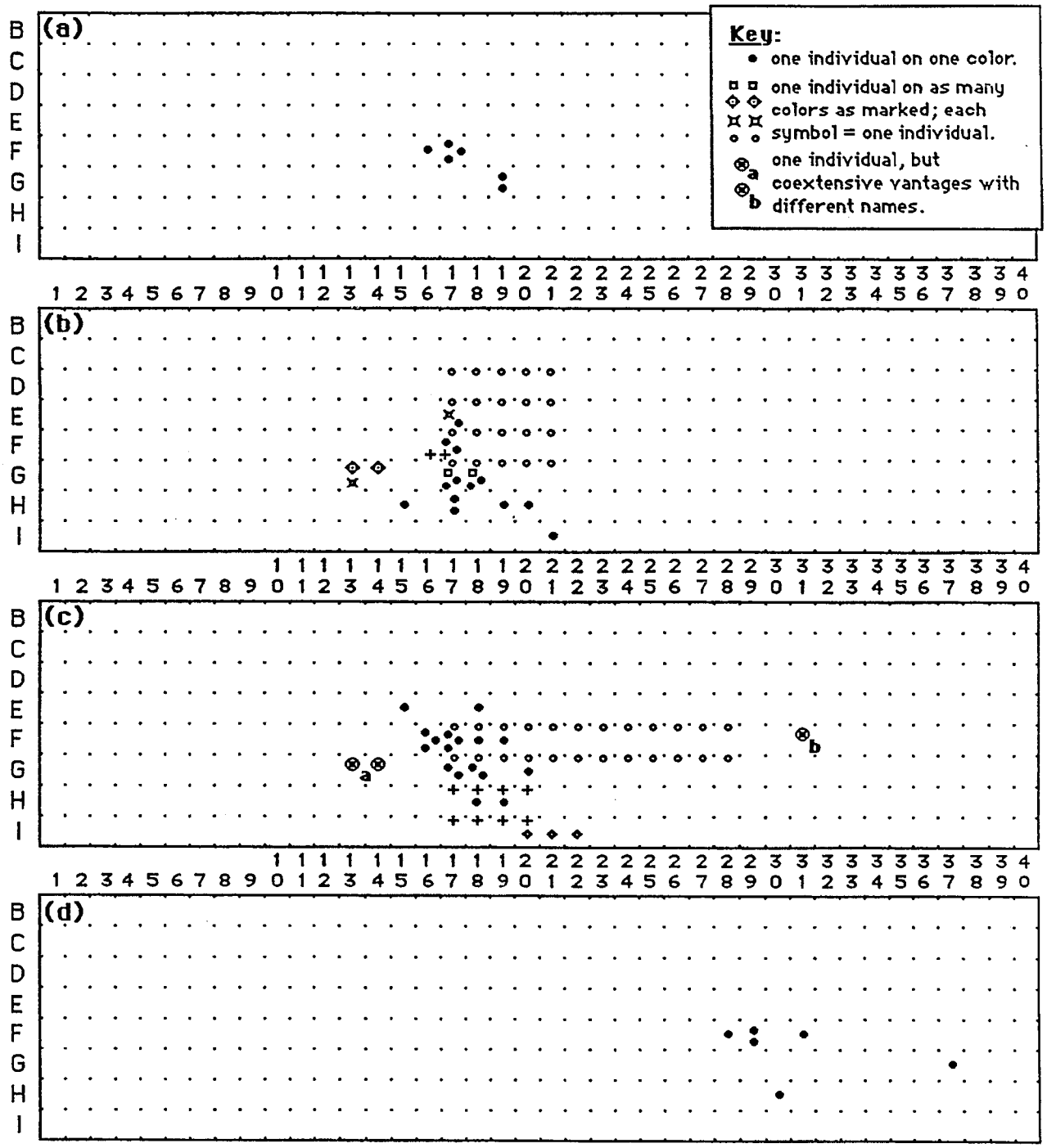
This section balances the numerical analysis of skewing with examples from specific languages. These examples, like those of sections 8.1-2., in themselves substantiate little; implications for theory derive from the over-all numbers. However, the case studies round out the statistics with detail concerning non-correspondence of focus and mapping pattern, transference of skewing from the blue side to the green side of the category, exceptional systems, the skewing of naming ranges and of modifier distributions, and other specifics.

8.4.1. Foci

Figures 8.29a-30d depict aggregates of cool-category foci from speakers of single languages. The aggregates differ in distribution between languages:



Figures 8.29a-d. Aggregated cool-category foci from speakers of four languages: (a) Santa Buenaventura Nahuatl, (b) Chiquimula Quiché, (c) Palantla Chinantec, (d) Texmelucan Zapotec.



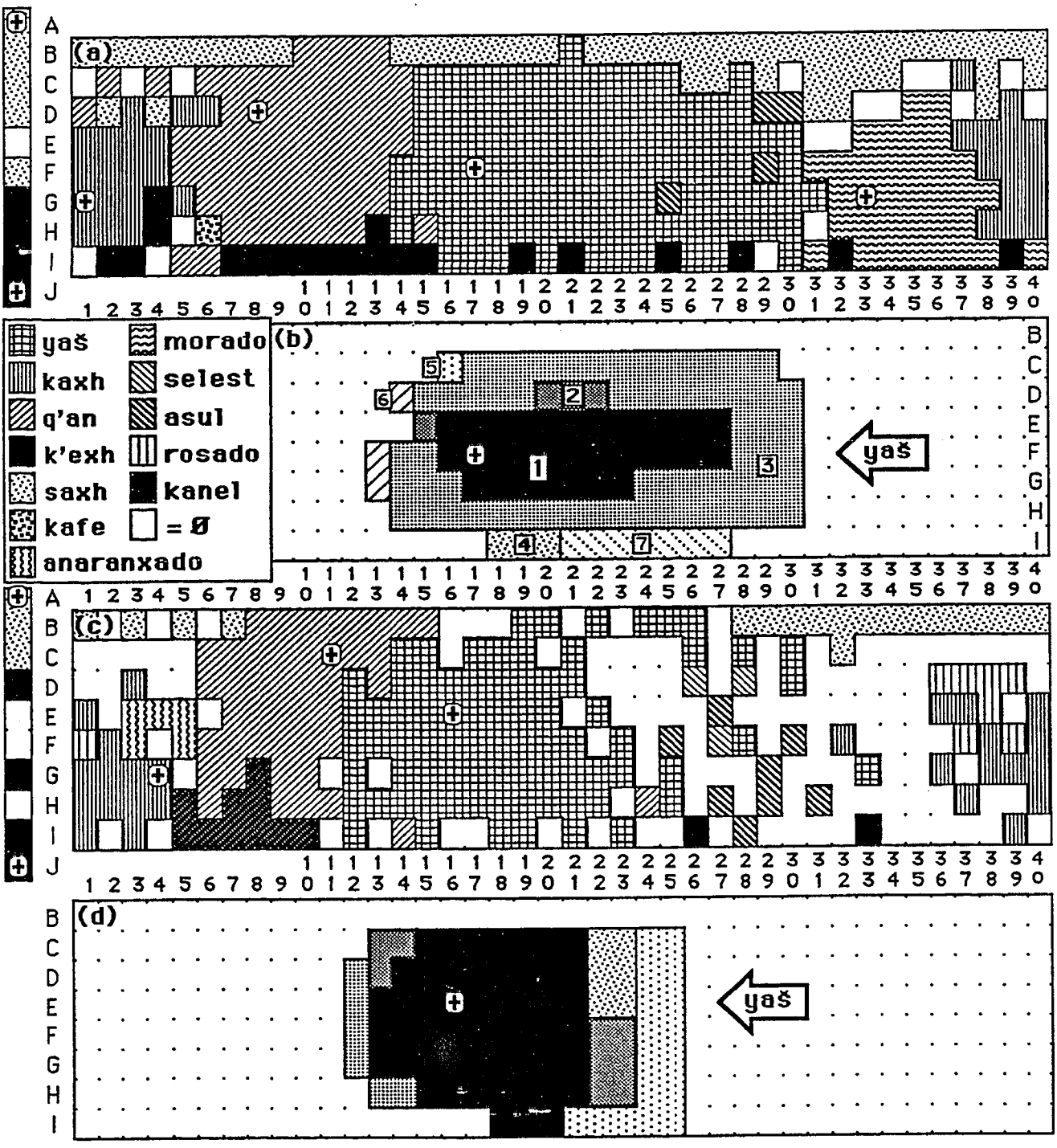
Figures 8.30a-d. Aggregated cool-category foci from speakers of four languages: (a) Jacaltec of Jacaltenango, (b) Patzun Cakchiquel, (c) Malinaltepec Tlapanec, (d) Lacandón of Naha'.

Figures 8.29a-b display foci from 10 speakers of Santa Buenaventura Nahuatl and from 10 speakers of Chiquimula Quiché. The Nahautl foci are centralized to the green side of column 23 and the Quiché foci are placed on or outside of unique green in column 17. All of the Nahuatl speakers mapped the cool category continuously, as in Figure 8.1b; all of the Quiché speakers mapped the cool category disjunctively, as in Figures 8.8b and 8.42c.

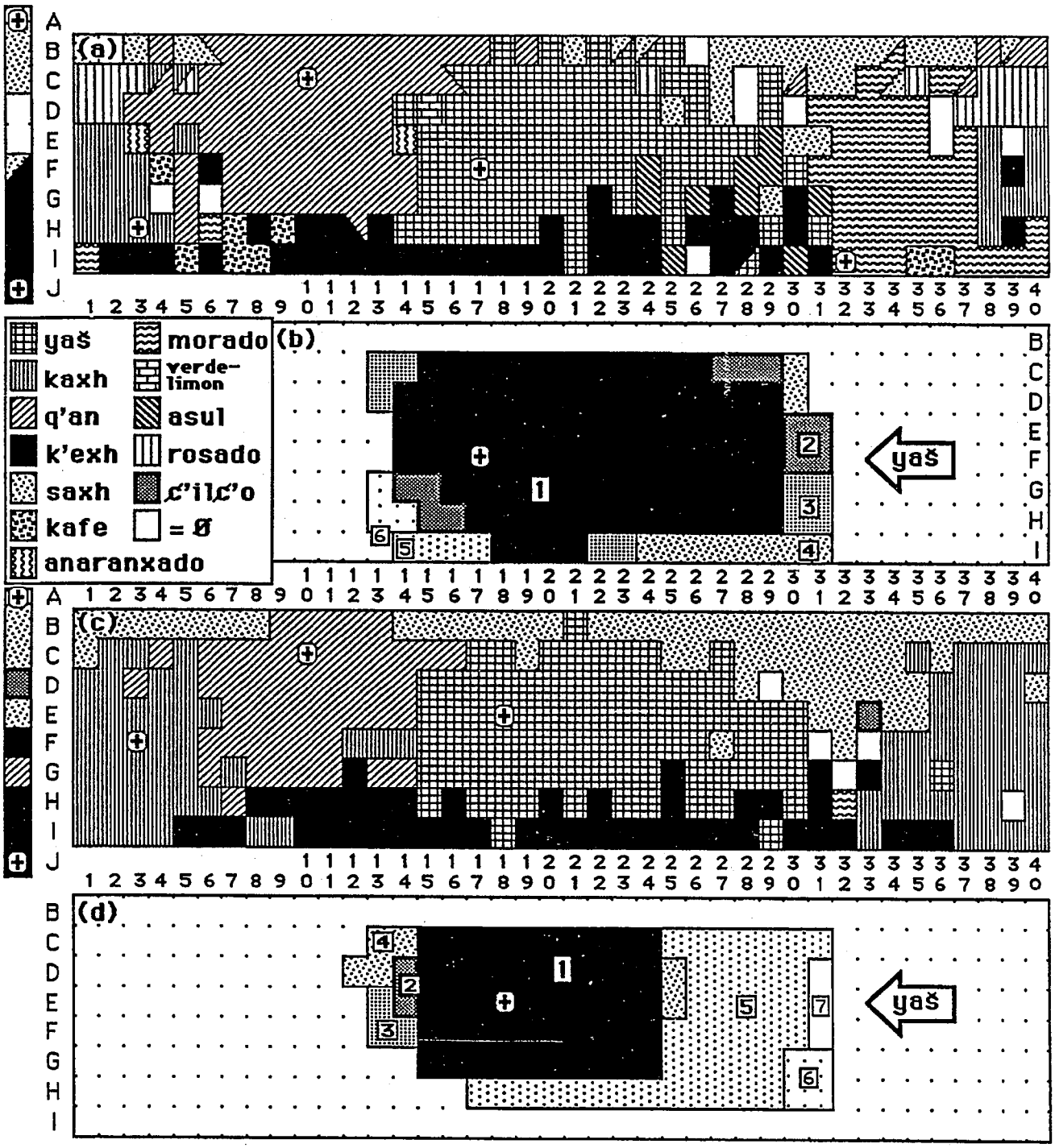
Figures 8.29c-30d display cool-category foci from 22 Palantla Chinantec speakers, 23 Texmelucan Zapotec speakers, 6 Jacaltec speakers (cf. Figures 8.31a-32d), 16 Patzun Cakchiquel speakers (cf. Figures 8.33a-34d, 8.41a-d), 22 Tlapanec speakers (cf. Figure 8.43), and 6 Lacandón speakers. These show less inter-speaker agreement than those from Nahuatl and Quiché. Two Zapotec speakers focused the cool category on its blue side, as did all of the Lacandón speakers. Lacandón is the only language of the Mesoamerican sample in which all individuals who were interviewed skewed the cool category toward blue.

8.4.2. Partial Correspondence

Figures 8.31a-32d display data from four Jacaltec speakers. In Figures 8.31a-d, speakers #1 and #2 showed the expected correspondence between a disjunctive mapping and a focus that is on or outside of the unique hue, column 17. The mapping of speaker #1 is disjunctive, because its first step did not breach column 29 of unique blue. In Figures 8.32a-d, speakers #3 and #4 did not show the expected correspondence. Speaker #3 executed a continuous first mapping step in conjunction with a focus in column 17; and speaker #4 disjunctively mapped the category while focusing it at a slightly centralized position in column 18.



Figures 8.31a-d. Naming ranges (a, c), foci, and mappings (b, d); Jacaltec of Jacaltenango, men, 1980; (a-b) speaker #1, age 40, (c-d) speaker #2, age 46.



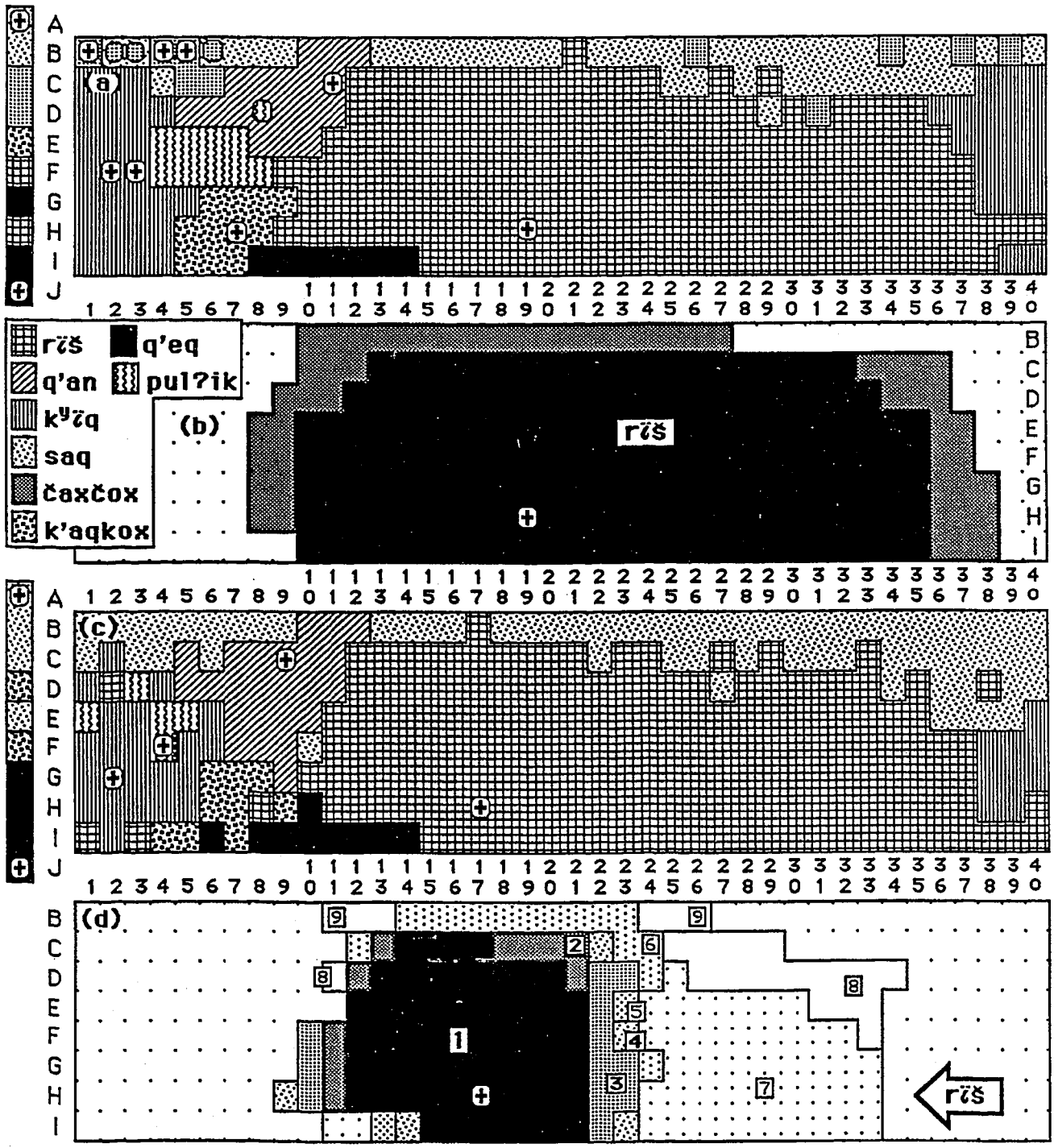
Figures 8.32a-d. Naming ranges (a, c), foci, and mappings (b, d); Jacaltec of Jacaltenango, 1980; (a-b) speaker #3, man, age 37, (c-d) speaker #4, woman, age 86.

Nevertheless, speaker #3 names color with 11 terms and speaker #4 names color with 6 terms; their uncharacteristic choices of foci correspond with separate evidence of attendance to distinctiveness and attendance to similarity. In comparison, speakers #1 and #2 use 8 and 10 color terms respectively.[10]

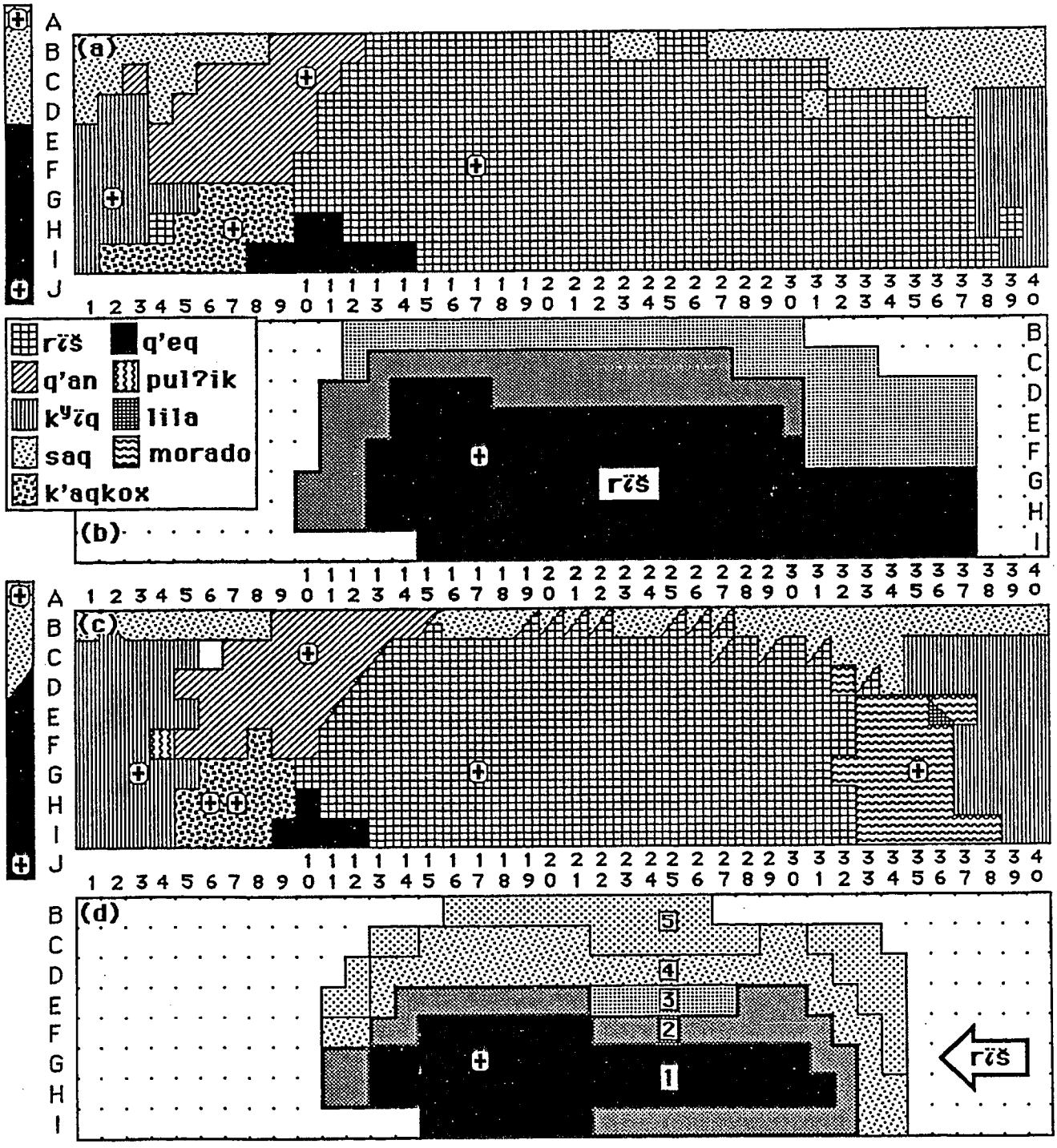
Figures 8.33a-34d display data from four Patzun Cakchiquel speakers. In Figures 8.33a-d, speaker #1 has shown the expected correspondence of a centralized focus and a continuous first mapping step; speaker #2 has produced the expected correspondence of a focus in column 17 and a disjunctive mapping. In Figures 8.34a-d, speakers #3 and #4 each show the rarer correspondence of a focus in column 17 and a continuous first mapping step. However, speakers #3 and #4 show a smaller first mapping step than speaker #1, and their mappings suggest that they have retracted higher values of membership toward darker color. The unexpected foci in column 17 correspond with greater differentiation within the category along the axis of dark-to-light, rather than between the unique hues. Speaker #4, whose mapping suggests the greatest differentiation of dark against light colors, uses the smallest cool-category naming range and, correspondingly, has developed a purple category with its focus at G35.[11]

[10]Correspondence between (1) the number of terms used to name all color and (2) other indications of the strength to which individuals attend to distinctiveness is also seen in the data from Tecpan Cakchiquel speakers, Figures 8.4a-5c. Other indications concern (a) mapping pattern and (b) number of null responses.

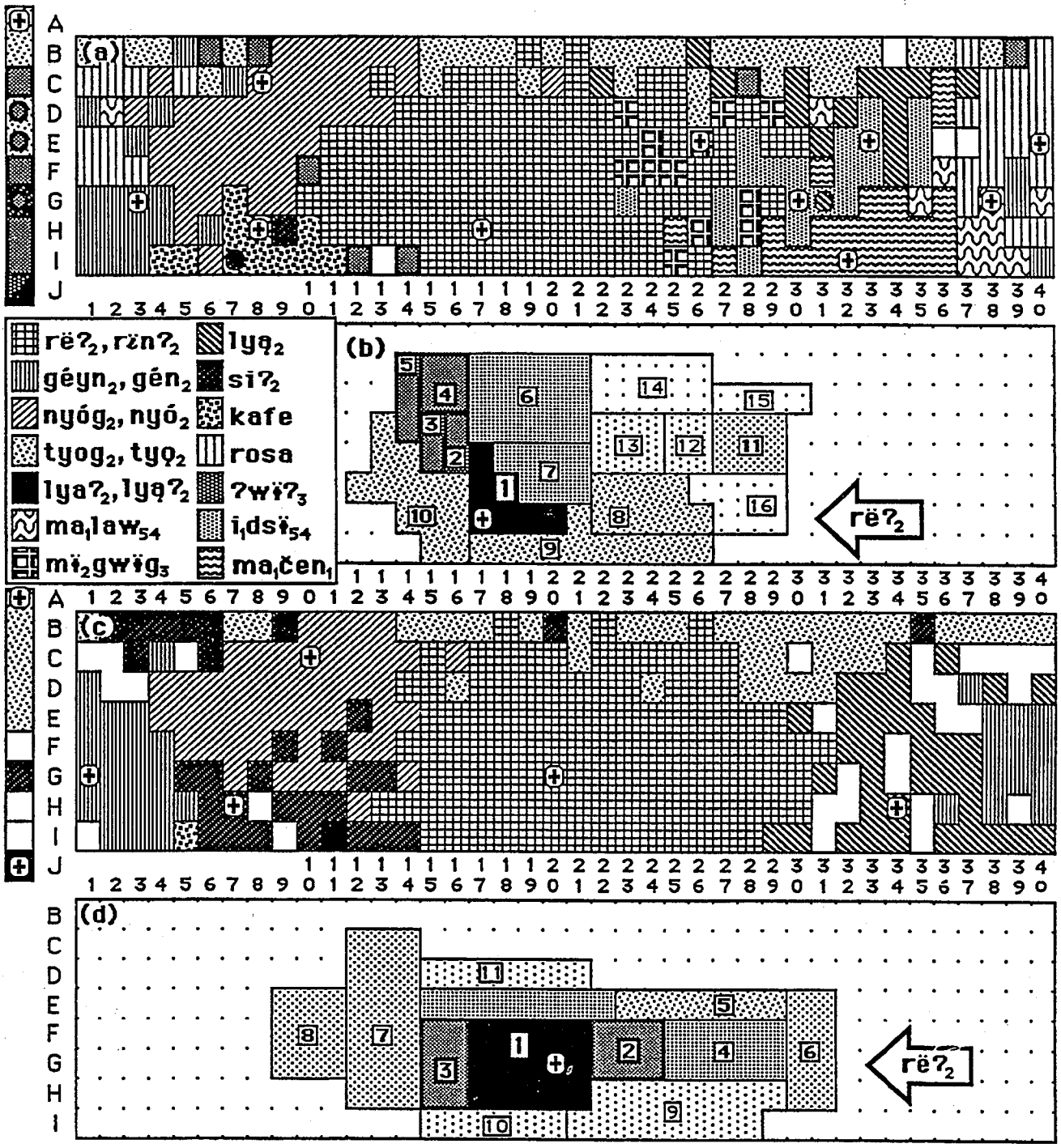
[11]Among those who named most of the 330 colors, speakers of Jacaltenango Jacaltec and of Patzun Cakchiquel used, respectively, some of smallest and the largest cool-category naming ranges of the Mesoamerican sample. Jacaltec speaker #4 of Figures 8.32c-d named the basic cool category 80 times, fewer than the average of 94 designations of the secondary cool category by Tenejapa Tzeltal speakers of Figures 4.1a-4c; Cakchiquel speaker #1 of Figure 8.33a-b named the basic cool category 177 times.



Figures 8.33a-d. Naming ranges (a-c), foci, and mappings (b, d); Patzun Cakchiquel, women, 1978 (a, c), 1979 (b, d); (a-b) speaker #1, age 29/30, (c-d) speaker #2, age 15/16.



Figures 8.34a-d. Naming ranges (a, c), foci, and mappings (b, d); Patzun Cakchiquel, 1978 (a, c), 1979 (b, d); (a-b) speaker #3, woman, age 24/25, (c-d) speaker #4, man, age 28/29.



Figures 8.35a-d. Naming ranges (a, c), foci, and mappings (b, d); Chinantec, Tepetotutla, 1979; (a-b) speaker #1, woman, age 41, (c-d) speaker #2, man, age 45.

Figures 8.35a-d display data from two Tepetotutla Chinantec speakers. Speaker #1, who named color with 14 terms, mapped the cool category disjunctively in 16 steps and focused it, as expected, in column 17. Speaker #2 showed less differentiation, both in his use of just 7 terms and with a disjunctive mapping of 11 steps. His centralized focus is not consistent with the disjunctive mapping, at least not when viewed in relation to the numerical trend that crosscuts Mesoamerican languages. However, the centralized focus is consistent with the lesser differentiation that is manifested by speaker #2 relative to the performances of other speakers of the same language, speaker #1 and the speaker of Figures 8.9a-b.

In sum, the unexpected correspondences among Cakchiquel speakers #3 and #4 involve a focus in column 17 that, nevertheless, correlates with separate evidence of strongest differentiation within a small group of individuals who speak one language. The unexpected correspondence of the Chinantec speaker involves a centralized focus that correlates with separate evidence of weakest differentiation within the same kind of small group. The different numbers of terms used by the Jacaltec speakers #3 and #4 correspond with foci placements as expected, while mapping patterns do not.

8.4.3. Non-Correspondence

Figures 8.36a-38d display data from speakers of Acatec, a language in which all nine individuals who used and focused the cool category during interviews countermanded the pan-Mesoamerican trend: Eight matched a disjunctive mapping and a centralized focus; one mapped the first step in green but placed the focus in blue. Figure 8.36a displays the focal aggregate:

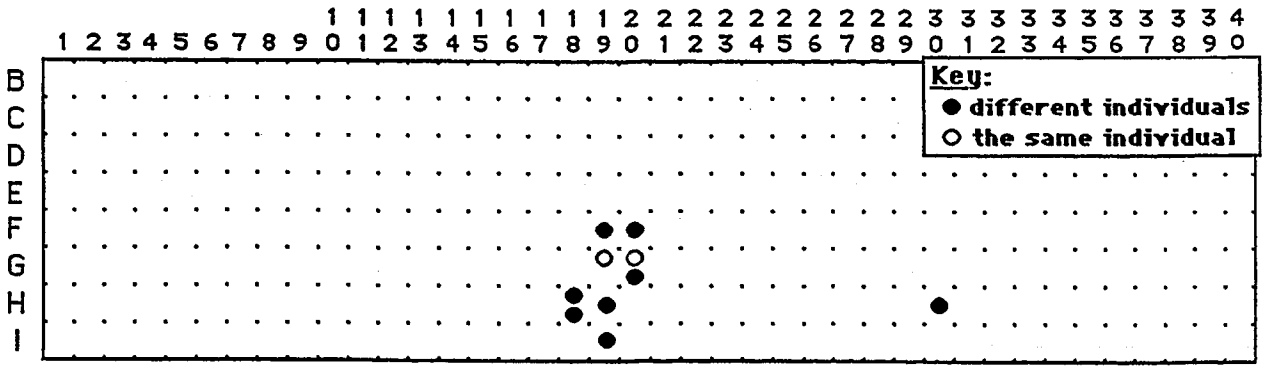
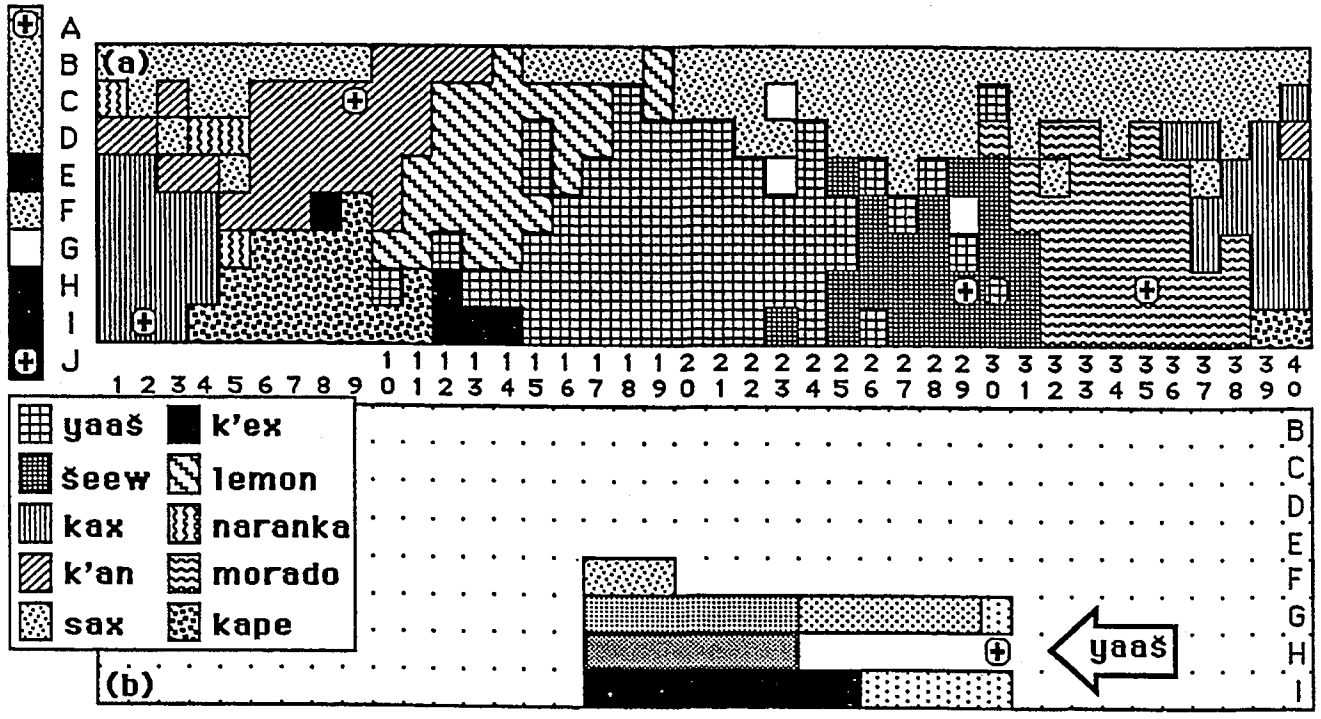


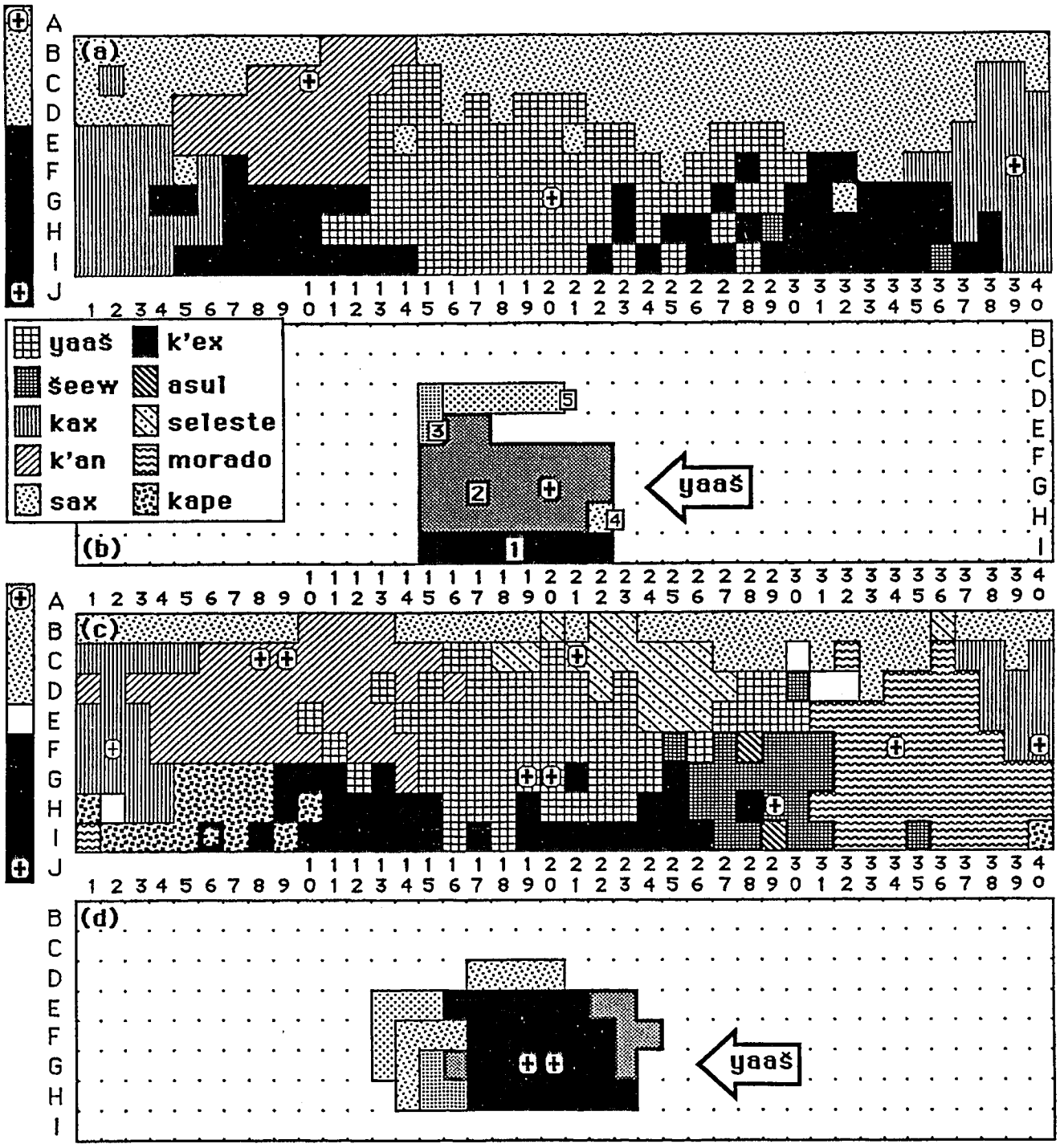
Figure 8.36a. Aggregated cool-category foci from 9 Acatec speakers, San M. Acatán.

In Figures 8.36b-38d, speakers #s 1-5 use naming ranges that show substantial skewing toward green. The skewing of naming ranges agrees with the disjunctive mappings, but both the naming ranges and mappings disagree with the centralized foci:[12]

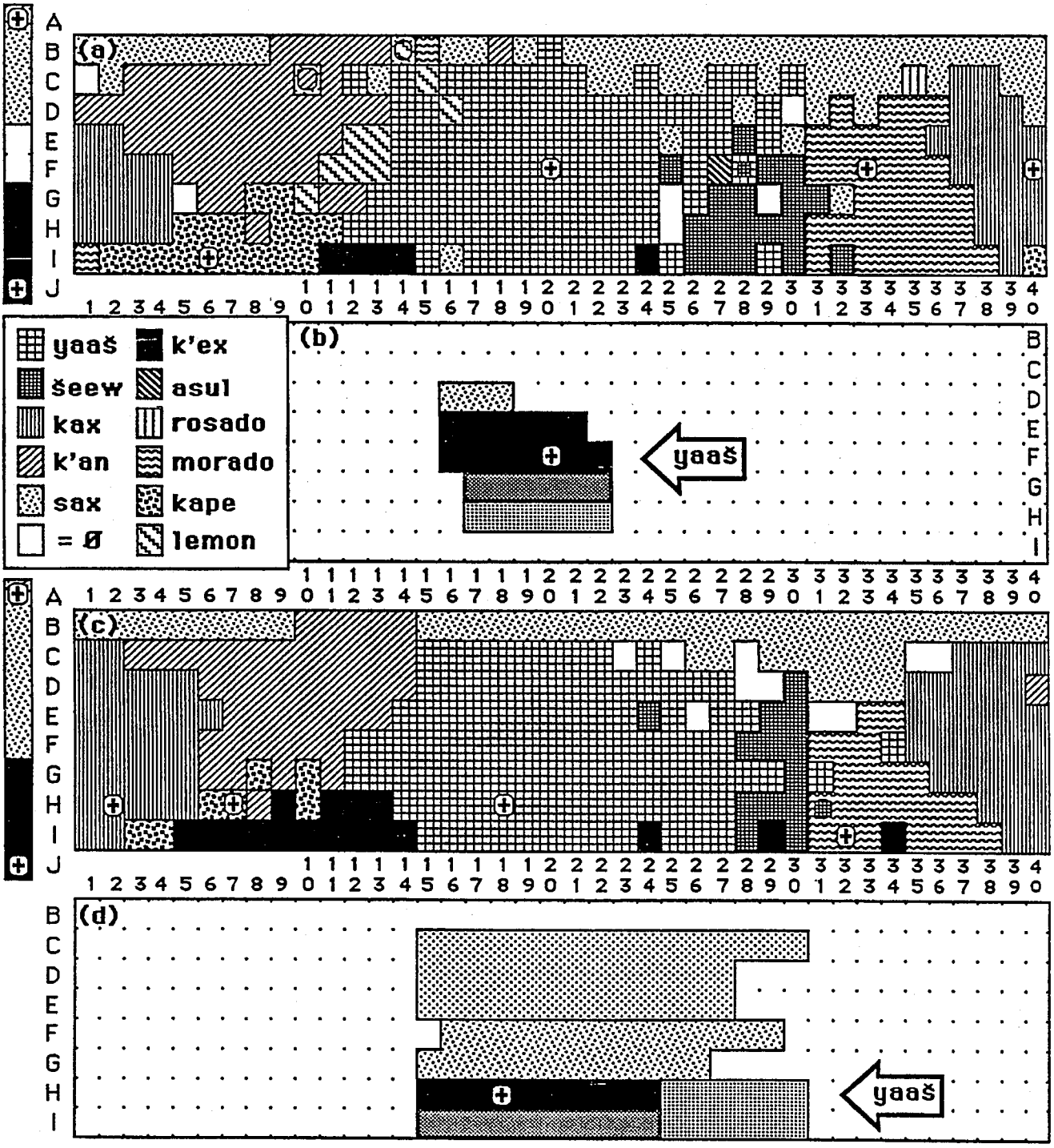


Figures 8.36b-c. Naming ranges (b), foci, and mapping (c), Acatec, San Miguel Acatán, speaker #1, man, age 58, 1980; cool category focused in blue at H30 but with its naming range and mapping skewed toward green (See footnote 15, page 328).

[12] A possible reason for this particular genre of non-correspondence is outlined in footnote 15, which depends on the analysis of transference in section 8.4.9.



Figures 8.37a-d. Naming ranges (a, c), foci, and mappings (b, d); Acatec, San Miguel Acatán, 1980; (a-b) speaker #2, woman, age 30, (c-d) speaker #3, man, age 30.

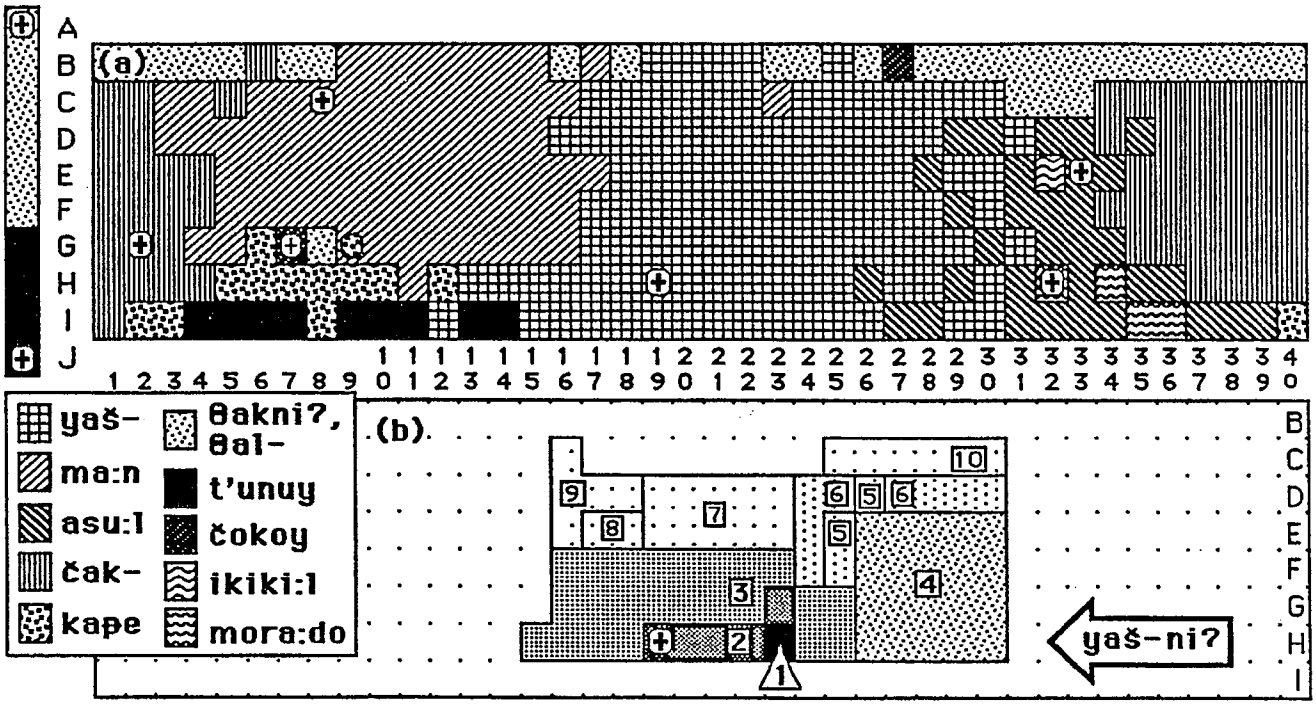


Figures 8.38a-d. Naming ranges (a, c), foci, and mappings (b, d), Acatec, San Miguel Acatán, men, 1980; (a-b) speaker #4, age 73, (c-d) speaker #5, age 40.

8.4.4. Extension of the Yellow-Focused Category Beyond Unique Green

Individual speakers of some Mesoamerican languages extend the yellow-focused category at low salience through unique green, which appears to cause unusual mapping patterns and foci placements within the cool category.[13]

In Figure 8.39a-c, a Huastec speaker mapped the yellow-focused category to column 18. Correspondingly, she began to map the cool category in turquoise of column 23, then mapped unique green with the third step and unique blue with the fourth step:



Figures 8.39a-b. Naming ranges (a), foci, and mapping of the cool category (b); Huastec, Xiloxuchil, Tantoyuca, woman, age 60, 1979. (Figure 8.39c on page 313.)

[13]Outside of Mesoamerica, as among Salishan languages of the Pacific Northwest, all (interviewed) members of specific communities categorize both unique yellow and unique green under one name (cf. MacLaury 1986, 1987). In Mesoamerica, only isolated individuals show weak manifestations of this tendency, which was most consistent among five of the ten Jicaque speakers in the sample.

The tendency might be initiated by the polarization of the yellow-category focus toward green, as seen in Figure 8.40a at C13 and Figure 8.40f at C-D12-15. This polarization is amply exemplified in section 7.1. (e.g., Figures 7.8b-c); it occurs as the warm category divides. Its putative effect on the extension of the yellow-focused category throughout green is not discussed under that section, because there is no evidence of the effect. The skewing of the cool category toward blue might establish a precondition for the green-ward extension of the yellow category (cf. Figure 8.49a, page 329); or, again, the skewing of the cool category toward blue could occur as an adjustment to the extension of the yellow category.

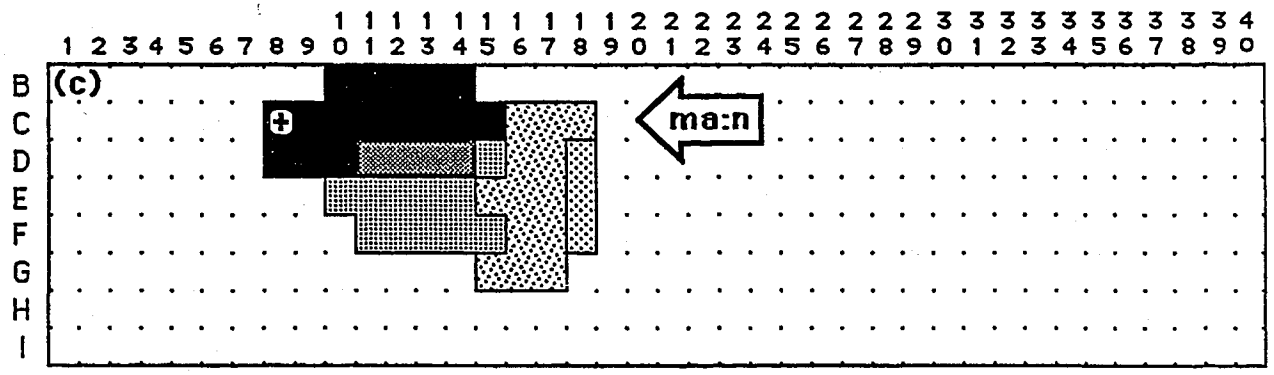
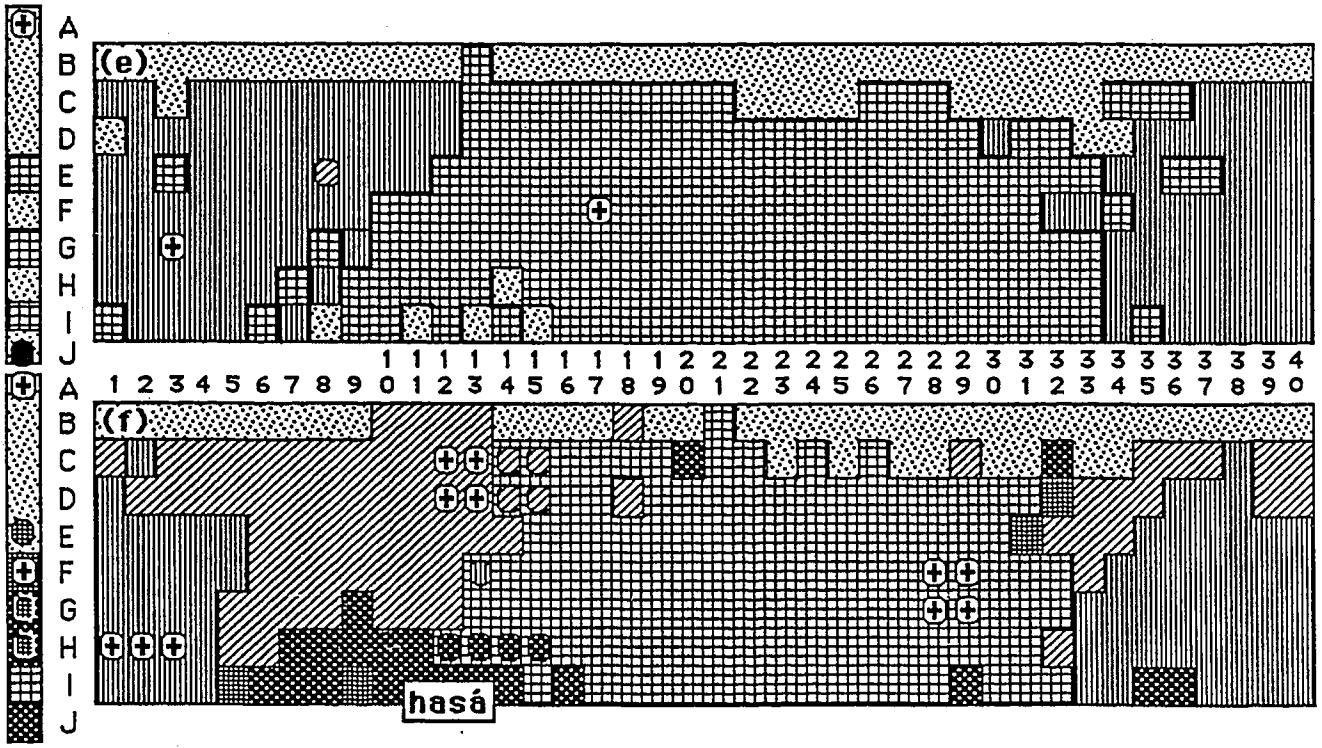
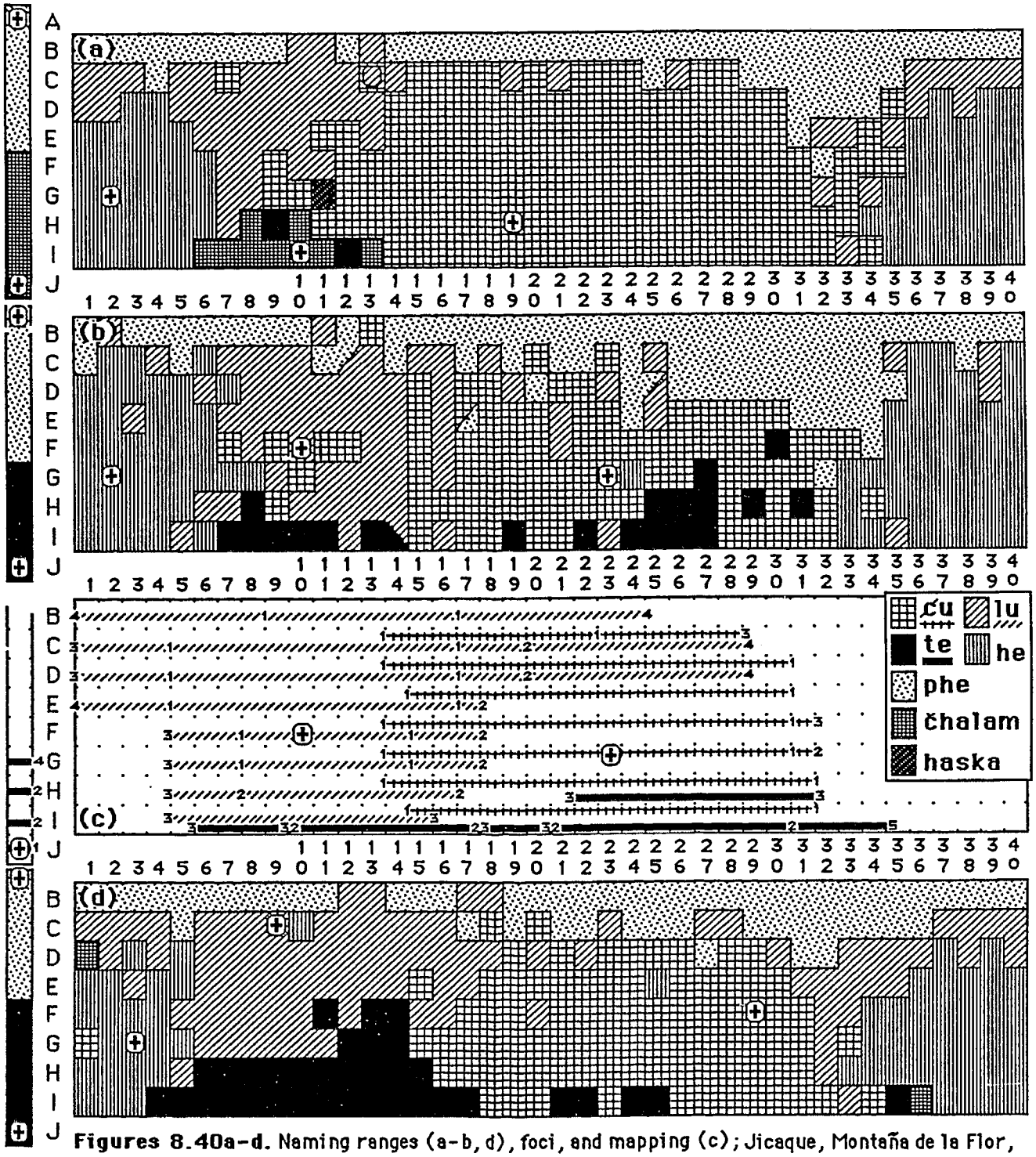


Figure 8.39c. Mapping of the yellow-focused category, same Huastec speaker.



Figures 8.40e-f. Supplement to Figures 8.40a-d (page 314); Naming ranges, Jicaque, Montaña de la Flor, women, 1977; (e) speaker #4, age 25 (cf. Figures 5.10a-c, 7.36); (f) speaker #5, age 43. See Figure 8.40c for key:



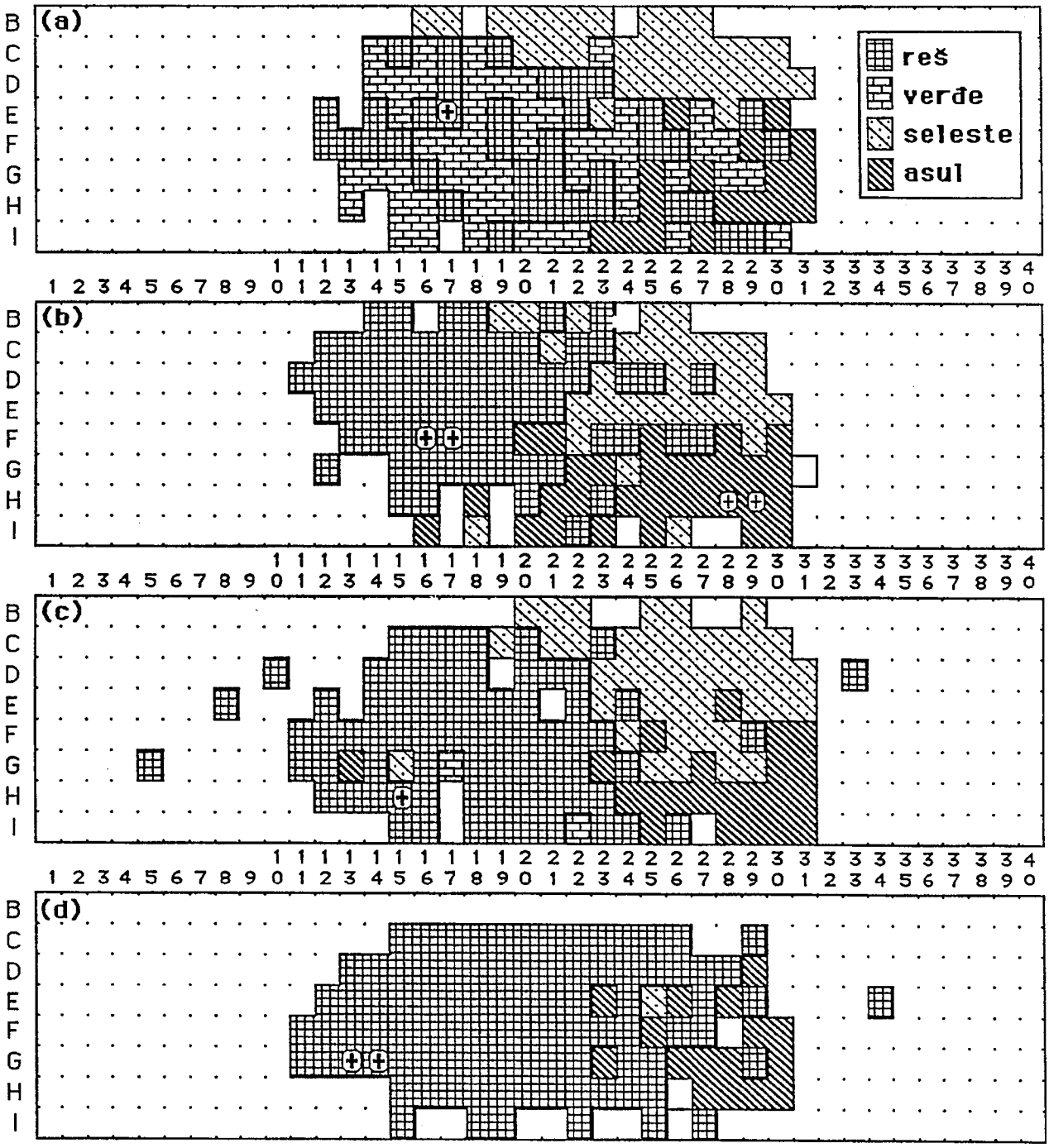
Figures 8.40a-d. Naming ranges (a-b, d), foci, and mapping (c); Jicaque, Montaña de la Flor, (a-b, d) 1977, (c) 1981; (a) man, age 20; (b-c) man, age 35/38; (d) woman, age 18.

