

Reaction Time in Children by Ruler Drop Method: A Cross-Sectional Study Protocol

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Abstract

Background: Reaction time (RT) is the time interval between stimulus and response. RT can be measured by ruler drop method (RDM). Till date, there is no set standard reference norm available for the school children by RDM. **Objective:** To determine the standard reference norms for RT in school going children. **Methods:** A sample of 152 students will be recruited based on predetermined set of inclusion criteria from the recognized primary school by convenience sampling method for the cross-sectional study. RT of all the recruited students will be estimated by RDM. **Statistical analysis:** Normality of the collected raw will be established by Kolmogorov Smirnov test of normality. Descriptive statistics will be used to report the standard reference norms of RT in mean (standard deviation). Independent t-test or Mann Whitney U test will demonstrate the gender differences of RT by RDM among the primary school children. **Conclusion:** This study will act as the foundation for other studies using RDM for reporting RT.

Keywords: Normal Value; Reference Value; Response Time; School Children; Standard Norm.

Introduction

Reaction time is defined as interval of time between presentation of stimulus and appearance of appropriate voluntary response in a person [1]. It varies with number of possible valid stimulus, type, order and intensity of stimulus, arousal, age, gender, physical fitness, hand dominance, practice and error, fatigue, fasting, distraction, alcohol, finger tremor, stress, drugs, intelligence, learning disorder, brain injury, illness, personality type, accuracy in hearing and vision [1, 2].

Lesser the reaction time it multiplies ones achievements in many areas such as, sports, academics, music, dance, driving, defense, etc. By identifying the person's reaction time, we can predict reacting abilities in the above mentioned situations. In case of children, this helps us to identify the

children with prolonged reaction time and to identify the cause. Thereby individual attention can be given to these children at their younger age. Thus estimating the reaction time of children at their younger age is more prior.

In the human life the age between 6-11 years are the rich years filled with growth and more remarkable changes in executive attention occurs between 6 and 8 years of ages where they make a move towards adulthood from their childhood [3, 4]. At the age of six years the child shows remarkable shift in the cognitive skills [5] which includes perception memory, intuition, awareness, reasoning, attention, judgment, and initiation-termination of activities [6]. These cognitive changes transform the body and mind of a child along with biological and psychological changes [7]. So, if reaction time norms for children are estimated during these age span,

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identifying the children deviating from these norms would be made easy.

Reaction time of an individual is estimated clinically by computerized neuropsychological test [8]. But high cost and professional guidance in estimating reaction time makes this unavailable for the school children. Though mobile based android applications are available for estimating reaction time, but the restricted usage of mobiles at schools makes this as a tough task. Thus there is a desire need to develop reference standard norms for RT using simple instrument used in schools like Ruler.

Eckner et al validated his simple instrument for the estimation of reaction time [9]. But the instrument has ceiling effect and in case of children it might have major effect. To minimize this effect, we have proposed a simple method to estimate reaction time by a ruler dropped at least a meter distance from the ground. A stainless steel meter ruler is used in the study to estimate the reaction time in the children [10].

Review of literature

Reaction time (RT) is defined by various authors in multi-ways. RT is an interval of time between presentation of stimulus and appearance of appropriate voluntary response in a person [1]. Also defined as the 'the interval of time between application of stimulus and detection of a response [11]. It measures the cognitive functioning of an individual [12-14]. This reaction time mainly depends on the type, number and duration of possible stimulus [2].

The first clinical examination of RT was performed by a psychologist F.C. Donders in 1868. He defined RT as the Speed of Mental Processes and assessed by means nerve conduction velocity using 'subtractive method'. Here he gave electric shock to both feet of the subject randomly as a stimulus to infer how much time was needed for comparing the tasks, such as identification, comparison or other higher-level judgments. The subject responded to the stimulus by pressing the telegraph key with his left or right hand with respect to the leg in which the shock is received [11, 14-16]. Many studies were carried out by different investigators to find RT by using Donders's subtractive method but the obtained RT was varied from person to person and laboratory to laboratory [14].

Later in the year 1930 the 'father of modern psychology' William Wundt, along with his students, extended the subtractive method into

experimental psychology and also they found a new application where RT was evaluated once the stimulus was identified through which they measure the duration of mental processes, attention, memory, and the integration of the ideas. They estimated attention or apprehension span in the form of result [14, 17].

