The hemodynamic response characteristics underlying the age-related change of brain activation during motor execution

T. Nakai¹, M. Miyakoshi³, E. Bagarinao¹, C. Nakai², and K. Matsuo³

¹Functional Brain Imaging Lab, National Center for Geriatrics and Gerontology, Obu, Aichi, Japan, ²School of Health Sciences, Toyoshashi Sozo University, Toyohashi, Aichi, ³Psychology, National Taiwan University, Taipei, Taiwan

Introduction
Brain areas are additionally activated in elderly subjects [1,2]. It was suggested that this additional recruitment of brain areas in elderly subjects was consistent with the compensation hypothesis and characterized neuropsychiatric at the systems level in the aging brain, rather than dedifferentiation hypothesis [2]. On the other hand, age-related reduction of BOLD signal (hemodynamic response function; HRF) has been reported in the primary visual area [3]. These age-related changes are of interest from the viewpoints of early detection of cognitive impairments. In this study, we investigated the characteristics of the HRF underlying the age-related change in order to estimate how the hemodynamic response is contributing to the statistical evaluation. Sequential finger tapping task was used, since it strongly demands activities of both primary and higher motor areas.

Material and Methods
Twenty-two healthy normal young (Y; under 50 years old, 11 males) and 22 healthy normal elderly subjects (E; between 60 and 75, 11 males) who gave written informed consent participated in this study. Two fMRI sessions were designed; 1) Sequential finger tapping task (2-3-4-5) at 1.5Hz paced by a prompting visual cue, 3 task blocks for each of right and left side interleaved with rest blocks, each 18 sec (TAP), 2) gripping and opening age groups and across the brain areas may give biases in statistical evaluation. For example, the difference between the age groups in ACG/CG may be underestimated. The age-related augmentation was observed in the higher motor areas and the associated areas involved in visuo-motor transformation. It represented the neuronal network recruited for complex movements. On the other hand, such augmentation was not observed in the lower motor areas. The % HRF has shown that the age-related reduction depended on the decreased HRF amplitude in the latter half of the task block and lack of post-stimulus peak (Fig.4).

Discussion
It was demonstrated that augmented activation in the elderly subjects mostly depend on the elevated amplitude of the BOLD signal between the initial and post-stimulus peaks, while the % amplitude of these two peaks was close between the two age groups. Different HRF shape between the age groups and across the brain areas may give biases in statistical evaluation. For example, the difference between the age groups in ACG/CG may be underestimated. The age-related augmentation was observed in the higher motor areas and the associated areas involved in visuo-motor transformation. It represented the neuronal network recruited for complex movements. On the other hand, such augmentation was not observed in the M1 in both of TAP and GRIP. This observation suggested that the neuronal demand was augmented to support cognitive processing for motor regulation rather than motor execution itself. In conclusion, it will be recommended to consider the potential bias induced by the non-linear dynamics of HRF to assess the age-related change of brain activation.

References
[1] Hutchinson et al., Neuroimage 17, 1720-, 2002