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Unconscious auditory information can prime visual word processing: A process-dissociation procedure study ☆

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Abstract

Whether information perceived without awareness can affect overt performance, and whether such effects can cross sensory modalities, remains a matter of debate. Whereas influence of unconscious visual information on auditory perception has been documented, the reverse influence has not been reported. In addition, previous reports of unconscious cross-modal priming relied on procedures in which contamination of conscious processes could not be ruled out. We present the first report of unconscious cross-modal priming when the unaware prime is auditory and the test stimulus is visual. We used the process-dissociation procedure [Debner, J. A., & Jacoby, L. L. (1994). Unconscious perception: Attention, awareness and control. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*, 304–317] which allowed us to assess the separate contributions of conscious and unconscious perception of a degraded prime (either seen or heard) to performance on a visual fragment-completion task. Unconscious cross-modal priming (auditory prime, visual fragment) was significant and of a magnitude similar to that of unconscious within-modality priming (visual prime, visual fragment). We conclude that cross-modal integration, at least between visual and auditory information, is more symmetrical than previously shown, and does not require conscious mediation.

Keywords: Unconscious priming; Cross-modal priming; Visual-to-auditory priming; Process-dissociation procedure

1. Introduction

The ability to assimilate stimuli presented in different modalities into unified percepts is a fundamental component of perceptually guided action and cognition. Such ability is illustrated by phenomena in which perception in one modality is dramatically affected by stimulation in another modality. For instance, in the McGurk effect (McGurk & MacDonald, 1976), the same sound is heard as a different phoneme depending on what lip movements are seen. While it is clear that information from different modalities is initially coded in distinct

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sensory areas, the processing levels at which cross-modal links is a matter of ongoing research. For instance, recent studies have shown multi-sensory integration to take place early in the cortical processing hierarchy, in brain regions traditionally held to be unisensory (see Ghazanfar & Schroeder, 2006, for a review). Such early locus suggests that integration processes are 'hard-wired' and automatic. However, it is unclear whether processing of a stimulus that is not perceived consciously, affects perceptual processing systems in other modalities, or if the output of such processing remains encapsulated within its own modality.

Several studies suggested that information from different sensory modalities may be integrated even when at least one modality is not attended (e.g., Driver & Grossenbacher, 1996; but see Dufour, 1999). However, while perception without attention and perception without awareness are frequently discussed in parallel (e.g., Debner & Jacoby, 1994), instructing subjects to ignore a given channel does not guarantee lack of awareness without an independent measure of conscious perception. Studies of preattentive cross-modal integration were typically not concerned with unconscious perception and did not therefore include such an independent measure.

The direct exploration of unconscious perception calls for dedicated experimental tools, with the *classical dissociation procedure* (Merikle & Reingold, 1998) being the most extensively used approach. The rationale of this procedure is to demonstrate a dissociation between two measures of perception, a direct measure held to index conscious perception and an indirect measure held to index unconscious perception. In a typical version of this paradigm, the masked implicit repetition priming paradigm (e.g., Forster & Davis, 1984), a word (henceforth, prime) is briefly presented and followed by a mask. Prime duration is set at a level where subjects either report not seeing the prime (subjective report, e.g., Cheesman & Merikle, 1986) or show zero sensitivity in judging between two different states of the prime (objective threshold, e.g., Draine & Greenwald, 1998). Exposure to the prime and mask is followed by say, a word-stem completion task, in which subjects must complete the stem with the first word that comes to mind (other tasks such as fragment-completion and lexical decision are also routinely used). Unconscious priming is said to occur when subjects complete the stem with a word related to the prime (target) significantly more often than is expected by chance. Putatively, such an effect demonstrates that a prime not consciously perceived can nonetheless bias performance, and is taken to reflect automatic or unconscious activation of representations shared by prime and target.

The classical dissociation procedure has been criticized on various grounds (e.g., Holender, 1986). Its opponents have claimed that the use of two different measures to index conscious and unconscious perception opens the possibility that the dissociation observed might result from a difference in sensitivity between the two measures rather than from the existence of two different underlying processes. The process-dissociation procedure (Jacoby, 1991) was designed to overcome these problems. This approach rests on the basic assumption that consciously perceived information is subject to voluntary control, whereas information perceived without awareness leads to more automatic responses. Debner and Jacoby (1994) relied on this qualitative difference to study unconscious perception by pitting conscious and unconscious processes in opposition. They used the masked repetition priming paradigm (e.g., Forster & Davis, 1984) with an important twist: In one condition (''inclusion''), subjects had to complete the stem with the prime, and if unable to, to provide the first word that came to mind. In another condition (''exclusion''), subjects were instructed *not* to complete the word-stem with the prime or, if they did not see it, to provide the first word that came to mind. Suppose for instance that the prime word had been FLOWER and the stem was FL - - -. In the inclusion condition, if the subject came up with FLOWER (correct inclusion trials), this might indicate either that the subject consciously perceived the prime or that conscious perception failed, but the effects of unconscious perception were sufficient for the word FLOWER to be the first to come to mind. Thus, the proportion of correct inclusion trials in the inclusion condition reveals the effects of an unknown combination of conscious and unconscious perception. In the exclusion condition, the subject could err and provide the prime word despite the instructions if the effect of unconscious perception was sufficient for the prime word to be the first to come to mind, but only if the prime word was *not* also consciously perceived. Had the subject consciously seen the prime, she or he would have followed the rules and avoided using this word as an answer. Thus, a proportion of *exclusion errors* (i.e., completing the stem with the prime, despite the instruction not to do so) that is larger than can be expected by chance, indicates that unconscious perception has occurred.