https://link.springer.com/referenceworkentry/10.1007/978-1-4419-1698-3_343

Finger-Tapping Test

The finger-tapping test (FTT) is a neuropsychological test that examines motor functioning, specifically, motor speed and lateralized coordination. During administration, the subject's palm should be immobile and flat on the board, with fingers extended, and the index finder placed on the counting device. One hand at a time, subjects tap their index finger on the lever as quickly as possible within a 10-s time interval, in order to increase the number on the counting device with each tap. The original procedure calls for five consecutive trials within a 5-point range for each hand, but variations include a total of six trials, in two sets of three. Results from FFT can be compared to age and gender normative data and may indicate motor impairment or lateralized brain dysfunction. The FTT is included in the Halstead-Reitan neuropscyhological test battery.

https://www.clearskymd.com/finger-tapping-test-parkinsons/

Finger tapping test and Parkinson’s

Non-invasive electromagnetic tracking sensors are positioned on the index finger and thumb and used to measure a patient’s movements in the finger-tapping test. In real-time, the movement of their fingers is recorded by a computer.

https://www.sciencedirect.com/topics/medicine-and-dentistry/finger-tapping-test

Finger Tapping Test

The Finger Tapping Test (Reitan and Davidson, 1974) measures motor speed by assessing the number of times subjects can depress a keyboard key using the index finger of their dominant and nondominant hands.

Alzheimer Disease

Fred F. Ferri MD, FACP, in Ferri's Clinical Advisor 2022, 2022

Mental Status Testing

Brief mental status testing can be done easily and quickly in the office. Commonly used cognitive tests to detect dementia include the Folstein Mini-Mental State Examination (MMSE), the Mini-Cog test, and the Montreal Cognitive Assessment. The Montreal Cognitive Assessment (MoCA,www.mocatest.org/) is a highly sensitive 30-point test that takes approximately 10 minutes to administer. Cognitive domains tested include visual-spatial, attention, verbal recall, language, abstraction, and orientation. A score of 25 points or less (26 points if the patient has less than 12 yr of education) indicates cognitive impairment.

https://www.barrowneuro.org/for-physicians-researchers/education/grand-rounds-publications-media/watch-neuroscience-grand-rounds/finger-tapping-brain-dysfunction-qualitative-quantitative-study/

In his search for measures of “biological intelligence,” Ward Halstead[6] identified the Finger Oscillation (or Tapping) Test as one potentially useful measure. In this test, subjects are asked to place their index finger on a key while their hand rests comfortably on a board. Subjects are then instructed to tap as fast as possible for 10 seconds. The procedure is repeated until five trials have been obtained with each hand in which each score is within five taps of one another.

Procedures

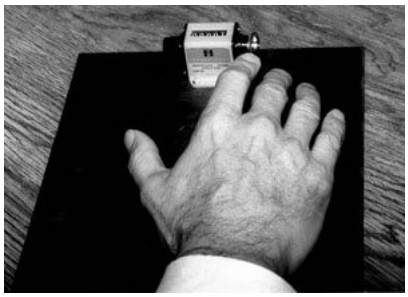
As a part of their clinical neuropsychological evaluation, each patient was administered the Halstead Finger Tapping Test.[14] Signed informed consent was obtained for each individual. Subjects were seated comfortably at a table on which the finger tapper was placed. Subjects were shown the finger-tapping device and its use was explained. They were instructed to tap as fast as possible for 10 sec, using the index finger of their preferred or dominant hand first. Additionally, all subjects were explicitly told to try and keep their other fingers down, resting comfortably on the

board when tapping. They were also asked to try and rest the heel of their hand on the board when performing the tapping task. The procedure was demonstrated by one of two investigators who tested all participants.

The standard procedure of the Halstead Finger Tapping Test was slightly altered. Instead of having the patient tap five consecutive trials with their preferred hand, they were given three trials with the preferred hand first, followed by three trials with the nonpreferred or nondominant hand. They were then given two to three more trials with each hand, depending on the range of their scores and signs of fatigue. The number of taps achieved in 10 sec for each trial and with each hand was obtained.

Data Analysis

The means and standard deviations of speed of finger tapping were calculated for both the right and left hands of the two groups. Standard t -tests were used to compare the differences between the groups. In addition, raw scores were converted to demographically corrected standard (T) scores (for age, education, gender, and handedness) using the norms from Heaton et al.[7] This correction was necessary given that the control subjects differed from patients in terms of education and the ratio of males and females.

