Modulating Neural Mechanisms Underpinning Episodic Memory for Face-Scene Image Composites: Effects of Attention Orientation and Associative Strength

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Ever since identifying brain regions selective for face processing, many studies have demonstrated such selectivity from a multitude of brain regions. Likewise, brain regions selective for scene processing have also been identified recently. However, relatively few studies have investigated how the two networks interact and integrate in processing faces viewed against scenes, which characterizes modal experiences of our daily lives. In the present talk, I will present a series of four fMRI experiments in two parts to investigate aspects related to this inquiry. In Part I, we examined how activation of brain regions selective for face and scene processing may be modulated by orienting to different aspects of face-scene composite images. Results from Experiment 1 showed that during encoding, for fusiform face area (FFA), brain activation was strongest with face-only (FO) images, followed by face-scene image composites when participants oriented their attention to the face (Fs), and weakest for scene-only (SO) images. Analogously, for parahippocampal place area (PPA), the strongest activation was found with scene-only images, followed by image composites when participants oriented their attention to scenes (Sf), and weakest for face-only images. In Experiment 2, adopting a generalized psychophysiological interaction (gPPI) approach, we examined the extent to which the effect of context shift decrement (CSD) can be accounted for in terms of functional connectivity (FC) of brain regions selective for face and scene processing, modulated by orienting attention during encoding. Results showed that the FC between the occipital face area (OFA) and other face-selective regions (insula, MPFC & HPC) was stronger when participants attended to faces in Fs than to scenes in Sf. In contrast, the FC between scene-selective regions, including occipital place area (OPA), retrosplenial cortex (RSC), and PPA were weaker when participants attended to scenes in Sf than to faces in Fs in the image composites. The stronger FC among face-selective regions during encoding may help explain less CSD for faces when the background scenes were removed during recognition. In contrast, the weaker FC among scene-selective regions during encoding may have led to greater CSD when faces were removed during recognition. In Part II, we investigated the role of the hippocampus cortex (HPC) in binding and differentiation during encoding and retrieval of face-scene image composites. In Experiment 3, participants were asked to perform a 2-back working memory (WM) task during encoding. For face-scene image composites, they made a positive response only when the currently displayed image, in terms of both face and scene, was identical to the one presented two images back. During recognition, they were shown face-scene image composites and judged whether their *combination* was identical to that during encoding. Results showed in contrast to face-only (FO) and scene-only (SO) images, both the left and right HPC exhibited greater activation during the encoding of face-scene composites. Likewise, for composite images, bilateral HPC exhibited greater activation when we contrasted between those that were exact or partial repetition versus those that were not repeated. During recognition, bilateral anterior HPC showed greater activation when the *recombined* composite images contrasted with the *old* composites. Moreover, bilateral HPC showed greater activation when the recombined composites were correctly rejected than when they were erroneously identified. In Experiment 4, we examined the neural mechanisms underpinning the retrieval of episodic memory for face-scene image composites of differential associative strength. During encoding, participants were shown face-scene composite images where a specific face was associated with a specific scene (Fan 1-1), a single face associated with multiple scenes (Fan 1-5), or multiple repetitions of a specific pairing between a face and a scene (R5). During recognition, participants were to judge whether the specific pairing of face and scene was presented during encoding or was a recombined version. The contrast between Fan 1-1 and Fan 1-5 highlights stronger activations of bilateral FFA to differentiate the specific links between a face and multiple scenes. On the other hand, the contrast between Fan 1-1 and its counterpart of five repetitions (i.e., R5) revealed all the relevant brain regions were more strongly activated due to multiple encounters. Finally, and somewhat unexpectedly, the activations of bilateral HPC were diminished in the contrast between R5 and Fan 1-5, suggesting the dual (and counteracting) role of HPC for binding in the former case and pattern differentiation in the latter case. In summary, the findings from four experiments demonstrate the behavioral effects of orienting attention and associative strength on episodic memory of face-scene image composites and highlight the brain mechanisms that may underpin these effects.