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COGNITIVE NEUROSCIENCE

# COMMENTARY
# Cracking the almond (Commentary on Prévost *et al.*)


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Recent advances in functional magnetic resonance imaging (fMRI) have provided an unprecedented peek into the activity of subareas of major anatomical structures in the healthy human brain. However, little is known about subregional activity in the human amygdala, a small, almond-shaped corticoid structure in the medial temporal lobe that lacks clear MRI landmarks for compartmentalization of its dozen nuclei. Previous attempts to localize functions within the amygdala using standard fMRI either have relied on gross subdivisions, such as quadrants (Dolcos *et al.*, 2004), or have estimated where the peak activation clusters lie (Davis *et al.*, 2010), sometimes with the aid of probabilistic atlases (Amunts *et al.*, 2005).

In pages 134–145 of this volume, Prevost *et al.* (2011) use high-resolution fMRI to evaluate amygdalar subregional responses during reward and avoidance learning. Their paper makes several important methodological advances, including improved resolution using a tailored fMRI protocol, increased precision due to a region-of-interest-based alignment approach and lack of spatial smoothing, and better specification of behavioral correlates using computational modeling. The results indicate that the centromedial (CM) and basolateral (BLA) divisions make dissociable contributions to avoidance and reward learning, respectively, for coding action value at the time of choice and for evaluating estimation uncertainty of the cue. The CM further correlated with reward value of anticipatory state signals in the avoidance condition. However, a lateral region of the BLA correlated with reward prediction errors at the time of trial outcome during both learning conditions, albeit in adjacent sectors.

These findings contribute to the broader literature regarding specialization of reward- and avoidance-based learning systems in the human brain and demonstrate the potential efficacy of high-resolution fMRI for investigating larger amygdalar subdivisions. Yet the findings show that reward and avoidance learning may not be neatly compartmentalized across subnuclear divisions in all aspects, and, curiously, neither region showed increased activation to putative aversive signals (loss of money) in the avoidance condition. Discrepancies between these observations and the clear role of both the BLA and the CM during classical fear conditioning remain to be resolved. Future studies could further validate anatomical localization by considering the known differences in relative connectivity of the CM and BLA with subcortical versus cortical association areas, respectively (Swanson & Petrovich, 1998), as demonstrated by Etkin *et al.* (2009) using functional connectivity analyses.

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