2. Color Naming Across Languages

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1. Introduction: Prior cross-linguistic research on color naming

This chapter summarizes some of the research on cross-linguistic color categorization and naming that has addressed issues raised in *Basic Color Terms: Their Universality and Evolution* (Berlin and Kay 1969, hereafter B&K). It then advances some speculations regarding future developments—especially regarding the analysis, now in progress, of the data of the World Color Survey (hereafter WCS). In the latter respect the chapter serves as something of a progress report on the current state of analysis of the WCS data, as well as a promissory note on the full analysis to come.

B&K proposed two general hypotheses about basic color terms and the categories they name: (1) there is a restricted universal inventory of such categories; (2) a language adds basic color terms in a constrained order, interpreted as an evolutionary sequence. These two hypotheses have been substantially confirmed by subsequent research.[1]

There have been changes in the more detailed formulation of the hypotheses, as well as additional empirical findings and theoretical interpretations since 1969. Rosch's experimental work on Dani color (Heider 1972a, 1972b), supplemented by personal communications from anthropologists and linguists, showed that two-term systems contain, not terms for dark and light shades regardless of hue—as B&K had inferred—but rather one term covering white, red and yellow and one term covering black, green and blue, that is, a category of white plus 'warm' colors versus one of black plus 'cool' colors. Rosch reported further that these 'composite' categories, as they were later christened by Kay and McDaniel (1978, hereafter K&McD), tend to be focused not only in white and black, but sometimes at the foci of red or yellow, on the one hand, and of green or blue on the other. B&K had conceived basic color categories in terms of foci and extensions and had expressed the evolutionary sequence of hypothesis (2) as a sequence of constraints on the successive encoding of foci. Rosch’s finding that composite categories may have multiple foci was a major reason for the reconception of the evolutionary sequence in terms of successive divisions of the color space (see e.g., Kay 1975: 258-262)[2].

K&McD modeled these successive divisions of the color space as fuzzy partitions. They interpreted individual color categories as fuzzy sets (Zadeh 1965), [3] and defined the notion of fuzzy partition in terms of a (standard) set of fuzzy sets (K&McD: 641-644). Accordingly, basic color categories were divided into three types. The first type consists of the six fundamental categories, corresponding to Hering's primaries (Hering 1964): black, white, red, yellow, green, blue.[4] The second type, the composites, consists of fuzzy unions of the fundamentals. These include the ‘white/warm’ and ‘black/cool’ categories of two-term systems, as well as several categories comprised by unions of pairs of the six fundamentals (about which more presently). The third type were called ‘derived’ categories and were defined in terms of the fuzzy intersections of the fundamentals. Examples of this type are colors that are seen as mixtures of fundamentals: for example, orange is seen as a mixture of red and yellow (Sternheim and Boynton 1966).[5]

The WCS was begun in 1976.[6] It was designed for two major purposes. The first was to assess the general hypotheses advanced by B&K against a broader empirical basis. Methodological objections had been raised to the empirical generalizations of B&K. The most important of these were that: (1) the twenty languages studied experimentally were not *prima facie* sufficiently numerous to justify universal conclusions; (2) the data were obtained in Berkeley rather than in native communities; (3) most of the speakers interviewed spoke English as well as their native language; (4) the number of speakers interviewed for most of the languages was three or fewer; and (5) the interviewers were not, for the most part, skilled speakers of the languages studied.[7] The second major purpose of the WCS was to deepen our knowledge regarding universals, variation and historical development in basic color term systems.

The methods and some initial results of the WCS are reported in Kay, Berlin and Merrifield (1991, hereafter KBM). With the help of field linguists of the Summer Institute of Linguistics and using a stimulus array substantially the same as that of B&K, comparable data on naming ranges and focal choices for basic color terms were collected on 110 languages *in situ*. In most cases twenty-five speakers were interviewed per language. Monolingual speakers were sought insofar as possible. A methodological departure of the WCS from the method of B&K was that chip-naming judgments were obtained on individual chip presentations, rather than the full array of stimuli. Judgments of best example (focal judgments) were obtained in the same way as in the original study, by requesting selection of the chip or chips that best represent each basic color word of the native language from an array of 330 color patches, representing forty equally spaced Munsell hues at eight levels of lightness (at maximum saturation) plus ten levels of lightness of neutral (black, grey, white) shade.

The preliminary results of the WCS, as reported in KBM, were as follows. (1) B&K had defined evolutionary stages on the assumption that all composite categories are eliminated in favor of the six fundamentals before any derived categories appear. Kay (1975) and K&McD had taken over this assumption in their reformulations of the evolutionary sequence, except for the latter's making formal provision for the optional early appearance of grey.[8] KBM report further cases of early grey and point out, more importantly, that either brown or purple or both not infrequently appear before the green/blue composite is dissolved. (2) Kay (1975: 260-261) had noted evidence from several sources that there might be languages with composite categories comprising yellow and green. MacLaury (1986, 1987a) was the first to document such categories with controlled stimuli. Several more have been found in the WCS languages and were reported in KBM. (3) Prior to the WCS, there had been no rationale offered in the literature for the restricted inventory of composite categories actually reported, distinctly fewer than the sixty-three logically possible combinations of the six fundamentals. KBM both extended the inventory of composite categories empirically attested and provided a partial explanation, in terms of generally acknowledged properties of the visual system, for the restricted membership of this inventory (KBM: 15 ff).

2. The current state of analysis of the WCS data

The initial stage of processing of the WCS data converted the hand-collected data for each collaborating speaker into two arrays, one for naming choices and one for focal choices. The data for the first five speakers of Buglere are displayed in part 2 of Figure 1, naming choices to the left and focal choices to the right. Each symbol in these arrays corresponds to a Buglere color term, as indicated in part 1 of Figure 1.[9] The columns represent the forty equally spaced Munsell hues mentioned earlier[10] and the rows levels of lightness.[11]

Figure 1, part 1: Buglere

Language	Country	Family	Tot. interviewees	Fieldworker(s)	Date
Buglere	Panama	Unclassified	25 (15 F; 10 M)	K. Fisher and J. Gunn	1978

Terms Appearing In Aggregate Naming Arrays

Symbol	Term	Users	Symbol	Term	Users
/	*jere/jerere*	25	*	*moloin/ moloinre*	25
-	*jutre/jusa*	25	@	*lere/lerere*	25
+	*dabe/dabere*	25	#	*leren*	24

Aggregate Naming Arrays

```
           Modal Agreement Level
            1         2         3         4
  01234567890123456789012345678901234567890
A ----------------------------------------- A
B ----------****--------------------------- B
C -**************@@@@@@@@@@-----#------**** C
D -*************@@@@@@@@@@@@@@#@#----*+**** D
E -+++++******@*@@@@@@@@@@@@@@@@####*#*++** E
F /++++*******@@@@@@@@@@@@@@@@########+++++ F
G /+++++*////@@@@@@@@@@@@@@#@#@@#####*+++++ G
H /++++//////////@@@@@@@@@@#@##########++++ H
I /+++/////////////@@@@@@@/@#/############+ I
J ///////////////////////////////////////// J
```

```
   30% Agreement Level, 8 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ----------------------------------------- A
B ----------****--------------------------- B
C -**************@@@@@@@@@@-----#------**** C
D -*************@@@@@@@@@@@@@@#@#----*+**** D
E -+++++******@*@@@@@@@@@@@@@@@@####*#*++** E
F /++++*******@@@@@@@@@@@@@@@@########+++++ F
G /+++++*////@@@@@@@@@@@@@@#@#@@#####*+++++ G
H /++++//////////@@@@@@@@@@#@##########++++ H
I /+++ ////////////@@@@@@@/@#/############+ I
J ///////////////////////////////////////// J
```

```
   70% Agreement Level, 18 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ----------------------------------------- A
B --- -----  **  ---- - ------------------  B
C -*     ******                  ----       C
D -     ******   @@@@@@@                    D
E   + +  ****     @@@@@@@@                  E
F  +++      *   @@@ @@@@         ##       + F
G /+++             @ @@ @        ###     ++ G
H /++++     // /   @@             ##        H
I /     /////////               #           I
J ///////////////////////////////////////// J
```

```
  100% Agreement Level, 25 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                                           C
D                                           D
E                                           E
F                                           F
G                                           G
H                                           H
I                                           I
J                                           J
```

Terms Not Appearing In Aggregate Naming Arrays

Symbol	Term	Users	Symbol	Term	Users
o	*lejre*	10	>	*mnule*	2
=	*kwajusa*	7	x	*dagikwale*	2

Speakers (By I.D. Number, Age And Sex)

1 21 F	6 30 F	11 40 F	16 18 M	21 26 M
2 22 F	7 35 F	12 40 F	17 18 M	22 35 M
3 22 F	8 35 F	13 40 F	18 18 M	23 45 M
4 23 F	9 35 F	14 45 F	19 20 M	24 45 M
5 30 F	10 38 F	15 50 F	20 23 M	25 45 M

