Characterization of Fine Motor Functions in Individuals with Alzheimer's Disease and Mild Cognitive Impairment

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Introduction

- This study explored the clinical features and the motor impairments in individuals with Alzheimer's disease (AD) and amnestic mild cognitive impairment (aMCI).

Methods

Table 1. Demographics and psychometrics of the participants (N = 48)

	CN CDR 0	**aMCI** CDR 0.5	**AD** CDR 1-2
N	16	12	20
Age (years), mean (SD)	74.2 (4.7)[a]	73.9 (4.8)[a]	74.9 (4.2)[a]
Gender, Male/Female	11/5[a]	8/4[a]	14/6[a]
Education (years), mean (SD)	9.3 (3.9)[a]	10.7 (3.2)[a]	9.9 (3.8)[a]
WMS-III			
LM I	10.4 (2.7)[a]	6.7 (3.1)[b]	2.7 (.9)[c]
LM II	9.9 (3.3)[a]	6.8 (2.9)[b]	2.8 (.9)[c]
VR I	12.4 (1.9)[a]	7.3 (2.0)[b]	3.4 (1.0)[c]
VR II	10.3 (2.8)[a]	6.9 (.3)[b]	6.1 (.7)[b]

Methods

Instruments and Apparatus

- Participants were seated on a chair in front of a table on which a digitizer tablet (487 x 318 x 12 mm, Wacom Intuos 5, Japan)
- On the digitizer tablet, an A4-sized paper was positioned with the vertical and horizontal edges parallel to the horizontal and vertical edges of the digitizer.

Digital tablet and inked pen

Methods

Drawing tasks for comparisons of movement speed and size control

(1) Drawing three 5 cm squared crosses, and

(2) Writing 2.5 cm of connected cursive '*llllll*'s (i.e., connected loops with a progression to the right)

Crossed straight lines llll's

Methods

Measures in size control in cursive l loops

- In cursive loops, the participants were required to copy lllllllls of the same size as the sample shown on the table.
- The sample shown for the participants was 2.5 cm in height and 1.0 cm in width. For measuring the size of an l, the height and width of the two strokes were averaged
- The height and width differences between the first and last loops were measured for the comparison of size control across the groups

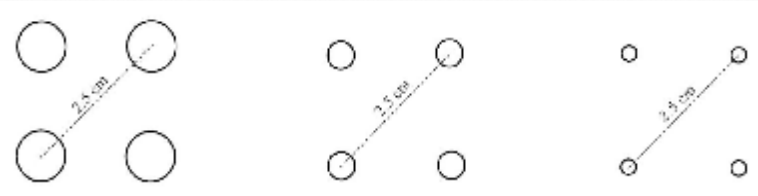
Methods

Measures in movement speed

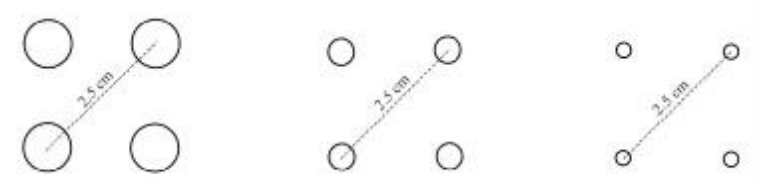
- The data of the X and Y position of the pen tip were smoothed with a 4th order Butterworth low-pass filter with a cut-off frequency of 15 Hz.
- In the lllllll task, the local maxima and minima of the X- and Y-coordinates were used to detect the extreme points to segment a loop into two strokes.
- The velocity was determined by averaging the tangential velocity per stroke. The mean velocity value came from the average of all trials per condition.

Graphic aiming tasks

- Fitts' task

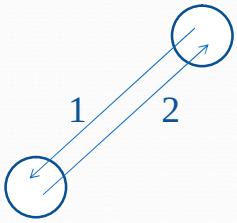


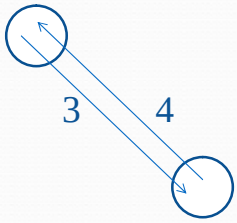
Aiming movement (Fitt's tasks)



Target size	**Large**	**Medium**	**Small**
Diameter	**8.8 mm**	**4.4 mm**	**2.2 mm**

Fitt's tasks





Equivalent movement
1. Wrist and fingers flexion
2. Wrist and fingers extension

Non-equivalent movement
3. Wrist extension and fingers flexion
4. Wrist flexion and fingers extension

