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Original Article

Relationship between visuo-perceptual function and manual dexterity in community-dwelling older adults

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Abstract. [Purpose] The purpose of the present study was to examine the relationship between visual perceptual function and manual dexterity in community-dwelling older adults. [Subjects and Methods] Fifty-eight participants were recruited by convenience sampling from local rehabilitation centers. This was a cross-sectional study that used the following four clinical tools: the Mini-Mental State Examination, 9 Hole Pegboard, Box and Block Test, and Motor-free Visual Perception Test, Third Edition. [Results] The Motor-free Visual Perception Test, Third Edition and Mini-Mental State Examination correlated significantly and positively with Box and Block Test, and did correlate significantly and negatively with 9 Hole Pegboard. [Conclusion] The results of this study suggest that visual perceptual impairment and cognitive dysfunction may influence manual dexterity in older adults, and rehabilitation of upper extremity function, along with visual perception and cognitive training, may be beneficial for this population.
Key words: Older adults, Dexterity, Visual perception

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INTRODUCTION

Functional use of the upper extremity is fundamental for performing movements required in daily activities. Upper extremity function is divided into two categories of motor skills: fine motor skills (e.g., feeding, dressing, and grooming) and gross motor skills (e.g., crawling, walking, and postural control)[1)]. It usually involves a repetitious sequence of limb motions to simultaneously move a body segment and maintain its stability. In older adults, the gross motor skills (e.g., for reaching and grasping) as well as fine motor skills (e.g., for manipulation) are slower and less accurate than in normal young adults[2)]. The key element of upper extremity function involves guiding movements of the hand. Therefore, whole-arm coordination, eye-head coordination, visual acuity, and muscle strength are important factors for well-coordinated upper extremity function[3)].

Visual deficits and cognitive impairment are major problems resulting in changes in reach, grasp, and manipulation in community-dwelling older adults. Upper extremity function, like other functional activities, is affected by age-related alteration in the visual system[4)]. Many previous studies have indicated that decreased velocity in reaching movements or in repetitive tapping tasks are associated with age-related changes in visual processing[4–6)]. Most of these studies used complex methods or equipment, such as kinematic measurement systems, to evaluate the relationship between upper extremity function and visual information[4–6)]. These measurement tools provide qualitative data on this relationship, but do not provide in-depth information on upper extremity function or the relationships among upper extremity function, visual deficits, and cognitive impairment.

This study used three clinical measurement tools. These tools are able to identify the scope of participants' characteristics, and are appropriate for examination of the relationships among visual perceptual function, upper extremity function, and cognitive function. The purpose of this study was to investigate the relationships among visual perceptual function, upper extremity function, and cognitive function in community-dwelling older adults.

SUBJECTS AND METHODS

Fifty-eight community-dwelling older individuals, recruited from three senior complex community centers, participated in this study. This convenience sample was recruited using a leaflet that provided information regarding the purposes, procedures, rights of subjects, data usages, and other aspects of this study. The study was carried out in accordance with the International Ethical Guidelines and Declaration of Helsinki and was approved by the local institutional review board. All of the participants signed consent forms. The inclusion criteria were as follows: age > 60 years, absence of neurological deficits, absence of severe orthopedic diseases that could impact the procedures, and absence of significant cognitive impairments that would

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prevent understanding of verbal instructions. The exclusion criteria were as follows: serious visual impairment, dizziness or other vestibular impairment, and a history of severe alcohol or medication abuse. Table 1 shows the clinical and demographic characteristics of the participants, including sex, age, and medical history.

This was a cross-sectional study, in which the following four clinical tools were used: the Mini-Mental State Examination (MMSE), 9 Hole Pegboard (9HP), Box and Block Test (BBT), and Motor-Free Visual Perception Test, Third Edition (MVPT-3). Two occupational therapists with clinical experience evaluated participants' performance on all measurements and followed the standard method for administration of each clinical measure in a small tidy therapy room. The testing lasted for approximately 45 minutes per individual.

The MMSE is a valid, reliable, and extensive test of cognitive function; it was developed as a to screening test for dementia and delirium by Folstein and Folstein in 1975. The tool is a 30-point questionnaire, with scores ranging from 0 (complete cognitive impairment) to 30 (no cognitive impairments) and consists of 10 items grouped into five domains: orientation, registration, attention-calculation, recall, and language[7)]. The 9HP is a simple, reliable, and valid measurement of finger dexterity. The tool is administered by asking the individual to take pegs from a container, one by one, and place them in holes on a board as quickly as possible. Participants must then remove the pegs from the holes, one by one, and replace them back into the container. The time (seconds) taken to complete the test is recorded as the score. A stopwatch, running from the moment the participant touches the first peg until the moment the last peg is placed in the container, is used to record the time[8)].

The BBT is a valid and reliable measure of manual dexterity. The individual is allowed a 15-second trial period prior to testing. The participant is asked to grasp one block at a time, transport the block over a partition, and release it into the opposite compartment. The score is the number of blocks carried from one compartment to the other in one minute. Each hand is scored separately[9)]. The MVPT-3, developed by Chalfant and Scheffelin is a representative measurement of visual perception and cognitive skill, The MVPT-3 includes five different areas: spatial relationships, visual discrimination, figure-ground, visual closure, and visual memory. Individuals older than age 10 start with the example for item 14. Reliability of MVPT-3 scores was assessed with internal consistency and test-retest stability estimates. Internal consistency estimates for the standardization sample ranged from 0.86 to 0.90 for ages 11 to > 85 years[10)].

