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Influence of response bias and internal/external source on lateral posterior parietal successful retrieval activity

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ABSTRACT

In studies of recognition memory, regions of the lateral posterior parietal cortex exhibit greater activity (as indexed by the fMRI BOLD signal) during correct recognition of "old" (studied) items than correct rejection of "new" (unstudied) items. This effect appears to be source-sensitive, with greater activity associated with recognition of perceived than imagined events. Parietal successful retrieval activity also varies with response bias, or the tendency to be conservative about making "old" judgments. Here, we examined whether differences in response bias associated with recognition judgments of perceived and imagined events could account for source-based differences in LPPC activity. Participants perceived and imagined items in response to cue words and then at test, made recognition judgments in blocks that knowingly contained either a high or low proportion of old to new trials. While participants were indeed more conservative when making judgments about perceived than imagined events, the neuroimaging results demonstrated that response bias and source effects occurred in non-overlapping parietal regions. These findings suggest that source-based differences in LPPC activity cannot be explained by differences in response bias associated with recognizing perceived and imagined events.

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1. Introduction

Functional neuroimaging studies of recognition memory have consistently identified regions of the left lateral posterior parietal cortex (LPPC) that exhibit greater neural activity (as indexed by the fMRI BOLD signal) during recognition of previously studied items (hits) than during correct rejection of new items (CRs), a finding referred to as the 'parietal old/new' or 'parietal successful retrieval' effect (for reviews, see Cabeza, 2008; Levy, 2012; Wagner, Shannon, Kahn, & Buckner, 2005). Additionally, there is evidence for a regional dissociation within LPPC such that activity in ventral regions is associated with recollection-based recognition, or recognition that involves retrieval of contextual details associated with the encoding event, whereas activity in more dorsal regions is

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associated with a-contextual, familiarity-based recognition (Kim et al., 2012; Rugg & Vilberg, 2013; Spaniol et al., 2009). A common approach for identifying the neural correlates of recollection and familiarity is to employ a source memory task, whereby studied items are presented from one of multiple 'sources,' (e.g., visual items presented on left or right side of screen, auditory words presented in male or female voice; e.g., Duarte, Henson, & Graham, 2011; Elward, Vilberg, & Rugg, 2014; Frithsen & Miller, 2014; Hayama, Vilberg, & Rugg, 2012; Yu, Johnson, & Rugg, 2012). At retrieval, activity elicited by source correct trials (i.e., items recognized along with source information) and source incorrect trials (the item is recognized but source information is forgotten) are thought to reflect recollection and familiarity processes, respectively. There is strong behavioral evidence suggesting that mnemonic information acquired through different sources is qualitatively distinct, and the processes involved in making source discriminations may depend on the category of sources being discriminated (Johnson & Raye, 1981; Johnson, Foley, Suengas, & Raye, 1988; Johnson, Hashtroudi, & Lindsay, 1993; Johnson, Raye, Foley, & Foley, 1981; Johnson, Raye, Foley, & Kim, 1982). For instance, memories from an external source, or for information acquired through perception, tend to contain greater sensory information than internally generated memories, or memories for thoughts and emotions, which contain greater information regarding the cognitive operations that were engaged during encoding (Johnson et al., 1981, 1982). Despite this phenomenological dissociation, in neuroimaging studies employing source memory tasks, the choice of which particular source manipulation to implement is seemingly made without regard to the possibility that the neural correlates associated with retrieving source information may differ depending on the category of retrieved source details (e.g., internal or external). In two recent studies, we examined how LPPC activity differed according to the internal/external (i.e., perceived/imagined) source of retrieved information (King & Miller, 2014; King, Schubert, & Miller, 2015). Indeed, we found that LPPC successful retrieval activity varied as a function of internal/external source, with retrieval of perceived, but not imagined events, eliciting a parietal successful retrieval response. These effects could not be explained by any discernable differences in behavioral performance associated with perceived and imagined events (e.g., source accuracy, item memory, reaction time). However, there is evidence that parietal retrieval activity varies with response bias, or the tendency to be conservative or cautious about judging items as old (Aminoff et al., 2015; O'Connor, Han, & Dobbins, 2010), and in our two prior studies, the designs did not allow for independent assessments of response bias associated with perceived and imagined events. Hence, the goal of the current study was to test whether differences in response bias could explain source-based differences in parietal retrieval activity.

Our two prior studies that utilized functional magnetic resonance imaging (fMRI) to examine neural correlates associated with retrieval of perceived and imagined events employed similar task paradigms (King & Miller, 2014; King et al., 2015). Each study involved an initial encoding phase, during which participants perceived and imagined images of objects in response to cue words, followed by a source memory test, where participants made perceived/imagined/new judgments to old and new cue words. In both studies we found evidence for a source effect, such that words that were paired with a visually presented image at study were associated with greater retrieval-related activity at test than words presented with the cue to visually imagine the cue word referent. In addition, while perceived study items elicited a robust parietal successful retrieval response (as indexed by the "hits" or studied items recognized as old greater than correct rejections contrast), there was little evidence of parietal successful retrieval activity associated with imagined items. We refer to these findings as *source effects*, intending to imply a difference in the BOLD activity associated with retrieval of items encoded through different sources (perception *vs* imagination) rather than the *source accuracy effects* (difference in signal associated with source hit than source miss trials) commonly referenced in the literature.

In our original study (King & Miller, 2014), the task was sufficiently difficult and included a large enough number of trials to allow for examination of variations in brain activity according to both study source (perceived, imagined) and source attribution (perceived, imagined, new). Unlike in other studies (e.g., Duarte et al., 2011; Elward et al., 2014; Frithsen & Miller, 2014; Hayama et al., 2012; Yu et al., 2012), we failed to identify any source accuracy effects in LPPC (source "hits" > source "misses"). However, memory performance in this experiment was quite low, so this null result may have been due to the inclusion of 'lucky guesses' in the source hit conditions. In other words, we believe the difficulty of the task in the previous studies contributed to the failure to elicit any activity associated with recollection per se (which is typically assessed using a source accuracy contrast). However, there was a robust successful retrieval effect (identified by the hits > CR contrast), which, given the lack of source accuracy effects was likely driven by a combination familiarity-based recognition and recollection of non-criterial contextual information (i.e., contextual information that is non-diagnostic of the source, for instance, the color of the perceived/imagined object). Surprisingly, this recognition effect only occurred for the items that were originally perceived and not imagined – despite the lack of behavioral evidence to suggest that familiarity strength differed for perceived and imagined events. In this study, we also failed to identify any effects of source attribution. In other words, LPPC activity varied according to whether an item was perceived or imagined at encoding and not according to whether it was attributed to perception or imagination at test. These findings suggest that LPPC retrieval activity is better explained by the internal/external source through which information was encoded than by any processes that would lead to a particular memory judgment.

In a follow-up experiment, we tested whether source-based differences in LPPC retrieval activity could be explained by a difference in the perceptual vividness of memories of perceived and imagined events (King et al., 2015). Participants perceived and imagined both pictures (high vividness) and sentences (low vividness) in response to cue words prior to making perceived/imagined/new source judgments. Again, we found evidence for a main effect of source