Figure 1, part 2: Buglere

Individual Naming Arrays

```
                                    ***  Speaker  1    ***
            1         2         3         4                       1         2         3         4
  01234567890123456789012345678901234567890             01234567890123456789012345678901234567890
A ----------------------------------------- A         A                                           A
B ---------*****-------#------------------- B         B                                           B
C -**--*-********@@@#@@-#@@--##-#------**** C         C   +++    *                               C
D -*-***********@@@@@@@@##@####/#---**+**+- D         D                                           D
E /*+*********@*@@@@@@@@@@#########/#*@++** E         E                                           E
F -+++***-****@@@@@@@@@@@@######@####**++++ F         F                              #            F
G /+++*+*////@/@@@@@@@##@############*+#+++ G         G                   @                       G
H /++++/////////@@@@@@@@@@##@##########++++ H         H                                           H
I ///+///////////@@@o@@@@@@@//##/#####/###/ I         I                                           I
J ///////////////////////////////////////// J         J                                           J

                                    ***  Speaker  2    ***
            1         2         3         4                       1         2         3         4
  01234567890123456789012345678901234567890             01234567890123456789012345678901234567890
A ----------------------------------------- A         A ----------------------------------------- A
B ---------*-***@----o@*------------------- B         B                                           B
C -*************@@o@ooo@@@-@@@###-#----**** C         C                                           C
D /+************oo@@o@o@@@@oo#######o#+***+ D         D        *                                  D
E /+++*+******@*@o@o@@@@@@@ooo##########*** E         E                                           E
F /+++********@@@@o@@@oo@@o#####o#####+++++ F         F                  @                        F
G /++++++****@o@oooooo@@o#o###########+#+*+ G         G  +                                        G
H /+++++++/o/oo@/ooooo@o@#/######o#####++#+ H         H                              #            H
I /++++//////////@ooo@oooo/o/##o/#####++o++ I         I                                           I
J ///////////////////////////////////////// J         J ///////////////////////////////////////// J

                                    ***  Speaker  3    ***
            1         2         3         4                       1         2         3         4
  01234567890123456789012345678901234567890             01234567890123456789012345678901234567890
A ----------------------------------------- A         A                                           A
B ---*>>-->-****-*---@-@----->>--->--->---> B         B                                           B
C -++*+-*********o@@@@@@@@>->------>->-*--+ C         C          *                                C
D >*++++********@@@@@@@@@@-@-@-@#-#--##--*+ D         D                                           D
E >++++++****@@@@@@@@@@@@@@@@@#@@@>*-##++++ E         E                 @                         E
F /+++++++++*@@@@@@@@@@@@@@@#@########-++++ F         F     +                       #             F
G -++++++/++@@@@@@@@@@@@@@@#############+++ G         G                                           G
H /+++++//////@/@@@@@@@@@@######@###+##++++ H         H                                           H
I /++++///////////@@@@@@@#//##############+ I         I                                           I
J ///////////////////////////////////////// J         J                                           J

                                    ***  Speaker  4    ***
            1         2         3         4                       1         2         3         4
  01234567890123456789012345678901234567890             01234567890123456789012345678901234567890
A ----------------------------------------- A         A ----------------------------------------- A
B ---**-*--*****@--####@------------------- B         B                                           B
C +*--***********@@@@@@######-#=#----+-**++ C         C             *                             C
D -+-*+++*****@@@@@@@@@@#@##@#@###-#@#+#**+ D         D                                           D
E /++-+++*+**#@@@@@@@@@@#@####@####-###**++ E         E                                           E
F /++++**++@*@@#@@@@@@@@#@@#@@##########+*+ F         F                     @                     F
G /+++++*+@@@@+@#@@@@@#@@@#####@@####@###*+ G         G   +                            #          G
H /#+++///+@//@/@#@@@@@@#@@@/@##@######*#@+ H         H                                           H
I /+++-+@/////////@##@@@/@#/@##########+#/+ I         I                                           I
J ///////////////////////////////////////// J         J ///////////////////////////////////////// J

                                    ***  Speaker  5    ***
            1         2         3         4                       1         2         3         4
  01234567890123456789012345678901234567890             01234567890123456789012345678901234567890
A ----------------------------------------- A         A ----------------------------------------- A
B -*+*+--*-**++o-----o-o@o---------------** B         B                                           B
C -*+**+*******o*o@o#oo#o@ooooooo----*+*++* C         C                                           C
D -+*+*****+**@ooo#oooooooo#oo#oo-**#**++** D         D                                           D
E /****+*++**ooooooooooooo##ooooooo****+++* E         E  *****                                    E
F /*+*+****/**@#oo#oooooooooo##@ooo*+****+* F         F                                           F
G /**+*++/+///o/o#oo#ooooooo##o##o#o**+*+++ G         G  +++               @         #            G
H /+++++/**//////ooo#o@ooooooooo#o#oo*****+ H         H                                           H
I /******//////////#ooooo#/##oo##oooo#+**** I         I                                           I
J ///////////////////////////////////////// J         J ///////////////////////////////////////// J
```

Numerous recombinations of the data in the individual speaker arrays were performed, two of which merit particular mention here. First, the reader will note in the middle of part 1 of Figure 1 four arrays of the same general shape as those in part 2 of Figure 1. These also refer to Buglere but they characterize the data for the language sample as a whole, rather than for each speaker individually. They are labeled Modal Agreement Level, 30% Agreement Level, 70% Agreement Level and 100% Agreement Level. The Modal Agreement array displays for each stimulus chip the symbol corresponding to the term most often applied to that chip, regardless of how often that was. The 30% Agreement array displays for each stimulus chip the symbol corresponding to the term most often applied to that chip only if that term was used for that chip by at least 30% of the respondents; otherwise no symbol is recorded for the chip. The 70% Agreement and the 100% Agreement arrays are constructed correspondingly, according to the obvious substitutions. These displays are called ‘naming arrays’ because they record a mapping from stimulus colors to the terms assigned to them in the naming task.

Arrays of the other type to be considered here are called ‘term maps’. The term maps are illustrated for Candoshi in Figure 2, part 2. There is a separate map for each term. In the map for a given term, each chip *c* receives a typographical symbol (including blank) of visual ‘density’ intuitively commensurate with the frequency with which speakers named *c* with that term, this frequency expressed as a proportion of the number of speakers naming any stimulus with that term.[12] Term maps give a graphic portrayal of the meaning of each term. High-agreement symbols tend to occur in the interior of categories and lower agreement symbols at the edges. Term maps also give a quick but accurate insight into the degree of consensus of speakers regarding the reference of a term. Compare the very high agreement (‘#’) throughout the blue region in the application of the traditional Candoshi green/blue term and the lower consensus on the emergent green term and the purple term. Note finally that the two phonologically similar[13] Candoshi words for yellow have similar term maps. Term maps provide important information, beyond that given in the naming arrays, for characterizing an internally variable speech community with respect to its degree of basic color term development.

Figure 2, part 1: Candoshi (Peru; Jivaroan; Map: x;[14] B. Hinson[15])

Basic stage	IV. $_{G/Bu}$ → V
Derived categories	purple (weak)
Heterogeneous categories	desaturated (weak)

Candoshi is transitional between stages IV and V. An original green/blue composite category (*kavabana* ‘=’) appears to have recently split and a new term for green (*kamachpa* ‘*’) has emerged. *Kavabana* extends at 30 % agreement to unique green and the green term is almost exclusively confined to yellowish and brownish greens. Nonetheless, all 11 speakers used *kamachpa* ‘green’. These facts suggest that *kavabana* was originally focused in blue and denoted all of blue or green and that this term is currently retracting from green. Two similar expressions are found for ‘yellow’ (*ptsiyaro* and *ptsiyaromashi*), the second of which is treated here as a morphological variant of the first.[16]

A weak term for purple (*tarika* ‘P’) has begun to emerge: four speakers have a well-established word for this category and two show incipient purple.

Finally, a desaturated term (*pozani* ‘x’) occurs with a discontinuous distribution. It is also weak and displays low consensus in the term map.

Basic Color Terms

Term	Gloss	Symbol
kantsirpi	‘black’	•
borshi	‘white’	o
chobiapi	‘red’	+
ptsiyaro(mashi)	‘yellow’	|
kavabana	‘green/blue (blue-focused)' → ‘blue’	=
kamachpa	'(emergent) green’	*
tarika	‘purple’	P
pozani	‘desaturated’	x

Aggregate Naming Arrays

```
         Modal Agreement Level                         30% Agreement Level, 4 of 11 speakers
            1         2         3         4                1         2         3         4
  01234567890123456789012345678901234567890          01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A    A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo|||||oooo=o=ooo==oooooooooooooo B    B oooooooooo|||||oooo=o=ooo==oooooooooooooo B
C o++++++||||||||**===*==*=======oooo++++++ C    C o++++++||||||||**===*==*=======oooo++++++ C
D o+++++|||||||||**===*============xx++++++ D    D o+++++|||||||||**===*============xx++++++ D
E x++++++|||||*******=================+++++ E    E x++++++|||||*******=================+++++ E
F •++++++|||||*****===================+++++ F    F •++++++||||| ****===================+++++ F
G •+++++x++x*x*****==================++++++ G    G •+++++x+   x*****==================++++++ G
H •+++++++x•••••***=***================++++ H    H •+++++++ •••••***=***================++++ H
I •++++••••••••••**=**==*=============P++++ I    I •++++••••••••••**=**==*=============P++++ I
J ••••••••••••••••••••••••••••••••••••••••• J    J ••••••••••••••••••••••••••••••••••••••••• J
```

```
    70% Agreement Level, 8 of 11 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oo oooooo |    ooo      o   ooooo ooooo o B
C o  +       |         =  =   = =  o        C
D o+ +           *     ==========       +   D
E  +++++    |   **     ===========      +++ E
F  +++++               ===========      +++ F
G ●+++++      *   * = =  ==========    ++++ G
H ●++++          **   *  ==========      ++ H
I ●      ●●●●●●●●*         ========         I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   100% Agreement Level, 11 of 11 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B o                       o   ooo o  oo o   B
C o                                         C
D                           =  =            D
E   ++++                  = ====            E
F  +++                    = ======          F
G  + ++                     === ==        + G
H ●  +                     = =====          H
I ●       ●● ●●●             =====          I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

Figure 2, part 2: Candoshi

Term Maps

(# = 81-100% agreement, + = 61-80 % agreement, - = 41-60% agreement, . = 21-40% agreement)

```
•: kantsirpi 'black'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B                                           B
 C                                           C
 D                                           D
 E .                                         E
 F -                                         F
 G #                                         G
 H #     .. .-.--                            H
 I #    --+#######                           I
 J ######################################### J

11 of 11 speakers searched; 11 used term
```

```
o: borshi 'white'

             1         2         3         4
   01234567890123456789012345678901234567890
 A ######################################### A
 B ##+###+##-     ##+- - +-#. +#####+###+#++ B
 C #                              ++#- .     C
 D +                              . .        D
 E .                                         E
 F                                           F
 G                                           G
 H                                           H
 I                                           I
 J                                           J

11 of 11 speakers searched; 11 used term
```

```
+: chobiapi 'red'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B                                           B
 C  --++-.                            ..-+++ C
 D  ++++-.                            --++-+ D
 E  #####+                            .-+### E
 F  #####-.                           ..-### F
 G  #####...                          .+##+# G
 H  ####+..                          . .++++ H
 I  ++++ .                            . .-+- I
 J                                           J

11 of 11 speakers searched; 11 used term
```

```
|: ptsiyaro 'yellow 1'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B          .++++-                           B
 C   .  ..+###+###. .                    .   C
 D  . .--+###+##-- .   .                ..   D
 E  .    -#+#+#--                       .    E
 F     .. .+#+#-.                            F
 G        .-.-.                              G
 H       . . ..                              H
 I                          .                I
 J                                           J

11 of 11 speakers searched; 5 used term: 1..3,5,11
```

```
|: ptsiyaromashi 'yellow 2'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B          .#+##-                           B
 C       .+##+###+#                          C
 D       -++++##+-                           D
 E       .+++#+..                            E
 F        -+-+-.                             F
 G        ..                                 G
 H                                           H
 I                                           I
 J                                           J

11 of 11 speakers searched; 8 used term: 1,4..10
```

```
=: kavabana 'green/blue'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B                    -.+.. -+.              B
 C                 .---.+-.++-+#+#           C
 D                 .--+.#+##+#####-- .       D
 E                 ..---#########++-+-..     E
 F               ...-+++###########+-+.      F
 G               ...-++#++#########++-.      G
 H                ..+-..-+##########+.-.     H
 I                  -.--+.++#######+--...    I
 J                                           J

11 of 11 speakers searched; 11 used term
```

```
*: kamachpa '(emergent) green'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B                                           B
 C                  --.-.- .-                C
 D                 .+---.- .                 D
 E               .-+++----                   E
 F               .++++-..-                   F
 G             . ++-++--- ..                 G
 H              ...+++.-++-.                 H
 I                  #+.+-. + .               I
 J                                           J

11 of 11 speakers searched; 11 used term
```

```
P: tarika 'purple'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B                                           B
 C                                           C
 D                                           D
 E                                           E
 F                                    . -++    F
 G      .                           ---.  .  G
 H      -..                         ------.  H
 I  ++++                           --.-#---- I
 J                                           J

