Colors on hands:
Phonological markedness of sign language color terms

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Introduction

Color Terms in Spoken Language

- Intuitively, *purple* is a less 'basic' color term than *white*. One may wonder whether this 'basicness' of colors is reflected in natural languages in one way or the other.
- Berlin & Kay (1969; henceforth: B&K) found an implicational hierarchicy in the color term systems of different languages: if a language has a term for a 'lower ranked' color, it also has terms for the 'higher ranked' colors, cf. Figure 1.
- For instance, when the vocabulary of a language contains a term for 'blue', it will also contain terms for 'white', 'black', 'red', 'green', and 'yellow'.
- In later versions (Kay & McDaniel 1978; and others) these seven stages were reduced to three subgroups:
  1. white, black;
  2. red, green, yellow, blue;
  3. brown, purple, pink, orange, grey.

Sign Language Color Terms

- The few studies on color terms in sign languages (SL) revealed methodological problems, since common SL strategies such as fingerspelling and pointing conflict with B&K's defining criteria (Nyst 2007; Woodward 1989).
- Still, it has been suggested that the same hierarchy can be applied to SLs.
- The central question guiding our research is: Are there any (possibly modality-specific) characteristics in which SL color terms correspond to the proposed hierarchy?

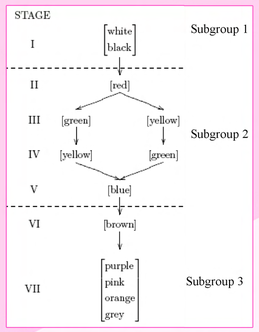

Figure 1: Hierarchical ordering of basic color terms as proposed by B&K (1969); divided into three subgroups according to later revisions (Kay & McDaniels, 1978; Kay & Regier, 2003; among others)

Phonological Markedness Score

RED (NGT)

	features	N
HC	[one]	1
POA	[HEAD],[lo],[mid] [prox],[contact]	5
M	[repeat] (x2)	2

BLUE (NGT)

	features	N
HC	[all → one] [opp → radial] [joined] + 2x change	7
POA	([NSS]), [ipsi]	1
M	[pivot] (x2)	2

Figure 2: Two examples of NGT color terms: RED & BLUE.
Note the difference in number of features of both colors. This results in the following calculation:

RED: (1 x 0,56) + (2 x 0,35) + (5 x 0,09) =1,71
BLUE: (7 x 0,56) + (2 x 0,35) + (1 x 0,09) =4,71

In order to determine the phonological markedness of a given color sign, we developed a Phonological Markedness Score (PMS) based on the following criteria.

(i) The **phonological representation** of signs as suggested by Sandler (1989, 1996; Sandler & Lillo-Martin 2006), Feature count:
- The more complex the phonological representation of a parameter (i.e. the more features are needed to describe it), the more marked it is;
- The parameters Hand Configuration (HC), Movement (M), and Place of Articulation (POA) were taken into account;
- The maximum feature count for each of the three parameters is 10 (the score for M is doubled); two-handedness and feature change were taken into account;
- Default features such as the HC-feature [open], the POA-feature [neutral signing space (NSS)] and the M-feature [straight] receive 0 as value.

(ii) Evidence from the **sign language acquisition** of parameters (Conlin et al. 2000):
- The scores determined on the basis of (i) were not simply added up;
- Rather, the individual scores were weighted differently based on error rates in acquisition reported in Conlin et al. (2000): HC 56%, M 35%, POA 9%.

Combining (i) and (ii), we arrive at the following PMS formula:
$(N_{HC} \times 0{,}56) + (N_{M} \times 0{,}35) + (N_{POA} \times 0{,}09)$

Research Question & Hypothesis

Is there a correlation between the basicness of a color and the phonological markedness of the corresponding sign?

- Hypothesis: Across different stages of the hierarchy in Figure 1, color terms increase in phonological markedness.
- Hence, the lower a color is ranked on the hierarchy, the more complex the sign for that color term will be.

Data

Corpora

- Color terms from 14 sign languages were extracted from online and print dictionaries; see Figure 3. A total of 184 color signs was investigated.
- 13 sign languages can be classified as "subgroup 3 languages" (contain more then 10 terms for different colors)
- 33 color signs show multiple variants: Turkish Sign Language e.g. has four signs for 'yellow'. All variants were included in the sample as separate signs.
- One sign language can be classified as a "subgroup 2 language", containing only signs for 'black', 'white' and 'red': AdaSL (Nyst 2007).

