Introduction and Methods

The field of neuroesthetics is a recent marriage of the realms of neuroscience and art. The objective of neuroesthetics is to comprehend the perception and subjective experience of art in terms of their neural substrates. In this study, we examined the effect of a number of original pieces of art on the brain of the artist herself and on that of a novice as she experienced the artwork for the first time. This allowed us to compare neural responses not only amongst different visual conditions but also between an expert (i.e. the artist) and a novice.

Lia Cook lent her artwork to be used in this study. The pieces, which she believes to have an innate emotional quality, are cotton and rayon textiles. All of the pieces are portraits with a somewhat abstract, pixelated appearance imparted by the medium. In order to better understand the neural effects of the woven facial images, we used several types of control images. These included (i) scrambled woven pieces, or textiles that were controlled for color, contrast, and size but contained no distinct facial forms; and (ii) photographs, which were all photographs of human faces but were printed on heavy paper and lacked the texture and unique visual appearance of the textiles. All of the pieces are 12.5 in. x 18 in.

The expert and novice were each scanned with functional MRI while they viewed and touched the tapestries and photographs. The subjects completed 100 trials divided across two functional scans. Each trial lasted a total of 12 s, with jittered intervals of 4 s to 6 s between trials. Each trial consisted of an initial 6 s during which subjects were instructed to feel samples of the art media that were situated in their lap. These samples were 5 in. x 8.5 in. pieces of textile and paper. After feeling one of the materials, subjects were instructed to view an image for 6 s. The images were held up by an experimenter behind the scanner and viewed by the subject via a mirror. The reason for using the actual materials instead of projecting them on a computer screen was to expose the subjects to the visual appearance of the textures, which are not readily apparent in photographs of the work. There were a total of 5 pseudo-randomly distributed trial types in the experiment: (i) touch woven, see woven, (ii) touch photo, see photo, (iii) touch woven, see photo, (iv) touch photo, see woven, and (v) touch woven, see scramble. The incongruent conditions were included as controls for the effect of the material on the viewing experience, and the scrambled images were included as controls for the appearance of a face in each of the art pieces.

Preprocessing and analysis of brain data were conducted using BrainVoyagerQX version 2.3.1 (Brain Innovation, Maastricht, Netherlands). Data acquisition was performed on a 3T Siemens Allegra head-only MRI scanner with 36 coronal slices, 3 mm thick, 3 mm x 3 mm in-plane resolution, 2 s TR, and whole-brain coverage.

Results

The following sections describe the contrast that was examined and a brief discussion of each. Applying a contrast between two conditions identifies areas of the brain that were more active in one condition than another. This allows us to determine what effects different trial types had on neural activity.

All seeing images > All touching materials

In this first contrast, we approach the material in a broad sense in order to get a feel for the data. We identify all areas that are more responsive during the image-viewing portion of the trials than during the material-touching portion of the trials. We would expect to see greater activity in the occipital cortex, which contains most of the visual processing regions, during the image-viewing trials. Conversely, we expect to see more activity in the somatosensory and motor cortices, which run from the top of the brain in the center down the lateral sides of the hemispheres, during the material-touching trials.

Here, we see the differences in activity as expected. There is greater activity in the occipital (mostly visual) cortices for image-viewing trials (as seen in the yellow-orange regions in Figure 1 below) and greater activity in the somatosensory and motor cortices for material-touching trials (as seen in the blue-green regions in Figure 1 below). Given that we have established these expected patterns of activity, we can see how brain activity is modulated by different conditions and different viewers.

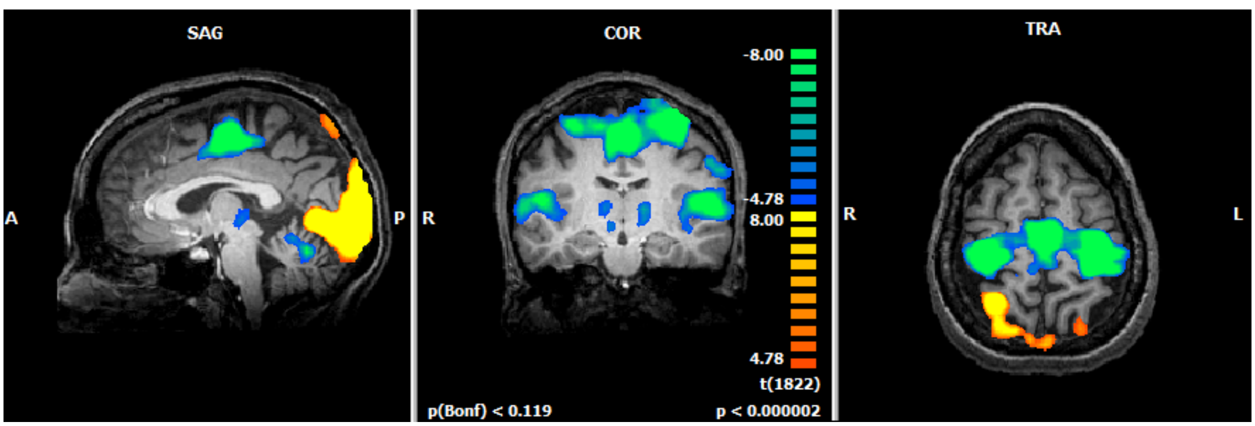

Figure 1. All seeing images > All touching materials. Greater activity for images is in yellow-orange, while greater activity for materials is in green-blue ($p < 0.000002$).