11 of 11 speakers searched; 6 used term: 1,3,4,6,8,9
```

```
x: pozani 'desaturated'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B   .. ..    .  .  .....    .      .   . .- B
 C  --.--..           .. ...... .... -..-.-- C
 D . - ..                   .     ..----..-- D
 E -                              .-...      E
 F .     ..                        .         F
 G       -. ..-  .                           G
 H        .....                              H
 I                                           I
 J                                           J

11 of 11 speakers searched; 10 used term:  1..4,6..11
```

3. Recent conceptual developments

Analysis of the WCS data is currently being conducted within the following conceptual framework, based on our provisional examination of the data (and therefore subject to revision as the analysis proceeds).

A. Ever since B&K (41-45) discussed the ‘premature’ appearance of grey, evidence has accumulated suggesting that the temporal development of basic color term systems should be seen, not as a single process, but as two partially independent processes: (1) the division of composite categories into the six fundamentals and (2) the combination of fundamental categories into derived categories.[17] (Recall KBM’s report that purple or brown or both frequently appear before green and blue separate.) Consequently, the developmental status of a system is now expressed in terms of a ‘basic stage’, which characterizes the system with respect to its composite and fundamental categories, plus a list (often very short) of the derived and heterogeneous[18] categories which correspond to basic color terms in this system. For example, we might have a system characterized as “Stage V; purple, pink”, which would be a system containing basic color terms corresponding to black, white, red, yellow, green, blue, purple and pink. There are just five basic stages, corresponding to systems containing two to six composite or fundamental categories. This conceptual simplification leads to a more perspicuous notation for the sequence of stages, which will be described presently.

B. The categories spanning yellow and green remain a problem, as discussed in KBM. They are few in number, but they unquestionably exist and cannot be dismissed as ethnographic or experimental error. A special study of systems containing categories of this kind is planned. For the moment, systems with a category spanning yellow and green are set aside. (They are taken up again in connection with Figure 4.)

C. Composite category reduction is itself profitably viewed as consisting of two partially independent processes: dissolution of the white/warm channel (w) and dissolution of the black/cool channel (c)[19]. From this perspective, composite category reduction is the same thing as basic stage evolution, that is, the progressive division of the two original composite categories into their six constituent fundamentals, representing the sequence of basic stages I through V. Progress from Stage I (two composite categories comprising three fundamentals each) to Stage V (six fundamental categories) requires two divisions in each of the w and c channels.

D. Although w-division and c-division are partially independent processes, they interact. In our model, the first of the four divisions is always in the w channel, with the result that Stage II systems retain the 3-fundamental c-composite category (Bk/G/Bu). Also, the fourth and final division is always in the c channel, entailing that Stage IV systems always retain a c-composite (and, of course, no w-composite). (See Figure 3 below.)

E. In addition to such constraints on the interaction between the w and c channels, our model also sets constraints on the process of division within each channel. The w channel is more tightly constrained than the c channel. These intra-channel constraints are presented in Table 1 in both words and symbols.

Table 1

w(arm)1:	$\begin{bmatrix}\ldots\\ \text{W/R/Y}\\ \ldots\end{bmatrix}$	$\rightarrow$	$\begin{bmatrix}\text{W}\\ \text{R/Y}\\ \ldots\end{bmatrix}$	A W/R/Y category (always) divides into a W category and a R/Y category.
w(arm)2:	$\begin{bmatrix}\ldots\\ \text{W}\\ \text{R/Y}\\ \ldots\end{bmatrix}$	$\rightarrow$	$\begin{bmatrix}\text{W}\\ \text{R}\\ \text{Y}\\ \ldots\end{bmatrix}$	A R/Y category divides into a R category and a Y category.
c(ool)1:	$\begin{bmatrix}\ldots\\ \text{Bk/G/Bu}\\ \ldots\end{bmatrix}$	$\rightarrow$	$\left\{\begin{matrix}\begin{bmatrix}\text{G/Bu}\\ \text{Bk}\\ \ldots\end{bmatrix}\\ \text{or}\\ \begin{bmatrix}\text{G}\\ \text{Bk/Bu}\\ \ldots\end{bmatrix}\end{matrix}\right\}$	A Bk/G/Bu category divides either into a G/Bu category and a Bk category or into a G category and a Bk/Bu category.
c(ool)2:	$\left\{\begin{matrix}\begin{bmatrix}\text{G/Bu}\\ \text{Bk}\\ \ldots\end{bmatrix}\\ \text{or}\\ \begin{bmatrix}\text{G}\\ \text{Bk/Bu}\\ \ldots\end{bmatrix}\end{matrix}\right\}$	$\rightarrow$	$\begin{bmatrix}\text{G}\\ \text{Bu}\\ \text{Bk}\\ \ldots\end{bmatrix}$	A two-component cool category (either G/Bu or Bk/Bu) divides into its components.

F. The between-channel and intra-channel constraints introduced by our model restrict basic stage evolution to the system types and developmental trajectories portrayed in Figure 3. Within this framework, there are just eight basic system types possible, with three possibilities at Stage III and two possibilities at Stage IV.[20]

G. The limitation to basic stages and to just the types shown in Figure 3 allows a more transparent notation for types than was previously available. Each of the five types constituting Stages III and IV is unambiguously represented by subscripting to the roman numeral denoting the stage an indication of the composite category representing the c channel, as shown in boldface in Figure 3.

Figure 3

		W R/Y G/Bu Bk **III.$_{G/Bu}$** w2→	W R Y G/Bu Bk **IV.$_{G/Bu}$** c2↓	
W/R/Y Bk/G/Bu w1→	W R/Y Bk/G/Bu c1↑ c1→ w2↓	W R/Y G Bk/Bu **III.$_{Bk/Bu}$** w2↓		W R Y G Bu Bk
		W R Y Bk/G/Bu **III.$_{Bk/G/Bu}$** c1↑ c1→	W R Y G Bk/Bu **IV.$_{Bk/Bu}$** c2↑	
I	II	III	IV	V

H. Our initial screening of the data indicates that the vast majority of the languages in the WCS sample fit the model set out in Table 1 and Figure 3 and thus correspond to one of the eight basic system types shown in Figure 3. One important aspect of the ongoing analysis of the WCS materials is to evaluate this claim on a careful language-by-language basis and to establish the extent to which every language in the sample can be revealingly characterized in terms of this model. It should be noted that, according to the model, a given stage subtype may be reached by more than a single route. Type IV.$_{G/Bu}$ can develop either from III.$_{G/Bu}$ via w2 or from III.$_{Bk/G/Bu}$ via c1. Type IV.$_{Bk/Bu}$ may develop either from III.$_{Bk/Bu}$ via w2 of from III.$_{Bk/G/Bu}$ via c1. Type V may develop, via c2, from either IV.$_{G/Bu}$ or IV.$_{Bk/Bu}$. It is clear from our preliminary analysis that some languages are better characterized as transitional between subtypes (according to a specific transition; see Table 1) than as belonging to a single stage or type. Also, while some languages seem to be best characterized as recently emerged instances of their type, others appear to be on the verge of evolving into a new type. Related to the goal of discovering whether the data of every language are naturally organized by the model is the converse goal of checking the extent to which every subtype and transition generated by the model is realized in attested languages (cf. note 20).

I. When applied to the data from individual speakers, it appears that the specific inter-category transitions proposed in Table 1 and displayed for full systems in Figure 3, will go a long way toward ordering language-internal variation as well. Evaluating this preliminary generalization constitutes another current research activity.

J. Systems containing yellow/green composites can now be added to the picture, as shown in Figure 4. Extension of the model to yellow/green systems requires us to add significant complexity of an *ad hoc* kind[21] to cover a small amount of data. Yellow/green systems remain an area that needs careful additional work.

Figure 4

		W R/Y G/Bu Bk **III.G/Bu** w2→	W R Y G/Bu Bk **IV.G/Bu** c2↓	
W/R/Y Bk/G/Bu w1→	W R/Y Bk/G/Bu c1↑ c1→ w2↓	W R/Y G Bk/Bu **III.Bk/Bu** w2↓		W R Y G Bu Bk
		W R Y Bk/G/Bu **III.Bk/G/Bu** c1↑ c1→	W R Y G Bk/Bu **IV.Bk/Bu** c2↑	
		W R Y/G/Bu Bk **III.Y/G/Bu** →	W R Y/G Bu Bk **IV.Y/G** ↑	
		W R Y/G Bk/Bu **III.Y/G** ↑		
I	II	III	IV	V

K. Two categories have turned up in the preliminary analysis that do not fit any of the generalizations mentioned so far (see also Greenfield 1987). One is a category of desaturated, non-vivid or ‘bad’ color. Usually this category contains grey and a diverse collection of hues that never attain high saturation. An example is Candoshi *pozani*. Note in the aggregate naming arrays (Figure 2) that at modal and 30% agreement *pozani* (‘x’) has a scattered distribution and that this term does not occur at all in the 70% agreement array. The term map for this term (Figure 2) shows a wide range, with no chip attaining a high level of consensus. Compare the lack of ‘#’ and ‘+’ here to the maps for the other terms (emergent purple being a partial exception). Lack of focus appears to be characteristic of desaturated terms, and probably of heterogeneous terms generally. Since the WCS data contain only hues at maximum available saturation, careful study will be required to decide if and when a ‘desaturated’ term may name an unbroken volume of the color solid. Another problematical category for which there appears to be some evidence is a category one is tempted to gloss ‘peripheral red’. Several languages have a term that includes colors on the long wavelength border of red, such as parts of pink, orange, maroon, or brown, and also colors on the other, purple, side of red, including a variety of red-purples and lavenders of different lightness levels. We characterize categories which do not name a continuous area of the surface of the color solid as *heterogeneous*.[22]

4. Current and future activities of the WCS

The research activities currently underway are conveniently described within the framework of a planned publication.[23] This is to be a two-volume monograph of which the first volume is devoted to analysis and the second to presentation of the WCS data in a format that will make them readily available to all scholars.

It is convenient to describe the second volume first. This volume will present the full WCS data for each speaker of each language along with some summary information for that language. A prototype Volume 2 entry for one language, Buglere, is given in Figure 1.

In Figure 1, the initial table gives language name, country, language family (if known), number of interviewees, name(s) of fieldworker(s), and date of data collection.

The second table lists the terms that occur in the aggregate naming arrays, each term preceded by the typographical symbol representing it in the arrays which follow. This list contains every term which was the most popular name given to any chip. It will always include all the basic terms, and sometimes include one or two non-basic terms as well.

The four aggregate naming arrays at modal, 30%, 70% and 100% agreement appear as the third item of Figure 1. These have already been discussed.

Following the aggregate naming arrays are a table listing the remaining terms for the language (those not appearing in the aggregate arrays), and a table representing each native collaborator by an identifying number, followed by corresponding age and sex information.[24]

On the second page of Figure 1, the individual naming arrays for each collaborator are given, with naming data on the left and focus data on the right. Figure 1 shows only the first five of the twenty-five Buglere speakers participating in the study. The full Volume 2 entries will of course include the data from all participating speakers of the languages in question. Thus, each Volume 2 entry presents the full WCS data on chip naming and focus identification, arranged in such a way as to maximize their utility to other researchers.

Volume 1 of the proposed monograph will present the analysis of the WCS data. There will be chapters on a number of theoretical topics, several of which were touched on above. Chief among these are the accuracy and generality of the hypotheses embodied in Table 1 and Figures 3 and 4. Also, the nature and extent of heterogeneous categories, the prevalence in the data (or lack thereof) of the phenomenon of coextension (MacLaury 1986, 1987b,1991,1992), and the special problems posed by yellow/green categories must be considered.[25] A number of other general issues have not been mentioned. Notable among these is the treatment of purple in languages which lack a basic term for purple. This question is important because of the apparently privileged position purple holds perceptually in ‘closing the hue circle’, that is, shading into short wavelength blue on one side and long wavelength red on the other just as green and yellow each shades into the adjacent shorter and longer wavelength colors (see, e.g., J&D: **000**). Preliminary screening of the 110 WCS languages reveals sixteen with a basic term for purple and at least one undivided composite. No other non-fundamental hue comes close to this number, suggesting independently a special status for purple.

In addition to chapters, or sections, devoted to the topics sketched in the preceding paragraph, a significant portion of Volume 1 will be devoted to an analysis of each language in the sample on the model of the prototype entry for Candoshi given in Figure 2.

In Figure 2, the title line gives the name of the language, the country in which the data were gathered, the genetic affiliation and an indication of which map the language is marked on, there being a section with maps indicating the location of each language elsewhere in the volume.

The table just below the title line gives the evolutionary stage coordinates of the language in terms of (1) basic stage, (2) derived categories and (3) heterogeneous categories. The notation ‘$\text{IV.}_{\text{G/Bu}} \rightarrow \text{V}$’ in Figure 2 indicates that Candoshi is classified as transitional between stages $\text{IV.}_{\text{G/Bu}}$ and V. The full range of possibilities envisaged for basic stage characterizations are as follows.

X → Y	in transition from X to Y
X	stable X
→ X	entering (‘early’) X
X →	exiting (‘late’) X

Below the table characterizing the evolutionary stage, there is a portion of text which reports the analysis, based on the aggregate naming arrays and the term maps (both shown further on in the figure), which underlies the classification assigned.[26] Candoshi represents an interesting example partly because it demonstrates how the distinctions established in connection with Table 1 and Figure 3 can order what might otherwise be confusing data. It is projected that the set of analytical distinctions proposed here will permit stage characterizations and brief analyses which capture the main features of internal variation of each color term system while simultaneously placing it in the developmental sequence with some finesse. Analysis of the stage status of the language concludes with a discussion of the derived and heterogeneous categories, if any.

The table in the middle of the first page of Figure 2 presents the basic color terms of Candoshi. As mentioned, this set of terms will normally coincide with the set of terms represented in the aggregate naming arrays, although additional criteria are used to determine the basic color terms. These include all the criteria of B&K: 5-7, especially as these have been evaluated by the field linguist (in response to instructions accompanying the field kit).

The list of basic color terms is followed by the four aggregate naming arrays.[27]

The second page of Figure 2 presents the term maps for Candoshi.

To summarize, Volume 1 will consist of a number of chapters dealing with theoretical topics as indicated above, plus a long section containing an analysis of each language in the WCS sample in the format of the analysis of Candoshi constituting Figure 2.

5. Examples of Individual Color Naming Systems

In this section, we apply the conceptual framework developed above. Here we present analyses of WCS languages that are representative of the basic stage types predicted by the theoretical scheme embodied in Table 1 and Figure 3, following the format envisaged for Volume 1 entries.

Stage I

$$\begin{bmatrix} \text{W/R/Y} \\ \text{Bk/G/Bu} \end{bmatrix}$$

As indicated in footnote 20, the World Color Survey sample includes no languages exhibiting a Stage I color system, although earlier field research by Rosch on the Dani shows that such systems do exist and that they conform to the typology suggested here. Furthermore, while the WCS files contain no single language whose basic stage could be classified as Stage I, numerous individual speakers in several languages, e.g., Martu-Wangka of Australia, show Stage I systems of color naming.

Stage II

$$\begin{bmatrix} \text{W} \\ \text{R/Y} \\ \text{Bk/G/Bu} \end{bmatrix}$$

Ejagham (Nigeria, Cameroon; Niger-Congo; J. Watters)

Basic stage	II
Derived categories	none
Heterogeneous categories	none

Ejagham is a Niger-Congo language spoken by 80,000 people in Nigeria (45,000) and Cameroon (35,000).[28] Its color classification illustrates a typical Stage II system, with terms for Bk/G/Bu (*ényàgà*), W (*ébáré*), and R/Y (*ébí*) These categories are strongly established at high levels of consensus (80-100 % agreement in the term maps). In the WCS sample, Stage II systems are found predominantly in Africa.

Basic Color Terms

Term	Gloss	Symbol
ényàgà	‘black/green/blue’	●
ébáré	‘white’	○
ébí	‘red/yellow’	+

Aggregate Naming Arrays

