

Exploring the Relationship between Postural Control and Brain Activity using Dual-Task Methodology

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Background

- Attention is a limited cognitive resource which tends to function most proficiently when entirely focused on a single task. Depending on the situation, greater attention may be prioritized to one task, thereby limiting the attention devoted to a competing task.
- Loss of attention is commonly associated with a higher likelihood of falling, especially with the elderly. Understanding how attention is allocated during a balance task, when paired with competing cognitive tasks, can be used to develop therapeutic protocols designed to aid elderly individuals as well as those with disease conditions that demand a higher efficacy of balance control.
- Dual-task refers to the simultaneous performance of two or more single-tasks with distinct goals.

Objectives

1. Gain insight into attention tradeoff between balance task and cognitive distractor task.
2. Analyze hemodynamics of brain's frontal lobe using functional near infrared spectroscopy (fNIRS).

Methods

- 3 test conditions (all while standing and wearing OBELAB headset).
 - Cognitive task: Identify how many times "probe" sound is heard.
 - Balance control task: Sway about ankles in response to light vibration (via C2 tactors) applied to abdomen and lower back.
 - Combine cognitive and balance task.
- NIRSIT software for analysis of fNIRS activation patterns.

Results

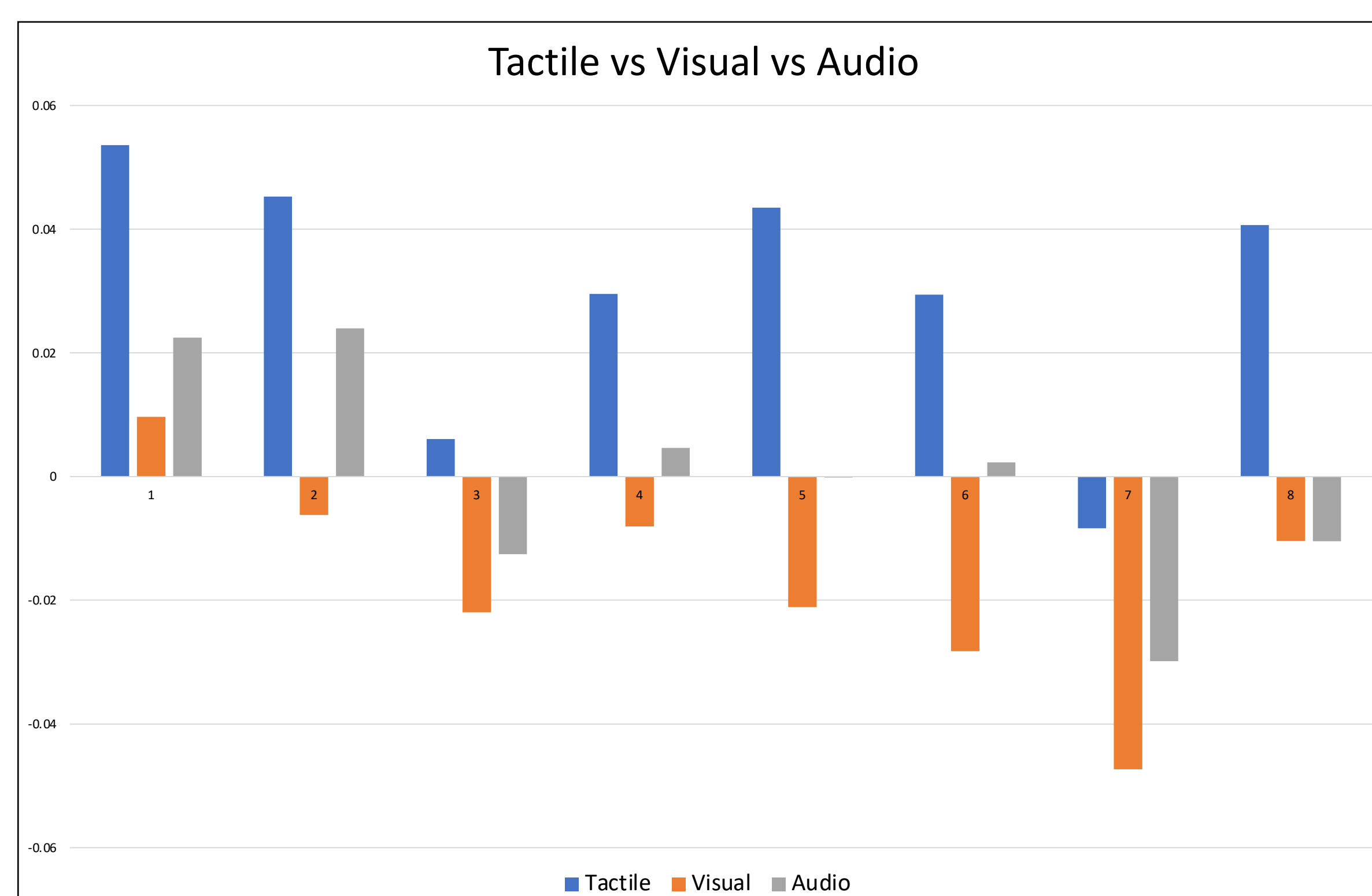


Figure 1: Performing balance task in response to tactile feedback produced greatest activation.

- Adding stimuli to tactile only condition suppresses activation.

Results (cont.)

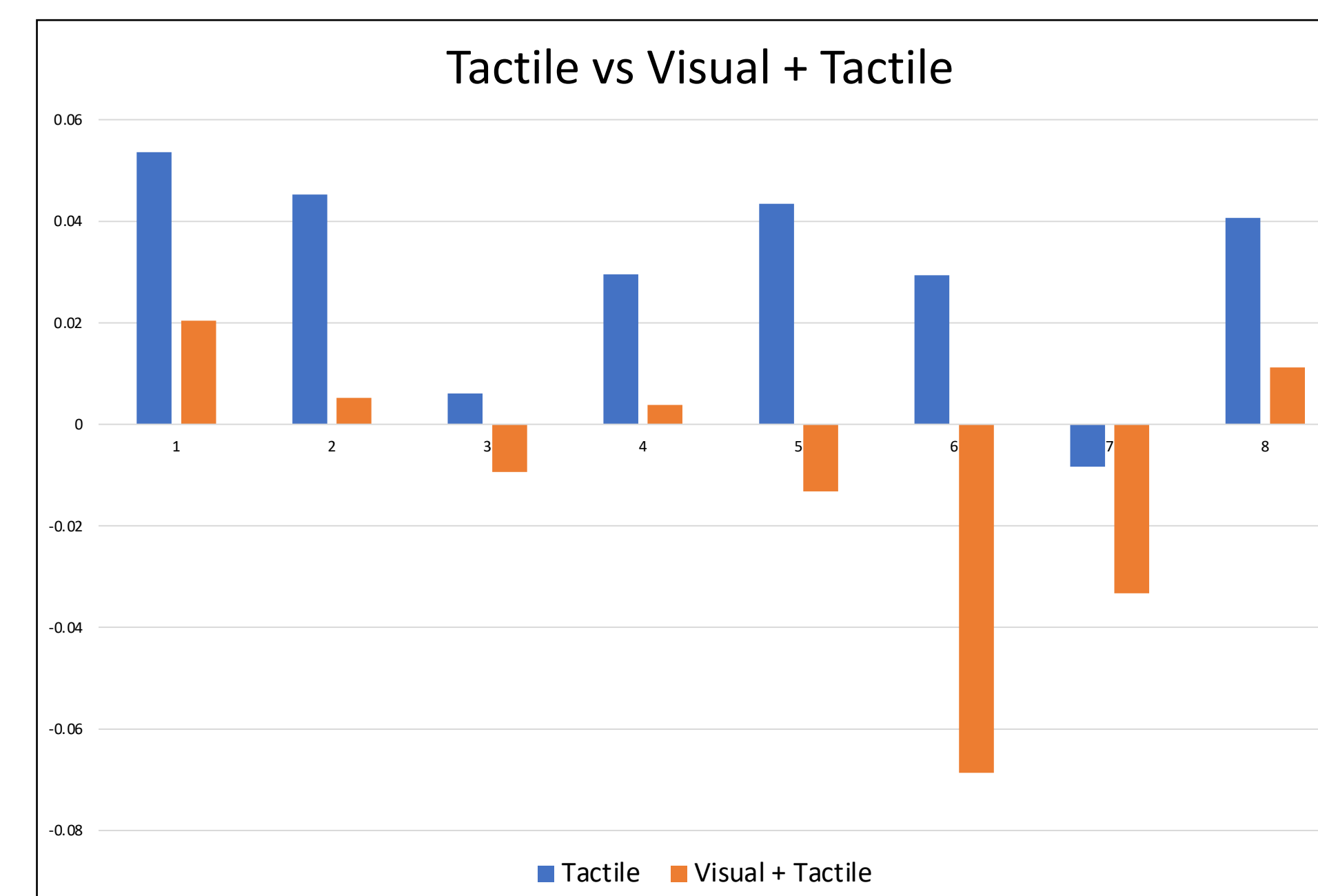


Figure 2: Addition of visual stimulus to tactile only condition suppresses activity.

