

## Reply to Lee and Baxter: Perceptual deficits cannot explain impaired configural-relational maintenance in bilateral hippocampal injury

We thank Lee and Baxter for highlighting the question of whether the hippocampus may be critical for perceptual discrimination (1). We agree that this is an issue that is still open for debate. In fact, we have not systematically investigated this issue in our study (2). Instead, our goal was to ensure that the behavioral impairment in configural-relational (CR) short-term maintenance that emerged in patients with bilateral hippocampal sclerosis could not be accounted for by a perceptual difficulty. To that end, our perceptual discrimination condition was designed to match the perceptual requirements of the CR working memory task, and we thus used the same stimuli in the perceptual control condition as those used in the CR maintenance condition.

Our data support the strong conclusion that bilateral hippocampal sclerosis impairs short-term CR maintenance under conditions where perceptual identification/discrimination is not impaired. Although this finding, per se, does not rule out the possibility that increasing the difficulty of perceptual discrimination along the lines suggested by Lee and Baxter will lead to a perceptual impairment also in this patient group, the data clearly show that deficits in CR maintenance can occur under conditions where they cannot be accounted for by perceptual deficits. Therefore, our data suggest that at least for some forms of

processing (i.e., CR) that do not involve a change in the viewpoint, short-term maintenance depends more critically on hippocampal integrity than perception.

This said, we would like to point out that the temporooccipital theta synchrony that we have observed during CR maintenance already emerged during scene presentation before the delay period. Therefore, it is likely that this presentation period involves perceptual encoding. Theta oscillatory synchrony may therefore be an interesting tool to study functional aspects of perceptual feature integration under conditions where Lee and Baxter expect patients with hippocampal injury to show an impairment, even when the task involves no demands on working memory. An interesting possibility is that the same type of theta synchrony that supports CR maintenance may also contribute to perception under such conditions.

**Nathan Cashdollar<sup>a,b,1</sup>, Nilli Lavie<sup>b</sup>, and Emrah Duzel<sup>b,c,d</sup>**

<sup>a</sup>University College, London Institute of Neurology, and National Hospital for Neurology and Neurosurgery, London WC1N 3BG, United Kingdom; <sup>b</sup>University College, London Institute for Cognitive Neuroscience, London WC1N 3AR, United Kingdom; <sup>c</sup>Institute of Cognitive Neurology and Dementia Research, O.v.G University, 39120 Magdeburg, Germany; and <sup>d</sup>German Centre for Neurodegenerative Disorders–Magdeburg, O.v.G University, 39120 Magdeburg, Germany

1. Lee ACH, Baxter MG (2010) The hippocampus and configural-relational information: A relationship confined to memory? *Proc Natl Acad Sci USA* 107:E21.
2. Cashdollar N, et al. (2009) Hippocampus-dependent and -independent theta-networks of active maintenance. *Proc Natl Acad Sci USA* 106:20493–20498.

Author contributions: N.C., N.L., and E.D. wrote the paper.

The authors declare no conflict of interest.

<sup>1</sup>To whom correspondence should be addressed. E-mail: n.cashdollar@ucl.ac.uk.