```
          Modal Agreement Level
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooooooooooooooooooooooooooooooooo B
C o++++++++++++●●●●●●oooooooooooooooo+o++++ C
D o+++++++++++++●●●●●●●●●●●●●●●●●oooo++++++ D
E ●+++++++++●●●●●●●●●●●●●●●●●●●●●●●●●++++++ E
F ●+++++++●●●●●●●●●●●●●●●●●●●●●●●●●●●++++++ F
G ●+++++●+●●●●●●●●●●●●●●●●●●●●●●●●●●●++++++ G
H ●+++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●●++++++ H
I ●+++●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   30% Agreement Level,  8 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooooooooooooooooooooooooooooooooo B
C o++++++++++++●●●●●●oooooooooooooooo+o++++ C
D o+++++++++++++●●●●●●●●●●●●●●●●●oooo++++++ D
E ●+++++++++●●●●●●●●●●●●●●●●●●●●●●●●●++++++ E
F ●+++++++●●●●●●●●●●●●●●●●●●●●●●●●●●●++++++ F
G ●+++++●+●●●●●●●●●●●●●●●●●●●●●●●●●●●++++++ G
H ●+++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●●++++++ H
I ●+++●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
    70% Agreement Level, 18 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooo   ooooooooooooooooooooooooooo B
C o+++ + +++++             oooooooooo  ++++ C
D o++++++++++    ●●●●●● ●   ●  ●     ++++++ D
E  +++++++++  ● ●●●●●●●● ●●●●●●●● ●  ++++++ E
F ●+++++++  ●●●●●●●●●●●●●●●●●●●●●●●●●++++++ F
G ●+++++● ●●●●●●●●●●●●●●●●●●●●●●●●●● ++++++ G
H ●++++ ●●●●●●●●●●●●●●●●●●●●●●●●●●●●  +++++ H
I ●  + ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●   + I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
  100% Agreement Level, 25 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oo  oo  o       ooo o oo oo oooo o oooooo B
C o                               o         C
D   +  +++                             ++   D
E  ++++++                              ++++ E
F  +++++           ●●   ●      ●       +++  F
G ●++           ● ●●●  ●●● ● ● ●●●        + G
H ●++++   ● ● ●●●●●●●●●●●●●●●●●●●●●         H
I ●     ● ●●●●●●●● ●●●●●●●●●●●●●●●          I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

Term Maps

(# = 81-100% agreement, + = 61-80 % agreement, - = 41-60% agreement, . = 21-40% agreement)

```
●: ényàgà 'black/green/blue'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C               -.---+---.-... ...          C
D .           ..++#+###+#+-++++++....       D
E +         --+++#######+########+#--       E
F #       --+#++#####################.      F
G #     +-++########################-...    G
H #    -+###########################+-.     H
I #-..-################################--.. I
J ######################################### J

25 of 25 speakers searched; 25 used term
```

```
o: ébáré 'white'

            1         2         3         4
  01234567890123456789012345678901234567890
A ######################################### A
B ##########++++########################### B
C #...-..     ....--.-+-+-+++##+#####-+ .   C
D #            . . .   ...--.....++-+       D
E -         .       .            .          E
F                                           F
G                                           G
H                                           H
I                                           I
J                                           J

25 of 25 speakers searched; 25 used term
```

```
+: ébí 'red/yellow'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B           ....                            B
C  +##-#-#####+..                    --#### C
D  ##########++-.                  . ###### D
E  #########.-..                   .-+##### E
F  #######-.. ..                    .+##### F
G  #####.-..                        -++#### G
H  ####-.                           --+#### H
I  -++-                            .   --++ I
J                                           J

25 of 25 speakers searched; 25 used term
```

Stage III.$_{G/Bu}$

$$\begin{bmatrix} \text{W} \\ \text{R/Y} \\ \text{G/Bu} \\ \text{Bk} \end{bmatrix}$$

Múra-Pirahã (Brazil; Unclassified; S. Sheldon)

Basic stage	III.$_{G/Bu}$
Derived categories	none
Heterogeneous categories	none

Múra-Pirahã is an unclassified language spoken by a small group of foragers residing in four villages along the Maici River in west-central Brazil. The language exemplifies a Stage III.$_{G/Bu}$ system, with color terms for four basic color categories (W, R/Y, G/Bu, Bk). All four are well established at the 70% level of agreement in the aggregate naming arrays. Múra-Pirahã naming responses suggest that the focus of the composite R/Y category is in red while that of G/Bu is in green.