All seeing woven > All seeing photo

In this contrast, we compared all trials in which the subjects were seeing the woven images to all trials in which the subjects were seeing photos, with the exception of the scrambled category. We expected to see some difference between the ways the brain processed the appearance of the two materials.

Here, we see greater activity in primary visual cortex for all trials in which both subjects are viewing woven images than for trials in which they are viewing photographs (Figure 2). Primary visual cortex, also known as V1, Brodmann area 17, or striate cortex, is an early processing center in the pathway from the eyes to the neocortex. Primary visual cortex integrates information about contrast, shape, patterns, and spatial organization of the visual field and passes this information onto higher order visual areas. These higher order areas also have feedback connections into V1, which modulate its activity. It is possible that the sharp contrasts and the grid-like appearance of the woven images is especially engaging for the contrast-sensitive cells in V1. It is also possible that the lack of immediate clarity in the images, which are somewhat abstract representations of faces, require top-down modulation of V1 to process the images, and this modulation appears as an enhancement of V1 activity.

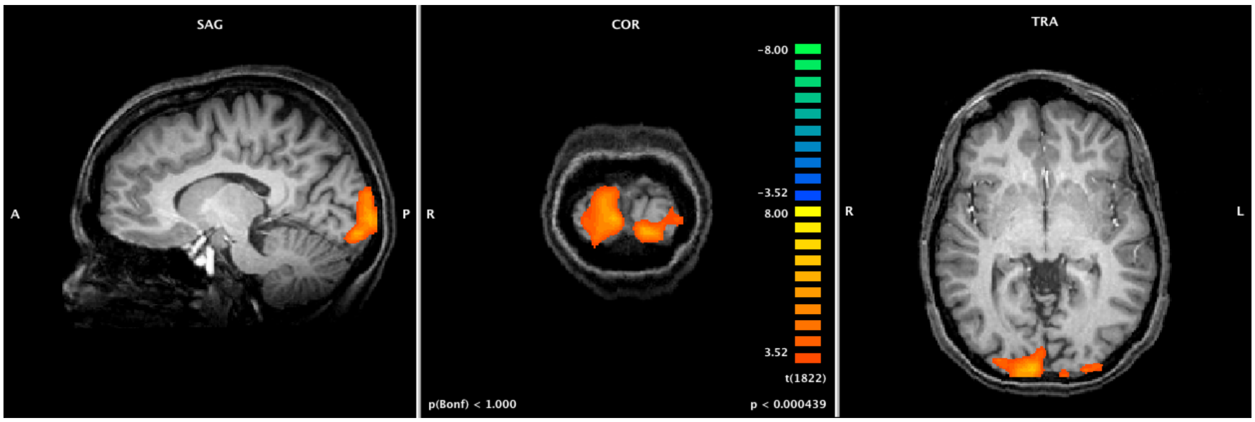

Figure 2. All seeing woven > All seeing photo. Greater activity for woven images is in yellow-orange ($p < 0.0004$).

All seeing faces (woven and photo) > All seeing scrambled images

In this contrast, we compared all trials in which the subjects were seeing woven and photo images with faces to all trials in which the subjects were seeing the scrambled images without faces. We expect that the face images will engage the fusiform gyrus (FFG). This region, also deemed the “fusiform face area”, is classically responsive to face stimuli.

Here, we see activity as expected. The fusiform gyrus is more active when subjects were viewing face stimuli than when they were viewing non-face, scrambled stimuli (Figure 3). Now that we have explored the effects of different types of trials, we can compare activity across the expert and the novice.