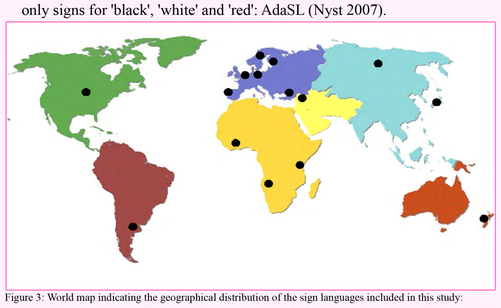

Figure 3: World map indicating the geographical distribution of the sign languages included in this study:

- American Sign Language > http://www.aslpro.com/cgi-bin/aslpro/aslpro.cgi
- Argentine Sign Language > http://manosquehablan.com.ar/diccionario/Colores/
- Bulgarian Sign Language > http://www.youtube.com/watch?v=vWhdNLQ6jVw.
- Catalan Sign Language > http://lsc.wiksign.org/wiki/Categoria:Colors
- German Sign Language > http://www.sign-lang.uni-hamburg.de/alex/lemmata/oberbegr/farbe.htm
- Japanese Sign Language > http://ja.wikipedia.org/wiki/%E6%97%A5%E6%9C%AC%E6 http://www.youtube.com/watch?v=DwABn-iiLu8
- Latvian Sign Language > http://www.liis.lv/latval/zimval/vin.htm
- Namibian Sign Language > Namibian Signs. Sign Language Instruction DVD For Families Of Hearing Impaired Children. British High Commission Windhoek CLaSH.
- New-Zealand Sign Language > http://homepages.ecs.vuw.ac.nz/~pondy/nzsl/home-vocab.html
- Russian Sign Language > http://www.stanford.edu/group/ll/data2/rsl/index9.html
- Sign Language of the Netherlands > http://www.kegg.nl/egg_gebaren.php
- Swedish Sign Language > http://130.237.171.78/fmi/iwp/cgi?db=Digital%20version%20av%20Svenskt%20teckenspr%C3%A5 kslexikon& loadframes
- Tanzanian Sign Language > Kamahi ya lugha ya alama Tanzania: Tanzanian Sign Lan guage dictionary : Swahili/English - sign language. Tanzania Association of the Deaf.
- Turkish Sign Language > http://turkisaretdili.ku.edu.tr/en/wordlist.aspx# http://turkisaretdili.ku.edu.tr/en/wordlist/sozluk.aspx?Cat=4#
- Adamorobe Sign Language > Nyst (2007)

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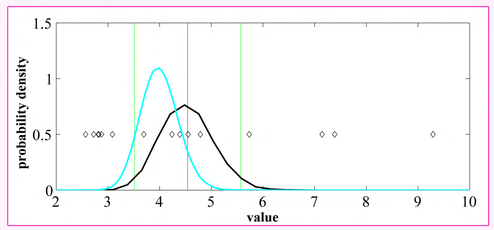
Methodology

Bootstrapping

- Bootstrapping is used to estimate how sensitive a statistic (here: the mean) is to the sample that happened to be selected. This is especially relevant when one only has a small sample from an unknown distribution.
- Bootstrapping creates new "virtual" samples from the original sample, by drawing (with replacement) random elements from the original sample. We used "case resampling" where the virtual samples are the same size as the original sample (see Figure 4a).
- Bootstrapping gives a more detailed picture of what the range of the statistic (the mean, indicated with a red line in Figure 4b) is than ordinary confidence intervals would (vertical green lines).
- However, bootstrapping cannot do magic. As in Figure 4b, when using a small sample (15 data points from the gamma (8, 0.5) distribution indicated with black diamonds) the spread of the mean calculated by bootstraping (black line) can still be quite different from the spread of the mean calculated by really taking new samples (light blue line).



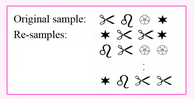


Figure 4a (above): Case resampling

Figure 4b (left): Bootstrapping example. For explanation, see text.

Interpretation (cf. Figure 4)

- Highest point of the black curve indicates the most likely value of the mean: the further it is to the right, the higher the mean value.
- Width of the black curve indicates the spread of the mean: the wider the curve, the less certain the mean is.
- Applied to our study this implies: (i) the more the highest point is to the right, the more phonologically marked the color sign is; (ii) the less overlap there is between curves, the more certain we are that the difference in PMS between two colors is real.

Discussion & Conclusion

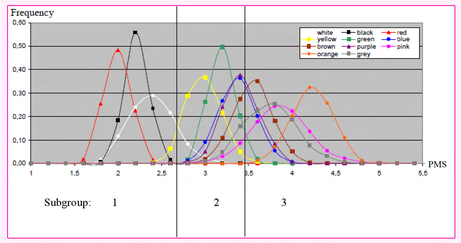


Figure 5: Bootstrapped means of color terms' phonological markedness.
Note how markedness increases with the color's position in the hierarchy.

Results

- Across our sample, color terms increase in phonological markedness according to the 3 subgroups.
- An analysis of the PMS of all 184 color signs (on a scale of 0-10) yields PMS scores between 0.8 and 6.0.
- Remarkably, across SLs the color signs for 'red' are exceptional in that in almost all SLs, RED was phonologically less marked than WHITE or BLACK.
- In Catalan SL e.g., the score for RED is 1.71 (sign and score very similar to Figure 2), while WHITE has a PMS of 3.63 and BLACK of 3.25.
- Possible explanation for the deviant behavior of RED: use of pointing signs.

Further Research:

- What is the status of the color sign variants? Dialectal variation? Historical change?
- Does this correlation between 'basicness' of a color term and its PMS apply to spoken languages?

The 'basicness' of a color term is reflected in the phonological markedness of the corresponding color sign: PMS increases as color terms become'less basic'.

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