Basic Color Terms*

Term	Gloss	Symbol	Term	Gloss	Symbol
bio^{3}*pai*^{2}*ai*^{3}	'black'	•	*bi*^{3}*i*^{1}*sai*^{3}	'red/yellow'	+
ko^{3}*biai*^{3}	'white'	○	*a*^{3}*hoa*^{3}*saa*^{3}*ga*^{1}	'green/blue'	=

***** Raised numerals represent phonemic tones.

Aggregate Naming Arrays

```
         Modal Agreement Level
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooooooooooooooooooooooooooooooooo B
C o++++ooo+++oo=o==o=o=o=oooooooooooooo++++ C
D o++++++++o+ooo================ooooo++++++ D
E ●++++++++oo===================oooo+++++++ E
F ●+++++++o●o●===================●●●+++++++ F
G ●+++++●●●●●●●●===========●=====●●++++++++ G
H ●++++●●●●●●●●●●●===========●==●=●++++++++ H
I ●+++●●●●●●●●●●●●●●●=●●●●●●●●=●●=●+●+●++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   30% Agreement Level,  8 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooooooooooooooooooooooooooooooooo B
C o++++ooo+++oo=o==o=o=o=oooooooooooooo++++ C
D o++++++++o+ooo================ooooo++++++ D
E ●++++++++oo===================oooo+++++++ E
F ●+++++++o●o●===================●●●+++++++ F
G ●+++++●●●●●●●●===========●=====●●++++++++ G
H ●++++●●●●●●●●●●●===========●==●=●++++++++ H
I ●+++●●●●●●●●●●●●●●●=●●●●●●●●=●●=●+●+●++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   70% Agreement Level, 18 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooooooooooooooooooooooooooooooooo B
C o+++ oo       o   =o     oooooooooo  ++++ C
D o++++++++     =============  = oooo +++++ D
E ●++++++       ================     ++++++ E
F ●++++++       ============== ==    ++++++ F
G ●+++++● ●●●●●● ========== = ==     ++++++ G
H ●++++ ●●●●●●●●● ========  =       +++++++ H
I ●++  ●●●●●●●●●●●●   ●●  ●●●  ●  ● ●   +++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
  100% Agreement Level, 25 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B o ooooooo   o oo o    o o oooooooo oooooo B
C                   =               o       C
D  + +                                 +    D
E  +++           = ==  =      =        ++++ E
F  ++             ====               +++++ F
G ●++               ===                 +++ G
H   +++      ●                         ++++ H
I        ●●●                                I
J                                           J
```

Term Maps

(# = 81-100% agreement, + = 61-80 % agreement, - = 41-60% agreement, . = 21-40% agreement)

•: *bio*^{3}*pai*^{2}*ai*^{3} 'black'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                                           C
D .                                         D
E #          ..                  . ..       E
F #       .+-+..              -  -+..       F
G #     ++####+#-          - . ..--..       G
H #    +#########-.   . . -..-..-.-.        H
I #..-+##########+++--+++++##--#--+-+--.    I
J ######################################### J

25 of 25 speakers searched; 25 used term
```

o: *ko*^{3}*biai*^{3} 'white'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A ######################################### A
B ######################################### B
C #. .-+#+.. -+-+-.- +-+-+++#########-+     C
D +     .. -.++-   .        ... +####-.     D
E .      ..-+...          .     --+..       E
F        ...-                      ..       F
G                                           G
H                                           H
I                                           I
J                                           J

25 of 25 speakers searched; 25 used term
```

+: *bi*^{3}*i*^{1}*sai*^{3} 'red/yellow'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C  +##-. .--+-                       -.#### C
D  ######+#-+.                       -+#### D
E  ######+-.                       .-###### E
F  ######-                          -###### F
G  ##### .                         --###### G
H  ####.                           -####### H
I  #+-.                            - -.+### I
J                                           J

25 of 25 speakers searched; 25 used term
```

=: *a*^{3}*hoa*^{3}*saa*^{3}*ga*^{1} 'green/blue'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C           . .-.++-#.--+...                C
D             .-############++++.           D
E         . ..--##########++####.. .        E
F         .  .++##############-##-.         F
G             . -##########-#+#++-..        G
H                -####+#+#+++--+.+-.        H
I                ...-+. .-.  -+.--          I
J                                           J

25 of 25 speakers searched; 25 used term
```

Stage III.$_{\text{Bk/Bu}}$

$$\begin{bmatrix} \text{W} \\ \text{R/Y} \\ \text{G} \\ \text{Bk/Bu} \end{bmatrix}$$

As previously mentioned (cf. note 20), no unequivocal Stage III.$_{\text{Bk/Bu}}$ language has yet been attested in the preliminary analysis of the WCS data sets. However, the presence at Stage IV of four languages with W, R, Y, G, and Bk/Bu and at Stage III of three yellow/green languages with W, R, Y/G and Bk/Bu indicates that Stage III.$_{\text{Bk/Bu}}$ systems are likely to be discovered. Furthermore, Konkomba shows several Stage III.$_{\text{Bk/Bu}}$ features and is worthy of discussion here.

Konkomba (Ghana, Togo; Niger-Congo; M.A. Langdon)

Basic stage	II→ ?III.$_{\text{Bk/Bu}}$→?IV.$_{\text{Bk/Bu}}$
Derived categories	none
Heterogeneous categories	none

Konkomba is a Niger-Congo language spoken in northeastern Ghana (220,000 speakers) and Togo (50,000 speakers). The aggregate naming arrays for this language suggest that, like many other African languages, it originally exhibited a Stage II color system but is moving toward a Stage III.$_{\text{Bk/Bu}}$ system (developing a term for G), or, alternatively, may be in rapid transition toward IV.$_{\text{Bk/Bu}}$ (developing in addition a term for Y). The data suggest that the terms *bɔmbɔn*, *pipi(i)n*, and *maman* at one time marked the categories Bk/G/Bu, W, and R/Y, respectively. These terms are used by all 25 speakers in the sample.[29] A new term, *ŋaankal*, used by 19 speakers, is emerging at 30% agreement level as the name of the category G (primarily in the light greens, while its full range appears to be that of a G-G/Bu term), leaving *bɔmbɔn* to cover the category Bk/Bu. Finally, the term *diyun*, used by a small number of speakers (9) and emerging at modal agreement level, appears to be developing as a term for Y. While *maman* remains largely the most popular term for the yellow area of the spectrum, including focal yellow, *diyun* is a well-established Y for a majority of its users, as seen in its term map. Its full range indicates that some users extend it to other light colors in the warm area.

Basic Color Terms

Term	Gloss	Symbol	Term	Gloss	Symbol
bɔmbɔn	‘black/blue’	●	*ŋaankal*	‘green'	*
pipi(i)n	‘white’	○	*diyun*	'yellow'	|
maman	‘red/?yellow’	+			

Aggregate Naming Arrays

```
           Modal Agreement Level
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooooooooooooooooooooooooooooooooo B
C o++++++++++||******o*oooooooooooooo+o++++ C
D o++++++++++|******●*●*●o*ooooo●oooo++++++ D
E ●++++++++++●●***●****●●●*●●●●●●●o++++++++ E
F ●+++++++++●●●●●●●●●**●●●●●●●●●●●●●●++++++ F
G ●+++++++●●●●●●●●●●●●*●●●●●●●●●●●●●+++++++ G
H ●+++++++●●●●●●●●●●●●●●●●●●●●●●●●●●+++++++ H
I ●++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   30% Agreement Level, 8 of 25 Speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo oooooooooooooooooooooooooooooo B
C o++++++++++  * *  *o oooooooooooooo+o++++ C
D o++++++++++  *****●*●*  *oooo ●oo o++++++ D
E ●+++++++++  ● **●****●●●*●●●●●●   +++++++ E
F ●+++++++++ ●●●●●●●●**●●●●●●●●●●●●●●++++++ F
G ●+++++++●●●●●●●●●●●●*●●●●●●●●●●●●●+++++++ G
H ●+++++++●●●●●●●●●●●●●●●●●●●●●●●●●●+++++++ H
I ●++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
  70% Agreement Level, 18 of 25 Speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                 o                o        B
C   +                                       C
D  ++++++++                             ++++ D
E  ++++++                      ●      +++++ E
F  ++++++                     ●      ++++++ F
G ●+++++               ●   ●●  ●      +++++ G
H ●++++    ●●●●●●●  ●●  ●●●●●●●●●●    +++++ H
I ●+     ●●●●●●●●●●●●●●●●●●●●●●●●●●         I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
  100% Agreement Level, 25 of 25 Speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                                           C
D                                           D
E  +++++                                    E
F  ++++                                  +++ F
G  ++                                     ++ G
H   ++                      ● ●           +  H
I                                           I
J                                           J
```

Term Maps

(# = 81-100% agreement, + = 61-80 % agreement, - = 41-60% agreement, . = 21-40% agreement)

•: *bɔmbɔn* 'black/blue'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                                           C
D                .  .....  .    .           D
E -           .  .-.. .-...-.--+-..         E
F -        ........--..-.--++-+---.--       F
G #       -.--+-.-----.+++-#++-++--..       G
H #    ...-+#+#++++-++-+#++######+--.       H
I #....+++###+#######+#+++#########-+--.... I
J ######################################### J

  25 of 25 speakers searched; 25 used term
```

o: *pipin* 'white'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A +++++++++++++++++++++++++++++++++++++++++ A
B +++-----+-....++#+++--++++++++++++++----+ B
C +               .. -..-...++-.-++-+....   C
D +                   . .....-...-...       D
E .                      .  .    ..         E
F                                           F
G                                           G
H                                           H
I                                           I
J                                           J

  25 of 25 speakers searched; 23 used term:
2,4..25
```

o; *pipiin* 'white'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A ----------------------------------------- A
B --.--....... ..- ------..-.----.-..----.. B
C ..             .    ...  ...--.-..        C
D .                         . ..  ..        D
E                                .          E
F                                           F
G                                           G
H                                           H
I                                           I
J                                           J

  25 of 25 speakers searched; 21 used term:
1..3,6..10,12,14..25
```

+: *maman* 'red/?yellow'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C  -+++--.---  .                     . ---- C
D  #+#++##+.-.                       +-+#++ D
E  ######-+-.                      ..+##### E
F  ######+-. .                     . +##### F
G  #####--.                        .-+##### G
H  ####---.                         +++#### H
I  +++-..                          ....---- I
J                                           J

  25 of 25 speakers searched; 25 used term
```

*: *ŋaankal* 'green'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C          .   -.-..+..  . .                C
D            ..++-#---.-..-..               D
E           ....-+--+++--.+....  . ..       E
F           . --.--------..... ..           F
G            .. ---.--+....  ...... .       G
H                ....... .                  H
I                                           I
J                                           J

  25 of 25 speakers searched; 19 used term:
2..10,12..15,17,20..24
```

|: *diyun* 'yellow'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B           ..-                          .  B
C  . .  -.++-+-.. ..                 ....-. C
D           .--+...                   . .   D
E           . ...-                   .      E
F                                           F
G                                           G
H                                           H
I                                           I
J                                           J

   25 of 25 speakers searched; 9 used term:
5..8,10,11,19,21,24
```

Stage III.$_{\text{Bk/G/Bu}}$

$$\begin{bmatrix} \text{W} \\ \text{R} \\ \text{Y} \\ \text{Bk/G/Bu} \end{bmatrix}$$

Kwerba (Irian Jaya, Indonesia; Trans-New Guinea; J. and S. De Vries)

Basic stage	→ III.$_{\text{Bk/G/Bu}}$
Derived categories	none
Heterogeneous categories	none

Kwerba, a Trans-New Guinea language, is spoken by some 1500 people in the Upper Tor River area of Irian Jaya, Indonesia (western half of the island of New Guinea). It typifies an early Stage III.$_{\text{Bk/G/Bu}}$ system. In this language, an expression is attested for the composite category Bk/G/Bu, words for W and R are well established, and a term for Y, *kainanesɛnum*, has begun to emerge. Sixteen of the twenty-five speakers interviewed use this term, and the category appears to be well on its way to becoming fully established for the language as a whole.

Basic Color Terms

Term	Gloss	Symbol	Term	Gloss	Symbol
icɛm	'black/green/blue'	•	*nokonim*	'red'	+
əsiram *(əhɛrɛm, ərɛm)**	'white'	○	*kainanesɛnum*	'yellow'	|

* Terms in parentheses are synonyms for *əsiram* .