In the year 1938 Julia from the University Minnesota found the relation of RT of 5 year old children to various factors by using Mill's reaction board with accessory key and she is aimed to find the speed of reaction to auditory stimulus in relation to their sex, intelligence and work status. In this study she selected 50 girls and 50 boys of age five year five month to five year seven month. During procedure the main board of apparatus was held by experimenter and the part was placed in front of the child. The Experiment was consisted with 25 trials in which the children were divided into of group of five trials and first three group of tests performed with the rest of 15 min; the fourth and fifth groups of tests conducted with the rest of 30 seconds each [18].

Sternberg et al introduced a new method for calculating RT known as 'additive factor method' to overcome limitation of Donders and other methods. It explains the stages of information processing. In this method the stimulus was given by a sequence of visually presented digits ranging from zero to nine. The subject will give either positive response or negative responses [14].

There was a major shift of cognitive behavior from operational orientation after the World War II. The philosophical adjustment leads to evolution of computerized batteries in calculation of RT in 1970-80s, hence these years are known as golden years [19, 20]. Various studies were performed to evaluate RT by using computer.

In the year 1972 Spring et al performed a study Reaction Time in Learning-Disability and Normal Children. They estimated the RT of 22 children with poor reading and 22 children with normal reading, aged between seven to 12 years and IQ of 94 to 130 by pressing one switch of corresponding letter when two upper-case letters were presented simultaneously. 80 trials were given prior and again 40 trails were given after the rest of ten minutes. At last they concluded that the children with learning disability show longer RT when compared to normal children [21].

RT was also assessed by using the mobile phone with test battery installed. Kaisa Rolig in her thesis estimated the feasibility mobile phones in the calculation of RT. Now a day mobile became an important part of life hence it reduces cost effective

for the subjects. The subject can repeat the measurement whenever required. But these measurements are varied from laboratory measurement with controlled environment also the structure each models of phones and their software's are varies from one another. There is also comparatively small screen and buttons when compared with computer [19].

Ruler drop method (RDM) is another simplest method to estimate the RT. Subject/athlete was asked to perform RDM by sitting with their dominant forearm resting on a flat horizontal table surface, with their open hand at the edge of the surface. The examiner/assistant was suspending the ruler vertically such that the other end of ruler was aligned with the top of the subject/athlete open hand. When the examiner/assistant releases the apparatus, the subject/athlete should catch it as quickly as possible. Then the distance travelled by the ruler is the converted into time by the formula $d = vt + \frac{1}{2}at^2$ [22].

Eckner et al validated this RDM through his observational study on evaluating a clinical measure on RT, where he evaluated the RT of 65 healthy individual with mean age 45.5 years and right hand dominants by RDM. They found excellent inter-rater (ICC= 0.92) and test-retest (ICC = 0.86) reliability also they calculated RT by using a soft ware of simple reaction time task developed using E-Prime which was installed in a personal laptop for validation of RDM. The participant were asked to sit in front of computer such that their dominant forearm should rest on the laptop keypad and they have to press space bar as the black circle on the white background on the computer screen was changed to a black randomly at the time interval of 4-15 seconds. Time interval between stimulus and pressing the button was recorded by computer in milliseconds. Feedback was given after the each trial [9].

Later Eckner et al evaluated the RT of Division I Football Players from National Collegiate Athletic Association by RDM. He selected Cog State Sport tests passed 68 athletes aged between 18-23 years. The study was aimed to compare RT by RDM (RT_{clin}) with RT by computer (RT_{comp}) with neuropsychological test battery installed. This computer monitor consist playing cards in the middle with inverted face. Athletes should press the key 'K' as quickly the card turns upward. And they conclude that there is a positive correlation between RT_{clin} and RT_{comp} ($r = 0.44$) [20].

S. S. M. Fong et al was conducted a study to compare the physical fitness and RT of 20 Taekwondo practicing children aged between 10 to 14 years and the 20 children from the community with same age group. The RT of was estimated by

RDM and the physical fitness was measured in terms of Sit-and-Reach Test, Leg-Split Test, One-Minute Curl-Up Test and Skin fold Measurements. The procedure of RDM was repeated for three times and the average of these was used for data analysis. They estimate RT of Taekwondo practicing children was 0.19 millisecond and RT of children from the community was 0.22 millisecond [23].

In our pilot study, we evaluated the reliability and validity of RT of 12 school children aged between 6-10 years by using RDM [24, 25]. We used a metal ruler with one meter length. We did a small modification in the procedure that Ruler was suspended vertically such that across 5 cm was aligned with the top of the child's open hand and Distance the ruler travelled from starting 5 cm was recorded. The trial was repeated 3 times. To estimate the validity of RDM we used an android based mobile application known as criterion referenced Reaction speed®. We found good intrarater reliability (0.81) and moderate to good degree of validity (0.54) [10, 25].