The means and standard deviations of the dependent measures were analyzed using descriptive statistics. Pearson correlations were used to determine the relationships between manual dexterity, static and dynamic balance, and visual perception. The collected data were analyzed using the PASW version 18.0 for Windows (SPSS Inc., Chicago, IL, USA), and the significance level was set at $p < 0.05$.

Table 1. Clinical and demographic characteristics of the study participants (N=58)

Variables		Number	Percentile
Gender	Male	20	34.5
	Female	38	65.5
Age (yrs)	61–65	1	1.7
	66–70	12	20.7
	71–75	9	15.5
	76–80	19	32.8
	81–85	10	17.2
	> 85	7	12.1
Medical history	Osteoarthritis	55	94.8
	Hypertension	46	79.3
	Diabetes	48	82.8

Table 2. Mean and standard deviation of clinical outcome measures in this study (N=58)

Variables		Mean	Standard deviation
Mini-Mental State Examination (scores)		25.6	2.7
9 Hole Pegboard (seconds)	Right	14.2	4.0
	Left	15.3	4.3
Box and Block Test (scores)	Right	63.1	10.6
	Left	59.3	11.8
Motor-Free Visual Perception Test-Third Edition (scores)		44.3	8.3

RESULTS

Table 2 shows the means and standard deviations for the four clinical measures. The MMSE correlated significantly and positively with the BBT on the dominant and non-dominant sides, with BBT on the non-dominant side, and with MVPT-3. The MMSE correlated significantly and negatively with 9HP on the dominant and non-dominant sides. The 9HP on the dominant side demonstrated a significantly positive correlation with 9HP on the non-dominant side as well as a significantly negative correlation with MMSE and BBT on both the dominant and non-dominant sides. The 9HP on the non-dominant side had a significantly positive correlation with the 9HP on the dominant side and a significantly negative correlation with MMSE and BBT on the dominant and non-dominant sides. The BBT on the dominant side had a significantly positive correlation with MMSE, BBT on the non-dominant side, as well as with MVPT-3, and had showed significantly negative correlation with 9HP. The BBT on the non-dominant side had a significantly positive correlation with MMSE, with BBT on the dominant side, and with MVPT-3, and a significantly negative correlation with 9HP, The MVPT-3 correlated significantly with MMSE and BBT. However, the MVPT-3 did not correlate significantly with 9HP on either the dominant or non-dominant side (Table 3).

DISCUSSION

This study examined the correlations among visual perception, manual dexterity, and cognitive impairment

Table 3. Relationship among the clinical outcome measures in this study (N=58)

Variables	MMSE	9HP-Rt	9HP-Lt	BBT-Rt	BBT-Lt	MVPT-3
MMSE		−0.458**	−0.419**	0.420**	0.423**	0.777**
9HP-Rt	−0.458**		0.928**	−0.357**	−0.417**	−0.171
9HP-Lt	−0.419**	0.928**		−0.317*	−0.432**	−0.148
BBT-Rt	0.420**	−0.357**	−0.317*		0.932**	0.341**
BBT-Lt	0.423**	−0.417**	−0.432**	0.932**		0.322*
MVPT-3	0.777**	−0.171	−0.148	0.341**	0.322*	

*p<0.05; **p<0.01; MMSE: Mini-Mental State Examination; 9HP-Rt: 9 Hole Pegboard-Right; 9HP-Lt: 9 Hole Pegboard-Left; BBT-Rt: Box and Block Test-Right; BBT-Lt: Box and Block Test-Left; MVPT-3: Motor-Free Visual Perception Test-Third Edition

for community-dwelling older adults. The most important findings are as follows: (1) visual perceptual function had a negative correlation with the 9HP performance and a positive correlation with the BBT performance; (2) visual perceptual function had a positive correlation with cognitive function had; and (3) cognitive function showed a negative correlation with the 9HP score and a positive correlation with the BBT score.

Visual perception is necessary for basic and instrumental activities of daily living (ADLs) as well as for functional activities. Previous studies have reported that age-related visual dysfunctions include generally decreased visual acuity and adaptability, reduction of depth perception, and reduction in peripheral vision[11, 12)]. Because of the close relationship between vision and perception, age-related visual changes influence perceptual abilities in older adults. Older individuals demonstrate decreased visual discrimination, impaired figure-ground discrimination, decreased visual memory, decreased spatial relations, decreased pattern recognition, and poor attentional processing[13)]. Visuoperceptual dysfunction influences functional activities such as basic-ADLs, instrumental-ADLs, as well as work and recreational activities[14, 15)]. Brown et al. reported that the impairment of visual-motor integration in older adults leads to poor balance skills and to a higher incidence of falls and accidents[16)]. Zheng et al. also reported that older adults with visual acuity impairment demonstrated instrumental-ADLs functional state decline and an increased risk of mortality[17)]. The results of this study suggest that improved visual perceptual function in older adults is associated with improved manual dexterity.

This study also measured cognitive impairment in order to investigate the relationships among visual perception, cognitive function, and manual dexterity. Visual perceptual impairment can interfere with cognitive abilities in older adults. Although there is no universal effect of aging on learning, age-related changes in memory, processing ability, attention, and executive functions such as problem solving, mental flexibility, or abstraction are well documented[18)]. This study demonstrated that cognitive performance can affect manual dexterity in older adults. Therefore, visual perceptual impairment and cognitive dysfunction can lead to decline in upper extremity function in older adults. Age-related visual perceptual impairment and cognitive dysfunction should be considered in light of their effect on manual dexterity in older adults. The results of this study also suggest that there may be benefits to approaches that involve rehabilitation of upper extremity function, concurrent with visual perception and cognitive training for older adults. Future studies are therefore needed to evaluate the therapeutic effects of visual perception and cognitive training programs on upper extremity function in older adults.

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