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Letters Response

Confusion abounds about confounds: response to Diana and Ranganath

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We agree with Diana and Ranganath [1] that there is ‘confusion about confounds,’ so we begin with a brief explanation of what a confound is. The scientific method involves manipulating an independent variable across conditions while holding all other variables constant. If a dependent measure changes across conditions, then that change can be attributed to the independent variable. However, if the independent variable and a nuisance variable both differ across conditions, then a confound exists. In that case, change in a dependent measure cannot be attributed to the independent variable.

We claimed that when the independent variable involves memory processes (recollection vs familiarity), memory strength is often a nuisance variable (strong vs weak). In response, Diana and Ranganath state: ‘Recollection leads to high confidence because retrieval of specific details is rarely spurious... Thus, confidence is an emergent property of recollection, not a confound.’ However, even if one agrees that recollection implies high confidence (if P then Q), it does not follow that high confidence implies recollection (if Q then P). To assume otherwise is to commit a logical fallacy (affirming the consequent). The point is that familiarity (like recollection) can occur with high confidence. Indeed, all dual-process theories agree that high confidence is an emergent property of both recollection and familiarity (e.g. [2]). If

one proposes that recollection is associated particularly with hippocampal activity, then one must also show that equally strong familiarity is not associated with hippocampal activity. This is why it is essential to equate confidence (and accuracy, whenever possible) when comparing recollection and familiarity.

In studies of source memory using functional magnetic resonance imaging (fMRI), items recognized with low confidence followed by incorrect source recollection (decisions assumed to be based on familiarity) typically do not yield elevated hippocampal activity, whereas items recognized with high confidence followed by correct source recollection (decisions assumed to be based on recollection) typically do yield elevated hippocampal activity [3–5]. Wais *et al.* [6] eliminated the strength confound by comparing high-confidence responses for both source-correct and source-incorrect decisions and found that hippocampal activity was similarly elevated for both kinds of decisions (see also [7]). Diana and Ranganath [1] object that high-confidence recognition followed by incorrect source recollection might not reflect strong familiarity but could instead reflect strong task-irrelevant recollection. Under that interpretation, the results could still be consistent with the idea that hippocampal activity reflects recollection. However, the inability to measure task-irrelevant recollection is an inherent limitation of the source memory procedure that applies to low-confidence recognition as well as high-confidence recognition [3–5]. For example, low-confidence recognition followed

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by incorrect source recollection, which is typically not associated with elevated hippocampal activity (although it is sometimes associated with perirhinal activity), might not reflect familiarity but could instead reflect weak task-irrelevant recollection. If so, then a reasonable interpretation is that fMRI activity in the hippocampus is detectable when memory is strong (but not when memory is weak) regardless of whether the memory reflects recollection or familiarity [8]. It is not clear to us why Diana and Ranganath are concerned about the limitations of the source memory procedure only when decisions are made with high confidence.

We have suggested that the Remember/Know procedure helps to address the issue of task-irrelevant recollection because Know judgments, even when made with high confidence, imply the relative absence of both task-relevant and task-irrelevant recollection [9,10]. When confidence is equated for Remember/Know judgments, both recollection and familiarity are supported by the hippocampus [11].

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Letters

Familiarity, recollection and medial temporal lobe function: an unresolved issue

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Although we agree with Wixted and Squire [1] that the different structures of the medial temporal lobes (MTL) are likely to process different kinds of information, we disagree with their view that the distinction between recollection and familiarity is unlikely to throw light on MTL functional organisation, for two main reasons.

First, neuroanatomy and neurophysiology suggest not only that there are different informational inputs to the MTL structures, but also that these inputs are processed differently by the perirhinal and parahippocampal cortices, which have similar neocortical cytoarchitectures [2], and by the hippocampus, which has a different and mainly three-layered paleocortical cytoarchitecture. Considerable neurophysiological evidence helps characterise what this processing difference might be: the hippocampus, unlike its neocortical MTL neighbours, is specialised for rapid creation of pattern-separated memory representations, which support pattern completion and recollection [3]. Furthermore, the same characterisation is derivable from computer simulation based on neuroanatomical and neurophysiological features of the hippocampus and neocortical MTL structures [4].

Second, the claim by Wixted and Squire that almost all studies that succeed in avoiding the confound between recognition memory strength, on the one hand, and familiarity and recollection, on the other, indicate that the hippocampus supports both familiarity and recollection is misleading and incorrect. The claim is misleading because it presupposes that many studies have avoided the confound, whereas hardly any have if doing so requires matching of familiarity and recollection on retrieval measures of memory strength, such as accuracy. No studies have yet examined whether hippocampal patients who show preserved overall familiarity still show preservation of very strong familiarity that produces recognition memory judgements as accurate as those produced by recollection; this needs to be done. Nothing new is learnt from patients who show impaired strong familiarity if they are already identified as impaired at overall familiarity, as well as recollection [5]. This issue will remain unresolved until we understand why some ‘hippocampal’ patients show good item recognition and preserved overall familiarity and some do not.

With respect to published fMRI studies, we have argued [3] that recognition memory strength for familiarity and recollection cannot be appropriately matched using the

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