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Reliability and Validity of Application based measurement of Reaction time

Pankhuri Vairagade[1], Hitav Someshwar,[2] Geeta Bhatt[3]

[1]*MPT student K.J Somaiya College of Physiotherapy, Mumbai, Maharashtra, India.*
[2]*MPT student K.J Somaiya College of Physiotherapy, Mumbai, Maharashtra, India.*
[3]*HOD Department of Neurophysiotherapy, K.J Somaiya College of Physiotherapy, Mumbai, Maharashtra, India.*

***Corresponding Author**: **PankhuriVairagade**
Email id: pankhurivairagade02@gmail.com

ABSTRACT

Background: Reaction time is an important indicator of neuromuscular status in any age group. Drop ruler test (DRT) is a commonly used measure to estimate reaction time, it has certain limitations. To overcome this, a simple, portable and convenient App based measurement of reaction time is validated and reliability is checked.
Method: The study was conducted on 93 individuals between the age group of 19-25 years. For concurrent validity reaction time was measured using Drop Ruler Test by examiner A. Reaction time was measured using Reaction time Application by examiner A and examiner B.
Results: Reaction time Application correlated strongly with Drop Ruler Test r=0.790 ($p<0.001$)
Conclusion: Application based measurement of Reaction time is a valid measure and showed acceptable test-retest reliability and therefore can be used clinically as an assessment tool.
Keywords: Drop Ruler Test, Reaction time Application, Reaction time.

INTRODUCTION

Reaction time is defined as the time between presentation of a stimulus, and, initiation of an appropriate voluntary response.The most common assessment of neurological function is Reaction time.[1] Reaction time is the most important component of motor movements.[2]It determines the attentiveness and alertness of an individual and it must be lesser where multi or dual tasking are must. For any response to occur the stimulus activates the sense organs and the impulse is then conducted to the brain and from the brain is sent back to execute the movement required to accomplish the task. Slowed performance is usually accompanied by prolong Reaction time.[3,4]

Reaction time are of three different types: 1) Simple Reaction Time (SRT) - In SRT, there is only one stimulus and one response to that stimulus. Some studies reported that SRT is determined when an individual is asked to press a button in case of an appearance of light or sound. 2) Choice Reaction time (CRT) -consists of multiple stimuli and multiple responses, one must give appropriate response to a particular stimulus. Serial reaction time is a variant of choice reaction time in which the order of stimulus type is not random. Any stimulus of 'y' type is likely to follow a stimulus of 'x' type. This type of reaction time gets faster with practice and can anticipate the stimulus that will appear next. 3) Recognition Reaction Time (RRT) – there are some stimuli which should be responded to, called the 'memory set' and others that should not get any response called the 'distractor set'[5]

Reaction time has both functional and clinical importance in many contexts for example, sport related concussion where it represents measurable

consequence of brain injury.[6] A prolong reaction time is common after a concussion due to the disturbances in the neuro cognitive pathways as a consequence of brain injury.[7]

Until recently, the gold standard method of measuring Reaction time was the 'Drop Ruler Test.'[8] It is a simple test based on the relation between distance, acceleration and time for a free falling body (Chudler,2009) It requires a person to catch the measuring stick that has been dropped the clinician then measures the length or distance the ruler has travelled before being grasped to provide a measure of simple clinical reaction time.[9-12] Despite of having acceptable test-retest reliability, drop ruler test has certain limitations for example-it is tedious, require more attempts, less accurate, lack of hand-eye co-ordination, sitting position and questionable and intra-rater reliability.[9-12] To overcome these limitations, a simple, easy to use, convenient and portable app-based measurement of reaction time is validated and reliability is checked.

The application-based reaction time called the Reaction Test Pro, version 4.0 developed by freedom games available on google play store and apple store was used to find out the reliability and validity. With the improvement and wider use of technology, capacitive touch screens and powerful processing capability provide an opportunity to develop information processing tasks easy and more accurate.[13] The apps allow to geographically disparate individuals to contribute in clinical management and data for research.[13] Similar applications can be used extend and expand health care institutions and health initiatives and also to make assessment easier and faster.

The aim of this study is to determine the efficacy of a mobile platform to measure Reaction time. Statistical analysis was designed to evaluate the reliability and validity of the mobile based application of reaction time over traditional Drop Ruler Test.

METHOD

The healthy individual in the age group of 19-25 years were recruited in this study. Informed consent was obtained from all the participants included in this study. The inclusion criteria of the study were (1) age group of 19-25 years (2) with corrected eye vision and (3) those willing to participate. The exclusion criteria were (1) no cardiorespiratory, neurological or musculoskeletal involvement (2) no history of concussion prior 6 months.

TESTING PROCEDURE AND APPARATUS

All the participants were tested by using Drop Ruler Test by examiner A. All the participants were tested by using Reaction Test pro application on both android and IOS platform by examiner A and examiner B. Reaction time was measured early in the morning, in a quiet, well lit room in K.J Somaiya College of Physiotherapy, Mumbai, India. To avoid any kind of auditory disturbances, participants were instructed to wear noise cancellation headphones. Drop Ruler test and Reaction Test Pro were tested on the participant seated on the wooden chair with arm rest. The hand arm distance of all the participants was kept at a 90 degrees angle. The participants were instructed to press on the screen with their index finger as soon as the green circle appeared on the IOS and Android screens. The reaction time was calculated in milliseconds. Average of 3 trials were calculated both by examiner A and examiner B on android and IOS platforms. Statistical analysis was done and reliability was checked.