In Figures 8.40a-d, data from three Jicaque speakers show degrees of compensation within the cool category to the extension of the yellow category. In Figure 8.40a, speaker #1 focused the cool category in a centralized position that is skewed toward green. In Figure 8.40b-c, speaker #2 focused the cool category in column 23, a statistically rare choice (cf. Figure 8.21). The naming range and mappings suggest that speaker #2 has positioned the focus between a green extension of the yellow-focused category and a blue extension of the black-focused category. In Figure 8.40d, speaker #3 focused the cool category on unique blue at F29 in apparent juxtaposition to the extension of the yellow category. In Figure 8.40e (cf. Figure 7.36), the cool category of the most conservative Jicaque speaker of the sample is focused on unique green of F17, which suggests that the skewing toward blue is a progressive development from an original skewing toward green. In Figure 8.40f, speaker #5 polarized the yellow-category focus toward green and focused the cool category in blue.

8.4.5. Naming Ranges

In section 8.3., no statistics are provided that correlate naming ranges and foci. Yet the data of Figures 8.1a-16, 31a-51c strongly suggest that a tedious count of naming ranges, individual-by-individual and color-by-color, would show the correlation: The major name of a centrally focused cool category is likely to be applied more evenly throughout green and blue than is the major name of a cool category whose focus is placed on a unique hue or polarized.

Figures 7.41a-d show partial correspondence of focus placement and the application of a naming range. Cakchiquel speakers #S1-3 placed a focus in columns 17, 16-17, and 15 respectively, and each shows correspondingly less application of the cool-category name to blue colors. Yet speaker #4, who shows greatest polarization of the cool-category focus at G13-14, also shows the most balanced application of the cool-category



Figures 8.41a-d. Naming ranges and foci; Cakchiquel, Patzun, 1978; (a) speaker #1, man, age 73, (b) speaker #2, man, age 37, (c) speaker #3, woman, age 23, (d) speaker #4, man, age 78.

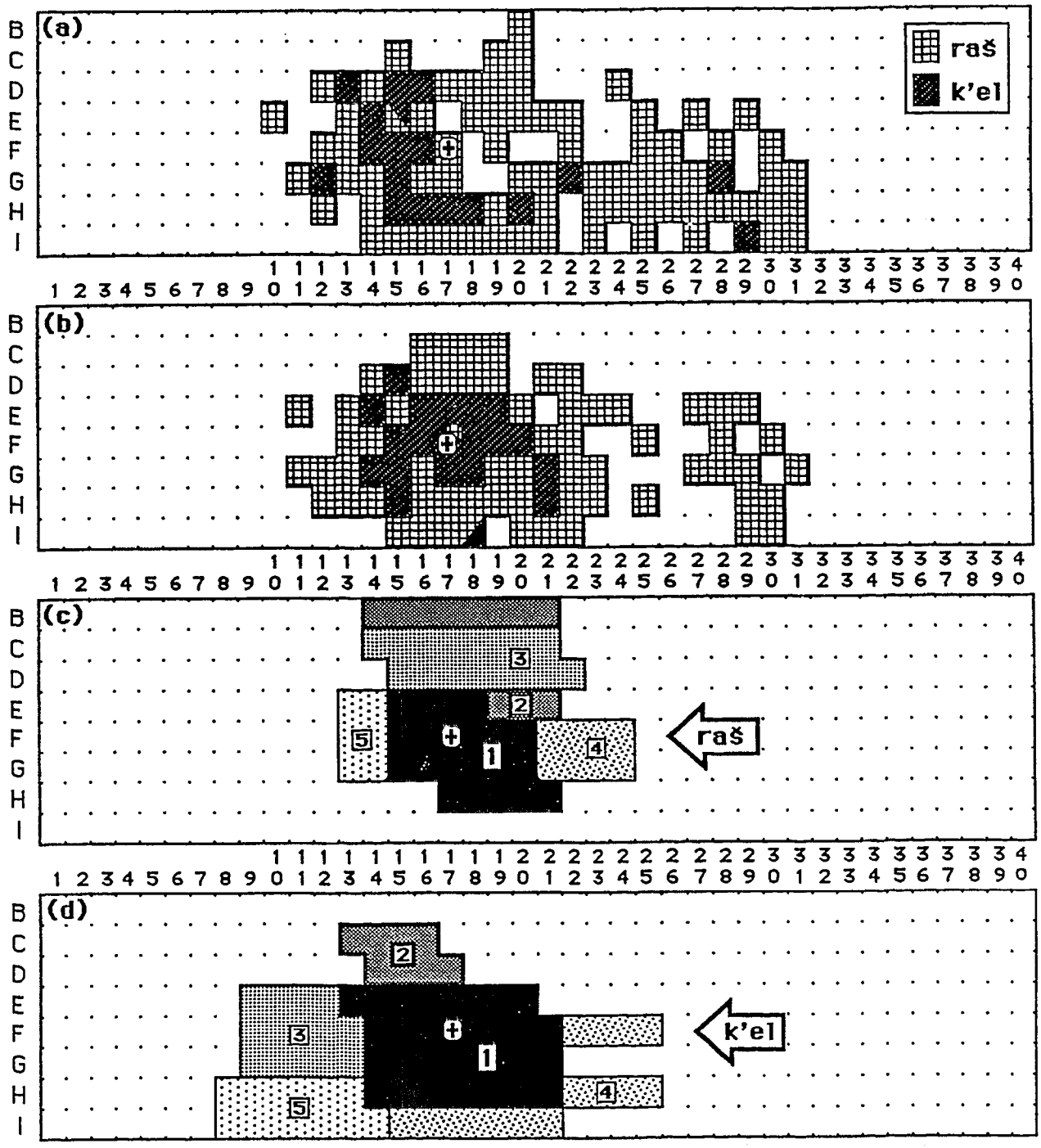
name to green and blue. Nevertheless, each of the four naming ranges is substantially skewed toward the focus of the category to which it pertains.[14]

8.4.6. Secondary Focal Categories

Almost all secondary categories that occur within the single-vantage cool categories of the Mesoamerican sample encompass low-membership colors, such as those of Figures 8.7d, 8.9d, and 8.15-16. However, 7 of the 11 Quiché speakers interviewed in Chiquimula showed the reverse pattern: a secondary category that is named with a separate root encompassed colors of high membership around the cool-category focus. This is the only example.

In Figures 8.42a (page 318), speaker #1 named the cool category with coextensive terms. One of them, *k'el*, mainly designates high-membership green and blue. Its focus was not elicited. In Figures 8.42b-c, speaker #2 used *raš* to name colors throughout the cool category and used *k'el* to name only the green colors about the focus. Both terms are focused on unique green at F17, and they are similarly mapped. Possibly speaker #2, like speaker #1, related the terms coextensively, but he has "crossed over" and confined all data regarding *k'el* to the green side of the category (cf. section 7.2, Figures 7.21a-25d, especially 7.25c-d [Mam *č'el* is a cognate of *k'el*.]); or, if the relationship is actually one of inclusion, it could have developed from coextensivity, crossover, and confinement. Apart from color, *k'el* names a green parrot species (Sp. *chocoyo*), its original and primary meaning (cf. Figure 9.17c, Zapotec *lŭr* 'green-with-blue' [< Sp. *loro* 'green parrot species']). Figures 8.8a-c displays data from a third Chiquimula Quiché speaker who did not name a secondary focal category.

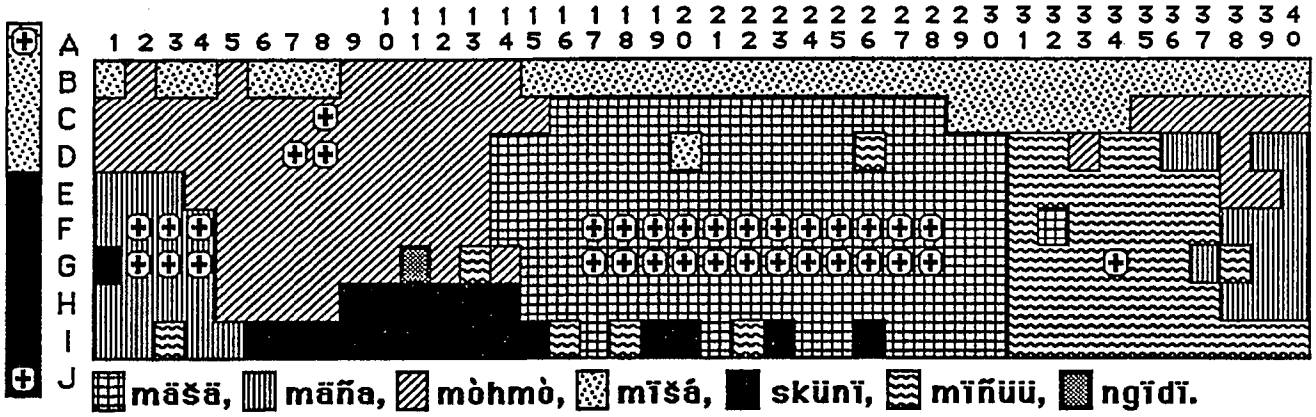
[14]The data of Figures 8.33a-34d differ markedly from those of Figures 8.41a-d, although all are from speakers of Patzun Cakchiquel. The former were collected under the MCS and the latter under the WCS. Neither recording included an indication of residential units, such as *aldeas*, *cantones*, or *cazarías*, within Patzun. The distinct surveys were probably conducted within different parts of the municipality.



Figures 8.42a-d. Naming ranges (a-b), foci, and mappings (c-d); Quiché, Chiquimula, men, 1980; (a) speaker #1, age 70, (b-d) speaker #2, age 68.

8.4.7. Extended Foci

An extended focus is defined, a bit arbitrarily, as one that covers three or more adjacent colors. Extended foci were not counted among the quantitative data of section 8.3., Figures 8.17a-28a. In spite of their breadth, most cases of extended foci show skewing:


A B C D E F G H I J
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0

8.4.8. Modifiers

Burgess, Kempton, and MacLaury (1983, 1985) present the original study of color-category modifiers as indices of skewing. Throughout the Mesoamerican data the relationship of modifiers to values of membership within the cool category is rich and varied, and it is worthy of chapter-length treatment. However, the intent here is only to extend the original study of exclusively Tarahumara modifiers.

One monolingual speaker of Western Tarahumara was interviewed twice, in different years. The first interview occurred in January 1978 in the speaker's native village, Huicochi, after he had become literate in Tarahumara and had assisted in translation work. The second interview occurred in December 1979 in Mitla, Oaxaca after he had received further linguistic training; he had finished a four-month intensive linguistic workshop the day before the interview.

Correspondences within the results of each interview evidence a greater skewing toward green in the more recently elicited data; the Tarahumara speaker, speaker #1, had advanced the skewing process during the interim between interviews. Figures 8.45a-46d display data from both interviews of speaker #1 and data from one interview of a speaker of Central Tarahumara, speaker #2, a younger linguistic assistant from Samachiqui.

Figures 8.45a-b show naming ranges and foci from the first and second interview of speaker #1. During the first, he centralized his cool-category focus at F19 and he named the category 70 times on the green side of column 23 and 76 times on the blue side. During the second, he focused the category on unique green at F-G17 and named it 78 times on its green side and 77 times on its blue side. The correspondences among the focus and the naming range show a slightly greater skewing toward green during the second interview. These are corroborated by further correspondences among modifiers that differentiate high and low values of category membership:

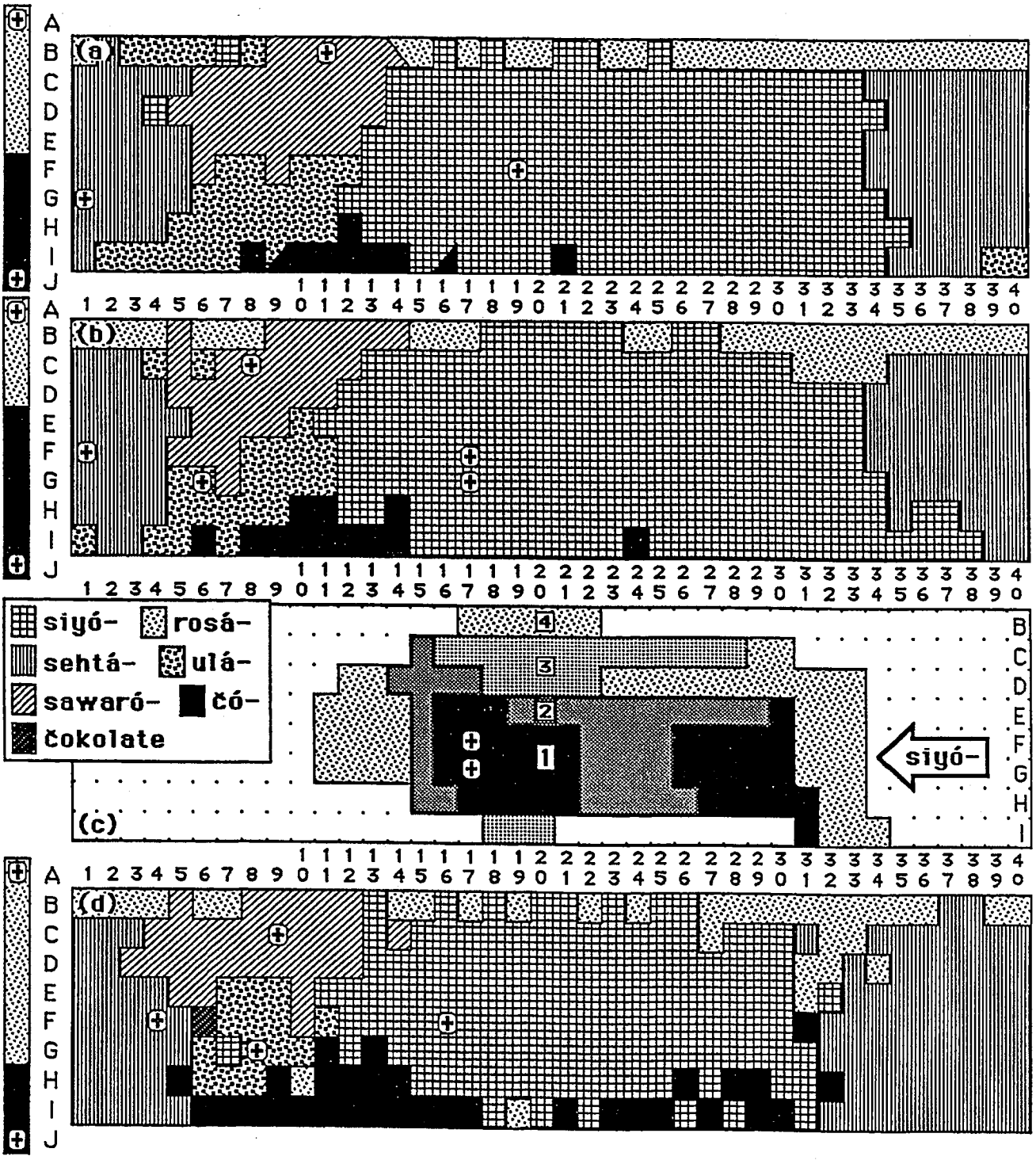
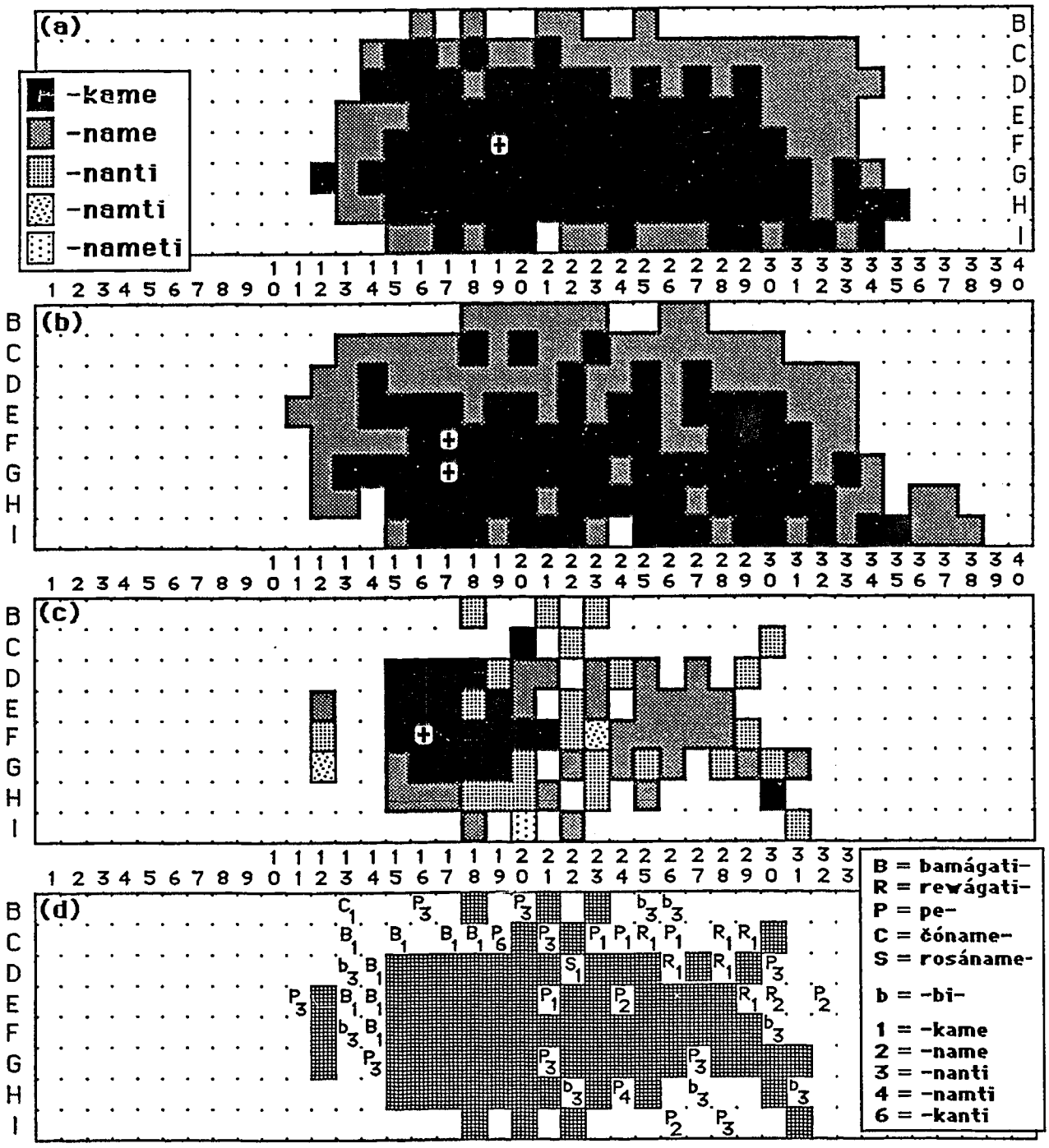


Figure 8.45a-d. Naming ranges (a-b, d), foci, and mapping (c); Western Tarahumara, (a) Huicochi, speaker #1, man, age 31, January 1978, (b-c) speaker #1, December 1979, (d) Samachiqui, speaker #2, man, age 25, 1978.



Figures 8.46a-d. Modifiers and foci, Tarahumara, same speakers as in Figures 7.45a-d; (a) speaker #1, January 1978, (b) speaker #1, December 1979, (c-d) speaker #2, 1978.

Figures 8.46a-b show uses by speaker #1 of obligatory postposed modifiers. During both interviews, he postposed to the root only *-kame* or *-name*, the former designating higher membership and the latter lower membership. During his first interview, he used *-kame* 90 times and *-name* 55 times, a ratio of 1.000-to-0.633. During his second interview, he used *-kame* 79 times and *-name* 82 times, 1.000-to-1.048; he showed keener differentiation among values of membership by assigning higher value to fewer colors and lower value to more.

During the second interview, he differentiated further by using three optional preposed modifiers that he did not use during the first: *bánaga-* 'focal green', *čoname-* 'dark', *čokame-* 'very dark'. These usages are not diagrammed.

Figure 8.45c depicts the disjunctive mapping of the cool category that speaker #1 rendered during his second interview. Mappings were not elicited during the first. The mapping shows slight skewing toward green: the first mapping step covers 20 greens and 17 blues, and the fourth or last step covers 21 greens and 25 blues (from Burgess, Kempton, and MacLaury 1983: fig. 7; 1985: fig. 11).

The only data that show less skewing during the second interview than during the first are these: During the first, he applied high-membership *-kame* 48 times to green and 42 times to blue, a difference of 6; he applied low-membership *-name* 33 times to blue and 23 times to green, a difference of 10. During the second, he applied *-kame* 41 times to green and 38 times to blue, a difference of 3; he applied *-name* 43 times to blue and 37 times to green, a difference of 8. During the second interview, the postposed modifiers were more evenly applied to green and blue than during the first.

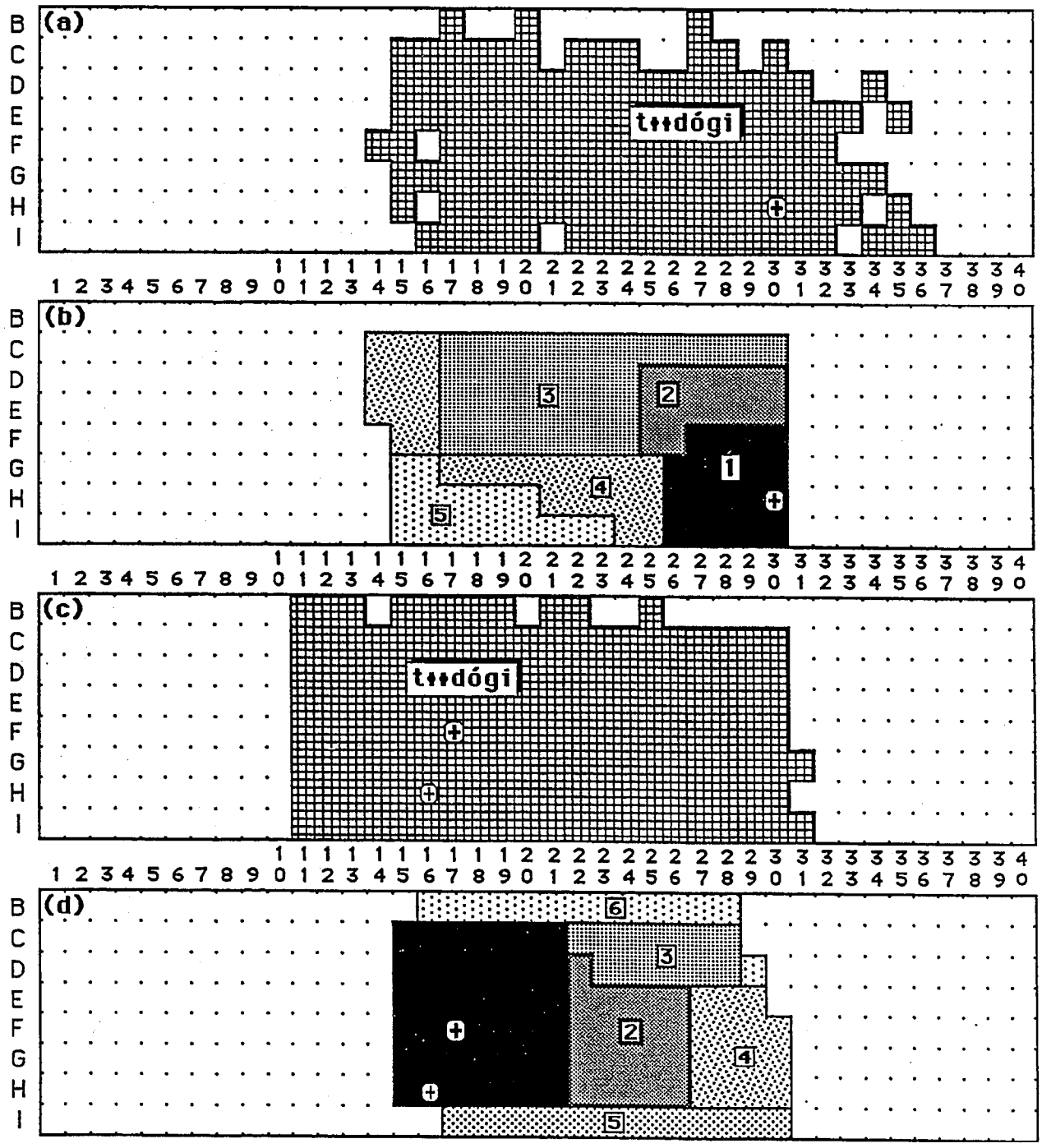
Figure 8.45d depicts naming ranges and foci from speaker #2, which show greater skewing toward green than do any of the data from speaker #1; and speaker #2 applied the cool-category root, *siyó-*, to fewer colors than did speaker #1: he applied the term 69 times to green and 46 times to blue, and he polarized the cool-category focus in column 16. The ratio of usages in green and blue, the paucity of usages, and the polarization together

suggest that speaker #2 attended more strongly to distinctiveness among cool colors than did speaker #1.

In Figures 8.46c-d, the distribution of modifiers from speaker #2 corroborates that suggestion: he used five optional preposed modifiers, one optional postposed modifier of first order, *-bi-*, and six obligatory postposed modifiers. Figure 8.46d shows that the obligatory postposed modifiers assume more peripheral meanings when combined in a phrase with the optional modifiers, as P_3 = *pe siyó-nanti,* b_3 = *siyó-bi-nanti,* R_1 = *rewágati siyó-kame,* B_1 = *bamágati siyó-kame,* and so forth. This use of modifier combination to displace meaning toward lower value of membership constitutes a device of rare sophistication and complexity. Further, the distribution of simple postposed usages shows maximal membership, *siyó-kame,* in green and a predominance of lesser membership, *siyó-name* and *siyó-nanti,* in blue. Lowest membership, *siyó-namti* and *siyó-nameti,* occur in turquoise at F23 and marginal colors, G12 and I20. The greater skewing toward green of speaker #2 corresponds with highly refined modifier differentiation whose maximal designations cluster almost exclusively in green.

8.4.9. Transference

This section addresses a numerical trend noted in section 8.3.: (1) a greater percentage of basic cool categories is skewed toward green than of secondary cool categories; (2) a greater percentage of disjunctively mapped cool categories is skewed toward green than of continuously mapped cool categories. Generally, a basic category is accompanied by a stronger attendance to distinctiveness than a secondary category, and a disjunctively mapped category is accompanied by a stronger attendance to distinctiveness than a continuously mapped category. In brief, as the attendance to distinctiveness



Figures 8.47a-d. Naming ranges (a, c), foci, and mappings (b, d); Northern Tepehuán, Barborigame, women, 1981; (a-b) speaker #1, age 81, (c-d) speaker #2, age 50.

increases -- as the cool category approaches its complete division -- the category tends more frequently to be skewed toward green and less toward blue.

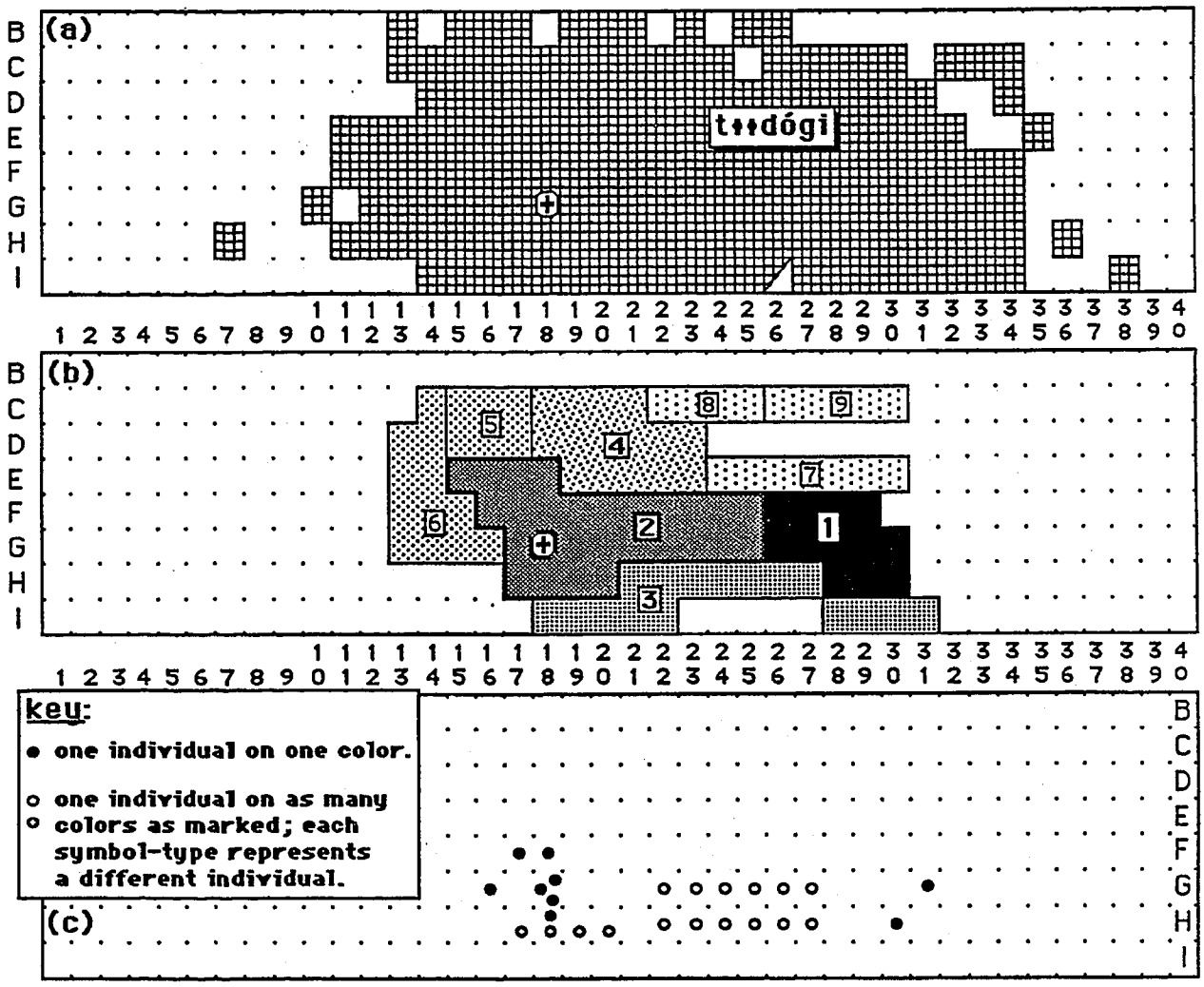
This tendency entails that among the speakers of some languages, at some point in the development of the cool category, a "transference" of skewing occurs; categories that originally were skewed toward blue become skewed toward green. The data of Figures 8.47a-48b exemplify phases of this transference in progress among three speakers of Northern Tepehuán.

In Figures 8.47a-d, speaker #1, age 81, skewed the cool category toward blue, and speaker #2, age 50, skewed it toward green. But neither speaker has evidenced coextensivity.

In Figures 8.48a-b, speaker #3, age 52, has mapped his cool category with its first step in blue, but has focused it in green at G18. Each datum indicates skewing toward an opposite side of the category. Speaker #3 appears to represent the intermediate phase between the skewing toward blue of the older speaker #1 and the skewing toward green of speaker #2, the contemporary of speaker #3.

The data from Northern Tepehuán indicate that transference occurs as some individuals maintain two vantages of the cool category while designating each vantage with the same name. In effect, these individuals covertly compose the cool category from coextensive vantages. The transference is completed when an individual, such as speaker #2, favors the skewing toward green and shows no sign of skewing toward blue.

This account of transference, which poses a state of intermediate and transitory covert coextensivity, is opposed to the logical alternative: that transference would occur by a gradual shift in a single vantage; a cool-category focus would migrate from the blue side of the category to the green side and, for a time, would be placed on column 23 of true turquoise. The alternative account is improbable, at least among individuals -- such as the



Figures 8.48a-c. Naming range (a), focus, and mapping (b), Northern Tepehuán, Baborigame, speaker #3, woman, age 52, 1981; (c) focal Aggregate, Northern Tepehuán.

Northern Tepehuán speakers -- who markedly skew the cool category toward blue. Pronounced skewing is produced by a strong attendance to distinctiveness. Yet a centralized focus of the kind entailed by a "migration" could be produced only by weakening the attendance to distinctiveness while strengthening the attendance to similarity. More likely, the attendance to distinctiveness is not decreased during transference, but rather it is maintained in force within a coextensive composition. The coextensivity

provides a vantage from either a position that includes unique blue or a position that includes unique green. This situation appears to characterize the cool category of Northern Tepehuán: Speakers #s 1-3 all markedly skew the cool category, and speaker #3 does so in two directions.

Figure 8.48c displays the focal aggregate from the eleven Northern Tepehuán speakers who contributed foci to the sample. Ten focused the cool category in either blue or green; one woman, age unrecorded, mapped the category continuously in conjunction with an extended focus, G-H 22-27, that showed slight skewing toward blue.[15]

The continuous migration of a focus from one side of the cool category to the other -- and of an attendant single vantage -- might indeed occur under other conditions, as it apparently does when the yellow-focused category is extended beyond unique green. Figure 8.40a-f depict this condition, under which a Jicaque speaker focused the cool category in column 23 (cf. Figures 8.40b-c). In that case, the migration of skewing was progressing from the green side of the category toward the blue side. But that localized situation is independent of what here is called "transference" of skewing, which seems to be Pan-Mesoamerican and everywhere involves a switch in vantage from blue to green.

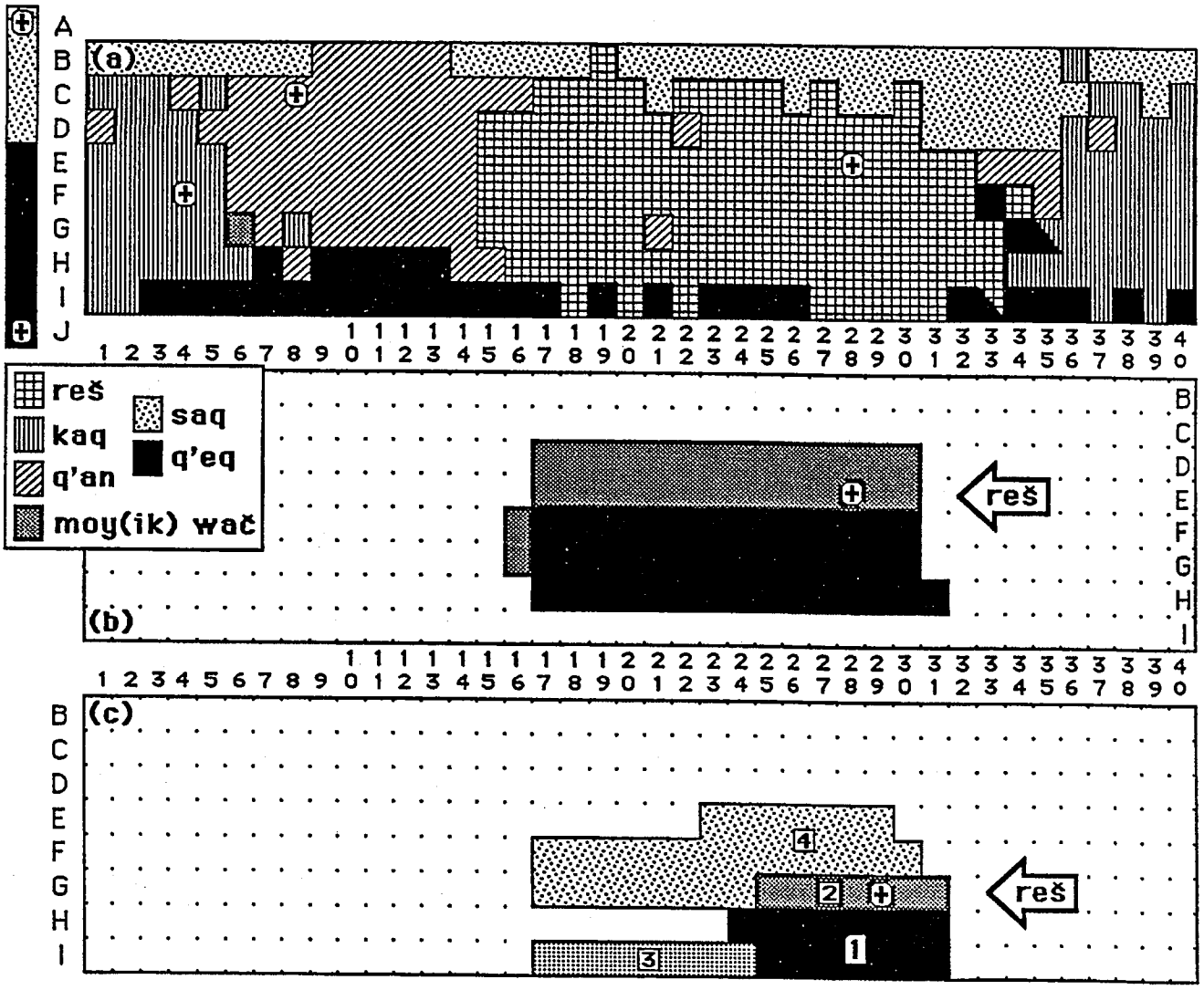
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[15]The focal aggregates of Northern Tepehuán and of Acatec, Figure 8.36a, are similar: Both are constituted by (1) a preponderance of foci that are placed in green but slightly centralized and (2) one focus or a few foci polarized in blue. Data such as those from Northern Tepehuán speaker #3, Figures 8.48a-b, establish that a covert and, likely, temporary coextensivity is maintained by, at least, some speakers during the process of transference (See also Figures 8.52a-b). Since the coextensivity is covert (not named with two terms), it is undetermined how many Northern Tepehuán speakers of the present sample maintain it. But if it is assumed that most do maintain coextensivity, then the pattern within the focal aggregate makes sense:

It has been shown in Chapters V-VII that coextensivity almost always involves a dominant and a recessive vantage. Transference toward green would link unique green with the dominant vantage. Accordingly, individuals who focus the cool category in reference to green would focus the dominant vantage. As a rule -- as has been shown in the earlier chapters -- the focus of a dominant vantage is centralized, as indeed the foci tend to be among the Northern Tepehuán speakers. The centralized focal aggregate from Acatec might have the same explanation. The single Acatec focus in blue suggests that transference is occurring in that language (cf. Figures 8.36b-c), although the process might be at a more advanced phase than it is in Northern Tepehuán. The advancement of the process might have eradicated most outward signs of covert coextensivity in the Acatec data, except (1) the lone focus in blue and the centralization of all other foci, and (2) the disagreement of the latter with naming ranges and mappings that both are markedly skewed toward green.

In Figures 8.52a-b, dominant-recessive focal aggregates in Tzeltal and Seri cool categories further suggest covert coextensivity.

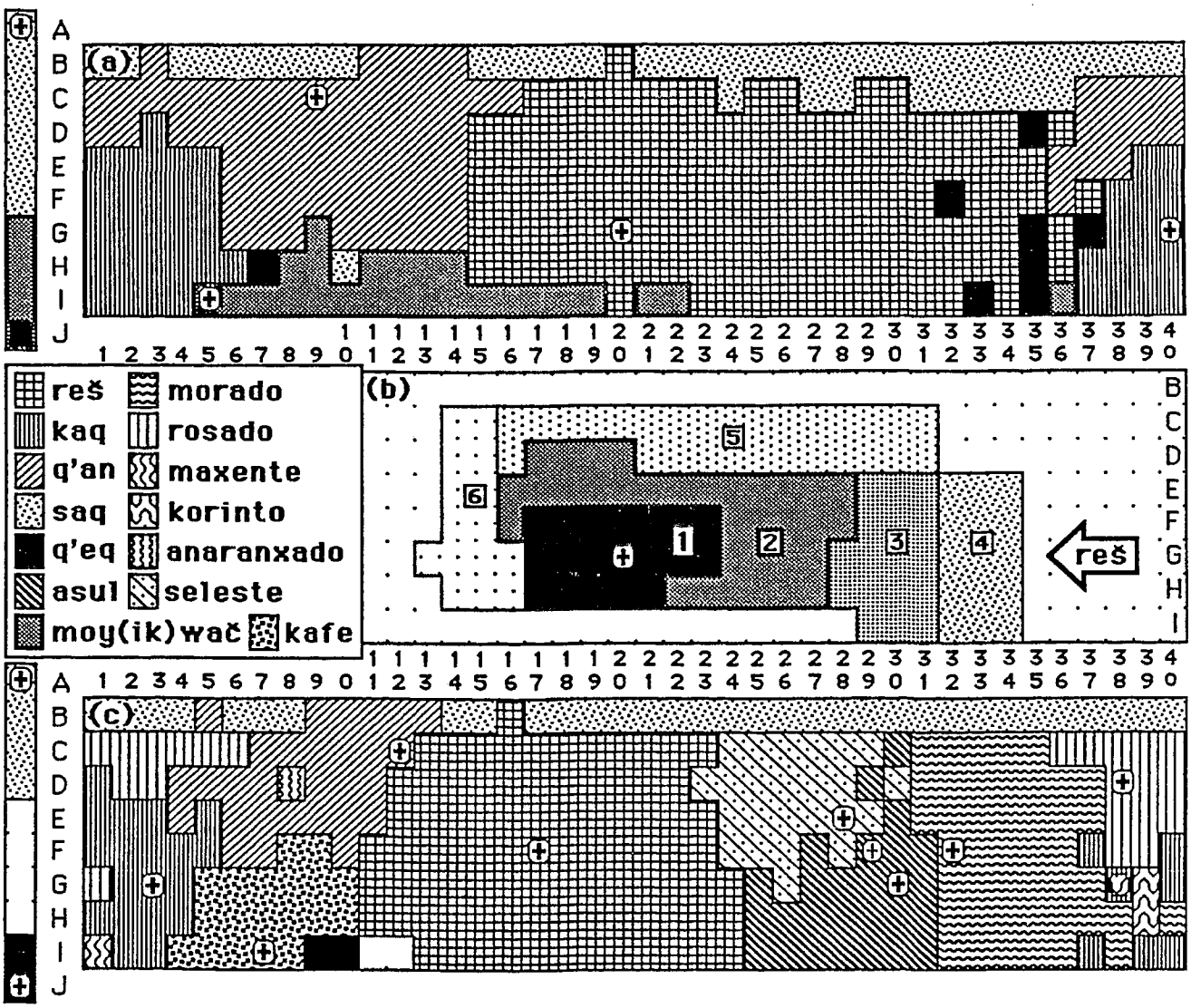
Figures 8.49a-50c display data from four Pocomchí speakers. In Figure 8.50c, data from speaker #4 shows the ultimate result of transference to skewing toward green: Younger speakers name exclusively green colors with the term that older speakers use to name a cool category that is skewed toward blue.



Figures 8.49a-c. Naming range (a), foci, and mappings (b-c); Pocomchí, San Cristóbal Alta Verapaz, 1979; (a-b) speaker #1, woman, age 40, (c) speaker #2, man, age 70.

In Figures 8.49a-b, speaker #1, age 40, produced a naming range and a focus that are skewed toward blue, and her mapping is continuous. In Figure 8.49c, speaker #2, age 70, focused and disjunctively mapped the cool category with skewing toward blue.

Speaker #2 was hesitant and reluctant to respond to any elicitation. He provided only fragmentary naming data, which are not shown; his curtailed, four-step mapping is consistent with his hesitancy.

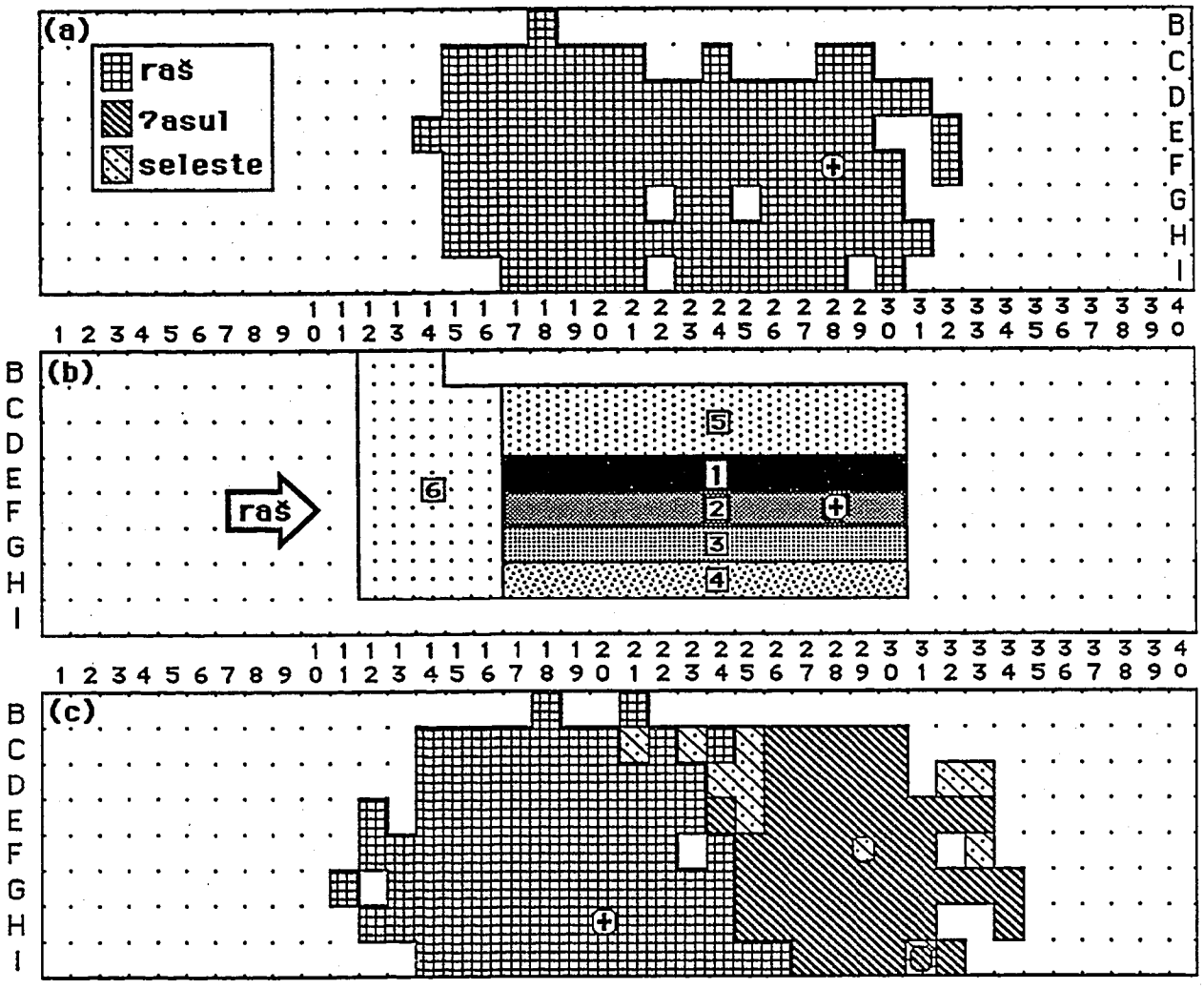


Figures 8.50a-c. Naming ranges (a, c), foci, and mapping (b); Pocomchí, (a-b) San Cristóbal Alta Verapaz, speaker #3, man, age 30, 1979, (c) Chialli, Tactic, speaker #4, man, age 17, 1978.

In Figures 8.50a-c, speaker #3, age 30, used a naming range that is skewed toward blue, but produced a focus and a disjunctive mapping that is skewed toward green. He appeared to manifest an intermediate phase of transference. His disjunctive mapping

suggests a stronger attendance to distinctiveness than does the continuous mapping of speaker #1, who showed skewing toward blue in all data.

The discrepancy in skewing between the naming range and focus of speaker #3 is similar to that seen among the data from the first interview of Tarahumara speaker #1, Figure 8.45a; he named the cool category 70 times in green and 76 times in blue, but focused it in green. During his second interview, he skewed all responces toward green.

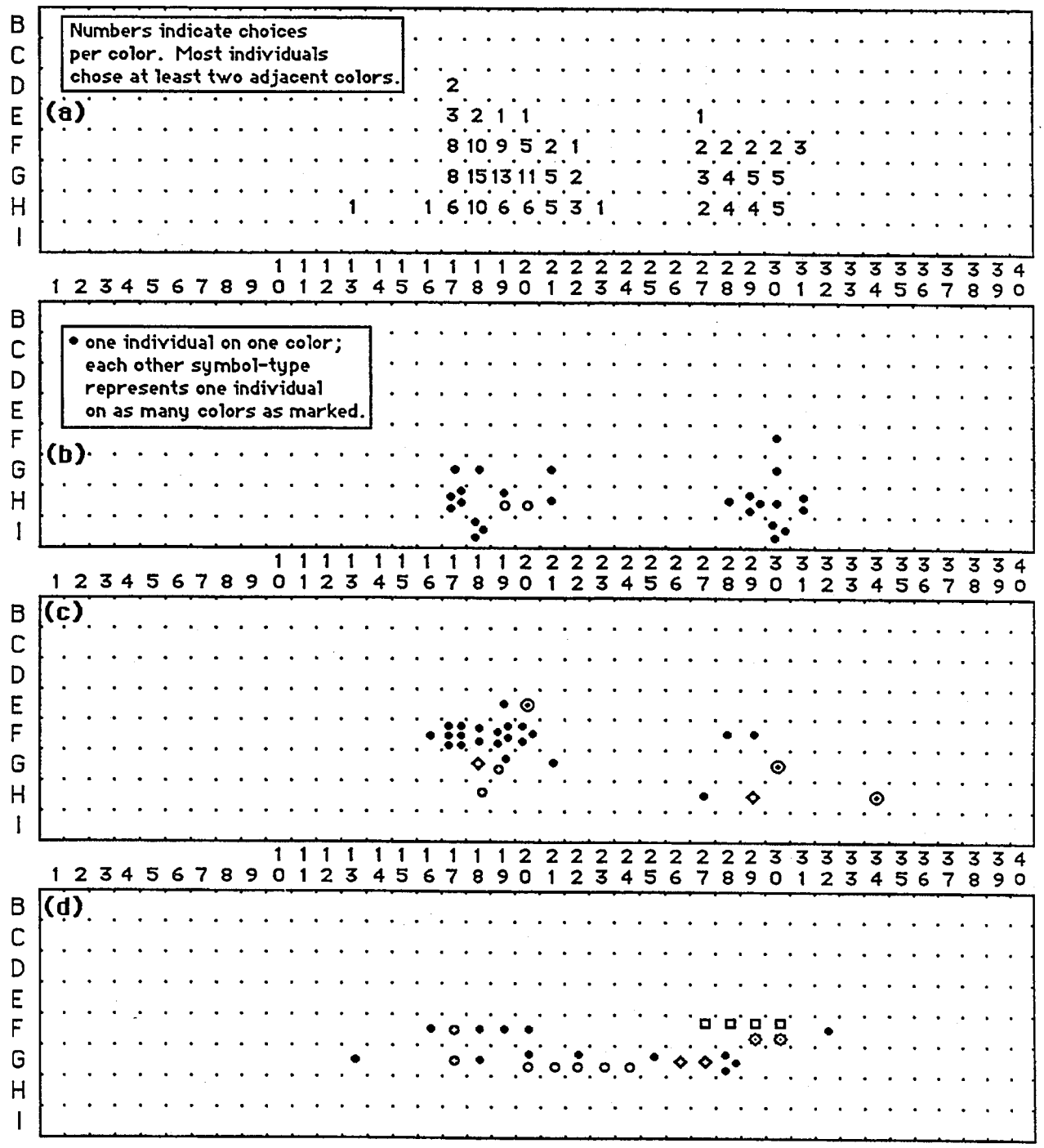


Figures 8.51a-c. Naming ranges (a, c), foci, and mapping (b); Sacapultec, San Juan Sacapulas, 1979, men; (a-b) speaker #1, age 72, (c) speaker #2, age 17.

Figures 8.51a-c display data from Sacapultec speakers #1 and #2, ages 72 and 17. Data from a third man, age 78, appears in Figures 8.14a-b. The latter man mapped and focused the cool category with skewing toward blue, and speaker #1 focused the category with the same skewing. Speaker #2, who is much younger than the other two, named only green with the term that the older men used to name both green and blue, the ultimate result of transference to skewing toward green. Two additional Sacapultec speakers who were interviewed, a man and a woman of ages 28 and 55, applied the historical "cool" term only to green, as did speaker #2.

Figures 8.52a-d display focal aggregates from four languages whose speakers appear to be undergoing transference of skewing within the cool category; each aggregate pertains to both green and blue.

Figure 8.52a displays the aggregate of foci elicted by Berlin and Kay in 1968 from 40 Tzeltal speakers. Since these were elicitited with the original Berlin-and-Kay array of contiguous rectangular chips, 27 individuals voluteered extended foci. Each number in the figure represents the selections within its corresponding color. This representation differs from Berlin and Kay's (1969: 9, fig. 3) normalization of the same data that depicts each extended focus with one center-most dot. Berlin and Kay's acetate mappings, like the mappings of Figures 4.1a-4c, indicate that some of the Tzeltal speakers maintained the black-focused category throughout cool colors. Thirty one speakers focused the cool category in green and 9 in blue. The distribution of foci are identical to one that would be predicted to occur in response to dominant-recessive coextensive vantages: almost all selections in green are either in the unique-hue column or centralized, that is, 2 or 1.47% are polarized, 27 or 19.70% are in column 17 of unique green, and 108 or 78.83% are centralized within columns 18-23; but fewer selections in blue are centralized than are placed in the uniqe-hue column or polarized, that is, 15 or 34.40% are polarized, 11 or 25.00% are in column 29 of unique blue, and 18 or 40.09% are centralized within the narrow band of columns 27-28. The distribution of Tzeltal foci match the stipulation that,



Figures 8.52a-d. Aggregates of foci from the cool category: (a) Tenejapa Tzeltal, (b) Seri of Desemboque, (c) Lowland Guarajío, (d) Western and Central Tarahumara.

during transference, individuals covertly maintain coextensive vantages of the cool category; the dominant vantage is taken from a position that includes unique green. Berlin and Kay recorded one individual who appeared to manifest both vantages: first he spontaneously polarized his focus in blue at E-G30, but then he reviewed his choice, cancelled it, and centralized his final choice at G20 in green.

In Figure 8.52b, the focal aggregate of 25 Seri speakers is distributed much like that of the Tzeltal speakers. Thirteen individuals placed foci in green in either the unique-hue column 17 or a centralized position, like the foci of a dominant coextensive vantage; among blues, 12 individuals either slightly centralized, polarized, or placed foci in column 29 of unique blue, like the foci of a recessive coextensive vantage.

In Figure 8.52c, the focal aggregate from 25 Guarajío speakers shows a pattern among greens that is much like that of the Tzeltal and Seri aggregates; however only five Guarajío speakers focused the cool category in blue. Two of them chose dual or triple foci; the dual pair is centalized at G18 and placed in the unique-blue colum at H29, and the triple foci are centralized at E20 and polarized at G30 in blue and H34 in purple. Both speakers produced the pattern that would be expected of dual or triple foci if they were positioned from the perspective of each coextensive vantage within a dominant-recessive set. Among the triple foci, the two that are polarized in blue and purple might represent an ambivalent choice or a change of mind.

In Figure 8.52d, 16 speakers of Western and Central Tarahumara showed less of a pattern, specifically among blues, than did the speakers of Tzeltal, Seri, and Guarajío. However, the data of Figures 8.45a-c and 8.46a-b indicate that transference is underway among at least one of the 16. Burgess, Kempton, and MacLaury (1983:143-4) observed substantial mismatching between the foci of Figure 8.52d and the tendency to skew high-membership modifier distributions toward green, a further sign of transference. They also observed marginal, isolated uses of the high membership modifier in purple (1985: 61, fig. 7), which appear to have been polarized in that way from a covert recessive vantage.

8.5. Conclusions

Conclusions are of three orders: (1) a discussion, without a definitive explanation, of the predominance of skewing toward green and of transference toward green throughout Mesoamerica; (2) a summary of the three-part hypothesis and of the statisical correspondences that support its parts; (3) a review of the literature that has developed data and theory concerning the internal composition of the cool category.

8.5.1. Skewing Toward Green and Transference Toward Green

Figures 8.17a-21 show that, at least, three times as many speakers of Mesoamerican languages skew the cool category toward green than toward blue. A comparison of other statistics shows that individuals who attend more strongly to distinctiveness -- those who map disjunctively and/or who use a basic cool category -- are more inclined to skew toward green than individuals who attend less to distinctiveness -- those who map continuously and/or who use a secondary cool category. Increased attendance to distinctiveness is accompanied by transference of skewing from blue toward green.

There are two possible explanations for predominant skewing toward green in Mesoamerica: (1) the stronger perceptual salience of green and (2) areal diffusion. They do not conflict with each other. At the present, neither explanation is fully developed. Although the explanation of perceptual salience is promising, it requires more data from non-Mesoamerican languages.

8.5.1.1. Perceptual Salience of Green

As noted in section 2.1.1.1., item 2, Ratliff (1976) reports that the S-cones, whose output largely stimulates +B and -B responses within the +B-Y and +Y-B cell-types of the LGN, are slow to interact, sparse, and peripherally distributed in the retina. Thus, blues are less discriminable than greens.

In section 1.4., Figure 1.5 represents the uneven surface of the psychological color solid, the maximum values of saturation that are visible to humans. The values of green are twice those of blue.

These physiological and psychological attributes of green and blue might make green the most salient and, hence, the most attractive color toward which to skew the cool category. Under the same account, transference of skewing away from blue and toward green would be encouraged as the attendance to distinctiveness is augmented, because the *difference* in psychological salience between green and blue would become more important as the augmentation increased.

This explanation is qualified by a major observation: In specific non-Mesoamerican languages, all speakers skew or historically have skewed the cool category toward blue through all phases of its division. All speakers of these languages who have divided the cool category retain the historical "cool" term to name the blue category. In brief, the purported perceptual salience of green is insufficient to induce transference away from blue in all languages.

However, the evidence against the explanation is flawed. Persistent skewing toward blue through later stages of color-category evolution is well attested in five languages: Shuswap and other Salishan languages (MacLaury 1986, 1987), Chilcotin (1986), Aguaruna (Berlin and Berlin 1975), Mikasuki (WCS files), and Japanese (Mitsunobu 1971). Some of them have persistently skewed the cool category toward blue in juxtaposition to a yellow-focused category that extends through unique green, as is shown to occur among Jicaque speakers in section 8.4.4. The rest were or still are in intimate contact with another language that maintained the yellow-with-green category; apparently the idea that green and yellow are associated bridged the linguistic boundary, even though the yellow-with-green category itself was not widely adopted:

All Shuswap speakers name yellow and green with the same term; and a minority of them retain the cool category, which is skewed toward blue. A similar situation prevails in

other Salishan languages throughout a diffusion area. Speakers of Chilcotin, an Athapascan neighbor of Shuswap, also skewed an original cool category toward blue, and most now use its historical term to name just blue; although few if any Chilcotin speakers use a fully developed yellow-with-green category, some show apparent traces of the areal influence from Salish (cf. MacLaury 1986: figs. 12a-c). Ray (1953) recorded a Chilcotin yellow-with-green category with his spectrogram (cf. section 1.6.). Mikasuki is the neighbor of a language that names yellow and green with one word, in this case Creek. Aguaruna speakers indeed use a moderately salient set of terms that each names both unique yellow and unique green and is focused on both colors (Berlin and Berlin *ibid.*: 68-70, figs. 5-8). Japanese was in contact with Ainu over a broad territory, and most recorded dialects of Ainu used the yellow-with-green category (Batchelor 1926: 451; Hattori 1964: 282-3).[16]

Other languages that are rumored to focus the cool category in blue, such as Vietnamese, might have been casually observed or studied prior to a transference.

Statistics similar to those of Figures 8.18-21 remain to be culled from the results of the World Color Survey. Such statistics should be compiled on the basis of the distinction between basic, secondary, and coextensively composed cool categories, like those of the figures. An example of the reason for observing the distinction comes from Lacandón: all speakers of Lacandón in the Mesoamerican sample skew the cool category toward blue (cf. Figure 8.30d). However, features of their naming data indicate that the Lacandón do

[16]Hattori provides color terms from ten Ainu dialects. Some appear to have used warm and cool categories. Others have transformed the original 'cool' term to yellow-with-green. MacLaury (1986: 5) hypothesizes an evolution among Pacific Northwest languages that integrates the Berlin-and-Kay sequence with the same flip-flopping of categories: Stage IIIa (Warm, Cool) → IIIa' (Yellow-with-Green, Cool), IV (Cool) → IV' (Yellow-with-Green), IIIa' → IV'. In the former two transformations, the category that is next to divide in the sequence is the one that shifts its range: from red to green on the pivot of a yellow focus (IIIa → IIIa') or from blue to yellow on the pivot of a green focus (IV → IV').