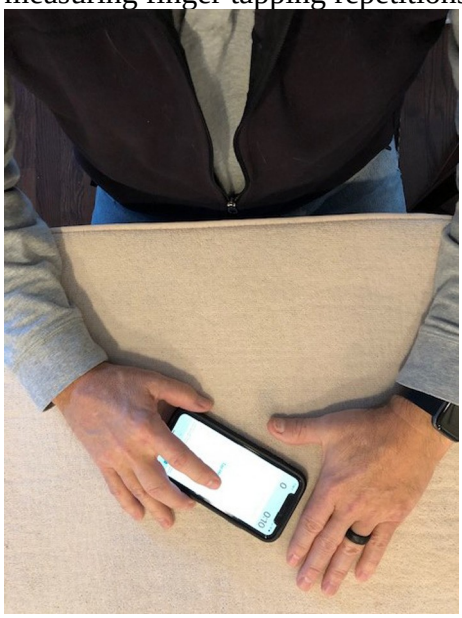


https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8332647/

Measurement of finger tapping performance using a smartphone application: a pilot study 2021

[Conclusion] A small sample of young adults showed that measures of finger tapping were easily obtained using a smartphone app. The measures demonstrated acceptable reliability and known groups validity. They, however, may not reflect performance at other measures of voluntary movement functions.

Historically, however, its measurement has often involved use of instrumentation designed specifically for documenting the number of finger taps an individual can complete over a period of time such as 10 sec[2]. More recently, procedures using desk-top calculators[3] or computer keyboards[4] or mouses[5] have been proposed for measuring finger tapping performance. Currently, smartphone applications (apps) have also been employed for measuring finger tapping repetitions.



https://pubmed.ncbi.nlm.nih.gov/24175464/

Computerized measures of finger tapping: effects of hand dominance, age, and sex 2013

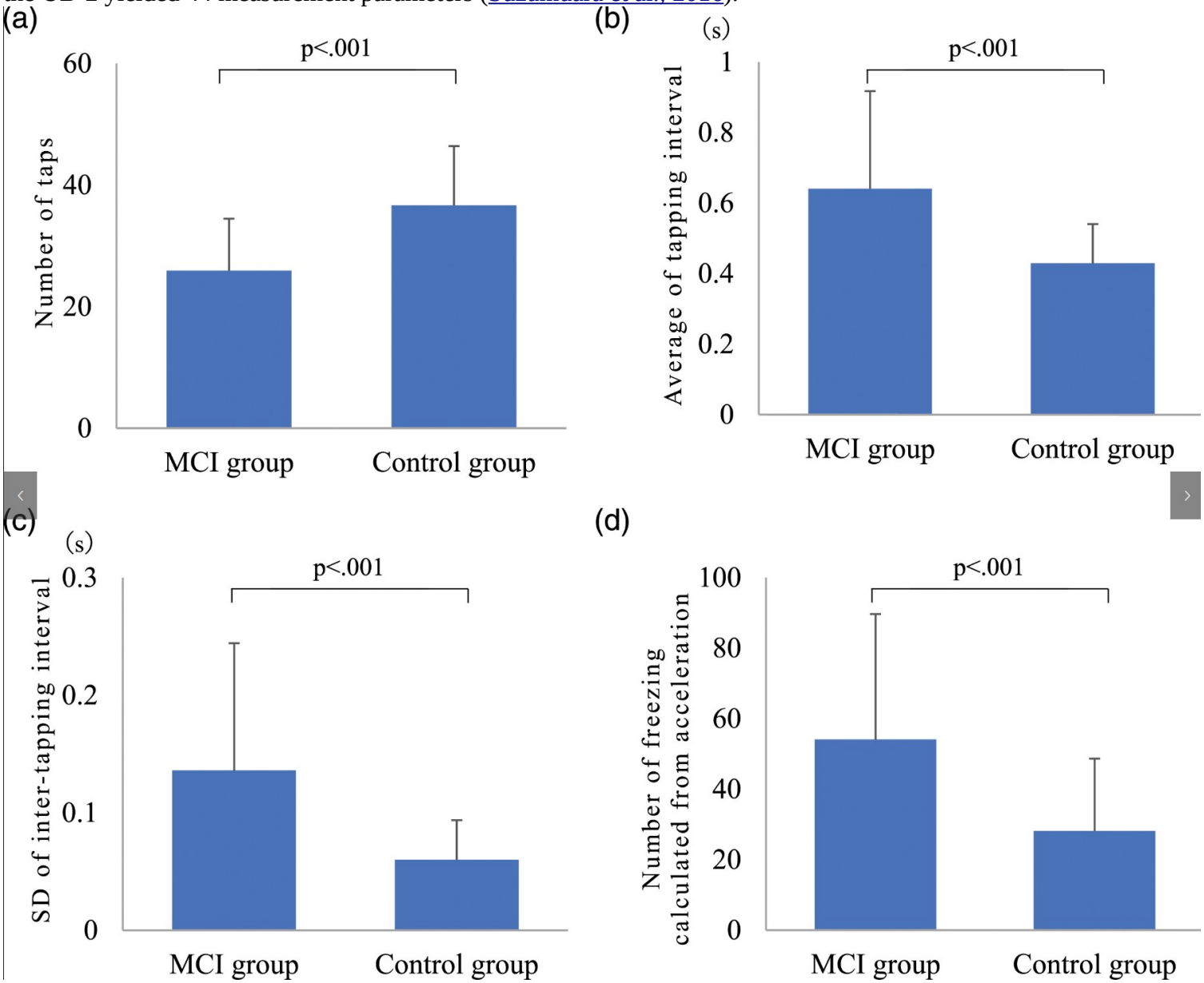
Computerized measures of digit tapping rate were obtained over 3 successive, 10-sec. periods in the right and left index fingers, from a community sample of 1,519 participants (ages 18 to 65 years; 607 men, 912 women). Differences between the dominant and non-dominant hands were found for tapping rate, movement initiation, and button down times, and the decline in tapping rate over the successive, 10-sec. periods. Declines were found in tapping rate in older participants in association with increased intertap variability. Men had higher tapping rates than women in all age ranges. The computerized finger tapping test is an efficient and precise measure of tapping speed and kinetics of potential utility in research and clinical studies of motor performance.

