Object familiarity modulates effective connectivity during haptic shape perception.

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Visual cortical areas are routinely active in normally sighted individuals during haptic shape perception but there is debate about whether this is due to visual imagery, mediated by top-down pathways from prefrontal areas, or engagement of multisensory representations via bottom-up pathways from somatosensory areas. In two functional magnetic resonance imaging experiments, participants haptically discriminated the shape of unfamiliar (Experiment 1) or familiar (Experiment 2) objects (HS task). In separate sessions, the same participants in each experiment made shape judgments on visual images of objects represented by words they heard (VI task). Regardless of familiarity, VI- and HS-related activations overlapped in the lateral occipital complex (LOC) bilaterally, left ventral premotor cortex, left ventral intraparietal sulcus, and left pulvinar. For familiar objects, there were additional overlap zones in left prefrontal and posterior parietal cortex. We then performed multivariate Granger causality analyses of effective connectivity on task-specific time series data from these experiments, using a novel method that eliminates zero-lag correlations (correlation-purged Granger causality) thus yielding purer estimates of effective connectivity. These analyses showed that the VI and familiar HS tasks activated similar networks involving top-down paths into the LOC, consistent with the use of visual imagery during haptic perception of the shape of familiar objects. However, the unfamiliar HS task activated a different network characterized by bottom-up, somatosensory cortical inputs into the LOC. We conclude that LOC activation during haptic shape perception reflects visual imagery, but that this is mediated by object familiarity. Thus, shape representations in the LOC are flexibly accessible, either top-down or bottom-up, according to task demands.