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Short Communication

Perceptually specific and perceptually non-specific influences on rereading benefits for spatially transformed text: Evidence from eye movements

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ABSTRACT

The present study used eye tracking methodology to examine rereading benefits for spatially transformed text. Eye movements were monitored while participants read the same target word twice, in two different low-constraint sentence frames. The congruency of perceptual processing was manipulated by either applying the same type of transformation to the word during the first and second presentations (i.e., the congruent condition), or employing two different types of transformations across the two presentations of the word (i.e., the incongruent condition). Perceptual specificity effects were demonstrated such that fixation times for the second presentation of the target word were shorter for the congruent condition compared to the incongruent condition. Moreover, we demonstrated an additional perceptually non-specific effect such that second reading fixation times were shorter for the incongruent condition relative to a baseline condition that employed a normal typography (i.e., non-transformed) during the first presentation and a transformation during the second presentation. Both of these effects (i.e., perceptually specific and perceptually non-specific) were similar in magnitude for high and low frequency words, and both effects persisted across a 1 week lag between the first and second readings. We discuss the present findings in the context of the distinction between conscious and unconscious memory, and the distinction between perceptually versus conceptually driven processing.

1. Introduction

The levels-of-processing (LOP) framework (Craik & Lockhart, 1972) was influential in promoting the idea that "deep" semantic processing produces a more durable and elaborate memory representation than "shallow" perceptual processing. However, since the 1970s, a variety of memory theories have acknowledged the role of perceptual (in addition to semantic) influences on memory performance, in response to evidence that memory for perceptual details can be surprisingly long-lasting. Much of this evidence came from memory studies that manipulated the congruency of surface variables (i.e., font, color, etc.) across the study and test phases of the experiment, to show that memory performance was better when perceptual aspects of the stimulus were the same rather than different during encoding and retrieval. Such perceptual specificity effects were most frequently shown with perceptual implicit (or indirect) tasks (for reviews, see e.g., Levy, 1993; Roediger & McDermott, 1993; Roediger & Srinivas, 1993; Roediger, Weldon, & Challis, 1989; Schacter, 1987; Tenpenny, 1995) that employed a variety of physically degraded (i.e., data-limited) retrieval cues (e.g., masked words, word stems, word fragments,

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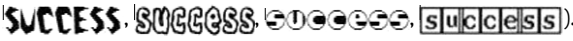
picture fragments, etc.), but similar effects were also occasionally shown with explicit (or direct) tasks, such as recognition memory tasks (Beiderman & Cooper, 1992; Cave, Bost, & Cobb, 1996; Cooper, Schacter, Ballesteros, & Moore, 1992; Jolicoeur, 1987; Kolers, Duchnicky, & Sundstroem, 1985; Milliken & Jolicoeur, 1992; Rajaram, 1996; Ray & Reingold, 2003; Reingold, 2002; Srinivas, 1995, 1996).

Of particular relevance to the present study, the rereading paradigm has also been used to study the perceptual specificity of memory representations. The rereading paradigm examines the magnitude of the processing advantages that occur when the same text is read more than once (for reviews, see Levy, 1993; Raney, 2003). Because such rereading benefits (also referred to as text repetition effects, or priming effects) are assessed without explicitly instructing participants to refer back to their previous encounter with the text, the rereading task constitutes an implicit, or indirect, measure of readers' memory for their prior encounter with the text (Rayner, Raney, & Pollatsek, 1995). The rereading paradigm was used by Kolers (1975, 1976, 1979) in a seminal series of studies that pioneered the study of perceptual specificity effects during rereading. In Kolers' studies, participants were asked to read transformed text that had been derived from normal text by applying certain geometrical transformations, such as rotation about axes, inversion, and mirror reflection (Kolers, 1968). Using this approach, Kolers (1975) demonstrated that readers were faster at rereading inverted text if they had previously read the text in the same inverted text transformation, relative to text that was previously read in a normal typography. Furthermore, Kolers (1976) showed that readers were faster at rereading inverted text 1 year after the first presentation of the inverted text, even if they did not remember previously reading the text. In interpreting such findings, Kolers argued strongly that readers retain highly specific visual pattern-analyzing operations for over 1 year.