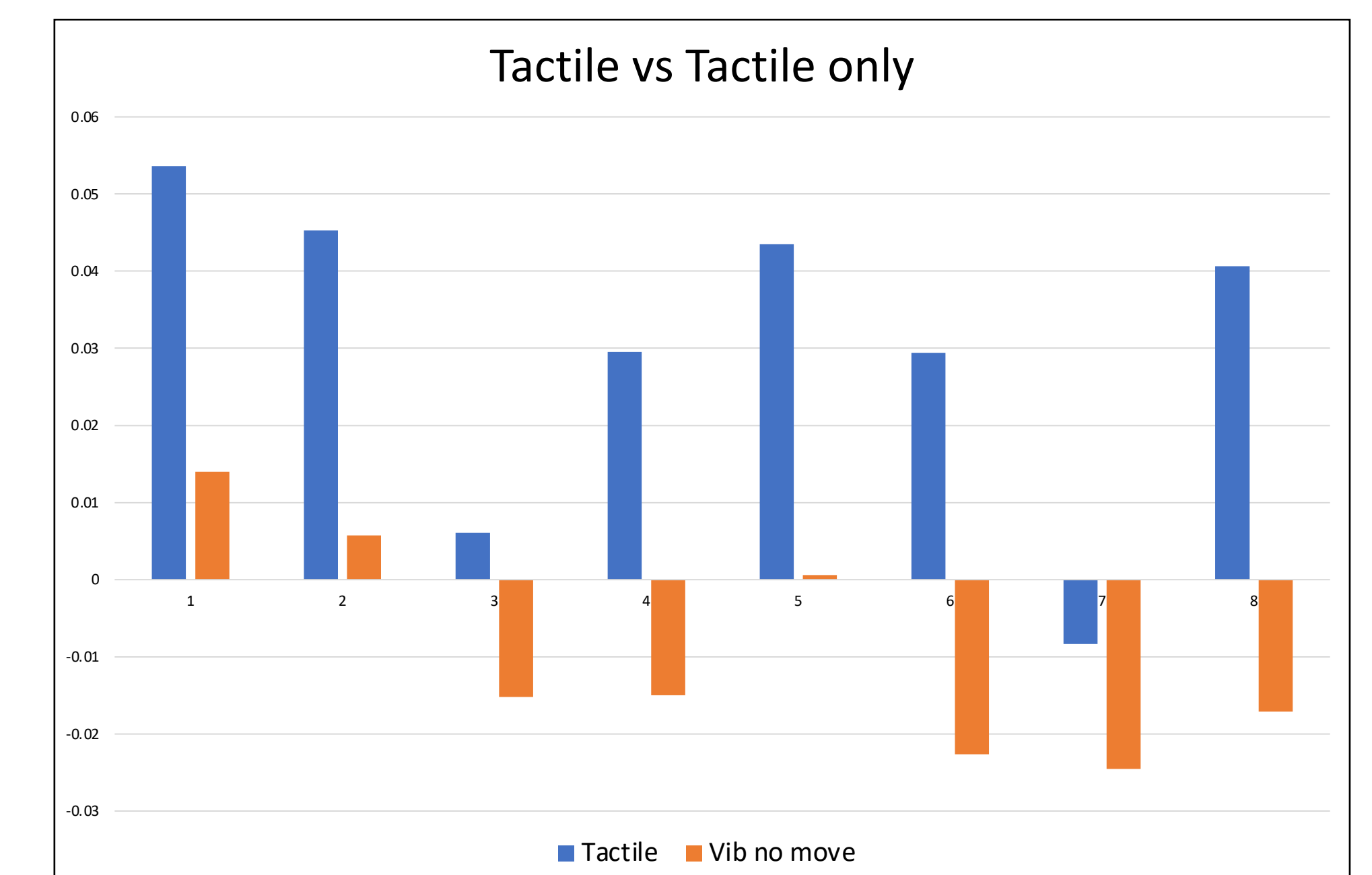


Figure 3: Ignoring tactile feedback, as opposed to performing balance task in response to tactile feedback, suppresses activity.