Berlin (n.d.) classified as "Stage IIIc" two Numic languages that named all of yellow and green with one term. Some Numic languages skew the cool category toward blue (cf. Nichols 1980: 162-5).

not strongly attend to the distinctiveness of colors; it appears that they encompass the cool category within a black-focused dark-cool category, and all use just five color terms. It remains to be seen whether Lacandón speakers in the future will undertake transference toward green as they attend to distinctiveness more.

8.5.1.2. Areal Diffusion

Skewing toward green might be a recently diffused trait of the Mesoamerican cultural area, although it is unlikely; indigenous-language bilingualism and intimate, sustained inter-village contact itself might not have been widely practiced in Mesoamerica during the present century. Throughout Mesoamerica, extensive blocks of languages skew the category toward green, while in enclaves speakers of some languages are undergoing transference (cf. section 8.4.9). Only Lacandón speakers unanimously skew a single-vantage cool category toward blue.

8.5.2. Skewing, Composition, and Division

The numerically supported correspondences shown in section 8.3. match the entailments of the three-part hypothesis of (1) skewing, (2) composition, and (3) division:

1. Skewing is inseparable from categorization itself, because categorization is the adoption of at least one vantage; the vantage is taken from a particular position.

This entails that all single-vantage cool categories will be skewed, even secondary categories that are not substantially dividing. Figures 8.18 and 8.20 show that both basic and secondary cool categories are skewed. Dual foci and foci in column 23 of maximal turquoise are rare. Figure 8.21 shows that the cool-category foci of the Mesoamerican sample that were placed on no more than two adjacent colors were placed in columns 23, 24, 25, and 26, respectively, at percentages of 1.60, 1.16, 1.01, and 1.45. Dual foci also are exceptional; they occur exclusively in cool categories that are coextensively composed, either permanently or while undergoing transference. The relationship of dual foci to these two environments is a topic of Chapter IX.

2. In the case of a category of just one vantage, the vantage point is composed by a coordination of both the attendance to similarity and to distinctiveness with one unique hue; different strength is ascribed to each attendance.

A strong attendance to similarity entails that continuous cool-category mappings will correspond with centralized foci; a strong attendance to distinctiveness entails that disjunctive mappings will correspond with foci that are either placed on a unique hue or polarized. An attendance to distinctiveness that is strong enough to have occasioned the full division of the cool category entails the following: among basic green and basic blue categories, a greater percentage of foci will occur on or outside of the unique hues than will occur within any class of cool categories, including those that are disjunctively mapped. The entailed correspondences are demonstrated by the statistics of Figures 8.23-27 and Table 8.1.

3. The strengths can shift reciprocally over time; as the attendance to distinctiveness increases, the attendance to similarity decreases. The shift causes change throughout the category in the distribution of membership values -- an enhancement of skewing -- which ultimately leads to the complete division of the category.

This entails that the cool category, when it is composed from one vantage, will divide by the retraction of its original range toward one of the unique hues. After division, the original term will name that unique hue and a new term will name the other. Figures 8.1-13 and 8.30-51 document generally how the retraction progresses and how it culminates. Under some conditions, cool categories that are coextensively composed involve a discontinuation and loss of the original term during advanced division, which is another topic of Chapter IX.

In section 8.4, data from small samples suggest other correspondences, such as those between (1) the position of a focus and the number of color terms used by an individual to name all colors, (2) the position of a focus and the elaboration of color modifiers, (3) the position of a focus and the number of times that each side of the cool

category is named with the basic root. Such correspondences were not developed among the statistics of section 8.3., although these too might match the entailments of parts (2) and (3) of the hypothesis.

8.5.3. Prior Research on the Cool Category

The following reviews observations and models that have been formulated from data concerning the cool category in various languages of Mesoamerica and elsewhere.

8.5.3.1. Aguaruna

As indicated in section 8.5.1.1., Berlin and Berlin (1975) recorded blue foci from 38 of 39 Aguaruna speakers who maintained the cool category; 16 speakers who used basic green and blue categories named blue with the historical "cool" term. This is the only case of consistent skewing toward blue that has been thoroughly quantified in a language in which at least some speakers are in an advanced phase of dividing the cool category; Berlin and Berlin noted Stages IIIa, VI, and V. This persistence of skewing toward blue corresponds with use of a moderately salient category that encompasses both unique yellow and unique green and that was focused on both of these hues. (Aguaruna is the only language that is known to have a secondary yellow-with-green category, which suggests a different origin than the flip-flop innovation evidenced by Jicaque, Figures 8.40a-f.)

8.5.3.2. Navaho, Apache, Eskimo, and Tzeltal

Landar, Ervin, and Horowitz (1960: 380) report that Navaho speakers focused the cool category in blue, but they provide no quantification from separate individuals. Data collected (by Phil Greenfeld, MCS) from 31 Apache speakers on four reservations show some cool categories that are focused in blue, others focused in green, and two that are dual-focused in both green and blue. Only one term is used to name the category. Mismatching of foci and first mapping steps suggest that Apache speakers represent a case of transference; the dual foci might have been volunteered by individuals in transition who maintain two vantages of the cool category, as does the Northern Tepehuán speaker of

Figures 8.48a-b. Navaho and Apache are closely related in time and space, and both represent Stage IV.

Heinrich (1974) shows that among a sample of purportedly Stage-IV Eskimo speakers, some focused the cool category in blue and others in green; the former were slightly more numerous. Berlin and Kay (1969: 5) show that among 40 Tenejapa Tzeltal speakers, 31 focused the cool category in green, 9 in blue, and none between. The two samples might represent early and late phases of transference. Data from the Mesoamerican Color Survey, Figures 4.1a-4.7c (and 5.1a-c, 6.1a-4c, 6.11a-13, 6.26a-c, 7.1a-c) show Stages II-IV among 9 Tenejapa Tzeltal speakers; 7 focused the cool category in green, 2 in blue.

8.5.3.3. West Futunese

Dougherty (1975) records an exceptional complex of semantic relationships within the basic cool category of West Futunese. Her data indicate that some speakers overtly named coextensive vantages of the cool category with recent innovations (e.g., *ibid.*: fig. 2.21); others maintained coextensive vantages while naming each with the original 'cool' term. The coextensivity had two results: (1) Speakers of Stages IIIa and VI focused the original term in blue, in green, or in a dual manner, from one, the other, or both of the vantages. Stage-IIIa foci included 2 green, 2 blue, and one dual; Stage-IV foci included 3 green, 12 blue, and 4 dual. (2) Speakers at an advanced phase of division, which Dougherty calls Stage V, retracted the range of the original term toward opposite unique hues. Twenty-one women and one man retracted it toward green, 4 men toward blue. The opposite patterns suggest the crossover effect of coextensivity, like that exhibited by speakers of San Ildefonso Ixtahuacán Mam, Figures 7.21a-25d.

8.5.3.4. Fuzzy-Set Union

Kay and McDaniel (1975,1978) argue that any composite color category is formed by application of a fuzzy-set logical operation to two or three unique hues (cf. section

1.7.1.2.). This operation, called "the fuzzy-set union," entails that a color will be a member of the cool category to the degree that it is *either* green *or* blue, but *not both.* Thus, membership values of the cool category are graded such that they are represented at middle brightness across the category as a symmetrical bimodal curve with its crests at unique green and unique blue, a dip to a medium value between the unique hues in turquoise, and lowest values at its ends where the category-margins reach neighboring unique hues. The symmetrical bimodal curve is depicted in Figure 1.12. A major implication of this model is that the cool category -- as well as any composite color category -- is constituted by logic rather than by cognition.

Kay and McDaniel formulated their model with particular data at hand, mainly those from Aguaruna, Eskimo, Tzeltal, and West Futunese. The Aguaruna data, which all were skewed toward blue, were not by themselves addressed. However, those from Eskimo, Tzeltal, and Futunese appeared to strongly support the model: Eskimo and Tzeltal speakers focused the cool category either on green or on blue, but not between; Futunese speakers focused the category on green, on blue, on both green and blue, but not between. These seemed sufficient to justify the bimodal curve of membership values with equal maxima in both green and blue.

At the time of this formulation, skewing, transference, and coextensivity had not been recognized. Kay and McDaniel had no means of knowing that such cognitive processes could each account, respectively, for the focal aggregates of Aguaruna, Eskimo and Tzeltal, and Futunese.

It has been attested throughout Chapters III-IX that a number of processes and semantic relationships occur within composite categories. It appears that the three-part hypothesis of skewing, composition, and division ties together and accounts for these processes and relationships more exhaustively than can the fuzzy-set union. For example:

1. The fuzzy-set union is static; it does not incorporate a mechanism that explains how and why a composite category changes its internal composition and the size of its range toward an eventual division.

2. Without this dynamic, the fuzzy-set union cannot account for and interrelate the semantic types of near-synonymy, coextensivity, inclusion, and complementation; nor can it explain why the types evolve through a continuum.

3. The fuzzy-set union predicts that foci of a category will be placed either on one unique hue, on the other, or on both; and it must explain deviation from the prediction as error or random variation. It cannot explain correspondences, such as those between continuous mappings and centralized foci or between disjunctive mappings and foci on or outside of the unique hues.

4. The fuzzy-set union is detached and disembodied; an individual does not place himself at a particular vantage point in relation to it. Thus, the model cannot explain the pervasiveness of skewing, the rarity of dual foci within categories that are not coextensively composed, the transference of foci from one side of a category to the other, or the retraction of an original category-name to just one unique hue.

Points **1.-4.** constitute an argument against the logical composition of composite color categorization and in favor of its cognitive composition. *Composite color categorization is cognitive rather than logical.* The three-part hypothesis of skewing, composition, and division provides a cognitive alternative to the fuzzy-set union.

The cognitive model is indebted to and dependent on five critical advances that Kay and McDaniel established during their work on color categories as fuzzy-sets. While the cognitive model supplants the notion that color categories are logical operations on neural response, it incorporates the five enduring contributions: (1) Value of membership is a matter of degree (cf. Rosch, Section 1.7.2.3.). (2) Degree of membership is expressable as a curve, as in Figures 1.12 and 8.13. (3) Composite, primary, and derived color categories are distinguished, respectively, as those encompassing two or three, one, and no

unique hues or other pure colors. (4) the unique hues and other pure colors are universally fixed in human color perception, and their invariance is explicable by findings from visual physiology. (5) All composite and primary color categories are focused and composed in reference to the unique hues and pure colors.

8.5.3.5. Tarahumara

Burgess, Kempton, and MacLaury (1983: fig. 7; 1985: fig. 10) recognized skewing, and they proposed the predecessor to the model of Figure 8.13. They anticipated phases 2-5b of the present model; but, for a first phase, they inserted Kay and McDaniel's symmetrical bimodal curve. The first phase was based on data from their main informant, which are reproduced above as Figures 8.45a-c and 8.46a-b and which include a mapping. The mapping happens to be one of the most evenly proportioned among the 260 cool-category mappings of the Mesoamerican sample. Also, the Tarahumara focal aggregate was distributed in both green and blue, Figure 8.52d. These coincidences led Burgess, Kempton, and MacLaury to minimize the subtle evidence of skewing in the well-proportioned Tarahumara data.

None of these data justify the bimodal curve. Further, Figures 8.45a-b suggest that the key informant of the original study was undergoing transference; his first naming range is skewed toward blue while his second is skewed toward green.

Chapter IX

Complex Composition

9.0. Preface

The object of this chapter is to review the cool categories whose internal compositions are the most complex of the Mesoamerican sample. These data complement those addressed in Chapter VIII regarding cool categories that are composed from a single vantage. The single-vantage compositions tend to be simplex in comparison to those that will be treated here. Thus, the data of Chapter VIII might foster an incomplete or over-simplified expectation of what the cool category can involve. The present chapter completes the account with an analysis of the relationship between *covert coextensivity, dual foci,* and *the emergence of separate secondary categories on both the green side and the blue side of the basic cool category.* In some Mesoamerican languages, such as Mazatec and Mazahua, the cool category manifests complexity of the order that Dougherty (1975) found in the dual-focused cool category of West Futunese.

1. Covert Coextensivity.[1] An individual can compose the cool category from two vantages while naming each with the same name. In Table 5.1, under item 1., this "covert coextensivity" is contrasted against a parallel attribute of coextensivity in the warm category, in which each vantage always bears a distinct name. In Chapter V and in conjunction with that table, the difference is attributed to the greater perceptual similarity of green and blue.

[1]Berlin (1969) introduced "covert" to the theory of categorization as a descriptor of unnamed categories.

A. Optional Naming of Coextensivity in the Cool Category. The numbers presented in Chapter VIII show that, of the 589 cool categories in the Mesoamerican sample, 478 are composed from one vantage, 102 are composed from coextensive vantages, and 9 are doubtful cases of coextensivity. Of the 102, 44 involve vantages that are named with different roots, 10 involve vantages that are named with the same root but differentiated with modifiers, and 48 involve vantages that are named with the same root and not differentiated on any level.

B. Evidence of Covert Coextensivity. When coextensive vantages are separately named, evidence of coextensivity can consist simply of the naming ranges themselves. However, evidence of covert coextensivity consists of mismatching between a focus, a mapping, and, sometimes, a naming range, and it consists of gross inconsistencies between the responses of a single individual during different interviews. The evidence is further buttressed by recurrence of such mismatches throughout data from many members of a specific community, whereas little or no mismatching occurs in data from other communities. Shared mismatching indicates shared coextensivity.

C. Transference. The statistic of 102 coextensively composed categories is problematical, even with the quoted margin of another 9 doubtful cases. The statistic includes only cases in which coextensive vantages are strongly attested, either by use of separate names or by wide recurrence of mismatching or by both. The statistic does not include the many cases of transference, in which individuals covertly maintain coextensivity while they transfer a dominant vantage from the blue side to the green side of the cool category. For example, the Northern Tepehuán speaker of Figures 8.48a-b demonstrated covert coextensivity by placing a first mapping step in blue and a focus in green; but it is undetermined how many of his contemporaries maintain covert coextensivity without so manifesting it. In Figures 8.36a, 8.48c, and 8.52a-c, speakers of Acatec, Northern Tepehuán, Tzeltal, Seri, and Guarajío placed foci in green and in blue in conformity with the pattern that is characteristic of dominant-recessive coextensivity.

Yet no specific speaker of these languages is counted among the 102 cases, because (with two exceptions) coextensivity cannot be individually attributed to any one of them.

Theoretically, there is a difference between coextensivity that temporarily arises as a consequence of transference and coextensivity that is maintained over generations and, often, named with two or more terms. Empirically, it is virtually impossible to distinguish temporary and long-standing coextensivity among cases that are covert. Moreover, "temporary" is imprecise; it is undetermined whether transference transpires within one generation or takes longer.

2. Dual Foci. Dual foci will occur only in the context of a single category that is coextensively composed; each focus of any dual pair is placed in reference to a distinct vantage. Figures 5.5a-6 show dual foci in the environment of overtly named coextensivity; the name of one vantage can be dual-focused as a result of the crossover effect (cf. Table 5.1, item 2.). Figure 8.52c shows dual and triple foci, presumably, in the context of transference and covert coextensivity; each dual or triple set shows the dominant-recessive pattern.

The relationship of dual foci to covert coextensivity is important to theory because Kay and McDaniel (1978) cited dual foci as evidence in support of the symmetrical and bimodal fuzzy set-union model of composite color categorization. But at that time, the relationship -- as well as coextensivity itself -- was not recognized.

3. Separate Secondary Categories of Green and of Blue. In Chapter VIII (e.g., Figures 8.7a-d, 8.9a-c, 8.11, 8.15-16), it is shown that a relationship of inclusion can develop in the cool category, but almost always by the emergence of a secondary category on specifically the low-membership side of a strongly skewed composition. In just one language of the Mesoamerican sample, Chiquimula Quiché, seven of the eleven speakers who were interviewed named a secondary category with a lexical root on the focal side of the cool category (cf. Figures 8.42a-d).

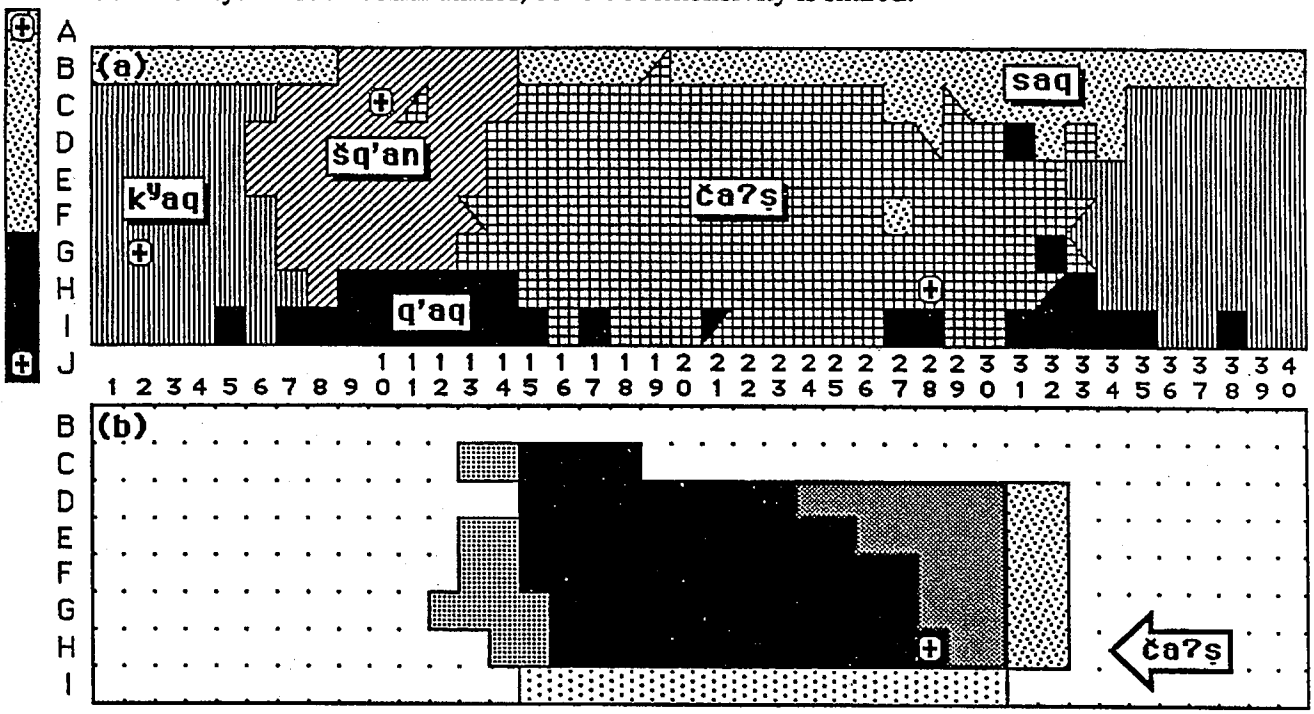
A coextensively composed cool category can contain two secondary categories, one on each side. Probably, on each side, a secondary category encompasses the low-membership colors of the vantage that is focused on the opposite side. This probability is consistent with the nearly universal development of secondary categories among the low-membership colors of basic single-vantage categories. It seems unlikely that a secondary category would coincide with low membership in the context of one vantage but not in the context of two.

4. Historical Consequences of Covert Coextensivity. As the cool category approaches a full division, covert coextensivity can affect the eventual disposition of the historical "cool" term. The effects are unlike those that would accompany the division of a single-vantage cool category. **(a)** Coextensivity increases the chance that the historical "cool" term will name blue instead of green; as division culminates, the term can name either vantage while a newer term names the other. Conversely, as a single-vantage category divides, the original term and its focus will transfer to green; the transfer will occur unless the category always has been skewed toward green or unless the transfer is discouraged by the presence of a yellow-with-green category. **(b)** Separate secondary categories in green and in blue can gain salience at the expense of the historical "cool" term. This original term can disappear entirely, leaving the formerly secondary names of 'green' and 'blue' as the only basic terms. Situations **(a)** and **(b)** can combine: The original "cool" term can survive as the name of just green or of just blue, and one of the two former secondary terms can prevail as the name of the opposite color.

The foregoing principles (**1-4.**) are exhibited by the data of sections 9.1-2., which show how covert coextensivity as a theoretical construct is critical to the explanation of complex composition within the cool category. Section 9.3. treats coextensivity on the axis of dark-versus-light.

9.1. Covert Coextensivity

Covert coextensivity -- that is, coextensive vantages that are named with the same term -- is demonstrated by non-correspondence of data, as between a focus and a first mapping step. The evidence is convincing when it derives from several members of one community. In such communities, covert coextensivity is shared.



Figures 9.1a-b. Naming ranges (a), foci (a-b), and mapping (b); Mam, San Ildefonso Ixtahuacán, woman, age 56, 1980.

Figures 9.1a-b display data from the oldest Mam speaker among the eleven who were interviewed in San Ildefonso Ixtahuacán. Naming ranges and mappings from the other ten are shown in Figures 7.21a-25d. The ten younger speakers overtly named two and three coextensive vantages. The oldest speaker shared the coextensivity, but she named both vantages with the same word. Evidence of her covert coextensivity is seen in the non-correspondence of her focus and first mapping step. Although these data coincide on the blue of H28, the predominant portion of the first mapping step covers green.

9.1.1. Dual Foci

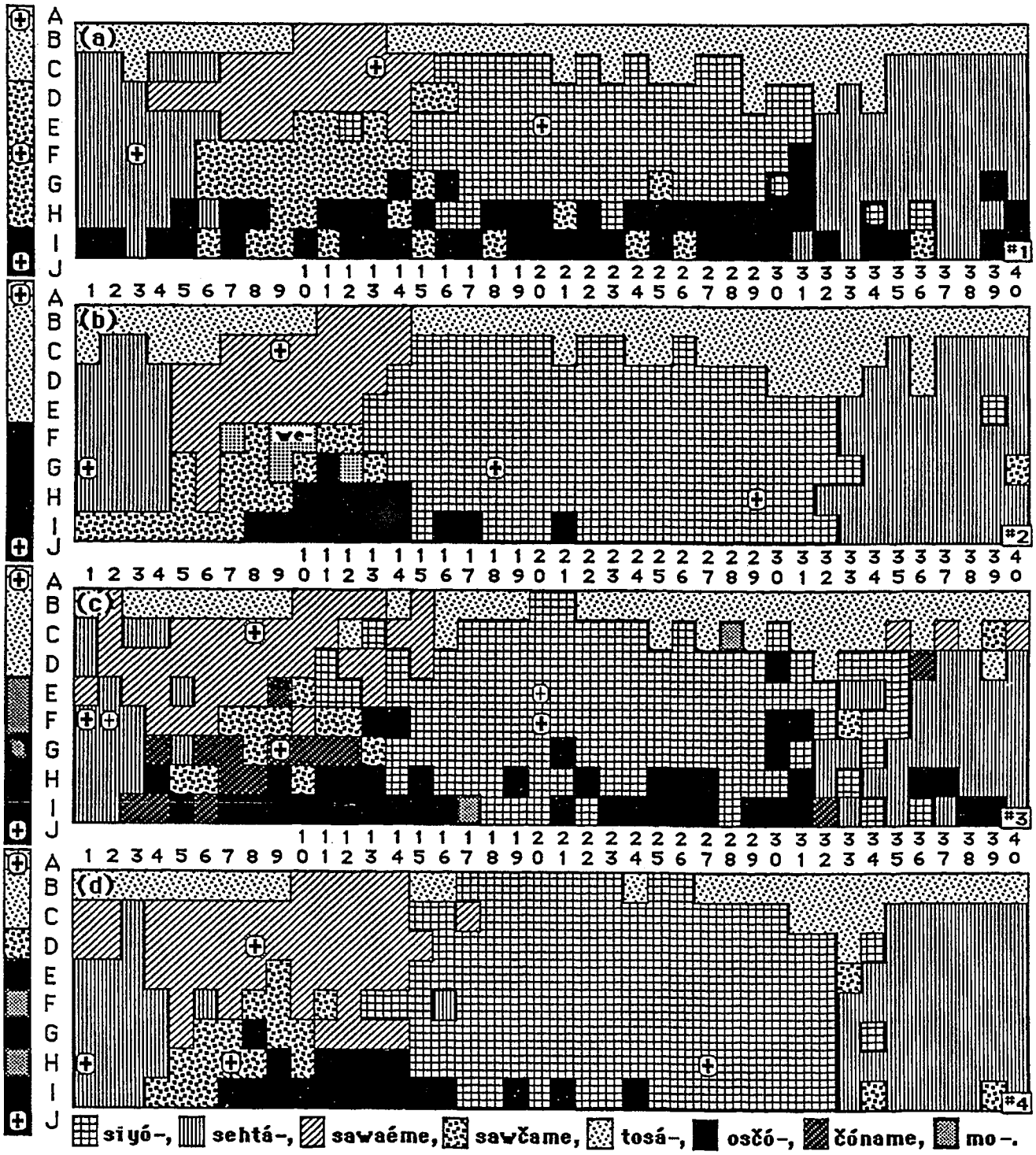
"Dual foci" are more accurately called *single foci of distinct coextensive vantages within one category.* Dual foci occur exclusively in the context of both overtly named coextensivity (cf. Figures 5.5a-6) and covert coextensivity. The latter includes the temporary coextensivity that is integral to transference.[2]

Figures 9.2a-d display triple, dual and single foci in the context of probable transference among Guarajío speakers. The Guarajío focal aggregate appears in Figure 8.52c. Speaker #1 placed triple foci, one centralized in green at E20 and two polarized in blue and purple at G30 and H34. Speaker #2 placed dual foci, one slightly centralized in green at G18 and the other in the unique-blue column at H29. Speakers #3 and #4 both show one centralized focus, at G20 in green and H27 in blue.

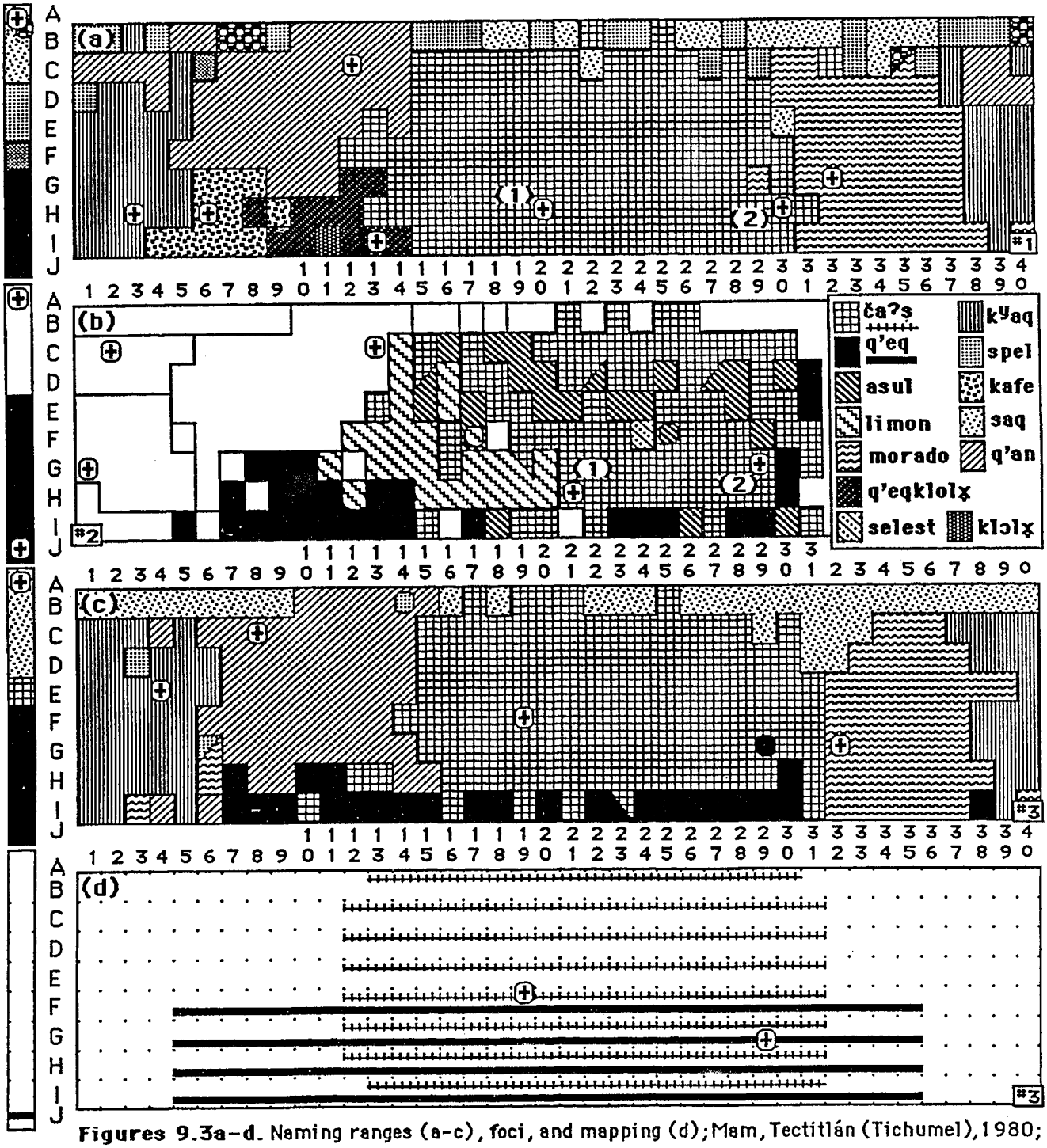
Figures 9.3a-d show dual foci and a single focus in the cool category of three Tectitlán Mam speakers. Speaker #2 overtly named two coextensive vantages. Speakers #1 and #2 both placed a first focus in green and a second in blue with the dominant-recessive pattern; the green foci are centralized and the blue foci are polarized or on the unique hue. Speakers #2 and #3 both extended the black-focused naming range well into blue, and speaker #3 focused it at G29. These data and those of Guarajío speakers #1 and #3 suggest that coextensivity and transference have occurred within a secondary cool category that is encompassed by a black-focused dark-cool category.

An increasing attendance to distinctiveness might have encouraged a few speakers of Guarajío and of Mam to focus both coextensive vantages of a covert pair. Conservative Tzeltal speakers (cf. Figures 4.1a-4c), who also include the cool category within a black-focused dark-cool category, used fewer color terms than did any speaker of Guarajío or

[2]As discussed in section 8.4.9., transference is evidenced when some members of a community demonstrate skewing toward green in mappings, foci, and naming ranges, others of the same community demonstrate skewing toward blue, and yet others yield non-corresponding data. Transference can be suggested, if not evidenced, by focal aggregates that are distributed in green and blue; an aggregate strongly suggests transference when it shows a pattern of dominant-recessive coextensivity, with "green" foci predominately on the column of unique green or centralized and the "blue" foci predominately on the unique-blue column or polarized (cf. Figures 8.36a, 8.48c, 8.52a-b, and 9.30b-d).



Figures 9.2a-d. Naming ranges, foci; Guarajío, Alamos; (a) woman, age 20, (b-d) men, 50, 48, 55; 1978.



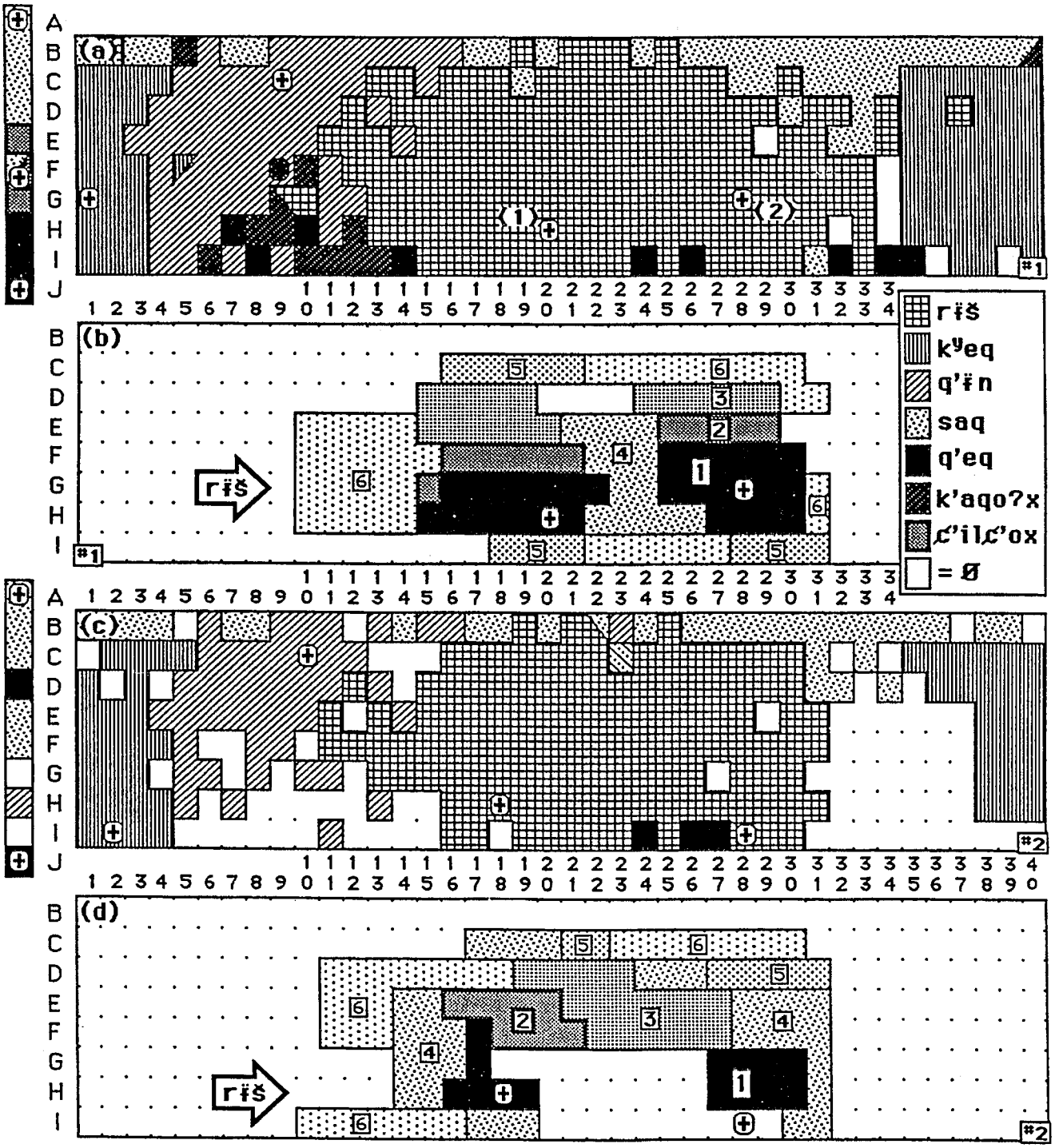
Figures 9.3a-d. Naming ranges (a-c), foci, and mapping (d); Mam, Tectitlán (Tichumel), 1980; (a) speaker #1, man, age 33, (b) speaker #2, woman, age 45, (c-d) speaker #3, woman, age 50.

Tectitlán Mam. Few terms implies strong attendance to similarity. No Tzeltal placed dual foci (cf. Figure 8.52a).

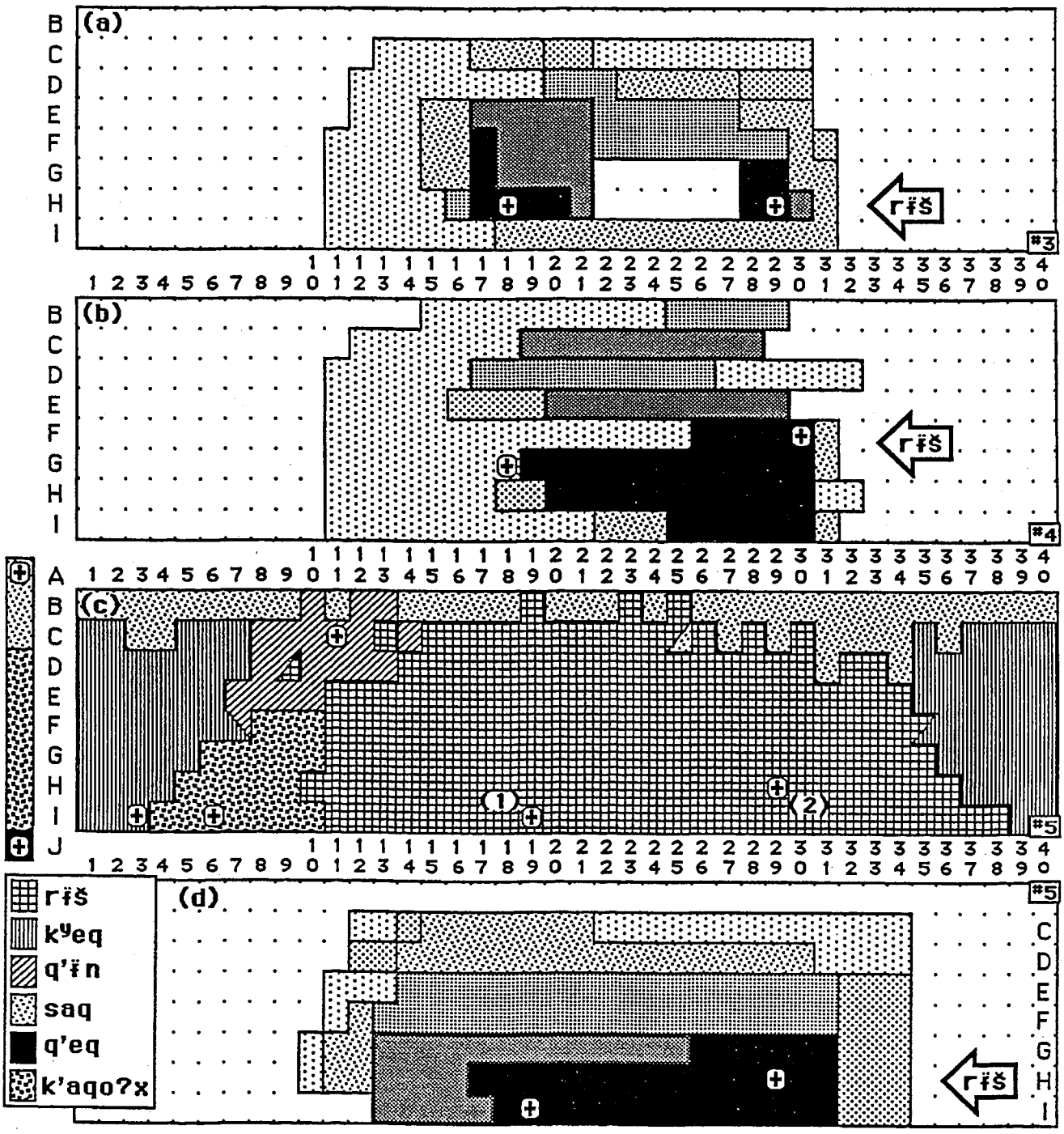
In Figures 9.4a-8d, nine speakers of Tecpan Cakchiquel showed a very different tendency than did the speakers of Guarajío and Tectitlán Mam. Among the eleven individuals who were interviewed in Tecpan, these nine placed dual foci; only two placed a single focus, both in green (cf. Figures 8.4a-5c). The shared preference for dual foci corresponds with a second exceptional tendency: Eight of the eleven declined to name a substantial number of colors; for example, speaker #2 gave 80 null responses, #6 gave 112, and #9 gave 75. The reluctance indicates a shared emphasis on distinctiveness and discrimination, one that is stronger than that maintained by speakers of Guarajío or of Tectitlán Mam. The shared outlook might have encouraged nine of the eleven to focus both of the covert coextensive vantages. (The rare tendency of a majority of individuals to offer substantial null responses was also shown by eight of the eleven Mam speakers of San Ildefonso Ixtahuacán. Ten of the San Ildefonso Mam speakers focused and overtly named two or three coextensive vantages of the cool category [cf. Figures 7.21a-25d].)

Transference and an accompanying covert coextensivity is demonstrated by the data from the nine Cakchiquel speakers as follows: (1) speakers #S 1-2 and 4-5 mapped the cool category with skewing toward blue, and speakers #S 3 and 6-9 mapped it with skewing toward green; (2) those that skewed toward blue named more colors (i.e., gave fewer null responses) and used a broader cool-category naming range than those that skewed toward green. These correspondences suggest that transference occurred from skewing toward blue to skewing toward green as the attendance to distinctiveness increased. Speakers #S10-11 rendered continuous rather than disjunctive mappings; however, speaker #11 centralized the blue focus and named the cool category broadly while speaker #10 centralized the green focus and named the cool category sparingly.[3]

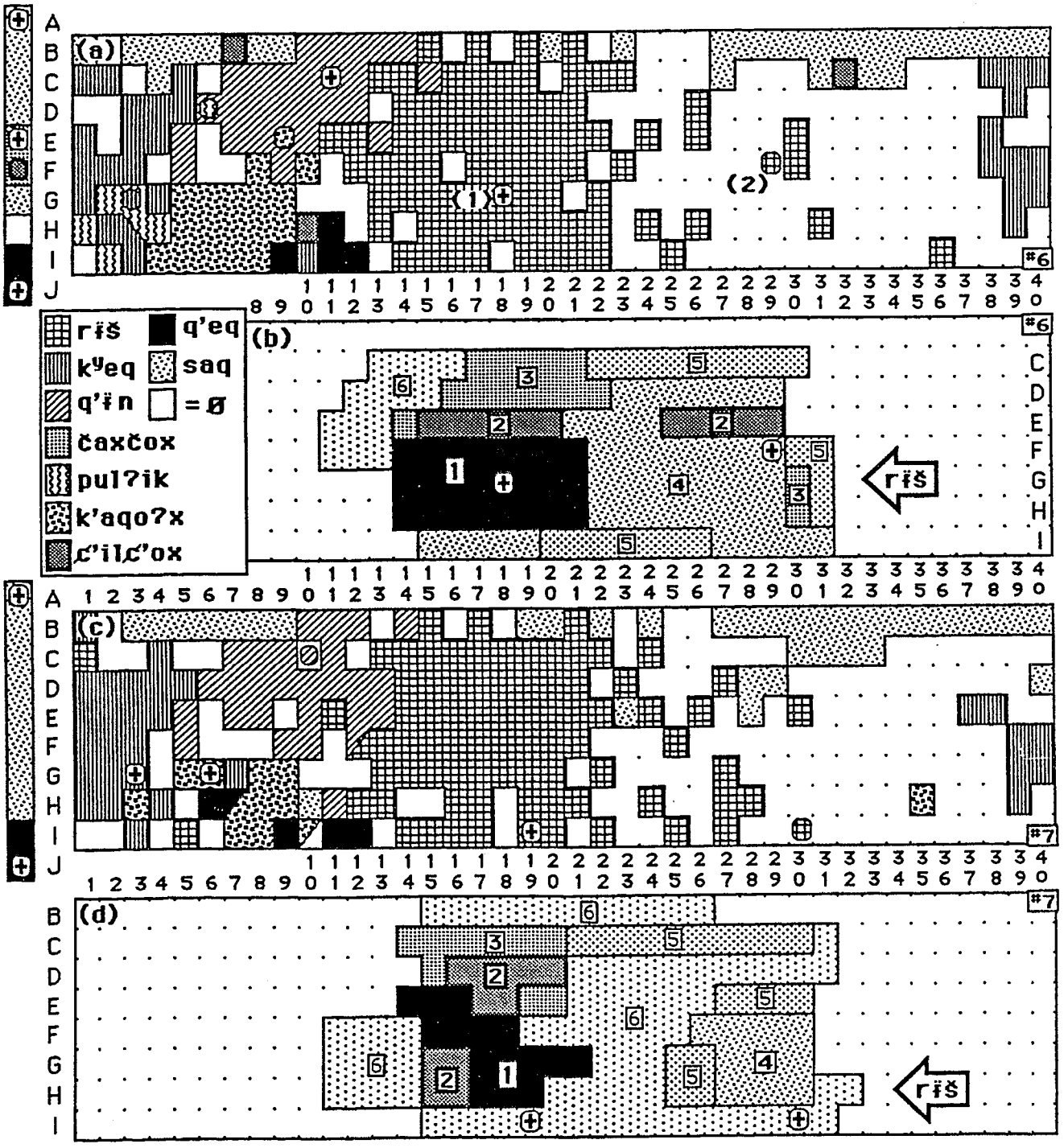
[3]The naming ranges of speakers #3 and #4 are excluded from the figures, because they were elicited together.



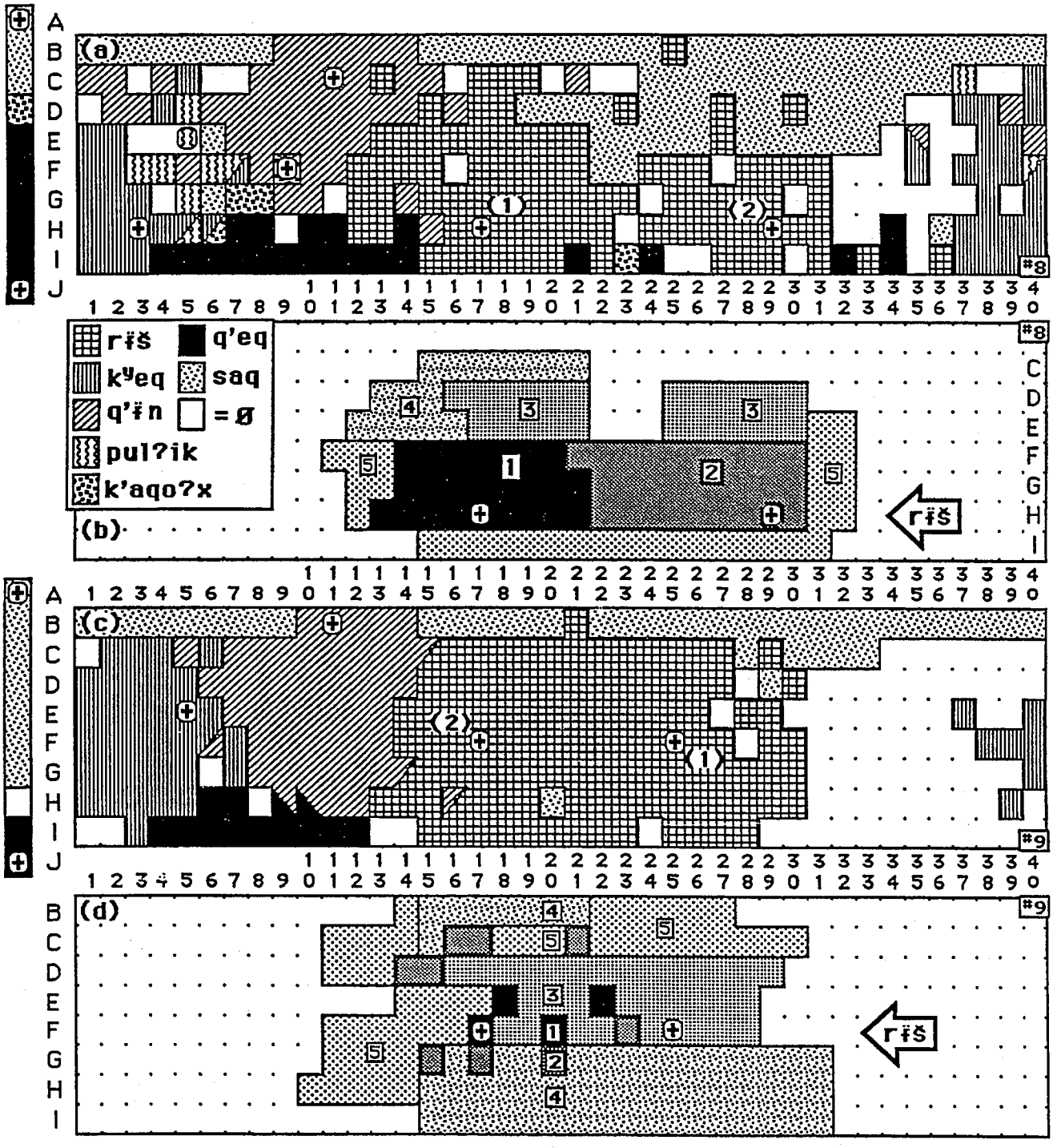
Figures 9.4a-d. Naming ranges (a, c), foci, and mappings (b, d); Cakchiquel, Panajabal, Tecpan, 1980: speakers #^{S} 1-2, men, (a-b) age 32, (c-d) age 20.



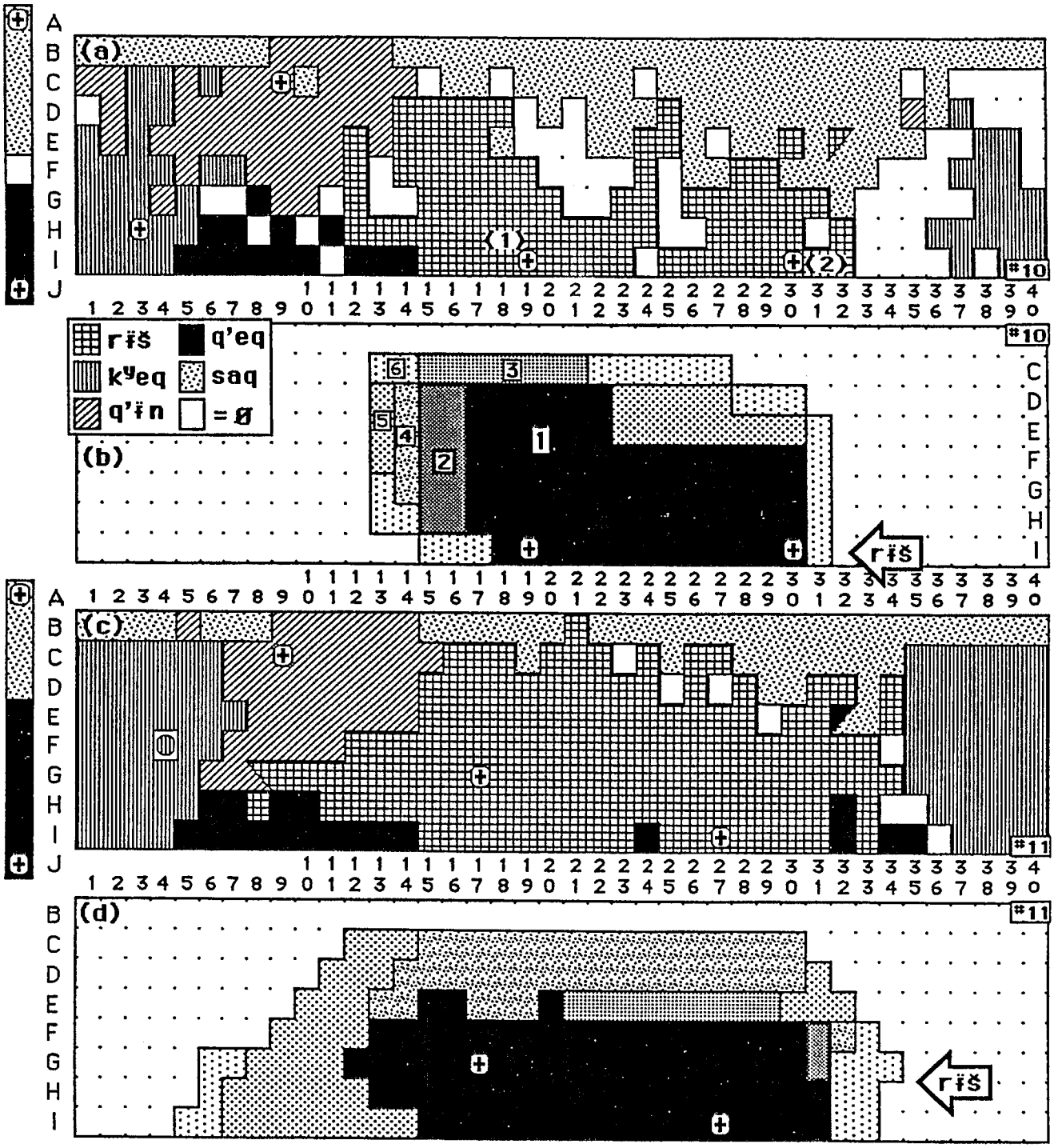
Figures 9.5a-d. Naming range (c), foci, and mappings (a, c-d); Cakchiquel, Panajabal, Tecpan, 1980: (a-b) speakers #S 3-4, men, ages 50 and 19, (c-d) #5, woman, 20.



Figures 9.6a-d. Naming ranges (a, c), foci, and mappings (b, d); Cakchiquel, Panajabal, Tecpan, 1980: speakers #^{S} 6-7, (a-b) woman, age 25, (c-d) man, age 20.



Figures 9.7a-d. Naming ranges (a, c), foci, and mappings (b, d); Cakchiquel, Panajabal, Tecpan, 1980: speakers #S 8-9, men, (a-b) age 20, (c-d) age 25.

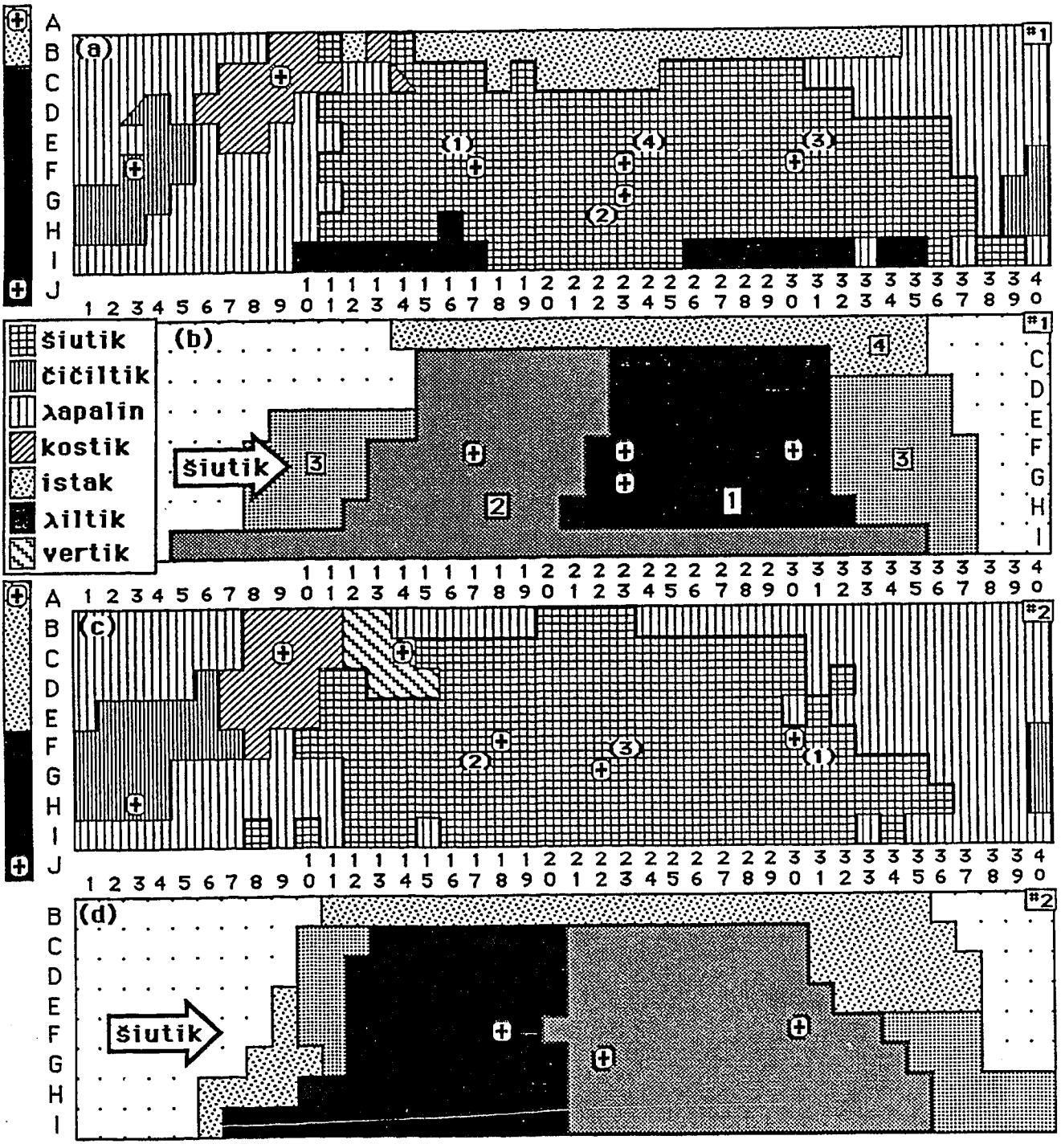


Figures 9.8a-d. Naming ranges (a, c), foci, and mappings (b, d); Cakchiquel, Panajabal, Tecpan, 1980: speakers #S 10-11, men, (a-b) age 31, (c-d) age 18.

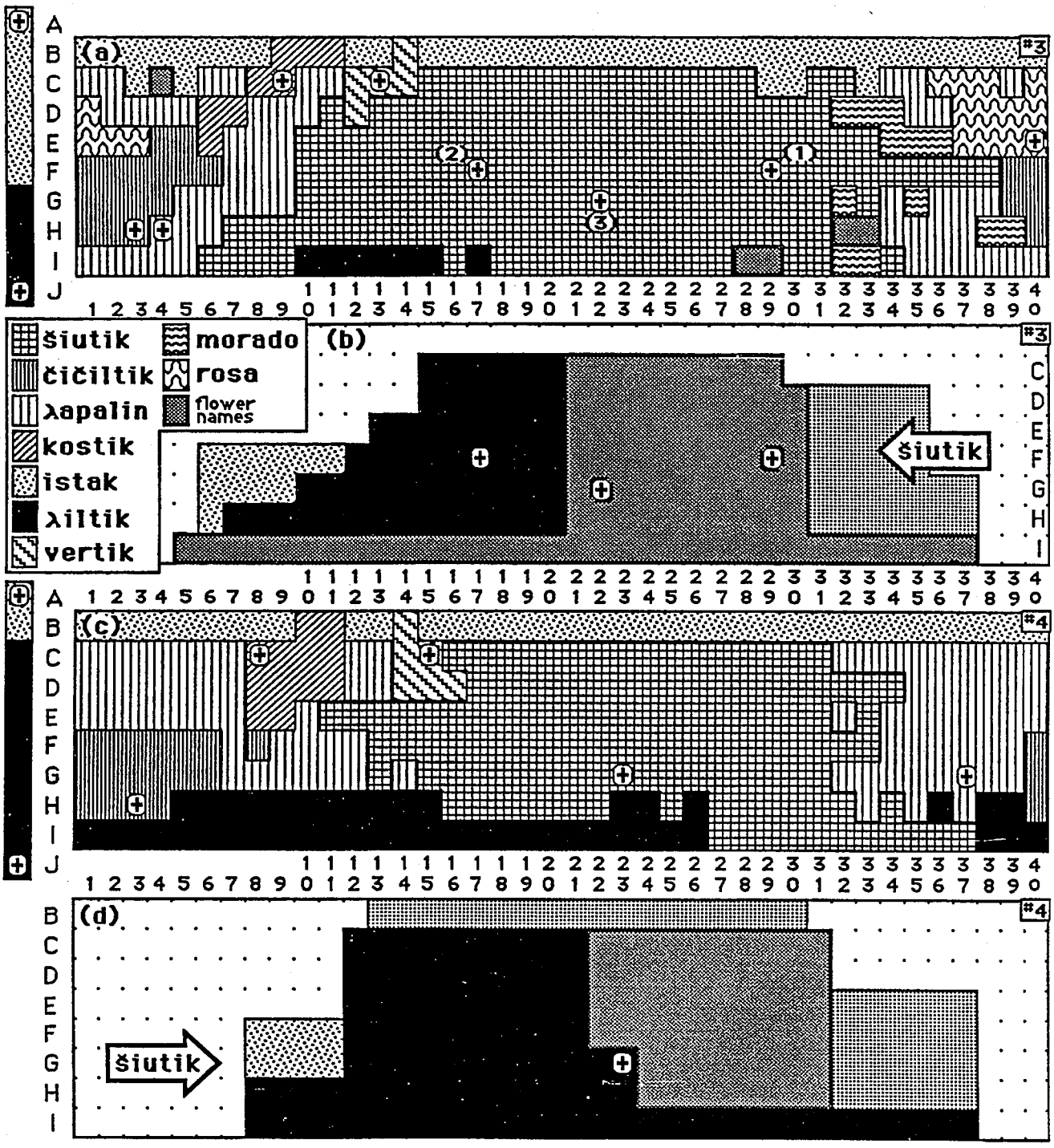
In Figures 8.9a-12d, Nahuatl speakers of Santa María Tonanzintla and San Pedro Tonanzintla show yet another pattern of foci placement in the context of covert coextensivity.[4] Individuals tend, first, to focus both vantages and, last, to place a fully centralized focus. The preference coincides with advanced language death; Nahuatl is no longer used openly in Santa María and San Pedro; speakers are elderly, scarce, and always fluent in Spanish. In response to profound social change, those who remember Nahuatl might have adopted an analytical view of the world. They demonstrate this view when they systematically focus all notable points within the cool category, first each vantage and then a color that equally represents both. Ordinarily, a strong attendance to distinctiveness would foster the division of the cool category; but the disuse of Nahuatl for more than two decades might have shielded the broad application of its color terms from gradual curtailment. That is, individuals use the terms with the ranges that they remember having used at a former time. But they treat the internal composition of these ranges with an attendance to distinctiveness that they have enhanced since then. They have enhanced that attendance to deal, in general, with increasing complexity of their current surroundings.

