KINEMATIC AND NEUROPHISIOLOGICAL ANALYSIS OF HAND DEXTERITY IN HEALTHY SUBJECTS

M. De Riggi[1], D. Birreci[1], S. Grandolfo[1], A. Martini[1], L. Angelini[2], A. Cannavacciuolo[2], S. Aloisio[1], M. Bologna[1]
[1]Department of Human Neurosciences, Sapienza University of Rome, Rome, Italy
[2]IRCCS Neuromed, Pozzilli (IS), Italy

INTRODUCTION: Aging is associated with neurophysiological changes that impair fine motor control and reduce manual dexterity, negatively affecting functional independence and quality of life in older adults. Despite the clinical relevance of these alterations, few objective and sensitive tools are currently available for their specific assessment.

OBJECTIVES: to validate the kinematic analysis of the Coin Rotation Task (CRT) as a sensitive measure of manual dexterity. Specifically, the study sought to: (1) compare the performance of young and older adults, (2) assess the effect of hand dominance, and (3) investigate correlations between CRT kinematic parameters and neurophysiological indices obtained through Transcranial Magnetic Stimulation (TMS).

METHODS: Thirty healthy right-handed participants were recruited and divided into two groups: 15 young adults (aged 20–30 years) and 15 older adults (aged >65 years). All participants were free from neurological or motor disorders. Each participant performed the CRT and the finger tapping (FT) task with both hands. Motor activity was recorded using a 3D optoelectronic motion capture system ***(FIG. 1)***. TMS was concurrently performed to measure corticomotor excitability (input/output curve), as well as intracortical and interhemispheric inhibition. Data were analyzed using repeated-measures ANOVA and Pearson's correlations.

RESULTS: In In the CRT, significant effects of both age and hand dominance were observed: younger participants and the dominant hand showed higher rotation speed and a greater number of movements compared with older participants and the non-dominant hand ***(FIG. 2-3)***. The coefficient of variation (CV) of movement rhythm was significantly higher in older adults, indicating increased execution variability. No significant group differences emerged in the FT task. TMS measures did not reveal marked differences between young and older adults; however, a negative correlation was found between the slope of the cortical input/output curve on the non-dominant side and CRT rotation speed ***(FIG. 4)***.

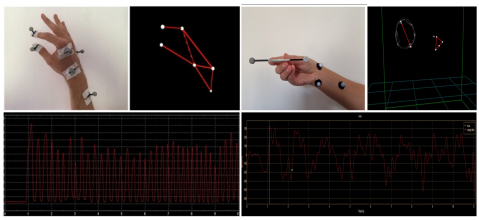

FIG. 1 *Kinematic recordings of coin rotation task and finger tapping. The kinematic system included three infrared cameras and reflective markers fixed on the subject's hands. Several movement parameters were calculated, including movement velocity and amplitude, movement rhythm and the sequence effect.*

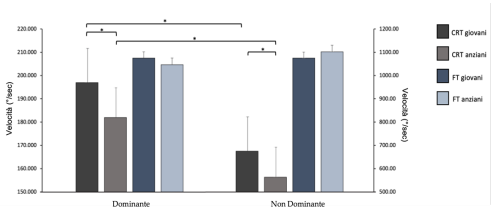

FIG. 2 *Comparative histogram of mean speeds in the coin rotation task (CRT) and finger tapping (FT), performed by young and older subjects, distinguishing between the dominant and non-dominant sides. Asterisks indicate statistically significant differences.*

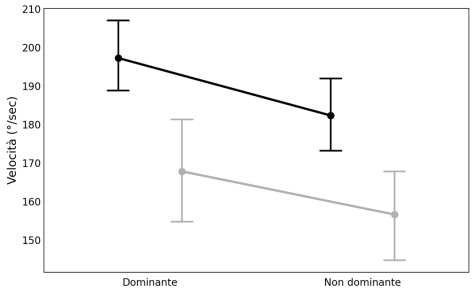

FIG. 3 *Line plot of the rmANOVA results for movement speed in the coin rotation task (CRT). Mean movement speed in the CRT (measured in [°/sec]) for young (black line) and older (light gray line) subjects, under dominant and non-dominant hand conditions. The rmANOVA showed a significant main effect of hand dominance (p = 0.007), with faster performance using the dominant hand in both groups, and a significant main effect of group (p = 0.007), with young participants performing significantly faster than older ones. Error bars indicate the standard error of the mean (SEM).*

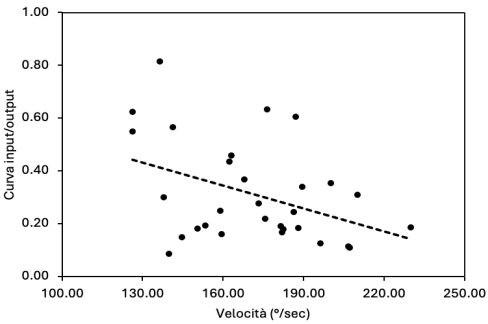

FIG. 4 *Correlation between mean movement speed in the Coin Rotation Task performed with the non-dominant hand (x-axis) and the input–output curve of the non-dominant side (y-axis). The Pearson correlation coefficient (r) was calculated in a sample of 30 participants to assess the association between corticospinal excitability and fine motor performance. A significant negative correlation was found (r = –0.401; df = 28; p = 0.028), indicating that increased corticospinal excitability is associated with lower execution speed in the task.*

CONCLUSIONS: Kinematic analysis of the CRT provides an objective and clinically relevant measure for assessing manual dexterity, capable of detecting age-related alterations even in relatively small samples. This approach may contribute to the early diagnosis of motor decline and to monitoring the effectiveness of rehabilitative interventions in older adults.

MAJOR REFERENCES: *(**1**) De Riggi M. et al. Aging, frailty, and their effects on motor performance: evidence from kinematic analysis. Neurol. Sci. (2025);1:1-5 (2) Clark J., Loftus A. Hammond, G. Age-related changes in short-interval intracortical facilitation and dexterity. NeuroReport (2011);22:499-503 (3) Bologna M, Guerra A, Paparella G, et al. Neurophysiological correlates of bradykinesia in Parkinson's disease. Brain (2018);141:2432-2444*