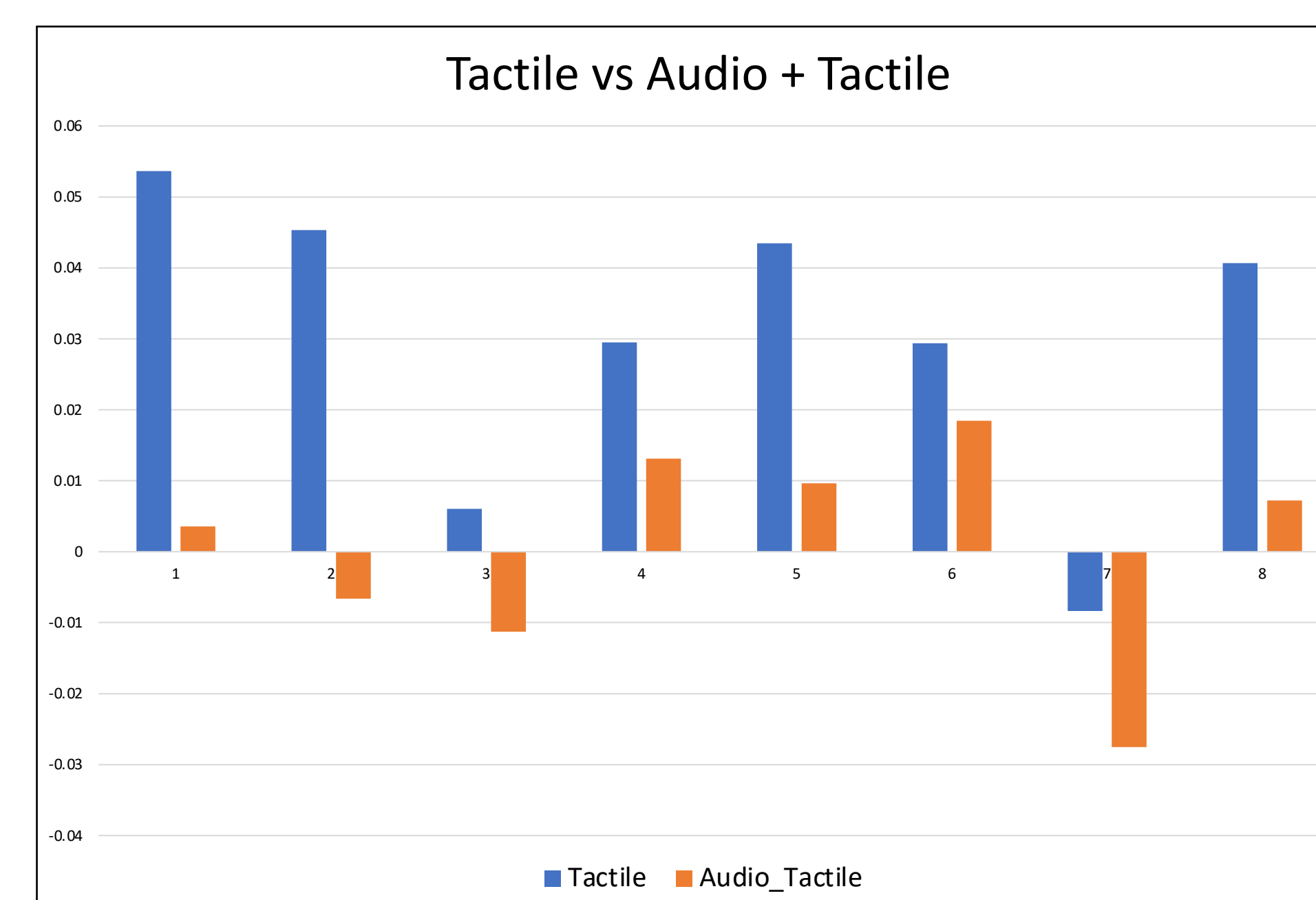


Figure 4: Addition of auditory stimulus to tactile only condition suppresses activity.