In the figures, speakers #s 1-3 placed triple foci, on both vantages of the cool category and on a central color. But speakers #4-6 showed only fragments of the triple focus selection: Speaker #4 placed only a central focus on exactly column 23, a rare choice; speaker #5 placed only a blue focus, and speaker #6 placed only a blue focus and a central focus. Speaker #7 underwent the naming elicitation and focus elicitation three times, but mapped the terms only during her third interview. She volunteered three different patterns of naming ranges and three different focus choices: her first focus was in green, her second in blue, and her third was a triple choice on blue, on green, and exactly between. Her focus in just blue corresponded with her broad use of a chartreuse-focused

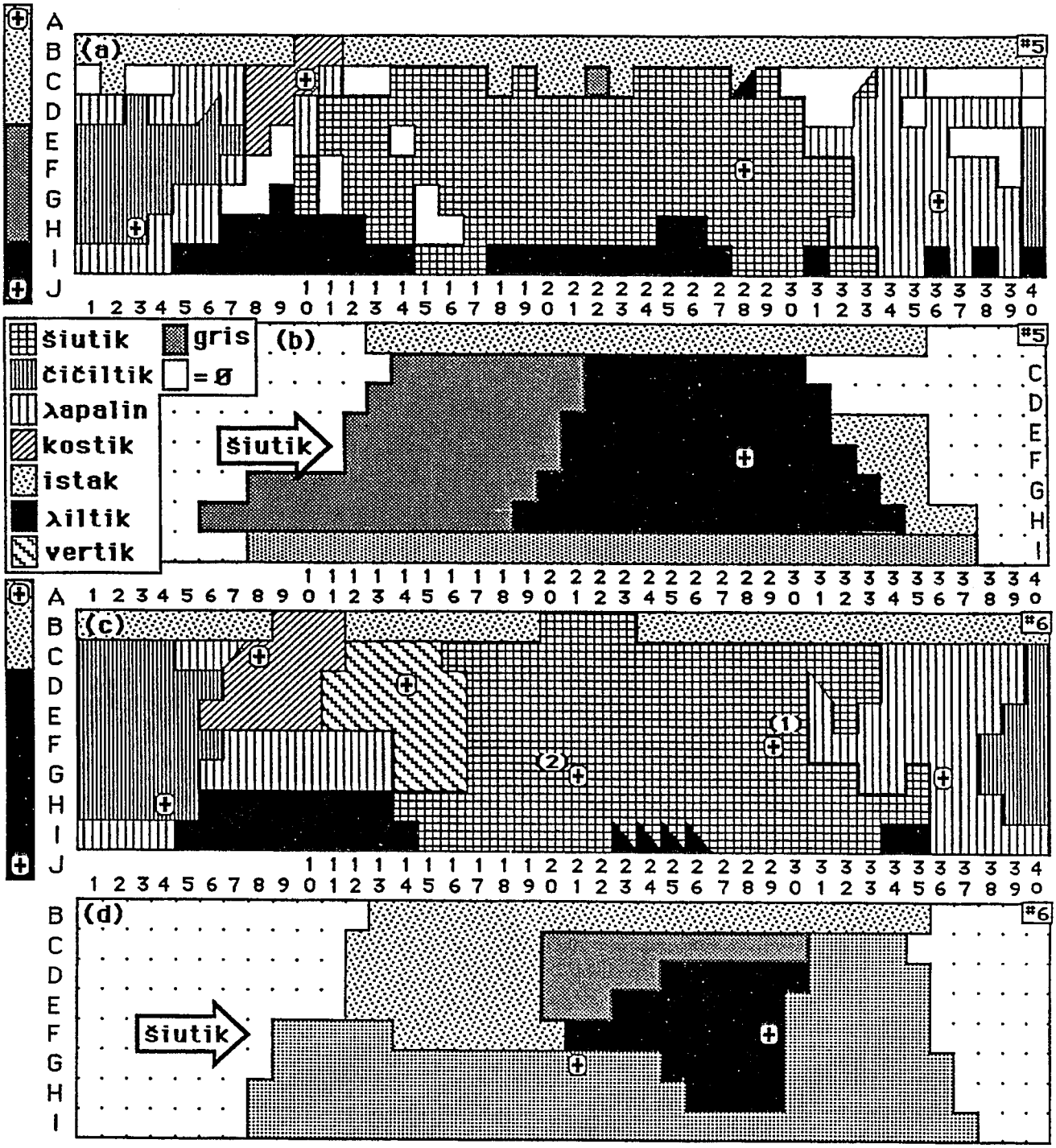
[4]Santa María Tonanzintla and San Pedro Tonanzintla are located in the immediate orbit of Cholula, Puebla, an urban center, and they are part of the economic mainstream of Mexico. San Pedro is a *barrio* of Santa María, and the two polities have long practiced a tradition of intermarriage (T. Knab, personal communication; cf. Knab 1980; Knab and Hasson de Knab 1979).



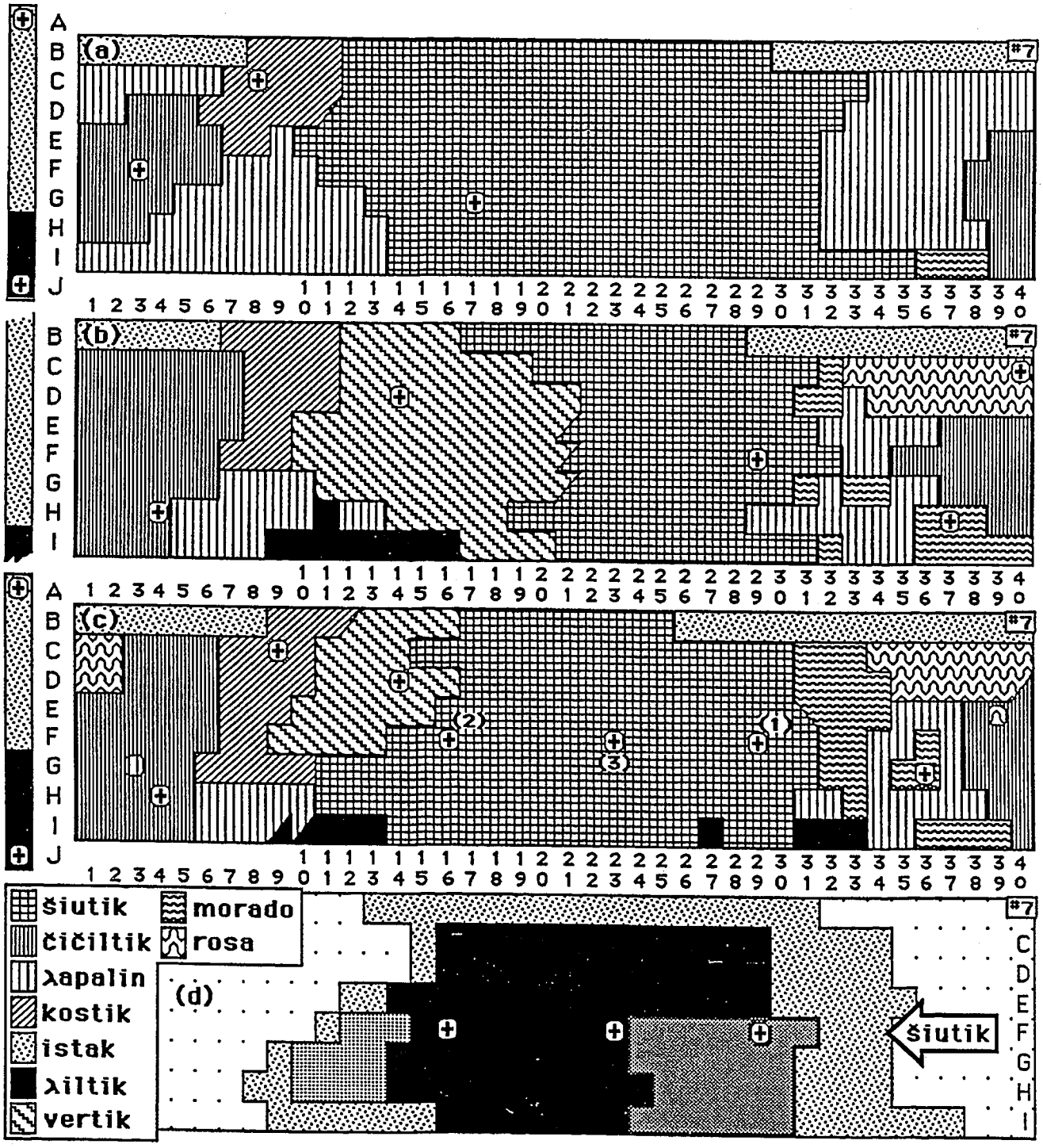
Figures 9.9a-d. Naming ranges (a, c), foci, and mappings (b, d); Nahuatl, San Pedro Tonanzintla, 1980: (a-b) speaker #1, woman, age 82, (c-d) speaker #2, man, age 84.



Figures 9.10a-d. Naming ranges (a, c), foci, and mappings (b, d); Nahuatl, San Pedro Tonanzintla, 1980: (a-b) speaker #3, man, age 82, (c-d) speaker #4, woman, age 66.



Figures 9.11a-d. Naming ranges (a, c), foci, and mappings (b, d); Nahuatl, Santa María Tonanzintla, 1980: (a-b) speaker #5, woman, age 70, (c-d) speaker #6, man, age 70.



Figures 9.12a-d. Naming ranges (a-c), foci, and mapping (d); Nahuatl, Santa María Tonanzintla, three elicitations (a, b, c-d), 1981: speaker #7, woman, age 79.

secondary term, and her focus in just green corresponded with the neglect of the same term. Her triple foci corresponded with a reduced range of the chartreuse-focused term.

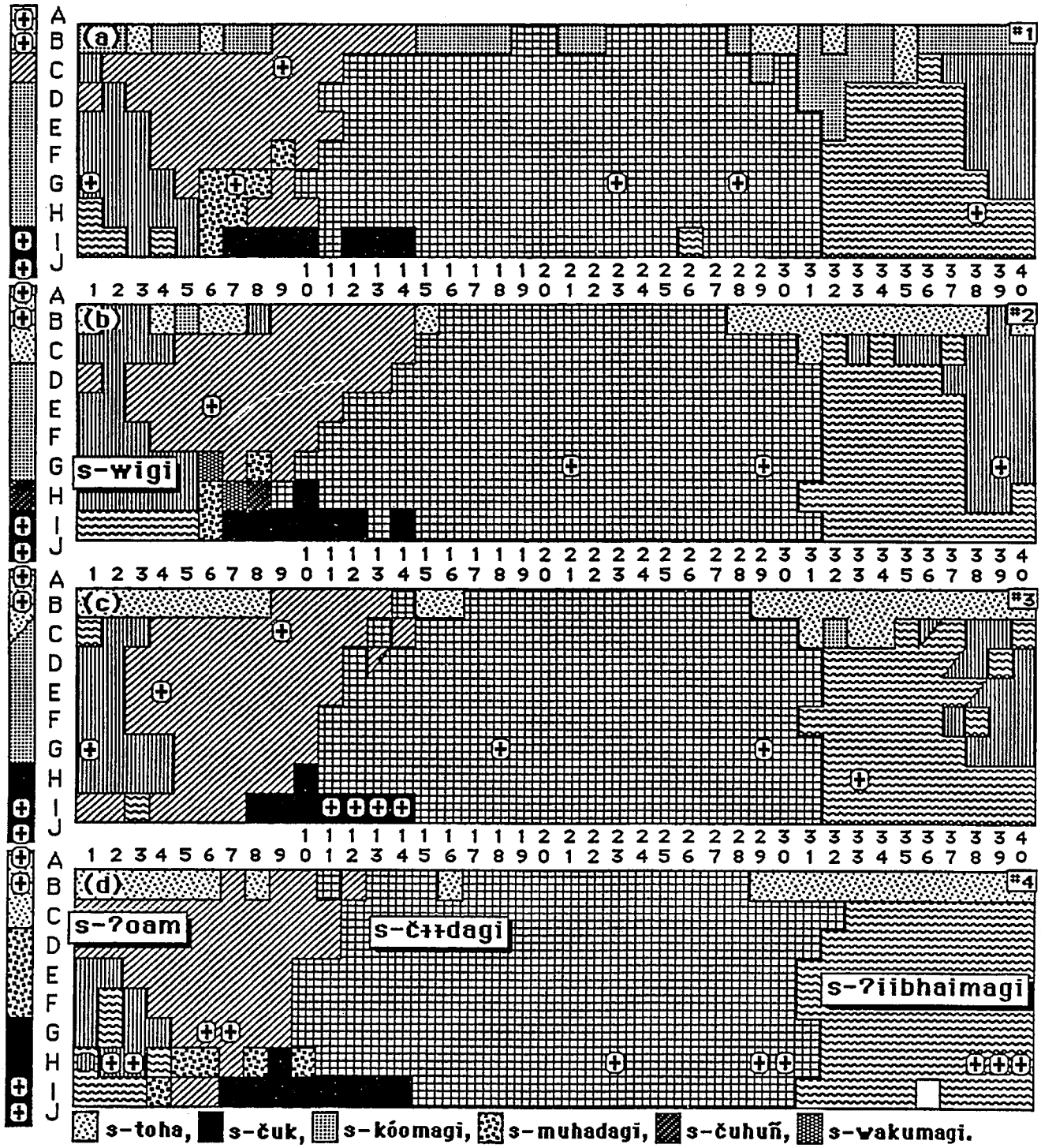
Covert coextensivity is independently evidenced among the seven Nahuatl speakers by their different directions of mapping: Speakers #s1, 5 and 6 cover only blue with the first mapping step, and speakers #s 2, 3, 4, and 7 cover only green. Also, speakers #s 1, 2, 3, and 7 mismatched their first focus placement and first mapping step.

In Figures 9.13a-14d, speakers of Papago and Pima exhibit yet another distinctive pattern of dual foci:[5] one focus is fully centralized and the other is placed in blue. Speakers #s 1-2 and 4 show this pattern. Speaker #1 deviates in that her blue focus is also slightly centralized. Speaker #3 deviates in that her centralized focus is placed in column 18 just to the inside of unique green, not fully centralized. This speaker also placed dual foci on yellow and orange colors, C9 and E4. Thus, the deviant pattern might reflect the preference of one individual to focus all perceptually salient colors, regardless of their value of membership in a category.

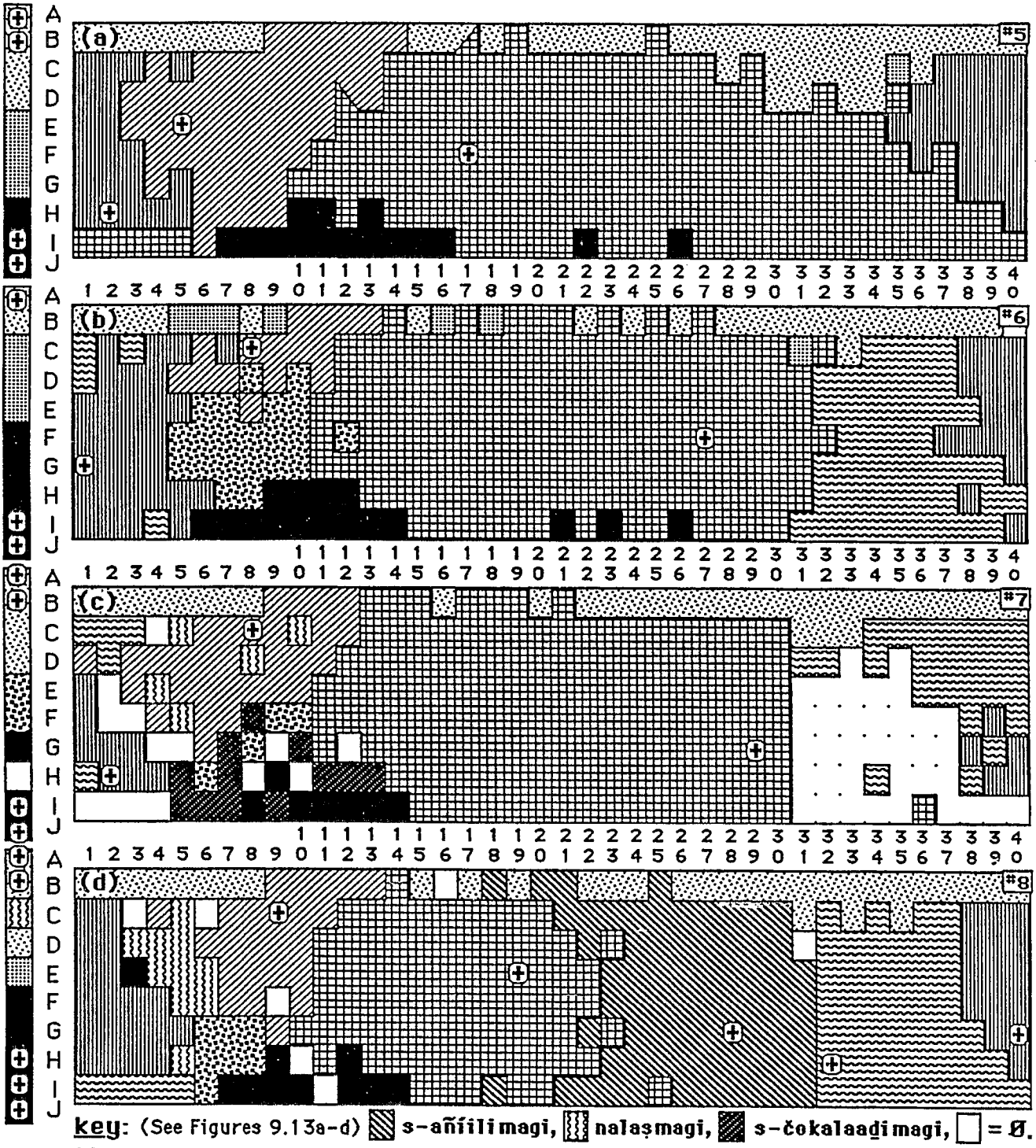
It is unlikely that speakers #s 1-2 and 4, by coincidence, all show a fragment of a prevailing tendency to place triple foci, as did the Nahuatl speakers. Some of the Nahuatl speakers showed just a fragment of the triple pattern, as did speaker #6 of Figures 9.11c-d. The fragmentary focus-placement of speaker #6 is identical to the pattern seen in Papago/Pima. However, almost all of the Nahuatl speakers who were interviewed placed more than one cool-category focus, whereas only four Papago/Pima speakers in a sample of 25 placed dual foci.

The specific dual-foci pattern of Papago/Pima strongly expresses an attendance to similarity with the fully centralized focus while expressing distinctiveness with the blue focus. The speakers of these languages are conservative and traditional, yet they have

[5]Papago and Pima are treated together, as "Papago/Pima," because they are very closely related and geographically contiguous, and their use of all basic and most secondary color terms is identical.



Figures 9.13a-d. Naming ranges and foci;(a-b) Papago, Tótogwauñ, women, (a) age 38, (b)58; (c) Papago, O?odam, woman, age 62; (d) Pima, Blackwater, Gila River, woman, age 57; 1978.

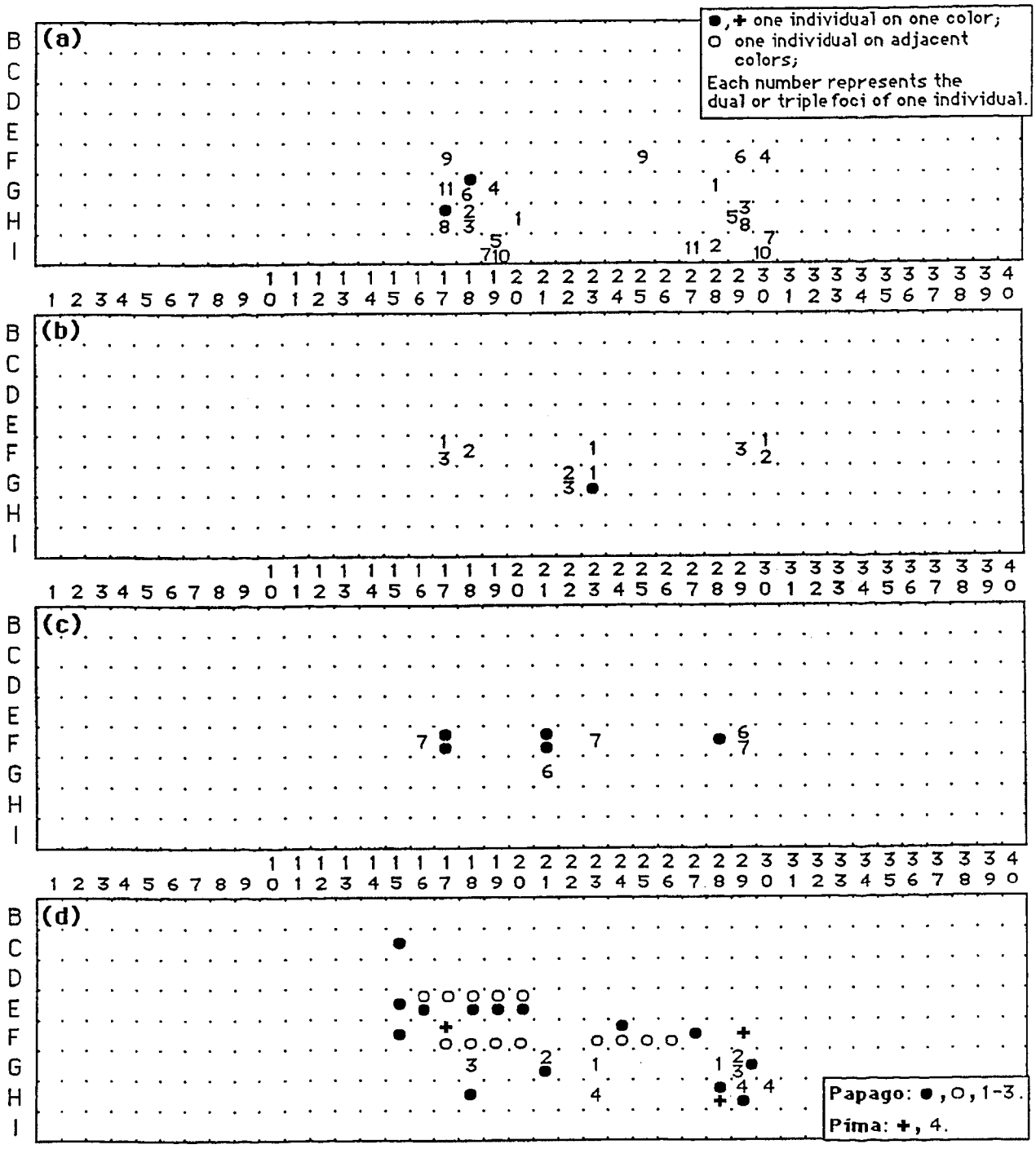


Figures 9.14a-d. Naming ranges and foci; (a-b) Pima: (a) Gila Crossing, man, age 76, (b) Casa Grande, man, age 57; (c-d) Papago: (c) Ko-loodi, woman, age 66, (d) Tótogwuañ, man, 42; 1978

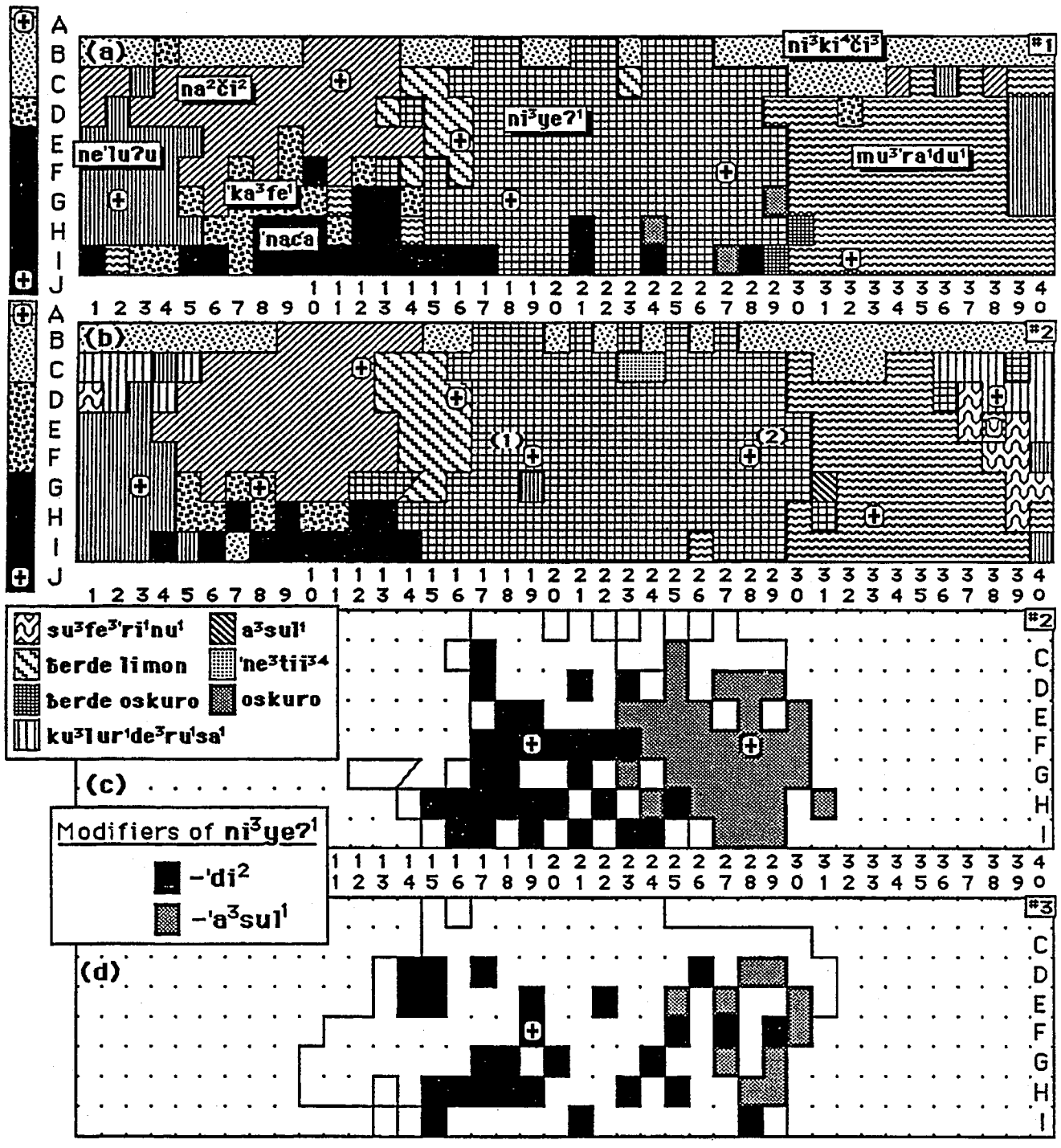
undergone abrupt culture change during adulthood in the southwestern United States. The suggestion of dual attendance to similarity and to distinctiveness parallels evidence of the same from the Navenchauc Tzotzil, who are also undergoing abrupt change through enhanced contact with a national society (cf. page 117, item 4; Figures 4.8-14, 6.15a-16c).

The Papago/Pima dual foci occur in the context of covert coextensivity, the precondition for any culture-specific pattern of multiple foci: Speakers #S 5-8 placed foci either in green or in blue; the Papago/Pima focal aggregate is seen in Figures 9.15d. Speaker #8 applied the original "cool" term only to green; the Pima speaker of Figure 8.15 named green with a moderately salient secondary term and applied the original 'cool' term predominantly to blue.

Figures 9.15a-d compare the aggregates of dual and triple foci from Tecpan Cakchiquel, San Pedro and Santa María Tonanzintla Nahautl, and Papago/Pima. The aggregates show three distinct patterns. A fourth pattern is evident in the Guarajío focal aggregate of Figures 8.52c, and this can be compared further with the Tzeltal and Seri focal aggregates of Figures 8.52a-b. The three latter aggregates appear to reflect a shared coextensivity of a dominant green and a recessive blue vantage. Among all languages, the specific differences between the aggregates might result from the different strengths at which speakers of these languages attend to similarity and to distinctiveness. Some Tzeltal and Seri speakers evidenced a dark-cool category (cf. Figures 4.1a-4b, 7.31), an indication of strong attendance to similarity; none who were interviewed placed dual foci. Guarajío and Mam speakers (cf. Figures 9.2a-3d) show notable use of black-focused terms to name cool colors; a few palced dual foci. The majority of Cakchiquel speakers placed dual foci, and most Nahuatl speakers placed triple foci; the Cakchiquel speakers show independent evidence of a strong attendance to distinctiveness, and the Nahuatl speakers have all but stopped speaking the language in a complex, changing environment. A few Papago/Pima speakers, who live on reservations in the southwestern United States, fully centralized one



Figures 9.15a-d. Focal aggregates: (a) Tecpan Cakchiquel, Panajabal, 13 speakers; (b) San Pedro Tonanzintla Nahuatl, 4 speakers; (c) Santa María Tonanzintla Nahuatl, 7 speakers; (d) Papago and Pima, 23 speakers.



Figures 9.16a-d. Naming ranges (a-b), foci, and modifiers (c-d): Zapotec, Santa María Lachixío, 1979, (a) speaker #1, woman, age 40±, (b-c) speaker #2, woman, age 33, (d) speaker #3, man, age 53.

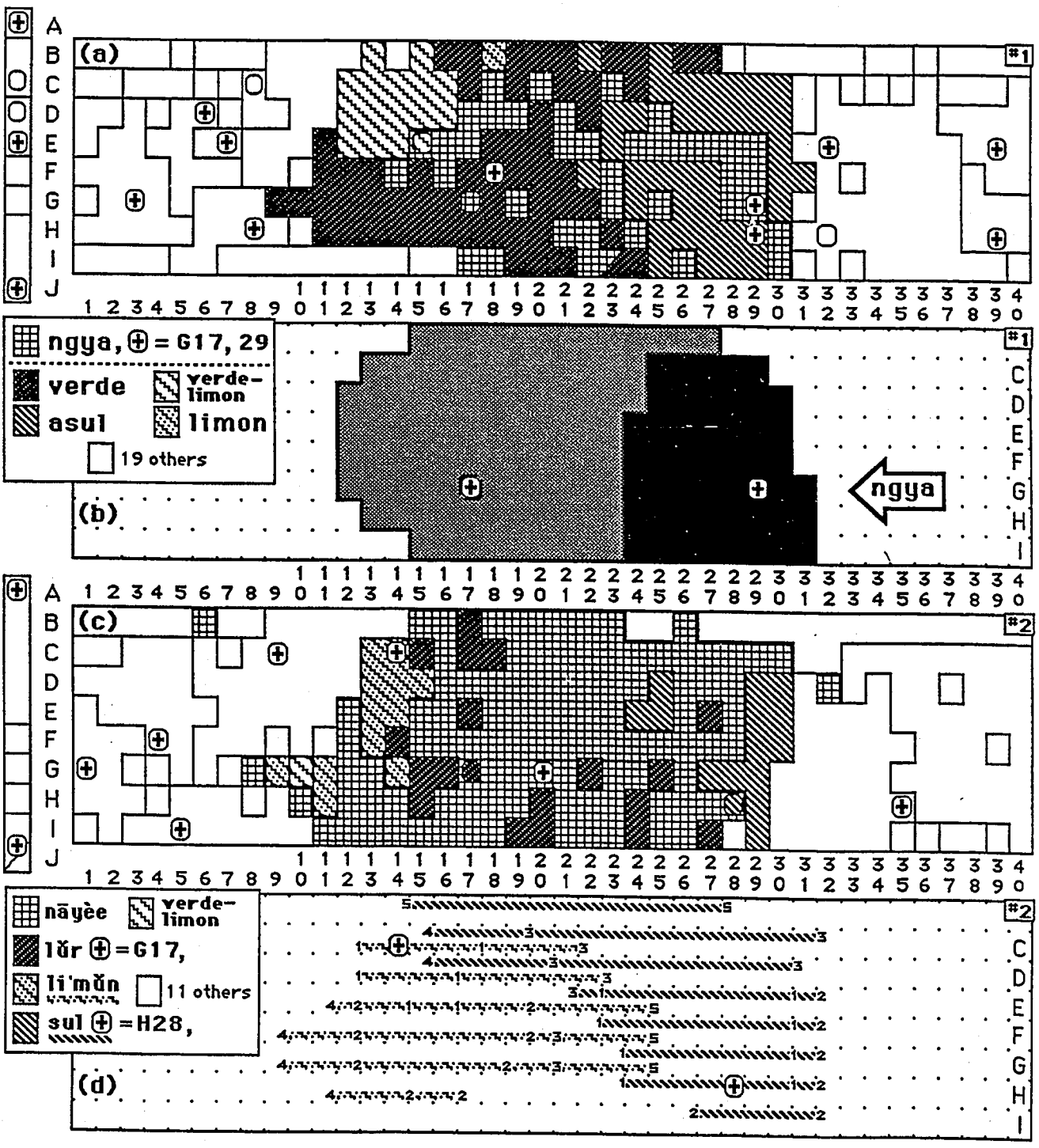
focus while placing the other in blue, possibly an outward sign of strong dual recognition of similarity and distinctiveness.

Figures 9.16a-d display data from three of the eleven Zapotec speakers who were interviewed in Santa María Lachixío. Nine of them focused the cool category in green, as did speaker #3. But speakers #1 and #2 placed dual foci. These dual foci are in a class apart from all others in the Mesoamerican sample, because both foci of each pair are slightly centralized; they do not manifest the pattern of dominant-recessive coextensivity. It might be that the blue focus of each pair was centralized to mark contrast against the broad, fully developed purple category whose naming range abuts column 29 of unique blue.

Figures 9.16c-d compare modifiers of speakers #2 and #3. Speaker #2, who placed dual foci, used modifiers to distinguish the green and the blue side of the category; speaker #3 so distinguished only the blues. In this particular case, dual foci correspond with advanced differentiation. Speaker #1 did not volunteer modifiers.

9.1.2. Dual Secondary Categories of Green and of Blue

In a basic cool category that is composed from a single vantage and markedly skewed, a secondary category can develop among the low-membership colors that are farthest from the vantage point (cf. Figures 8.7a-d, 8.9a-c, 8.11, 8.15-16, 9.12b). Separately named secondary categories on the focal side of a single-vantage category are very rare in the Mesoamerican sample (cf. Figures 8.42a-d). This statistic suggests that secondary categories within a coextensively composed cool category also develop on the low-membership side of a vantage. Since coextensivity involves at least two vantages, separate categories can emerge on both the green and the blue side of one coextensively composed cool category; each secondary category is constituted from (or pertains to) the vantage that is skewed toward and focused on the side that is opposite the colors that the secondary category encompasses. Since secondary categories within the basic cool category encompass -- almost without exception -- low-membership colors, only a



Figures 9.17a-d. Naming ranges (a, c), foci, and mappings (b, d): Zapotec, (a-b) San Juan Mixtepec, man, age 26, 1979; (c-d) San Cristóbal Amatlán, woman, age 50, 1981.

coextensively composed cool category will include two separate secondary categories of green and of blue.

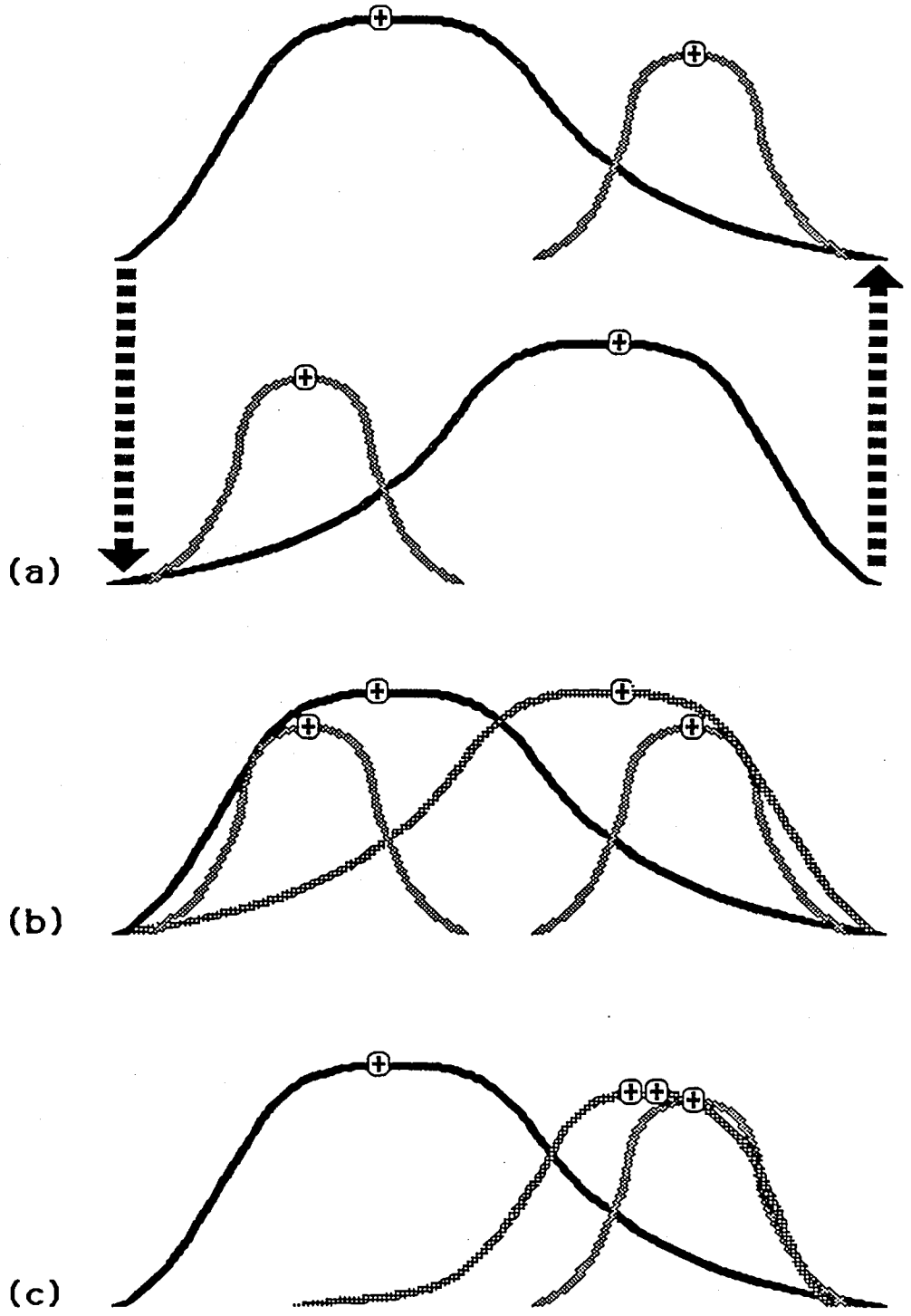
Figures 9.17a-d exemplify the relationship of coextensivity to dual secondary categories on opposite sides of the cool category. The examples are from Zapotec speakers of San Juan Mixtepec and San Cristóbal Amatlán.

In Figures 9.17a-b, the speaker from San Juan Mixtepec named the cool category at low salience and focused it on G17 and G29 in the unique-hue columns; he mapped the term with a first step in blue and a second in green. He separately named green and blue at high salience and focused the two secondary categories at F18 and H29.

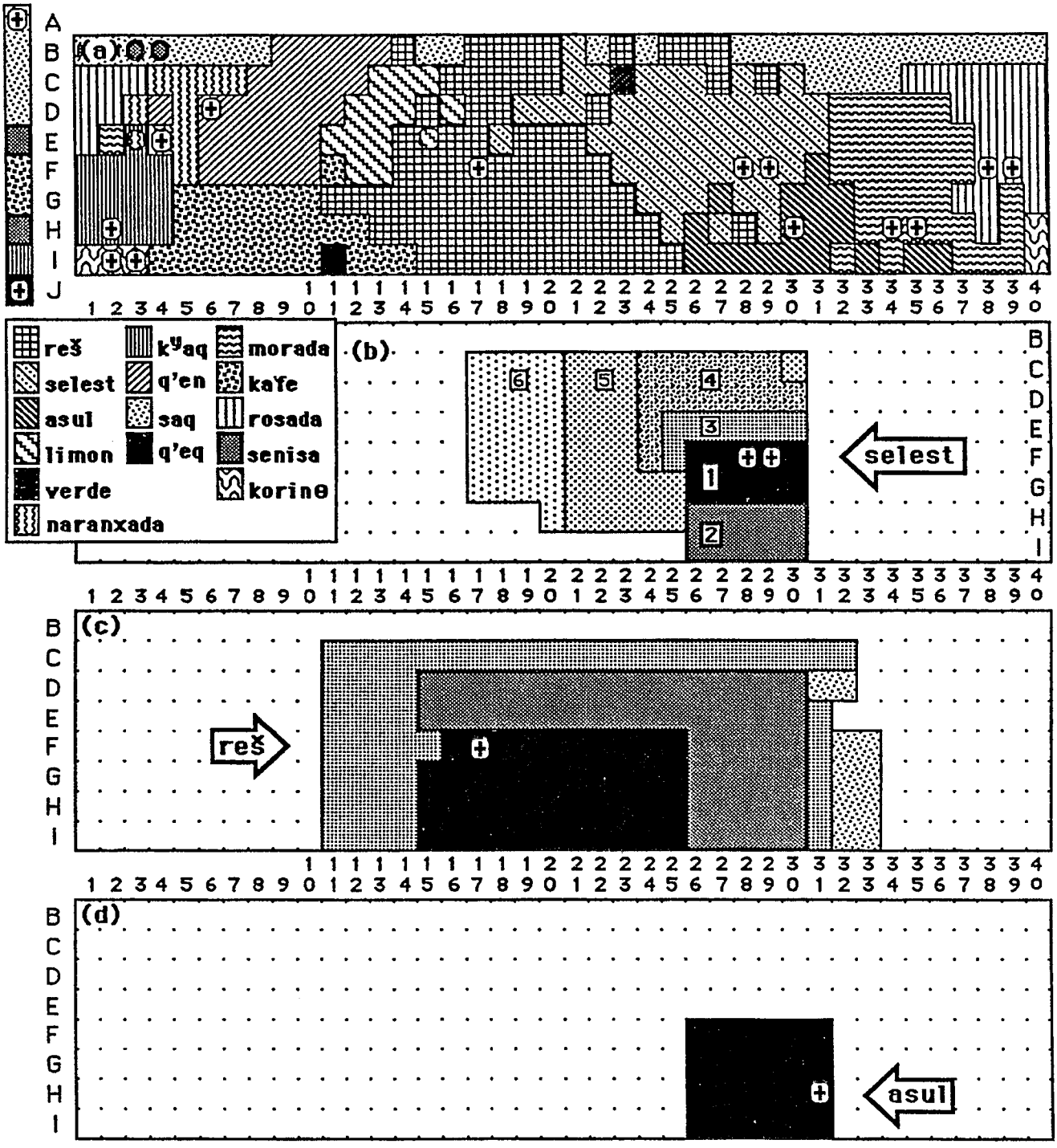
In Figures 9.17c-d, the speaker from San Cristóbal Amatlán overtly named and focused coextensive vantages in a dominant-recessive pattern, G17 and G20; and she named secondary chartreuse-focused and blue-focused categories at low salience, C14 and H28. Her mappings of the secondary categories cover, respectively, all of the greens and all of the blues.

Figures 9.18a-b display an idealized depiction of the relationship between coextensive vantages and secondary categories; the dominant-recessive aspect is omitted for simplification. Figures 9.18a represents the relationship of each secondary category to the low-membership portion of each vantage. Figure 9.18b represents the manner in which secondary categories and vantages combine to compose the cool category. The Zapotec speaker of San Juan Mixtepec maintains covert coextensive vantages while that of San Cristóbal Amatlán separately names them. Yet the idealization of Figures 9.18a-b generally represents both compositions:[6]

[6]Figures 9.18a-c and supporting data (cf. Figures 9.17a-d, 9.19a-30d, 9.33a-d) show co-occurrence of coextensivity and inclusion in the cool category. But the co-occurrence is not observed in the warm category. The difference could be added to Table 5.1 as item 10. The tentative explanation is the same as that of crossed over mismatching in the cool category (cf. section 7.2.): Attendance to distinctiveness and perceived similarity strongly contend. The former encourages a view that the cool category is more evolved toward division than does the latter, and both views are expressed or, at least, manifested in data.



Figures 9.18a-c. Curves of membership values within the cool category showing the relationship between coextensive vantages and subordinate categories: (a-b) idealized depiction, (a) separated and (b) combined; (c) abstract depiction of the data in Figures 9.19a-d.



Figures 9.19a-d. Naming ranges (a), foci, and mappings (b-d); Uspantec, Las Pacayas, woman, age 40, 1979.

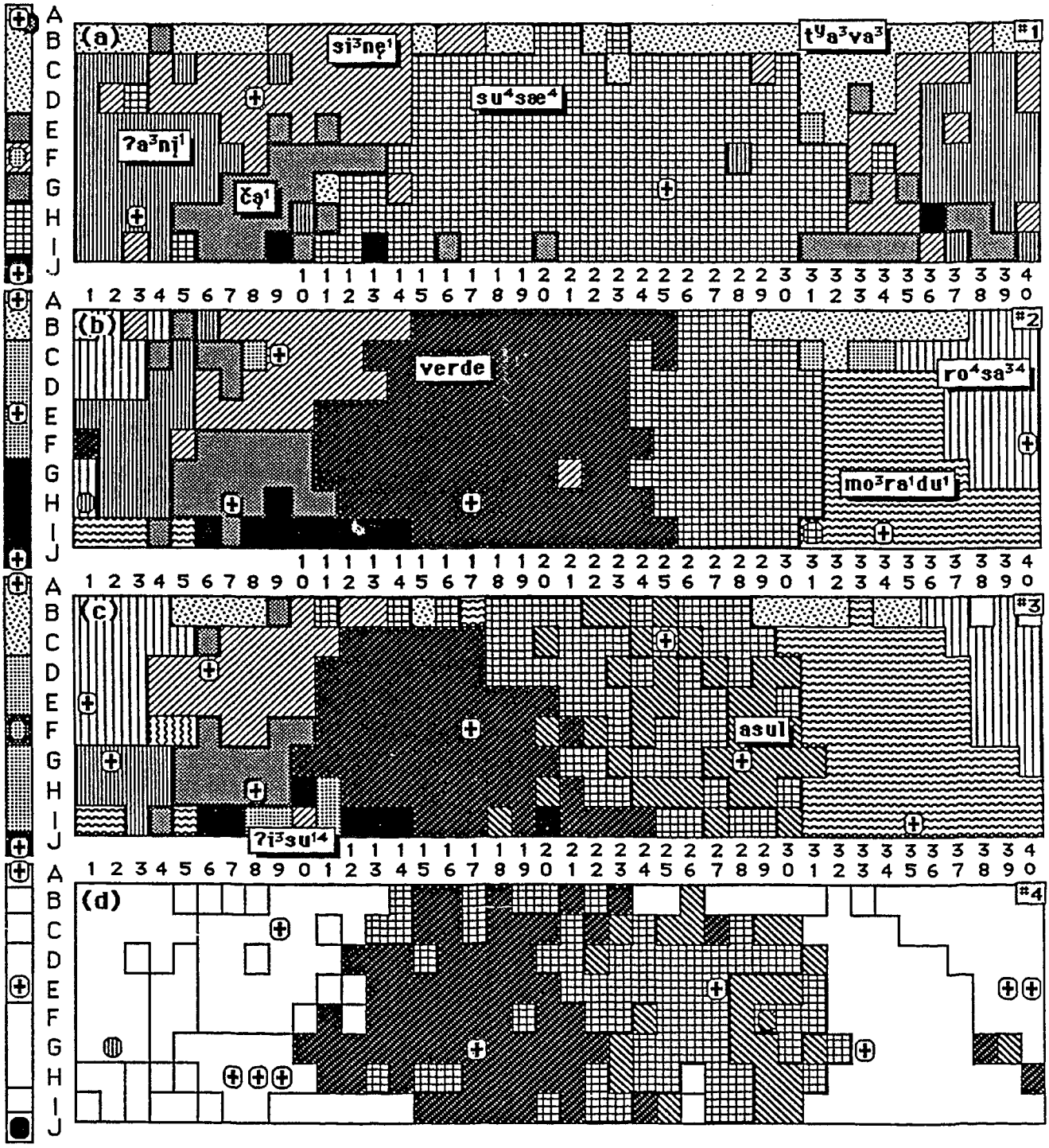
Figures 9.18c specifically represents the data of Figures 9.19a-d, that were elicited from an Uspantec speaker. These exemplify one of the innumerable ways in which the general principle that is ideally represented in Figures 9.18a-b can vary in a real composition. The Uspantec speaker named and mapped coextensive vantages that are extremely dominant and recessive; yet she focused each on a unique hue. She polarized the focus of a secondary blue category at H31, and she used one secondary category rather than two.

Only this token case from Uspantec is diagrammed in Figures 9.18c to contrast real variation against the idealized diagrams of Figures 9.18a-b. The two Zapotec speakers also show variation in the ascription of salience. Such variation is endless among individuals in the Mesoamerican sample. Further examples from Mazatec, Mazahua, and Matlatzinca appear in Figures 9.20a-31d in the context of other discussion:

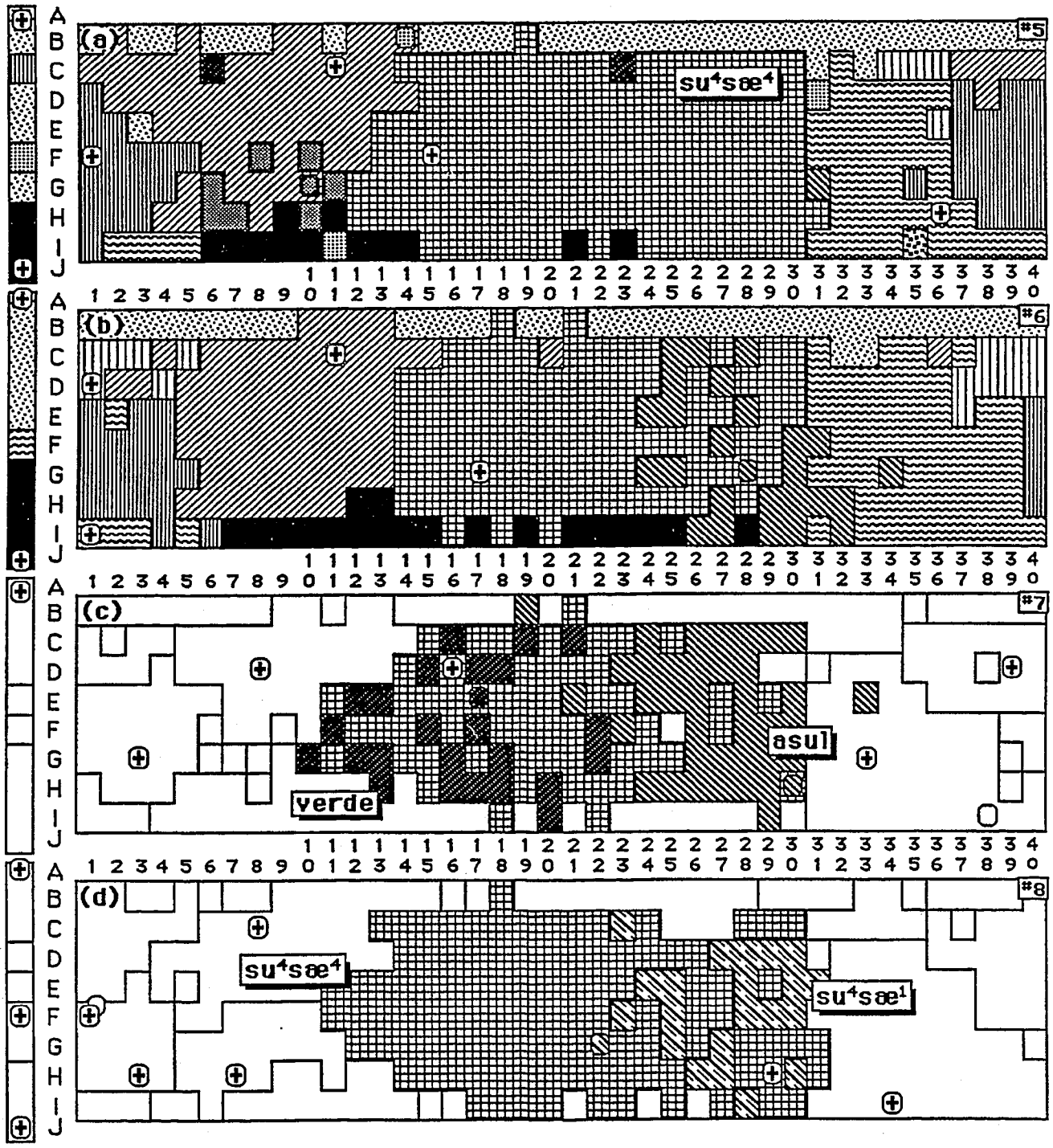
Figures 9.20a-23c display data from 15 of the 25 Mazatec speakers who were interviewed in Chiquihuitlán de Benito Juarez. Covert coextensivity is evidenced by the distribution of foci within the aggregate of Figures 9.23d and by the following correlative developments among naming ranges:

In Figure 9.20a-d, speakers #^{S} 1-4 focused the original "cool" term in blue. Speaker #1 showed a simple use of the term. Speaker #2 confined the term to only blue and polarized its focus at I31. Speakers #3 and #4 intermixed the 'cool' term with names of green and of blue secondary categories; their 'green' term is more salient than their 'blue' term. Speakers #s 5-7 show the mirror image of that pattern:

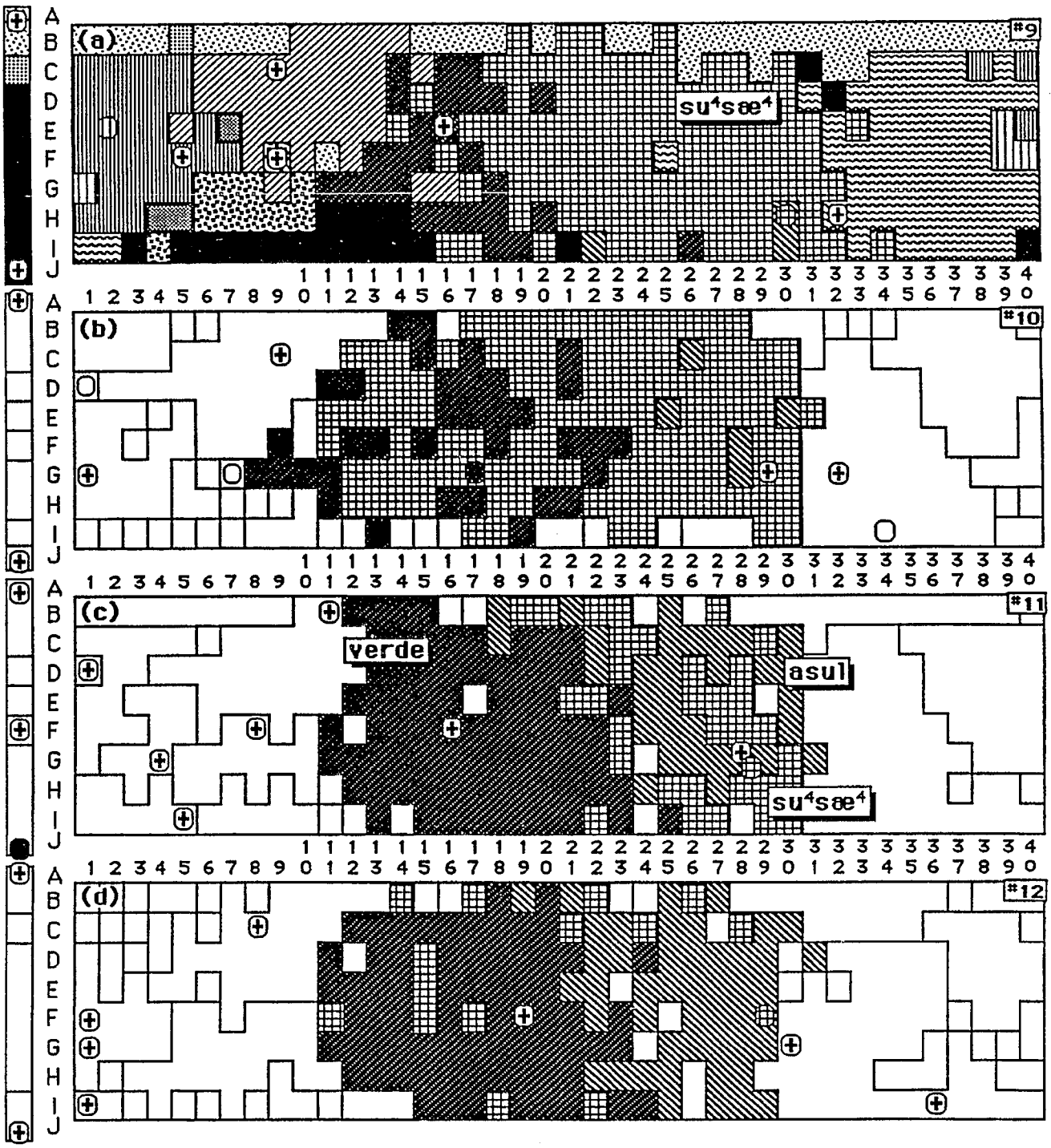
In Figures 9.21a-c, speakers #^{S} 5-7 focus the 'cool' term in green (cf. Figure 6.18). Speaker #5, like #1, showed a simple usage. Speaker #6 named a secondary blue category at low salience. Speaker #7 named a secondary blue category at high salience and a secondary green category at low salience.



