Constraints on Concept Formation

Dany Jaspers (CRISSP-HUBrussels, KULeuven)

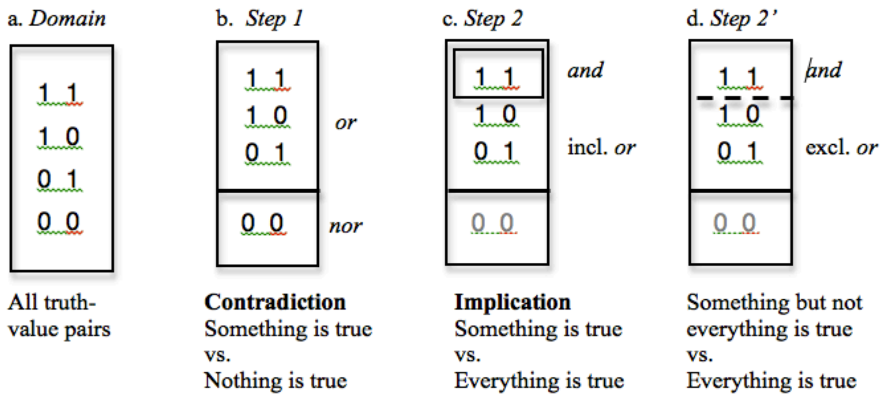
1. Introduction

A limitation on natural concept formation and lexicalisation in natural language has hitherto gone unobserved. To bring it to light and show its relevance to biolinguistics, I will first characterize the nature of this Concept Formation Constraint (CFC) by illustrating its operation in the lexical domain of logical operators. Secondly, I will extend the constraint to a wide range of other lexical domains. Third, a proposal will be made about the origin of this constraint by proving the existence of a surprising homology between logical concepts on the one hand and the system of primary (*RGB*) and secondary (*YMC*) colour percepts on the other. This colour-logic homology suggests that basic conceptual oppositions are innate patterns deeply rooted in the physiological structure of human cognition, somehow linked to the system of trichromatic vision that generates the colour oppositions.

2. The Concept Formation Constraint for logical operators

In the realm of propositional operator concepts, a set of four natural operators is generated by making subtractions from a fixed domain space of values via a series of two successive binary divisions. There is an initial exhaustive division between the contradictories NOR and OR (1b); within the remaining non-NOR space of values, we can either carve out the subset AND, leaving inclusive OR as superset space (1c), or we can divide the inclusive OR space exclusively into AND and exclusive OR (1d).

(1)

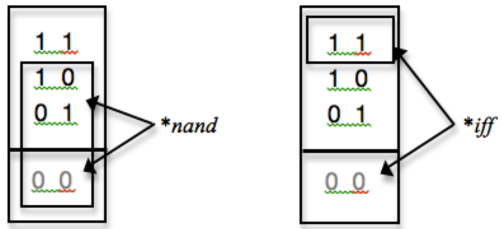


Natural logical terms are lexicalisations of concepts that match and respect these two natural binary divisions of the concept space. This results in a set of four naturally lexicalized concepts that can be summarized by means of the following XP-like structure in labeled bracketing format:

(2) [$_{D}$ *nor* [$_{or\text{-inclusive}}$ *or*-exclusive *and*]].

Of these four, three are contrary concepts (NOR, OR-excl, AND), while the fourth, OR-incl, is a subspace of the original domain D and denotes the union of the two contraries *and* and *or*-exclusive. One can of course freely decide to violate the CFC and create concepts which are non-congruent with the natural binary divisions. That will however systematically result in notions which never arise naturally in normal natural language acquisition. Thus in the realm of propositional operators one can cut across the basic NOR-OR division (1b) to create the two well-known but nonnatural operators **nand* and **iff*.

(3) a. *Illicit Term* b. *Illicit Term*



Similar considerations apply in the realm of quantifiers, for which the natural pattern and the two nonnatural operators which straddle the fence of the opposition of step 1 are given in (4):

(4) [$_{\text{D}}$ *no* [$_{\textit{some maybe all}}$ *some-but-not-all* *all*]]; **nall* (= NO + SOME-BUT-NOT-ALL) (Horn 2012) and *allno (= NO + ALL) (Jaspers 2012)

3. The Concept Formation Constraint in other lexical domains

Further data indicate that the incremental binary CFC is extremely general in functional lexis, witness the following examples from the realms of different kinds of deixis (with –deictic/+deictic as foundational opposition), which are just a tiny selection of the patterns that will be presented:

(5) [$_{\text{D}}$ *what* [$_{\textit{THAT}}$ *this* *that*]]; **thatwhat* and **whis*

(6) [$_{\text{D}}$ *where* [$_{\textit{THERE}}$ *here* *there*]]; **therewhere* and **wh-here*

(7) [$_{\text{D}}$ 3$^{\text{rd}}$ PERSON SING [$_{\text{2nd PERSON-inclusive}}$ 2$^{\text{nd}}$ PERSON SG-excl 1$^{\text{st}}$ PERSON SG]]; **s/heI*(=3SG+1SG) and **s/heyou*(=3SG+2SG)

Note that the intermediate subspace term is often reused for one of the new concepts that arise in step 2. This corresponds to what is known about colour terms, which often develop an additional narrower denotation as a new category carves out part of their original denotation (Berlin & Kay 1969).

4. The Logic-Colour Homology

Looking at the lexis for the primary (RGB) and secondary (YMC) colours of the additive colour system, we observe once more that the three primaries and one secondary colour (Y) have natural lexicalisations, while the names *magenta* and *cyan* are crafted terms. Moreover, of the four natural terms, Y is the one that denotes an additive mix of two primaries (R and G), i.e. it denotes a percept resulting from the combined activation of the two cone types that separately generate R and G percepts. This results in a pattern of percept relations that is identical in its structure to that of all the XP-representations above. And once again there are two perfectly logical perceptual mixes M and C which however get nonnatural lexicalisations.

(8) [$_{\text{WHITE}}$ BLUE [$_{\text{YELLOW}}$ GREEN RED]]; *M (= R+B) and *C (=G+B)

Their special linguistic status matches a perceptual asymmetry between the colour mixes Y and CM: Y is perceived as a *unary* colour, not as reddish-green, while C and M are perceived as combinations: bluish-green and reddish-blue. Note also that the initial domain colour WHITE is (like Y) perceived as a unary colour rather than as bluish-yellow. All of this is widely taken in colour vision science to mean that the trichromatic RGB base has superimposed on it a pair of binary oppositions (Hering 1964/1920). Combining this idea with the fact that trichromacy appears to have arisen in primates from a dichromat state by development of a novel M/L photopigment (Jacobs 2009) – i.e., elaboration at the Y pole, we are driven to conclude that the R – G opposition is a binary division within the Y percept space of the basic B – Y opposition as in (8), which yields precisely the familiar XP-like structure also typical of CFC. The biolinguistic relevance of this isomophism is expressed in the final sentence of the introduction.

References: Berlin & Kay (1969), *Basic Color Terms. Their universality and evolution*, University of LA Press; Hering, E. (1964 [1920]). *Outlines of a Theory of the Light Sense.* Cambridge, Massachusetts: Harvard University Press. Horn, L. R. (1989), *A Natural History of Negation,* University of Chicago Press, Chicago; Jacobs, G. (2009) "Evolution of color vision in mammals", Phil Trans Royal Society, 364, 2957-2967; Jaspers (2012), Logic and Colour, *Logica Universalis*, Volume 6, Issue 1-2, pp 227-248.