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Brief article

The conceptual grouping effect: Categories matter (and named categories matter more)

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Abstract

Do conceptual categories affect basic visual processing? A conceptual grouping effect for familiar stimuli is reported using a visual search paradigm. Search through conceptually-homogeneous non-targets was faster and more efficient than search through conceptually-heterogeneous non-targets. This effect cannot be attributed to perceptual factors and is not explained by a long-term representational reorganization due to perceptual-learning. Rather, conceptual categories seem to modulate visual representations dynamically, and are sensitive to task-demands. Verbally labeling a visual target further exaggerates the degree to which conceptual categories penetrate visual processing.

Keywords: Concepts; Categories; Visual search; Labels; Top-down effects; Visual processing; Attention

1. Introduction

People interpret what they see – quickly and automatically recognizing familiar objects as members of categories (Grill-Spector & Kanwisher, 2005). To what degree is visual processing itself shaped by conceptual knowledge? The classic separation

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between perceptual and conceptual systems has been challenged by mounting evidence for a much more interactive view (for review see Goldstone & Barsalou, 1998). Evidence from single-cell recordings has further blurred the line between the bottom-up processes of "pure" perception and top-down feedback that is potentially open to conceptual influences (Hupe et al., 2001; Lamme, Super, & Spekreijse, 1998; Lee & Nguyen, 2001). The remarkable speed at which object categorization occurs (Fabre-Thorpe, Delorme, Marlot, & Thorpe, 2001) further suggests that basic perceptual processes such as attentional selection and grouping may be penetrable by conceptual knowledge. While much is known about the effects of category-learning on perceptual organization, for example, the improved ability to discriminate stimuli following category training (e.g., Goldstone, 1994), considerably less is known about how object categories influence perceptual processes on-line. The present experiments use the paradigm of visual search to study how what we know affects what we see.

Theories of visual processing have often overlooked the possible contributions of conceptual categories (Wolfe & Horowitz, 2004 for discussion). In particular, the idea that conceptual categories affect performance in the domain of visual search has fallen into disfavor following failures to replicate Jonides and Gleitman's (1972) oh-zero effect (e.g., Duncan, 1983) and findings arguing that category effects hinge on perceptual rather than conceptual factors (Krueger, 1984; Levin, Takarae, Miner, & Keil, 2001). At the same time, it is clear that visual search performance cannot always be reduced to low-level visual factors. It is strongly affected by familiarity (Frith, 1974; Malinowski & Hubner, 2001; Wang, Cavanagh, & Green, 1994) and controlling for physical differences, is sensitive to the categorical relationship between targets (T's) and non-targets (N-T's) such as "blue vs. green" (Daoutis, Pilling, & Davies, 2006) and "steep vs. non-steep" (Wolfe, Stewart, Friedman-hill, & O'Connell, 1992). The origin, mechanisms, and specificity of these effects remain largely unknown. For instance, it is unclear to what degree representational differences between color categories and tilt categories are the product of experience and learning versus physiological constraints, and to what degree they are due to long-term representational change versus on-line representational reorganization.

The first aim of this work was to test for the presence of category effects in visual search while (1) controlling for all physical factors and (2) using familiar yet clearly learned stimuli. This was achieved by varying the *conceptual heterogeneity* of letter non-targets. It is known that physical N-T heterogeneity correlates positively with search times – searching for a T among L's is harder if L's are presented in varying orientations due to grouping of perceptually similar N-T's (Duncan & Humphreys, 1989). Experiment 1 tests for the presence of *conceptual grouping* by investigating whether N-T heterogeneity similarly slows search.

An effect of conceptual categories on visual processing can be attributed to two sources. First, items within a conceptual category may have become represented as more similar due to extensive practice with categorizing together these stimuli (e.g., Goldstone, 1994; Harnad, 1987). In this way, conceptual homogeneity may have turned into perceptual homogeneity. Alternatively, con-