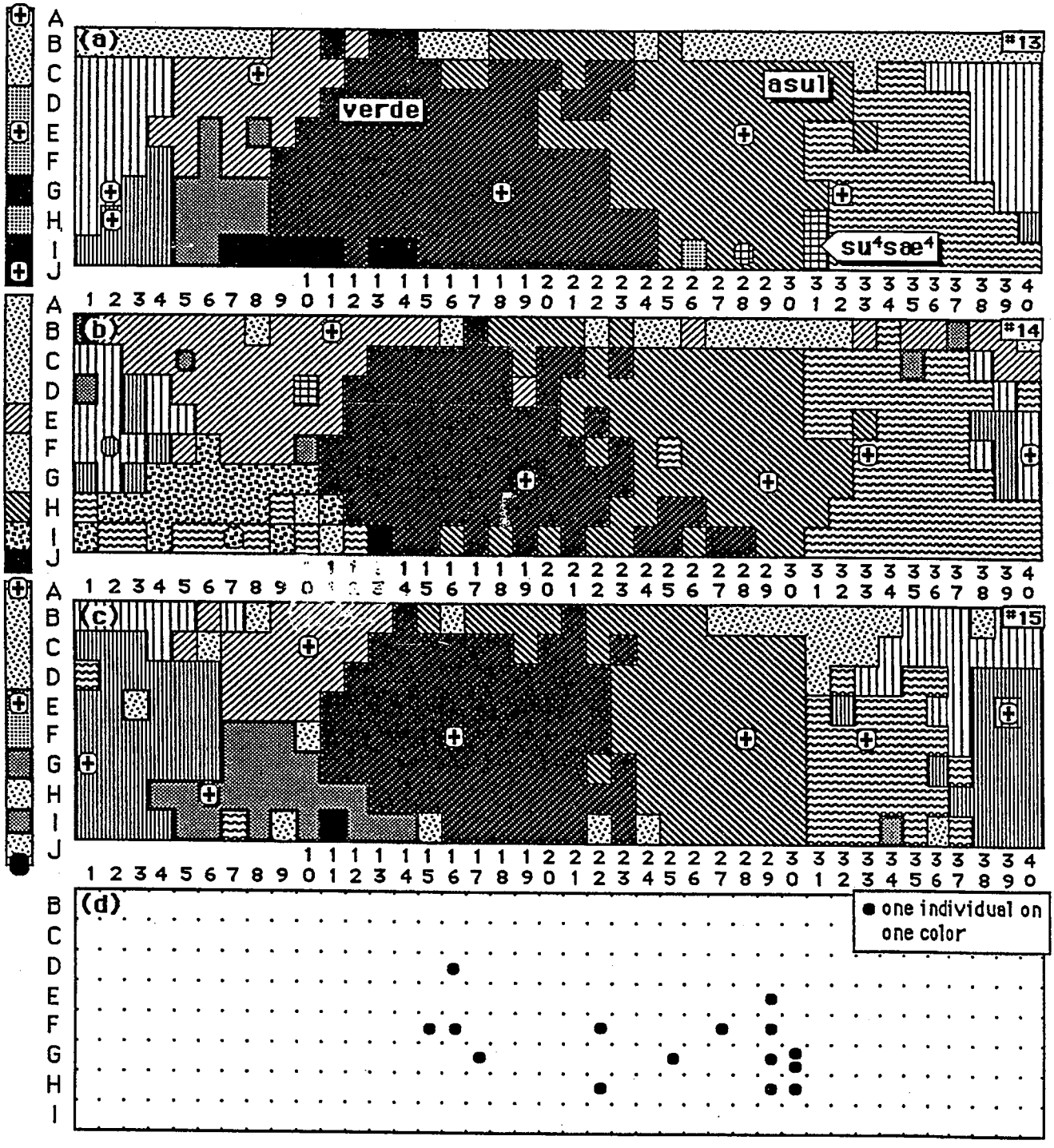
Figures 9.20a-d. Naming ranges and foci; Mazatec, Chiquihuitlán, 1977: (a) speaker #1, man, age 60, (b) #2, man, 49, (c) #3, woman, 29, (c) #4, woman, 35.



Figures 9.21a-d. Naming ranges and foci; Mazatec, Chiquihuitlán, 1977: (a) speaker #5, man, age 61, (b) #6, man, 40, (c) #7, man, 28, (d) #8, woman, 34.



Figures 9.22a-d. Naming ranges and foci; Mazatec, Chiquihuitlán, 1977: (a) speaker #9, man, age 35, (b) #10, woman, 50±, (c) #11, woman, 38, (d) #12, woman, 35.



Figures 9.23a-d. Naming ranges and foci (a-c); Mazatec, Chiquihuitlán, 1977: (a) speaker #13, woman, 22, (b) #14, man, 39, (c) #15, woman, 38. Focal aggregate, cool category,15 individuals (d).

In Figure 9.21d, speaker #8 focused the 'cool' term in blue and intermixed it with a 'blue' term that is derived from the original root by a change in pitch; but the focus of the 'blue' term is centralized at G22. This relationship between naming ranges is the mirror image of that shown by the Mazatec speaker of Figure 7.16, who applied the tonally derived term to green.

In Figures 9.22a-d, speakers #s 9-12 exhibit four phases through which the original "cool" term progressively lost salience as the 'green' and 'blue' secondary terms gained salience. Throughout the process, the "cool" term was focused in blue, and it was more frequently used to name blue by speakers #s 9-11.

Figures 9.23a-c show the final phase of category-division in which the historical "cool" term had been supplanted by the 'green' and 'blue' terms as the latter became basic. Speaker #13 named the historical "cool" term only at H-I31 and focused it at I28. Speaker #14 used the original term once at D10, and speaker #15 had replaced it completely.

Figures 9.23d displays the focal aggregate of the 15 Mazatec speakers whose naming ranges evidenced the cool category. None placed dual foci or placed a focus on more than one color.

Covert coextensivity in Mazatec provided two options that enabled different individuals to identify the 'cool' term with opposite vantages: Speakers #s 1-4 and 8-13 identified the term with the blue vantage; speakers #s 5-7 identified it with the green vantage. Further, more individuals identified the 'cool' term with the blue vantage than with the green vantage. Coextensivity fosters a precondition under which the historical "cool" term need not be retracted toward the green unique hue as category-division progresses; the term can remain attached to blue throughout the division, and it can emerge finally as the basic 'blue' term. Speaker #2 used such a 'blue' term. Covert coextensivity in Mazatec also enabled the formation of a secondary category on the low-membership side of each vantage, giving rise to the development of both a green and a blue category. As these categories gained salience, the historical "cool" term was displaced in either green or

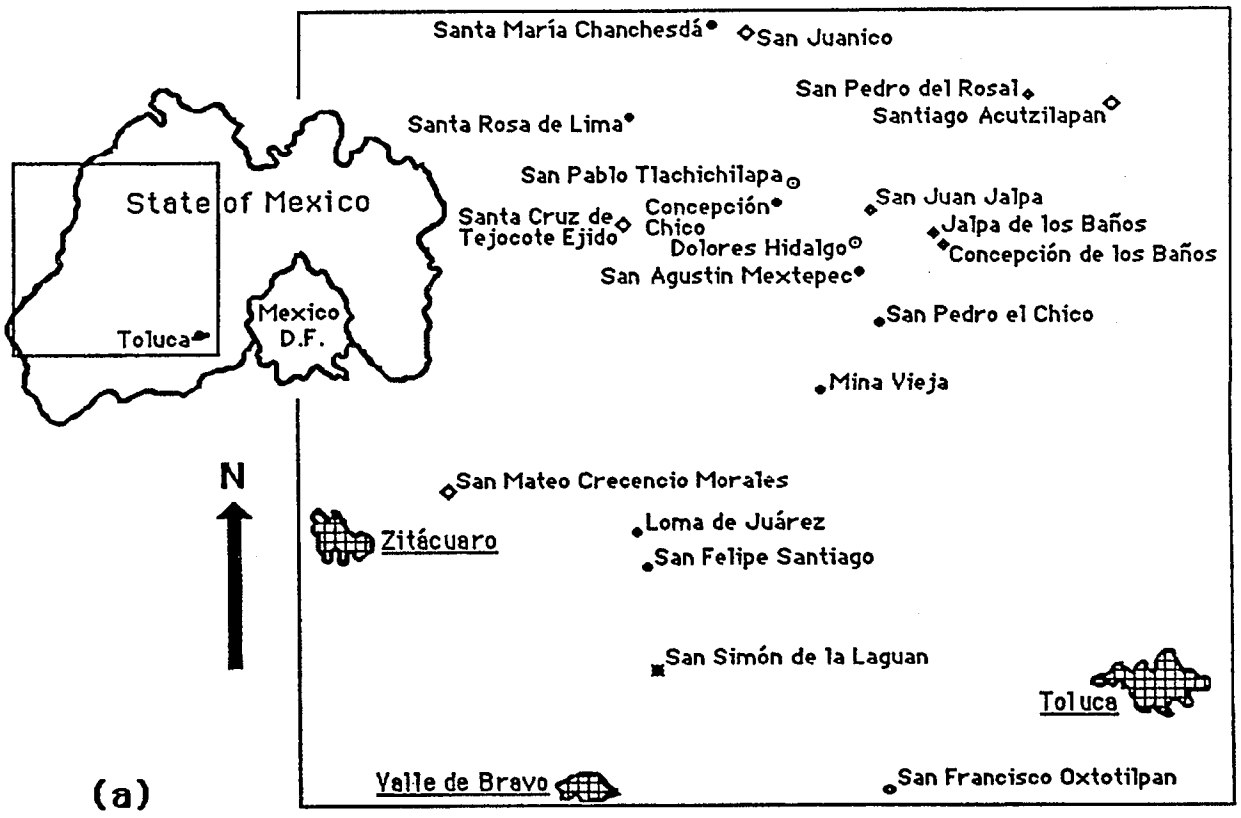
blue or both. Speakers #14 and #15 represent the final phase of this process; the historical "cool" term has been supplanted entirely.

9.1.3. An Areal Study

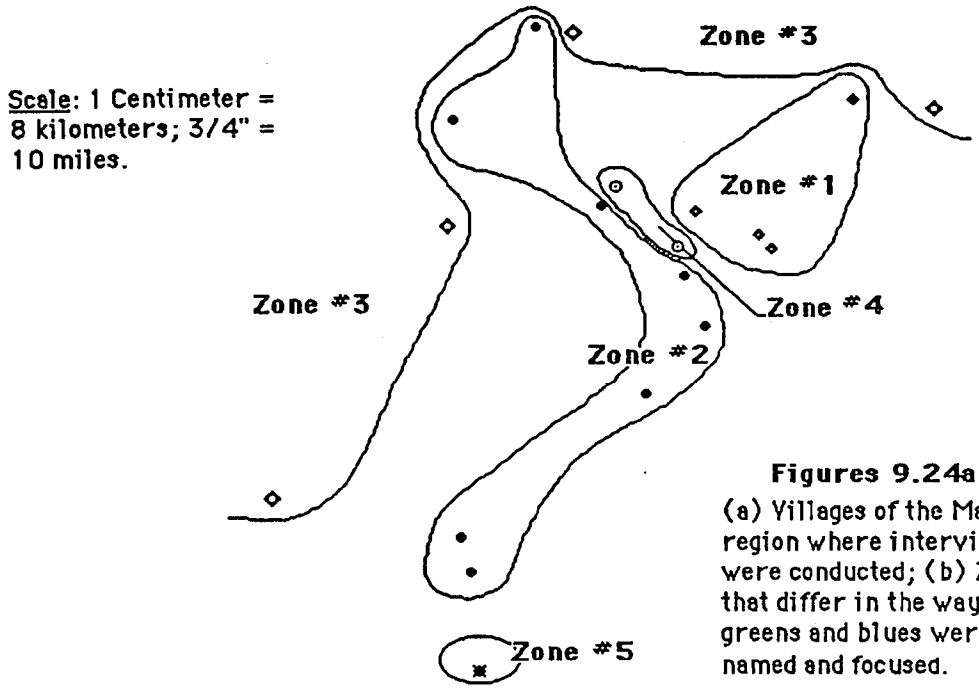
The same compositions that are found in Mazatec are seen in Mazahua and Matlatzinca. Twenty-five Mazahua speakers were interviewed in 19 of the 20 villages that are plotted on the map of Figure 9.24a; San Francisco Oxtotilpan is Matlatzinca-speaking. In Figures 9.25a-28b, data from 14 of the 25 represent at least five distinct compositions of the cool category that accompany an area-wide coextensivity. Each composition characterizes one of five zones within the Mazahua region, those depicted in Figure 9.24b. Figures 9.30a-d show yet a sixth composition in Matlatzinca that further demonstrates the varied effect of the widely shared coextensivity.

Zone #1. This zone includes speakers #s 1-4 from Concepción de los Baños, Jalpa de los Baños, San Pedro del Rosal, and San Juan Jalpa, whose data appear in Figures 9.25a-d. All of them characterized zone #1 by applying the original cool term throughout green and blue. Two of the four showed evidence of coextensivity: Speaker #4 overtly named coextensive vantages and speaker #2 placed dual foci. Speakers #1 and #3 focused the original cool term only in blue; and speaker #4 focused it only in green at E18 and F17, where he also focused two other terms. He showed, further, four terms in total, at least three of which are coextensive throughout the cool category. Some Mazahua speakers, such as #3, used *k'ą̈ngī*, a derivative of the original 'cool' term, *k'ą̈ngą̈*.

Zone #2. This zone includes speakers #5 and #6 from Concepción Chico and San Agustin Mextepec. Their data, which appear in Figures 9.26a-b, are typical of the ten individuals who were interviewed in Zone #2: All predominantly applied the original 'cool' term to blue and named green with another highly salient term.

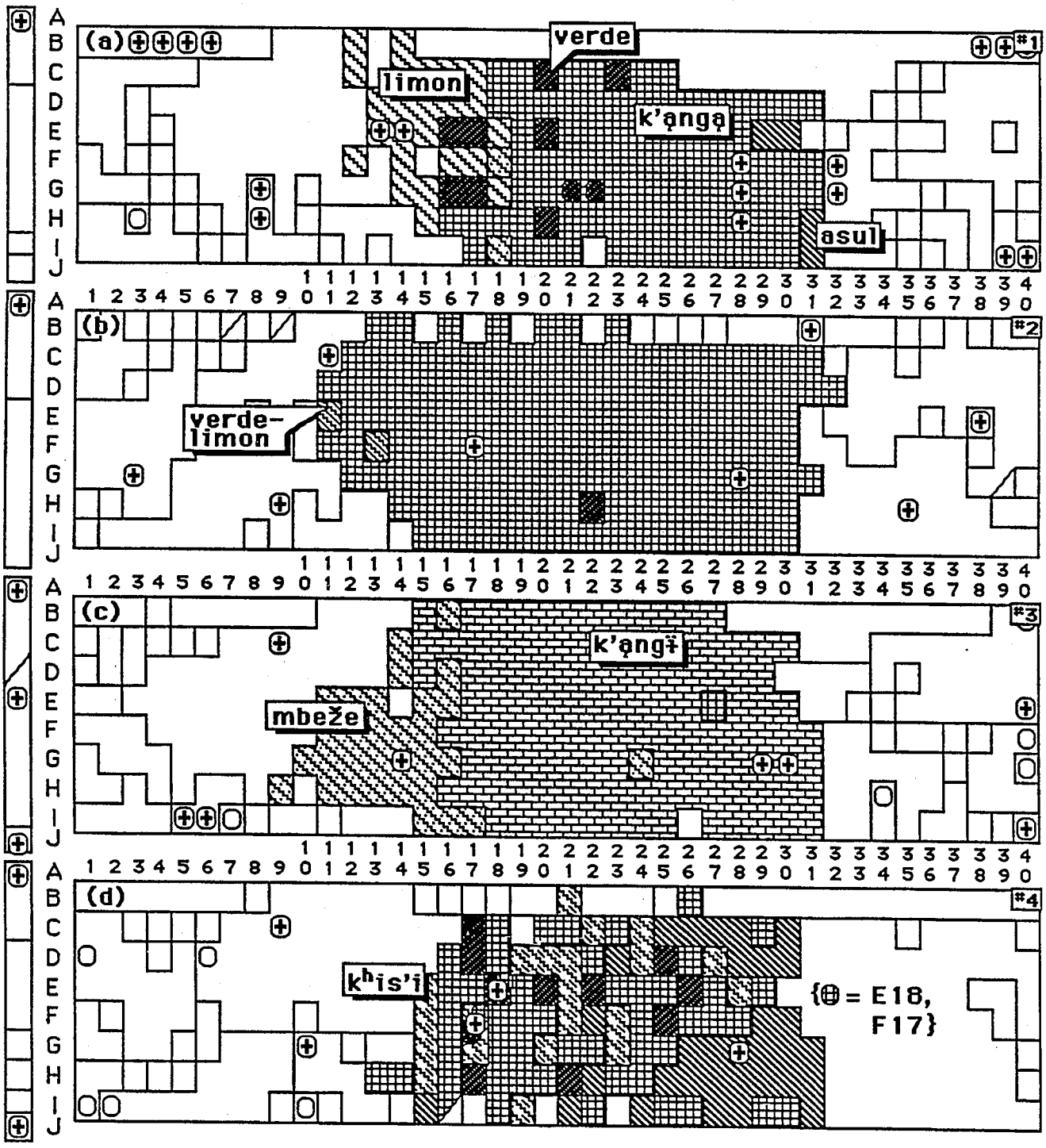


(a)

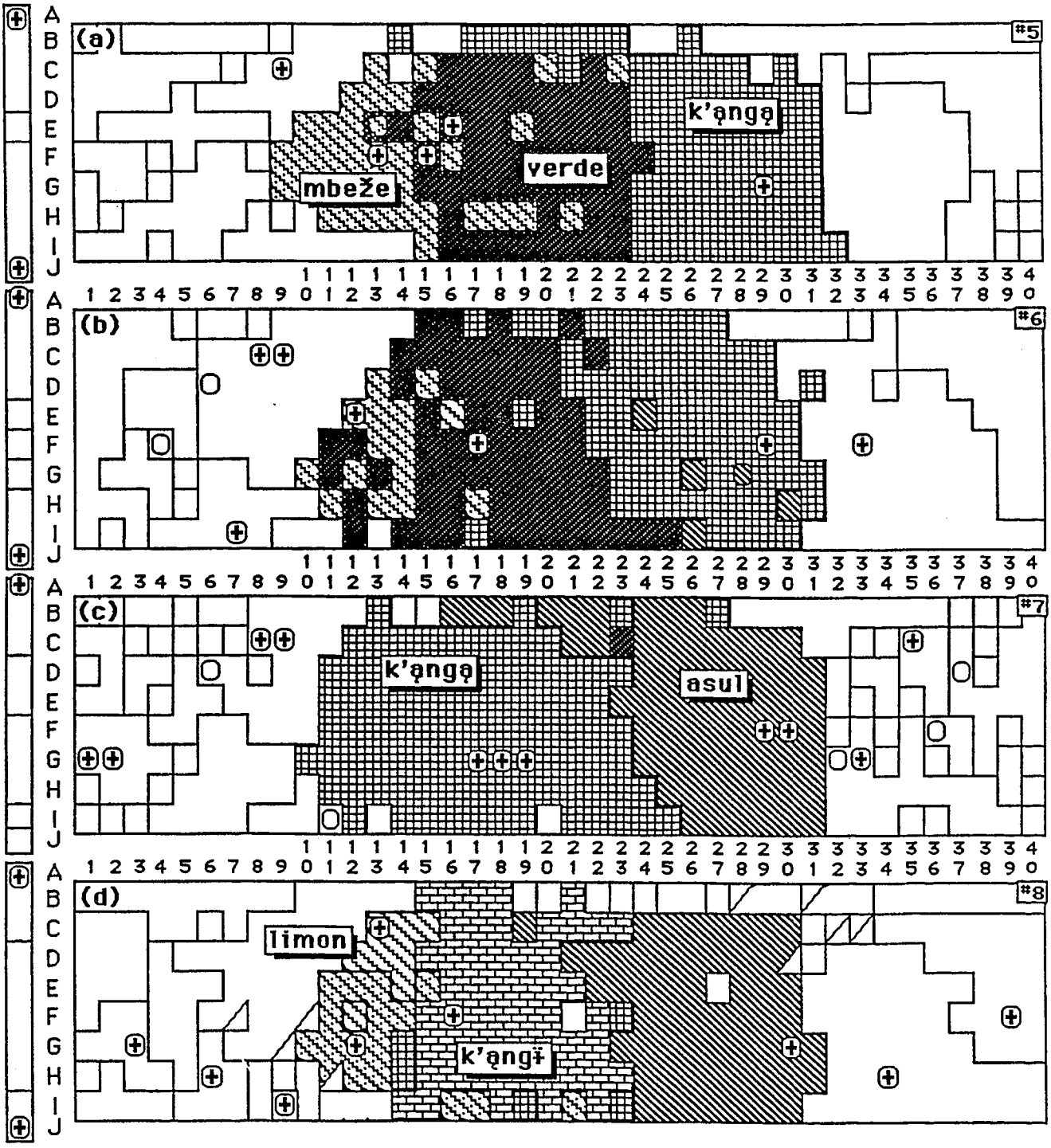


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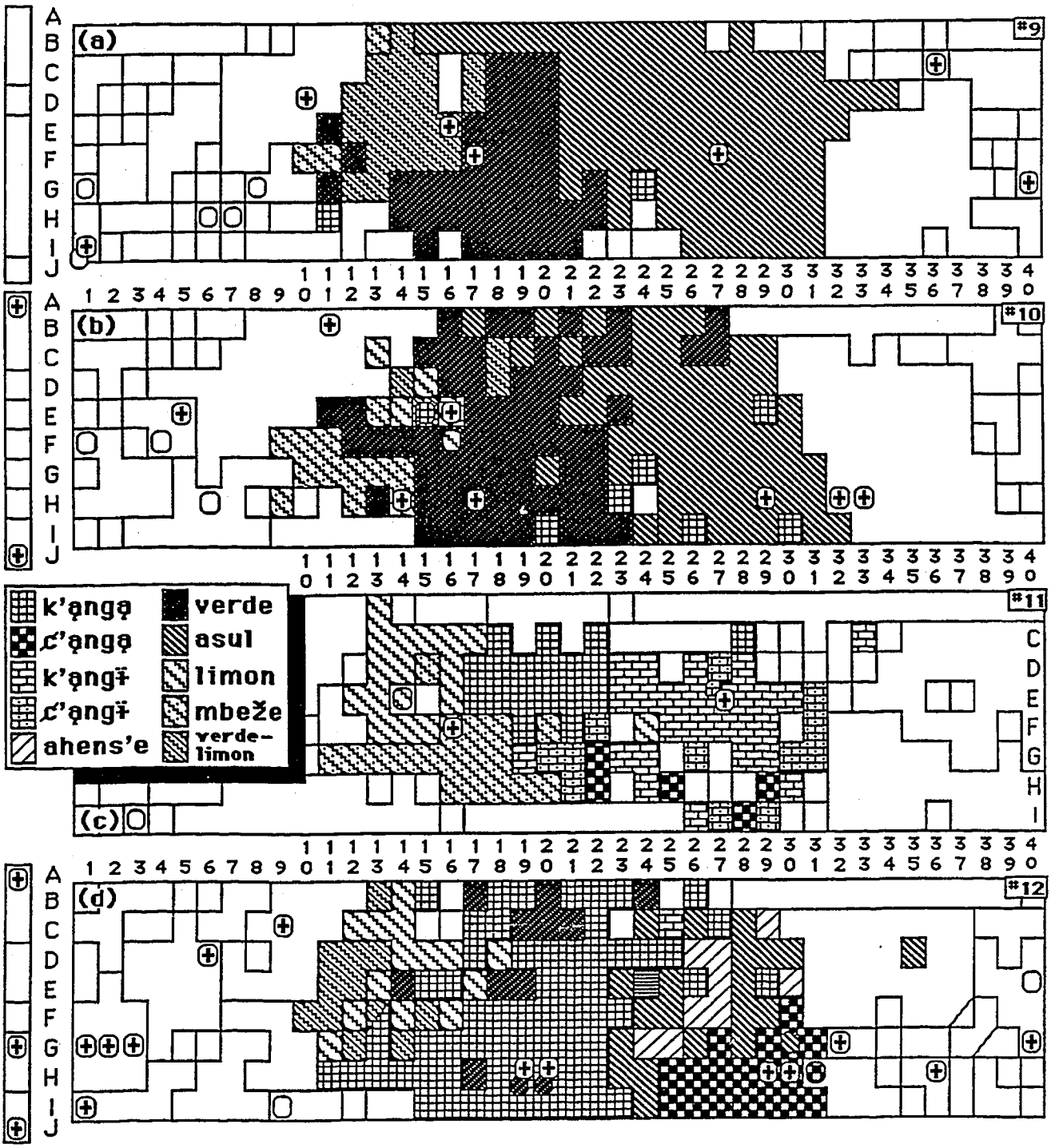
Figures 9.24a-b.
(a) Villages of the Mazahua region where interviews were conducted; (b) Zones that differ in the way that greens and blues were named and focused.



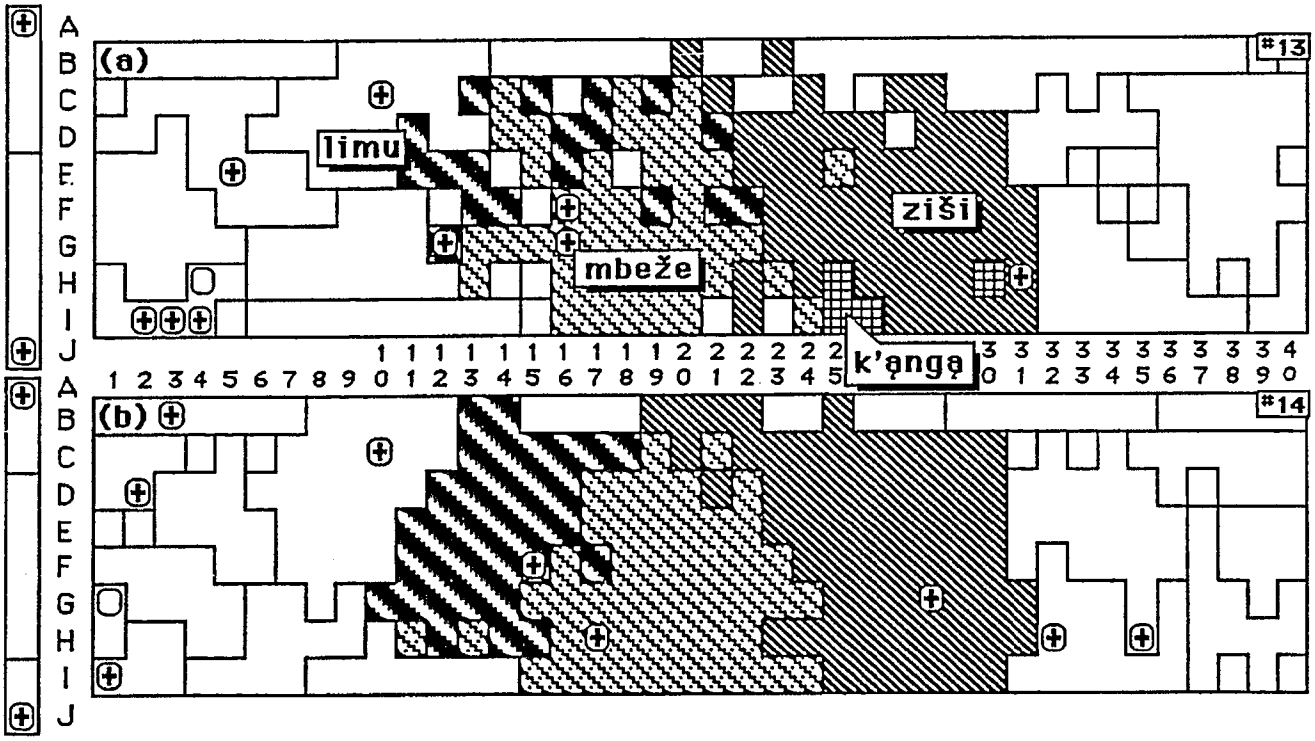
Figures 9.25a-d. Naming ranges and foci, Mazahua, 1978: (a) speaker #1, Concepción de los Baños, woman, age 70, (b) #2, Jalpa de los Baños, man, 36, (c) #3, San Pedro del Rosal, woman, 38, (d) #4, San Juan Jalpa, man, 69.



Figures 9.26a-d. Naming ranges and foci, Mazahua, 1978: (a) speaker #5, Concepción Chico, woman, age 34, (b) #6, San Agustin Mextepec, woman, 45, (c) #7, Santiago Acutzilapan, man, 37, (d) #8, San Juanico, man, 37.



Figures 9.27a-d. Naming ranges and foci, Mazahua, 1978: (a) speaker #9, San Pablo Tlachichilapa, woman, age 22, (b) #10, SP Tlachichilapa, woman, 40, (c) #11, Dolores Hidalgo, man, 53, (d) #12, Dolores Hidalgo, woman, 53.



Figures 9.28a-b. Naming ranges and foci, Mazahua, 1978: (a) speaker #13, San Simón de la Laguna, woman, age 37, (b) #14, San Simón de la Laguna, woman, 40.

Individuals from Zone #2 and Zone #3 show mirror-image patterns:

Zone #3. This zone includes speakers #7 and #8 from Santiago Acutzilapan and San Juanico, two of four villages on the periphery of the Mazahua region. Their data, which appear in Figures 9.26c-d, are typical of the four individuals who were interviewed in Zone #3, one in each village: All predominantly or exclusively applied the original 'cool' term, *k'ẹngẹ,* or its derivative *k'ẹngī,* to green.

Zone #4. This zone includes speakers #9 and #10 from San Pablo Tlachichilapa and speakers #11 and #12, two of the three who were interviewed in Dolores Hidalgo, Figures 9.27a-d. Zone #4 really consists of two zones that each show a distinctive composition:

Speakers #9 and #10 had almost supplanted the original 'cool' term with salient secondary terms. The focus of the 'cool' term was not elicited from speaker #9, and speaker #10 focused it in green at E15.

Speakers #11 and #12 named green or predominantly green with the original 'cool' term, and they named blue with three and two derivatives of the original term respectively. The focus of the original term was not elicited from speaker #11, and speaker #12 focused it in green at H19-20. The complexity of the compositions used by speakers #11 and #12 is equivalent to that used by speaker #4 of San Juan Jalpa, Zone #1, five kilometers North of Dolores Hidalgo, Figure 9.25d.

Zone #5. This zone includes speakers #13 and #14 from San Simón de la Laguna, Figures 9.28a-b. These speakers, like #9 and #10, have virtually supplanted the original 'cool' term with salient names for green and for blue. In this zone, both names are native words.

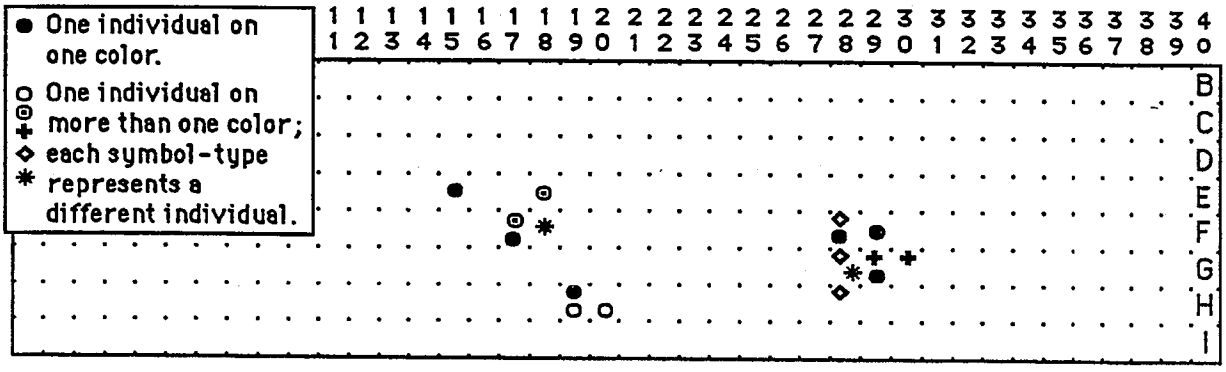
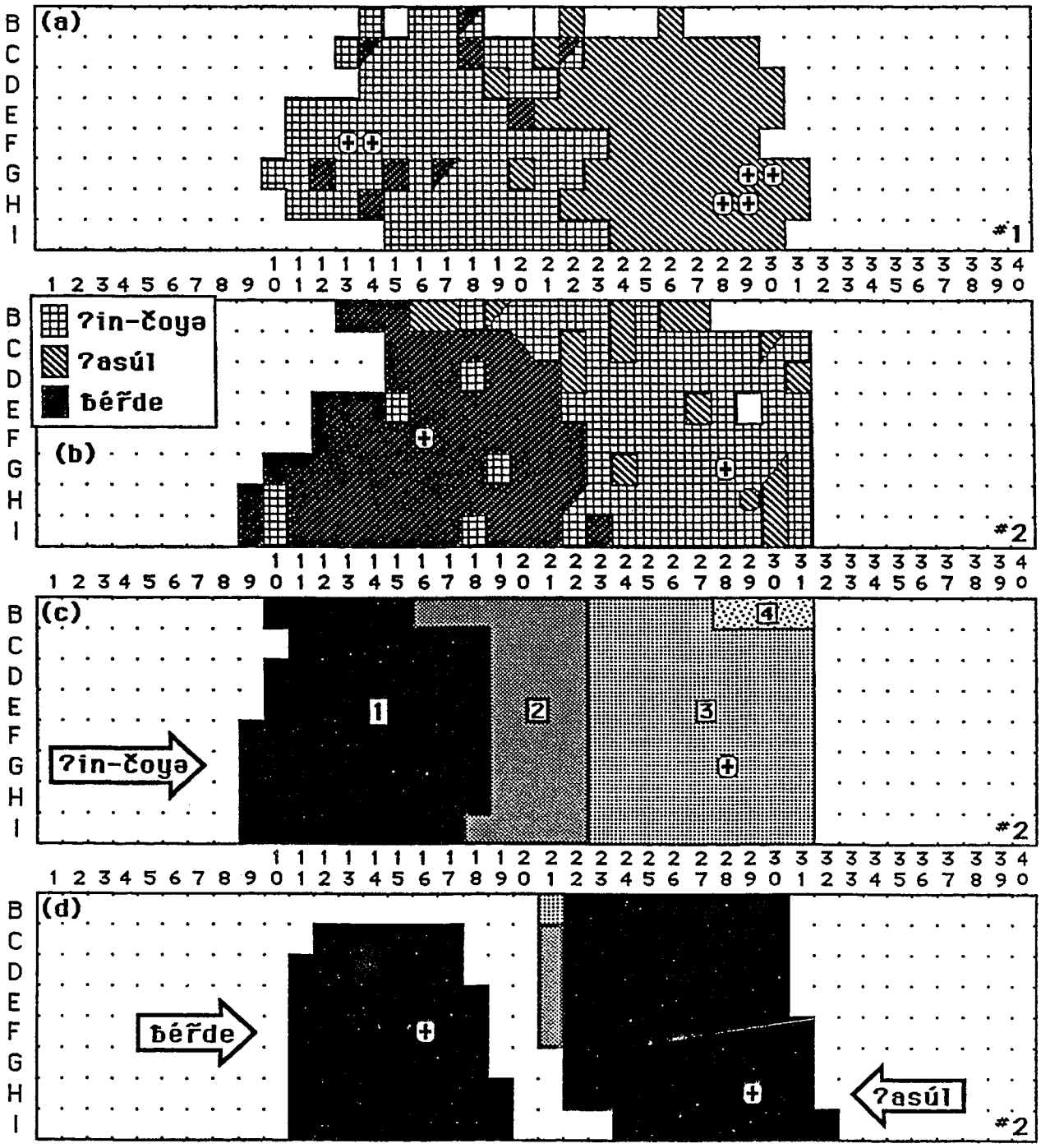


Figure 9.29. Focal aggregate, cool category, 11 individuals, Mazahua, 1978.

Figure 9.29 displays the focal aggregate from the eleven Mazahua cool categories that were attested by a naming range in both green and blue. Mappings were not collected.

The map of Figure 9.24a shows the only village where Matlatzinca is the principle language, San Francisco Oxtotilpan. Figures 8.30a-d display data from two of the three members of that community who were interviewed. The data indicate that these speakers share the coextensivity that is maintained, overtly or covertly, throughout the adjoining



Figures 9.30a-d. Naming ranges (a-b), foci, and mapping (c-d); Matlatzinca, San Francisco Oxtotilpan, 1979: (a) speaker #1, man, age 35, (b-d) #2, woman, 48.

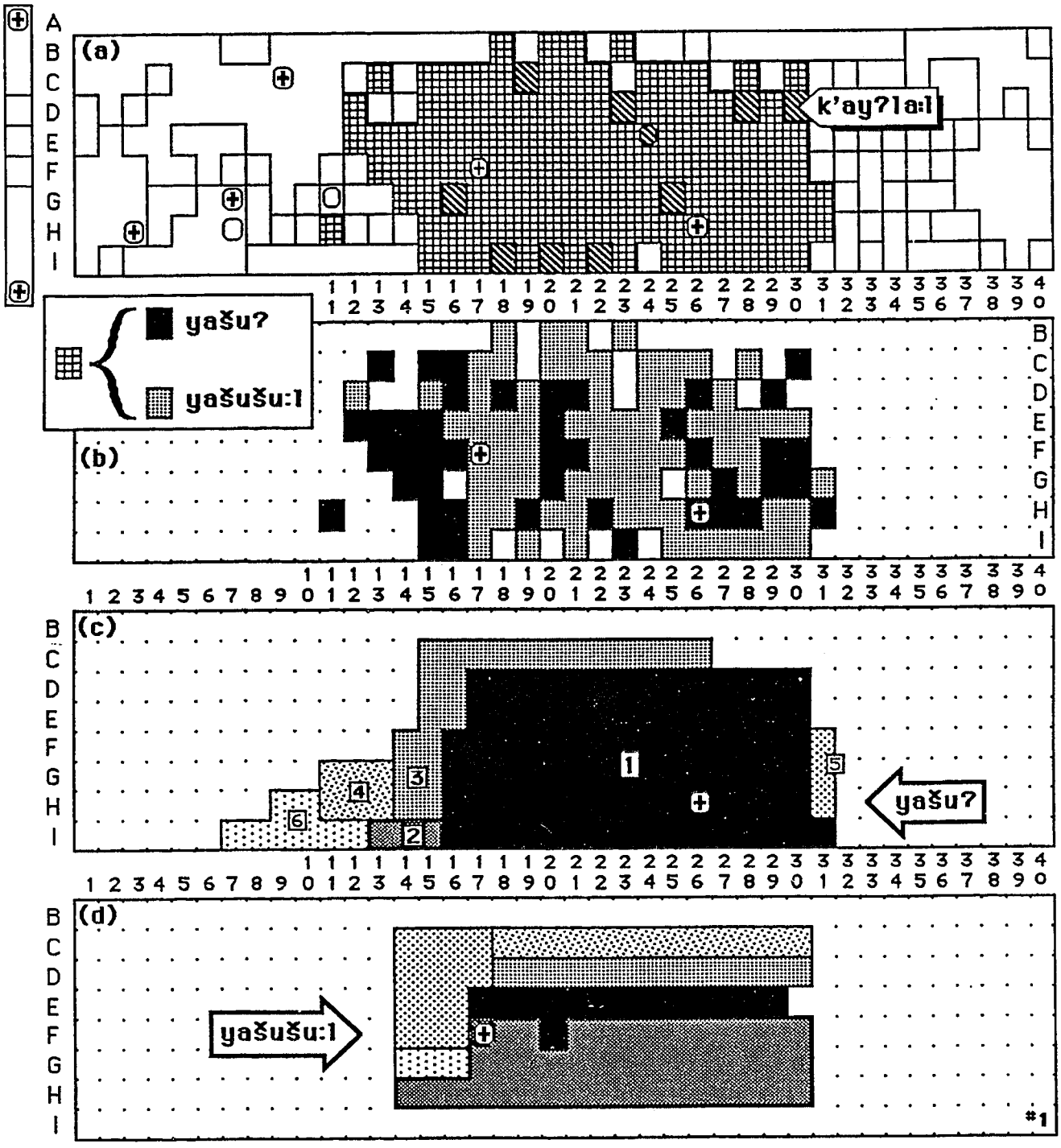
Mazahua region. Among the Matlatzinca, the coextensivity is covert: Speaker #1 applied the original 'cool' term only to greens, and speaker #2 applied it predominantly to blues. Speaker #2 further evidenced covert coextensivity by focusing the cool category in blue but mapping it with a first step in green. The focus and the mapping were elicited nine months apart. She also named, mapped, and focused both a green and a blue secondary category, which generally tend to develop only after coextensivity has been established as a precondition.

9.2. Modifier Coextensivity

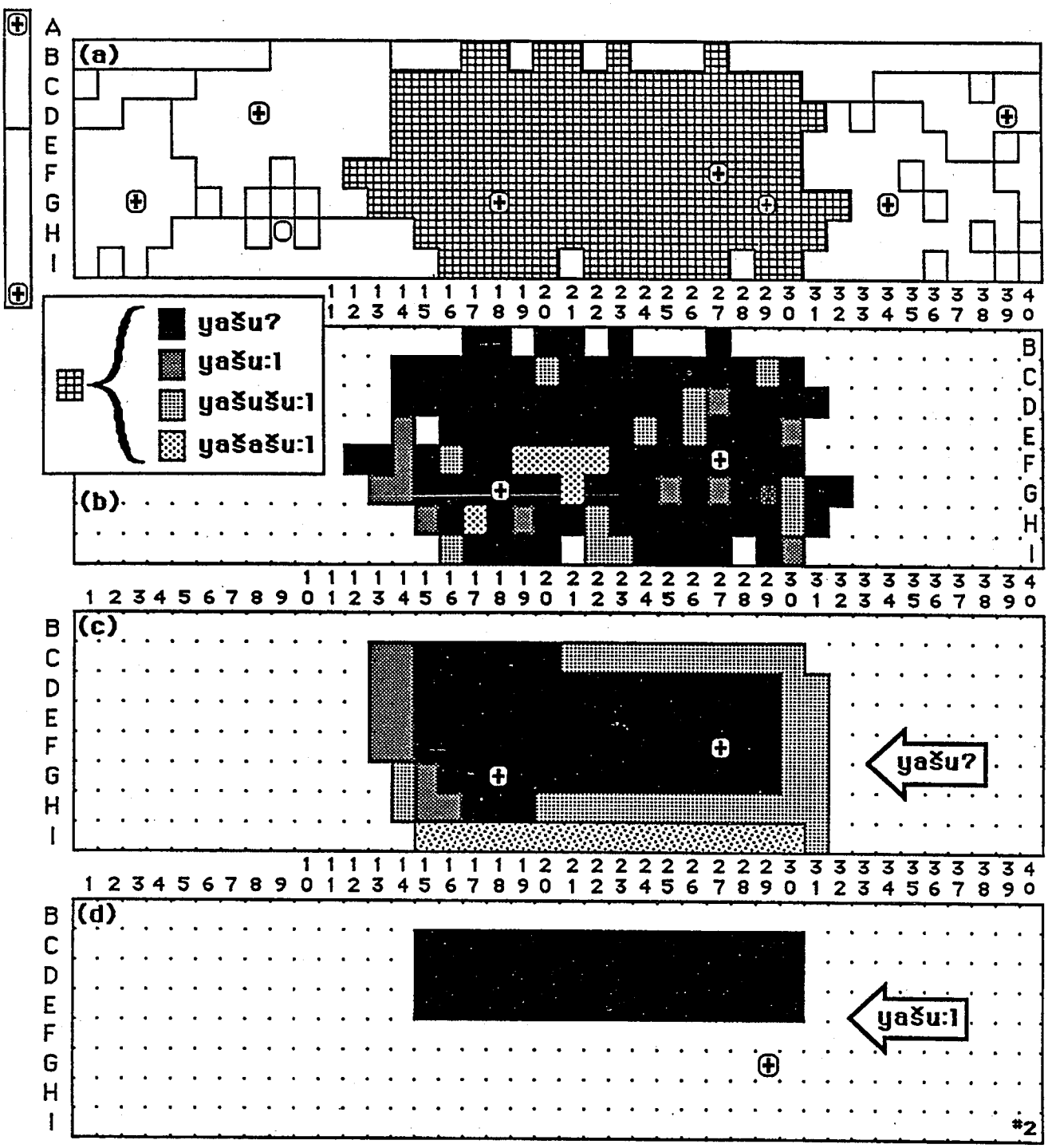
The ten speakers of Huastec who were interviewed in Huehuetlán, San Luís Potosí, differentiated coextensive vantages with modifiers of one root. They named the vantages with *yašuʔ*, the unmodified name of the cool category, and with *yašu:l, yašušu:l,* and *yašašu:l.* The reduplication historically might have designated 'light' cool colors, because *yašušu:l* is used with this meaning in the Huastec of Veracruz State (cf. Figure 9.35, page 394).

The naming of coextensive vantages with modifiers in Huehuetlán Huastec is unique among the languages of the Mesoamerican sample. Elsewhere coextensivity is either covert or named with at least two roots. Nevertheless, the cool category of Huastec manifests the characteristics that are typical of coextensively composed cool categories in other languages: dual foci, mismatching of a focus and a first mapping step, mappings of distinct terms that progress step-by-step in opposite or different directions, and secondary categories on both the green and the blue side of the category. Figures 9.31a-34d display data from four speakers of Huehuetlán Huastec:

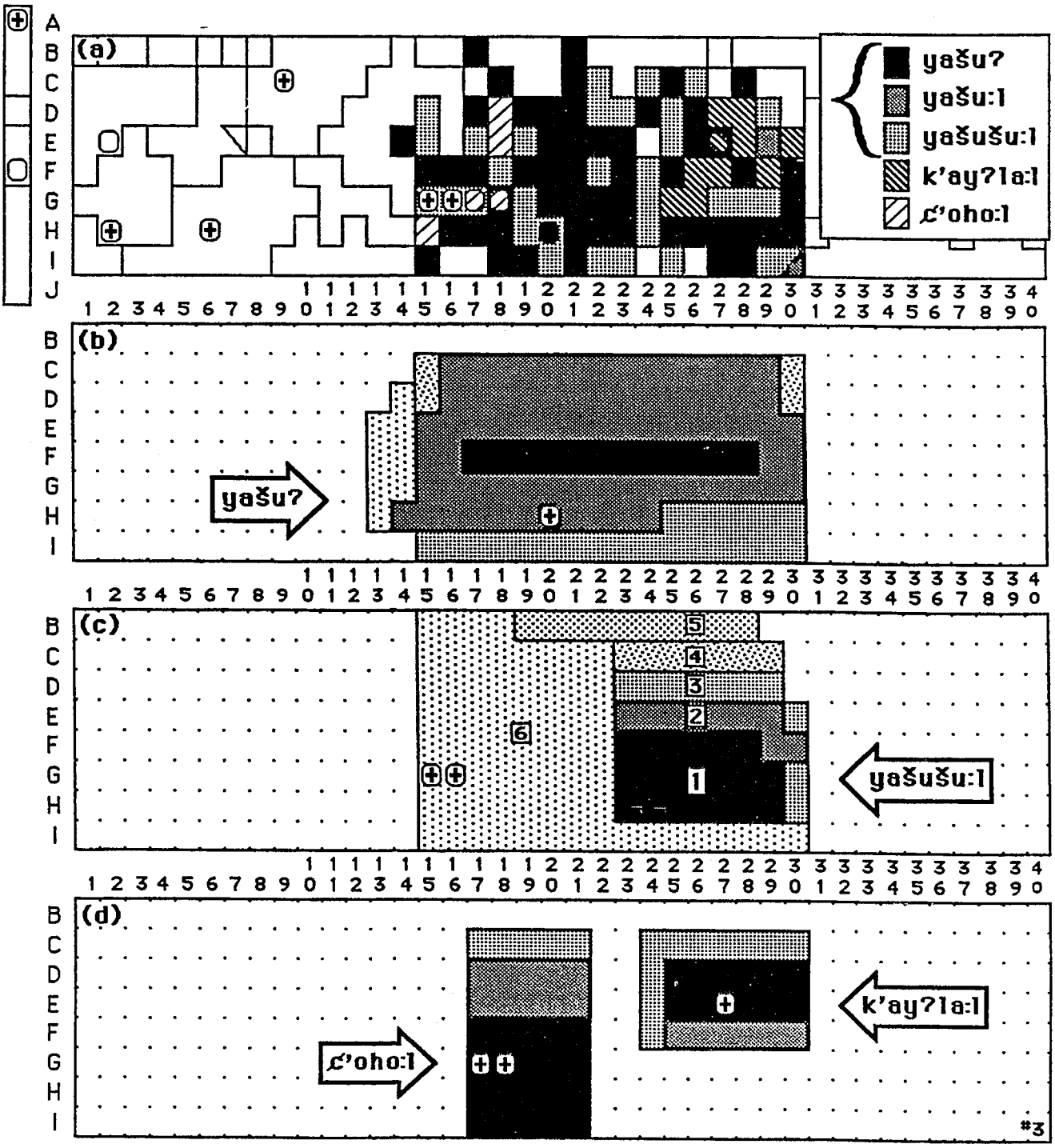
In Figures 9.31a-d, speaker #1 named coextensive vantages with an unmodified and modified cool-category root and with a second root, *k'ayʔla:l* 'sky'.



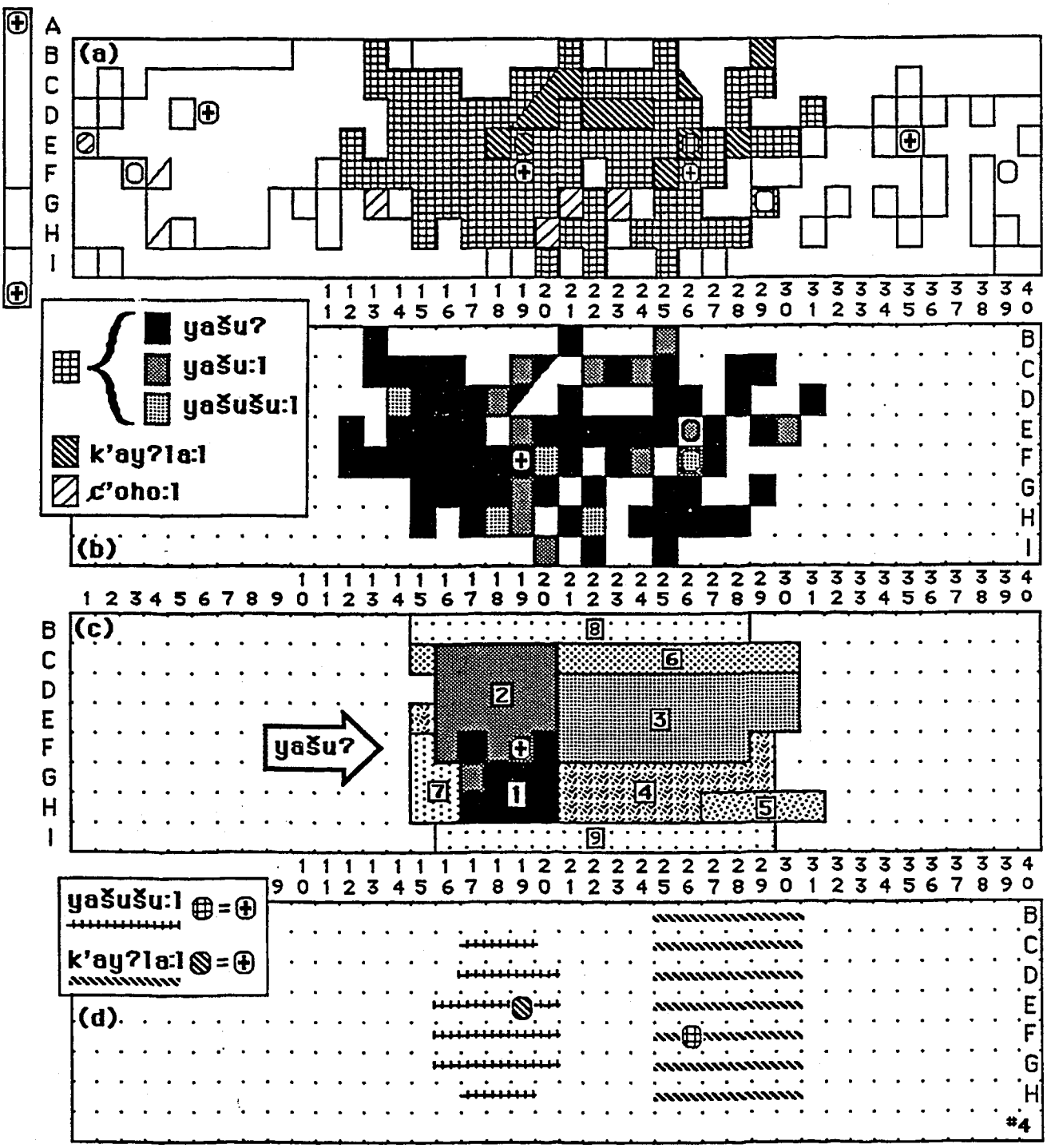
Figures 9.31a-d. Naming ranges of roots (a), naming ranges of modifiers (b), foci, and mappings of unmodified and modified roots (c-d), Huastec, Huehuetlán, speaker #1, man, age 55, 1979.



Figures 9.32a-d. Naming ranges of roots (a), naming ranges of modifiers (b), foci, and mappings of unmodified and modified roots (c-d), Huastec, Huehuetlán, speaker #2, woman, age 25, 1980.



Figures 9.33a-d. Naming ranges of roots and of modifiers (a), foci, and mappings of unmodified and modified roots (b-d), Huastec, Huehuetlán, speaker #3, man, age 45, 1980.



Figures 9.34a-d. Naming ranges of roots (a), naming ranges of modifiers (b), foci, and mappings of unmodified and modified roots (c-d), Huastec, Huehuetlán, speaker #4, woman, age 51, 1980.

In Figures 9.32a-d, speaker #2 ascribed dual foci to the unmodified root, and she named additional vantages with at least two modified forms, *yašu:l* and *yašušu:l*. A third form, *yašašu:l*, might name a secondary green category; neither *yašašu:l* nor *yašušu:l* was mapped.

In Figures 9.33a-d, speaker #3 named coextensive vantages with one unmodified root and two modifications. Foci and first mapping steps mismatch. Green and blue were separately named with two secondary terms, *¢'oho:l* 'herb' and *k'ay?la:l* 'sky'.

In Figures 9.34a-d, speaker #4 named coextensive vantages with a root, two modifications, and a second root, *k'ay?la:l*. This second root and the reduplication of the first root were mapped on opposite sides of the category, where each mismatched its focus. The crossover effect is like that seen among the San Ildefonso Mam speakers of Figures 7.21a-25d, especially Figure 7.22b.

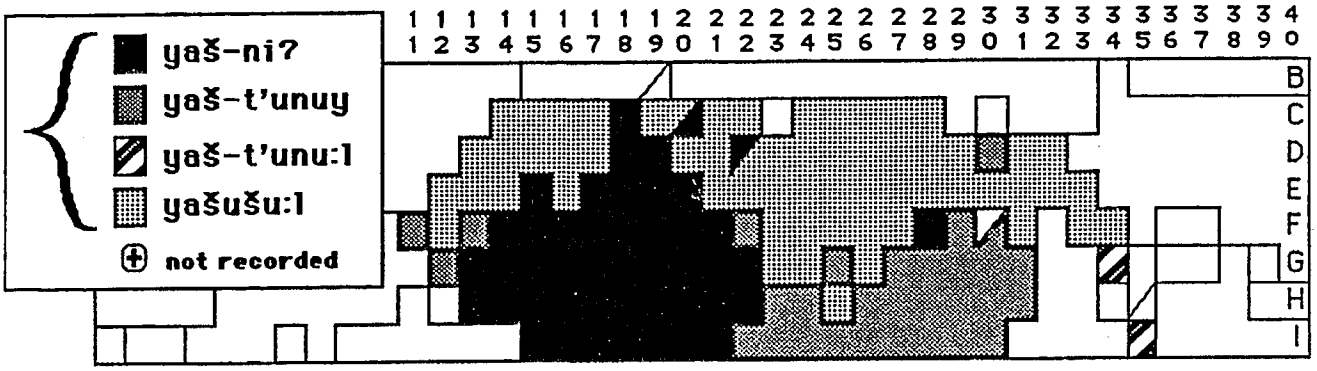
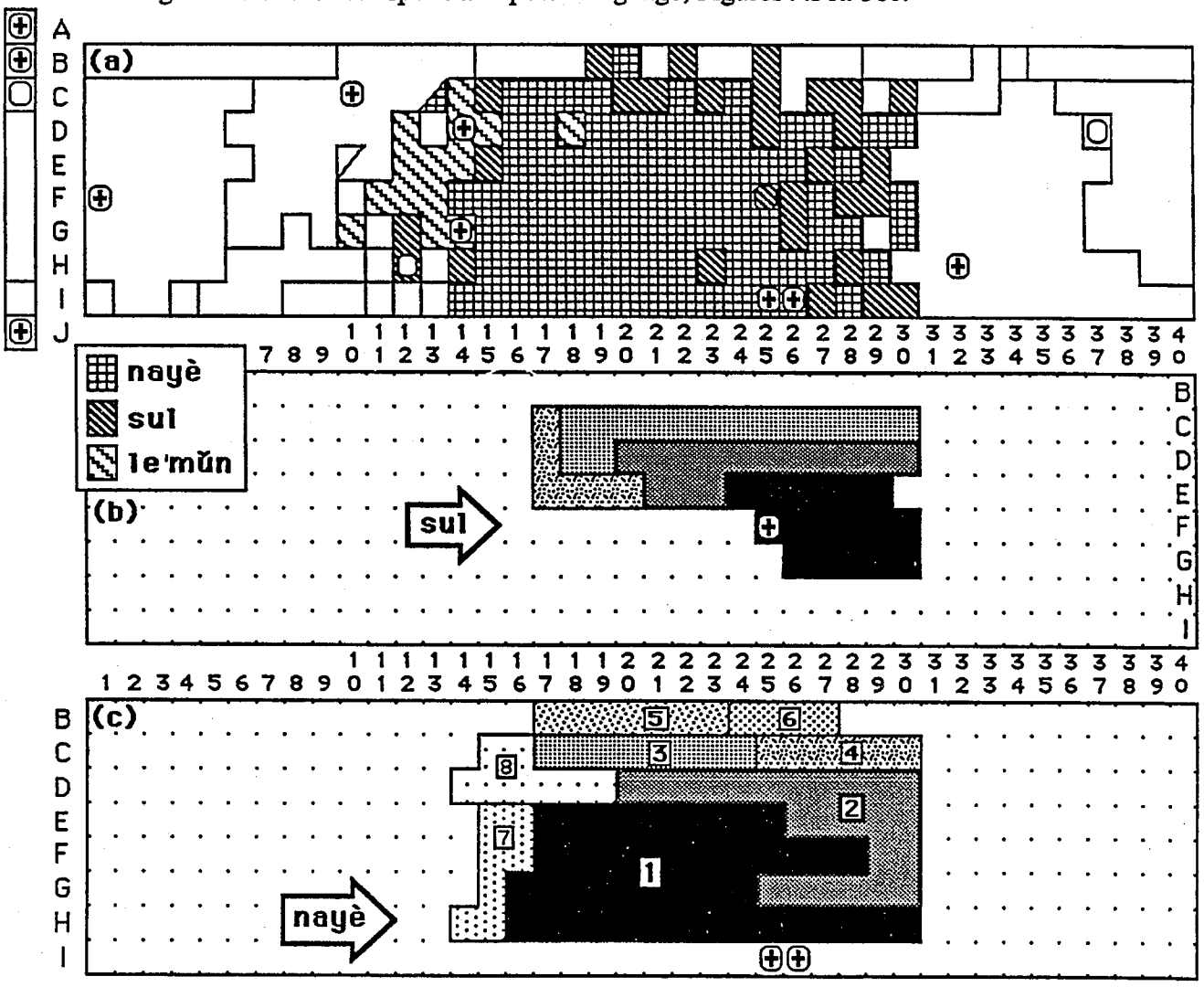


Figure 9.35. Naming ranges of modifiers of one root, Huastec, Xiloxuchil, Tantoyuca, woman, age 55, 1978.

Figure 9.35 displays the use of modifiers in the cool category of a Tantoyuca Huastec speaker, Veracruz State. This speaker modified the cool-category root differently than did the Huehuetlán Huastec speakers. She distinguished light and dark and applied the reduplication only to light colors.