https://apps.apple.com/us/app/cns-tap-test/id495396849
CNS Tap Test is an adaptation of the Finger Tap Test (FTT) or Finger Oscillation Test (FOT) which is used to measure the status of the central nervous system (CNS), and is one of the most commonly used tests in neuropsychology, because of its simplicity and reliability, and because it generates relevant data about fine motor control, which is based on motor speed as well as kinesthetic and visual-motor ability.
The procedure for testing is:
- Rest hand palm down on the heel of the hand on a flat surface
- Tapping is done with the index (pointing finger), and all other fingers remain on the flat surface
- The timer starts with the first tap
- When the timer expires no further taps will be accepted
- The result can either be saved or discarded.

https://academic.oup.com/acn/article/30/2/99/5517?login=false
Abbreviating the Finger Tapping Test 2015
The traditional FTT is said to take 10 min to administer (Strauss, Sherman, & Spreen, 2006). However, if all 10 trials are given with each hand, and all breaks between trials are allotted as instructed (30 s between trials, 1 – 2 min break after every 3 trials), the test would have to take at least 15 min.
The FTT uses a wooden board with a small lever attached to an analog counter, as in Reitan and Wolfson (1993). Each trial lasts for 10 s. The standard discontinue rule is after 5 consecutive trials fall within 5 taps of each other, or at 10 trials if that criterion is not reached. The resulting score is the mean of the “5 within 5” trials, or else the mean of all 10 trials. Administration procedures deviated slightly from standard HRNB instructions; after 3 consecutive dominant-hand trials, 3 nondominant-hand trials were completed, and then this went back and forth until the test was complete; in essence, the allotted 1 – 2 min breaks after every three trials were filled by switching to the other hand. A minor deviation from standard procedures in this way is not unprecedented (e.g., Prigatano & Borgaro, 2003), and it is not considered likely to have interfered with study outcome

https://journals.sagepub.com/doi/full/10.1177/15691861221109872
Finger Tapping Test for Assessing the Risk of Mild Cognitive Impairment 2022
The UB-2 magnetic sensing finger-tapping device (Maxell, Tokyo, Japan) was used as the measuring device (see Supporting Information Figure S1). The UB-2 is a non-medical device that measures the distance between magnetic sensors attached to the thumb and index fingers, with high measurement precision and safety for the human body. The reliability of finger tapping devices has been evaluated for three types of reproducibility: when measurements were taken at different times, when using different devices, and during inter-rater testing, and the reproducibility has been reported to be high (Sano et al., 2011). The device samples voltage output from the sensors at 100 Hz. This voltage is converted to distance based on a conversion curve calculated before every measurement from the calibration voltages obtained when the participant closes the two fingers and holds a 6-cm block. Magnetic sensors were placed on the thumb and index finger of both hands using an elastic band. The bilateral finger-tapping test was carried out using the index fingers and thumbs. The finger-tapping task consists of four types of movements: tapping of a single hand (left or right hand), tapping simultaneously with both hands (left and right tapping at the same time), and tapping with alternate hands (alternate left- and right-hand tapping) (see Supporting Information Figure S2). The finger-tapping task was assessed by occupational therapists with at least 5 years of experience. Measurements were taken individually, with the participant sitting in a chair in a quiet environment. When we examined the participants, we ensured that they kept the following positions: (1) the elbow joint was off the desk, (2) the forearms were in the intermediate position between pronation-supination, and the upper arms were kept close to the body, (3) the wrist joints were in slight dorsiflexion, and (4) the third to fifth fingers were held lightly (see Supporting Information Figure S3). In addition, measurements were taken with open eyes. Before measuring each movement, participants were instructed to practice once for approximately 5 s to confirm the degree of understanding of the tapping task. We asked the participants to tap as fast as possible. After practice, the participants performed each task in the following order: left hand, right hand, simultaneously, and alternate hands, and

movements were measured for 15 s (Total time for the four movements: 60 s). When measurements were completed, the UB-2 yielded 44 measurement parameters (Suzumuara et al., 2016).



