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Short communication

DISTRIBUTION OF THE HUMAN REACTION TIME MEASUREMENTS

Piotr JAŚKOWSKI

Department of Biophysics, School of Medicine, Fredry 10,
61-701 Poznań, Poland

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Abstract. Simple motor reaction time to visual stimuli in dependence of stimulus intensity was measured and the histograms representing the distribution of reaction time were constructed. It was found that the reaction time distributions are positively skewed for all stimulus intensities used. The mean value, the standard deviation as well as the coefficient of skewness increases as the stimulus intensity decreases.

During the study of the laws of simple motor reaction time (RT) some special properties of standard deviation behavior were revealed; it was found that standard deviation (SD) decreased when the intensity of stimulus increased (2). The premises concerning this subject can be found in previous works (e.g., (4)). Moreover, Lichtenstein and White (3) as well as Donchin and Lindsley (1) have observed that a distribution of simple reaction time was positively skewed. These facts induced me to do preliminary research on the variability of simple reaction time in dependence on intensity of stimulus.

Two well-trained subjects (PJ and EW) with normal vision and without refractive errors were used in the experiment. The light source was 100 W-halogen tube. The light from source passed through the optical system and formed the light patch of diameter 0.7° on the ground-glass screen. The patch was flashed by the electromagnetic shutter controlled by the random generator. The flash duration was 100 ms. The optical system and the screen were assembled in a box. The observer was seated in a dark room, at a laboratory table on which the apparatus box was placed and viewed monocularly stimuli appearing on the screen through a circular tube in the wall of the box. The tube was fitted with a 3-mm artificial pupil. On the outer surface of this wall special goggles were mounted to rest the subject's head. The test stimulus was superimposed on the black background (background luminance was less than 10^{-6} cd/m^2). To facilitate fixation, two weak fixation lights with a radius of 3 min arc were projected symmetrically 0.5° to the left and to the right from the center of the test target. The observer's task was to respond to the flash as fast as possible by pressing a key. The subject took part in eight sessions. During one session the luminance of the test was constant and the subject responded to 100 (EW) or 150 (PJ) flashes. Every session consisted of two or three blocks (50 responses per block) between which 5 min pauses were applied. The noise caused by the apparatus was masked by giving white noise to both ears of a subject.

For every intensity of stimulus the histograms representing the distribution of the reaction time measurements were made. The set of histograms for PJ was shown in Fig. 1. One can see that if intensity of stimulus decreases, both the average and the SD increase. The mean value, which is marked by a little arrow, is slightly shifted to the right with respect to the maximum of the distribution. The value of SD was higher for EW than for PJ. Moreover, it was observed that (i) all histograms seem positively skewed, (ii) the histograms are practically symmetrical for high intensity and (iii) their skewness rises when intensity diminishes. These observations are confirmed by statistical analyses: for all data sets the mean value, the standard deviation and the coefficient of skewness were calculated. The coefficient of skewness was calculated on the basis of the formula:

$$\gamma = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^3}{\left[\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right]^{3/2}},$$

where x_i — a result of the i-th measurements, $\bar{x}$ — the mean value and n — the total number of measurements.

The results are shown in Fig. 2. All values decrease if stimulus intensity increases approaching the asymptotical values. The behavior of average and SD is in accordance with previous findings (e.g., (2)): both the average and SD decrease when stimulus intensity increases. The coefficient of skewness is positive for all values of test intensity and