Kolers' conclusions generated a great deal of controversy (Craik, 1989; Graf, 1981; Graf & Levy, 1984; Horton, 1985, 1989; Masson, 1984, 1986; Masson & Sala, 1978; Tardif & Craik, 1989; for a review, see Levy, 1993), and several researchers have argued strongly that Kolers' findings were due to conceptual rather than perceptual influences (e.g., Graf & Levy, 1984; Horton, 1985; Masson & Sala, 1978; Tardif & Craik, 1989). According to these critics, transformed text receives more extensive conceptual (or semantic) processing than normal text, and this enhanced conceptual processing produces the superior rereading benefits in the transformed text conditions used by Kolers. This criticism is difficult to refute because Kolers' use of identical sentences and passages during both readings makes it is difficult to rule out the possibility that readers were using their memory for the gist, or meaning, of the passages to assist them during rereading.

To address past criticisms of Kolers' work, an eye tracking and rereading paradigm (Sheridan & Reingold, 2012) was recently used to examine perceptual specificity effects for individual target words that were read twice in two different sentences. A key advantage of this paradigm is that it isolates perceptual processing because the change in context prevents readers from using their memory for the meaning of the sentence to help them to decipher the target word. Using this paradigm, Sheridan and Reingold (2012) presented target words (e.g., "success") in a variety of distortion typographies (e.g., ). Perceptual specificity effects were demonstrated such that fixation times were shorter on target words that were previously read in the same distortion typography (i.e., the congruent condition), relative to target words that were previously read in a different distortion typography (i.e., the incongruent condition). These perceptual specificity effects were significant for low frequency, but not for high frequency target words, and they persisted across a 1 week lag between the first and second readings (for similar findings of long-lasting perceptual specificity effects, see e.g., Goldinger, 1996; Kolers, 1976; Ray & Reingold, 2003; Roediger & Blaxton, 1987; for reviews, see Levy, 1993; Roediger & McDermott, 1993).

However, Sheridan and Reingold (2012) demonstrated no significant differences in fixations times across the incongruent condition and an additional baseline condition that employed a normal typography (i.e., non-distorted) during the first reading and a distortion typography during the second reading. Since both the incongruent and baseline conditions involved a change in typography across readings, the incongruent versus baseline contrast provided a way to assess whether initially reading text in a distortion typography rather than normal text produces perceptually non-specific rereading benefits. It is somewhat surprising that Sheridan and Reingold (2012) did not show any incongruent versus baseline differences, in light of past claims that difficult-to-read typographies enhance rereading benefits by producing more extensive conceptual processing relative to normal text (e.g., Horton, 1985).

One possible reason for why there were no baseline versus incongruent differences is that the distortion typographies used by Sheridan and Reingold (2012) were not as extreme as Kolers' geometrical transformations (Kolers, 1968). We hypothesize that using transformations might reveal perceptually non-specific rereading benefits, by magnifying processing differences during encoding across the baseline versus the incongruent conditions. Accordingly, the goal of the present study is to employ the Sheridan and Reingold (2012) paradigm while using similar transformations to the ones employed in Kolers' original studies. We expect to replicate Sheridan and Reingold (2012)'s perceptual specificity effects (i.e., shorter fixation times for the congruent relative to the incongruent condition) for low frequency words, and to possibly extend this finding to high frequency words. Moreover, we predict that the transformations might reveal perceptually non-specific effects (i.e., shorter fixation times for the incongruent relative to the baseline condition). Similar to Sheridan and Reingold (2012), we explore these two types of effects under a variety of conditions, by manipulating target word frequency (high frequency, low frequency) and by examining the impact of a 1 week lag between the first and second presentations of the target words.