Biocybernetics and Biomedical Engineering
2012, Volume 32, Number 3, pp. 79–94

An Attempt to Speed-up the Examination of Saccadic Reaction Time

DAGMARA WITKOWSKA*, JAN OBER

Laboratory for Oculomotor Research, Department for Biophysical Measurements and Imaging, Nałęcz Institute of Biocybernetics and Biomedical Engineering, Polish Academy of Sciences, Warsaw, Poland

One of possible ways to speed-up the prosaccadic latency examination is applying the target walk paradigm. The authors describe the physiological phenomena involved in carrying such paradigms, which may affect latency time and which should be balanced in this kind of task. Thirteen subjects were examined applying the newly designed target-walk paradigm and for comparison the standard prosaccade task. A significant reduction of the saccadic latency ($p < 0.01$) was found on average by 21 ms, which probably resulted from an increased saccadic decision urgency forced by the new test design. Another reason can be different ways of capturing of the subject's attention achieved in this task.

K e y w o r d s: saccadic latency, standard prosaccade task, inhibition of saccadic return, directional asymmetry

1. Introduction

Every second our eyes make in average three saccadic movements. These are closely linked with attention processes, working memory, long-term memory, learning and decision making [1]. Studying different aspects of saccades control not only widens our knowledge about the underlying cognitive processes [1], but has proved to be useful in diagnosing some neurodegenerative diseases [1–3]. The fact that neither the observer nor the person being examined can influence dynamics of the saccadic responses, provides objectivity of the saccadic examination. Due to increasing interest of applying saccadic latency monitoring in clinical research and diagnosis, develop-

* Correspondence to: Dagmara Witkowska, Laboratory for Oculomotor Research, Department for Biophysical Measurements and Imaging, Nałęcz Institute of Biocybernetics and Biomedical Engineering, Polish Academy of Sciences, ul. Szeherezady 132, 60-195 Poznań, Poland, e-mail: dwitkowska@ibib.waw.pl
Received 07 September 2011; accepted 24 April 2012

ing a short and attention-catching examination procedure become very important. An example of its application in the field of medical diagnosis can be Huntington's disease (HD), which progression is accompanied by changes in saccadic latency distribution [3]. The increase of saccadic latency also occurs in patients with Alzheimer's disease and can be used as a reliable indicator of its progression [2]. Regular monitoring of saccadic latency can also help to define whether subject's ageing follows in the physiological course [4].

Due to natural high variability of the latency time, the reliable monitoring of its parameters requires analysis of high number of saccadic responses [5]. Programming of saccadic response involves the superior colliculus and other subcortical structures, which are responsible for target localization and saccade generation. The superior colliculus possesses its connection with the cortical area (the parietal cortex, the frontal regions) which receives impulses from V1 and other areas of the visual cortex [1]. Saccade generation is connected with processing of signals that carry information about position, luminance, size etc, and also the signals that depend on fulfilling current goals and the subject's intentions [1].

Signal conduction from the retina to the superior colliculus lasts about 40 ms. Conductions of muscles contraction command from the superior colliculus itself needs another 20 ms to reach the eye muscles [1, 6]. Meanwhile, the typical saccadic latency is around 200 ms and it changes from trial to trial. Carpenter claims that such additional delaying of the saccade is caused by the higher level response procrastination which reflects the necessity to evaluate if it is the target worth shifting the gaze to [7]. Duration of 10° saccade oscillates around 50 ms and increases with the saccade amplitude (2.2 ms per degree). During this time the vision mechanisms are suspended preventing the visual slip from being noticed. It means that the more saccades are generated, the less time remains for seeing [7]. This is an enough good reason for evaluating the potential advantage of performing each of the saccades. The system also takes into account constraints of attention resources available for reaching its current goals. Carpenter suggests the existence of an over-riding mechanism of attention directing that decides between competitive targets and prevents occurrence of the less important saccades [7]. He proposes a model of saccadic decision making (LATER- Linear Approach to Threshold with Ergodic Rate). It is associated with an increment of information available for particular responses. In the moment of target onset decision signal S starts from initial level S_0 and increases linearly with rate *"r"* until it reaches the decision threshold S_t. Reaching the threshold S_t causes the initiation of saccade to a target. The rate *"r"* varies from sample to sample about the average *"μ"* with variance *"σ^2"*. Variability of this rate exhibits characteristics of a normal distribution [6–11]. Saccadic latency, like other responses, is characterized by a skewness of distribution towards the responses with longer latencies. However, reciprocal values of saccadic latency are characterized by the normal distribution. After transformation the distribution to the cumulative and by proper axis scaling, the distribution of latency on the probability scale presented as the function of reciprocal