

Do Infants See Colors Differently?

Infants, unlike adults, store color categories in the brain's right hemisphere. This new finding reveals the surprising power of language over perception.

By Rick Hanley and Debi Roberson

How do we perceive a rainbow? And does everyone perceive a rainbow in the same way? These seemingly simple questions can reveal some interesting features of the human brain. For instance, is the “striped” appearance of the rainbow—the seven distinct bands of color that we see—a construct of our higher mental processes, or do the mechanics of human color vision determine it at a very early perceptual level? If your language does not have separate words for “blue” and “green” (and many languages, including Welsh, do not), do you perceive these shades as more similar than a speaker of English?

Searching for answers to these questions, in recent years many scientists have concluded that speakers of languages that label color in ways distinct from those used in English may see a different rainbow from that of English speakers. Recent studies have claimed that language processing is automatically involved in perceptual decisions about color in the brains of adults, even when hues are visible only briefly (100 milliseconds) or when decisions do not require participants to name colors verbally. Moreover, these effects are language-specific, so speakers of Russian or Korean show a different pattern of responses to color than speakers of English.

A recent study in PNAS by researchers at the University of Surrey challenges this view, however. It suggests an intriguing and novel account of color categorization in infants. In this study 18 English-speaking adults and 13 four-month-old infants were shown a colored target on a colored background. Adults were faster to initiate eye-movements toward the target when the target and background colors came from different color categories (for example, blue target, green background) than when both target and background were the same color (such as different shades of blue).

How Babies See Color

This discrimination advantage for different-category compared to same-category judgments is called Categorical Perception (CP). It is now clear that the effect in adults is language-driven. For instance, healthy, right-handed adults only show CP selectively when colors are presented to the right visual field. It is generally accepted that CP occurs because colors presented to the right visual field preferentially access language-processing areas located in the left hemisphere.

The authors of the new article agree with the current general consensus that CP in adults depends on privileged access to language areas in the left hemisphere. They also agree that the precise color terms that are represented in language are culturally transmitted during childhood and that there has been no “nativist,” or innate, pre-linguistic partitioning by the visual processing pathways into innate color categories in the left hemisphere. This idea fits with their data demonstrating that four-month-old infants showed no hint of CP when targets were presented in the right visual field. Because these infants have not yet acquired language, it is unsurprising that

they do not show language-driven category effects in the left hemisphere.

So far, so predictable. What is striking, however, is that the same four-month-old infants did show a CP effect in the right hemisphere, exactly the reverse of the effect shown by adults. When a green target appeared on a green background in the left visual field (which has preferential access to the right hemisphere), infants were significantly slower to move their eyes toward the target than when a blue target appeared on the same green background. The authors claim that their results provide some evidence for pre-linguistic partitioning of color categories in four-month-old infants, but only from stimuli that preferentially access the right hemisphere. Such a result provides some empirical evidence for the existence of an innate pre-linguistic category boundary between blue and green.

If infants show an initial innate organization of color into precise categories in the right hemisphere of the brain, does such organization persist into adulthood? The answer to this question appears to be, “no, it does not.” Even when the dominant left-hemisphere system is suppressed by a concurrent task that prevents access to verbal codes in the left hemisphere, or cannot be reached in split-brain patients—people who have had the connection severed between their two hemispheres, no trace of categorical organization in the right hemisphere remains. If the present results are really evidence of some pre-linguistic, and possibly innate categorical organization in the right hemisphere, the pre-linguistic system is not merely overshadowed in the process of language learning. Rather, it is completely obliterated. In this case, the power of language to shape our cognitive categories must be enormously strong, and Whorf’s controversial views about the relationship between language and thought would appear to have been vindicated.

Future Questions

Yet there are several reasons to be cautious about such an interpretation of the present results. If an innate organization of color categories were present in all humans before language categories are learned, we might expect to find it in our nearest primate relatives as well. A recent study of baboons has shown this not to be the case, however.

A number of methodological features make the new findings hard to interpret. Because of the difficulties of carrying out eye-tracking studies with infants, the data came from only half of the 26 infants that they tested. The colors used for adults were too difficult for infants to discriminate, so the researchers chose a set of just three widely separated colors for the infant testing. These comprised two targets (one green and one blue) and a background color that was just on the green side of the boundary between green and blue. As a result, there is a larger “perceptual distance” between the blue target and the green background than between the green target and the green background. This greater distinction might be enough to produce differences in the discriminability of the two targets. No direct comparison with adults can be made to investigate this confounding factor between perceptual distance and color category, because the adults in the study saw a different set of colors.

A small difference in discriminability might affect responses only in the right hemisphere for several reasons. In terms of the organization of the infant brain, integration of the two hemispheres is generally not complete before two years of age, so little transfer of information from one hemisphere to the other would be expected at four months. The visual system develops asynchronously across hemispheres, with right hemisphere development preceding left in most humans. In addition, processing of visual information for color and location may not be fully

integrated before 26 weeks, due to the earlier maturation of the parvocellular visual stream, relative to magnocellular stream. (The parvocellular visual stream is better at perceiving color and fine details.) The readiness of the two hemispheres to respond to a second stimulus, after exposure to an attention-grabbing stimulus presented in central fixation also differs in young infants. All these factors might contribute to greater sensitivity to a small difference in the discriminability of target and background in the right hemisphere compared with the left.

The present results deal only with a single category boundary, that between green and blue, so more evidence would be required to infer a complete set of pre-partitioned color categories in the right hemisphere of infants. More research is also needed to discover what the situation would be for infants born to speakers of the many documented languages that use a single term to describe all those shades that an English speaker would call green and blue.

In conclusion, the new data present a most interesting challenge to researchers in the field but, given the significance of the theoretical consequences of such a powerful relation between language and thought, much wider investigation of the issues seems called for. It is to be hoped that the new findings will act as a spur to other infant labs to join and broaden the investigation of these fascinating phenomena.

Mind Matters is edited by Jonah Lehrer, the science writer behind the blog The Frontal Cortex and the book Proust was a Neuroscientist.