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## Visual interference disrupts visual knowledge



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## ABSTRACT

We show that visual interference impairs people's ability to make use of visual knowledge. These results provide strong evidence that making use of stored visual knowledge—long-term memory of what things look like—depends on perceptual mechanisms. In the first set of studies, we show that presenting visual noise patterns during or after hearing a verbal cue greatly reduces the effectiveness of the cue on a simple visual discrimination task. In the second experiment, participants were tasked with answering questions about visual features of familiar objects, e.g., verifying that tables have flat surfaces. Accuracy in answering visual, but not encyclopedic questions was reduced when viewing colorful noise patterns. This result is most parsimoniously explained by positing that judgments required activation of visual representations that were being interfered with when viewing irrelevant patterns. Although much of our conceptual knowledge may abstract away from perceptual details, knowledge of what things look like appears to be represented in a visual format.

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## Introduction

Much of what people know about objects comes from visual experience (Cree & McRae, 2003; Hoffman & Lambon Ralph, 2013). For example, our knowledge that alligators are animals with sharp teeth and long tails comes at least in part from seeing alligators, even if only in pictures. Yet, many have argued that although we learn many things *via* our sense of vision, the visual knowledge itself (also called visual long-term memory) is amodal—represented and accessed independently of perceptual processes (Caramazza, Hillis, Rapp, & Romani, 1990; Pinker, 1994; Pylyshyn, 1986; Tulving, 1972). Apparently contradicting this amodal view are studies showing that asking people to think about what things look like elicits patterns of neural activity that overlap with patterns evoked by

actual visual processing (Amsel, Urbach, & Kutas, 2014; Martin, 2007; Simmons et al., 2007). At present, however, there is little direct evidence for the *causal* involvement of visual processes in making use of visual knowledge (Mahon & Caramazza, 2008; Papeo, Pascual-Leone, & Caramazza, 2013). It remains possible that the perceptual activation measured in such tasks is epiphenomenal or reflects explicit mental imagery (Albers, Kok, Toni, Dijkerman, & de Lange, 2013; Kosslyn, Ganis, & Thompson, 2001; Naselaris, Olman, Stansbury, Ugurbil, & Gallant, 2015). If, however, it can be shown that disrupting visual processes disrupts visual knowledge (and *specifically* visual knowledge),<sup>1</sup> a parsimonious conclusion would be that this visual knowledge was at least partly constituted by the now disrupted representations.

To establish whether visual knowledge and visual perception rely on common mechanisms, we interfered with

