DETECTION OF DIFFERENCE IN NEURAL ACTIVITY DURING VISUOMOTOR FINGER-TAPPING TASK BY THE ELDERLY: AN FMRI STUDY

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Purpose: Early diagnosis of decline in cognitive performance is urgent for patients with mild cognitive impairment (MCI). This study is an attempt to examine the applicability of a cognitive performance task for the elderly, with a particular focus on visuomotor coordination of bimanual finger movements. Finger movements coordinated with visual cue are necessary in daily living, such that information is exchanged via object manipulation, writing letters, and so on. In order to detect difference of the elderly's neural activity during visuomotor coordination of finger movements, an fMRI study was conducted on elderly and younger adults.

Background: For measurement of finger movements, bimanual finger-tapping task is one of the most commonly-used paradigms for fMRI study. Previous studies have compared brain activities among task variations in terms of movement frequency, presence or absence of pacing cue, symmetry of bimanual movements, and so on [1, 2]. Asymmetrical bimanual finger coordination (i.e., tapping different fingers of both hands at the same time) has been demonstrated to be more difficult than symmetrical one (i.e., tapping same fingers of both hands), because each finger essentially has its own unique policy [3]. Although age-related change in behavior and neural basis of bimanual wrist coordination has been previously revealed [4], bimanual finger coordination remains to be explored. We then compared brain activity on the visually-guided bimanual finger-tapping task between younger and elderly groups.

Methods: Fifteen healthy younger adults (9 males, age 25±6) and 15 healthy elderly adults (8 males, age 68±4) participated in the experiment on a 3T scanner (Siemens Trio/Tim) in accordance with the local ethics regulations. All the participants were right-handed. *Data acquisition*: T2* weighted GRE-EPI sequences were acquired with the following parameters: TE = 30 ms, TR = 3000 ms, FA = 90°, matrix 64 x 64, FOV = 192 mm, 39 axial slices, 3 mm thick. The fMRI task consisted of three blocks, each of which included presentation of visual cues for the two modes of bimanual finger tapping (i.e., symmetrical and asymmetrical) with constant intervals. With the three blocks, different frequencies of movement were assigned as 1.0Hz, 1.5Hz, and 2.0Hz, respectively. On the basis of a pilot behavioral data, these frequencies were expected to be manageable for older adults (Data not shown). Participants were required to use their index and middle fingers of both hands to press response buttons in tune with visual cues, while their brain activity was measured in the MRI scanner. Presentation ver. 0.80 (Neurobehavioral Systems) were used for presenting visual cues and obtaining behavioral data. *Data analysis*: The functional brain images were preprocessed and analyzed with SPM 8. First-level contrasts for each condition of the task (2 types of mode x 3 levels of speed) were entered into second-level, random effects analyses of variance (ANOVA) on the basis of the general linear model (GLM).

Results: Group analyses ($p < .001$) indicated differences of brain activity between younger and elderly age group. As shown in Figure 1, elderly adults showed higher activation than younger adults in bilateral somatosensory cortex and bilateral lingual gyrus throughout all the conditions. In addition, as movement frequency got higher (i.e., 1.5Hz and 2.0Hz), activation of left cuneus and bilateral inferior frontal gyrus (IFG) became stronger in the elderlies than in youngers. Figure 2 indicates differences of tapping mode (asymmetrical – symmetrical) in each age group. In younger adults, bilateral supplementary motor area (SMA) was activated more highly in asymmetrical mode than in symmetrical one at 1.5Hz and 2.0Hz frequency levels. In older adults, on the other hand, no significant mode difference was found at all the levels of movement frequency.

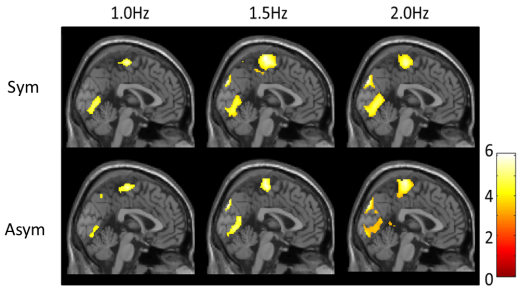

Figure 1. Group activation, elderly (n = 15) – younger (n = 15) adults on each condition (2 types of mode x 3 levels of movement frequency) of visuomotor bimanual finger tapping task.

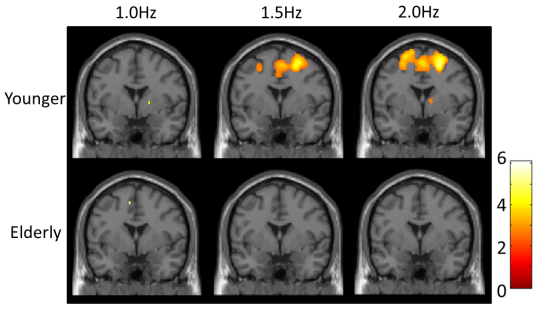

Figure 2. Group activation, asymmetrical – symmetrical mode of visuomotor bimanual finger tapping task by younger (n = 15) and elderly (n = 15) adults on each level of movement frequency.

Discussion and Conclusion: The present results indicated that, compared with younger adults, elderly adults consistently showed activation in bilateral somatosensory cortex and bilateral lingual gyrus during visuomotor bimanual finger-tapping task in tune with visual cue, irrespective of tapping mode and movement frequency. In the elderlies, at the same time, movement frequency of the bimanual fingertapping task influenced on activation in left cuneus and bilateral IFG, whereas the tapping mode (i.e., symmetrical/asymmetrical) did not differentiate their activity. It was suggested that movement velocity of visuomotor finger-tapping task, rather than its mode difference, may work as a detector of difference in the elderly's cognitive performance. This study has now highlighted an elderly-specific neural activity in visuomotor coordination of finger movements, which raises a consideration point to construct a cognitive performance task for early diagnosis of MCI.

References: [1] Debaere, et al. (2004) NeuroImage 21: 1416-27. [2] Lavrysen, et al. (2008). NeuroImage 39: 1938-49. [3] Byblow, et al. (1994) Human Movement Science 13: 3-28. [4] Goble, et al. (2010) Human Brain Mapping 31: 1281-95.