9.3. Coextensivity on the Brightness Dimension

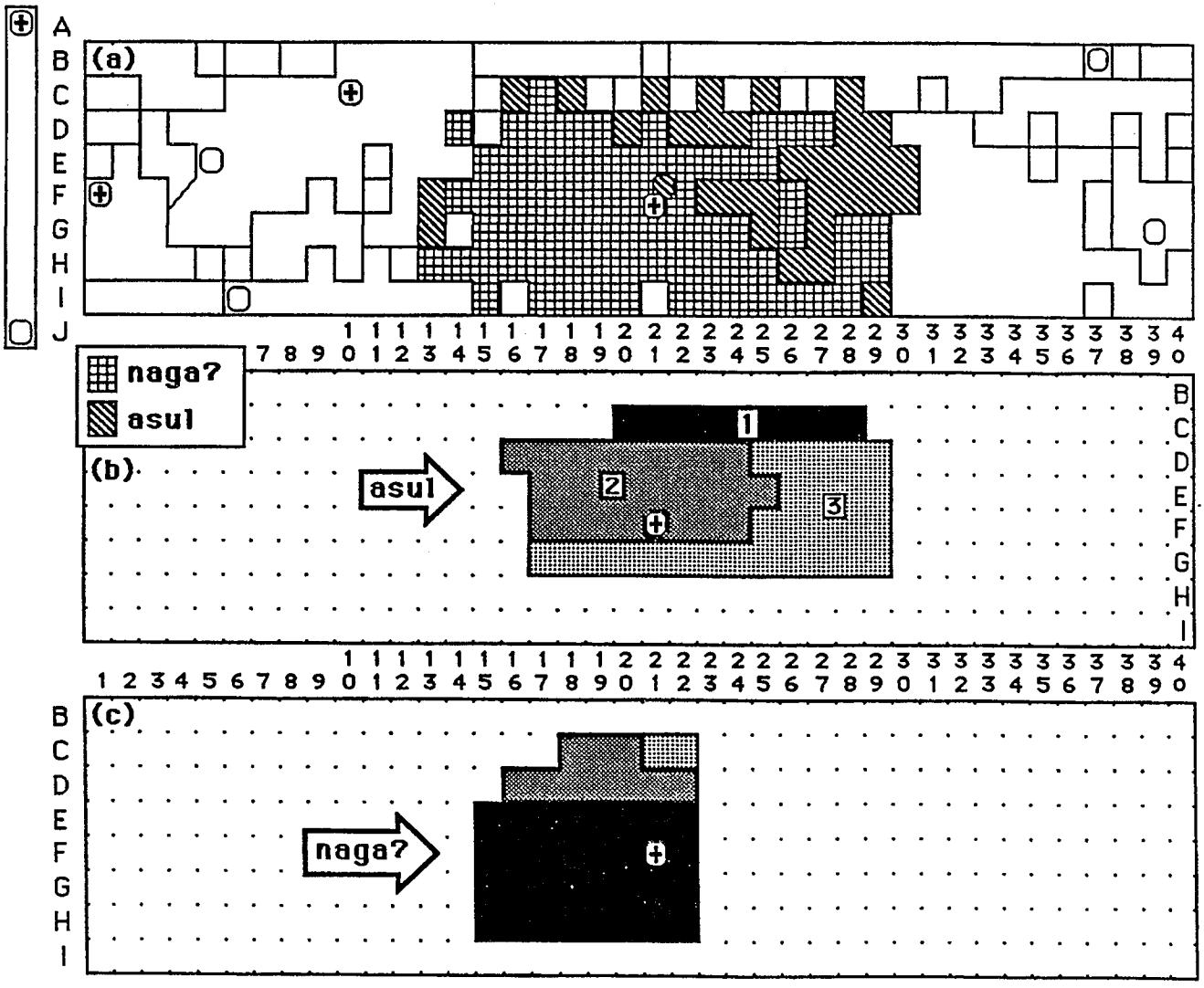
Among the 104 clearly attestable cases of cool-category coextensivity in the Mesoamerican sample, four speakers of different languages juxtaposed the vantages on the axis of dark-versus-light; no two speakers of one language shared this rare practice, although three of the four spoke a Zapotec language, Figures 9.36a-38c.



Figures 9.36a-c. Naming ranges (a), foci, and mappings (b-c); Zapotec, San Cristobal Amatlán, man, age 55, 1981.

The rarity of coextensivity on the brightness dimension of the cool category implies that individuals prefer to constitute its vantages only by coordinating unique hues with the

attendances to similarity and to distinctiveness. Yet a few individuals add a third set of coordinates, darkness and lightness.

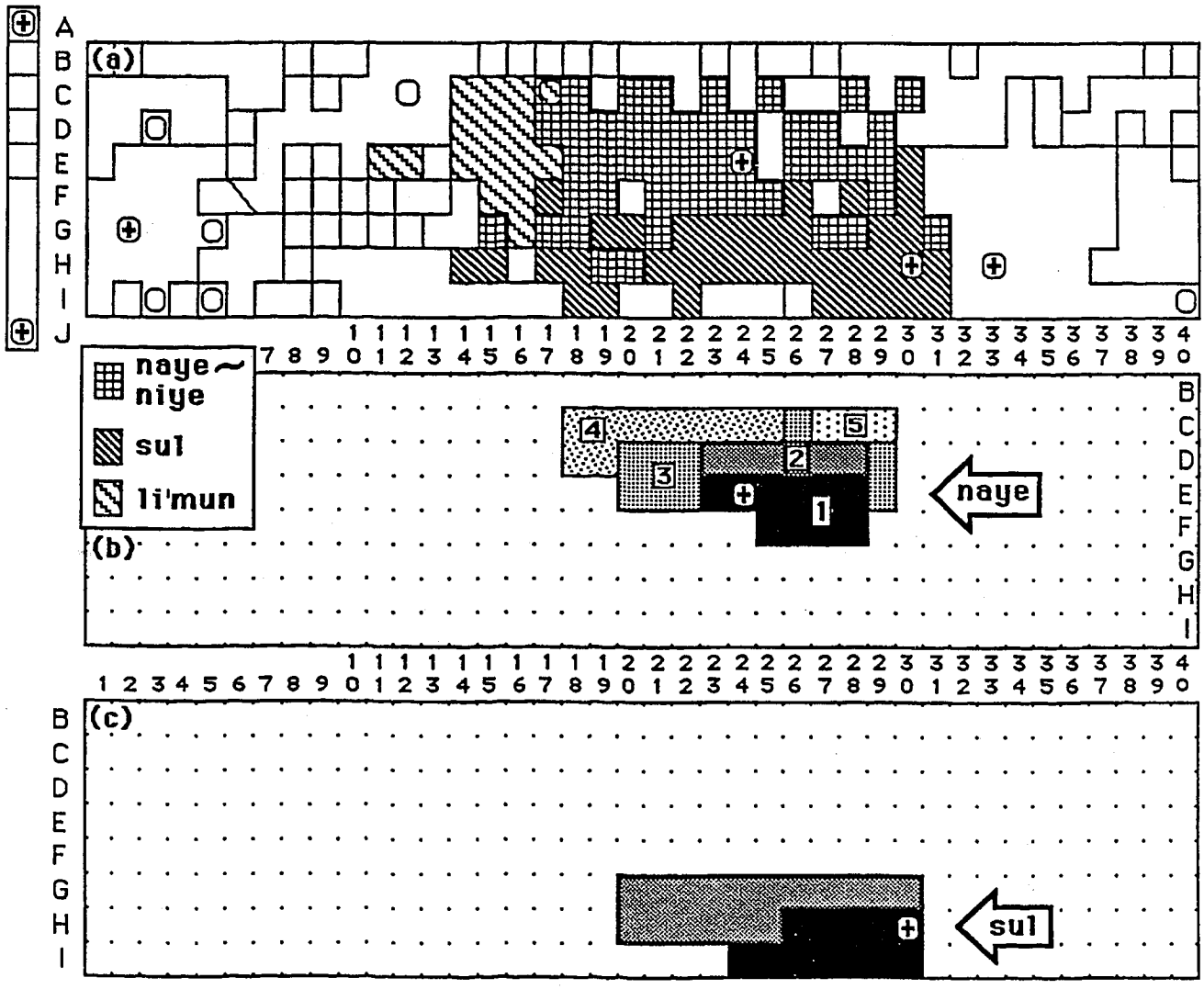


Figures 9.37a-c. Naming ranges (a), foci, and mappings (b-c); Zapotec, San Baltazár Chichicapan, woman, age 80, 1980.

For these individuals, a vantage consists of two perceptual coordinates -- (1) a unique hue and (2) an extreme of brightness -- and a cognitive coordinate of (3) either similarity or distinctiveness. Probably, dark-to-light coextensivity is rare because it is more complicated to constitute a vantage point with the extra perceptual coordinate. Further,

since a brightness coordinate is not essential to the constitution of a vantage point, its use requires an explanation (See Chapter VIII, page 297, footnote 8, especially paragraph 5).

Figures 6.26a-c (page 204) exemplify brightness coextensivity in the cool category of a Tenejapa Tzeltal speaker. The system involves three terms that are focused at I19, H29, and H38. They imply triple coextensivity.



Figures 9.38a-c. Naming ranges (a), foci, and mappings (b-c); Zapotec, Santo Domingo Amatlán, man, age 32, 1981.

Figures 9.36a-38c exhibit the three remaining examples, all from Zapotec speakers of, respectively, San Cristóbal Amatlán, San Baltazár Chichicapan, and Santo Domingo

Amatlán. The vantages of the latter, Figures 9.38a-c, appear to have been juxtaposed more strongly than those of the other speakers. The latter data show little indication that the two terms name coextensive vantages rather than separate categories of light cool colors and dark cool colors.

Among the 478 cool categories of the Mesoamerican sample that are composed from only one vantage, a coordinate of *darkness* appears to have been included in the vantage point of a few. The inclusion of this extra coordinate in a single vantage is as rare as it is among coextensive vantages. Examples are seen in the data from Patzun Cakchiquel, Figures 8.33a-34d (pages 305-6). Most speakers of that language composed the cool category on the dimension of brightness (See Chapter VIII, footnote 8, page 297).

Finally, the brightness dimension of coextensivity might explain a recurrent enigma among Mesoamerican cool categories: some individuals apply and map a term on exclusively the darkest cool colors, throughout row I or H-I only. Such a term might name a very recessive coextensive vantage on the brightness dimension. No example of an extreme case is depicted. The Mixtec speaker of Figure 9.39 shows a slightly more extended usage than just rows H-I:

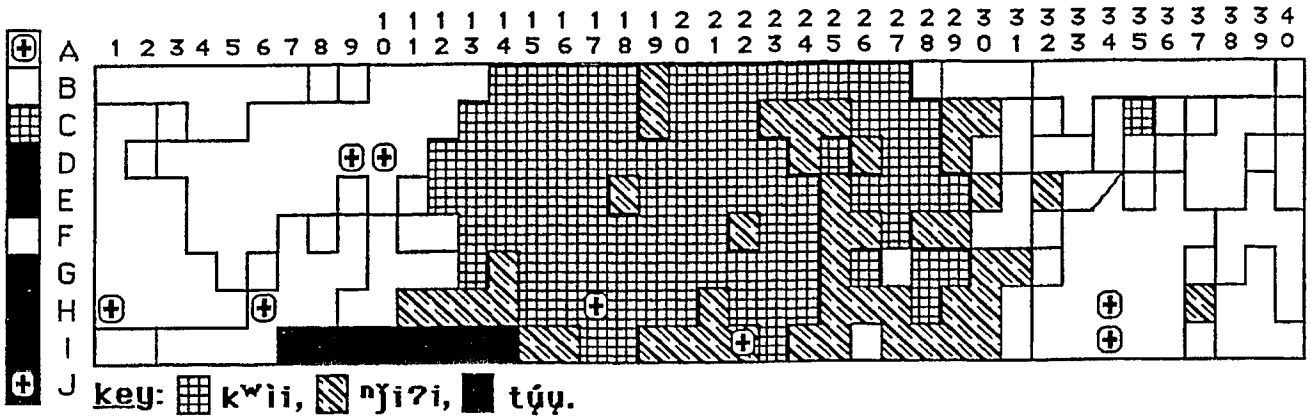


Figure 9.39. Naming ranges and foci, Mixtec, Peñoles, woman, age 38, 1978.

9.4. Summary

In the main, the foregoing demonstrates the use of *covert coextensivity* as a theoretical construct to account for complex composition of the cool category. In the Mesoamerican sample, complex composition consists of any combination of the following: (1) mismatching of data, as between a focus, a naming range, or a first mapping step, that recurs among different members of a community; (2) mismatching of data that were elicited from one individual during different interviews; (3) a focal aggregate that is distributed with a dominant pattern in green and a recessive pattern in blue; (4) dual foci and triple foci; (5) secondary categories both of green and of blue; (6) retraction of the historical "cool" term toward blue rather than toward green; (7) disagreement among individual speakers of one language when (a) some apply the historical "cool" term to green, (b) some apply it to blue, and (c) some replace it by increasing the salience of 'green' and 'blue' secondary terms until both become basic.

Complex composition is further manifested by a vast array of individual variation regarding the relative salience of secondary terms, the salience of secondary terms in relation to that of the original "cool" term, and the use, at various levels of salience, of distinct terms for the coextensive vantages. As a final complication, the crossover effect can enable, at least, one term of a coextensive pair to be dual focused, and it can allow each term to be focused on the same side of the cool category (cf. Figures 5.6-7c).

In most of the cases that are reviewed above, covert coextensivity was evidenced by more than one independently elicited line of data. For example, among the Tecpan Cakchiquel speakers, recurrent dual foci correlated with variation between mappings, some of which were skewed toward blue and others skewed toward green.

Individual speakers of different languages placed dual and multiple foci to the extent that they attended to distinctiveness. The strength of the attendance was evidenced by corresponding data concerning naming ranges, mappings, null responses, and number of

terms used to name all color. In Tzeltal and Seri, no speakers placed dual foci; few did so in Tectitlán Mam, Guarajío, and Pima/Papago; most did so in Tecpan Cakchiquel and Tonanzintla Nahuatl. Strong attendance to distinctiveness encouraged individuals to single out and to contrast covert coextensive vantages and to focus them separately.

Further patterns among focal aggregates correspond with language death and/or immersion of traditional culture in an environment of acelerating change: Nahuatl speakers placed triple foci, one focus in turquoise; Papago/Pima speakers strongly centralized one focus of a dual pair.

The study of the cool category in Mazahua and Matlatzinca showed that (1) coextensivity was shared over an area, (2) the area traversed a linguistic boundary, and (3) the resultant complex composition assumed distinct forms within "zones" or groups of villages.

The study of the cool category in Huehuetlán Huastec showed that, in the environment of green and blue, coextensive vantages can be differentiated with modifiers. Nevertheless, many of the characteristics of complex composition -- crossover, dual foci, dual secondary categories, and mismatching of data -- arose in conjunction with the naming of coextensivity on the secondary level; they are the same characteristics that have arisen in the cool categories of other languages in conjunction with coextensivity that is covert or that is named with separate roots.

Finally, a review is devoted to the only four attestations of coextensivity in the cool category that is juxtaposed on the axis of dark-to-light. Probably, this kind of coextensivity is rare because it requires the use of an extra perceptual coordinate. In cool categories that are composed from only one vantage, an extreme of brightness has been incorporated into the vantage point with commensurate rarity.

Chapter X

Conclusion

10.0. Preface

The foregoing hypotheses apply only to composite color categories, the present subject of analysis. It is merely suggested that some of them extend to other kinds of categories, both in the color domain and outside of it. The suggestion will be explored throughout Volume II in regard to primary, derived, and residual color categories. The hypotheses remain untested in regard to categories that do not pertain to color.

Five broad classes of conclusions are drawn from the analysis:

First, the general thesis of this work has been confirmed: *Composite color categorization is most exhaustively explained by hypotheses that are built up from a small number of perceptual and cognitive axioms; perception and cognition are equally critical to this kind of categorization.*

Second, there are specifically four axioms, three of them perceptual and one of them cognitive, that are capable of interacting or "engaging" in a way that provides a foundation for hypotheses that can address the dynamics of composite color categorization. *Perception is physiologically determined, universal, and invariant whereas cognition is mutable; categorization changes as different individuals attend more or less, at reciprocal strengths, to perceptions of similarity and distinctiveness.*

Third, there are the hypotheses themselves and the particular observations that they account for and interrelate. The observations consist of correspondences between independently elicited data. The hypotheses explain why and how the warm category and

the cool category (1) transform from a relatively stable state to a full division, (2) divide in a universal order, and (3) show internal difference in composition and in semantic type as they change. The hypotheses also explain why and how (4) internal cognitive composition and semantic relationships evolve through a continuum and (5) individuals who share universal perception, nevertheless, vary in systematic ways.

Fourth, there are issues concerning earlier hypotheses, namely Rosch's notion of the prototype and family resemblances and Kay and McDaniel's fuzzy-set union. The effectiveness of these constructs is compared against that of the key notions developed in the present analysis: *Any color category is composed of one or more vantages; each is taken from a standpoint that is constituted by perceptual and cognitive coordinates. A category assumes a gamut of composition as the cognitive coordinates reciprocally and smoothly transform in strength. The continuum of composition sets preconditions for the evolution of semantic relationships, of which there are four ideal types.*

The reciprocity of coordinates, their assemblage as vantage points, and the continuous range of possible vantages are in close keeping with tenets of relativity physics. The likeness might not be accidental: human categorization probably emerged on the foundation of a much older capacity to cope with objects, motion, space, and time, which humans share with other species. The novel accomplishment depends on a primal ability to treat intangibles as though they were tangible, including one's own cognitions. Human beings coordinate cognitions and perceptions in the same way that they coordinate dimensions and time; and, thereby, they compose any composite color category as though it existed physically. Categorization differs little from the manner in which any creature constructs its position in relation to the material world.

Universally invariant perception, cognition, and relativity are integral to one theory. The relativity, however, is unlike Whorfian relativity, which advocates that cognition is arbitrary. The idea that linguistic relativity was of the Whorfian ilk placed relativity at odds with attested perceptual universals and, for a protracted period, forestalled integration of the

two concepts. Berlin, Kay, McDaniel, Rosch, and others postponed analysis of cognition and emphasized perception in their effort to counter the Whorfian view.

Fifth, there are some conclusions concerning Berlin and Kay's hypothesis of basic color-term evolution, which is reinforced by the present findings.

Sections 10.1-4 and 10.6-7 treat the hypotheses one-by-one, showing how each builds upon the same axioms and listing the observations that each explains. Sections 10.5 and 10.8 address the earlier theories.

10.1. Basic Categorization

Berlin and Kay's "basic color category" and Rosch's "basic level of categorization" are united when the latter is regarded as cognitive as well as perceptual. Perception constitutes a fixed hierarchy in which some groupings of color include others: black-with-green-with-blue includes black versus green-with-blue which, in turn, includes black versus green versus blue. Conversely, cognition is mutable; the attendances to similarity and to distinctiveness shift reciprocally in strength. The shift *smoothly and continuously* moves the basic level through the perceptual hierarchy toward greater specificity and differentiation; the reciprocity of strength prevents the movement from abruptly jumping from one level to the next in the hierarchy.

The movement of the basic level explains why Tzeltal speakers who maintain the superordinate black-with-green-with-blue category name the subordinate green-with-blue category less saliently than do Tzeltal speakers who do not maintain the superordinate category: Each group maintains basic categorization at a slightly different level than the other.

The continuity of movement explains why Berlin and Kay's defining criteria of a basic color category can be split between hierarchically related categories; in every case, the Tzeltal subordinate category is more salient than the superordinate category: The criteria themselves are accurate to the extent that they apply to two categories at once when basic

categorization has moved to a position between perceptual levels. The splitting of criteria does not justify altering them or assigning priority to one of them.

10.2. A Continuum of Semantic Types

The same cognitive shift that propels continuous evolution of basic categories also propels continuous evolution of semantic types within categories. *Near-synonymy*, three forms of *coextensivity*, and *inclusion* evolve within a composite category as the reciprocal shift in strength between the attendances to distinctiveness and to similarity causes the category to divide; full division results in semantic *complementation*. Clear types represent ideal points on a continuum of intermediate variants.

Semantic evolution is not obligatory. Rather, any balance between the two cognitions sets the precondition for development of one particular cognitive composition of vantages or categories. If the composition develops, its vantages or categories can be separately named. If they are so named, the balance between cognitions will determine the semantic relationship. A strong attendance to similarity determines near-synonymy. A more equal balance determines coextensivity. A stronger attendance to distinctiveness determines inclusion. A very strong attendance to distinctiveness provokes complete category division and complementation. But since complex compositions need not develop and since more than one name need not be applied, some categories undergo all phases of division under just one name; in other categories, the first semantic relationship to emerge will be of a type that is late in the continuum, such as inclusion.

10.3. Semantic Types in Distinct Perceptual Environments

Red and yellow appear more distinct than green and blue. *In part*, this explains why:

1. The warm category divides before the cool category in evolutionary order.

2. Semantic types within the warm category, such as coextensivity, show more dichotomous and discernible characteristics than their equivalents in the cool category.

3. As the warm category enters an advanced phase of division, its vantages retract toward polarized foci in opposite directions, first one and later the other; different orders of data match each other. But as the cool category approaches full division, a contention heightens between cognitive attendance to distinctiveness and inherently strong perception of similarity. The enhanced cognition occasions confinement of data regarding any vantage to one side of the category; but the perception encourages a weak identification of any term with a particular vantage. The result is a mismatch of naming ranges and mappings on opposite sides of a coextensively composed category. The crossover can pertain to the naming range and mapping of both vantages.

4. The full gamut of semantic types is more likely to evolve in the warm category than in the cool category. The cool category is often named with just one word throughout its division. After the cool category fully divides, one of the unique hues can remain unnamed for a period.

The perceptual difference between red and yellow versus green and blue does not by itself cause the differences that are outlined as 1-4. Rather the four effects are caused by the engagement of the perceptual difference with the two mutable cognitions whose strengths shift reciprocally. The *perceptions*, the *cognitions*, and *their capacity to engage* contribute equally to the account of effects 1-4. *Cognition plays as critical a part as does perception in any event concerning composite color categorization.*

10.4. Vantages and Coordinates

The data concerning coextensivity show that a category can be named with different words that are focused in reference to opposite unique hues. The words name the category from different vantages. Such usage powerfully demonstrates the pertinence of a vantage to categorization.

Any vantage is taken from a particular position that, in turn, is constituted by coordinates. In physical experience, such a position or vantage point is made up of the

three perpendiculars and one temporal coordinate. In a composite color category, a vantage point is made up of perceptual and cognitive coordinates. *Perception and cognition are equally influential in shaping the composition of a category.*

A statistical test, Table 6.1, supports the hypothesis that coextensive vantages are composed from specific perceptual and cognitive coordinates: (1) the unique hues and (2) the attendances to similarity and to distinctiveness. *The same axioms that provide for continuous change in category evolution, in category division, and in the evolution of semantic types further provide the coordinates of any vantage point.*

The evidence supports a fresh concept of composite color categorization: *a category is composed of one or more vantages; each is taken form a position that is constituted by different perceptual and cognitive coordinates. In turn, the specific composition of a category is determined by the balance of strengths between its cognitive coordinates and by the distance between its perceptual coordinates. A shift in the balance precipitates change through a continuum toward full division; an ensuing gamut of composition establishes preconditions for types of semantic relationship. Coordination of cognitions and perceptions further determines the order in which composite categories will divide.*

Further statistical tests, such as that of Table 8.1, indicate that any composite category is a vantage; the *vantage principle* does not only pertain to coextensivity, but pertains to all composite categorization. The statistics derive from data regarding cool categories that are named with one term and that do not manifest evidence of covert coextensivity.

The tests yield specific implications concerning any category that is composed from a single vantage:

1. All single-vantage categories are skewed because the vantage point is fixed on one side or the other of the category; any such category is slightly skewed even when not substantially undergoing division.

2. The standpoint of a single-vantage category is composed of one perceptual coordinate and two cognitive coordinates; as the attendance to distinctiveness gains strength, skewing is enhanced and division progresses; highest values of membership are retracted toward the vantage point, leaving low values on the far side of the category.

3. Division is completed when the attendance to distinctiveness is strengthened to an extent that the low values reduce to zero; the historical "cool" term names only the colors whose unique hue had been part of the original vantage point.

After division, many individuals compose the green and the blue category, in part, from a coordinate on the brightness dimension, in particular "darkness." They seek to bolster or to replace the attendance to similarity, which has been diminished greatly or even eliminated by the full division. The replacement fulfills the minimal number of coordinates -- probably three -- with which humans are predisposed to compose any vantage, whether it is in regard to a physical thing or a category. The vantages of primary basic color categories are a topic of Volume II. A few individuals adopt coordinates on the brightness dimension before the cool category has divided.

10.5. Earlier Models of Color Categorization

The notion that a color category is a vantage composed from a standpoint of perceptual and cognitive coordinates differs from two other models of color categorization: (1) Rosch's concepts of the prototype and family resemblances; (2) Kay and McDaniel's fuzzy-set union. Rosch holds that members pertain to a category to the extent that each shares attributes with a prototype, the member that is composed of more such attributes than any other; the attributes themselves are directly perceived. Kay and McDaniels hold that a composite color category is composed by a logical operation on pure color percepts; the resultant values of membership inversely match the degree to which each pure percept intergrades with another.

Both models (1-2) share the flaw of emphasizing perception while minimizing or ignoring cognition. Consequently, neither can address two major genre of observations, change and correspondence:

1. Change. Any theory of color categorization should explain why and how a composite category changes from a relatively stable state through continuous phases of division toward a complete split into separate categories. The explanation should simultaneously address the continuum of cognitive compositions and appertaining semantic types that evolve as the category undergoes the same change. But since universal color perception is invariant, perception cannot propel change. Fuzzy-set logic also lacks that capacity.

The instigator and propellant of change is cognition, because cognition is mutable. The cognitive axiom of the present theory articulates with universal perception in a manner that produces the kinds of change observed among composite categories. Further, the same engagement of axioms explains why some categories divide before others and why basic color-category evolution and semantic evolution both progress continuously rather than by abrupt leaps.

2. Correspondence. A theory of color categorization should explain correspondences among data, such as those that accompany coextensivity and skewing (cf. Tables 6.1 and 8.1). When Kay and McDaniel developed their model and Rosch developed hers, the descriptive methodology for producing such data was not at hand. Nevertheless, they all had noted variation among composite-category foci. Neither model offers an account of this variation other than attributing it to error or randomness. In particular, Rosch's concept of the perceptual prototype is at a loss to explain why the foci of dominant coextensive vantages are centralized and why the foci of recessive coextensive vantages are less centralized, placed on a unique hue, or polarized. Nor does this concept explain correspondences within single-vantage cool categories between a continuous

mapping and centralized focus or between a disjunctive mapping and a focus that is placed on a unique hue or polarized.

The present theory differs from the other two accounts by placing perceptual and cognitive axioms on the same footing. The engagement of these provides a basis for hypotheses that can address change and correspondence. However, the same axioms lead to further differentiation of the present theory by fostering its major tenet: A category is a vantage; it is not an assessment of family resemblances to a prototype and it is not a logical operation. This tenet has four implications concerning the nature of categorization and its relationship to other behavior, none of which are shared by the earlier models:

1. Categorization is accomplished on the basis of a primal ability: to treat something non-substantive as through it were substantive. With this ability, an individual can constitute a vantage point by coupling reciprocally related cognitions to one unique hue; and an individual can separate each cognition from the other such as to couple them with opposite unique hues of a coextensively composed category. The primal ability is also used to accomplish other forms of behavior that are both unique and critical to the human species. For example, metaphor is a treatment of something non-substantive as though it were substantive (cf. Lakoff and Johnson 1980).

2. When cognitions and perceptions are treated like things in order to compose a category from a vantage point, the category itself is treated as though it existed physically: the vantage point endows the category with a fixed position in which the categorizer stands and looks on. The standpoint is inherent to the category; that is, it is part of the category by virtue of the way that the category is composed. The inherence of a standpoint means that categorization involves the same order of embodiment as does the direct observation of physical objects and events.

A category differs from concrete events and objects specifically and only in that some of its coordinates are cognitive rather than dimensional and temporal. Human beings

have accomplished categorization by creating an abstraction that, nevertheless, is as similar to concrete experience as it can be.

3. From different standpoints, a category assumes compositions of different sizes and distinct degrees of skewing, just as physical objects and events differ when observed from different standpoints.

4. The present theory is consistent with the more conservative of two phylogenetic accounts: At some point in hominid evolution, early humans set themselves apart from other animals by developing unique abilities, such as categorization. They might have done this by (1) slightly altering behavior that all higher animals engage in, namely, the apprehension of objects and events from vantage points composed of coordinates. Or they might have done this by (2) innovating categorization *in vacuo*, with no antecedents. The latter possibility (2) is radical if not outlandish, but the former (1) is conservative: categorization is accomplished by treating cognition in the same manner that all creatures treat physical dimensions. The accomplishment is dependent on the primal ability to treat non-things as things.

10.6. Covert Coextensivity

It is important to consider covert coextensivity, because it occasions complexities that would otherwise appear to contradict some of the claims that have been made regarding single-vantage categories.

Certain coextensive compositions of the cool category are "covert" in the sense that their distinct vantages are not separately named. Covert coextensivity can foster mismatching of independently elicited data, and it can encourage dual foci and dual secondary categories of green and of blue. As the secondary categories gain salience, they can supplant the historical "cool" term. Dual foci are actually single foci of different vantages. Kay and McDaniel mistook such foci in West Futunese for support of their fuzzy set-union model.

10.7. Transference

Transference is the switching of a vantage point from the blue side to the green side of the cool category. Green is perceptually more salient than blue. As the attendance to distinctiveness increases, the *difference* in salience becomes more important to the categorizer. Then the green unique hue is incorporated into the vantage point and unique blue is abandoned as a possibility.

Transference explains two statistics from the Mesoamerican data: (1) three times as many cool categories are skewed toward green than toward blue. (2) A higher percentage of cool categories is skewed toward green among those that show independent evidence of stronger attendance to distinctiveness, such as basic status or disjunctive mapping; a lower percentage is skewed toward green among those that are secondary or continuously mapped.

Transference is accompanied by temporarily maintained covert coextensivity. For a period, either vantage or both can be focused. Transference itself explains why speakers of certain languages focus the cool category in green or in blue. The accompanying coextensivity explains why the aggregates of such foci manifest a dominant-recessive pattern, that is, predominantly centralized in green and predominantly placed on the unique hue or polarized in blue. Kay and McDaniel mistook such foci in Tzeltal for further support of their fuzzy set-union model.

The hypothesis of transference requires testing against non-Mesoamerican data.

10.8. Basic Color-Category Evolution

Berlin and Kay's theory of basic color-category evolution -- and its revisions -- will be further discussed in Volume II, after analysis of primary, derived, and residual categories. However, some hypotheses and findings of the present volume pertain to the order in which composite color categories divide into primaries. Such developments alter

Berlin and Kay's theory very little, although they add clarification that makes the theory less vulnerable to misunderstanding.

1. Evolutionary Order. Berlin and Kay's major prediction is upheld by all data from Mesoamerica: In a language or an individual system, the cool category can be unaccompanied by the warm category, but not the reverse. The dark-cool category can occur without the light-warm category, although the rare and tentative evidence of the latter is accompanied by the dark-cool category in every case.

Some regularities are explained by the part of axiom #3 that is supported by findings from visual physiology: green and blue appear more similar than red and yellow. However, this perception by itself causes nothing. Rather, the perception affects the order of color-category evolution because it is singled out from others and engaged with a particular cognition. As the cognition changes, the perceptual universals constrain evolution. The very occurrence of evolution despite the invariance of color perception is a powerful argument for adding the cognitive axiom to the evolutionary theory of basic color categories.

2. Non-Primacy of Specific Unique Hues. The warm category can be focused in either red or yellow, and the dark-cool category can be focused in either black or a cool color. As these categories divide, the semantic ranges of their names will retract toward their foci; and, after division, the term that once named the warm category will name just red or just yellow but not both, and the term that once named the dark-cool category will name just black or just cool colors. In a coextensively composed category, the dominant vantage point can incorporate any one of the pertinent unique hues.

3. Yellow-with-Green. In one language of the Mesoamerican sample, Jicaque, some speakers add a minimally salient yellow-with-green category before the cool category has divided. Berlin and Berlin (1975) noted the same at moderate salience among the Aguaruna. MacLaury (1987) documented a highly salient yellow-with-green category in

Shuswap, a non-Mesoamerican language; most speakers had retracted the historical "cool" term to just blue. The measurement of JNDs attributes discrimination distance, from shortest to longest, to green/blue, red/yellow, and yellow/green. It is neurologically possible for the yellow-with-green category to develop; but it is least probable, especially if it develops at the expense of supplanting the cool category in green. In the absence of a neurological explanation of the yellow-with-green category, the remaining alternative is a cultural explanation.

4. Evolution Through an Invariant Perceptual Hierarchy. Berlin and Kay implicitly subscribe to an invariant perceptual hierarchy of potential levels of inclusion. A language evolves color categories by working its way through the hierarchy from the most general level of two composite categories toward the most specific level of six primary and five derived categories. They assert that languages "attain" or "achieve" this specific level.

Under the present proposal, languages evolve color categories without a long-range perceptual target. Rather, as the attendances to similarity and to distinctiveness reciprocally shift strengths, it becomes easier for individuals to categorize at levels of increasing differentiation and specificity and it becomes harder to categorize at more general levels. Basic categorization moves through the perceptual hierarchy without an end-point in mind.

5. Split Criteria. The reciprocal shift of cognitions can leave basic categorization at a point between two perceptual levels. In such cases, Berlin and Kay's operational criteria for defining a basic color category will be split between two categories: a subordinate category will be more salient than a superordinate category. The mutability and reciprocity of cognitions explains and predicts the occurrence of split criteria. The criteria are accurate indicators of the basic categorization, even when it falls between levels of the perceptual hierarchy.

6. Motives. Speculation concerning the motive for changing cognition includes societal complexity, culture contact, and exposure to novelty.

7. Centralized and Polarized Foci. Berlin and Kay originally stipulated that foci would be placed on "focal colors," that is, the best or purest examples. After McDaniel explained the placement of foci in terms of the opponent process model, the prediction became even more specific: foci would be placed on the unique hues and on purest red, white, or black.

However, most of the foci within the aggregates from Mesoamerica are centralized or polarized. Only a plurality are placed on columns of the Munsell array that contain a unique hue. The cognitive axiom explains centralized foci as the result of a strong attendance to similarity, and it explains polarized foci as the result of a strong attendance to distinctiveness. The explanations are supported by correspondence between foci and other data, such as continuous and disjunctive mappings (cf. Tables 6.1 and 8.1).

8. Dark Foci. Among cool colors, foci are often placed between a unique hue and pure black, especially in the basic categories of green, of blue, and of purple. The unique hues are coupled with a coordinate of brightness, specifically darkness, after the attendance to similarity has weakened to an extent that does not serve well as a coordinate.

9. Semantics. The evolution of semantic types through a continuum complements the smooth and continuous evolution of basic categories through a perceptual hierarchy. Both evolutions are propelled by the same cognitive shift.

When the attendance to similarity is strong, some individuals intermix applications of distinct color terms with little care for "precise" usage. Although the intermixture makes sense in view of this cognitive explanation, it would give the misimpression of sloppiness if it were assumed that perception alone is named. It would likewise appear sloppy through the eyes of an observer who attends strongly to distinctiveness.

It is unlikely that any Stage-I system will involve the use of just two neatly applied terms. People who maintain the light-warm category attend strongly to similarity, a cognition that encourages the development of near-synonymy. The few light-warm categories that have been substantiated around the world are lexically complex, if not cluttered with terms. The light-warm category could be difficult to identify on the basis of just naming data.

10.9. Descriptive Method

The foregoing hypotheses and findings have been tested against, or at least derived from, correspondences between independently elicited naming ranges of roots and of modifiers, foci, and ranges and steps of mappings. Few of the tests and affirmations would have been possible without the method of obtaining separate orders of quantifiable data from individuals.

10.10. Earlier Advances

The present theory builds directly on earlier advances. Among the indispensable contributions and concepts are Berlin and Kay's "basic color category" and its universal order of evolution, the work of R. De Valois and his associates in visual physiology, McDaniel's and Zollinger's simultaneous but independent use of the opponent process model to account for the unique hues and other perceptual constraints, Kay and Dougherty's analyses of variation, Rosch's work on category gradation, and reports from the field by Dougherty, Hage and Hawkes, Heider, Berlin and Berlin, and many others, which demonstrate that the observations from Mesoamerica have parallels elsewhere.

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Appendix I

The ideal of this appendix is not yet attained. It is to provide a specimen or two of color categorization in enough national languages so that any reader can appraise data in reference to a familiar standard. Beside the American English informant (Figures 1.4a-b), speakers of eight worldly languages and dialects named color chips and chose foci. Cross-cultural representation will be expanded as individuals of diverse origins contribute.

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1. Spanish, Mexico..... page 2.
2. Portuguese, Brasil..... 3.
3. Japanese (data collected by P. Downing, WCS; K. Uchikawa)..... 4.
4. Finnish (data collected by M. Heller and others, WCS)..... 6.
5. French..... 7.
6. Icelandic..... 10.
7. Spanish, Spain..... 11.
8. Shanghaiese..... 12.

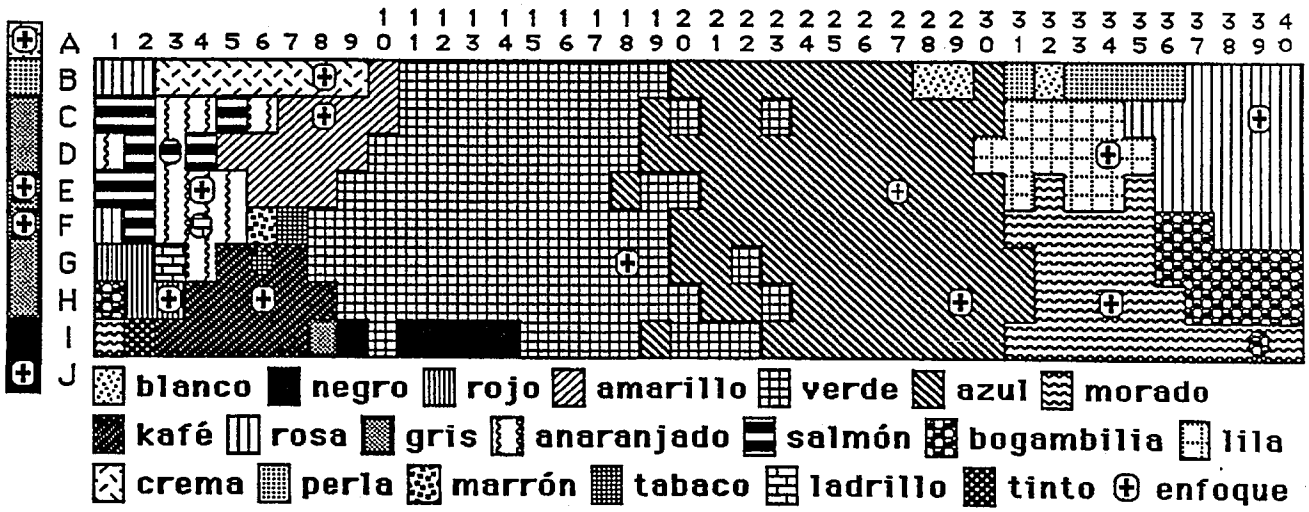


Fig. 1a. Términos de color, Español, México, D.F.; mujer, edad 32, 1985.

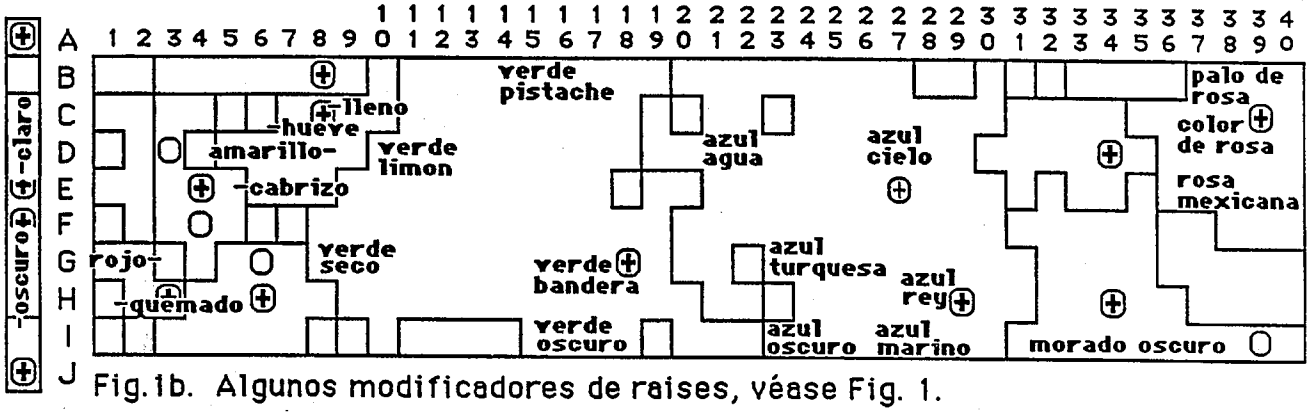


Fig.1b. Algunos modificadores de raises, véase Fig. 1.

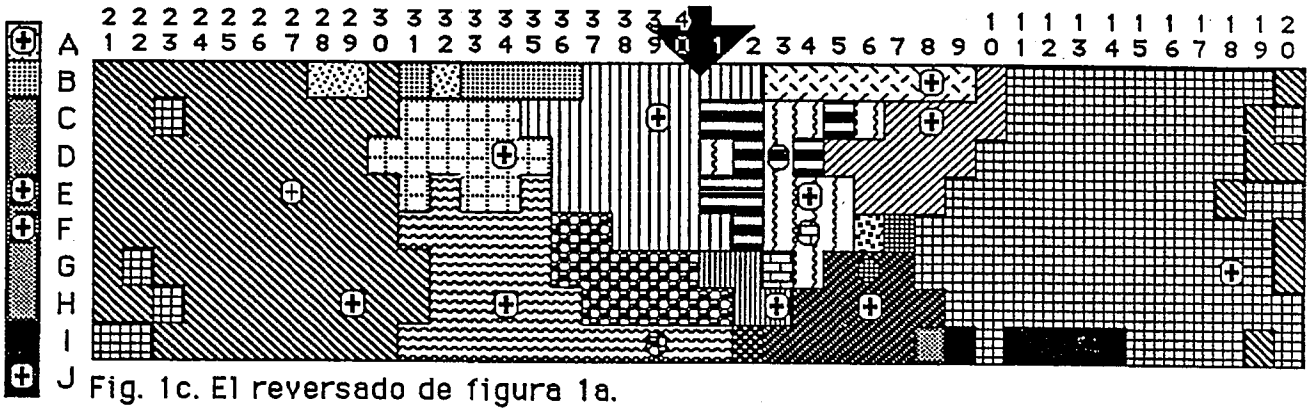
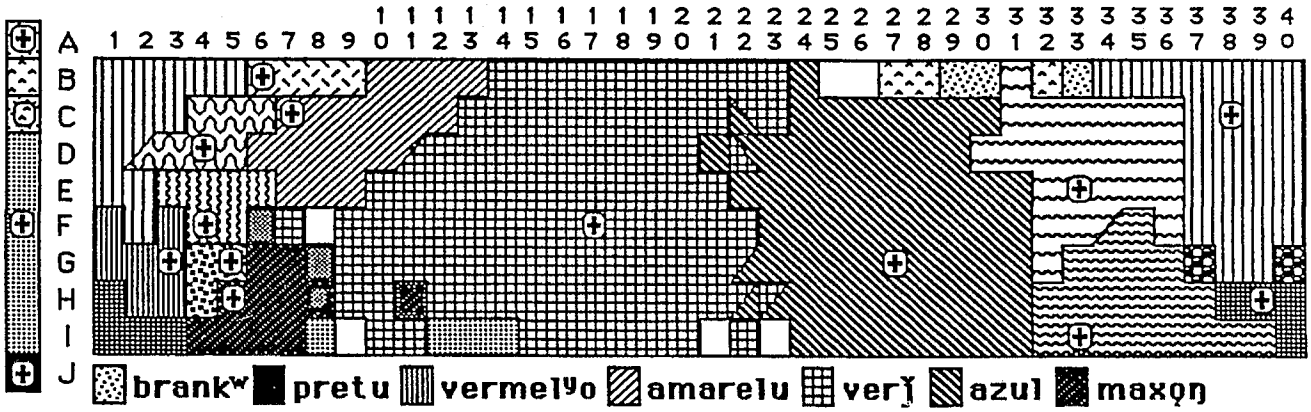


Fig. 1c. El reversado de figura 1a.



branco, preto, vermelio, amarelo, verde, azul, marron, rosa, roxo, cinza, laranja (girimom, abobora), lilás, salmon, vinho, areia, ferrugem, violeta, gelo, cor de burro fugido.

Fig. 2a. Termos para cores em Português do Brasil, sexo feminino, 40 anos, 1986.

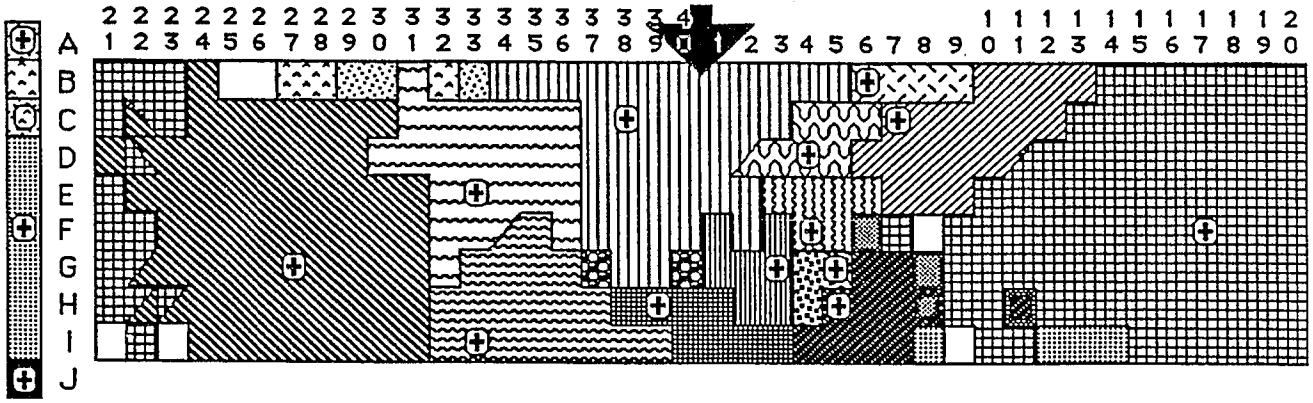
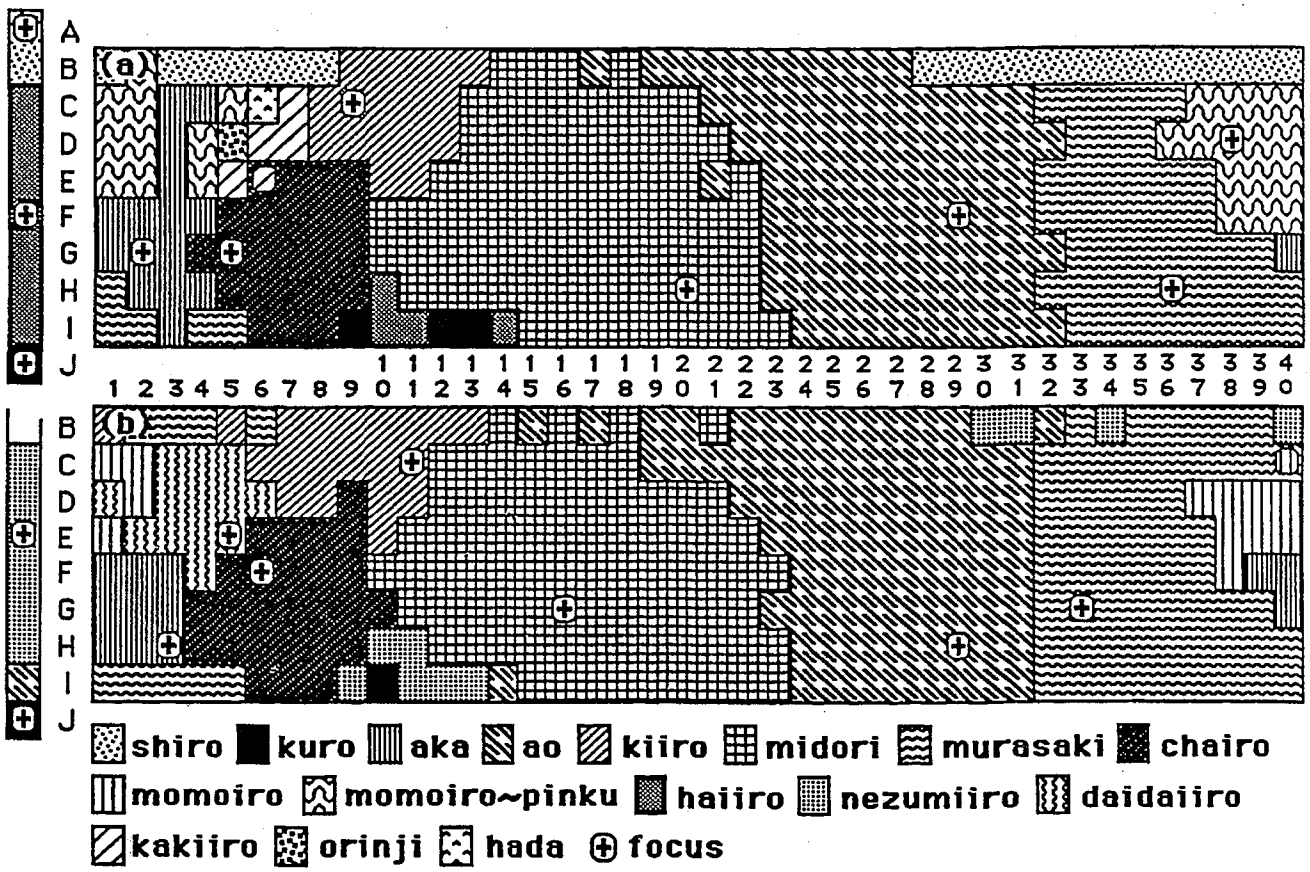


Fig. 2b. Inversão da figura 2a.



Figs. 3a-b. Japanese, (a) woman, age 26, 1980, (b) man, age 31, 1980.

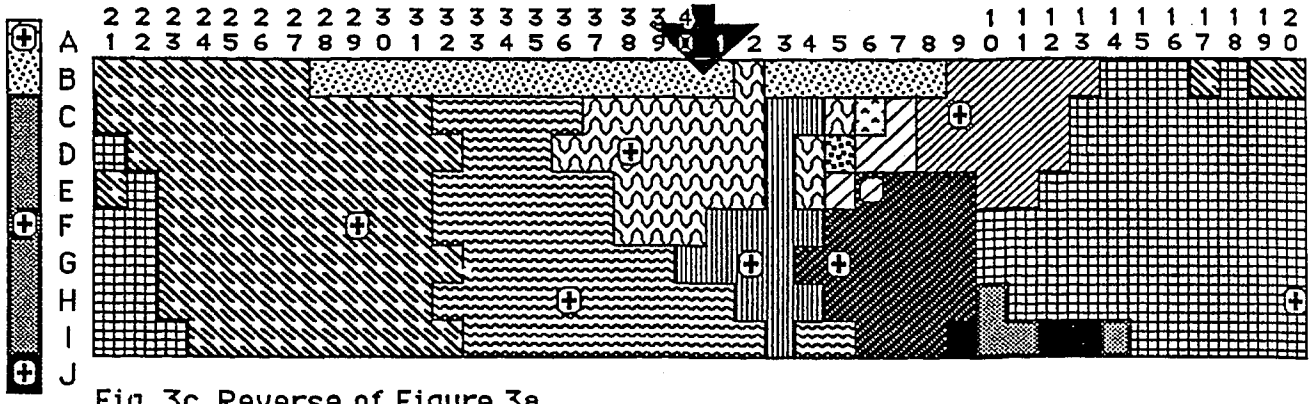
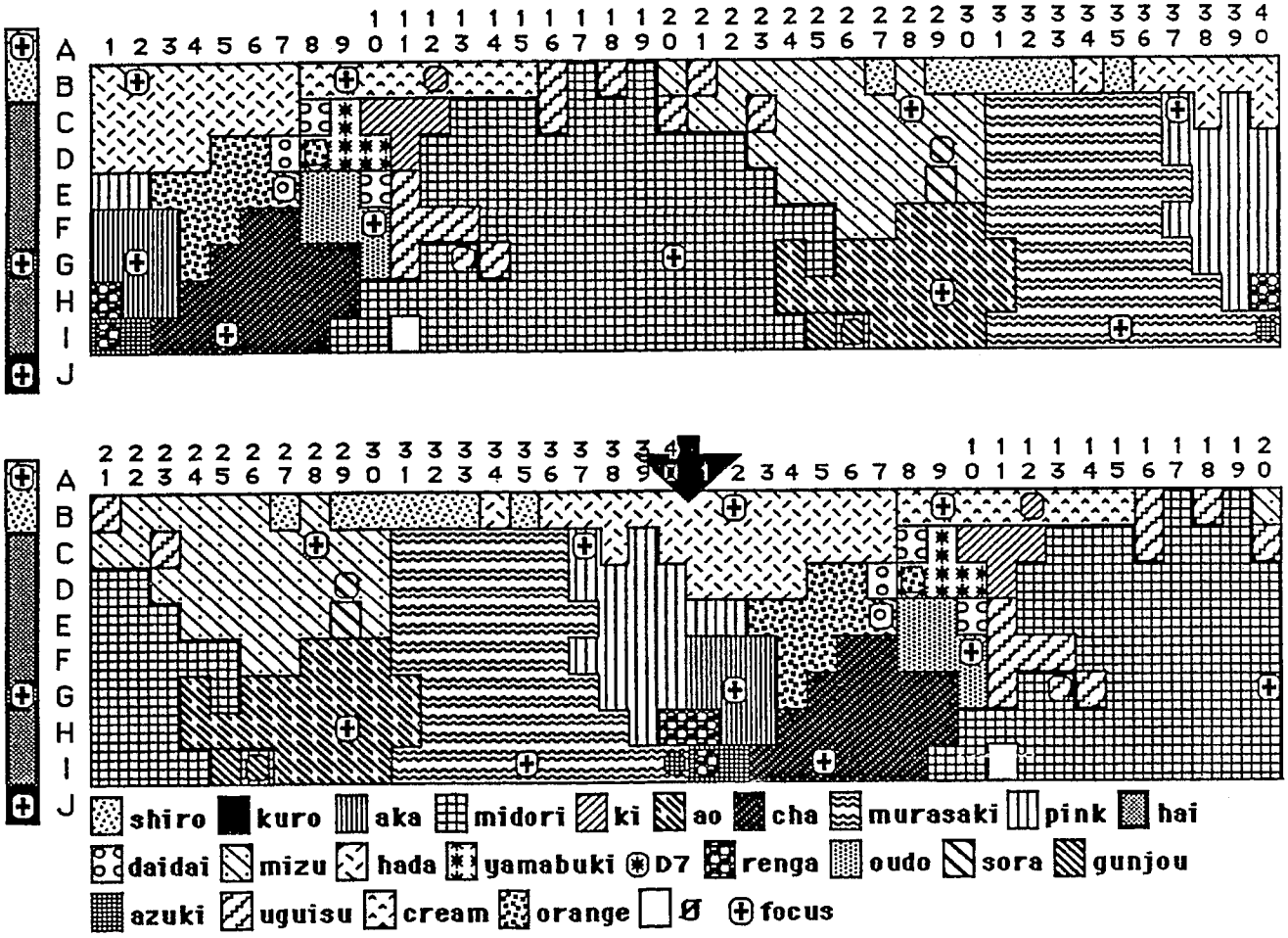
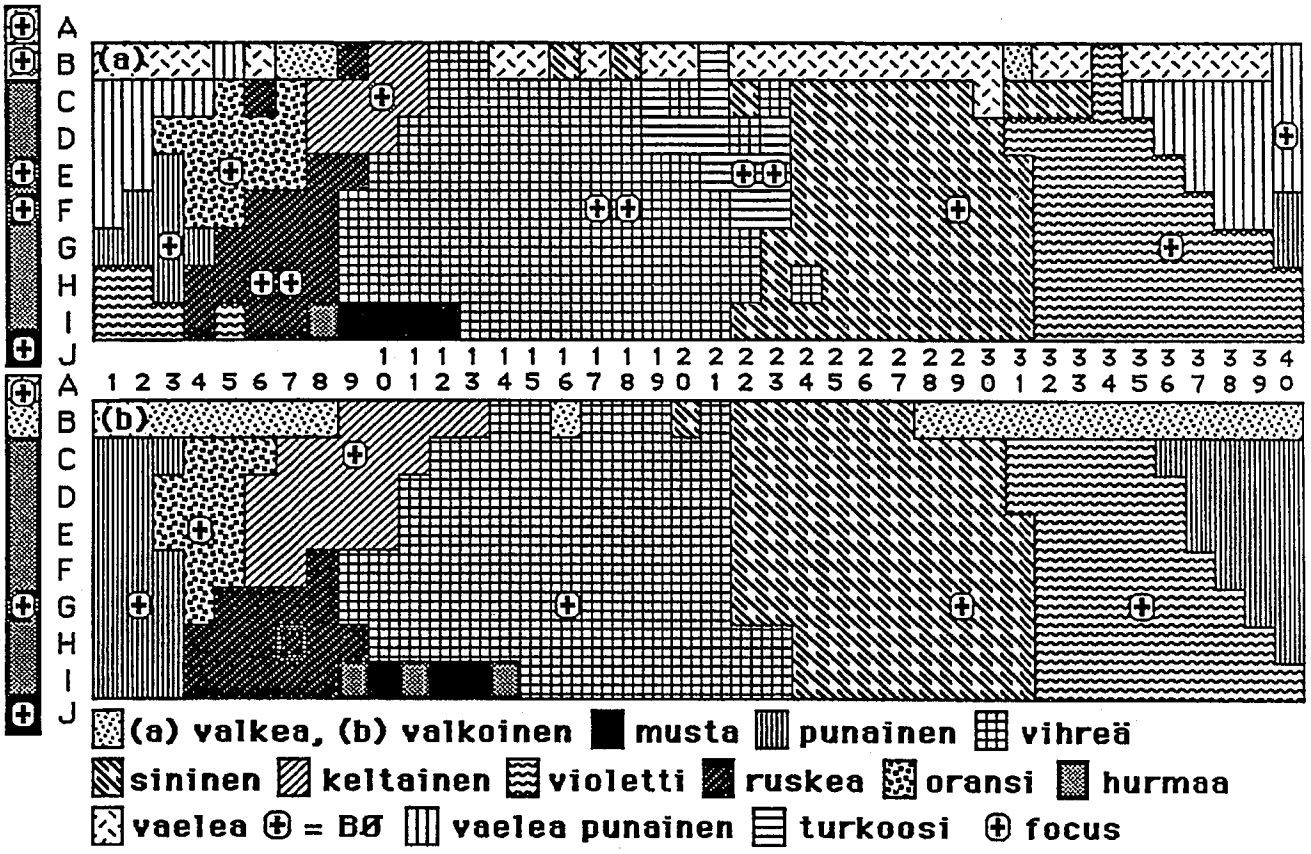


Fig. 3c. Reverse of Figure 3a.



Figs. 3d-e. Color term roots and foci, Japanese, Kanagawa-ken, woman, age 31, 1986.



Figs. 4a-b. Finnish; (a) Pori, Satakunta, man (artist/painter), age 28, 1977;
(b) Lapendranta, Kymenlaani, woman, age 28, 1977.