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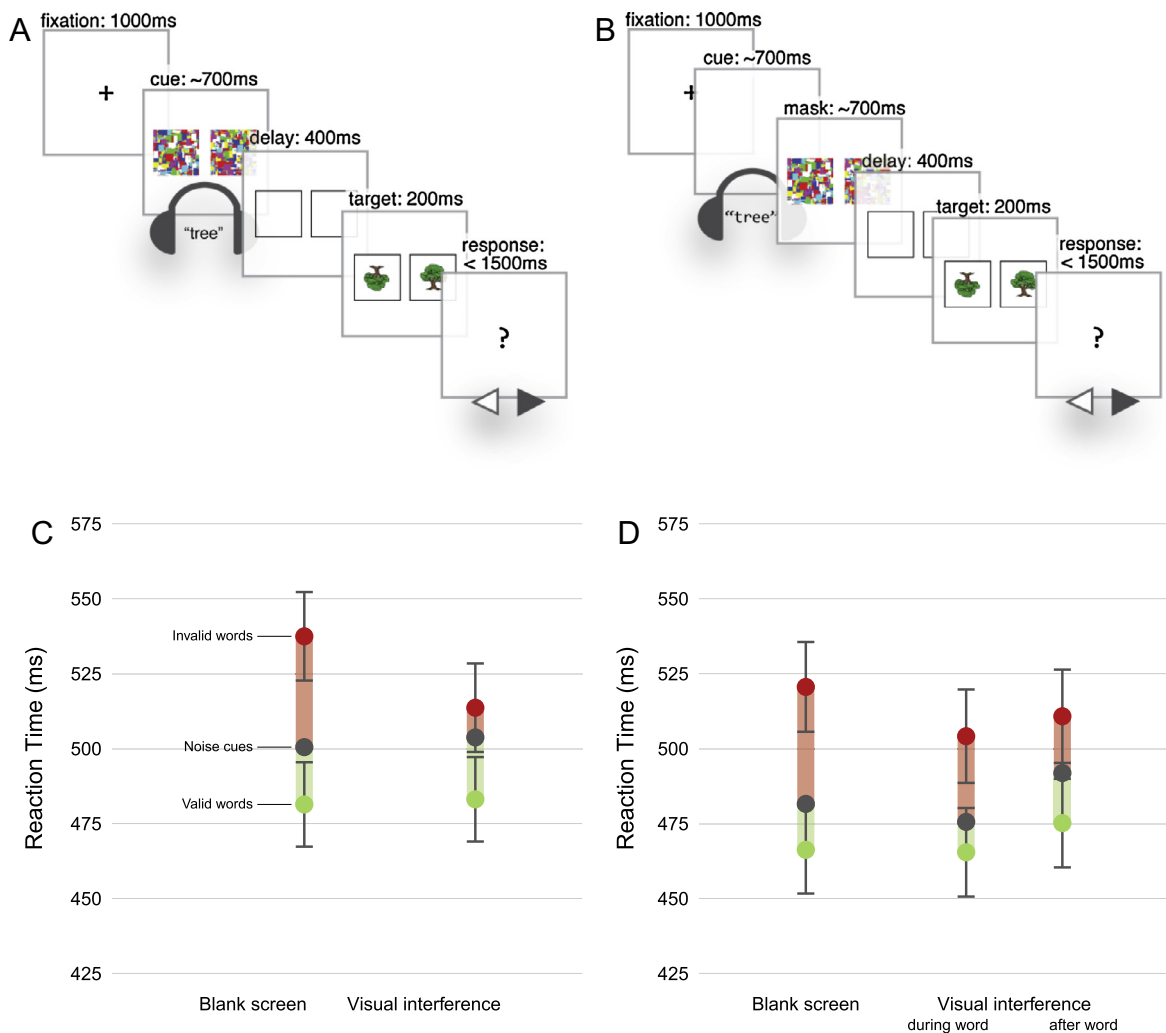
<sup>1</sup> Our claims do not require visual interference to completely abolish the ability to make use of visual knowledge. The key requirement is that visual interference should impair visual—and specifically visual—knowledge.

visual perception and measured the impact of this interference on simple behavioral tests of visual knowledge. To foreshadow the results: In Experiments 1A–1C, visual interference reduced a robust verbal cueing effect where hearing the name of an object speeds its visual recognition. These results show that the effect of hearing verbal cues on visual recognition (e.g. the benefit of hearing “dog” on recognizing a picture of a dog) results from the label activating visual representations that can be disrupted by irrelevant visual input. In Experiment 2, we extend these results to a completely linguistic domain and find that visual interference impaired accuracy in verifying statements concerning visual properties of common categories, e.g., that tables have flat surfaces, but left encyclopedic and otherwise nonvisual knowledge, e.g., that tables are furniture, unaffected. These results provide compelling

evidence that perceptual representations are at least partly constitutive of our knowledge of what things look like.

### Experiment 1A: Visual interference disrupts verbal cueing of visual recognition

Hearing a name affects visual recognition of the named category. For example, in the task depicted in Fig. 1A, hearing “tree” prior to seeing pictures of an upright and an upside-down tree makes it easier to recognize which tree is upright and which is upside-down (a validity advantage) while slowing performance on judging the orientation of another object, e.g., a car (an invalidity cost) relative to baseline trials on which no word is heard (Lupyan & Thompson-Schill, 2012).



**Fig. 1.** Visual interference reduces verbal cueing of visual knowledge. (A) A sample trial from Experiment 1A in which visual interference is presented during a valid verbal cue prior to deciding which of the two images was upright. (C) Results of Experiment 1A when interference was presented during the auditory word cues. Valid cues improved performance (size of green bars) and invalid cues (e.g., “dog” preceding tree pictures) impaired performance (size of red bars) relative to baseline in which the verbal cue was replaced with uninformative white noise. The total cueing effect (size of full bar) was reduced by visual interference. (B) A sample trial from Experiment 1B which included trials in which the visual interference was delayed until the offset of the auditory cue. (D) Results from Experiment 1B when interference was presented during or after the word cues. The total cueing effect was reduced to a similar extent even when the interference was delayed. Error bars show  $\pm 1$  SE of coefficient estimates.

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