Origins of Mind: Lecture 02

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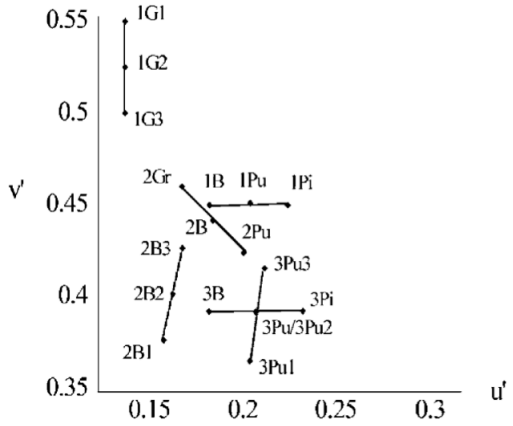
1. Categorical Perception of Colour

What is categorical perception of colour commonly taken to explain? The diagram below represents sequences of three colours. The vertical sequence shows three greens and the uppermost horizontal sequence shows a blue, a purple and a pink.



Daoutis et al. 2006 figure A1

Each colour differs from its neighbours by the same amount according to a standard measure based on the human eye's abilities to discriminate wavelengths.

Yet the greens are often judged to look quite similar and the blue-pink-purple to look very different (Roberson et al. 1999, p. 12–7). When people are asked to name these colours, they often give the same name to the greens but different names to members of the blue-pink-purple sequence. And people are generally faster and more accurate in discriminating between members of the blue-pink-purple sequence than members of the green sequence (faster: Bornstein & Korda 1984; more accurate: Roberson et al. 1999, p. 22–7).

pop-out 'Such targets pop out of the display, so that the time it takes to find them is independent of the number of distractors' (Treisman 1986, p. 117).

When target and distractors differ in colour category there can be pop-out effects (Daoutis et al. 2006).

A process is *automatic* just if whether it happens is independent of the subject's task and motivation (to a significant degree)

vMMN (visual mismatch negativity): an event-related potential thought to index preattentive change detection in the visual cortex

2. Categorical Perception in Infancy

Categorical perception of colour emerges early in infancy. This has been demonstrated with four-month-olds using habituation (Bornstein et al. 1976) and visual search (Franklin et al. 2005).

Slightly older infants can make use of colour properties such as red and green to recognise objects.

For instance, nine-months-olds can determine whether an object they saw earlier is the same as a subsequently presented object on the basis of its colour (Wilcox et al. 2008).

By the time they are two years old, toddlers who do not comprehend any colour words can use colour categories implicitly in learning and using proper names; for instance, they are able to learn and use proper names for toy dinosaurs that differ only in colour (Soja 1994, Experiment 3).

So infants and toddlers enjoy categorical perception of colour and may benefit from it in recognising and learning about objects.

However children only acquire concepts of, and words for, colours some time later; and colour concepts, like colour words, are acquired gradually (Pitchford & Mullen 2005; Kowalski & Zimiles 2006; Sandhofer & Smith 1999; Sandhofer & Thom 2006).

2.1. Other cases

Infants enjoy categorical perception not only of colour but also of orientation (Franklin et al. 2010), speech (Kuhl 1987, 2004; Jusczyk 1995) and facial expressions of emo-

tion (Etcoff & Magee 1992; Kotsoni et al. 2001; Campanella et al. 2002).

3. Categorical Perception and Knowledge

Categorical perception provides 'the building blocks—the elementary units—for higher-order categories' (Harnad 1987, p. 3).

'The module … automatically provides a conceptual identification of its input for central thought … in exactly the right format for inferential processes' (Leslie 1988, pp. 193–4)

Acquiring colour concepts depends on acquiring colour words (Kowalski & Zimiles 2006).

'the course of acquisition for color is protracted and errorful' (Sandhofer & Thom 2006)

'the earliest conceptual functioning consists of a redescription of perceptual structure' (Mandler 1992)

Colour words shape adults' categorical perception (Roberson & Hanley 2007; Winawer et al. 2007).

Categorical perception provides 'the building blocks—the elementary units—for higher-order categories' (Harnad 1987, p. 3).

4. Categorical Perception in Infants and Adults

In adults, categorical perception of colour disappears in the face of predictable verbal interference but not non-verbal interference (Roberson & Davidoff 2000; Pilling et al. 2003; Wiggett & Davies 2008).

'surprising it would be indeed if I have a perceptual experience as of red because I call the perceived object 'red" (Stokes 2006, pp. 324–5)

There is evidence that the infant mode of categorical perception of colour continues to operate in adults, although it is often inhibited or overshadowed by the adult mode (Gilbert et al. 2006).

References

Bornstein, M., Kessen, W., & Weiskopf, S. (1976). Color vision and hue categorization in young human infants. *Journal of Experimental Psychology: Human Perception and Performance*, *2*(1), 115–129.

Bornstein, M. & Korda, N. (1984). Discrimination and matching within and between hues measured by reaction times: some implications for categorical perception and levels of information processing. *Psychological Research*, *46*(3), 207–222.

