Effect of target size and environmental illumination on reach to grasp movement for old adults

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1. Introduction
During move the human arm, reach to grasp the target, the target appearance and environment influence reach-to-grasp movement. With Aging, natural visual and motor degeneration, how the target size and environmental illumination affect to reach-to-grasp movement for old adults is still ambiguous. Thus, this study aims to elucidate the effects of target size and illumination on reach-to-grasp movement for old adults.

2. Method
Sixty healthy old adults which had average age of 72.8 (SD=3.1) and arm length of 54.1 (SD=2.0) were recruited to participate in this study. All subjects were free from musculoskeletal discomfort, neurological and sensory motor disorder. For experimental design, object size and illumination were independent variables. Five cylinder targets with different size were the diameter of 0.5 (Φ) and height of 0.5(h), 1×1, 2×2, 3×3 and 5×5 cm, respectively. Five environmental illuminations with 4000k colour temperature were 50, 150, 300, 500 and 750lux, separately. Each subject was asked to reach target in front of the acromion process with the distance of subject's arm length, grasp it then bring it backward to put it on the certain area.

For kinematic analysis, an ultrasound three dimensional motion capture system (Zebris Medical GmbH, Germany) was used to collect and calculate the data including the maximal aperture (the distance between thumb and index), time to maximum aperture and the range of motion of wrist flexion-extension, wrist radial-ulnar deviation and elbow flexion. Moreover, the reaction time comprise reaching time, returning time and complete time were measured and analysed as well.

For data processing, Analysis of variance (ANOVA) was conducted to assess the effects of target size and illumination on the reach to grasp movement. Statistical analyses were performed using the SPSS version 14.0 statistical analysis software. Significant level was set at p > 0.5. Post hoc testing was conducted using Duncan’s multiple range tests.

3. Results
The results of this study indicated that target size has significant influence in maximum aperture, time to maximum aperture, wrist flexion-extension, wrist radial-ulnar deviation, returning time and complete time (p<.05). The Duncan’s multiple testing indicated that increased target size have greater maximum aperture, lengthen time to maximum aperture, less wrist flexion-extension and few wrist radial-ulnar deviation. For reaction time, small target size induced longer returning time and lengthens complete time. It is reasonable that bigger target require greater grasp aperture and have more natural position of wrist during reach-to-grasp. Moreover, small target cause more time to pick up it and need more returning time and complete time for old adults.

Environmental illumination only has significantly affected in maximum aperture (p<.05). It displayed that high illumination cause greater grasp aperture. It does not consistent with previous study. The reason might because the fixed target location (subject’s arm length), even with lower visual information providing from the environment (lower illumination), the elderly still can adapt target location with the experience and then smoothly and effectively reach-to-grasp target.
Furthermore, there is no interaction effect between target size and illumination on the all measurements (p>.05).

4. Discussion
The primary results of this study indicated that target size is a remarkable factor to affect reach-to-grasp movement for old adults. Elderly shows more wrist flexion-extension and wrist radial-ulnar deviation angle while reach to grasp small target. The small target also causes longer returning and complete time for old adults. Moreover, environmental illustration wouldn’t influence time to maximum aperture, wrist flexion-extension, wrist radial-ulnar deviation, returning time and complete time. It’s probably due to the same target location requiring less visual information. The findings of this study can provide useful information for clinical training of upper extremity, rehabilitation goal setting or relevant references.

**Keywords:** Reach to grasp, Target size, Illumination, Elderly, Hand aperture