Need of the study

To develop reference standard norms for RT using Ruler Drop Method

Clinical significance

RT reference standard norms could act as benchmark in comparing with age appropriate values among the school children and to determine how much they differ from their peers.

Objective of the study

To estimate the standard norms for RT in primary school going children.

Methodology

1. *Study design:* Cross sectional study
2. *Study setting:* Sports lab of respective school
3. *Sample population:* Children with typical development
4. *Sampling technique:*
 - ❖ Selection of school: Convenience sampling
 - ❖ Selection of children: Simple random sampling
5. *Sample size* n = 152

- ❖ Estimated by the formula, $n = (Z\alpha/d)^2$
 $\alpha = 31.4$ ms (from pilot study)
 $\alpha = 0.314$ s;
 $d = 0.05$ (5 % error)

Inclusion criteria

- ❖ Aged between 6-12 years
- ❖ Male and female gender
- ❖ Typical development with optimum health
- ❖ Able to understand simple command

Exclusion criteria

- ❖ Uncooperative children
- ❖ Open wound, recent fracture, contracture or any nerve injury in the upper limb
- ❖ Any other condition that prevents the children from performing the test

Materials used

- ❖ Metal Ruler of 1 meter length (Camline)
- ❖ Cotton
- ❖ Insulative tape
- ❖ Chair and table
- ❖ Measuring tape (Coman®)
- ❖ Weighing Machine (WC 150)
- ❖ Other necessary stationary

Procedure

A sample of 152 children will be participating in this study during the month of October, 2014 to March, 2016 with the prior permission from the principal of participating school and also parents/legal guardians. The ethical clearance will be obtained from institutional research ethics committee of Maharishi Markandeshwar institute of physiotherapy and rehabilitation Mullana, Ambala Study will be done by the guidelines laid by ICMR (2006) and Helsinki Declaration (Revised 2013). The assent from children and consent from their parents/legal guardians will be obtained prior to the study.

All anthropometric measurement will be taken before the initiation of study. To measure Reaction time (RT) by ruler drop method (RDM) the child will be made to sit with their dominant side elbow flexed

at 90° with mid-pronated forearm resting on a flat horizontal table surface, with the open hand at the edge of the surface. Ruler will be suspended vertically by the examiner, such that the lower end will be aligned across 5 cm between the web space (i.e. thumb and index finger) of the child's hand. Child will be asked to catch the ruler as quickly as possible, once it is released from the examiner's hand.

Distance the ruler travelled from starting 5 cm will be recorded. Then this distance will be converted into time by using following formula.

$$t = \sqrt{2d / g}$$

Where **d** is the distance travelled by ruler **g** is the gravitational constant (9.8m/s)

Three trials will be taken, then mean of this will be used for the analysis and the test will repeated for next two sessions to estimate the intra-rater reliability.

Outcome measure

- ❖ Distance (d) in centimeters

Data analysis

Data will be analyzed by SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). As our sample size is greater than 50 Kolmogorov Smirnov will be used to check the normality. Descriptive statistics will be expressed in terms of mean and \pm SD (standard deviation), if data follow normal distribution, otherwise median and IQR will be used. For the reference value of RT also follows the above situation.

Significant difference between male and female will be established by independent t-test or Mann Whitney U test depends on normality of collected data. Alpha value will be analyzed at the significance of less than 0.05 to minimize type I error.

Discussion

Estimating RT by RDM might be an interesting task to the school going primary children because in RDM, a moving ruler will be held between their fingers. The task might create motivation among all the children. Competitiveness and curiosity might prevail among them in completion of the task. Moreover, the study will be the first of its kind in estimating RT by RDM among the primary school going children.

Conclusion

The reference standard norms will be reported at the end of the study. The results could act as the foundation for all other study using RDM for estimating RT. The reference value of RT among the primary school children will help the researcher to compare them with the established reference standard norms. There by ideal scale for RT would be set up in the field of research.

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- ❖ Aranha VP, Samuel AJ. A light on the literatures of reaction time from the past leading to the future – A narrative review. *Pediatric Education and Research*, 2015; 3(1): 11-4.
- ❖ Aranha VP, Joshi R, Samuel AJ, Sharma K. Catch the moving ruler and estimate reaction time in children. *Indian Journal of Medical and Health Sciences*, 2015; 2(2): 23-6.

Conflict of Interest: None declared

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