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Effects of Saccade Induced Retrieval Enhancement on conceptual and perceptual tests of explicit & implicit memory

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ABSTRACT

The effects of saccadic horizontal (bilateral) eye movements upon tests of both conceptual and perceptual forms of explicit and implicit memory were investigated. Participants studied a list of words and were then assigned to one of four test conditions: conceptual explicit, conceptual implicit, perceptual explicit, or perceptual implicit. Conceptual tests comprised category labels with either explicit instructions to recall corresponding examples from the study phase (category-cued recall), or implicit instructions to generate any corresponding examples that spontaneously came to mind (category-exemplar generation). Perceptual tests comprised of word-fragments with either explicit instructions to complete these with study items (word-fragment-cued recall), or implicit instructions to complete each fragment with the first word that simply 'popped to mind' (word-fragment completion). Just prior to retrieval, participants were required to engage in 30 s of bilateral vs. no eye movements. Results revealed that saccadic horizontal eye movements enhanced performance in only the conceptual explicit condition, indicating that Saccade-Induced Retrieval Enhancement is a joint function of conceptual *and* explicit retrieval mechanisms. Findings are discussed from both a cognitive and neuropsychological perspective, in terms of their potential functional and neural underpinnings.

1. Introduction

1.1. Overview and scope of research

Recent experimental work has demonstrated that performing a sequence of goal directed horizontal saccades to a visual moving target can enhance performance on tests of particular forms of memory. The current experiment is concerned with the effects of such eye movements on different forms of memory tests that were designed to assess both explicit vs. implicit memory and conceptual vs. perceptual memory. Prior to discussing findings pertaining to eye-movement effects, the differences between types of memory (and memory tests) are outlined from the perspective of the explicit–implicit distinction and from the viewpoint of Transfer Appropriate Processing (TAP). Research indicates the theoretical and empirical value of both of these classifications (e.g., Gong et al., 2016; Mulligan & Besken, 2013), and they provide a framework for considering the effects of eye movements on retrieval.

1.2. Explicit vs. implicit memory

Explicit memory requires the intentional or voluntary retrieval of information and is typically accompanied by conscious awareness. It is measured by tasks such as recall and recognition that require test responses based on information recovered from a particular study experience or episode. In contrast, implicit memory refers to a form of retrieval that is unintentional or involuntary, in which conscious awareness about some past episode, and retrieval from that episode, are not required in order to respond. Memory is inferred by enhanced performance for studied compared to non-studied stimuli; a phenomenon called priming. For example, reading words can facilitate the subsequent perceptual identification of those words relative to non-studied words. Operationally, explicit and implicit memory tests differ by reference to retrieval instructions and have often been referred to as *intentional* and *incidental* tests respectively (e.g. Jacoby, 1984; Richardson-Klavehn, Gardiner, & Java, 1994, 1996; Roediger & McDermott, 1993).

The distinction between explicit and implicit memory receives support from a range of findings using different approaches. For example, explicit memory is found to be relatively more impaired compared to implicit memory as a function of selective medial temporal lobe damage, (Corkin, 2002; Daum, Channon, & Canavar, 1989; Glisky & Schacter, 1987; Glisky & Schacter, 1988; Glisky & Schacter, 1989; Glisky, Schacter, & Tulving, 1986; Graph, Squire, & Mandler, 1984; Scoville & Milner, 1957; Squire & Frambach, 1990; Weiskrantz &

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Warrington, 1979), schizophrenia (Danion, Meulemans, & Kauffmann-Muller, 2001), and ageing (e.g. Wiggs, Weisberg, & Martin, 2006).

Neuroimaging research has also detected differences in the activity of neural populations between these two forms of memory. For example, medial-temporal and prefrontal regions showing pronounced activity during explicit tasks (e.g., Donaldson, Wheeler, & Petersen, 2010; Rugg & Yonelinas, 2003; Schott et al., 2013) and activity *reductions* in a range of cortical regions while performing particular types of implicit tasks (e.g., Badgaiyan, 2000; Henson, 2003; Ward, Chun, & Khul, 2013). Experimental variables have also been found to dissociate explicit from implicit memory, with some influencing explicit but not implicit memory (Graf, Mandler, & Haden, 1982; Jacoby & Dallas, 1981) with other manipulations producing the reverse effect (Hayman & Rickards, 1995; Roediger, Weldon, Stadler, & Reigler, 1992) or crossed dissociations (Java, 1994; Mulligan, 2012). The dissociations observed between explicit and implicit have been used to argue for a distinction between cognitive or neural systems hypothesised to underpin performance on these tasks (Sherry & Schacter, 1987; Squire, 2009; Squire & Dede, 2015; Tulving & Schacter, 1990). This systems based approach has aligned explicit memory with a memory system dependent upon the integrity of the medial temporal lobes and is referred to as declarative memory. Implicit memory, in this context, is aligned with non-declarative memory, the functioning of which is attributed to a more widespread range of cortical and sub-cortical structures depending on the particular nature of the implicit task (e.g., Cabeza & Moscovitch, 2013; Schacter & Tulving, 1994; Squire 2004).