Campanella, S., Quinet, P., Bruyer, R., Crommelinck, M., & Guerit, J. M. (2002). Categorical perception of happiness and fear facial expressions: An ERP study. *The Journal of Cognitive Neuroscience*, *14*(2), 210–227.

Daoutis, C., Pilling, M., & Davies, I. (2006). Categorical effects in visual search for colour. *Visual Cognition*, *14*, 217–240.

Daoutis, C. A., Franklin, A., Riddett, A., Clifford, A., & Davies, I. R. L. (2006). Categorical effects in children's colour search: A cross-linguistic comparison. *British Journal of Developmental Psychology*, *24*, 373–400.

Etcoff, N. L. & Magee, J. J. (1992). Categorical perception of facial expressions. *Cognition*, *44*(3), 227–40.

Franklin, A., Catherwood, D., Alvarez, J., & Axelsson, E. (2010). Hemispheric asymmetries in categorical perception of orientation in infants and adults. *Neuropsychologia*, *48*(9), 2648–2657.

Franklin, A., Pilling, M., & Davies, I. (2005). The nature of infant color categorization: Evidence from eye movements on a target detection task. *Journal of Experimental Child Psychology*, *91*(3), 227–248.

Gilbert, A. L., Regier, T., & Ivry, R. B. (2006). Whorf hypothesis is supported in the right visual field but not the left. *PNAS*, *103*(2), 489–494.

Harnad, S. (1987). Psychophysical and cognitive aspects of categorical perception: A critical overview. In S. Harnad (Ed.), *Categorical Perception: The Groundwork of Cognition*. Cambridge: Cambridge University Press.

Jusczyk, P. (1995). Language acquisition: Speech sounds and the beginning of phonology. In L. Miller, Joanne & P. D. Eimas (Eds.), *Speech, Language and Communication*. San Diego: Academic Press.

Kotsoni, E., Haan, M. d., & Johnson, M. H. (2001). Categorical perception of facial expressions by 7-month-old infants. *Perception*, *30*(9), 1115–1125.

Kowalski, K. & Zimiles, H. (2006). The relation between children's conceptual functioning with color and color term acquisition. *Journal of Experimental Child Psychology*, *94*, 301–321.

Kuhl, P. K. (1987). The special-mechanisms debate in speech research: Categorization tests on animals and infants. In S. Harnad (Ed.), *Categorical Perception: The Groundwork of Cognition*. Cambridge: Cambridge University Press.

Kuhl, P. K. (2004). Early language acquisition: cracking the speech code. *Nature Reviews: Neuroscience*, *5*(11), 831–843.

Leslie, A. (1988). The necessity of illusion: Perception and thought in infancy. In L. Weiskrantz (Ed.), *Thought Without Language* (pp. 185–210). Oxford: Clarendon.

Mandler, J. M. (1992). How to build a baby: Ii. conceptual primitives. *Psychological Review*, *99*(4), 587–604.

Pilling, M., Wiggett, A., Özgen, E., & Davies, I. R. L. (2003). Is color "categorical perception" really perceptual? *Memory & Cognition*, *31*, 538–551.

Pitchford, N. J. & Mullen, K. T. (2005). The role of perception, language, and preference in the developmental acquisition of basic color terms. *Journal of Experimental Child Psychology*, *90*(4), 275–302.

Roberson, D. & Davidoff, J. (2000). The categorical perception of colors and facial expressions: The effect of verbal interference. *Memory*, *28*(6), 977–986.

Roberson, D., Davidoff, J., & Braisby, N. (1999). Similarity and categorisation: neuropsychological evidence for a dissociation in explicit categorisation tasks. *Cognition*, *71*(1), 1–42.

Roberson, D. & Hanley, J. R. (2007). Color vision: Color categories vary with language after all. *Current Biology*, *17*(15), R605–R607–R605–R607.

Sandhofer, C. M. & Smith, L. B. (1999). Learning color words involves learning a system of mappings. *Developmental Psychology*, *35*(3), 668–79.

Sandhofer, C. M. & Thom, E. E. (2006). Taking the task seriously: Reflections on measures of color acquisition. *Journal of Experimental Child Psychology*, *94*(4), 344–348.

Soja, N. N. (1994). Young children's concept of color and its relation to the acquisition of color words. *Child Development*, *65*(3), 918–937.

Stokes, D. (2006). Review of "seeing, doing and knowing" by mohan matthen. *British Journal of Aesthetics*, *3*(46), 323–5.

Treisman, A. (1986). Features and objects in visual processing. *Scientific American*, *255*(5), 114–125.

Wiggett, J. A. & Davies, I. R. L. (2008). The effect of stroop interference on the categorical perception of color. *Memory & Cognition*, *36*(2), 231–239.

Wilcox, T., Woods, R., & Chapa, C. (2008). Color-function categories that prime infants to use color information in an object individuation task. *Cognitive Psychology*, *57*(3), 220–261.

Winawer, J., Witthoft, N., Frank, M. C., Wu, L., Wade, A. R., & Boroditsky, L. (2007). Russian blues reveal effects of language on color discrimination. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(19), 7780–5.