Age-related changes in interpersonal synergies during finger force/torque production tasks

Sungjun Lee, Dayuan Xu, Jongah Kim, Jaebum Park[1*]

Department of Physical Education, Seoul National University, Seoul, South Korea[1]

INTRODUCTION

Aging causes negative changes in the neuromotor and sensory systems, including the processes of visual and somatosensory information. These changes may contribute to the deterioration of motor coordination in elderly persons (Tomasi & Volkow, 2012).

Recently, the research questions regarding synergic actions of the human neuromotor system have been expanded into the control strategies when two persons act together to achieve common goals (i.e., interpersonal synergies) and it has been propsed that sensory information play a critical role in stabilizing the performance acting by two persons (Slomka et al., 2015).

The purpose of this study was expand this topic into the age-related changes in interpersonal synergies. The current experiment aimed to investigate the age-related changes in interpersonal synergies when different sets of sensory information were provided during force and torque production tasks.

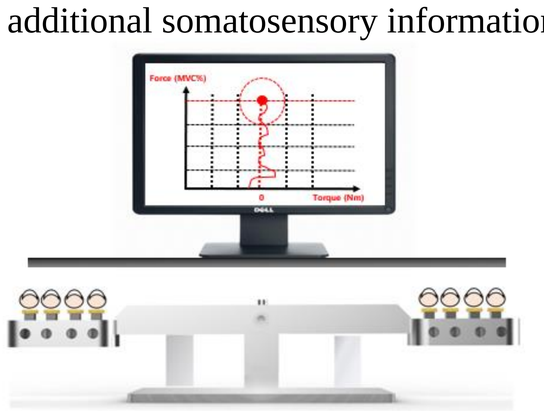
METHODS

Subjects

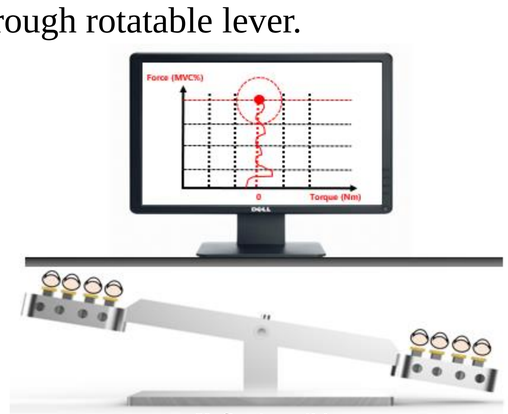
- Young group: 14 subjects (age: 27.4 ± 4.22 years)
- Elderly group: 4 subjects (age: 78.8 ± 1.09 years)

Procedure

- Each pair of two subjects in identical group was required to press the sensors attached on two ends of a lever using four fingers of opposite hands respectively.
- The instruction was matching the total force with the target force ($MVC_{10\%}$ of two hands) while maintaining 'zero' net torque performed by the two hands from respective subjects.
- All sets of subjects performed the tasks repeatedly in two conditions (fixed condition: only provide visual information; unfixed condition: provided additional somatosensory information through rotatable lever.



-Fixed condition-



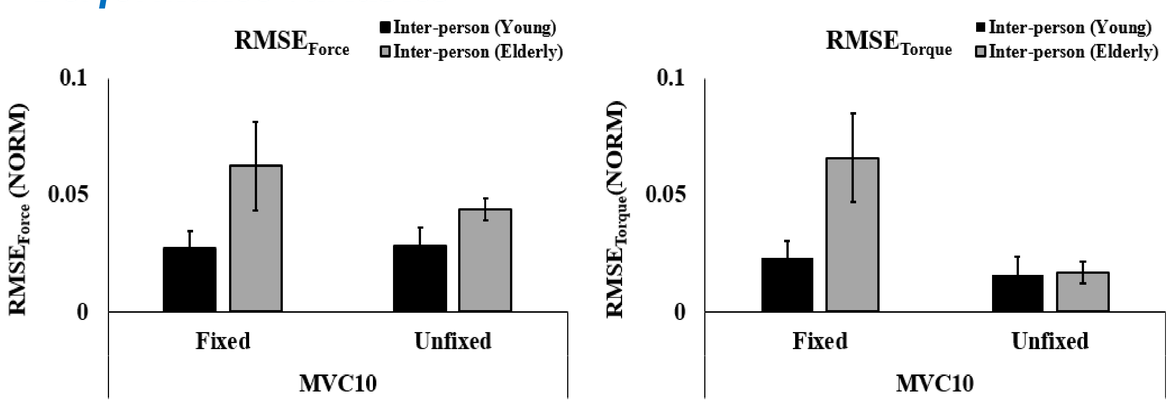
-Unfixed condition-

Data Analysis

- Force signals from 5s to 9s (0s as the initiation of task) were selected for further analysis.
- Performance was calculated as $RMSE_{Force}$ and $RMSE_{Torque}$ while motor coordination was calculated as force stabilizing synergy index ($\triangle V_{Force}$) and torque stabilizing synergy index ($\triangle V_{Torque}$) based on uncontrolled manifold (UCM) approach.

