Investigating the Efficiency of Motor Adaptation in Elderly Individuals During Grasping-and-Lifting Tasks in Response to Perturbations

Hsiu-Yun Hsu[1,2], Yu-Ching Lin[1,3], Chia-Fen Hsu [2], Li-Chieh Kuo[2]
[1] Department of Physical Medicine and Rehabilitation, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, TAIWAN
[2] Department of Occupational Therapy, College of Medicine, National Cheng Kung University, Tainan, TAIWAN
[3] Department of Physical Medicine and Rehabilitation, College of Medicine, National Cheng Kung University, Tainan, TAIWAN
Email: hyhsu@mail.ncku.edu.tw

Summary

This study examined motor adaptation efficiency in response to unexpected perturbations among 20 young adults (mean age 24.0 ± 3.2 years) and 19 older adults (mean age 69.5 ± 2.9 years). Participants completed the reactive Pinch-Holding-Up Activity (r-PHUA) test, with sensory and cognitive functions assessed through standardized tests. Older adults demonstrated significantly delayed reaction time and longer recovery to grip stability compared to younger adults (p < .001). Grip force increased twofold under dynamic lifting perturbation (p < .001). Sensory function, measured by the two-point discrimination tests and Semmes-Weinstein monofilament, was moderately to highly correlated with reaction and recovery times (p < .05). Additionally, peak grip force was moderately to highly correlated with working memory (r = .463–.577, p < .05) and sustained attention (r = .463, p = .046). The findings underscore the critical roles of sensory and cognitive functions in motor adaptation, particularly in older adults.

Introduction

Reactive motor adaptation is essential for optimizing movement, particularly in response to unexpected perturbations. Aging significantly impacts motor performance, with older adults often experiencing deficits in attentional resource allocation. These deficits may partly explain their challenges during reactive tasks. This study aimed to compare motor adaptation efficiency between younger and healthy older adults and investigate its relationship with sensory and cognitive functions in the older population.

Methods

This cross-sectional, observational study recruited 20 right-handed young adults and 19 older adults. Participants completed the r-PHUA test (Fig. 1), which involved perturbations during the lifting phase. The test-retest reliability of r-PHUA showed a high intraclass correlation coefficient (ICC = 0.868). Key parameters analyzed were reaction time, time to regain grip stability, and peak grip force. Sensory assessments included the Semmes-Weinstein monofilament (SWM) test and the two-point discrimination (2PD) test. Cognitive function was assessed using a battery of tests, including the Memory Span subtest, Knox Cube Test-Revised, and Conners Continuous Performance Test-3 (CPT-3).

Results and Discussion

Twenty young participants (mean age 24.0 ± 3.2 years) and nineteen older participants (mean age 69.5 ± 2.9 years) completed the study. Significant group differences were observed in peak grip force, reaction time, and time to regain grip stability (Table 1). Under dynamic lifting interference conditions, grip force increased twofold to maintain stability (p < .001). The older group demonstrated significantly delayed reaction time and time to regain grip stability compared to the younger group (p < .001). Reaction time and time to regain grip stability were moderately to highly correlated with sensory measures from the SWM and 2PD tests (p < .05). Furthermore, peak grip force was moderately to highly correlated with working memory (r = .463–.577, p < .05) and correlated with sustained attention as measured by the CPT-3 test (r = .463, p = .046) under lifting perturbation conditions.

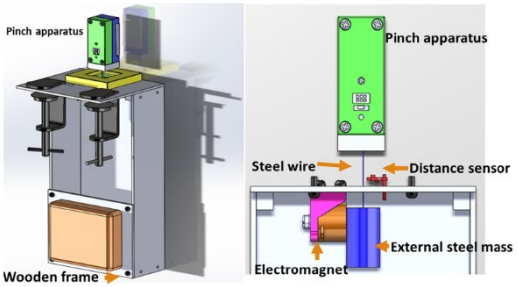

Figure 1: Schematic diagram of r-PHUA test.

Table 1: Comparison of motor adaptation parameters between older and younger groups

	Older adults	Younger adults	p-value
reaction time (s)	0.29± 0.09	0.11± 0.04	< .001
time to regain grip stability (s)	4.58±2.26	1.18± 0.72	< .001
peak grip force (N)	16.66 ± 5.21	7.07± 5.67	< .001

Conclusions

This study shows that responses to lifting perturbations are closely linked to sensory function. Additionally, attention and working memory are key to grip force control, highlighting the role of cognitive factors in motor adaptation in older adults.

References

[1] Strote, C., et. al (2020). *Experimental Brain Research*, **238(10)**: 2179–2188