APPLICATION DETAILS

Reaction Test Pro, version 4.0 developed by freedom games available both on Google and Apple store.

Mobile phone details:

1. IOS Platform- RAM-3GB, Operating system IOS v11.
2. Android platform- RAM-3GB, Operating system v7.0.

STATISTICAL ANALYSIS

Statistical analyses were conducted SPSS (Version 22, IBM Corporation, Armonk, NY, USA). To assess the test-retest and inter-rater reliabilities, the intraclass correlation coefficients (ICCs) were calculated for the drop ruler test reaction time scores, and for the mobile app reaction time scores. The test-retest reliability scores were calculated using the results of the test sessions administered by Examiner A, 24 hours apart. The inter-rater reliability scores were calculated using the results of the test sessions administered by Examiners A and B on the same day. To assess criterion validity, drop ruler test reaction time scores and reaction time scores through the mobile app was assessed using Pearson correlation coefficient scores (r).

RESULTS

Ninety-Three participants were included in the study. The 93 subjects ranged in age from 19 to 25 years, with a mean age of 21.96 years (SD ±2.07). The mean reaction time through drop ruler test from participants was 298.01 ms (range: 185.50–450.25 ms). The mean application-based reaction time from participants was 287.13 ms (range: 242.40–452.50 ms). Results from Application based reaction time trials are presented in Table 1.

Table 1- Application based reaction time across trials

Drop Ruler test	Mean	Range
Trial 1	305.59ms	161.12-527.32
Trial 2	283.40ms	184.19-470.54
Trial 3	272.41ms	190.31-409.66

The ICC comparisons demonstrated significant reliability during repeated measurements for Application based reaction time (ICC 0.713, p < .001, 95% CI 0.56–0.84). A one-way ANOVA was conducted to determine whether there were no statistically significant differences in drop ruler test reaction time over the course of the three trials, assessing for learning and fatigue effects. Comparison of reaction times across trials did not yield statistically significant differences in reaction times (Figure 1; F3,104 ¼ 1.35, p ¼ .26). Agreement between Reaction time measured with drop ruler test and application-based reaction time as a method for RT measurement was assessed via Bland-Altman analysis. The mean difference between pairwise results was 43.7 ms, again indicating Application based reaction times were faster in nature. The Bland-Altman limits of agreement, represented by the mean difference d ± 1.96 standard deviations (SD), were 140.8 msto 53.4 ms.

Criterion validity was assessed by calculating Pearson correlation coefficients between mean scores. Participants had an average response time of 298.01 ms, while average response time on application test were 287.13 ms. The app was positively correlated with the drop ruler test [r - 0.790, p <0.001].

DISCUSSION

The aim of this study was to find out the reliability and validity of mobile based reaction time application. The data indicates that mobiles have a sufficient central processing unit to accurately and reliably measure reaction time relative to the traditional method of evaluating reaction time. The accurate assessment of reaction time using mobile based platforms provides an opportunity in the clinical field by making the assessment quick and easier.

Traditionally reaction time was assessed using Drop Ruler Test and had certain limitations. It had questionable inter and intra-rater reliability.[9-12] Mobile based measurement provided a number of advantages over the traditional Drop Ruler Test in terms of accuracy and precision.[14]It is an automated process as opposed to manual scoring and provided a platform for the delivery of other computerized neurocognitive tests to evaluate multiple domains of cognitive functioning.[13] Examining Reaction Time using Drop Ruler Test was tedious and less accurate. It required more attempts due to the sitting posture and lack of hand-eye co-ordination.[10]

The data from this study indicate that mobile devices such as IOS and Android have sufficient accuracy and computational power to measure reaction time. Our study is consistent with the study done by Schatz et al, 2015 who reported that IOS devices like iPad showed relatively low timing delays and consistent variability. In general, the data from this study support the concept of using mobile based platforms as it provides temporal measurements that are consistent across test conditions. There is a strong co-relation for both Android and IOS mobile based application across the test-retest conditions. It appears that both the devices when planned carefully and programmed appropriately provide reliable and consistent timing data that can be used for the measurement of Reaction Time.

With the advancement in technology and widespread use of mobile devices it had become easier to collect the data which is more precise. These devices introduce a suite of applications, and, with the help of these applications, the researchers can collect objective and subjective data from the individuals. Incorporating objective and valid measures of neurological assessment such as reaction time can potentially expand the value of data collection in an effort to better characterize disease progression in neurological patients.

CONCLUSION

Limitations of drop ruler test were- it was less accurate, tedious and required more attempts. Application based measurement of reaction time has a good inter and intra-rater reliability when compared to drop ruler test. Hence, it is an easy and valid measure to assess reaction time.

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