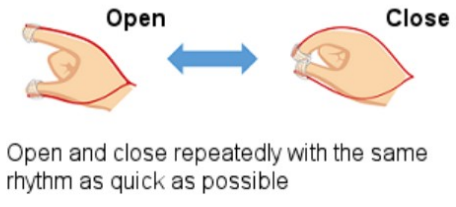
The primary benefit of the present study is the finding that finger-tap movements have the potential to be used as a screening tool for assessing MCI risk. In particular, the number of taps measured from finger tapping movements may be a useful parameter for capturing the decline in motor function during the MCI phase. This tool may be used as a supplemental method to increase the sensitivity of traditional cognitive tests for dementia. In the future, we also would like to verify the relationship between finger function and brain function in MCI patients by using neuroimaging techniques such as MRI and PET.

https://biz.maxell.com/en/wellness_beauty_care/finger_tapping/index.html

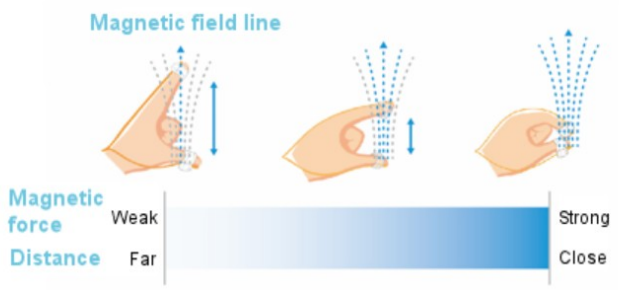
- Accurate measurement of finger movement with a magnetic sensor attached to the fingertip

1. Measurement device utilizing magnetism

The change in magnetic force that fluctuates due to the opening and closing movement of two fingers (finger tapping movement) is converted into an electric signal and converted into the distance between two fingers.



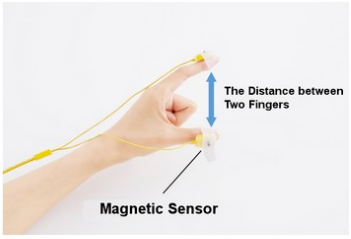
<Finger Tapping Exercise>

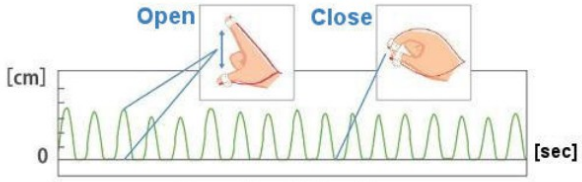


<Change in Magnetic Force by Finger Tapping>

2. Reproduce finger movements with waveforms

A magnetic sensor attached to the fingertip samples the distance between two fingers at regular intervals to visualize finger movements.



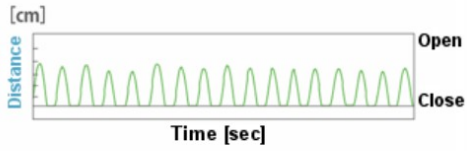


<Sampling Waveform>

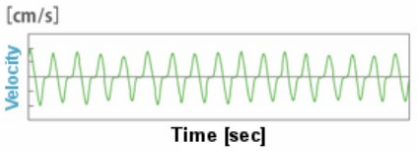
- Parameters[*2] (up to 248) can be calculated and analyzed immediately

1. Calculation and analysis of parameters of measurement data

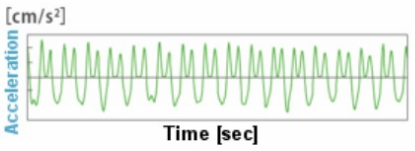
The sampled distance data is time-differentiated, the velocity and acceleration are calculated, and the parameters that indicate the characteristics of finger movement are calculated and analyzed.



(1) Distance Data



(2) Velocity Data



(3) Acceleration Data

The attached application "Just Tap" can analyze 44 vriety parameters.

Item	# of Types	Contents
Distance	7	Evaluate how the magnitude of finger movement has changed
Velocity	15	Evaluate how fast your finger moves
Acceleration	10	Evaluate the momentum of finger movement
Tap interval	8	Evaluate tapping timing
Phase difference	4	Evaluate the cooperation between both hands

The measurement pattern of tapping motion can be set by combining left hand only, right hand only, both hands at the same time, and both hands alternating.

With these combinations, up to 248 parameters can be calculated.

https://square.umin.ac.jp/jjcrs/2020_91-97e.pdf

Assessment of finger movement characteristics in dementia patients using a magnetic sensing finger-tap device 2020

Results: Significant differences were observed in total traveling distance, standard deviation (SD) of contact duration, SD of inter-tapping interval, and SD of phase difference between left- and right-hand tapping. MMSE score showed a weak negative correlation with the SD of contact duration of the left hand ($r = -0.28$, $p < 0.05$). Weak positive correlations were observed in total traveling distance of the left hand ($r = 0.3$, $p < 0.05$) and right hand ($r = 0.25$, $p < 0.05$) and the in-phase task for the right hand ($r = 0.28$, $p < 0.05$). Conclusion: These parameters may represent finger movements that are characteristic of AD and MCI.

