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We were pleased to receive comments on our recent manuscript (Vesia et al., 2010) and thank the authors for their critical review. The authors provide an excellent summary of the findings from our study, and have raised several important points regarding the role of both limb and visual-hemifield specificity on complex visuomotor transformations. We are grateful to the authors for raising these issues as this provides us with an opportunity to clarify our position and expand on some issues that were overlooked in the original paper.

In their journal club article, Ciavarro and Ambrosini (2011) question the role of superior parieto-occipital cortex (SPOC) region in encoding reach goals in retinal coordinates. They point to our data that suggest the potential presence of a TMS-induced, limb-specific effect for SPOC. The authors correctly point out that our analysis of limb specificity was limited to reach precision, which did not show limb-specific effects after TMS over SPOC. In contrast, Ciavarro and Ambrosini cite evidence from our reach accuracy data (Vesia et al., 2010; Fig. 6, D-G) that shows hand-specific effects of stimulation over SPOC. We agree entirely, and would have emphasized this result more if it had been possible to directly compare this effect with the qualitatively different accuracy effects we obtained from our other TMS sites. However, our conclusion that SPOC is involved primarily in goal encoding was drawn mainly from a different experiment (Vesia et al., 2010; Experiment 3), in which visual feedback of the hand negated the effect of TMS over other parietal regions, but not SPOC. Indeed, there is no logical contradiction in SPOC encoding limb-specific reach goals.

Moreover, we agree with their observation that our result does not prove that SPOC is restricted to encoding reach goals in retinal coordinates. Our study was not designed to test this hypothesis. In our study, we focused on the question of whether there is functional
specificity in these human parietal regions in goal-directed actions. Our finding that TMS over SPOC induces gaze-centered ‘magnetic reach’ errors is merely consistent with other studies suggesting that SPOC primarily uses visual coordinates for visually-guided reach (Fernandez-Ruiz et al., 2007; Beurze et al., 2010). Clearly, SPOC also shows additional more complex properties; for example, a recent neuroimaging study elegantly showed that this region could switch between visual and non-visual encoding, depending on the sensory modality used to specify the reach target (Bernier and Grafton, 2010).

Another controversy concerns the degree of functional segregation between the separate reach computations in these different parietal regions. There now is abundant evidence from functional imaging studies that reach planning produces large swaths of activation in parietal areas (Kertzman et al., 1997; Prado et al., 2005; Culham et al., 2006; Culham and Valyear, 2006; Hagler et al., 2007; Levy et al., 2007; Tosoni et al., 2008; Beurze et al., 2009; Filimon et al., 2009; Filimon, 2010). We, therefore, emphasized the novel functional segregations that we were able to identify using TMS in our study. As a result, although we did not explicitly state a strict functional division in our discussion, this point may have been overemphasized. In fact, although our study clearly provides evidence for some degree of segregation, we agree that these distinctions are not clear cut. Rather, effector and target information are represented likely in a distributed gradient across the parietofrontal cortical network (Medendorp et al., 2005; Beurze et al., 2009; Blangero et al., 2009; Filimon, 2010), with considerable intermingling of signals (Snyder et al., 1997). In our view, this may explain why some of these issues have been difficult to address with standard neuroimaging techniques that show activation rather than causation.

Finally, we completely agree with the suggestion that both visual hemifield and target eccentricity influence reach accuracy. In fact, recent evidence suggests that damage to similar parietal regions causes systematic retinotopic reaching errors in unilateral optic ataxia (Blangero et al., 2010). Considering the wide scope of our study (six experimental TMS sites plus controls;
saccade and reaching with left and right hand; two different visual conditions), we were unable to discuss all the data in detail, and again, we are grateful to these authors for raising several points that were overlooked in our original paper.

References