1.3. A challenge to the explicit–implicit distinction: The role of transfer-appropriate processing

An alternative framework for explaining explicit–implicit dissociations is based on the concept of Transfer-Appropriate Processing (TAP). According to this framework, the most important factor in explaining these dissociations is the overlap between the type of *processing* during encoding and retrieval (e.g., Roediger, 1990; Roediger, Weldon, & Challis, 1989; Weldon, Roediger, Beitel, & Johnston, 1995). In particular, memory is a function of the extent to which processes occurring during retrieval recapitulate those that occurred during encoding. Within this, a distinction has been made between *conceptual* (meaning-based) and *perceptual* (physical feature-based) processing (Jacoby, 1983; Roediger, 1990; Roediger et al., 1989; Weldon et al., 1995).[1]

This framework proposes that conceptual tests are influenced by the overlap in conceptual or semantic processing between study and test (e.g., Hamann, 1990; McBride & Shoudel, 2003; Ramponi, Richardson-Klavehn, & Gardiner, 2007; Srinivas & Roediger, 1990). Conversely, other tests are perceptual and are influenced by the overlap in surface or perceptual features between study and test (e.g., Blum & Yonelinas, 2001; Craik, Moscovitch, & McDowd, 1994; Roediger et al., 1992). For example, tests of conceptual memory provide test cues that are meaningfully related to the to-be-retrieved material (e.g., category labels), or are influenced by conceptual encoding processes. Typical examples of conceptual memory include free recall, recognition, and category-exemplar generation. In contrast, tests of perceptual memory often use fragmented perceptual test cues (e.g., word or picture-fragments) or are influenced by changes in perceptual features between study and test (e.g., item-modality). Examples of perceptual tests include word and picture fragment completion, perceptual identification and word-stem completion.

The TAP framework provides a challenge to the systems account of explicit–implicit memory by suggesting that dissociations that have typically been observed between these forms of memory are due to confounding retrieval orientation with the type of processing required by the memory test. In particular, explicit tests are typically conceptual in nature (e.g. recall and recognition), while implicit tests are perceptual (e.g. word-fragment-completion and word-stem-completion). Support for this idea came from Blaxton (1989), who examined performance on both explicit and implicit tests of memory in which the conceptual/perceptual processing demands were equated, and reported that retrieval orientation (explicit–implicit) was largely redundant. In addition, neuroimaging research indicates that when conceptual and perceptual processing demands are carefully controlled, explicit and implicit forms of memory retrieval may rely on common neural mechanisms (Cabeza & Mocovitch, 2013; Dew & Cabeza, 2011). Consequently, according to TAP, mnemonic performance is determined largely by the match/mismatch of conceptual/perceptual processing between study and test.

However, other reports indicate that explicit and implicit tests dissociate even when processing demands *are* equated (e.g. Cabeza, 1994; Gabrieli et al., 1999; Graf, Squire, & Mandler, 1984; Mulligan, 1998; Mulligan, 2012; Parker, Dagnall, & Munley, 2012; Tenpenny & Shoben, 1992; Vaidya et al., 1997). Furthermore, evidence from event-related potentials (ERPs) and fMRI reveal that explicit and implicit forms of memory do derive from distinct neural mechanisms (e.g., Buckner et al., 1995; Hou, Safron, Paller, & Guo, 2013; Schott et al., 2013; Voss, Federmeier, & Paller, 2012; Ward et al., 2013). Accordingly, there is a need to distinguish between both (i) explicit and implicit memory, and (ii) conceptual and perceptual processing. The present research takes both of these distinctions into account in relation to the effects of saccadic eye movements on memory.

1.4. SIRE effects: principal findings and explanations

Over the past decade, a number of research reports have shown that saccadic horizontal eye movements enhance memory accuracy. Referred to as Saccade Induced Retrieval Enhancement (SIRE) effects (Lyle & Martin, 2010) these findings have typically been found on tests of explicit (episodic) memory. For example, in one of the first published studies, Christman, Garvey, Propper, and Phaneuf (2003) found that 30 s of saccadic horizontal eye movements (induced by following a dot flashing from side-to-side on a screen) improved recognition accuracy for earlier presented words. Later research has replicated this effect and extended it to various forms of explicit memory, including: the recall of one's earliest childhood memories (Christman, Propper, & Brown, 2006), associative and contextual information (Parker, Relph, & Dagnall, 2008), landmark shape and location information (Brunye, Mahoney, Augustyn, & Taylor, 2009), true memory in children (Parker & Dagnall, 2012), visual scenes (Lyle & Jacobs, 2010; Parker, Buckley, & Dagnall, 2009), core components of autobiographical memory (Parker & Dagnall, 2010), episodic autobiographical memory fluency (Parker, Parkin, & Dagnall, 2013), specificity of episodic cognition (Parker, Parkin, & Dagnall, 2017), face memory (Lyle & Orsborn, 2011), the recall of neutral and emotive words (Nieuwenhuis et al., 2013; Phaf, 2017; Samara, Elzinga, Slagter, & Nieuwenhuis, 2011), and the reduction of both false recall and recognition of non-presented word associates (Christman, Propper, & Dion, 2004; Lyle, Logan, & Roediger, 2008; Parker & Dagnall, 2007). However, a recent paper did not find evidence that eye movements could increase memory on a test of free recall (Matzke et al., 2015). Considered amidst the background of positive findings, this result was surprising. Reasons for the null finding could include factors such as chance effects (false negative) or the overestimation generalisability of the effect in previous work. A more recent report that did find SIRE effects suggests that there are likely to be a number of factors that limit the generality of the influences of eye-movements on memory (Phaf, 2017), and that research should attempt to assess these factors from a theory driven perspective (Phaf, 2016).

[1] The distinction between perceptual and conceptual processing is not the only processing based account of memory. Another explanation, relates to the distinction between activation and elaboration (e.g., Graf & Mandler 1984; Mandler, Graf, & Kraft, 1986). Within this, implicit tests of memory require activation whilst explicit tests are considered to be dependent upon elaboration. This account is not developed upon further here due to the focus on perceptual (vs. conceptual) processing.