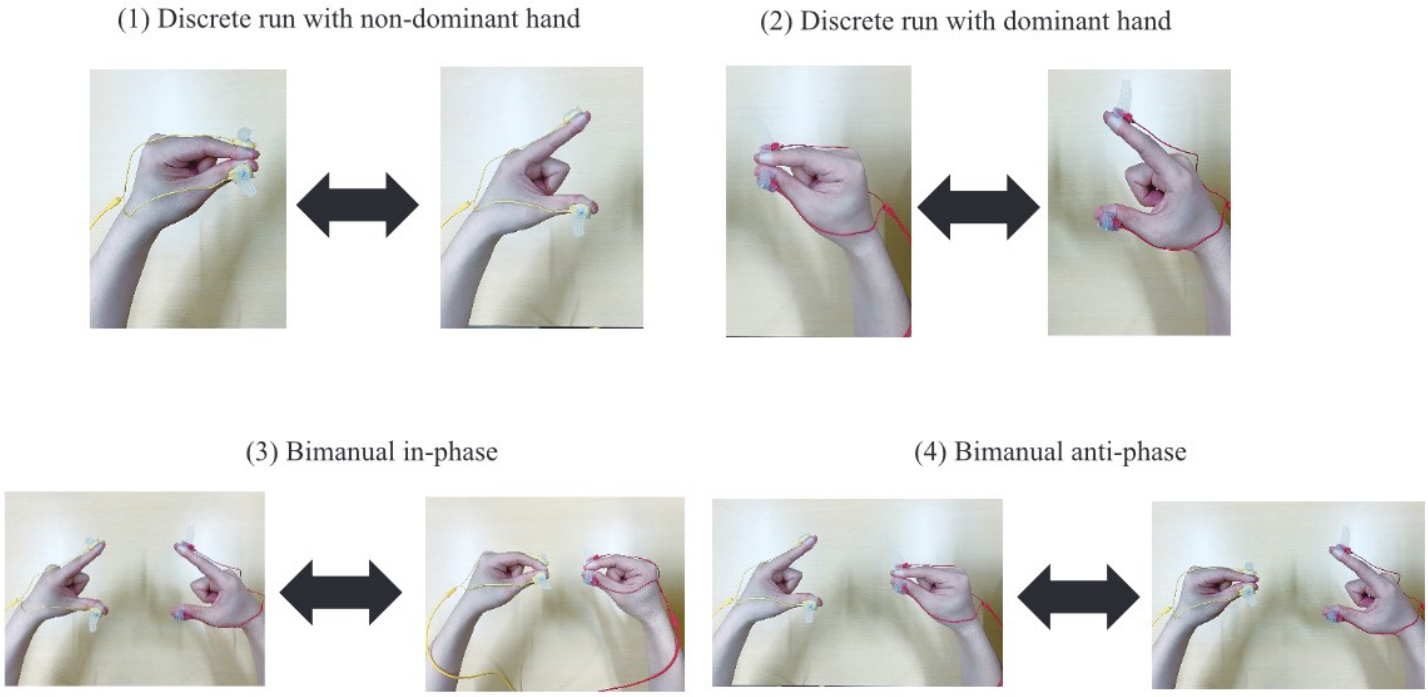


Figure 2. Finger-tapping (bringing the tips of the thumb and index finger together and apart).
(1) Non-dominant hand movement: Finger-tapping as fast as possible with the left thumb and index finger. (2) Dominant hand movement: Finger-tapping as fast as possible with the right thumb and index finger. (3) In-phase movement: Simultaneous finger-tapping as fast as possible with both hands. (4) Anti-phase movement: Alternating finger-tapping between the right and left hands as fast as possible. The distance between the two fingers is kept at about 3–4 cm apart when conducting Steps (1) to (4), and the task is performed for 15 s.

https://pubmed.ncbi.nlm.nih.gov/18002215/

Measurement system of finger-tapping contact force for quantitative diagnosis of Parkinson's disease 2007

The purpose of this study was to develop a measuring system of contact force in finger-tapping of Parkinson's disease patients and to show its effectiveness for quantitative diagnosis. This system was composed of a pair of 3-axis accelerometers, a touch sensor an analog to digital converter and a personal computer (PC). Firstly, a transfer function representing relation between the contact force and the accelerometer output during the finger contact phase of finger-tapping was determined. This means that the finger-tapping contact force could be estimated from the measured acceleration by using the determined transfer function. Secondly the developed system was applied to 27 normal subjects and 16 Parkinson's diseases subjects. Score of UPDRS finger tap test was evaluated for each subject by a neurologist. Finally, these sensors were attached to subject's index finger and thumb, and sensor signals were recorded and processed within the PC. The subjects were asked to execute continuous finger taps movement for 60 s. It was shown that the contact force was smaller as the subject was with the larger UPDRS score of tap test.

