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Color makes a difference: Two-dimensional object naming in literate and illiterate subjects

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Abstract

Previous work has shown that illiterate subjects are better at naming two-dimensional representations of real objects when presented as colored photos as compared to black and white drawings. This raises the question if color or textural details selectively improve object recognition and naming in illiterate compared to literate subjects. In this study, we investigated whether the surface texture and/or color of objects is used to access stored object knowledge in illiterate subjects. A group of illiterate subjects and a matched literate control group were compared on an immediate object naming task with four conditions: color and black and white (i.e., grey-scaled) photos, as well as color and black and white (i.e., grey-scaled) drawings of common everyday objects. The results show that illiterate subjects perform significantly better when the stimuli are colored and this effect is independent of the photographic detail. In addition, there were significant differences between the literacy groups in the black and white condition for both drawings and photos. These results suggest that color object information contributes to object recognition. This effect was particularly prominent in the illiterate group.

Keywords: Illiteracy; 2D visual naming; Color processing

1. Introduction

An influence of literacy and formal education on object naming performance has been described in several experiments (Ardila, Rosselli, & Rosas, 1989; Kremin et al., 1991; Manly et al., 1999; Reis, Guerreiro, & Castro-Caldas, 1994; Reis, Petersson, Castro-Caldas, & Ingvar, 2001). There is a clear evidence that formal education and/or literacy influence the object naming performance of two-dimensional (2D) pictorial object representations. This is not the case for real (3D) objects (Reis et al., 1994, 2001).

The performance on simple object naming tasks is mainly dependent on the systems for visual recognition, lexical retrieval, and the organization of articulatory speech output, as well as the interaction between these systems [e.g., (Gordon, 1997; Levelt, Praamstra, Meyer, Helenius, & Salmelin, 1998)]. Reading and writing are dependent on advanced visual and visuo-motor skills in coding, decoding, and generating 2D symbolic representations. In the literate group of this study, learning and practice in interpreting schematic 2D representations often took place simultaneously with the acquisition of written Portuguese in school. It is therefore likely that the interpretation and production of 2D representations of real objects as well as the coding and decoding 2D material in terms of figurative/symbolic semantic content is more practiced in literate group compared to the illiterate group, which generally have received little systematic practice in interpreting conventional visuo-symbolic representations. We have previously observed (Reis et al., 1994, 2001) that the illiterate group was significantly better on naming colored photos compared to black-and-white (B and W) line drawings, and

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it might be asked whether the illiterate subjects can take advantage of additional information provided in the photos, such as color and photographic detail. Thus, the question is whether object naming in illiterate subjects is relatively more dependent on surface-based representations than on edge-based representations. In other words, does information about the surface texture and/or color of objects facilitate the accessing of stored object knowledge?

The discussion about the influence of color on object recognition has recently been raised in several papers [for a review see, (Tanaka, Weiskopf, & Williams, 2001)]. According to Tanaka et al. (2001), objects represented by color and shape might show a recognition advantage over objects represented by shape only in conditions where access to edge information is limited. In addition, it was demonstrated by Price and Humphreys (1989) that brightness/texture gradients (photographic detail) affect object recognition and naming. Other studies have found that appropriately colored objects are recognized faster than monochrome objects and inappropriately colored objects (Naor-Raz, Tarr, & Kersten, 2003; Price & Humphreys, 1989) or that color does not affect categorical judgments but the facilitation occurs in object naming tasks (Davidoff & Ostergaard, 1988). On the other hand, Bierderman and Ju (1988) argue that edge-based representations are crucial for object recognition and the objects should be recognized as easily when represented by edge information as when represented by other types of information (e.g., color photos, which contain surface information such as color, texture, and relative brightness). However, according to Sanocki, Bowyer, Heath, and Sarkar (1998), using a different conception of edge-based information, edge information is not sufficient for object recognition. Overall, these studies suggest that the function of color in object recognition is not well understood and there is no agreement concerning its role in object naming/recognition. Furthermore, there are some evidence suggesting that, at a lower visual processing level, color helps to differentiate objects (Gegenfurtner & Rieger, 2000; Wurm, Legge, Isenberg, & Luebker, 1993). For example, very brief presentations of natural scenes are matched more accurately by subjects when shown in color than when shown as luminance-controlled grey-scale images, which indicates that color provides an important source of information in the pre-recognition stage of visual processing (Gegenfurtner & Rieger, 2000). According to Gegenfurtner and Rieger (2000), color information contributes at both the sensory (coding) and cognitive (representation) levels of information processing for object recognition in natural scenes. More recently, Tanaka et al. (2001) proposed an object recognition model, the "Shape + Surface" model of object recognition. This model allows objects to be represented in terms of both their shape and color (and possibly texture), though it remains an open question at which processing level color is integrated with shape.

Additional evidence from patients with visual agnosia indicates that the visual characteristics of the stimuli (e.g., drawings/photos vs. objects) have an influence on the error pattern during object naming (Davidoff & De Blesser, 1993). For example, patients that show dissociation while performing object naming with drawings compared to real objects produce mostly visual errors, suggesting a deficit in the visual recognition system. If additional perceptual information is provided, then performance improves significantly. In contrast, patients that show no picture vs. object differences produce mostly semantically related errors, suggesting a deficit in language processing (Davidoff & De Blesser, 1993). Chainay and Rosenthal (1996) verified that color produced a significant effect on the patients' performance. In addition, they found that color facilitated the naming of natural categories but not artifacts, while color had no or little effect on object recognition. This categorical effect of color has been observed in several studies [e.g., (Price & Humphreys, 1989; Tanaka & Presnell, 1999)]. However, a recent study failed to replicate these findings (Rossion & Pourtois, 2004). Rossion and Pourtois (2004) collected normative data for Snodgrass and Vanderwart's object database of 260 B and W line-drawings (Snodgrass & Vanderwart, 1980). They then compared these data to data collected using the same shapes with gray-level texture and color added. Whereas, the addition of texture and shading without color yielded a slight improvement in terms of naming agreement scores, the addition of color information unambiguously improved the naming accuracy and speeded correct response times. This was observed for fruits, vegetables as well as man-made objects, with and without a single diagnostic (prototypical) color (Rossion & Pourtois, 2004).

Given our previous results on object naming performance in literate and illiterate subjects as well as the recent interest in the role of color in object recognition and naming, the primary objective of the present experiment was to investigate whether color information can be used synergistically to access stored object knowledge and benefit illiterate more than literate subjects. Specifically, we aimed to investigate whether there are differences in edge-based and color-based information processing of two-dimensional visual objects between illiterate subjects and literate controls. To this end, we investigated their immediate object naming performance on line-drawings and photos, presented either in color or in black-and-white (i.e., grey-scaled) in a fully randomized study design. Based on our previous results that demonstrated that the illiterate population has problems with decoding 2D representations compared to 3D representations (Reis et al., 2001), we predicted that illiterate subjects would benefit most from the additional surface-based information provided by the color compared black-and-white stimuli as well as by the photos compared to the drawings.

2. Materials and methods

2.1. Participants

In this study, we investigated the literate and illiterate population of Olhão in southern Portugal that we have