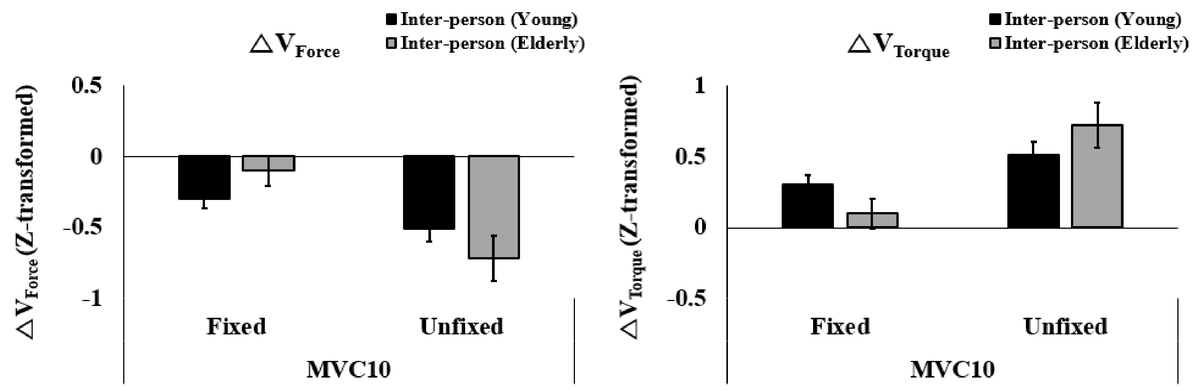
RESULTS

Performance variables

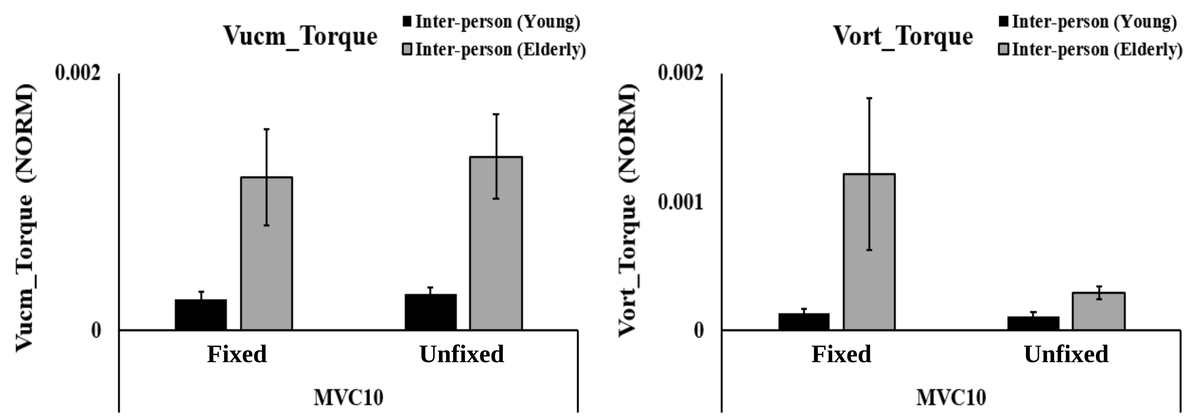


- Overall, $RMSE_{Force}$ and $RMSE_{Torque}$ tended to be larger for elderly group pairs comparing to young group pairs.
- However, in the unfixed condition, $RMSE_{Force}$ and $RMSE_{Torque}$ did not tend to be significant different between young group pairs and elderly group pairs.

Coordination variables



- Negative $\triangle V_{Force}$ implied a positive co-variation between two hands.
- $\triangle V_{Torque}$ was larger in unfixed condition than in fixed condition, especially for elderly group pairs.



- The two components of $\triangle V_{Torque}$ (good variance: Vucm_Torque; bad variance: Vort_Torque) were larger for elderly group pairs than young group pairs in both fixed and unfixed conditions.
- Specially for elderly group pairs, Vort_Torque was smaller in unfixed condition than fixed condition.

DISCUSSION

- Overall, performance error tended to be greater in elderly group pairs than in young group pairs, when producing low force ($MVC_{10\%}$) together. These results might be due to changes in the neuromuscular system caused by aging.
- When different types of sensory information (visual & somatosensory) were provides simultaneously, there was a greater decrement of performance error for elderly group pairs comparing to young group pairs.
- Also, there was a greater decrement of Vort_Torque for elderly group pairs.

CONCLUSION

These results might suggest the importance of multi-sensory information (visual & somatosensory) to compensate the decreased motor ability in elderly persons during pair works

LIMITATION

The limitation of the current study was temporality fail to recruit the same number of young and elderly groups due to the COVID-19.

REFERENCE

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