Aggregate Naming Arrays

```
          Modal Agreement Level
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooooooooooooooooooooooooooooooooo B
C o+++o+oo|||||o|oooooooooooooooooooooo++++ C
D o+++++++|||||o|●●●●●●●ooo●●●ooooooo++++++ D
E ●+++++++|●||●|oo●●●o●●●●●●o●●●●ooo+++++++ E
F ●+++++++●●●●●●●●o●●●●●●●●●●●●●●●●●●++++++ F
G ●+++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●+++++++ G
H ●+++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●+++++++ H
I ●+++●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   30% Agreement Level,  8 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooooooooooooooooooooooooooooooooooo B
C o+++o+o ||||| |o oooooooooooooooooooo++++ C
D o+++++++|||||o|  ● ●●  oo●●●ooooooo++++++ D
E ●+++++++  ||●|o ●●●o●●● ●● ●●●●ooo+++++++ E
F ●+++++++●●●●●●●●o●●●●●●●●●●●●●●●●●●++++++ F
G ●+++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●+++++++ G
H ●+++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●+++++++ H
I ●+++●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   70% Agreement Level, 18 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B   o  o  o         oo oooooo o  ooo o oooo B
C o                         o               C
D  +++++                              +++++ D
E  ++++++                            ++++++ E
F ●++++++                     ● ●    ++++++ F
G ●+++++      ●●        ●● ●●● ●●●   ++++++ G
H ●+++++ ●●●●●●●●●●● ●●●●●●●●●●●●●● +++++++ H
I ●+++ ●●●●●● ●●●●●● ●●●●●●●●●●●●●●    ++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
  100% Agreement Level, 25 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                                           C
D    +                                      D
E   +                                   + + E
F  + ++                                   + F
G   ++                                + +   G
H  +++                                 +    H
I                                           I
J                                           J
```

Term Maps

(# = 81-100% agreement, + = 61-80 % agreement, - = 41-60% agreement, . = 21-40% agreement)

```
●: icεm 'black/green/blue'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                 . . . ..                  C
D .              ..-.-......... .           D
E -        .  .  .-.-.---.--.---+...        E
F +       .+.-+---.-+-++++-+-+++#+---       F
G #     --++++#++-++---+++++#++++#++        G
H #    .+++#+####+#+++#+#++##+##+++-        H
I #   -######+##++#++#+#+##+##+##+#+---  .  I
J ######################################### J

25 of 25 speakers searched; 25 used term
```

```
o: əsiram 'white'

            1         2         3         4
  01234567890123456789012345678901234567890
A +++++++++++++++++++++++++++++++++++++++++ A
B ++++++++++-----++++++++#+++++++++#+++#+++ B
C +.....-. ......-.-.--+--++++--+++++-+-... C
D - .     .. ...  ............--.---+.      D
E .       ........   .  ... .  ...-...      E
F           .     .                         F
G       .    .  .                           G
H       .                                   H
I            .                              I
J                                           J
|
25 of 25 speakers searched; 24 used term:
1..9,11..25
```

```
+: nokonim 'red'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C  -++.-. . .                        . ---+ C
D  ++##++-                           -####+ D
E  ######-.                        .-+##### E
F  #####+-                         .-###### F
G  ##### .                         .+###### G
H  ####+                           .+###### H
I  ###-                            ..- #+## I
J                                           J

25 of 25 speakers searched; 25 used term
```

```
|: kainanesɛnum 'yellow'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B           ....                            B
C     . ..+++#+--.                          C
D      . --++++--..                         D
E        --.+-.+.                           E
F        .- ..                              F
G                                           G
H                                           H
I                                           I
J                                           J

25 of 25 speakers searched;16 used term:
1,2,4..6,8..13,15,17,18,23,24
```

Stage IV.$_{\text{G/Bu}}$

$$\begin{bmatrix} \text{W} \\ \text{R} \\ \text{Y} \\ \text{G/Bu} \\ \text{Bk} \end{bmatrix}$$

Sirionó (Bolivia; Tupí; P. and A. Priest)

Basic stage	IV.$_{\text{G/Bu}}$
Derived categories	none
Heterogeneous categories	none

Sirionó is a Tupian language spoken by approximately 500 individuals in the eastern Beni and northwestern Santa Cruz departments of the Bolivian lowlands. It is classified as Stage IV.$_{\text{G/Bu}}$. The language shows well established terms for W, R ,Y, G/Bu, Bk. The G/Bu composite category is focused in blue.

Basic Color Terms

Term	Gloss	Symbol	Term	Gloss	Symbol
erondeɨ	'black'	•	*echo*	'yellow'	|
eshĩ	'white'	○	*eruba*	'green/blue'	=
eɨrẽɨ̃	'red'	+			

Aggregate Naming Arrays

```
            Modal Agreement Level
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo|||||oooooooooooooooooooooooooo B
C o|++++|||||||||||o=o==o=o=oo=oooooo|o++|+ C
D o++++||||||||||||==============oooo++++++ D
E •+++++|||||||||===================+++++++ E
F •++++++|||||||||===================++++++ F
G •+++++•••••••||====================++++++ G
H •++++••••••••••===================+++++++ H
I •+++••••••••••••••=•••••••••====•=•••+++• I
J ••••••••••••••••••••••••••••••••••••••••• J
```

```
   30% Agreement Level,  8 of 24 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo|||||oooooooooooooooooooooooooo B
C o|++++||||||||||| =o= o o=oo=oooooo|o++|+ C
D o++++||||||||||||==============oooo +++++ D
E •+++++|||||||||===================+++++++ E
F •++++++||||| |||================== ++++++ F
G •+++++ ••••••||====================++++++ G
H •++++••••••••••===================+++++++ H
I •+++••••••••••••••=•••••••••====• •  +++  I
J ••••••••••••••••••••••••••••••••••••••••• J
```

```
   70% Agreement Level, 17 of 24 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B ooooooooo      oooo o ooooooooooooooooooo B
C o      ||||||||                ooo        C
D o+ +   ||||||||      ==  = =         + +  D
E  +++++ ||||  ||      ==== ====      +++++ E
F •+++++                  =  ====      ++++ F
G •++++              =   = == ===     +++++ G
H •++++  • •••••                       ++++ H
I •+   ••••••••••                        +  I
J ••••••••••••••••••••••••••••••••••••••••• J
```

```
  100% Agreement Level, 24 of 24 informants
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B  o                            o           B
C                                           C
D                                           D
E                                           E
F     +                                  ++ F
G  ++                                    ++ G
H    +                                    + H
I                                           I
J                                           J
```

Term Maps

(# = 81-100% agreement, + = 61-80 % agreement, - = 41-60% agreement, . = 21-40% agreement)

•: *erondeɨ* 'black'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                                           C
D                                           D
E -           .                     .       E
F +       .. ...                            F
G #     .++----.           . .     .        G
H #    .++-#####+-.     .... .. .           H
I # ..-+###+#####+-- -.+-++-++-- .. ...   . I
J ######################################### J

24 of 24 speakers searched; 24 used term
```

o: *eshĩ* white'

```
           1         2         3         4
 01234567890123456789012345678901234567890
A ######################################### A
B ##+##+###+... .+#++++-#+##+############## B
C #                . . .- ---+-+-###+ .     C
D +                       .  ..  --..       D
E .                                         E
F                                           F
G                                           G
H                                           H
I                                           I
J                                           J

24 of 24 speakers searched; 24 used term
```

+: *eɨrẽĩ* 'red'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C  .--.-                             ..--.- C
D  ++#-..                            .++++- D
E  +####.                          ..-+#### E
F  ####+-.                           -+#### F
G  ####-                            .++#### G
H  ####.                            ---#### H
I  +-+.                            .  .--+. I
J                                           J

24 of 24 speakers searched; 24 used term
```

|: *echo* 'yellow'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B      .   .+-++-                           B
C  .. ..-#######+--. ..  .           . ...  C
D     .-+#####+++--.. .              .    . D
E       .+++#-.++...                        E
F      ...----.....                         F
G       .   .. .-                           G
H                                           H
I                                           I
J                                           J

24 of 24 speakers searched; 24 used term
```

=: *eruba* 'green/blue'

```
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                     ..                    B
C                ...-.-....-..- .           C
D                ..-.+-++--#-+++--...       D
E            ..  ----++++#+-++##+--.        E
F            .....-+---+++#++#+#+--..       F
G               .----+---+++++##+++..       G
H               ..---+--.++-+-++++--...     H
I     ..          ..-...  ....--+-..... . . I
J                                           J

24 of 24 speakers searched; 24 used term
```

Stage IV.$_{Bk/Bu}$

$$\begin{bmatrix} \text{W} \\ \text{R} \\ \text{Y} \\ \text{G} \\ \text{Bk/Bu} \end{bmatrix}$$

Martu-Wangka (Australia; Pama-Nyungan; J. and M. Marsh)

Basic stage	IV.$_{Bk/Bu}$
Derived categories	none
Heterogeneous categories	peripheral red?

Martu-Wangka is an Australian (Pama-Nyungan) language spoken by about 820 people in the Jigalong area of Western Australia. It is classifed in the WCS as Stage IV.$_{Bk/Bu}$, with terms for W, R, Y, G, and a composite color category encompassing black and blue. At the 30% level of agreement, *parnaly-parnaly*, a term restricted in its distribution to brownish reds, is used by 15 speakers. According to the field linguists for Martu-Wanka, *parna* is the word for ‘earth, ground, sand’ and “probably does not qualify as a ‘basic’ color term, as it would appear to mean ‘earth-like’.” The term map for *parnaly-parnaly*, however, suggests a possible meaning of ‘peripheral red’. Although the judgment of the field linguists that *parnaly-parnaly* should not be considered a basic color term is probably deserving of acceptance, we have included the discussion of this term for completeness and to illustrate the kind of borderline cases that can arise in analyzing the WCS data.

Martu-Wangka color terms commonly exhibit reduplication and appear to be derived from verbs or nouns, e.g., *maru-maru* ‘black, blue’ < *maru* ‘to darken or become black’; *miji-miji* ‘red’ < *miji* ‘blood’; *yukuri-yukuri* ‘green’ < *yukuri* ‘grass’. The unreduplicated term *karntawarra* is the word for ‘yellow ochre’.

Basic Color Terms

Term	Gloss	Symbol	Term	Gloss	Symbol
maru-maru	‘black/blue’	●	*karntawarra*	‘yellow’	|
piila-piila/piily-piily/ pily-pily/pilya-pilya/ pira-pira/piirl-piirl/ piily/pilya/pirilypa/ pirilyi/pirly	‘white’	○	*yukuri-yukuri, yakuripiti*	‘green’	*
miji-miji	‘red’	+	*parnaly-parnaly, parna*	‘peripheral red’?	~

Aggregate Naming Arrays