https://www.researchgate.net/figure/elocity-and-amplitude-calculated-during-finger-tapping-movement-with-measured_fig3_5887270

Finger Taps Movement Acceleration Measurement System for Quantitative Diagnosis of Parkinson's disease 2014

The system was composed of two 3-axis piezoelectric element accelerometers, a pair of touch sensors made of thin stainless steel sheets, an analog-digital (AD) converter and a personal computer (PC). Fingerstalls, with these sensors, were attached to subject’s index finger and thumb. The acceleration and output of the touch sensors were recorded using the PC during the finger taps movements. Intervals between the single finger taps movements were calculated from the measured output of the touch sensors. Velocities during the single finger taps movements were calculated by integrating the measured acceleration. The amplitudes were calculated by integrating the velocities. The standard deviation of the single finger taps intervals, average of maximum single finger taps velocities and average of maximum single finger taps amplitudes were calculated from them. They were used as features for the quantitative diagnosis of Parkinson’s disease.

The size of the accelerometers was 20.5 mm x 12.5mm x 5.0 mm. The weight was 4.0 g, so it did not interfere with the natural finger taps movements. The frequency band was from 0.5 to 2000 Hz. The accelerometer was put on the distal interphalangeal joint of the index finger and interphalangeal joint of the thumb using fingerstalls (Fig.1 (b)). The touch sensors made of the thin stainless steel sheet were attached on the fingerstalls. The size of them was as same as the ventral surface of digit of the index finger and thumb. When the index fingers and the thumb contacted, the sensors were contacted. Outputs of the accelerometer and touch sensors were measured using the AD converter.

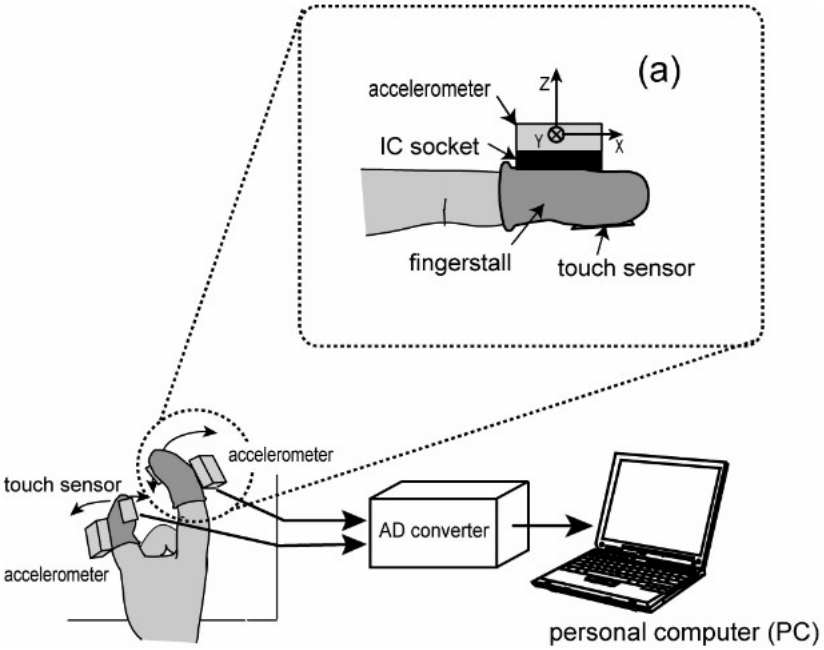


Fig.1 Finger taps movement measurement system.

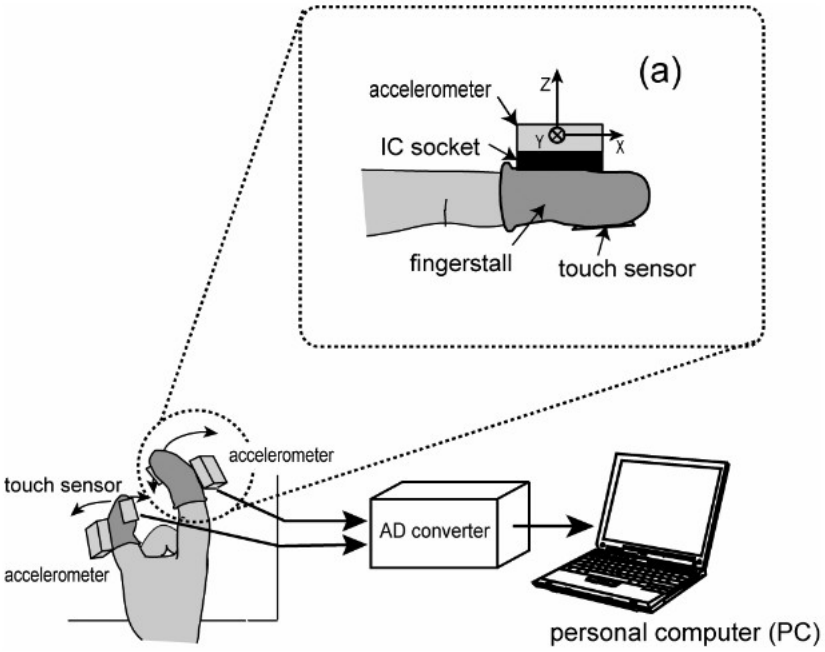


Fig.1 Finger taps movement measurement system.

