Title: Domain-General and Domain-Specific Brain Regions Involved in Statistical-Sequential Learning

Authors: Phillip Loan, Leyla Eghbalzad, Gretchen Smith

Faculty Advisors: Christopher Conway and Tricia King, Psychology Department

Keywords: Statistical learning, language, visuospatial, fMRI

Introduction: Statistical learning is the ability to detect and encode patterns in the surrounding environment across various domains such as language and visual-spatial processing. However, the neural correlates underlying statistical learning are underspecified. Specifically, it is not clear to what extent statistical learning relies on domain-general versus domain-specific neural mechanisms.

Methods: We developed two novel sequential learning tasks: a visuo-syllabic task in which printed nonsense syllables were presented sequentially on the screen and a visuo-spatial task in which flashing squares were presented sequentially in different locations. Both tasks incorporated statistically-constrained sequences generated from an artificial grammar. Following exposure to a subset of grammatical sequences, sixteen healthy adults (age M=22.5, 9 females) performed a familiarity judgment task for novel grammatical and ungrammatical sequences. We used fMRI with a 3T scanner to evaluate BOLD activity during the familiarity judgment task.

Results: We investigated the similarities and differences in activation of brain regions between the two tasks. For both tasks, we observed significant activation in the precuneous cortex (BA 7) and the posterior cingulate gyrus (BA 23). These areas are associated with language processing, visual/visuospatial processing, and working memory. In regards to differences between the tasks, we found significant activation in the inferior frontal gyrus and the prefrontal cortex (BAs 44, 45, 47, and 10) for the visuo-syllabic task, areas typically associated with language and syntactic processing. In contrast, during the visuo-spatial task, significant activation was observed in more posterior areas of the brain (BAs 19, 13, 40, 23 and 7), which have been associated with spatial working memory and visuo-spatial memory.

Conclusion: These results suggest a network of both domain-general and domain-specific mechanisms involved in statistical-sequential learning. The domain-general areas include secondary association cortex that is involved in a wide range of sensory, motor, and memory processes, whereas the domain-specific brain networks include frontal language areas for the syllabic task and posterior visual processing areas for the visual-spatial task. Overall, these findings support the idea that areas involved in perceiving specific types of stimuli are themselves the same areas involved in learning the structural patterns to which those stimuli adhere.