```
          Modal Agreement Level
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo||**ooooooooooooooooooooooooooo B
C o++++++|||||************ooooooooooo++++++ C
D o+++++|||||*************●●●●●●●ooo+++++++ D
E ●++++++||||*************●●●●●●●●+++++++++ E
F ●+++++~~~●~************●●●●●●●●●+++++++++ F
G ●+++++~+~●●●*●●*******●●●●●●●●●●+++++++++ G
H ●++++~●●●●●●●●●●●***●●●●●●●●●●●●●++++++++ H
I ●++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●+●●+++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   30% Agreement Level,  8 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo|| *ooooooooooooooooooooooooooo B
C o+++ + |||||************ ooooooooo  +++++ C
D o+++++|||||*************●● ●●●● oo+++++++ D
E ●++++++ | |*************●●●●●●●● ++++++++ E
F ●+++++~~   ************●●●●●●●●●+++++++++ F
G ●+++++~ ~●●●*●●*******●●●●●●●●●● ++++++++ G
H ●++++~●●●●●●●●●●●***●●●●●●●●●●●●●++++++++ H
I ●++++●●●●●●●●●●●●●●●●●●●●●●●●●●●●+●●+++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   70% Agreement Level, 18 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C              * ****                       C
D              **********              ++   D
E  +++        *********              +  +++ E
F  ++++        *********      ●●      +++++ F
G ●+++           ******     ● ●      ++++++ G
H ●+ ++    ●●●●●         ●●●●●●● ●     ++++ H
I ●     ●●●●●●●●●●●●●●●●●●●●●●●●●           I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   100% Agreement Level, 25 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                                           C
D                                           D
E                                           E
F                                           F
G  +                                        G
H                                           H
I                                           I
J                                           J
```

Term Maps*

(# = 81-100% agreement, + = 61-80 % agreement, - = 41-60% agreement, . = 21-40% agreement)

* A single linguistic variant for each basic category is shown in the arrays

```
●: maru-maru 'black/blue'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                     .  ...  ..            C
D                        ..-.-..-.          D
E +                    ...--.--++-          E
F -        . .. .   . ...-+++++++-.         F
G +      ...--.-- ......-+++++++++.         G
H #     .--#+###+-+-.--+++##++#+++-.        H
I #   .-+##################+####+-+.-.. ... I
J ######################################### J

25 of 25 speakers searched; 25 used term
```

```
o: piila-piila 'white'

            1         2         3         4
  01234567890123456789012345678901234567890
A ######################################### A
B +++++-++-+ .. -+-+-++-+-++-+++++++-++-+++ B
C -. ... .             .- .------+-+...   . C
D - .                     . .... ....       D
E         .                      .          E
F .                                         F
G                                           G
H                                           H
I                                           I
J                                           J

25 of 25 speakers searched; 21 used term:
1..5,7..9,11..18,20..23,25
```

```
+: miji-miji 'red'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C  -.....                           ...---- C
D  +----.                          ..--+++- D
E  #++++-                         .+-+++#++ E
F  ####- .                        ---+++### F
G  ###+- .                        .-++#+### G
H  #+#+.                          .--+++##+ H
I  ----.                         . -...---. I
J                                           J

25 of 25 speakers searched; 25 used term
```

```
|: karntawarra 'yellow'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B           ---.                            B
C        -+#--.                             C
D       -#+++-                              D
E        ----                               E
F         . .                               F
G                                           G
H                                           H
I                                           I
J                                           J

25 of 25 speakers searched; 17 used term:
1,3..5,7..9,12,13,15,16,18..20,22,24,25
```

```
*: yukuri-yukuri 'green'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B            ..-.                           B
C           ..-#+####++-.-                  C
D            .+##########. .                D
E           .-+########++-..                E
F            --+######+#-..                 F
G           ....-###++++..                  G
H                -.++-...                   H
I                                           I
J                                           J

25 of 25 speakers searched; 23 used term:
1..5,7..13,15..25
```

```
~: parnaly-parnaly 'peripheral red'?

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B           .                               B
C . .-..-.                          ...     C
D   .....                                 . D
E    . .-...                             .  E
F      .#+--..                              F
G     .-#.+-...                             G
H   .. ---+..   .                           H
I    ...                                    I
J                                           J

25 of 25 speakers searched; 15 used term:
1..3,5,7,9,11..13,15,16,21,23..25
```

Stage V

W
R
Y
G
Bu
Bk

Kalam (Papua New Guinea; Trans-New Guinea) [L. Scholz]

Basic stage	V
Derived categories	none
Heterogeneous categories	none

Kalam is a Trans-New Guinea language spoken by 15,000 people in the Hagen district of the Western New Guinea Highlands. It is classified as a Stage V system, with distinct terms for each of the six fundamental categories, W, R, Y, G, Bu, and Bk. At the modal level of agreement, a single purple chip is given the name *anjeŋ-ay*. Eight of the twenty-five Kalam collaborators use this term; in all cases it has an uneven, roughly 'peripheral red' distribution. *Anjeŋ-ay* is probably best not considered a basic color term of Kalam.

Basic Color Terms

Term	Gloss	Symbol	Term	Gloss	Symbol
mosimb	'black'	●	*walin*	'yellow'	|
tund	'white'	o	*minj-kimemb*	'green'	*
likañ	'red'	+	*muk*	'blue'	-

Aggregate Naming Arrays

```
          Modal Agreement Level
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo|||||oooooooooooooooooooooooooo B
C o|||||||||||||||*********oooooooooooo+oo+ C
D o+|+|||||||||||********-**-*--ooooo*+++++ D
E ●+++++||||||||**********---------o-++++++ E
F o++++++|||||||**********-----------++++++ F
G ●+++++||●●●||●*********-----------*++++++ G
H ●++++●●●●●●●●●********------------+++++++ H
I ●++++●●●●●●●●●●●*****●*-●---------++G++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
     30% Agreement Level,  8 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo|||||oooooooooooooooooooooooooo B
C o|   |||||||||||*********oooooooooooo     C
D o+ +|||||||||||********-**-*--ooooo  ++++ D
E  +++++||||||||**********---------  ++++++ E
F o+++++ |||||||**********--------- -++++++ F
G ●+++++ |  ●|  *********----------  ++++++ G
H ●++++●●● ● ●●●********------------+++++++ H
I ●++++ ●●●●●●●●●●*** * *-●--------- + ++++ I
J ●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●●● J
```

```
   70% Agreement Level, 18 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A ooooooooooooooooooooooooooooooooooooooooo A
B oooooooooo|||| ooo oo ooooooooooooooooooo B
C o       |||||||    *      o  oooooo o     C
D o     |||||||   **               o        D
E  ++ +  |||||   *            -          ++ E
F  +++            *        -  ----      +++ F
G  + ++            **  *     -----      +++ G
H  ++++                     -  ----    +++++ H
I  +++                        ----       ++ I
J                                           J
```

```
  100% Agreement Level, 25 of 25 speakers
            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C o                                         C
D                                           D
E                                           E
F                                           F
G                                           G
H                                           H
I                                           I
J                                           J
```

Term Maps

(# = 81-100% agreement, + = 61-80 % agreement, - = 41-60% agreement, . = 21-40% agreement)

```
•: mosimb 'black'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C                                           C
D                                 .         D
E .                                         E
F .       ..  .                             F
G +      ...-...                            G
H -    ---.-.----.                          H
I -    .--+--+-+--.- ... .-.. .   .         I
J ######################################### J

25 of 25 speakers searched; 18 used term:
1..6,8..11,14,16..19,21,23,24
```

```
o: tund 'white'

            1         2         3         4
  01234567890123456789012345678901234567890
A ######################################### A
B #####+##++    -+##++++################### B
C #.  ...               . .-#++#+####-+ ..  C
D +                             -+-#+       D
E .                              . .        E
F -                                         F
G                                           G
H                                           H
I                                           I
J                                           J

25 of 25 speakers searched; 25 used term
```

```
+: likañ 'red'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B                                           B
C   ..                                 .  . C
D  - -.                               .-.-. D
E  #++#+.                            -.+++# E
F  ###++.                            -++##+ F
G  #+##+                           ..+++#+# G
H  ####.                            --+###+ H
I  #+#-                             .. ++## I
J                                           J

25 of 25 speakers searched; 23 used term:
1..18,20..23,25
```

```
|: walin 'yellow'

            1         2         3         4
  01234567890123456789012345678901234567890
A                                           A
B         ..####-.                          B
C  ....--+#####++- .                     .. C
D   . .-#######+-                           D
E       .#####+-.                           E
F       .---+-..                            F
G        .  ... .                           G
H                                           H
I                                           I
J                                           J

25 of 25 speakers searched; 24 used term:
1..6,8..25
```

```
*: minj-kimemb 'green'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B                                           B
 C                ---++---+.                 C
 D              ..-++++----.-..              D
 E              .-+++-++.--....    .         E
 F            ...++#++-+-+-. .               F
 G              .-+++#+++-...        .       G
 H              ..-++-+--.-..                H
 I                .-.-.- ...                 I
 J                                           J

25 of 25 speakers searched; 25 used term
```

```
-: muk 'blue'

             1         2         3         4
   01234567890123456789012345678901234567890
 A                                           A
 B                                           B
 C                         .                 C
 D                      ..-.-+.+-.           D
 E                   ......---+#++.. .       E
 F                  ......-++++###+-.-       F
 G                   ... ----++###++..       G
 H                  .. ..--++#++#+#+-        H
 I            .     .. ...-.++++##+-..       I
 J                                           J

