**Cognitive Neuroscience Methods**

Katharine Crooks

Florida International University

**Methods**

**Participants**

One participant (42-year-old male) was selected to participate in this study, recruited from the community. The participant met all eligibility criteria: the participant was right-handed, had normal or corrected to normal vision, and did not have excessive task errors or excessive motion. The participant completed informed consent and assent prior to beginning the study with procedures approved by the Institutional Review Board. The participant was compensated for their time.

**Localizer Task**

Localizer tasks are commonly used to define a functional region via an independent experiment to define a functional region for each individual participant, which can then be used to analyze a separate task of interest (Berman et al., 2010). In this case, the task consisted of two runs of a block-design task. The participant viewed three types of blocks lasting 26 seconds each: faces, scenery, and mathematic equations (which served as a neutral stimulus) and used a button box to respond. In the face block, the participant was asked to indicate whether the face presented was male or female, while for the scenery blocks, the participant was asked to indicate whether the scene presented included water. Each stimuli was presented on the screen for 0.5 seconds followed by a 0.75 second interstimulus interval, during which a white plus sign on a black screen was shown as a fixation point. In total, the participant saw 840 stimuli (240 faces, 240 scenery, and 240 math equations), lasting approximately seven minutes.

**Visual Conditioning Associative Task (vCAT)**

A visual conditioning associative task (vCAT) was conducted to assess associative memory for shape and object pairs. In each trial, images appeared at the left and right, with specific ‘shapes’ at the center. Four shape-object pairs were created; during the trials, the participant learns through trial and error which household item is paired with which shape. A fifth shape, acting as the conditional trial, required participants to recall which shape-object pair had been presented the trial before, and associate that shape-object pair with either the image of scenery or a face. Images were presented to the participant for 1 second prior to allowing the participant to make a response; a white plus sign acted as a fixation point before the participants made their selection, and the phrase “Go!” in white lettering indicated when the participant should make their choice. Visual feedback was given through either “Yes!” in green text for a correct response or “No!” in red text for an incorrect response. The participants also completed ‘baseline’ trials where the task requires the participant to choose which one of two light-gray boxes on a ‘noisy’ background was lighter. Stimuli were presented for 1-4 seconds before the “Go!” prompted the participant to respond. In total, the participant completed 720 trials: 400 using the first four shapes, 200 using the fifth, and 120 using the baseline condition.

**Neuroimaging Data Collection and Preprocessing**

Neuroimaging data were collected on a 3T Siemens MAGNETOM Prisma scanner with a 32-channel head coil at the Center for Imaging Science at Florida International University in Miami, FL. A structural T1-weighted magnetization-prepared rapid gradient echo sequence (MPRAGE) (echo time (TE) = 2.9 ms, repetition time (TR) = 2500 ms, flip angle = 8°, 256x256 matrix, 176 sagittal slices, with 1mm isotropic voxel resolution) was collected in addition to a T2\*-weighted EPI sequence (TE = 35 ms, TR = 1760 ms, flip angle = 52°, 1800x1800 matrix, 66 axial slices, slice acceleration = 3, with 2mm isotropic voxel resolution). In total, 1420 whole brain volumes were acquired during the scanning.

Software utilized in neuroimaging data preprocessing followed a custom-scripted pipeline using Neuroimaging in Python (Nipype version 0.12.1; Gorgolewski et al., 2011): Analysis of Functional Neuroimages (AFNI version 20.1.00; Cox, 1996), FMRIB Software Library (FSL version 5.0.11; Smith et al., 2004), and FreeSurfer (version 6.0.0; Fischl, 2012). Functional scans were motion-corrected using AFNI’s 3dvolreg, finding the earliest volume with the least number of outliers to serve as the base for the motion correction. Artifact detection was conducted using rapidart with a z-intensity threshold of 3.0 and a global threshold of 10.0, and then both spatially (2.5mm fwhm isotropic kernel) and temporally smoothed (adaptive mean of 5-point linear filter) to improve the signal-to-noise ratio. In addition, slice timing correction was conducted using AFNI’s 3dTshift command to correct differences in timing across the slices. Functional volumes were co-registered from EPI space to FreeSurfer space using the BBRegister command.

**Anatomical Regions of Interest**

The anatomical focus of this study was to understand the visual aspect of associative memory, specifically the fusiform face area (FFA) and the parahippocampal place area (PPA) in order to account for both face and scene recognition. These regions were defined by binarizing the FreeSurfer parahippocampal and fusiform cortical segmentations.

**Task Neuroimaging Data Analysis**

Functional neuroimaging data were analyzed using a general linear model (GLM) approach through FSL. The model included both regressors of interest and regressors of non-interest. The regressors of non-interest were motion (specifically x, y, and z translations along with pitch, roll, and yaw rotations), the first and second derivatives of the motion parameters, normalized motion, first through third order Lagrange polynomials (accounting for low-frequency signal changes), and as well as a regressor for each outlier time-point that exceeded outlier thresholds. The regressors of interest were correct condition (CC), incorrect condition (IC), remain events (RE), face before baseline (F\_BL), and scene before baseline (S\_BL).