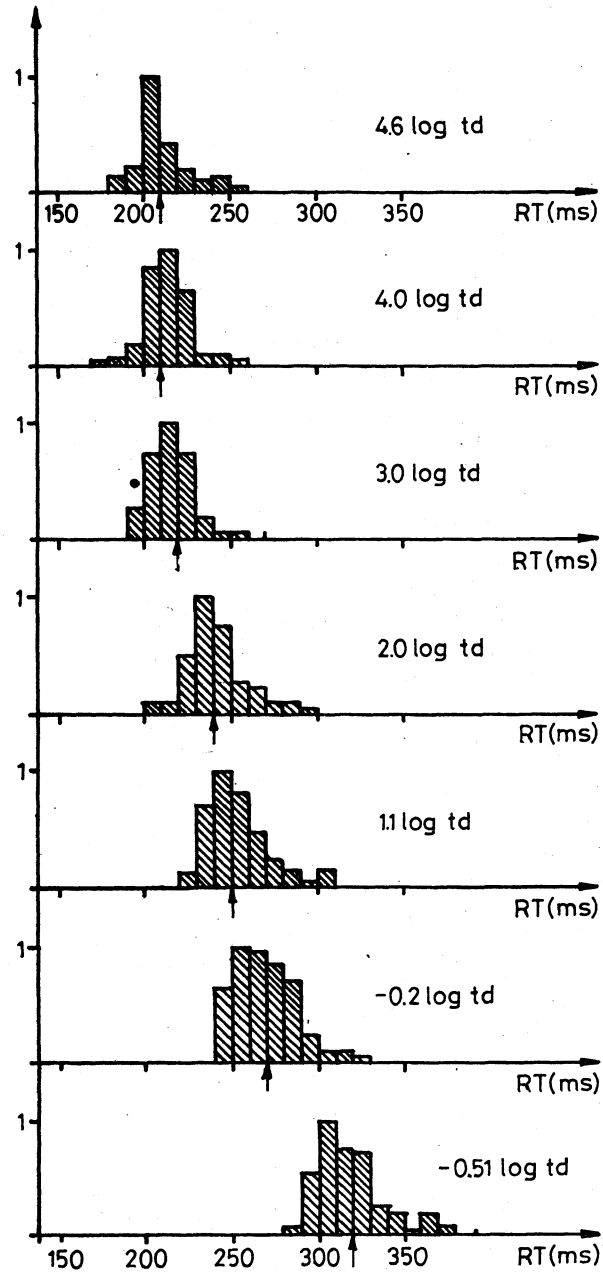

Fig. 1. The set of the histograms for PJ. The maximum of the distribution was normalised to 1. The arrows point to the arithmetical average of RT. In every histogram retinal illumination was specified. The frequency of occurrence is marked on the axis of ordinates. Abscissa, reaction time in ms.

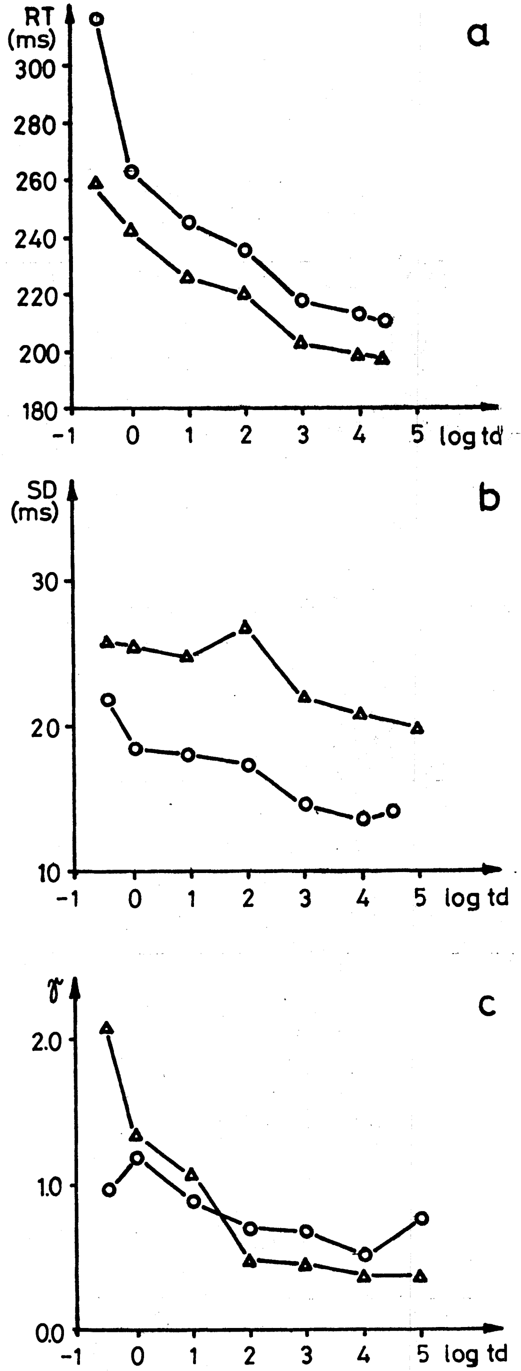

Fig. 2. Relationship between a, reaction time (RT); b, standard deviation (SD); c, coefficient of skewness (γ) and intensity of stimulus for both subjects (PJ, circles; EW, triangles). Abscissa, retinal illumination in log td.

for both subjects. Moreover, it is greater for low test intensities than for the high ones. This is very well seen for EW.

I cannot give any explanation for the fact that the distribution of reaction time measurements is asymmetrical but some indirect suggestions can be found in the literature. Lichtenstein and White (3) noticed that visual latency, measured by the perceived-order method, has symmetrical distribution. This method allows to determine the time, called the perception lag, which was considered to be a component of reaction time. If it is a fact that the distribution of the perception lag is symmetrical, then it means that a factor accounted for asymmetry of the reaction time measurements distribution must be linked with other components of reaction time, for example, with the process of taking the decision to press the key or the process of motor response. The increase of the coefficient of skewness must be searched for in decision processes. It is reasonable to assume that the time of taking the decision to press the key may be extended if the stimulus is hardly recognizable. In other words, some values of RT may be extended because of hindered decision taking. This causes the distribution of RT to be positively skewed; the easier and more frequently the process of decision taking is disturbed, the higher this type of asymmetry. In our laboratory futher investigations are prepared to verify the hypothesis outlined above.

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Erratum

In No. 2, Vol. 43, page 96 in the paper: "Facilitatory effects of electrical stimulation of the hippocampus on a one way active avoidance response in cats" by K. Gralewicz and S. Gralewicz, Fig. 2 was printed upside down in some copies. The Editors apologize for the error.