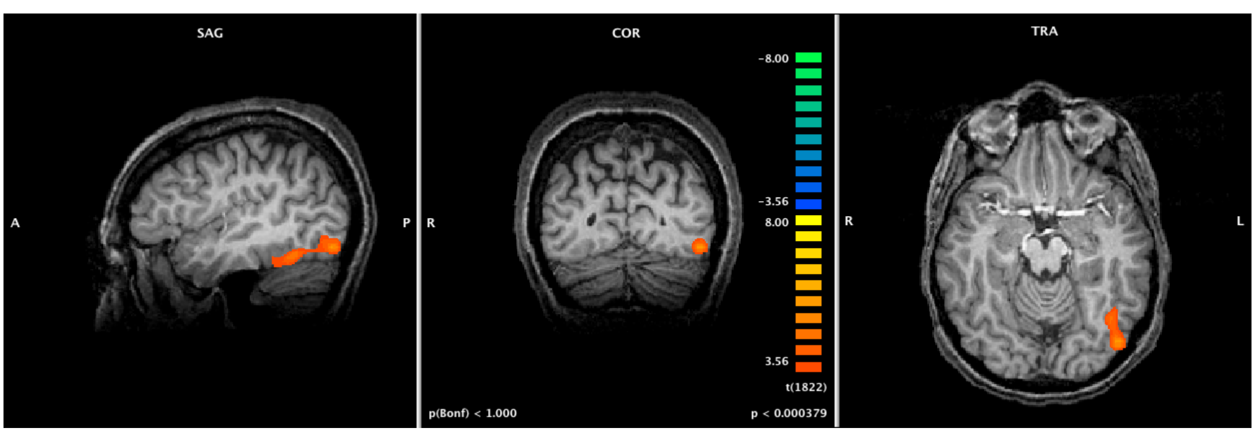

Figure 3. All seeing faces (woven and photo) > All seeing scrambled images. Greater activity for face images is in yellow-orange ($p < 0.0004$).

Expert seeing woven and photo > Novice seeing woven and photo

In this contrast, we compared the expert seeing woven and photo images immediately after touching the matching material to the novice experiencing the same trial types. We expected to see some enhancement, perhaps in tactile or visual areas of the brain, between the artist, who has intimate experience with her work, and the novice, who previously had none.

Here, we see greater activity for the expert (i.e. the artist) than for the novice in several higher order visual areas, including Brodmann areas 18 and 19 in the occipital lobe (Figure 4). These areas comprise visual areas V2, V3, V4, and V5/MT (Clark, Boutros, & Mendez, 2010). The higher order visual areas receive input from primary visual cortex and other areas. Some neurons in BA 19 integrate inputs different sensory modalities, including touch. Both the familiarity of the artist with her own work and with the materials from which it is crafted may have an influence on the increased activity in higher order visual areas for the expert versus the novice.

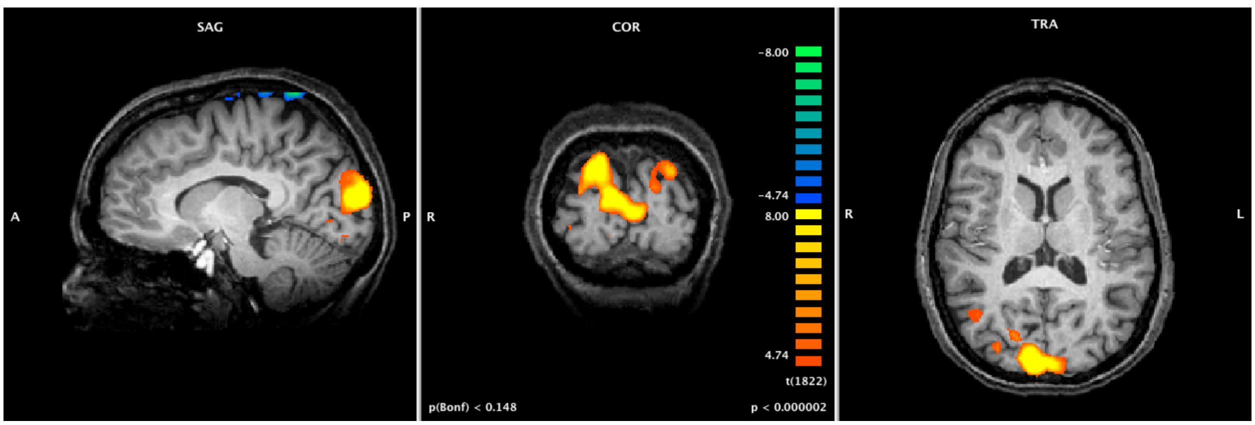

Figure 4. Expert seeing woven and photo > Novice seeing woven and photo. Greater activity for the expert is in yellow-orange ($p < 0.000002$).

In this contrast, there is also greater activity for the expert in the FFG. Given that many of the faces that appear in the artists' work are from amongst her friends and family, it might be expected that the FFG in her brain is more responsive than that of a novice who does not know these individuals personally.

Discussion

Overall, we discovered several interesting neural effects of woven and photographic images. We found that the woven material has an enhancing effect on neural activity in early visual processing areas. This may mean that the material is effectively more engaging, as it requires heightened processing. We also found that the artist showed greater neural activity in higher-order visual areas and the fusiform gyrus, likely due to her experience with the material and familiarity with the particular individuals depicted in it. Notably, we did not find any significant effect of sensory crossover; there was no visual activity associated with the tactile trials and vice versa. There was also no significant effect of expectation for congruency after the tactile stimulus (e.g. seeing a woven image after touching one). However, since this study only used two subjects, it is possible that these effects could be visible with additional data. Regardless, our foray into the realm of neuroesthetics with the artwork of Lia Cook yielded some interesting results.

References

Clark, D.L., Boutros, N.N., & Mendez, M.F. The Brain and Behavior: An Introduction to Behavioral Neuroanatomy. Cambridge University Press, 2010. pp. 34-35