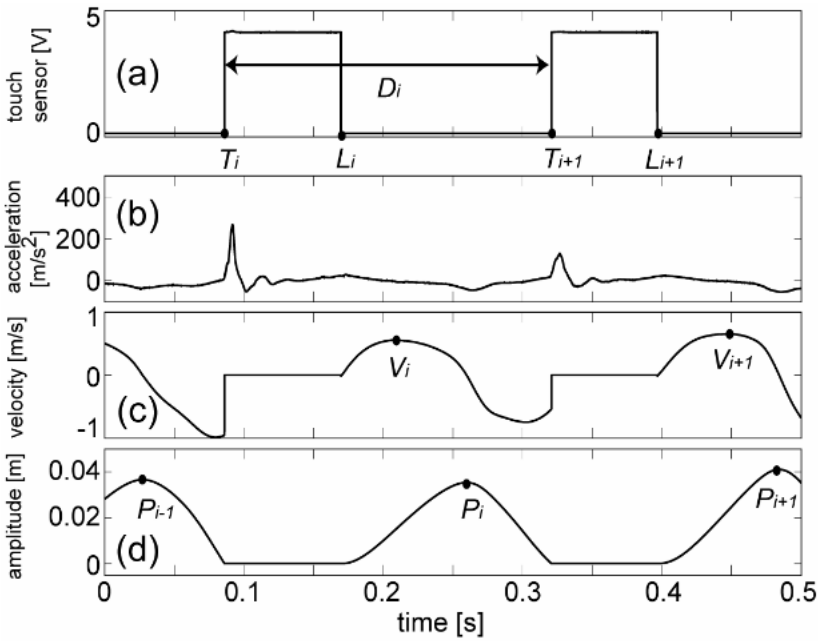


Fig.3 Measured acceleration and calculated velocity and amplitude during finger taps movement. (a) Output of touch sensor, (b) Measured acceleration, (c) Calculated velocity and (d) Calculated amplitude

https://bmcneurol.biomedcentral.com/counter/pdf/10.1186/s12883-017-0829-y.pdf
Results: A total of 1400 evaluations (four videos per each of the 35 subjects evaluated by 10 independent providers) were obtained. Impairments in finger tapping against the distal thumb crease of the non-dominant hand, identified by neurologists, had the greatest sensitivity (84%, $p < 0.001$) for detecting impairment. Finger tapping against the thumb crease was more sensitive than the thumb tip across all categories of providers. The best inter-evaluator reliability was associated with neurologists' evaluations for the thumb crease of the non-dominant hand (kappa = 0.83, $p < 0.001$)

https://pubmed.ncbi.nlm.nih.gov/34911423/

Long-term Physical Exercise Improves Finger Tapping of Patients with Alzheimer's Disease 2021

Background: Alzheimer's disease (AD) is a chronic neurodegenerative disease that has been characterized by progressive development of long onset early disease with complicated etiology and may cause memory loss, cognitive impairment, and behavioral changes. Physical exercise may play a preventive role in AD. In the present study, we investigated the impact of longer-term physical exercise on the finger tapping of AD patients by comparing the finger tapping of AD patients and healthy controls.

Methods: In this study, 140 subjects aged ≥ 60 years were enrolled. Group A consisted of 70 subjects (27 males and 43 females) without exercise habits who were selected from Yangpu District (Shanghai, China). Group B consisted of 70 subjects (27 males and 43 females) who were selected from Minxing District (Shanghai, China). All the subjects were right-handed as well. The subjects' data, including subjects' age, weight, height, Montreal Cognitive Assessment (MoCA), Mini-Mental State Examination (MMSE), and finger tapping frequency, were measured.

Results: The subjects were matched in age, weight, and height. The AD subjects' MoCA and MMSE scores were noticeably lower than healthy subjects' scores (P<0.001); besides, AD patients with exercise had significantly lower MoCA and MMSE scores than healthy controls with exercise (P<0.001). The finger tapping of AD subjects' left hands was significantly lower than that of healthy subjects without AD (P<0.01), and AD subjects with exercise tapped significantly slower with their left hand than healthy subjects with exercise (P<0.01). Meanwhile, AD subjects with exercise tapped significantly faster with the left hand than AD subjects (P<0.05). The right hands of AD subjects tapped remarkably less than healthy subjects (P<0.01) with or without exercise. Meanwhile, subjects with exercise tapped significantly faster with their right hand than healthy subjects (P<0.05), and AD subjects with exercise tapped significantly faster with their right hand than AD subjects (P<0.05).