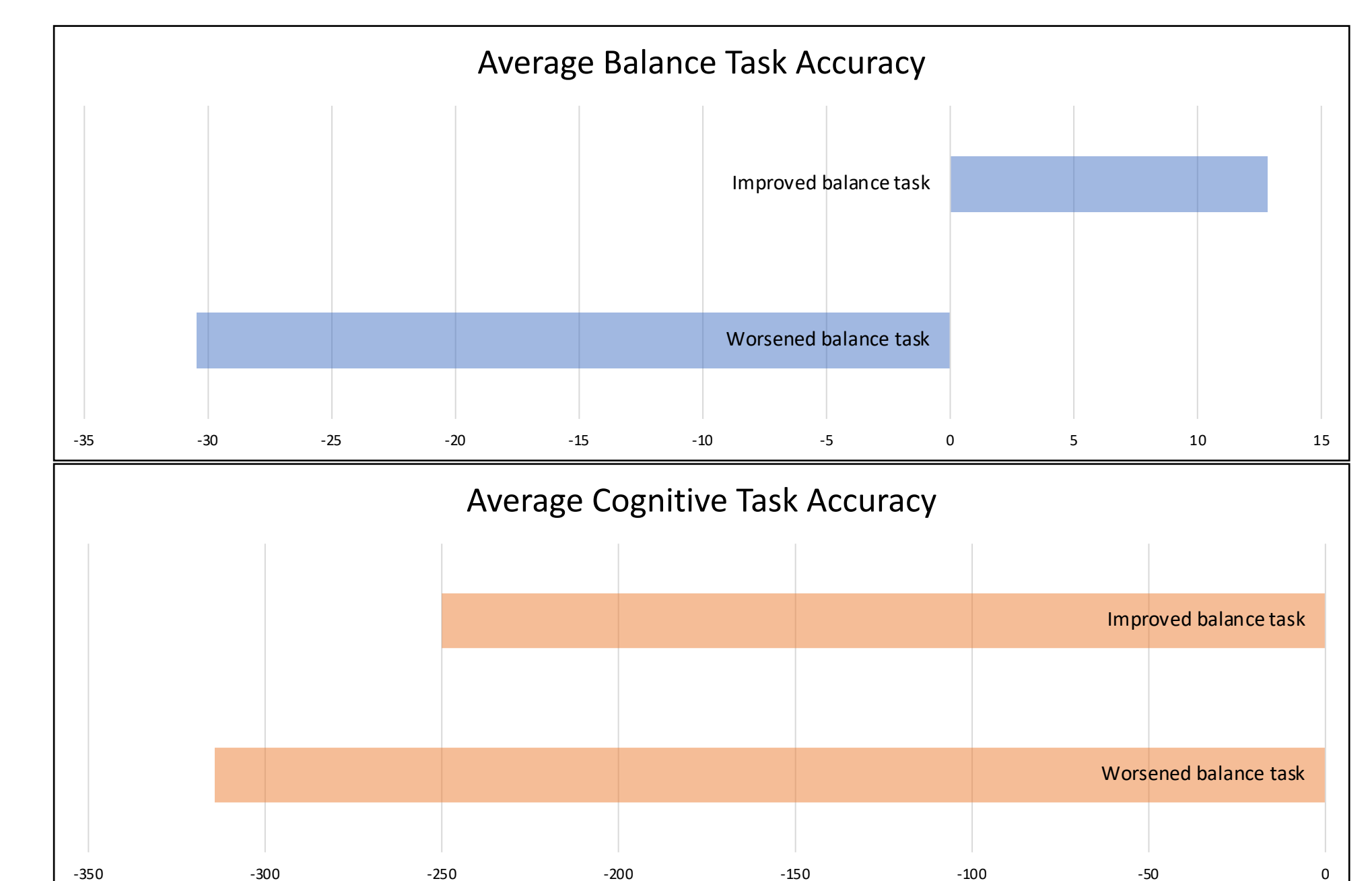


Figure 5: Average cognitive task accuracy decreases in dual-task condition, regardless of balance task accuracy.

- Visual condition dominates in [visual + tactile] condition (Figure 2) since activation pattern is more like [visual] than [tactile] (Figure 1).
- Activation in response to tactile feedback is driven by performance of balance task (Figure 3).
- All subjects showed decreased cognitive task accuracy with addition of balance task (Figure 5).
- Subjects that improved in balance task (with addition of auditory stimulus) showed reduced decline in cognitive task accuracy than those who performed worse on balance task (Figure 5).

Conclusion/Future Studies

- Tactile condition, by far, produces greatest activation.
- Dual-task results in decline of cognitive task accuracy, suggesting that balance task is prioritized (in non-threatening environment) since decline in cognitive task accuracy is far greater than that of balance task.
- Sensory biofeedback technologies for those experiencing postural control difficulties, particularly with the elderly.

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