Acquisition of graphomotor movement

- The drawing and aiming tasks were performed on an A4 size paper affixed to the surface of a digitizing tablet (Wacom, Intuos 5, Japan) using a wireless electronic inked pen with force sensitive tip (2048 levels)
- The digital tablet samples the X (horizontal) and Y (vertical) positions of the pen tip as well as the axial pen force, with a sampling frequency of 200 Hz

Measuring parameters of computerized analysis

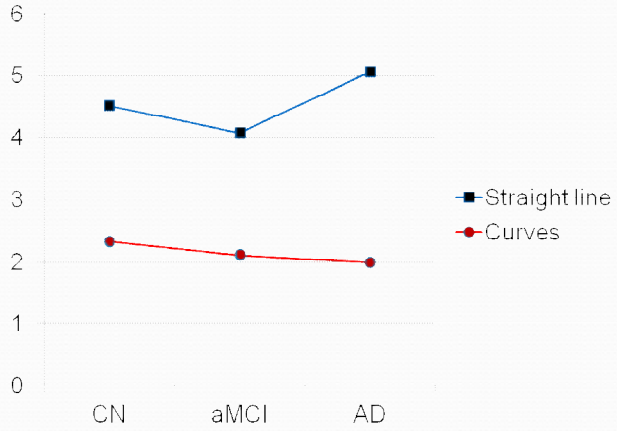
- *Mean stroke velocity:* The stroke velocity was calculated by dividing the stroke length by the elapsed time.
- *Mean peak velocity:* In every stroke, the peak was determined by the locus of maximal value. The mean value was derived from the average of all the strokes in all of the written tasks

Statistical Analyses

- Repeated measures ANOVA was used to test the significance of difference across the groups and tasks (or conditions), and the interaction effect of the group and task.
- Post hoc tests with Bonferroni correction were utilized to determine the locus of significant effects of the group (i.e., CN, aMCI, and AD).

Results

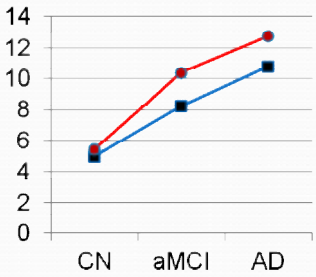
Mean stroke velocity (cm/s)



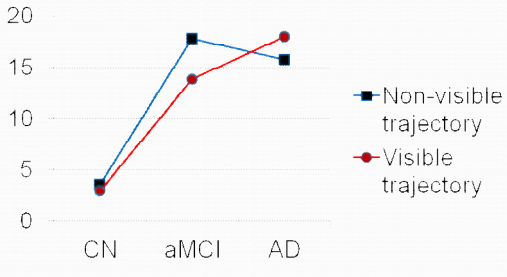
Results

Variability in copying circles

Mean square error



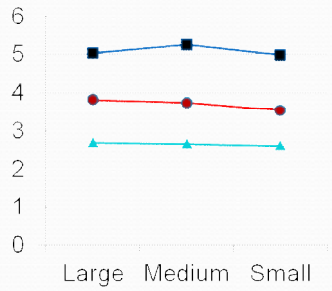
Variation of the radius



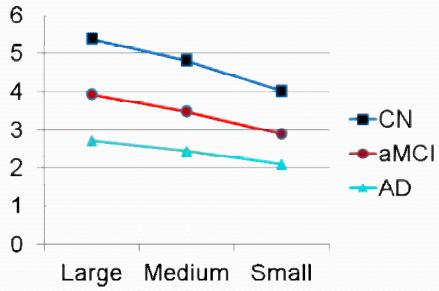
Results

Movement speed in Fitt's task

Equivalent movement



Non-equivalent movement



Discussion

The aMCI and AD participants showed difficulty in drawing circles, which requires coordination between fine motor skills and visuospatial function. This shows a clinical hallmark for the relationship between aMCI and the risk of AD.

Conclusion

- In summary, persons with aMCI as expected also have impaired fine motor function, and the degree of impairment in fine motor function is similar to but less impaired than that of AD.
- The results suggest that aMCI is characterized by motor dysfunction and cognitive impairment and that the degree of motor impairment, particularly aiming movements with accuracy constraint, may help identify those at risk for AD.

Thanks for your attention