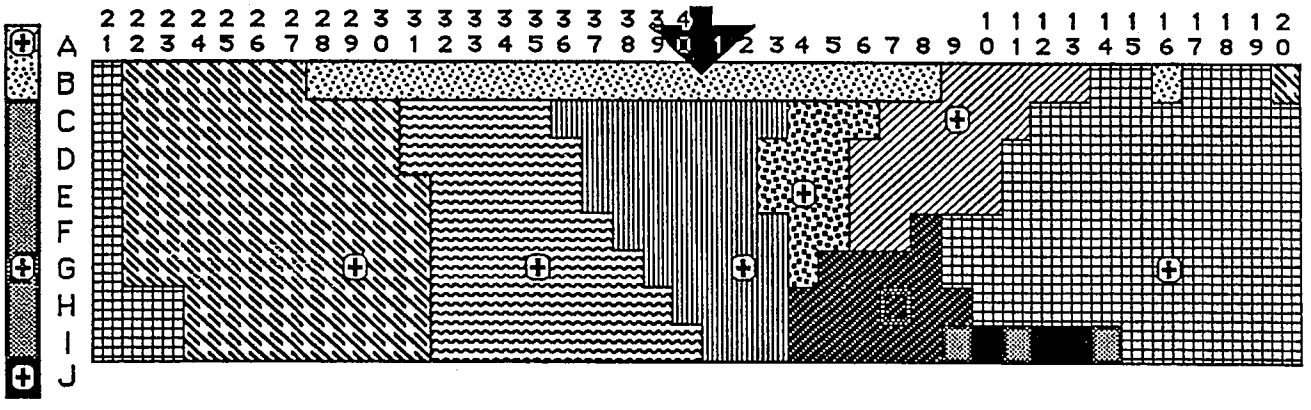


Fig. 4c. Reverse of Figure 4b.

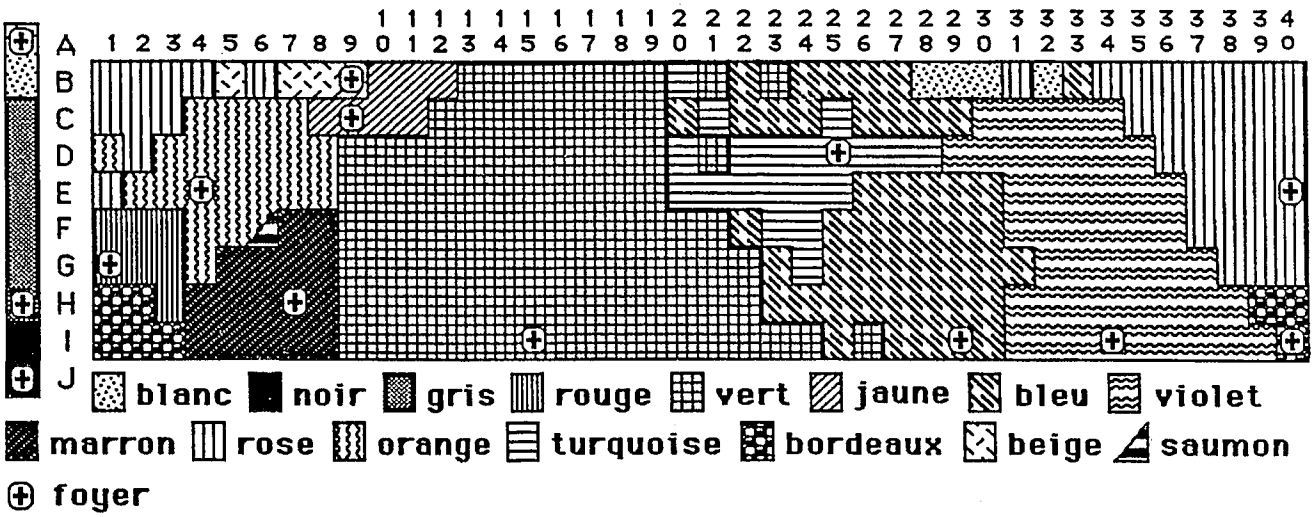


Fig. 5a. Termes de couleur, français, Paris, homme, 22 ans, 1986.

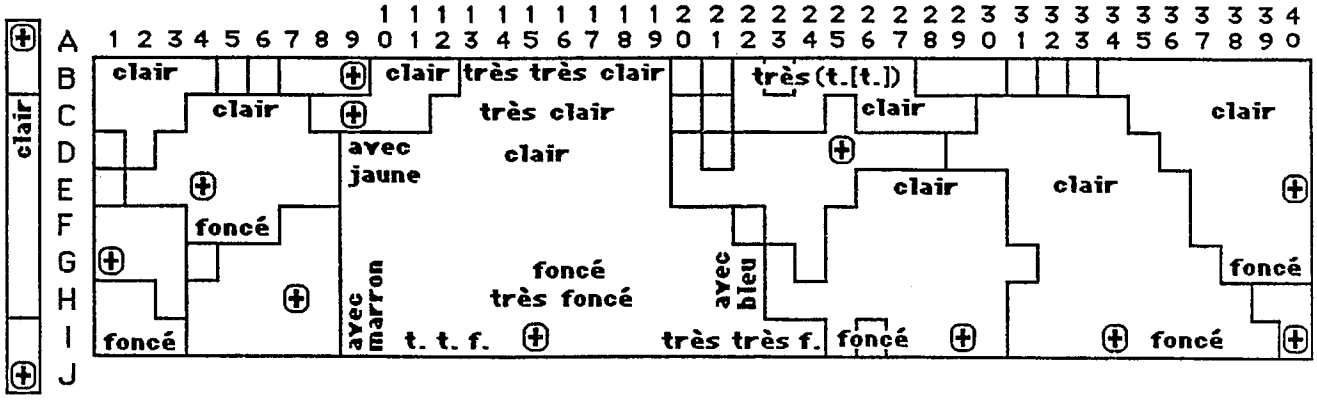


Fig. 5b. Adjectifes.

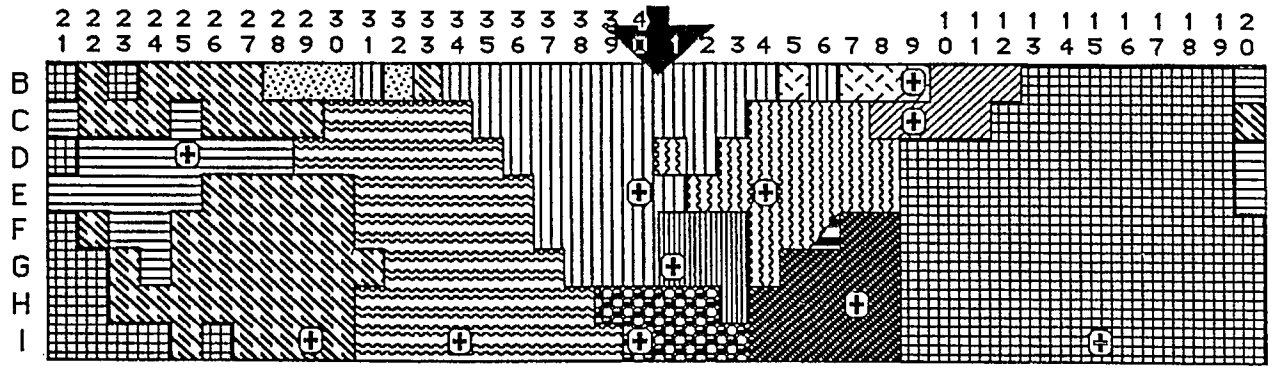


Fig. 5c. L'inverse de fig. 5b.

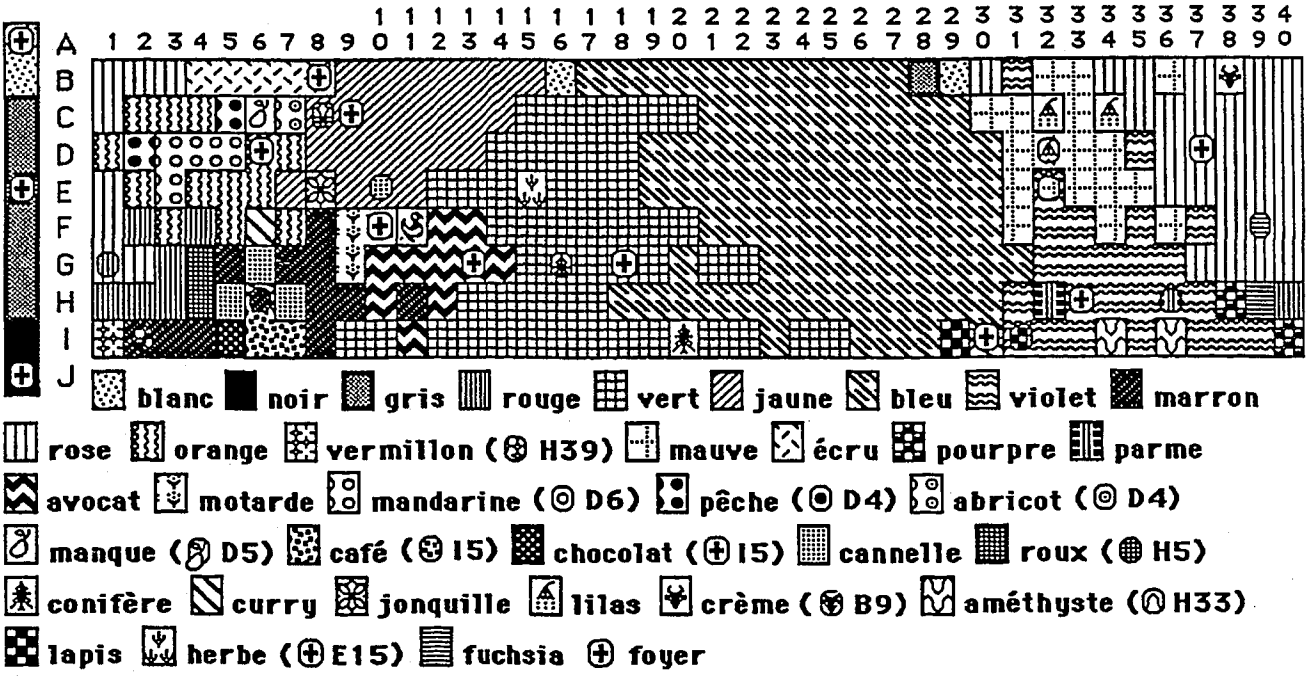
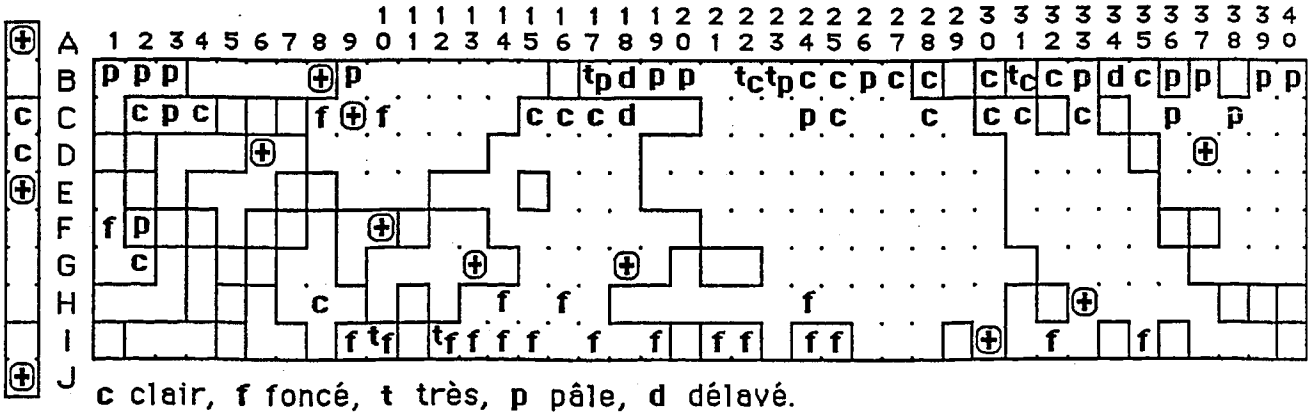
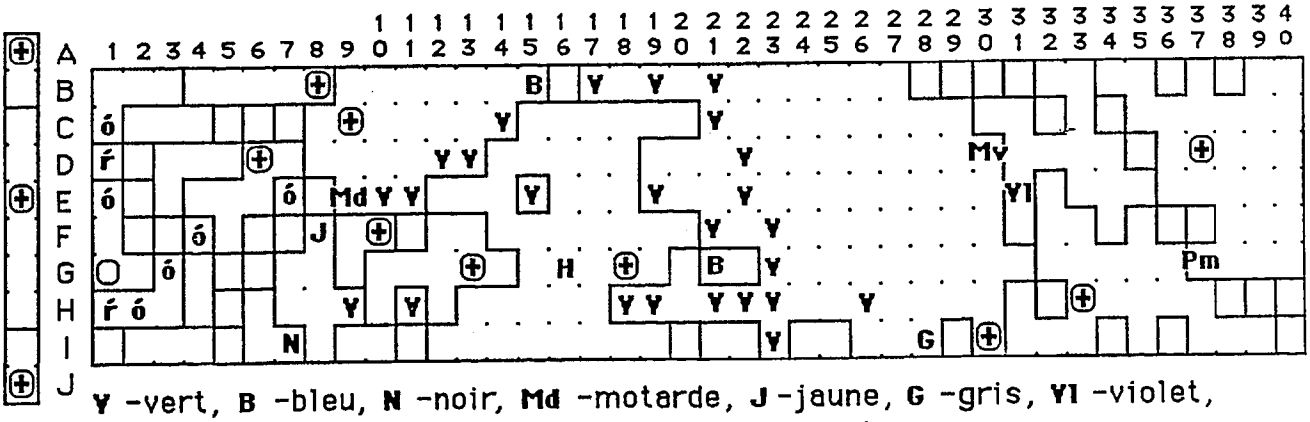


Fig. 6a. Termes de couleur français, La Rochelle, femme, 39 ans, 1986.



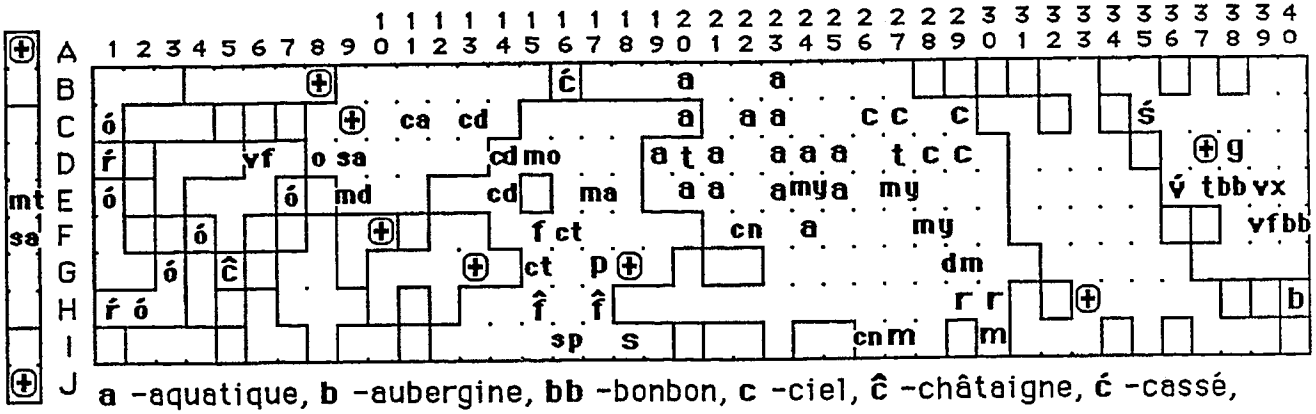
c clair, f foncé, t très, p pâle, d délavé.

Fig. 6b. Adjectifes.



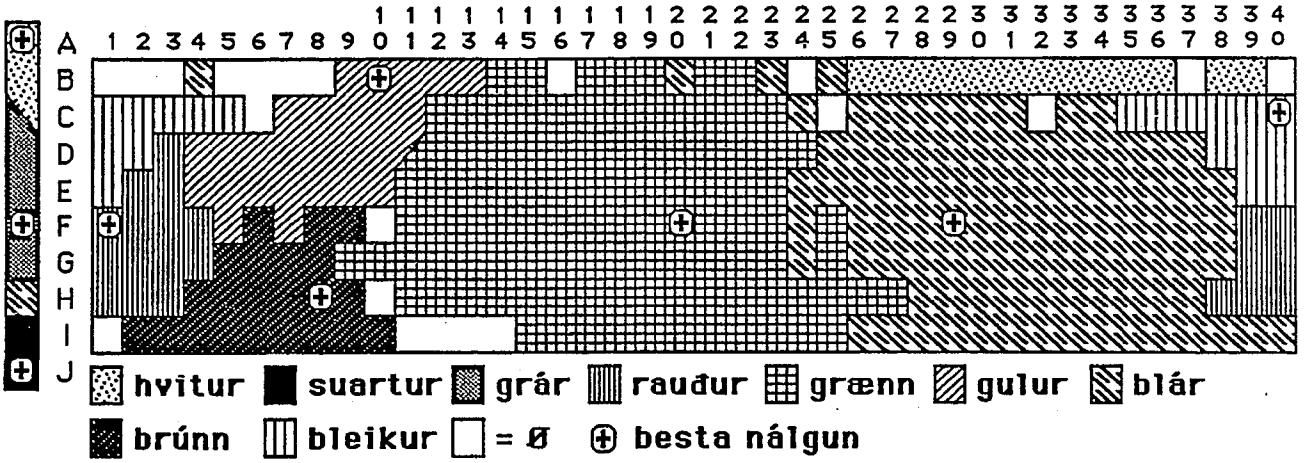
V -vert, **B** -bleu, **N** -noir, **Md** -motarde, **J** -jaune, **G** -gris, **Vl** -violet, **H** -herbe, **Pm** -parme, **Mv** -mauve, **ó** -orangé, **ŕ** -rosé.

Fig. 6c. Adjectifes.

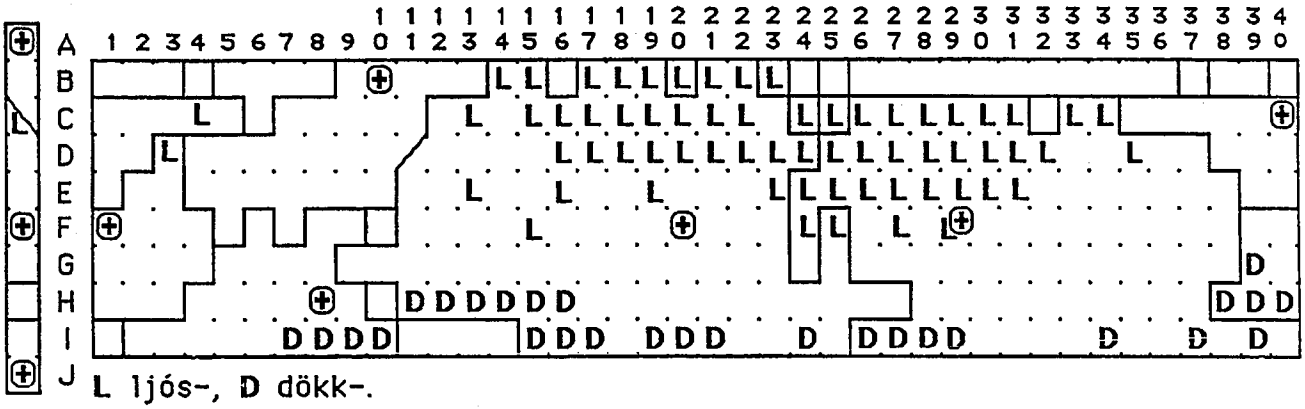


a -aquatique, **b** -aubergine, **bb** -bonbon, **c** -ciel, **ĉ** -châtaigne, **ć** -cassé, **ct** -criant, **cd** -criard, **cn** -canard, **ca** -canari, **dm** -de mer, **f** -fort, **f̂** -forêt, **g** -gamin, **m** -marine, **ma** -marin, **mo** -modern, **mt** -métal, **my** -moyen, **o** -ochre, **ó** -orangé, **r** -roi, **ŕ** -rosé, **s** -suisse, **ś** -sucré, **sa** -sale, **sp** -sapin, **t** -tendre, **v** -violacé, **vf** -vif, **vx** vieux-.

Fig. 6d. Adjectifes.

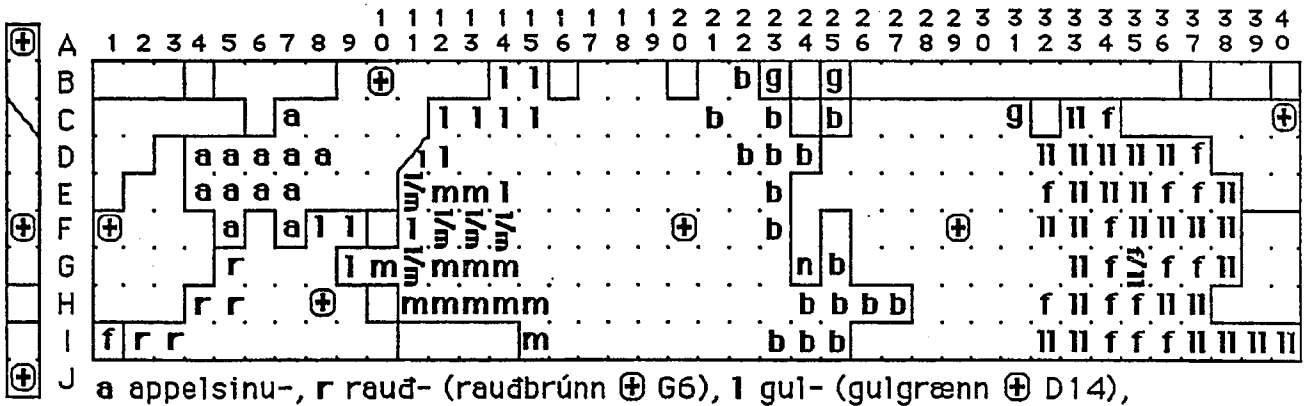


Mynd. 7a. Nafn litar, Islenska, Vestmannaeyjar, maður, aldur 30, 1986.



L ljós-, **D** dökk-.

Mynd. 7b. Lýsingarorð.



a appelsinu-, **r** rauð- (rauðbrúnn ⊕ G6), **l** gul- (gulgrænn ⊕ D14), **m** mosa- (mosagrænn ⊕ G12), **b** blá- (blágrænn ⊕ F23), **n** græn-, **g** grá-, **ll** lilla- (lillablár ⊕ F35), **f** fjólu-.

Mynd. 7c. Lýsingarorð.

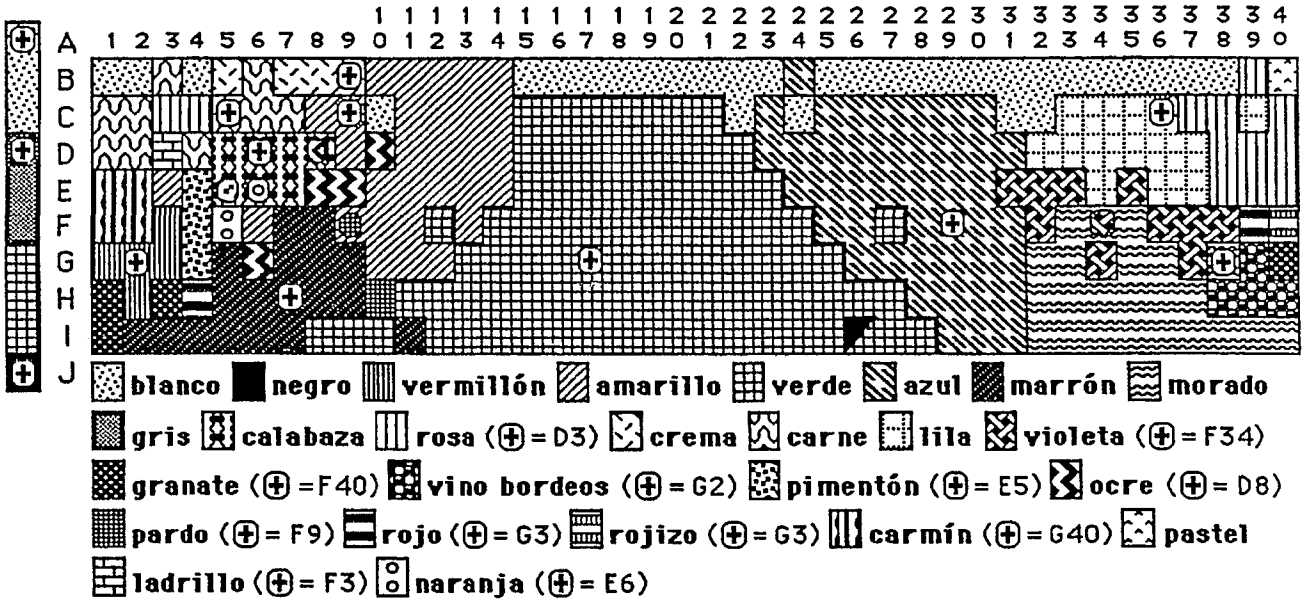


Fig. 8a. Téminos de color, Español, Madrid, hombre, edad 52, 1986.

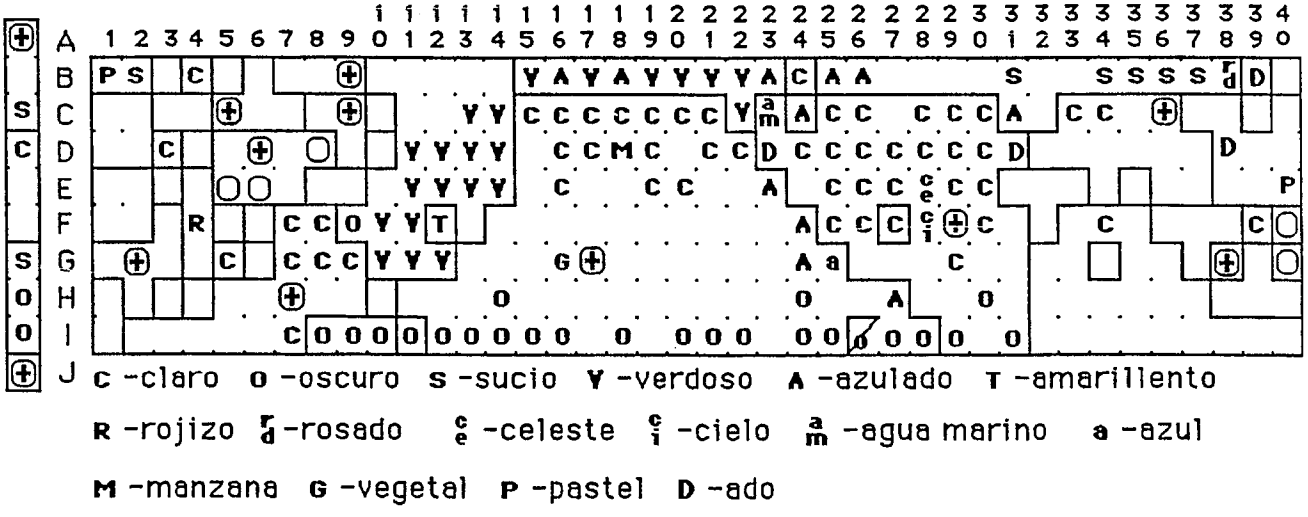
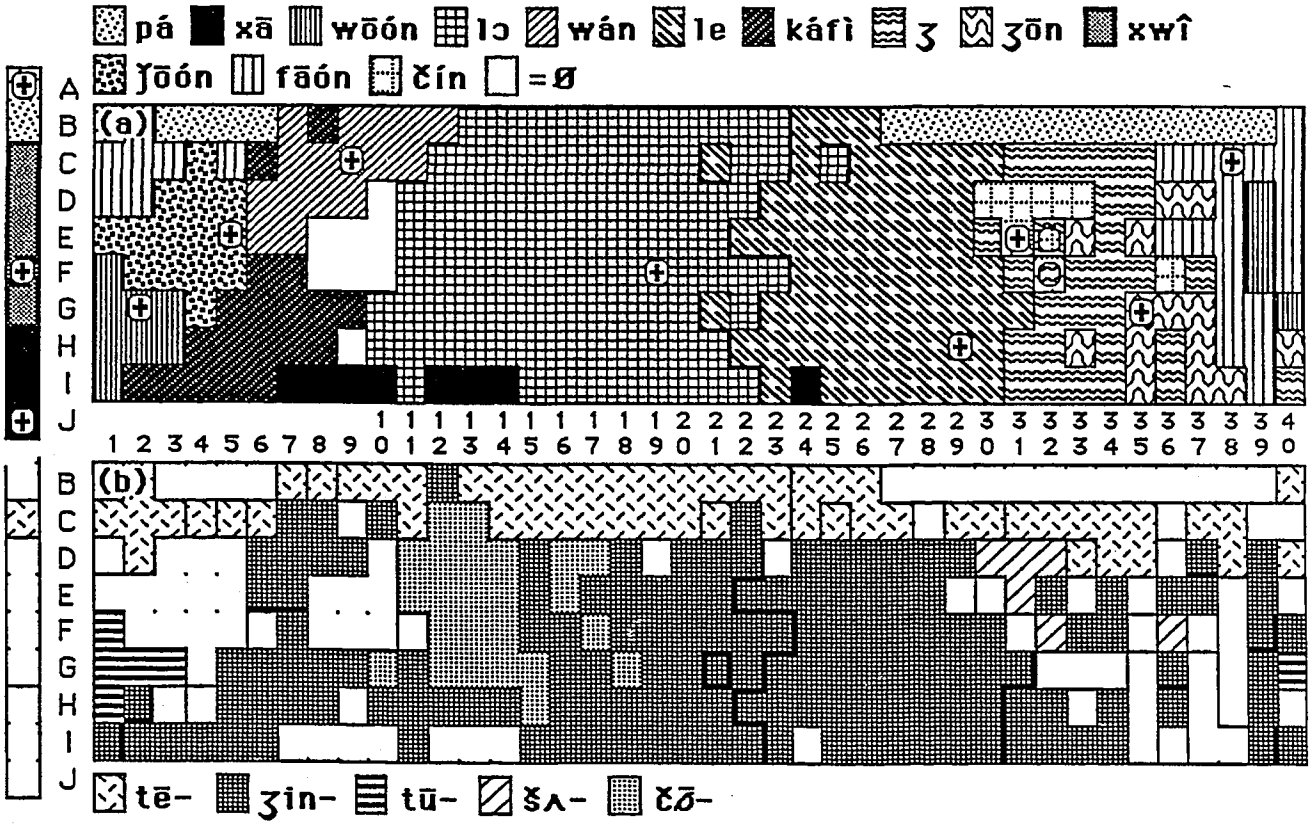


Fig. 8b. Modificadores de raises, véase Fig. 8a.



Figs. 9a-b. Shanghaiese, Center City Shanghai, China, woman, age 28, 1986; (a) roots and foci, (b) modifiers.

Appendix II

The intent here is to offer reconstructions of color categorization in ProtoMayan and ProtoOtomanguean, the two linguistic families most extensively covered by the preceding chapters. Like any reconstruction, the following is hypothetical and subject to revision. Probably, color categorization in the protolanguages varied among individuals, as it does in contemporary languages; and, probably, the range of variation in the protolanguages included a greater proportion of early-stage systems than is found today in the daughter languages. The semantic relationships among proto-color terms might have represented early phases along the continuum of near-synonymy, coextensivity, inclusion, and complementation. A reconstruction will allow a statement to the effect that a proto-system contained variants that had not evolved beyond a certain stage or type, although it might not specify the most conservative variant of the extinct system.[1]

The present effort will concentrate on the ranges of prehistoric categories and their relationships. It will be assumed that other investigators have accurately reconstructed lexical forms and some focal meanings. These include reconstructions of ProtoMayan (Kaufman 1964), ProtoMixtecan (Longacre 1957, 1962, 1967, 1968; Mak and Longacre 1960), ProtoPopolocan (Gudschinsky 1959; Fernandez de M. 1951), ProtoChiapanec-Mangue (Fernandez de M. and Weitlaner 1961), ProtoMazatec (Kirk 1966), Proto-

[1]Callaghan (1979) and Kristol (1980) suggest that a color-category system can regress or devolve, in Miwok and Italian dialects respectively; a composite color category can be reconstituted after all members of a community have divided it. Such seems unlikely since children learning to categorize color would have to innovate composite color categories in defiance of adult models when, usually, children strive to copy such models and adults encourage the copying. Callaghan advances her suggestion with commendable caution, and she notes that one of her Miwok glosses includes both black and blue. That gloss indicates that ProtoMiwok was probably at an earlier stage than the current Miwok systems. Kristol is less cautious. He notes that rural Italians name both green and blue *verde*; Classical Latin documents suggest *viridis* meant 'green'. But literate Latin speakers were not direct forebears of the latter-day peasants; the literati named blue, green, and black with single terms, not *viridis* (?) but *caeruleus* and *glaucus* (André 1949: 162-86).

Westscott (1975), Grieger (1880), and Moonwomon (1983) use ancient writings to infer semantic ranges of color categories, the former in ProtoIndoHittite and the latter two in Homeric Greek. The philological method enables typological reconstruction; for example, Moonwomon classifies Homeric Greek as Stage II. MacLaury (1975a-b), Branstetter (1977), Nichols (1980), and Kinkade (1986) employ various methods of reconstructing basic color terms and systems of categories from contemporary data.

Otopamean (Bartholomew 1965), ProtoChatino (Upson and Longacre 1965), ProtoChinantecan (Rensch 1978), and ProtoOtomanguean (Rensch 1976, 1977; Longacre 1964, 1967).

Each reconstruction will employ a different method. ProtoMayan color categorization is inferred from the broad, conservative ranges of color terms that were collected during the Mesoamerican Color Survey. ProtoOtomanguean color categorization also can be inferred from some rare broad ranges in contemporary data. But this reconstruction is mainly based on the diverse meanings of cognates that are related by rules of sound change to one or another ProtoOtomanguean root. It is assumed that an ancient root designated all of the current cognatic meanings; the cognates had become restricted to different portions of the original category as it divided within each daughter language.

1. ProtoMayan Color Categories

Kaufman (1982 [written personal communication]; cf. 1964: 108) reconstructs the names and focal meanings of five ProtoMayan color categories: **saq* 'white', **q'eq* and **ʔilehq'* 'black', **kaq* 'red', **q'an* 'yellow', **raʔš* 'green/blue'.[2] The MCS data

[2]Witkowski and Brown (1981) contest Kaufman's five-term reconstruction, asserting that "ProtoMayan had at least three basic color terms, 'black', 'white', and 'red',.... After ProtoMayan times 'yellow' and 'green' [*cool*] were added and diffused through the entire family (18)." "Color term diversity... within Polynesian is striking compared to...Mayan. ...both groups started from a similar "black," "white," "red" baseline 3,000-4,000 years ago. When Mayan color terminologies changed, because of intense linguistic and cultural interaction...they all tended to change in similar ways" (22). [Italicized word added.]

Their arguments concerning the cool category are: The Mamean reflexes of **raʔš* 'green-with-blue ("grue")' are irregular. Therefore "...*čaʔṣ*, denotes 'grue' and is probably a loan since it shows irregular correspondences" (23). But Kaufman (1982) writes "*čaʔṣ* in Mamean is cognate; it may be irregular, but the *environment* for **r → č*, namely *#__Vʔš*, does not apparently recur, so the change may be regular" [Italics Kaufman's]. Therefore, there is no conclusive evidence that the Mamean reflex of ProtoMayan **raʔš* is irregular.

Even if it could be demonstrated that the Mamean 'green-with-blue' reflex is irregular, this would not prove the reflex to be a loan. Moreover, if the reflex could be proven to be a loan, that still would not prove that a prehistoric Mamean 'green-with-blue' category was not named by another Mamean word -- such as the proto-form of Ixil *taṣ* 'unripe' -- which the loan replaced in reference to color. W&B's claim is unsound on three successive levels of argumentation and is, therefore, unconvincing. (Continued next page.)

suggest that these terms named the categories of a proto-system that had not evolved beyond Berlin and Kay's Stage II. The black-focused and cool-focused terms both named the dark-cool category, each from a different vantage. The terms bore either a coextensive or a nearly synonymous relationship. The red-focused and yellow-focused terms both named the warm category, each from a different vantage. They also bore either a coextensive or nearly synonymous relationship. The preponderance of data show that the white-focused term named pure white and light colors, although negligible evidence hints that its range also might have encompassed pure yellow and pure red.

The supporting data are: (1) *coextensive black-focused and cool-focused 'dark-cool' terms:* Tancaná Mam, Figure 7.26; (2) *black-focused dark-cool category:* Tenejapa Tzeltal,

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(Continued from preceding page) Oddly, W&B do not apply the same arguments to irregular 'black' reflexes. Kaufman (1982), next to his basic reconstruction of ProtoMayan 'black' as *q'eq, reconstructs "(*ʔi/ehq' in lowland area.)." Referring to the latter, he continues, "This maybe irregular or mangled." Had W&B applied their reasoning concerning irregular forms and loans consistently to all data, then -- while maintaining that čaʔṣ is irregular -- they would have had to reconstruct a ProtoMayan system in which half of all color percepts were unnamed, that is, both 'black' and 'green-with-blue' -- all of the dark-cool colors.

W&B's arguments concerning 'yellow' are: "The Central Mayan branch innovated the yellow meaning and added it to a term that originally meant 'ripe, cooked'. This term with its new meaning diffused therefrom to Huastecan, North Mayan, and South Mayan languages" (18). They associate Kaufman's ProtoMayan *ṯaq'-aʔŋ 'ripe' with Kaufman's *q'an 'yellow' by gratuitously reanalyzing 'ripe' as "*ta-q'aʔn" (23, Note 5). In this immediate context (23, Note 5), they incorrectly render the reconstruction of 'yellow' with a glottalized vowel, as "*q'aʔn," to make it appear identical to the last segment of their reanalysis. They support the reanalysis with words from Zoquean, such as kɬŋ- 'ripe, cooked', which they speculate to be loans from Mayan. They designate Central Mayan to be the innovator of their post-ProtoMayan 'yellow', because archaeological evidence suggests that the Central Mayan were first to develop Classic Mayan civilization.

Kaufman (1982) writes "*taq' means both 'cook' and 'ripen'...*ṯaq'-aʔŋ is 'ripe'. There is no relation between *q'an 'yellow' and *ṯaq'-aʔŋ 'ripe'." W&B have fabricated a linguistically unsupportable argument and have attempted to buttress it with a claim based on an assumption about color-term evolution and cultural complexity. This assumption (cf. section 2.1.3.) is the least developed and most problematical of Berlin and Kay's hypotheses (cf. section 1.7.1.1.). Even if W&B's linguistic re-segmentation were, somehow, remotely plausible -- and even if its resemblance to the 'yellow' proto-form were genuine -- the assumption concerning cultural complexity is wholly unreliable as a methodological construct on which to base claims regarding prehistoric languages. W&B's assertions concerning 'yellow' are unsound on three successive levels of argumentation and are, therefore, as void as their claims concerning 'green-with-blue'.

Figures 4.1a-4c and 8.2a-c; Tzotzil, Figures 4.8-11a and 7.29c-d, three others, no figures; Aguacatec, Figure 7.28b; Tectitlán Mam, Figure 9.3a-d; Amatenango Tzeltal, two individuals, no figures; Lacandón, two individuals, no figures; (3) *cool-focused dark-cool category:* Lanquín K'ekchí, Figures 7.20; Uspantec, Figures 7.27a-d, five others, no figures; Aguacatec, Figure 7.28a; San Sabastián Chuj, Figures 7.29a-b; (4) *nearly synonymous red-focused and yellow-focused 'warm' terms:* Tenejapa Tzeltal, Figures 6.12a-c; (5) *coextensive red-focused and yellow-focused 'warm' terms:* Tenejapa Tzeltal, Figures 5.1a-c, 6.1a-4c, 6.11a-c, and 6.13a-c; Tzotzil, Figures 6.5a-f, 6.15a-16c, and 6.20a-c; Aguacatec, Figures 5.2, 5.4a-d, 6.14a-b, 6.22a-c, and 6.17a-c; Uspantec, Figures 6.6a-7c; Amatenango Tzeltal, Figures 6.8a-10c; Tacaná Mam, Figure 6.17c; Jacaltec, Figures 7.9a-c; (6) *yellow-focused warm category:* Tenejapa Tzeltal, Figures 7.1a-c; Acatec, Figure 7.2a-c; Sipacapa Quiché, Figure 7.3; Aguacatec, Figures 7.4a-c; Huehuetlán Huastec, Figures 7.5a-c; (7) *red-focused warm category:* Jacaltec, Figures 7.10a-c; Tectitlán Mam, Figures 7.15a-c; San Sabastián Chuj, Figures 7.16a-c; Lanquín K'ekchí, Figures 7.20a-b; (8) *white-focused putative light-warm category:* Tenejapa Tzeltal, Figures 7.35a-c.

The reconstruction is based on the assumption that the foregoing data descend ultimately from ProtoMayan and do not represent a reconstitution of composite color categories (cf. footnote 1). Mirror-image relationships of inclusion (2-3, 6-7) suggest earlier coextensivity, presently seen in (1, 5). The data of (4) sparsely suggest near-synonymy in the ProtoMayan warm category, and that of (8) is all that hint of a ProtoMayan light-warm versus dark-cool, Stage I. In general, the data collectively indicate that ProtoMayan color categorization and semantics evolved to contemporary forms through the same process that Hage and Hawkes (1975; see footnote 5, Chapter V) report in Binumarien of New Guinea.

Speakers of many (if not all) Mesoamerican languages, including Mayan languages, associated colors with directions and a center, for example, Up=black, Down=white, Center=green-with-blue, East=red, South=yellow, West=white, North=black (Dixon

1899; Waterman 1908; La Farge and Byers 1931; Tozzer 1941; O'Neal and Dolores 1943: 391; Martí 1960; H. Berlin and Kelly 1961; Riley 1963; Collier 1966; Nowotny 1969; Marcus 1973). Apparently, the ancient Mayan used the foci of color categories to symbolize direction; the broad ranges and coextensive relationships of color terms did not hinder the symbolism. The unconfused practice implies that, in those times, speakers of Mayan languages consistently focused color categories in reference to particular pure colors. Such consistency characterizes coextensivity and late phases of near-synonymy, but not early phases of near-synonymy. Early near-synonyms can be focused on levels of brightness; later each can be re-focused arbitrarily in reference to **any** pure color. In this regard, the ancient Mayan differ from speakers of ProtoOtomanguean; some cognates in Otomanguean daughter languages name distinct pure colors and no color in common, whereas cognatic color-terms of any set among Mayan daughter languages name at least one pure color in common. ProtoOtomanguean is more likely than ProtoMayan to have named color categories with near-synonyms, because ProtoOtomanguean occupied an earlier horizon of Mesoamerican culture; near-synonymy is the earliest semantic type.

Some widely shared idiomatic uses of Mayan color names imply that broader meanings were formerly the rule. H. MacAurther (personal communication) notes that Aguacatec speakers describe a green, thriving cornfield as *q'eq* 'black'. S. and M. McMillen (personal communication) report that Uspantec speakers refer to moist, black soil as *reš*, 'green-with-blue'. T. Godfrey (personal communication) writes of Tancaná Mam that "*saq* can mean either 'white', or 'clear', or 'clean'; *čaʔṣ* can mean either 'green,' 'raw' ('uncooked'), 'unripe', or in the phrase *čaʔṣ č'oč* 'wet (ground, earth)'; *q'an* can mean either 'yellow' or 'ripe'; *kʸaq* can mean either 'red', 'hot', or 'fever'." In Uspantec, Aguacatec, and Tzeltal, some individuals adamantly insisted on beginning the mapping elicitation with 'white' and otherwise would not start. Perhaps they associated white with Down, bottom-most, and, therefore, first. Some rotated the Munsell array so that white was on the bottom and closest to them.

2. ProtoOtomanguean Color Categories

The method of reconstructing ProtoOtomanguean color categories exploits disparities among meanings of apparent cognates; related words from distinct branches of the family name different pure colors, for example, Trique *ga*^{3}*¢i*^{54} 'white', Zapotec *ga¢e* 'yellow', and Chocho *ga¢e* 'red'. It is unlikely that such cognates owe their semantic disparity to shifts in meaning from one pure color to another that occurred on later horizons. Rather, it is assumed that the ProtoOtomanguean root named all of the current meanings; its original range was retracted to a different pure color in each branch language.

This method is subject to one exception: A purple term that is cognatic with 'warm' terms can be extended to blue. Even recent loan words are extended from purple to blue, and the process is common. Thus, some members of a cognate set can designate red and/or yellow while others designate purple and blue, although a category that contained warm colors and blue is most unlikely. Such 'blue' meanings, which occur only in cognates from Trique, are interpreted as a recent purple-to-blue extension.

Tables II.1-7 and Rensch's set 235 display eight reconstructions, at least six of which surely designated a ProtoOtomanguean color category. Although the proto-system probably was at Berlin and Kay's Stage I, it was lexically complex. The same complexity characterizes the known contemporary Stage I systems (cf. section 10.8, item 9.). Color categorization evolved from ProtoOtomanguean to its modern forms in daughter languages by rearragement of relationships between categories and between words and by replacement of some old words with new ones, but there was little or no increase in lexical complexity. Some languages might have lost a term or two; for example, each Zapotec language appears to have discarded one or another of at least three terms for grades of white and yellow, probably as nearly synonymous naming of brightness levels yielded to focusing each term in reference to either pure white or pure yellow.

In the tables and sets, reconstructions follow Rensch's (1976) rules of regular sound change. In each table, the rules are numbered, described, and referenced to pages

of that source. Rensch's rules are provisional, and they might be reworked (cf. Kaufman n.d.). Presently, however, Rensch provides the only source of sufficient detail to reconstruct hypothetical relationships between apparent color-term cognates throughout the Otomanguean family. When the rules are revised, the etymologies will be adjusted.

Although Rensch's rules are obeyed throughout the tables, the present cognate sets differ from those that Rensch assembled. The differences are of five origins: (1) Rensch's sets were assembled in the theoretical vacuum that predated Berlin and Kay's (1969) publication. It was not evident to Otomangueanists that diverse meanings, such as white, yellow, and red, or as black, green, and blue, could be cognatic. *The departure of the present sets demonstrates the benefit of universalist semantic theory to historical linguistics, particularly to its obligatory concern with specific semantic domains.* (2) In some etymologies, alternative pathways of sound change are used to relate cognates, which leads to resorting Rensch's sets. (3) Rensch reconstructs only the stressed ultimate syllable of ProtoOtomanguean. Yet a few of his sets pertain to other syllables. Such syllables are not reconstructed. (4) Some of Rensch's rules are weakly supported, and his rules do not address specific combinations of contemporary sounds. These cases allow room for fresh interpretation, which, nevertheless, is consistent with what has widely occurred in Otomanguean languages. (5) Data not used by Rensch, many of them newly collected, are related by his rules to ProtoOtomanguean.

The ProtoOtomanguean ultimate stressed syllable is of a CV canon that can further include a preposed nasal (n), a preposed palatalizing element (Y) whose exact phonetics are unknown, two preposed laryngeals (ʔ and h, together H), a postposed nasal (n), and two postposed laryngeals (ʔ and h, together H). In ProtoOtomanguean, the preposing and postposing of these elements must have been optional or, at least, moveable, because different combinations of the elements with one or another CV root constitute most protoforms of color terms in Otomanguean branch languages. Rensch attributes consonantal alternations to ProtoOtomanguean, such as *k/kʷ/y or t/s/y*. These are

peripheral to the present reconstructions, although not excluded completely. Unfortunately, the more interchangeable elements that are admitted to a protolanguage, the greater will be the resources for arguing false relationships.[3]

2.a. Light-Warm

Table II.1 displays the argument than speakers of a language that was ancestral to, at least, Zapotecan, Mixtecan, and Popolocan named a light-warm category. It also shows that the light-warm category was maintained in ProtoZapotecan, and considerable lexical complexity followed suit through elaboration of penultimate syllables.

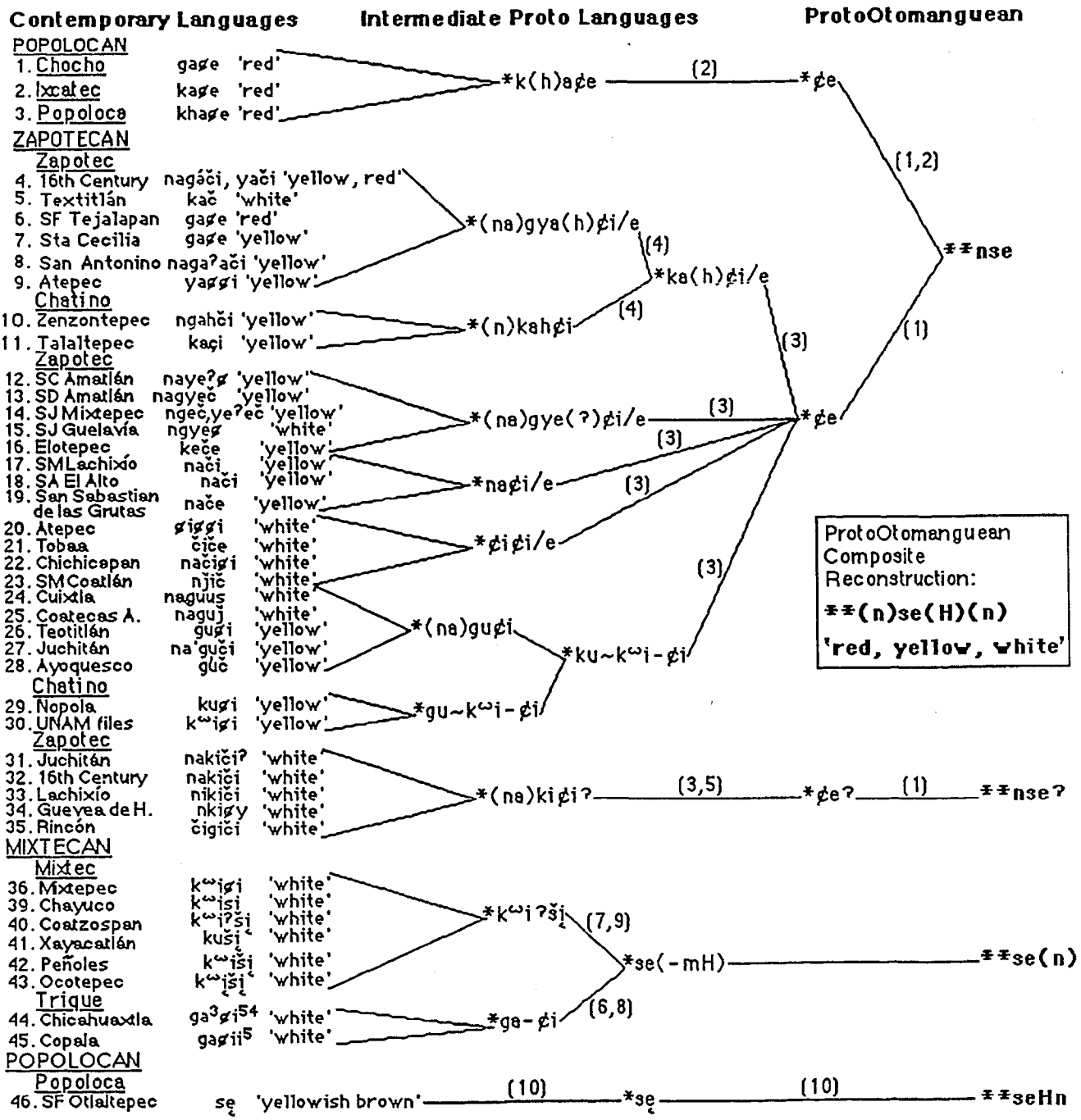
Two pre-Zapotecan forms, ***nse* and ***nseʔ*, might be collapsed to one form: Juchitán (31) *nikičiʔ* 'white' is the only glottalized variant in support of ***nseʔ*, although the Juchitán dialect is phonologically conservative. Conversely, San Pedro Cajonos Zapotec *-gašeʔ* 'yellow' (not in table) is glottalized, suggesting that ***nseʔ* was the only pre-Zapotecan protoform.

The Popolocan protoform **k(h)aȼe* (Fernandez de M. 1951: set 56) contains an irregular correspondence, which appears to descend from a transposition of the laryngeal in Rensch's reconstructed ***ka̰h-*, the "color formative" (see Rensch's set 121). The velar of this penultimate syllable descends as lenis **gy* in Zapotec, yielding both *g-* and *y-* variants. (A *g/y* alternation that originates from ***k-* is common throughout Zapotec languages, e.g., Mitleño *geuʔ/yeuʔ* 'river', *geblu/yeblu* 'respectful address' [data from M. Stubblefield].)

Juan de Córdova (1942) is the source of sixteenth-century Valley Zapotec (cf. Rendón 1969), in which glosses substantiate that *"nagàche"* named the warm category: *"Color amarillo nagàche, yàche"* (p. 80). *"Roxo vide vermejo Nagáche,"* (368)...*"Rubi piedra preciosa Quiequeza naxiñàa nachóno, 1. nagàche,"* (368)...*"Ruano cauallo de color*

[3]Otomanguean lexical data comes from numerous sources apart from the Mesoamerican and World Color Surveys. These include the historical linguistic works that are cited above, private card files of members of the Summer Institute of Linguistics of Mexico, and others (e.g., Belmar 1901; Juan de Córdova 1942; Pickett 1967; Robinson 1963; Williams and Pierson 1950; Barrera and Dakin 1978). Juan José Rendón of Instituto de Investigaciones Antropológicas, UNAM, provided the "Swadesh" 100-word lists of that institution from 50 Zapotecan languages, few of which are published (Rendón 1971; Suárez 1972).

Table II.1: Light-Warm



Rules: (1) *ns → *ɕ (PPn, Zpn, Rensch 1976: 90, 156); (2) **e → *e (PPn, 91); (3) **e → *i/(*e) (Zpn, 157); (4) *ɕ → ɕ/č (Zpn, 159, 161); (5) **CV? → CV? (Zpn, 160); (6) **e → *i (MXTn, 63); (7) *-emH → į́ (Mxt, 60-1, 71); (8) *s → ɕ (Trique, 81), (9) *s → š/_i (Mxt, 67); (10) **-eHn → *ę́ → ę́ (PPn, 91).

ruano y color asi vide leonado en ly color" (368)... *"Leonado color, vide color naàche natep, naxiñaa nateo"* (242)... *"Color de encarnado Naxiñayy"* (80).

The Zapotec languages depart from Rensch's rule ***ns* → *č* as ***ns* → *č/¢*. Rensch's rule of ***e, i* → **i* appears to be inconsistently realized among Zapotec languages, or recently descendant forms of **i* reverted to *-e* in some languages.

In MCS data, Otlaltepec Popoloca *¢eʔndaʔ* 'purple' might reflect a glottalized pre-Popolocan form, [?] ***nseʔ*, but in the penultimate syllable.

In ProtoMixtecan, Longacre's controversial *θ is replaced with **s* in agreement with suggestions from Arana Osnaya (1959) and Manrique (1977). The Mixtecan postposed element, **-mH*, is parenthesized in the table for its apparent instability; Trique $ga^{3}¢i^{54}$ and $ga¢ii^{5}$ 'white' show absence of vowel nasalization (as do the Popolocan terms of Table II.3).[4]

The derivation of Popolocan *sẹ* 'yellowish brown' (<--***seHn*) conforms to Rensch's rules. But it is suspicious, because it looks like other forms with an identical

[4]A set of words within a semantic domain can show uniform phonological characteristics, which might eradicate results of regular change. For example, in Tepetotutla Chinantec (cf. Figure 8.9a) and in Atatlahuca and Ocotepec Mixtec all of the oldest color words share a tone combination, or in Copala Trique color words end in either a long vowel or *-h*. Mixtec color cognates are:

	white	black	red	yellow	green	blue
Atatlahuca	kʷīšį́	hnūų́	kʷēʔé	kʷāą́	kʷīí	ndēé
Xayacatlán	kūšį́	tʔnNūų́	kʷāʔá	kʷāą́	kʷīí	ndyāā
Coatzospan	kʷīʔšį́	ndēe	kʷēʔe	kʷāa	kʷii	kʷii
Ocotepec	kʷīšį́	tūų́	kʷāʔá	kʷāą́	kʷīí ndēé	ndēé kʷīí
Diuxí	kʷìšį́	tNùú	kʷèʔé	kʷàą́	kʷìí	ɨndèê
Peñoles	kʷì šį́	túų́	tɨ́kʷèʔé	kʷàą́	kʷìi	kʷìi
Yosundua	kʷɨyɨ	hnuu	kʷaʔa	kʷaa	kʷii	nčaa
Ayutla	$ya^{3}a^{3}$	$tu^{3}u^{?1}$ $ndyà^{1}a^{?1}$	$kʷa^{1?}a^{1}$	$kʷą^{1}ą^{1}$	$kʷi^{1}i^{?3}$	$ndi^{3?}e^{?1}$
Chayuco	kʷìsí	tǫ́ǫ́	kʷāʔá	kʷą́ą́	kʷíí	ndyāá
Mixtepec	kʷiøi yaa	nčaʔi	kʷaʔa	kʷaa	kʷii	nčaa

meaning: Tepetotutla Chinantec *si*$^{?2}$ 'yellowish brown' (MCS, D. West) and Xochistlahuaca Amuzgo *si*$^{?}$ 'yellowish brown' (WCS, A. Bauernschmidt). Both conform to other rules and must descend from ***nsi*$^{?}$. The latter protoform would also produce the ultimate syllable of Amuzgo *kančï* 'white' and of Otomian *t'aši* 'white'. All four forms are other than Zapotecan-Mixtecan-Popolocan, which some have called the "Oaxacan branch of Otomanguean (cf. Manrique 1977)." Reconstruction of ***nsi* rather than ***nse* would exclude from cognation Popolocan forms 1-3 of Table II.1. Rensch reconstructs ***(n)si*$^{1/2}$ from his set 245:[5]

245 **(n)si$^{1/2}$

Pmn 23 *θi-ʔmim^{32}: M-SM,M-SE,M-J,M-M šu̱^{3}ʔu̱^{1} money, bit, M-SM,M-SE,M-M šu̱^{1}ʔu̱^{1} bright, shining;
T zą̈^{3}ʔą̈hą̈^{43} money, zą̈hą̈^{3} bit, zi^{3}-mi^{21}(čuh^{3}) yolk (of an egg), mi^{12} copper-colored, yellow ← **si

If the distribution of the tones of the PMn form was *θi^{3}-ʔmim^{2}, the POM tone may have been **^{2} rather than **^{1}.

PPn 242 *si^{3}-/sa-ne: I sa^{3}ne, P si^{3}ne^{3}, C sine;
PMaz *si^{3}ne^{2}: H si^{3}ne^{2}, SJ sine, Mz sini, S si^{3}ne^{1} yellow ← **si$^{1/2}$

A ka^{3}nčiʔ^{21} white ← **Ynsiʔ$^{1/2}$

PCM 55 *na-ⁿdi-ku-me yellow

PCM 255 *na-ⁿdi-li-me white ← **nsi

PCh 28 *ka·či: Y kutsi, T -kacį, Z -kači yellow;
IZ naguči yellow ← **nsi

Rensch's set 245 is rejected in the present analysis because (1) it involves diverse non-color glosses such as 'money' and 'yolk' (PMn), (2) it includes penultimate rather than ultimate syllables, as in PPn and PMaz (cf. Rensch's set 349, in which the same

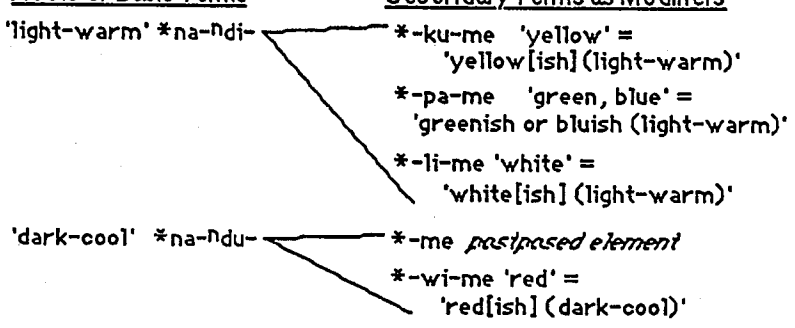
[5]See Rensch (1976: 184-5) for his abbreviations, most important of which are POM = ProtoOtomanguean, PMn = ProtoMixtecan, PPn = ProtoPopolocan, A = Amuzgo, POP = ProtoOtopamean, PZn = ProtoZapotecan, PCh = ProtoChatino, IZ = Isthmus Zapotec, PCn = ProtoChinantecan. Others represent particular languages and dialects.

cognates are used to reconstruct the ultimate syllable), and (3) it cites only Zapotecan forms that end in *-i* and none of those that end in *-e* (e.g., Table II.1, items 7, 19, and 21).