25 of 25 speakers searched; 25 used term
```

Notes

[1] Maffi (1991) provides relevant bibliography.

---

[2] Several studies in addition to Rosch's are cited in Kay (1975) as supporting the idea of color term evolution involving category boundaries as well as foci.

[3] A fuzzy set is a function from a (standard) set of objects to a real interval, conventionally the interval between zero and unity inclusive.

[4] These are called ‘fundamental neural response categories’ in the K&McD model. At the time, the opponent hue primaries of Hering (red, yellow, green, blue) were considered by vision researchers to benefit from direct neurophysiological confirmation in the response characteristics of certain LGN cells of the rhesus macaque (De Valois, *et al.* 1966). This simple model of the neurological substrate for the perceptual phenomena of color categorization (e.g., Sternheim and Boynton 1966, Wooten 1970) has more recently been replaced by more complex models, based on spatial as well as spectral opponency, by interaction within cells of color and luminance information, and on the behavior of a wider range of neural structures, including the cones, the horizontal cells, and the bi-polar and ganglion cells (e.g., De Valois and De Valois 1993). It is now recognized that the 1966 model of De Valois *et al.* failed to account for as wide a range of the perceptual phenomena of color as was originally thought. The validity of the six perceptually salient Hering primaries retains broad consensus in the vision research community, as does the conviction that a fully satisfying neurophysiological derivation must eventually be forthcoming (Abramov this volume).

Jameson and D'Andrade (this volume, hereafter J&D) propose to drive a further wedge between the Hering primaries and their neurophysiological substrate. J&D argue, with regard to the psychophysical level, that neither cancellation experiments nor after-image facts support perceptually unique red, green, yellow and blue as determinants of the axes of chromatic opponency. At the physiological level, they point to Abramov and

Gordon's (1994) observation that the crossover points of recorded LGN cells do not correspond well to the phenomenal unique hue points, but rather suggest axes like bright red/greenish blue and yellow-green/dark purple (although this latter point is effectively answered by De Valois and De Valois 1993, which J&D also cite).

J&D locate the Hering primaries at the level of a conceptual (or semantic) ‘color space’, a higher-level cognitive object, whose properties are inferred from the application of multidimensional scaling techniques to judged similarities among pairs of colors and whose relation to the psychophysics of color J&D acknowledge to be uncertain. Assuming, for the sake of brevity, that J&D are correct in all of this, the Hering primaries are deprived of significant psychophysical support.

Nevertheless, J&D accept the phenomenal reality of the Hering primaries. Indeed, they attempt to provide for them a different psychological substrate than that of standard opponent theory. The Hering primaries, whatever perceptual rationale they are finally accorded, remain a major interface between color vision and the semantics of color.

In unpublished work, Kemmerer (1995) argues that color *categories* cannot be represented at the ganglion/LGN level. Color constancy effects (modeled by Land, e.g. 1974) show that color categorization requires comparison of signals arising at points in the retina further separated than the diameter of the largest area represented by a ganglion or LGN cell. Based on the work of Zeki (most recently, 1993) and others, Kemmerer proposes a cortical model of the B&K findings. This model posits comparison and recoding of color signals at a series of cortical levels, including the V1, V2, V4 and TO areas.

[5] A derived category is defined as twice the fuzzy intersection (that is, twice the minimum) of the fuzzy categories from which it is derived. Consider the case of red, yellow and the derived category orange. It follows from the fuzzy set implementation of the opponent

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process model that the red function and the yellow function sum to unity throughout the range in which they are both non-zero. The derived category orange has a fuzzy set function that rises from zero at the red and yellow unique hue points to unity at the point at which the red and yellow fuzzy categories both have ordinates of .5. This procedure expresses formally the observations (i) that the more equal the mixture of red and yellow perceived in a color, the more orange that color appears and (ii) that a color that consists perceptually of an equal (non-zero) mixture of red and yellow is as orange as you can get.

[6] Funded by NSF grants BNS 76-14153, BNS 78-18303, BNS 80-06802, and SBR 9419702; also supported by the Summer Institute of Linguistics (SIL), the Anthropology and Linguistics Departments and the Institute of Cognitive Studies at University of California at Berkeley, and the International Computer Science Institute, Berkeley, CA. All these sources of support are gratefully acknowledged.

[7] Scientific challenges such as these merit serious attention. Epistemological and/or deontological critiques have also appeared, which empirical research is not equipped to address. For example, Saunders and van Brakel consider K&McD's “reductionist argument” according to which “six basic or atomic color categories ... can be reduced to Fundamental Neural Response categories,” as invalidated by the prior epistemological tenet that “... there is no privileged discourse in which what is true is independent of our choices, hopes and fears” (Saunders and van Brakel 1994: 8). The Western scientific tradition presupposes the existence of an objective world independent of human choices, hopes or fears. To suppose that the world exists independent of human sentiments is not, of course, to conclude that unbiased construals of that world are easy to achieve or that science provides a magic formula for avoiding bias. The empirical researcher believes that one can reduce (not eliminate) bias through the disciplined application of procedures of

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observation and inference designed specifically with the reduction of bias as their object and trusts that the exercise of this discipline can sometimes result in one type of understanding: scientific understanding. Saunders and van Brakel are not atypical of those post-modernists who leap from the observation that the attainment of scientific understanding is not trivial to the conclusion that it is not possible. We assume, contrariwise, that the existence of science provides strong evidence of its possibility. A comprehensive evaluation of the post-modern critique of research on color naming is beyond the scope of this paper. (See Hardin 1993 and Stanlaw 1993 for careful appraisals of several points.)

[8] See K&McD: 639. B&K and Kay (1975) had earlier noted a few exceptions to this rule with regard to grey and brown, but these cases were left unexplained by the generalizations embodied in the evolutionary sequence.

[9] Figures 1 and 2 contain more information than is conveniently explained at their first introduction. All the features in the figures will be fully explained in due course. The reader's patience is requested for the moment.

[10] Column 0 presents the neutral white-to-black sequence.

[11] All forty entries of row A denote a single pure white chip and all of row J a single pure black chip.

[12] For example, if at least 81% of the speakers who name any chip with the term being mapped name chip c with that term, then c receives '#'. If 61 - 80% of the speakers who name any chip with the term being mapped name chip c with that term, then c receives ‘+’.

If 41 - 60% of the speakers who name any chip with the term being mapped name chip c with that term, then c receives ‘–’. And so on, as indicated in the legend above the term maps in part 2 of Figure 2.

[13] And almost certainly morphologically related.

[14] See Section 4 for details on maps.

[15] Names in square brackets following a language name indicate the field linguist(s) who gathered data on that language for the WCS. We acknowledge with gratitude the work, not only of the SIL field linguists whose names appear here, but also of each of the over 100 such persons contributing to this study.

[16] This is supported by their almost identical distributions in their respective term maps. Therefore, in the aggregate naming arrays, they are assigned the same symbol '|'.

[17] MacLaury (1986) was the first to suggest this.

[18] Heterogeneous categories are discussed below.

[19] The use of the word ‘channel’ here is motivated by the fact that the grammar of English requires that *some* noun be employed and a choice like ‘what's-its-name’ or ‘thingamabob’ could be distracting. In particular, no pretense of denoting a neurological entity is intended.

[20] Some caveats apply. First, the reader is reminded that we have not yet introduced consideration of languages containing words for yellow/green categories (cf. Fig. 4).

Secondly, the WCS sample contains no examples of Stage I systems, although their existence is documented elsewhere, and therefore noted in Fig. 3. Thirdly, our initial screening of the WCS sample discloses no unequivocal example of type III.$_{\text{Bk/Bu}}$ (but cf. description of Konkomba in Section 5), although it indicates four languages at Stage IV with W, R, Y, G and Bk/Bu and three yellow/green languages at Stage III with W, R, Y/G and Bk/Bu (see Figure 4).

[21] That is, there are no evident generalizations, comparable to those summarized in Table 1, regarding yellow/green transitions.

[22] Further analysis may show the peripheral red category to describe an ‘unbroken’ region of the surface of the color solid in the sense that the surface of a lake with an island may be said to present an unbroken expanse of water. Thus the heterogeneous categories may turn out to be less bizarre than they appear at first sight.

[23] The format described here reflects our current thinking on the monograph. These decisions are subject to revision as the work proceeds.

[24] More information on speakers than this was gathered. The decision to restrict published information on individual speakers to age and sex stems from our initial evaluation of space constraints.

[25] These are spelled out in some detail in KBM.

[26] Consideration of the individual speaker data may also enter into this analysis.

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[27] The aggregate naming arrays also appear in the Volume 2 entries, as illustrated in Figure 1 for Buglere. This redundancy has been thought desirable to make each volume relatively self-contained.

[28] Here and in the following examples, geo-demographic data on individual languages, as well as their language family ascriptions, are derived from Grimes (1992).

[29] In the case of the W category, this applies to the combined data for the terms *pipin* and *pipiin*, which are analyzed as variants and given the same symbol 'o' in the aggregate naming arrays. The separate term maps for *pipin* and *pipiin* support this analysis by showing their overlapping distribution.

References

Abramov, I. (this volume). Physiological mechanisms of color vision. **000**.

Abramov, I. and J. Gordon 1994. Color appearance: On seeing red--or yellow, or green, or blue. *Annual Review of Psychology* 45: 451-485.

Berlin, B. and P. Kay 1969. *Basic Color Terms: Their Universality and Evolution*. Berkeley and Los Angeles: University of California Press. First paperback edition 1991, with a bibliography by Luisa Maffi.

De Valois, R.L. and K.K. De Valois 1993. A multi-stage color model. *Vision Research* 33(8): 1053-1065.

De Valois, R.L., I. Abramov, and G.H. Jacobs 1966. Analysis of response patterns of LGN cells. *Journal of the Optical Society of America* 56: 966-977.

Greenfield, Ph.J. 1987. What is grey, brown, pink,and sometimes purple: The range of “wild-card” color terms. *American Anthropologist* 88: 908-916.

Grimes, B. (ed.) 1992. *Ethnologue. Languages of the World*. 12th ed. Dallas: Summer Institute of Linguistics.

Hardin, C.L. 1993. Van Brakel and the not-so-naked emperor. *British Journal for the Philosophy of Science* 44(1): 137-150; 44(2): 377 [correction].

Heider [Rosch], E. 1972a. Universals in color naming and memory. *Journal of Experimental Psychology* 93: 10-20.

Heider [Rosch], E. 1972b. Probabilities, sampling and ethnographic method: The case of Dani colour names. *Man* 7: 448-466.

Hering, Ewald 1964 [1920]. *Outlines of a Theory of the Light Sense*. Cambridge, Mass.: Harvard University Press.

Jameson, K. and R.G. D'Andrade (this volume). It's not really red, green, yellow, blue: An inquiry into perceptual color space. **000**.

Kay, P. 1975. Synchronic variability and diachronic change in basic color terms. *Language and Society* 4: 257-270.

Kay, P., B. Berlin, and W.R. Merrifield 1991. Biocultural implications of systems of color naming. *Journal of Linguistic Anthropology* 1: 12-25.

Kay, P. and Ch.K. McDaniel 1978. The linguistic significance of the meanings of basic color terms. *Language* 54(3): 610-646.

Kemmerer, D.L. 1995. *Towards a cognitive neuroscience analysis of ther meanings of basic color terms*. Cognitive Science Technical Report # 95-7. SUNY, Buffalo.

Land, E. 1974. The retinex theory of color vision. *Proceedings of the Royal Institution of Great Britain* 47: 23-58.

MacLaury, R.E. 1986. Color in Mesoamerica: A theory of Composite Categorization. Doctoral dissertation. University of California at Berkeley.

MacLaury, R.E. 1987a. Color-category evolution and Shuswap yellow-with-green. *American Anthropologist* 89: 107-124.

MacLaury, R.E. 1987b. Coextensive semantic ranges: Different names for distinct vantages of one category. *Papers from the 23rd Annual Regional Meeting of the Chicago Linguistic Society* Part I: 268-282.

MacLaury, R.E. 1991. Exotic color categories: Linguistic relativity to what extent? *Journal of Linguistic Anthropology* 1: 26-51.

MacLaury, R.E. 1992. From brightness to hue: An explanatory model of color category evolution. *Current Anthropology* 33: 137-186.

Maffi, L. 1991. A bibliography of color categorization research 1970-1990. In *Basic Color Terms: Their Universality and Evolution*, by B. Berlin and P. Kay, 1st paperback edition. Berkeley: University of California Press. Pp. 173-189.

Saunders, B.A.C. and J. van Brakel 1994. Translating the World Color Survey. ms. 18 pp.

Stanlaw, J. 1993. Review of B. A. C. Saunders: *The invention of basic colour terms*. *American Anthropologist* 95(1): 183-184.

Sternheim, C.E. and R.M. Boynton 1966. Uniqueness of perceived hues investigated with a continuous judgemental technique. *Journal of Experimental Psychology* 72: 770-776.

Wooten, B.R. 1970. The Effects of Smultaneous and Successive Chromatic Constraint on Spectral Hue. Doctoral dissertation. Brown University, Providence, RI.

Zadeh, L.A. 1965. Fuzzy sets. *Information and Control* 8: 338-353.

Zeki, S. 1993. *A Vision of the Brain*. Cambridge, Mass.: Blackwell Scientific.