# A Light on The Literatures of Reaction Time from The Past Leading to The Future – A Narrative Review

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## Abstract

Reaction time (RT) is the measure of how rapid the person responds to the given stimulus. Most of the literatures have used RT as one of the outcome measure in training neurologically intact children and adults to achieve excellence. Here we present the detailed narrative review about RT from various databases such as PubMed, ProQuest, OvidSP and EBSCO. From critical analysis of this narrative review, it is found that there is dearth in literature lacking the reference standards of RT among them.

**Keywords:** Attention; Children; Reaction Speed; Narrative Review; Ruler Drop Method.

## 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 6-11years are the rich years filled with growth and change and more remarkable changes in executive attention occurs between 6 and 8 years of ages where they make a move towards adult hood 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, 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

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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, Aranha et al have proposed a simple method to estimate reaction time by a ruler dropped at least a meter distance from the ground. They used a stainless steel meter ruler in the study to estimate the reaction time in the children [10].

This narrative review will help us in identifying the literature available on RT and what the literature lacks on with special reference to children.

## Narrative Review of Literature

Reaction time (RT) is defined by various authors in multi ways. RT is a 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 due to the variation in different models of mobile phone which has comparatively smaller screen and buttons than computer [19].

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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].

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].

Aranha et al, evaluated the reliability and validity of RT of 12 school children aged between 6-10 years by using RDM. They used a metal ruler with one meter length with a small modification in the procedure that the metal ruler was suspended vertically such that across 5 cm was aligned with the top of the child's open hand. The distance travelled by the ruler from starting 5 cm was recorded. The trial was repeated 3 times. To estimate the validity of RDM, they used an android based mobile application known as criterion referenced Reaction speed®. They found good intrarater reliability (ICC = 0.81) and moderate to good degree of validity ($\rho$ =0.54) [10]. But no one has established the standard reference norms for RT among the children.

## Conclusion

The path-breaking work done by the narrative review will open up a new dimension of RT and its literature lacking among the children.

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