Nothing precludes that a POM form ***(Y)nsi(?)* 'light-warm' was replaced in Zapotecan-Mixtecan-Popolocan by ***(n)se(H)(n)* 'light-warm'.

Reconstruction of 'light-warm' is supported by the contemporary putative light-warm categories of Mazatec in Figure 6.18 and Mixtec in Figures 7.33a-b. The possible light-warm term of the contemporary Mazatec data, $t^{y}a^{3}wa^{3}$, is derived in Table II.7 (item 22). The various meanings of Zapotecan cognates 4-35 of Table II.1 imply that five words designated gradations of brightness in the ProtoZapotecan light-warm category.[6]

[6]Rensch cites Fernandez de Miranda and Weitlaner's (1961) ProtoChiapanecMangue reconstructions of color terms as **na-^{n}du-me* 'black, blue' (Rensch's set 94),**na-^{n}di-pa-me*, **ya-pa-me* 'green, blue, raw' (174), **^{n}di-/na-ku-me* 'yellow' (121), **are-^{m}bu-me* 'red' (81), **na-^{n}du-wi-me* 'red' (371), **na-^{n}di-ku-me* 'yellow', and **na-^{n}di-li-me* 'white' (245). The terms suggest a recently extinct Stage-I system of **^{n}di* 'light-warm' and **^{n}du* 'dark-cool'. The two roots appear to have been modified by secondary designations of specific pure colors: **-pa-me* 'green, blue', **-ku-me* 'yellow', **-li-me* 'white', **-wi-me* 'red'. Some secondary hue terms occurred in unbound form, for example, **ari-mbu-me* 'red' and **ya-pa-me* 'green'. Other reconstructions and current words from F&W, not used by Rensch, suggest further unbound forms: **^{m}bu-tipa* 'green, blue' (F&W set 4, p.40), *nansome* 'black' (F&W set 102), and, from two sets (F&W 212 and 55), *nandiú* 'red' and *nandiume* 'yellow' or together 'red-with-yellow, warm' (F&W naïvely dismiss the 'red' form of set 212 as a "printer's error," believing that it should have appeared as *na-^{n}du-wi-me* 'red'.). The ProtoChiapanecMangue color categories appear to have been these:



(Continued next page)

2.b. Dark-Cool

Table II.2 displays the argument that speakers of a language that was ancestral to, at least, Zapotecan, Mixtecan, and Popolocan named a dark-cool category.

(Continued from preceding page)

Secondary Terms as Roots

*ari-^{m}bu-me	'red'
*ya-pa-me	'green'
*na-ku-me	'yellow'
*na-nso-me	'black'
*^{m}bu-tipa	'green, blue'

Using Rensch's rules, the derivations from ProtoOtomanguean of ProtoChiapanecMangue color-term roots are:

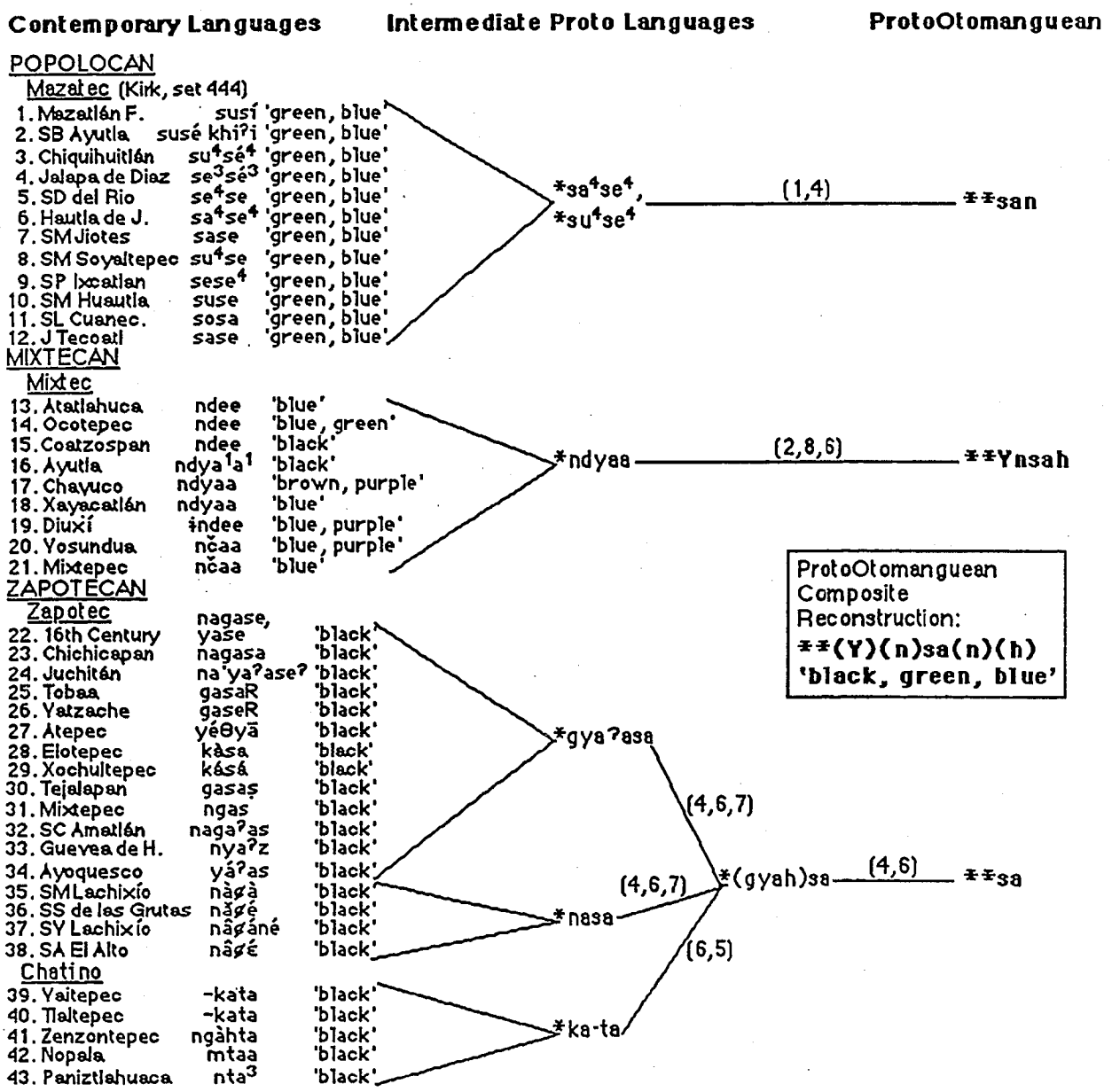
Meanings	POM		PCM	Rensch's Set	Rule	Table
'light-warm'	**nse	→	*^{n}di	245	1, 2	II.1
'dark-cool'	**ntu	→	*^{n}du	235	1, 3	none
'yellow'	**k^{ω}a	→	*ku	200	4	II.4
'yellow,red'	?		*-u	none	none	none
'red'	**nk^{ω}a	→	*^{m}bu	200	4	II.5
'red'	?		*wi	371	8	II.5
'green,blue'	**k^{ω}en	→	*pa	174	5, 6	II.6
'white'	**nye[?]	→	*li	none	7, 2	II.3[?]

Rules: (1) **ns,nt → *^{n}d (Rensch 1976: 129); (2) **e,i → i [except /_n] (132); (3) **u → *u (132); (4) no rule as rule 5 appears to prevail, although some data imply otherwise (cf. 128-9); (5) **k^{ω} → *p (129); (6) **en → *a (132); (7) **ny → *l,r (130) "[?]"= doubtful derivation; (8) *wi might derive as do forms in Table II.5, but no rule is evident.

"Table" refers to the table that would include each derivation, if it were included in a table. These derivations and those of Rensch's sets differ.

Finally, *^{m}*bu-tipa* and *bo-tipa* 'green, blue' (F&W set 4) appear cognatic with Otopamean 'black' forms (^{m}*bo*, etc.), although they are also identical to the PCM 'red' root **ari-^{m}bu-me* (dark red?). The PCM (?) 'black' form *(*)nansome* (F&W set 102) has no obvious derivation (?<*^{n}*du*); it probably named 'black' as a subset or recessive range of the dark-cool category. The *-u-* of **na-^{n}di-u-me* 'red, yellow' might be a reduction of *-ku-* or a reduction of what Rensch calls the "stem formative," *-wa*, also seen in *na-^{n}du-wa-me* 'black' of F&W set 102 (cf. Table II.7, ***wa*)

Table II.2: Dark-Cool



Rules: (1) **-an → *-e → -e (Mazatec, Rensch 1976: 92, 109); (2) **ns → *nd → nd (Mxtn, 62), **Yns- → *ndy- (Mxtn, inferred from Rensch: 62); (3) *-ah → aa (Mxtn, 72); (4) **s → *s → s (Maz, Zptn, 89, 156, 108); (5) *ty, s → t (Chatino, 159); (6) **a → *a → a (Mxtn, Zptn, 71); (7) *Yh → Y?Y (Zptn, 158); (8) **Yh → *YY → YY (Mxtn, 72).

Other possible cognates: Tlapanec māšā 'green, blue'.

In the table, The ProtoMixtecan reflex descends with meanings of 'black', 'green', and 'blue', which by themselves attest to a prior 'dark-cool' meaning. This cognate set, which appears in neither Longacre's nor Rensch's inventory, is exceptional for its derivation from a preposed palatal. Rensch (1976: 80) asserts that the absence of the preposed palatal characterizes ProtoMixtecan, although some Mixtecan forms might reflect the POM palatal (e.g., Rensch's set 235).[7] However, this generalization ignores the present cognate set. Since the set is ignored, the Mixtecan rule ***Yns-* → **^{n}ď-* is inferred without reference to Rensch; it produces correspondences of *-^{n}ďa-/-^{n}de-/-^{n}ča-* among Mixtec languages. Four other forms might be related to **^{n}ďaa* through further palatalization: Ayutla *^{n}di^{3}ʔe^{ʔ1}* 'blue', Mixtepec *^{n}ča^{ʔ}i* 'black', Ocotepec *^{n}dīʔī* 'purple, dark-cool', and Peñoles *^{n}ǰiʔi* 'blue, cool'.

The derivation of Zapotec cognates might lack a rule, as some reflexes involve *-e* or *-ɛ* rather than *-a,* for example items 22, 24, 36, and 38. Rensch's (1976: 162) explanation of item 24 as *a → e/C_ʔ* with *C[lenis] → C[fortis]* appears *ad hoc.* Rather, the a/e alternation might involve a POM palatal element, as suggested by the palatal of items 27 and 30; the uvular -R [ʁ] of forms 25-26 might also reflect such a palatal. The Zapotec penultimate syllable derives from the "color formative," ***kah-*, also seen in Table II.1 (Rensch, set 121, not shown).

Rensch disseminates reflexes that are included in Table II.2 throughout his cognate sets 121, 174, 263, and 303; for example:

263 **se
Mixtec of San Miguel tɨ^{2}ca^{3}i, (Longacre 1962: 241)
Mixtec of San Esteban tɨ^{2}ca^{2}yɨ^{2} charcoal ← **ye
PPn 330 *ti-ye: I ti^{1}ye, P ti^{3}ye^{1}, C tie black ← **ye
(Continued next page)

[7]Trique color roots containing *r*, might descend from ***YCV-: *ma^{4}ru^{345}* 'black', *ma^{4}ree^{35}* 'green', and *raʔw^{3}* 'pink' (cf. Rensch's set 235, Table II.7 [item 14], and discussion immediately below concerning Table II.2). Color terms specifically might, as a domain, represent an exception to the exclusion of the ProtoOtomanguean palatal in ProtoMixtecan.

(Continued from preceding page.)
IZ naya?ase?, ya?se? black ← **hse/?se
PCn *lia·? (L):O la?[2], U lia?[3], Q lah?[23],
P lí?[3], L lä·?[3] black ← **Ynye?n

303 **sa(n)
PMaz - Kirk 455 *sa[4]se[4], *su[4]se[4] green ← **san
PO (Bartholomew) *n?yą raw ← **n?yan
IZ na'ya?a raw ← **yah

Rensch includes (Juchitán) Zapotec *naya?ase?* in set 263 on the basis of the *ad hoc* rule (*a → e/C_?* with *C[lenis] → C[fortis]*), which is not supported by the reflexes of Table II.2. Juchitán Zapotec (item 24) is the only Zapotec language which manifests the final glottalization on 'black'; it appears to develop as the echo of an interrupted vowel in the penultimate syllable, as in *bi?iji?* 'seed' and *be?eje?* 'tiger'. Further, the preposed laryngeals of Rensch's ***hse/?se* derive from the penultimate of *naya?ase?*, which is the *y-* variant of the preposed "color formative. (See below, this page; Rensch's set 121)"

In set 263, PPn **ti-ye* 'black' might relate to POM ***sa* of Table II.2 via PPn ***an → *e* and a *s/y* consonantal alternation, although this far-fetched argument requires other evidence.

Rensch's PCn ***Ynye?n → *lia·?* is based on weak evidence (p. 169): ***ny → *l* is attested only by set 396 (PPn **ntyihi* 'pasture, grass', PMC **ni-lu* 'flower', IZ *gye?* 'flower', PCn **li* 'flower'). It might be that PCn **lia·?* 'black' is related to ProtoMixtec **[n]dyaa* (Table II.2) through an unattested change of ***nd → *l* in Chinantecan. In Tepetotutla Chinantec, *lya?*$_2$ 'black' and *lyą$_2$* 'blue' contrast.

In set 303, PMz **sa[4]se[4]*, **su[4]se[4]* and the PO and IZ forms that mean 'raw' would be related through the *s/y* alternation. However, that is unlikely. Both the Zapotec word for 'raw' and that for 'green, blue' derive from ***kah*, an ultimate syllable that is identical in segmental shape to the penultimate "color formative" that Rensch reconstructs in set 121. In Table II.1 this sequence is hypothesized to evolve with a *gy-* as ***kah* or ***kanh → *gaha → *gya?a → naga?a* 'green,blue', *naya?a* 'raw'. In set 174 (cf. Table II.6),

which derives from **(h)k^{w}e(ʔ)(n), Rensch comments, "The following form seems to be cognate, but the vowel is difficult: *na'gaʔ* 'green'." POM **(h)k^{w}e(ʔ)(n) also descends as a "color formative', as seen in Table II.1, items 24-30, 36-43.

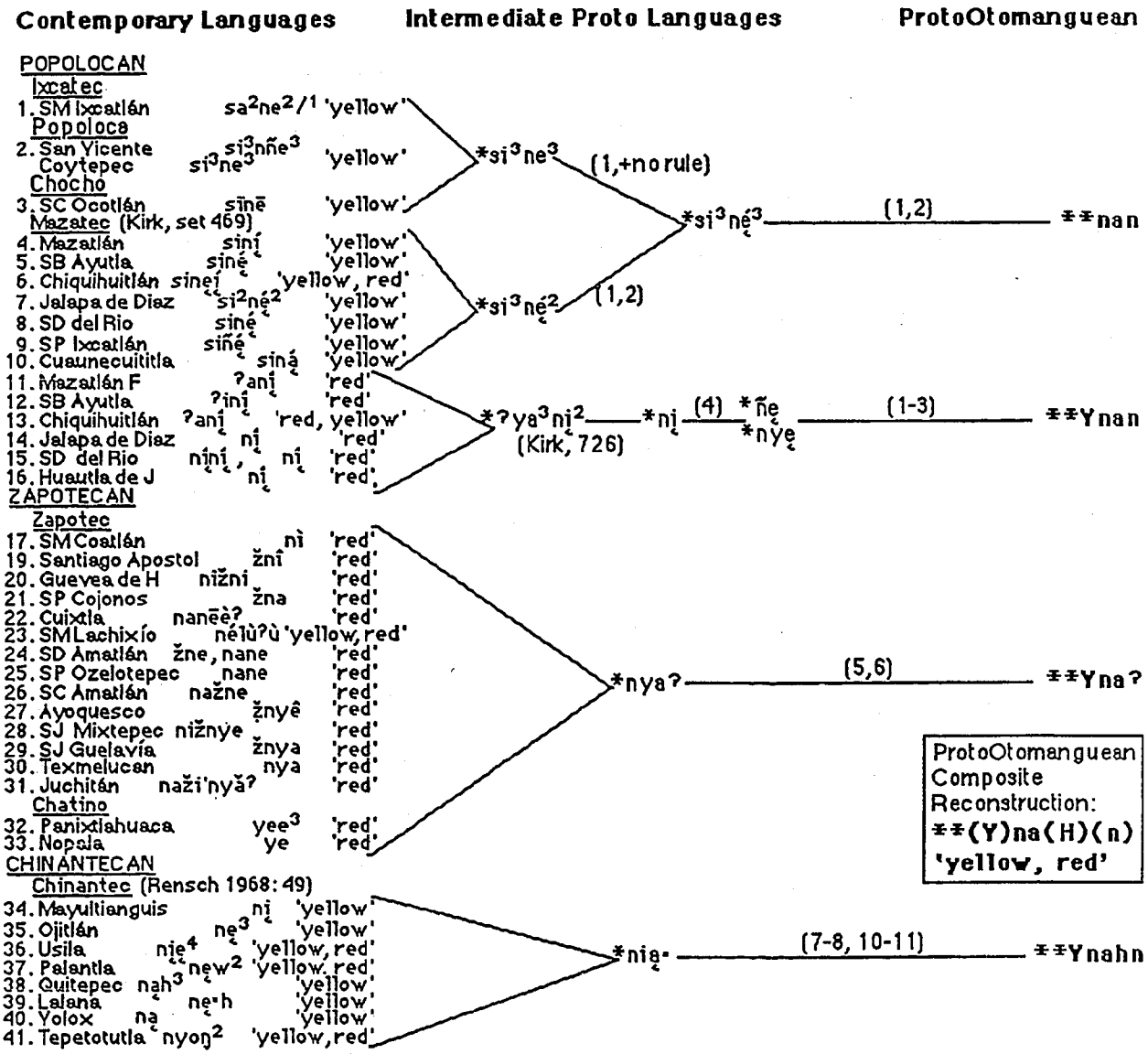
The reconstruction of the dark-cool category in Zapotecan-Mixtecan-Popolocan is supported by data from contemporary speakers of Mixtec (e.g., Figures 5.7a, 7.30, 7.33b) and Mazatec (Figure 6.18), who name a dark-cool category with reflexes of three different proto-forms; none of them derives from the reconstruction shown in Table II.2. Various Otomanguean branch languages, each at some point, named the dark-cool category with at least one newly adopted word, probably with a relationship of near-synonymy or of coextensivity to the original word. In each branch, the old term ceased to name the dark-cool category before the new term. Merrifield (1972: 267) comments on the Chayuco Mixtec term, *ndyāá* (cf. Table II.2, item 17): "The term.... for brown-purple was given a disjunctive mapping: a deep brown...and a deep purple.... A possible internal reconstruction...is as follows: *ndyāá* originally mapped all the dark colours. The word for soot (*tǫ̣ǫ̣*) was taken over for true black, being modified as a color word to *tọ̄ọ́*. The reference of *ndyāá* was gradually limited to its present colour referents."

The POM reconstruction **(Y)(n)sa(n)(h) might have other reflexes, such as ProtoChinantecan *r- 'green, blue' (Rensch 1978: 98) or Trique *ma^{4}ẓee^{35}* 'green, (blue)' (→ *ma^{4}ree^{35}* 'green', younger speakers, Copala, observation during MCS). Rensch (1976: 80, 170) cannot provide enough analysis to decide these cases. Contemporary reflexes of ProtoChinanatec *r- have been called vibrant, liquid, and lamino-domal spirant. Casual observation of such terms during MCS interviews yielded an impression of spirantial and retroflexed qualities. See section 2.i. for other possible reflexes.

2.c. Warm, Term #1

Table II.3 displays the first of three arguments that speakers of ProtoOtomanguean used a category that was focused among warm colors and included, at least, red, yellow,

Table II.3: Warm(1)



Other Cognates: Trique ni⁵a?⁵ 'colorful, pretty' (Rensch 1976: set 63), Tlapanec mæ'nya 'red, red-and-yellow' (cf. Figures 5.3, 7.19b "mäña"; see Rensch 1977); Otomí thæní 'red' (cf. Figure 8.12a); Chichimeca Jonaz hinin? 'red' (cf. Figure 5.11a); Xochistlahuaca Amuzgo či²na⁴ 'pink.

Rules: (1) **n → *n → n (PPn, Rensch 1976: 88); (2) **an → *ęʔ → ęʔ (PPn, 92); (3) **Yn → *ñ or *ny (Mzt, no rule in Rensch 1976); (4) *ye → i, *ai → i/n_ (Mz, no rule); (5) **CV? → *CV? → CV?/CV (Zptn, 158, 160); (6) **Yn → *ny → ny, n, y (Zptn, discussed in text); (7) **ahn → *aʔ· (Chtn, 302-3, 309, 311); (8) **YCV[backed] → *CiV (Chtn, 307); (9) *iaʔ· → e/ie/ah/iw/ew/æ (Chtn, 309, 311); (10) **n → *n → n (Chtn, 303); (11) origins of long vowels are obscure (Chtn, 315).

and purple. The names of this "warm category" might have been nearly synonymous or coextensive throughout the light-warm category, but there is no evidence. If the category contained just warm colors, then it was included within the light-warm category that is reconstructed in Table II.1. The category was common to the ancestors of, at least, Zapotecan, Popolocan, and Chinantecan; cognates probably occur also in Mixtecan, Otopamean, and Tlapanec (Rensch [1977] argues that Tlapanec is Otomanguean.).

Rensch, in set 349 (next page), recognizes the cognation of the Chinantecan and Popolocan reflexes that are focused in yellow; but he does not include the Zapotecan and Mazatec reflexes, perhaps because the red focus of these appeared too distinct from yellow in terms of the color meanings familiar to an English speaker. However, MCS and WCS data show that in contemporary languages (e.g., Table II.3, items 6, 13, 23, 36, and 37) Mazatec and Zapotec reflexes mean 'red, yellow' (cf. Figures 6.18, 7.19a) and Chinantecan reflexes mean 'yellow, red' (cf. Figures 7.7a-d, 7.8a); the warm range of the reconstructed POM category is perpetuated into the present by some individuals. See Figures 5.3, 6.17b, 6.19, and 6.23 for red-with-yellow uses of Tlapanec *mæ'nya*.

Contemporary 'warm' terms in Otomanguean languages bear relationships of coextensivity and inclusion. Yet the ProtoOtomanguean names of warm colors might have been focused in reference to levels of brightness and related to each other as near-synonyms. That the daughter-language reflexes are focused in reference to either red or yellow implies that the reference was not fixed in ProtoOtomanguean. The lack of fixed reference to one or another pure color characterizes the early phase of near-synonymy. Probably the reference became fixed independently, to red or to yellow, in each daughter language as near-synonymy evolved into coextensivity later than the ProtoOtomanguean horizon. The other near-synonyms for warm colors are reconstructed in Tables II.4-5.

In cognate set 200 (discussed under Table II.4), Rensch relates a Zapotec reflex, item 31 of Table II.3, to ***(n)k$^{\omega}$a(ʔ)*, another reconstructed warm-category term. The implied relationship only could be a rare alternation, *n/k$^{\omega}$* (cf. Rensch, sets 141 and 186).

The possibility is supported by the mutually exclusive relationship of ***nan* and ***k^{w}a*, which descend in the same language only in Jalapa de Diaz Mazatec (cf. Table II.3, item 15, and Table II.4, item 21). The latter Mazatec reflex might derive from another source.

Rensch's set 349 is as follows:

349 **na
PPn 242 *si-/sa-ne: I sa^{3}ne^{3}, P si^{3}ne^{3}, C sine;
PMaz *si^{3}ne^{2}: H si^{3}ne^{2}, SJ sine, Mz sini,
S si^{3}ne^{1} yellow ← **nan
PCn *niᵩ· (L): O neᵩ^{3}, U niᵩᵩ^{4}, Q nᵩh^{3}, P neᵩw,
L neᵩ·h^{3} yellow ← **Ynah

His depiction of set 349 omits the nasalization of PMz forms, which is included in Table II.3, items 4-16 (from Kirk 1966: set 469). The omission leads to the lack of a rule that would explain the attested denasalization of Ixcatec, Chocho, and Popoloca forms, items #s 1-3 (and Rensch's set 349). Table II.3 violates Rensch's rules regarding the Mazatec forms, items #s 4-16; the rules do not provide for this change: **ñᵩ* → **niᵩ*. The departure is justified by representing **ñᵩ* as **nyᵩ;* such a CyV cluster is attested to collapse into CV reflexes in other linguistic branches, for example, items 17-19 and 34, Table II.3. There is no argument against interpreting **ñ* as **ny;* Rensch elsewhere depicts contemporary forms as "ñ" when they are transcribed as /ny/ in phonemic statements (cf. *na'žiña?* of Rensch, set 200, versus *na'žinya?* of Pickett 1967: 292, 294).

The Zapotecan protoform **nya?* is reconstructed with a glottalized vowel, which occurs in two reflexes (#s 22 and 31). The pertinent rule is *CV? → CV?, CV, which is a modification of Rensch's Zapotecan rule of *CV? → CV?. Moreover, the Zapotecan cognates show variation of *n/ny/y,* a subject that is not addressed by Rensch's rules; the same variation occurs among other Zapotecan cognate sets, for example, words for 'hand': Juchitán *na?,* San Juan Mixtepec *nya,* Ayoquesco *yă?,* and (from Uspson and Longacre 1961: set 49) ProtoChatino **ya?.* The Chatino cognates, #s 32-33 of Table II.3, are not widely reported in descriptive materials; they have been largely supplanted by the

expansion of *nga²à* 'red', which is derived by a change of pitch from *nga²á* 'green' (as is Trique $ma^4 ẓee^{35}$ 'red' from $ma^4 ẓee^{53}$ 'green').

According to Rensch's rules (1976: 302-3, 209, 311), ProtoChinantecan **a·* is derived from ***ahn;* thus, **Ynahn is reconstructed in Table II.3, rather than ***Ynah* of his set 349.

2.d. Warm, Term #2

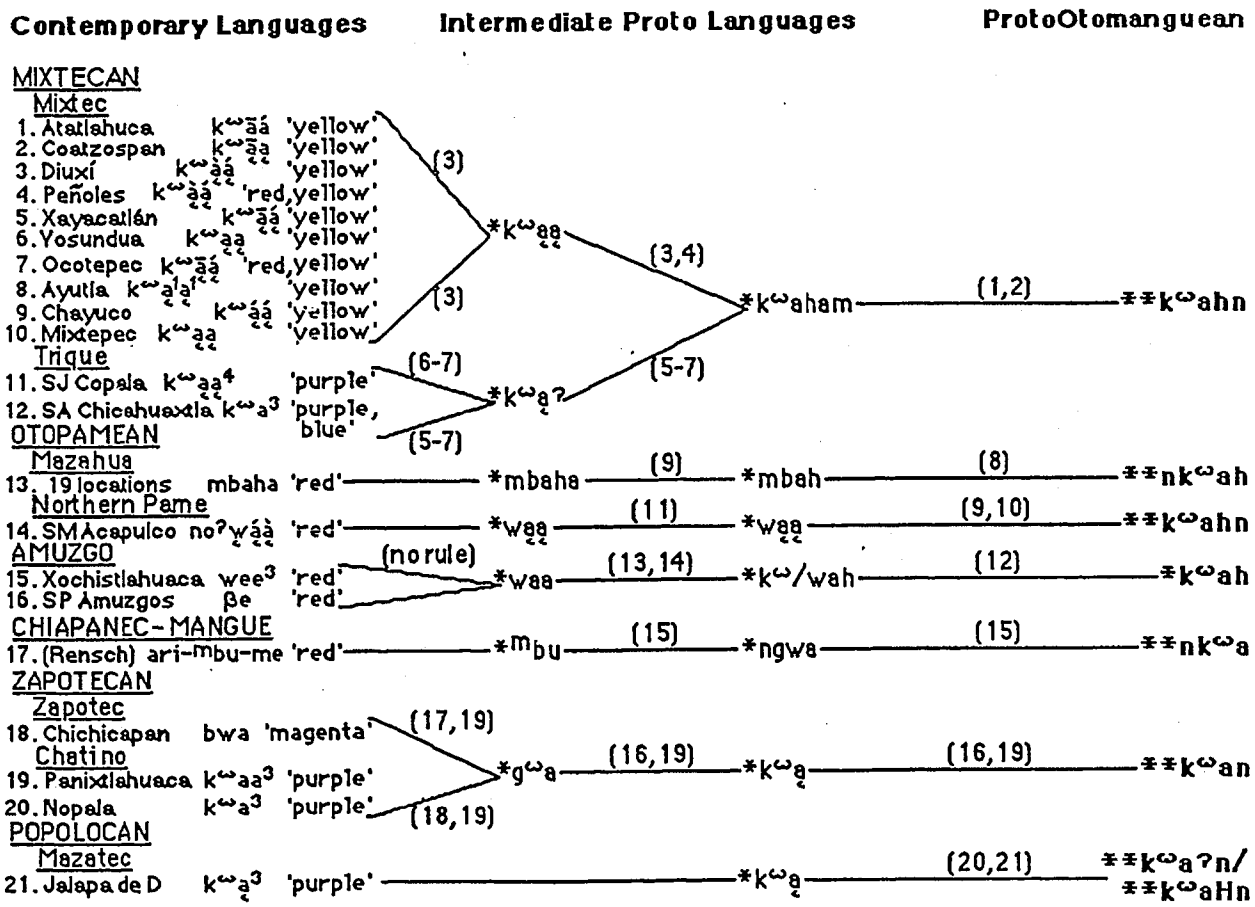
Table II.4 displays the second of three arguments that speakers of Proto-Otomanguean named a category that contained warm colors with nearly synonymous terms; it is not known whether the terms applied only to a warm category or to the light-warm category. Since the reconstruction relates reflexes of diverse branch languages, it pertains directly to ProtoOtomanguean.

This cognate set includes meanings of 'yellow', 'red', 'purple', and 'blue'. It appears that in Zapotec, Chatino, Mazatec, and Trique, the reflexes of the original 'warm' term were isolated in purple, a color that is commonly encompassed by the warm category. Specifically Trique fashioned a purple-with-blue category by extending the purple category throughout blue, but this change was recent; older speakers of Copala Trique still maintain a green-focused cool category with low membership in blue. The blue meaning of the purple-focused term does not derive from a protolanguage. Speakers of Palantla Chinantec have, by the same recent process, extended a purple-focused Spanish loan word to blue.

The meanings of yellow, red, and purple in different branch languages imply the same ancient near-synonymy as do the meanings Table II.3. Contemporary data showing the extension of yellow-focused Mixtec cognates throughout warm colors appear in Figures 6.17a, 6.21, 7.30, and 7.33b.

In Table II.4, there are some problems with the rules of sound change: (1) Rensch provides no rule for Amuzgo ***aa* → *ee* (items 15-16). The process is parallel to the Mixtec variation of $k^{ω}a²a/k^{ω}e²e$ 'red', discussed under Table II.5. In Mixtecan, such

Table II.4: WARM (2)



Rules: (1) **-n → *-m (Mxtn, Rensch 1976: 60,64); (2) **Vmh → **VhVm (Mxtn, 60); (3) *-aham → *aa (Mixtec, 63, 71-2); (4) **VhV → *VV (Mixtec, 60-1, 72); (5) *aham → *a? (Trique, 83-4); (6) **kʷ → *kʷ → kʷ (Mxtn, 62, 67, 80); (7) *CVh → CV? → CV?/CVh/CV (Trique, 84); (8) "D" *nkʷ → mb (Otomí-Mazahua, 137); (9) *Vh → VhV (Otomí-Mazahua); (10) "B" **kʷ → *w → w (Pame, 137); (11) **aha → *aa → aa; (12) kʷ/w (Amuzgo, cf. 119, kʷ, w); (13) **Vh → VV (Amuzgo, norule; see 125, **Vh → **VhV → V́); (15) **nkʷ → *mbu (Chapanec-Mangue, 128-9, 131); (16) **CVn → *C[lenis]V → C[lenis]V (Zptn 155, 157); (17) *kʷ[lenis] → b (Zapotec, 154, 161); (18) *kʷ[lenis] → kʷ (Chatino, 154, 160); (19) **a → *a → a (Zptn, 161-2); (20) **-aHn → *-a (PPn, 92), **Cah → *Cha, thus *Ca?n and not *Cahn (93-4); (21) **kʷ → *kʷ → ku (PPn, 89, 99).

ProtoOtomanguean Composite Reconstruction:
**(n)kʷa(H)(n)
'yellow, red, purple'

variation might be caused by optional use of the postposed nasal, *-*m*. (2) Rensch provides no specific rule for the hypothetical ChiapanecMangue sequence (his set 200).

The data are poorly recorded and the sequence doubtful. (3) In Otopamean, the Mazahua reflex and Northern Pame reflex differ by variation between what Bartholomew and Rensch call consonantal series "B" and "D," in which initial consonants are prenasalized or weakened respectively. (4) The long vowel in the Panixtlahuaca Chatino reflex (#19) appears to be a recent development that is manifested throughout final vowels in data from that language. (5) Zapotec $*g^{\omega} \rightarrow b^{\omega}$, rather than $*g^{\omega} \rightarrow b$, is an exceptional change in just Chichicapan Zapotec, for example Chichicapan *b$^{\omega}$ela* 'meat' and Juchitán *beLa* 'meat'. (6) Jalapa de Diaz Mazatec $k^{\omega}ę^{3}$ was correctly recorded with a nasalized vowel by J. Schram during an MCS interview. Rensch's rules indicate that the protoform should be $*k^{\omega}a?n$ rather than $*k^{\omega}ahn$, because Mazatec $*Cah \rightarrow Cha$; k^{ω}- is rare in Mazatec, occurring in only four of Kirk's 731 reconstructions, specifically sets 216, 218, 225, 226 (cf. 215, 217, 219-24); none of these sets includes the present reflex or its cognate. The word might have been applied to purple recently from an origin apart from color. Schram transcribed the term as *"ku$ę^{3}$,"* which conforms to Rensch's rule (1976: 89, 99).

Other words that are similar in shape and meaning to those of Table II.4 are Mazahua *šikhwa* 'residual color' and Mezquitál Otomí *mbøkwa* 'purple' (WCS and MCS data).

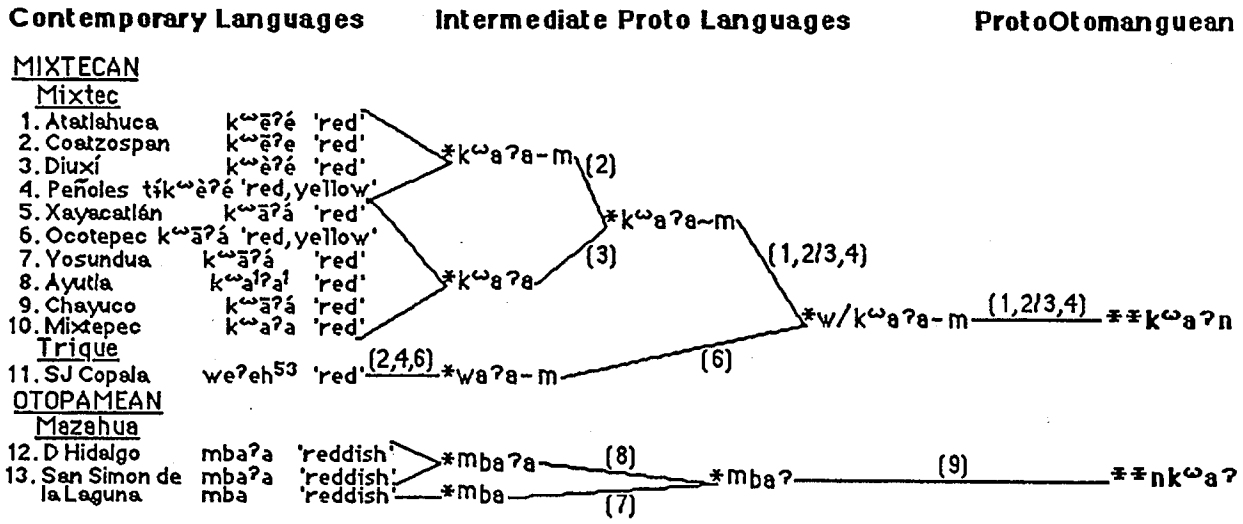
The Protoforms of Table II.4 appear to relate closely to those of Table II.5.

2.e. Warm, Term #3

Table II.5 displays the third argument that speakers of ProtoOtomanguean named with near-synonyms a category that contained, at least, the warm colors, including red and yellow.

The evidence that the protoform $**(n)k^{\omega}a?(n)$ named both red and yellow resides exclusively in the meanings of the modern Peñoles and Ocotepec Mixtec reflexes, items 4

Table II.5: WARM (3)



Rules: (1) **kʷ → *kʷ → kʷ (Mxtn, Rensch: 1976: 67, 80); (2) *Ca?a-m → Ce?e (Mxtn, 83); (3) *Ca?a → Ca?a (Mxtn, 83); (4) **CV? → *CV?V → CV?V (Mixtec, 72); (5) **CV? → *CV?V → CVV?V/CV?V (Trique, 84); (6) *kʷ/w → k,w (Mxtn, 33); (7) **CV? → *CV → CV, not (8) **CV? → *CV?V (Mazahua, 146); (9) **kʷ → *mb → mb (Mazahua, 137, "D" form).

ProtoOtomanguean Composite Reconstruction: **(n)kʷa?(n) 'red, yellow'

and 6 (cf. Figures 6.21, 6.25b, and 7.30). This composite protoform and that of Table II.4, ***(n)kʷa(h)(n)*, differ only by occlusive and spirantial laryngeals.[8] The Mazahua pair, item 13 of Table II.5, might place the laryngeal contrast on the ProtoOtomanguean horizon. Probably the contrast was first used to differentiate near-synonyms that were focused in reference to levels of brightness, ***kʷa?* versus ***kʷa(h)*.

The Mazahua contrastive pair *mbaha* (Table II.4) and *mba?a/mba* (Table II.5) name focal and marginal shades of red, good red and off-red respectively. One variant of the second member, *mba?a*, is not explained by Rensch's (1976: 146) Otomian rule, **CV? → CV*. That is, *mba* is the expected reflex of ***nkʷa?;* however, D. and S.

[8]This minimal difference between reconstructed names of one category, now coextensively related in Mixtec, bolsters the case for two rather than one laryngeal in ProtoMixtecan, discussed by Rensch (1976: 43-51, 60, 72) versus Longacre (1957: 75-92).

Stewart recorded *mbaʔa* during three WCS interviews and *mba* during one of the three at San Simón de la Laguna. The rare variants, never previously recorded, were volunteered by two individuals at San Simón and by one at Dolores Hidalgo, in the southern extreme and northern center of the Mazahua region (cf. Figure 9.24a-b [Map]).

Other irregularities of Table II.5 originate from the hypothetical optionality of ProtoMixtecan postposed nasal, **-m*, which produces reflexes of both *aʔa* and *eʔe* among Mixtec languages and *eʔe* in Trique. The Mixtec and Trique reflexes differ further by an apparent consonantal alternation, k^{w}/w.

200 **(n)k^{w}aʔ

Mixtec of San Miguel k^{w}aʔa red	← **k^{w}aʔ
PCM 81 *ari-^{m}bu-me red	← **nk^{w}an
Mazahua mbaha red	← **nk^{w}ah
IZ naži'ña? red	← **naʔ

This set may be related to POM 121, 371.

371 **we

Trique we^{4}ʔeh^{3} red	← **weʔ
Amuzgo we^{2} dark red	← **wen
PCM 212 *na-^{n}du-wi-me red	← *we

This set might be related to POM 200.

Rensch, in set 200, suggests a relationship between reflexes that are presently included in both Tables II.3 and II.5, and he combines reflexes that are now in Tables II.4 and II.5. Set 371 comprises reflexes from Amuzgo and ChiapanecMangue which also might be included among those of Table II.5 (See footnote 3.); rule (2) of that table might account for the /e/ vowel in two of the three linguistic branches of set 371, although Rensch restricts the rule to Mixtecan. Set 371 displays the San Andrés Chicahuaxtla reflex that was not recorded during the 11 interviews there under the MCS; the survey noted only the San Juan Copala reflex, Table II.5, item 11.

2.f. Cool

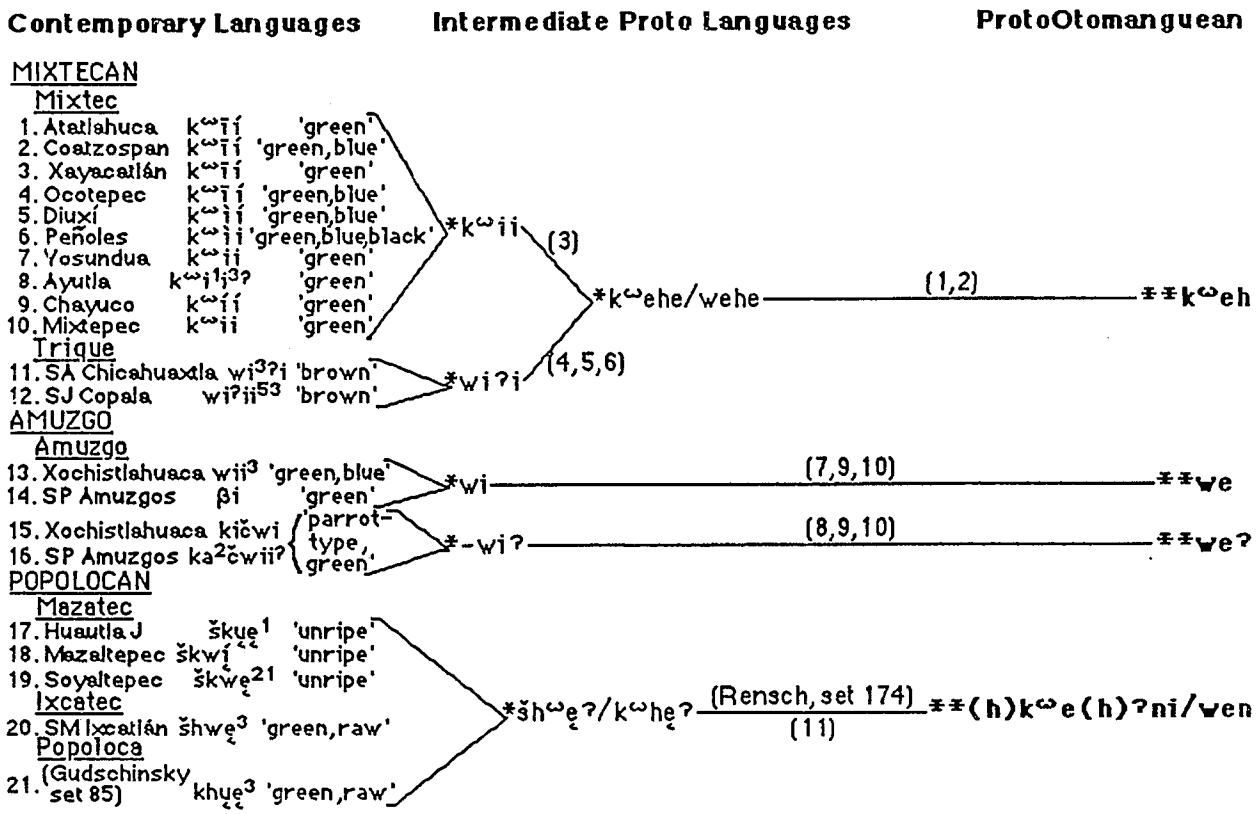
Table II.6 displays the argument that ancestral speakers of Mixtecan and Amuzgo used a cool category, but the argument is weak. Reconstructed forms are related to terms that meant 'raw'; a 'raw' term could have been independently adapted to the cool category in different linguistic branches. In the text above, a close affinity is demonstrated between the words for 'raw' and 'green, blue' in Zapotecan, and one example is given of the polysemy of 'raw, green-with-blue' that is common among Mayan languages. Such linguistic links between 'raw' and 'green, blue' are widely recurrent in Mesoamerica.[9] Some speakers of Peñoles Mixtec use *kʷli* to name black as well as blue and green (cf. Figures 7.30 and 7.33), which suggests that the term meant 'dark-cool'.

Rensch's POP **poe-th* suggests a derivation from ***kʷe*, although this does not square with his rule of ***kʷe* → **p* (p. 138), ***w* → **o*, and ***oe* → **ø* (p. 146). Thus, **p*- of **poe-th* is not addressed by these rules; there is no rule of ***kʷ* → **po*/_*e*. The term *bøthe* means 'river moss' in San Antonio el Grande Otomí (MCS data), although it is applied to green with a salience that implies that it has become a color word (as has 'orange' in English). However, its meaning of 'river moss' hints that this, and not 'green', was the meaning of **poe-th;* in San Antonio el Grande Otomí, *k'ammí* means 'green, blue'. That term and its Otopamean cognates might be related to ***kʷe*: Ixtenco *nk'angí*, Mezquitál *k'angí*, Mazahua *k'angᵩ*, Northern Pame *niŋgíhily*ʔ, all meaning 'green' or 'green, blue'. The Otopamean 'black' terms -- Otomí *mbo*, Mazahua *pothí*, Northern Pame *nambóò*, Chichimeca Jonaz *zi-mbo*ʔ and *u-'mbo*, and Matlatzinca *ʔim-bohutí* -- are not above suspicion as possible derivatives of ***nkʷe*, although there are no rules for such. See ProtoChiapanecMangue **mbu-tipa* 'green, blue' (footnot 6, final paragraph). OP and PCM forms might descend from a second POM 'dark-cool' term.

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[9]Two Otomanguean protoforms, ***kʷe* and ***kah*, might descend as words for 'raw, green-with-blue' and as the "color formative." For example, Mixtec *kʷiši* 'white', Zapotec *guȼi* 'yellow', Popolocan *gaȼe* 'red', and Zapotec *gaȼi* 'yellow'.

Table II.6: COOL



ProtoOtomanguean Composite Reconstruction:
**kʷ/we(H)(n)
'green, blue' [?] 'raw'

Rules: (1) **CVh → *CVhV → CVV (Mxtn, 60-1, 72); (2) **kʷ → *kʷ → kʷ (Mxtn, 62, 67, 80); (3) **e,i → *i → i (Mxtn, 63); (4) **w → *w → w (Trique, 81); (5) same as (3), 63; (6) **CVh → *CVhV → CV?, CV?V (Trique, 84); (7) **CV → CV (Amuzgo, 123); (8) **CV? → CV? (Amuzgo, 125); (9) **e,i → i/kʷ, w_ (Amuzgo, 125); (10) **w → w (Amuzgo, 119); (11) Popolocan reconstructions are from Gudschinsky, set 85, and Rensch, set 174.

2.g. Black

The argument that speakers of ProtoOtomanguean named a black category is seen in Rensch's set 94 (next page). No table apart from that set is necessary, because these data are the only evidence of the category. The evidence is weak, because the protoforms appear to be related to words that mean 'dark' and 'soot'. Independent adaption in branch

languages of such words to color cannot be precluded. The argument is flawed in same way as is that of the ProtoOtomanguean cool category.

Set 94 **(n)(h) tu (h) (n)[1]

PMn 235 *tu(m)(h)/hnumh[42]: M-SM ha[2]-tu̱[3]u̱[1], tu̱u̱[1] black
(ⁿdo[2]ko[2]) tu̱u̱[1] the black zapote M-SE (he[2]e[3])
Nu̱[3]u̱[1], Nu̱[1]u̱[1] black, (ⁿdo[2]ko[2])Nu̱[1]u̱[1] black zapote
M-J tu̱u̱ black; C tu̱ŭ[1] soot; T (re[3]ko[45])
ču̱[53] black zapote, (zi[21]) ču̱[3] negro, čo[345]
soot, ma[4]ru[345] black ← **tu(h)(n)/hnuhn[1]
If Trique r reflects **Yt, this set agrees with PCn
in indicating the preposed palatal element.

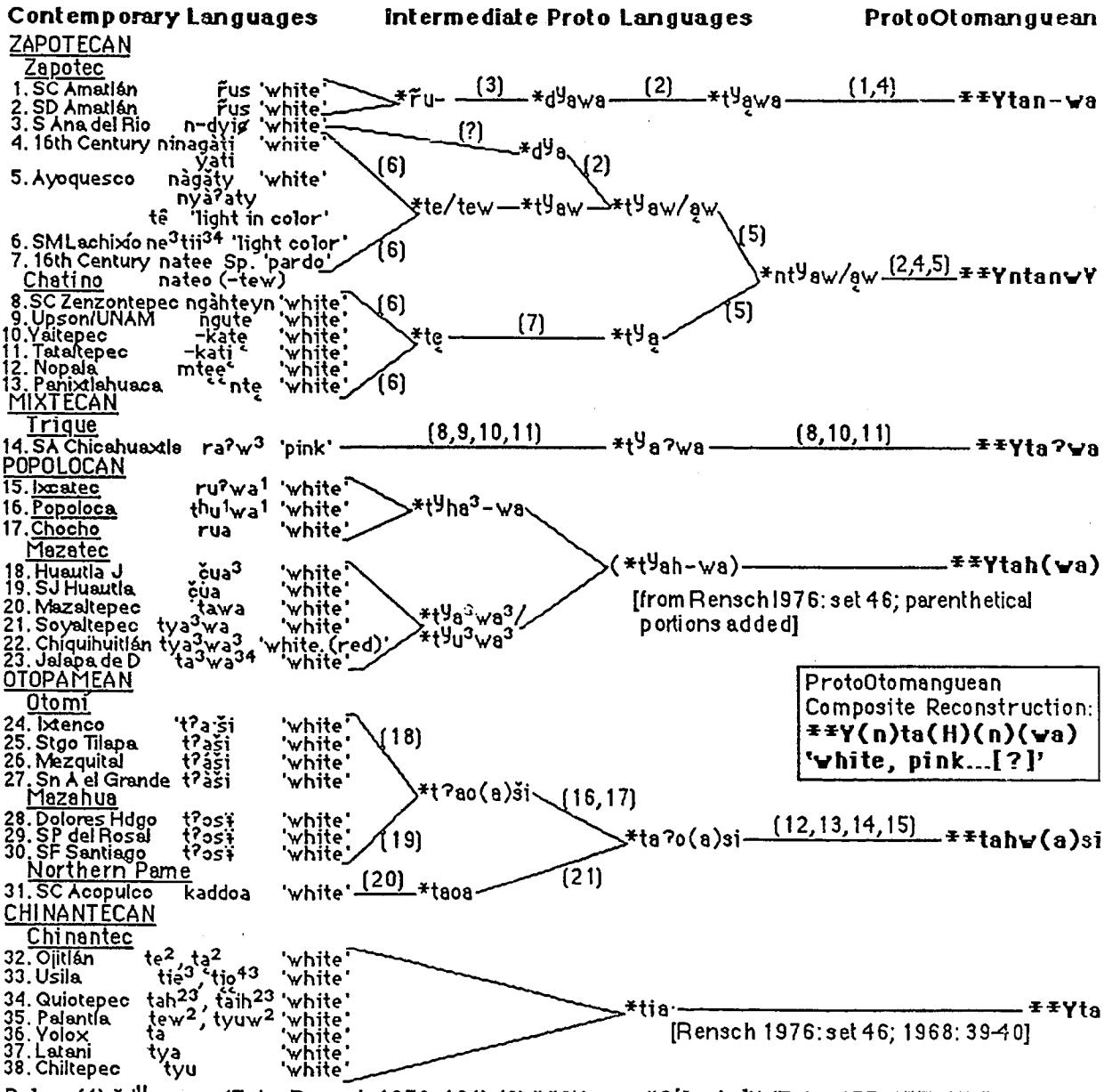
A nto̱[2] black; nᵗu[2] soot ← **ntuhn; **tnuh
PCM 102 *na-ⁿdu-me black, blue, crow, dark ← **ntu
IZ naču?undu? dark ← **nhyun
PCn *t(i)u· ~ *t(i)u·n(H): O to̱[31], U a[3]tau̱[32],
Q tüh[3], ca[3]tu̱ih[242] deaf mute,
P tew[1], tyuw[1], L tu·[2] blind ← **Ytu[1]

Sound rules are not discussed because the derivations of 'black' are Rensch's reconstructions. The PCM gloss of 'black, blue...' implies that the term named cool colors as well as black throughout a dark-cool category, although there is no direct attestation that 'green' was part of the meaning. Further Mixtec cognates are listed in footnote 4. Another Zapotec cognate of San Cristóbal Amatlán (MCS data) is *ničo?ol?* 'grey, dark brown'. Only the PMn, A, and PCM forms mean 'black'.

2.h. White

Table II.7 displays the argument that ProtoOtomanguean speakers used a white-focused term. There is some evidence that the term extended, at least, to pink; it might have been focused in reference to the highest level of brightness while naming the Proto-Otomanguean light-warm category from that vantage. Rosch's data from New Guinea (footnote 13, Chapter I, page 44) show that the light-warm category is often focused in pink or white.

Table II.7: White



Rules: (1) *dya → r (Zptn, Rensch 1976: 161); (2) **CVn → *C[lenis]V̨ (Zptn, 155, 157); (3) *awa → u (Zptn, no rule; but see Rensch: set 47, 394 'skin, mouth'; Zap. ru?a, ró?o 'mouth' ← *dya?wa); (4) **Yt → *t (Zptn, 155-6); (5) *ntyV → č; *ntyV → tyV/_V,V̨; *tyV → č, tyV/_V; *tyV → dyV/_V̨ (Zptn, 153-5, 161, *ntyV discussed in text.); (6) **e,i → *i, thus not *ee → *e (Zptn, 157); (*a → e, not addressed, although it might result as *tya → te (Zptn); (8) **Yt → *t → r (Trique, 84); (9) *CV? → CV/CVh/CV? (Trq. 83); (10) **a → *a → a (Trq., 83); (11) **w → *w → w (Trq., 81); (12) **t → *t (Otomian, 138); (13) **HwV → *HoV (Otmn, 139); (14) *s → š (Otmn, 145); (15) **i → *i (Otmn, 141); (16) *Ca?+ "stem formative" → C?a+SF (Otmn, 146); (17) *o(a) → o (Otmn, no rule); (18) *ao → a·(Otmn, no rule); (19) *ao → o (Otmn, 146); (20) *?ao → o/CC_ (Pame, 149); (21) *C[plain]/C[weak] → CC/C (Pame, 149).

In Zapotecan, Mixtecan, Popolocan, and Otopamean, the reconstruction includes a "stem formative," **-*wa*, that is postposed to a laryngeal; one of the Zapotec protoforms replaces the laryngeal with a nasal, although all signs of the laryngeal could have been eradicated within the highly collapsed reflex, *ñu-* (items 1-2). The ProtoChinantec reflexes show no evidence of the stem formative; the Palantla reflex (item 35) shows *-w* as a relatively recent, predictable development.

There are some inconsistencies between the proposals of Table II.7 and Rensch's rules: (1) Rensch does not provide for collapse of three vocoids to one, as in Zapotecan **awa → u* (items 1-2). (2) Zapotec reflex #3 does not have a predictable vowel. (3) Reconstruction of the stem formative of the protoform of items 4-13 is based on one reflex, *-w* of #7, that was recorded in the Sixteenth Century (Córdova 1942: 80). (4) The vocalic nasalization of the Chatino forms #s 8-13 is not reflected in the Zapotec forms #s 4-7. The loss of this nasalization is not explained: (5) Usually, such nasalization is transformed to the preceding consonant, making the consonant lenis (rule 3, Rensch 1976: 155, 157); however, the Zapotec syllable-initial consonant remains fortis in spite of the need to reconstruct vocalic nasalization as the origin of the Chatino forms. (6) This maintenance of a Zapotec fortis consonant in spite of reconstructed vocalic nasalization is accounted for by reconstructing consonantal palatalization in the protoform; thus, **YCV̨ → C[fortis]V*, **CV̨ → C[lenis]V*. Rensch has not adopted this rule. (7) The Zapotec rule **a → e/ty_w* is also not proposed by Rensch. (8) The Zapotecan **e* has become *i* or *y* in some final positions of polysyllabic words, for example items 4-6 and 11. (9) Although the Zapotecan reflexes #s4-13 appear to be cognatic with those of Chinantecan, Popolocan, Otopamean, and Mixtecan, the problems (2-8) suggest that their relationship to ProtoOtomanguean is not fully understood. (10) The Otopamean reconstruction involves a parenthetical vowel whose presence is implied by reconstructions in other branches. Yet Rensch's rules do not account for the disappearance of this vowel as **aoa → ao*. (11) Rensch only provides for the descent of the Mazahua vowel (items 28-30) as

**ao* → *ɔ*, but not for that of the Otomí vowel as **ao* → *aɸ* (cf. Rensch 1976: 146).

(12) Rensch does not account for the disappearance of the glottal stop in Northern Pame, item 31, as **CCʔao* → *CCao* or as **CCaʔɔ* → *CCao*.

Other possible cognates (MCS data) from Otomí mean 'red': Ixtenco *'tʰa·ní*, Santiago Tilapa *tʰieni*, San Antonio el Grande *tʰæ̀ni*, Mezquitál *tʰa·ni*. Newman and Weitlaner (1950:19) reconstruct **tʰɛni* 'red'. Rensch's rules (pp. 142-6) do not derive the **ɛ* from ProtoOtomanguean. He shows that ***CVh* → **C[stop]hV/_ stem formative* (e.g., *-wa*), which would have allowed the Otomian 'red' reflexes to descend as did the 'white' reflexes. If that were the case, then the stem formative was replaced by **-ni* , **nye*, or **nya* in the 'red' protoform; *-ni* is derived from ***Yna* 'warm' in Table II.3.

2.I. Vague, Desaturated, Residual

Finally, there are reflexes in four languages (MCS and WCS data) whose relationship to ProtoOtomanguean and to each other is an open question. All share a vowel articulation */a/* and all designate vague, desaturated, residual color: both Peñoles Mixtec *žàá* (lighter or grey focus), *žàʔá* (darker or brown focus) and Coatzospan Mixtec *žāa*, *žāʔa*, (same lighter and darker foci with coextensive ranges), Chiquihuitán Mazatec *čạ*^{1} (brown or grey focus), San Andrés Chicahuaxtla Trique *dah*^{5} and Copala Trique *dah*^{53} (lighter or grey focus, extended to light blue), Amuzgo of Xochistlahuaca *¢a*^{3} (grey, blue, or, most often, light blue focus) and of San Pedro Amuzgos *¢ɛ* (same).

These forms might be cognates of those in Table II.2, which derive from ProtoOtomangean ***(Y)(n)sa(n)(h)* 'dark-cool'. The dark-cool category of many contemporary Mesoamerican early-stage languages is residual (cf. footnote 3, Chapter VII, page 254). A ProtoOtomanguean residual dark-cool category could have set the condition for reflexes to descend with either 'residual' or 'black' or 'cool' meanings.

3. Summary

ProtoMayan named three color categories with five terms, maintaining a system not more advanced than Stage II. The focus of each term had a firmly established reference to a specific pure color, a characteristic of late phases of near-synonymy and all coextensivity.

ProtoOtomanguean, on an earlier horizon than that of ProtoMayan, named the colors of two basic categories with at least six terms, a lexically complex Stage-I system. Five names of light and warm colors are reconstructed. At least three were nearly synonymous and, with variation and instability, were focused in reference to brightness levels among reds and yellows. Only one name is reconstructed of the dark-cool category, although forms in Otopamean and ChiapanecMangue might allow reconstruction of a second name. Possible cognates that name vague, desaturated color hint that the ProtoOtomanguean dark-cool category was residual, as in some contemporary languages. Present terms for just 'green, blue' and just 'black' that descend from ProtoOtomanguean originally named non-color referents and might not have named color; some reflexes currently name 'dark-cool'.

ProtoZapotecan elaborated the inventory of near-synonyms that emphasized light-warm brightness levels. But each Zapotecan daughter language discontinued one or another of the brightness-level near-synonyms as foci stabilized in reference to pure white, yellow, and red.