

Cross-modal deactivation related to auditory task difficulty: Non-musicians verses conductors

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Background

BOLD signal decreases relative to baseline, or deactivations, can occur with stimulation of an opposing sensory modality (e.g., decreases in visual cortex during an auditory task) [1]. While these deactivations may be attention-related [2], one possibility is that they are directly related to the difficulty of the task at hand. Additionally, an open question is whether this type of cross-modal mediation is altered by extensive training and experience within one sensory system; specifically, whether extreme competency at a task will necessitate the same response. Here, we investigate BOLD signal decreases related to auditory task difficulty in both musically-untrained individuals and experienced conductors.

Methods

Control subjects were from a variety of careers and had no formal musical training; Conductors had a mean of 10 years podium experience, and were matched on all other demographics (age, gender, education, etc). Prior to fMRI, each subject's individual thresholds for auditory temporal-order judgment (TOJ) and pitch discrimination were determined. In conjunction with sparse-sampling MRI, subjects performed each auditory task at (*hard-task*) or well above (*easy-task*) their own threshold, as well as a visual TOJ. Matching individual thresholds ensured consistent relative task difficulty while compensating for expected performance differences between the groups. Alternating non-task (baseline) epochs consisted of no stimulation; subjects maintained fixation with eyes open during all epochs.

Results and Conclusions

Along with significant activation in auditory cortex, when performing the auditory tasks at difficult level (*hard-task*), control (non-musician) subjects show significant decreases (BOLD signal < baseline) in parietal and cingulate cortex. Additionally, significant (FWE corrected $p < .05$) deactivations are observed in visual cortex. In contrast, these deactivations are dramatically reduced when the same task is easier (*easy-task*). Conductors, on the other hand, show the same level of (small) deactivation in visual cortex for both conditions, regardless of matched task difficulty. No group differences are observed when performing visual TOJ. Further (ongoing) analyses using Biological Parametric Mapping [3], a toolbox designed for combining multiple imaging modality datasets, explore group differences related to other factors such as gray matter volume

(VBM). Together, these results show that cross-modal (visual changes during auditory processing) deactivations occur in compensation for task difficulty, acting perhaps as an intrinsic filter for non-relevant information. Additionally, it suggests that conductors may not require the same degree of intrinsic inhibition to perform at the same level, likely an outcome from their unique daily and career experiences.

References

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