Conclusion: Long-term physical exercises can improve finger tapping frequency, especially in patients with AD. Finger tapping frequency may be used as an index to monitor the cognitive decline in ageing AD patients.

https://pubmed.ncbi.nlm.nih.gov/30323772/

Can Long-Term Regular Practice of Physical Exercises Including Taichi Improve Finger Tapping of Patients Presenting With Mild Cognitive Impairment? 2018

Methods: The study population consisted of subjects of ≥50 years of age. Group one included 40 subjects without exercise habits from communities of Yangpu District in Shanghai, and group two included 60 subjects from a Tai Chi class in Shanghai Elderly University of Huangpu District. The Montreal Cognitive Assessment (MoCA) and a finger tapping test were conducted to assess the finger tapping frequency of all subjects.
Results: The MoCA score of MCI subjects was significantly lower compared to subjects without MCI ($P < 0.01$), and was not influenced by age, weight, or height. The finger tapping frequency of MCI subjects' left hands was significantly lower compared to that of healthy subjects without MCI ($P < 0.01$), and a similar trend was observed for the subjects' right hand. The MoCA score of MCI subjects in the Tai Chi class was significantly lower than that of healthy subjects without MCI ($P < 0.01$), which was not influenced by age, weight or height. The finger tapping frequency of MCI subjects' right hands was lower compared to that of healthy subjects in the Tai Chi class without MCI ($P < 0.05$), but no significant difference regarding the finger tapping frequency of the left hand was observed.
Conclusion: These findings suggested that finger tapping frequency of MCI subjects was significantly lower compared to normal subjects without MCI, and long-term Tai Chi exercise could reduce this significant difference. Moreover, there was no significant difference between groups for the subjects' non-dominant (left) hand

https://medicalxpress.com/news/2016-05-successful-alzheimer-type-dementia-finger-tapping-pattern.html
Successful extraction of Alzheimer's-type dementia finger-tapping pattern 2016
The National Center for Geriatrics and Gerontology ("NCGG") in Japan has succeeded in identifying an index finger-thumb tapping pattern unique to Alzheimer's-type dementia through clinical research focusing on the rhythmical movement of both hands (Figure 1). This result was achieved using a waveform analysis technique for finger-tapping movement developed by Hitachi, Ltd. which allows a variety of tapping patterns to be extracted from the measurement data on motor ability using the magnetic sensors, such as the discrepancy in contact time between the fingers. This achievement opens the way to advancing tests for the early detection of Alzheimer's-type dementia. Hitachi developed an analytical technique to capture multiple characteristics from the waveforms measured from the finger-tapping movement of both hands, and provided NCGG with the software. In addition to the 21 basic characteristics of finger-tapping movement available such as the distance opened between the fingers, tapping speed and phase difference of the two hands that can be measured with UB1, the new software also assesses an the additional 23 characteristics including the duration of contact between fingers and the degree of similarity between the movement waveforms of both hands, indicative of deterioration in two-handed rhythmical movement. This enhanced capability enables highly accurate assessment of various characteristics of finger- tapping movement.

https://pubmed.ncbi.nlm.nih.gov/31408867/
Is Reaction Time Slowing an Early Sign of Alzheimer's Disease? A Meta-Analysis 2019
This meta-analysis showed that simple reaction time (SRTs) are longer in individuals with MCI. Further studies are needed to determine the mechanism of SRT slowing, its anatomical correlates, and a threshold value for diagnosing prodromal AD.

https://pubmed.ncbi.nlm.nih.gov/28261945/
Cognitive decline and slower reaction time in elderly individuals with mild cognitive impairment 2017
Conclusion: Altered performance in a speed task was observed in patients with MCI. The FRT (flanker reaction time) task should further be explored for its role as a marker for cognitive decline in elderly individuals, particularly in those with MCI.

https://pubmed.ncbi.nlm.nih.gov/35887956/
Digital Cognitive Biomarker for Mild Cognitive Impairments and Dementia: A Systematic Review 2022
Moderate to large group differences were consistently observed in cognitive outcomes related to memory and executive functions, as well as some novel outcomes measured by handwriting/drawing tests, daily living tasks, and serious games. These outcomes have the potential to be sensitive digital cognitive biomarkers for MCI and dementia. Therefore, digital cognitive biomarkers can be a sensitive and promising clinical tool for detecting MCI and dementia.

https://pubmed.ncbi.nlm.nih.gov/34744026/
Diagnostic performance of digital cognitive tests for the identification of MCI and dementia: A systematic review 2021
Digital cognitive tests showed good performances for MCI and dementia. The digital test can collect digital data that is far beyond the traditional ways of cognitive tests. Future research is suggested on these new forms of cognitive data for the early detection of MCI and dementia.