

SACCADOMETER

device for early diagnosis of central and peripheral nervous system

*Institute of Biocybernetics and Biomedical Engineering - Polish Academy of Sciences
Authors: Jan Ober, Jacek Dylak, Wojciech Gryniewicz, R.H.S. Carpenter (Cambridge University)*

Physiopathology of the saccadic refixation response

Saccadic refixation is the stepwise relocation of the gaze between two fixation points. This relocation needs to take the shortest possible time, to avoid prolonged blurring of the vision, caused by displacement of the image on the retina.

Saccadic movements are characterised by exceptionally high speeds. In scarcely 30 ms, the eye rotates through an angle of 10° , and this requires an extremely fast increase or decrease of the tension in the oculomotor muscles. The neural firing rate, stimulating the muscle contraction, can reach 900 impulses per second, whereas in skeletal muscles it typically this rate does not exceed 40. Such rapid changes in frequency demand a high bandwidth in the whole of the eye movement control system. Limitation of bandwidth in any of the components of the control system will be reflected in a change in the saccadic movement dynamics, long before it is revealed in disorder in other kinds of movement. Studying saccadic dynamics therefore has great potential importance for the early diagnosis in the central and peripheral neuromuscular system.

Applications: diagnosis of subtle disturbances in central nervous system caused by disease development, before the appearance of disturbances in the locomotor system, diagnosis of central nervous system hypoxia, monitoring brain oedema in force-contact sports (for example boxing, rugby, football).

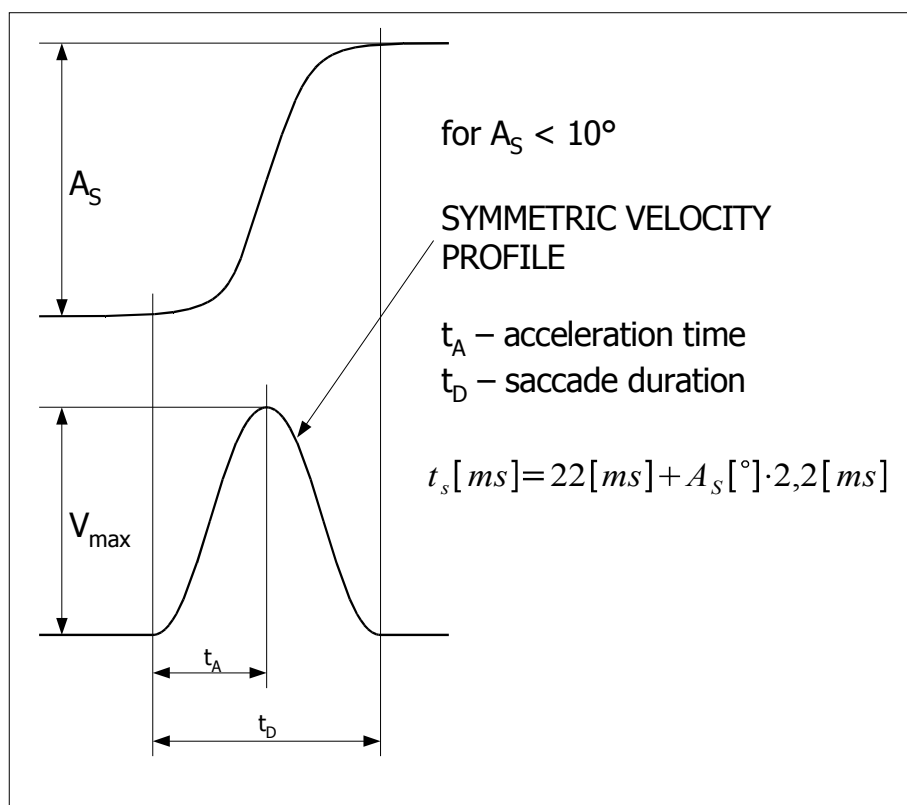


Fig 1. Saccade duration and its peak velocity measurement scheme

Saccadic refixation response parameters

Saccades are „**doubly hidden**” from observation by either physician or patient. For the physician, because of the low temporal sampling frequency of the observer’s visual system. For the patient, because during a saccade vision is completely blocked, so the patient is not aware of the visual consequences of slowing, through worsening of the neural image quality. The basic parameters of the saccadic movements are latency - the time lapse between stimulus and eye movement - and duration of the movement.

Latency (delay). Figure 2 shows the usual distribution of the saccadic response time following stepwise relocation of the fixation point. The delay, or reaction time, depends on a balance between a fast, semi-automatic, saccadic response and higher-level processes of procrastination. Super fast saccades can occur when the procrastination by higher parts of central nervous system is reduced. Conversely, delayed saccades can occur in lowered vigilance level or in cognitive disturbances (Alzheimer disease).

Duration of a saccade, a measure of its **dynamics**, is the most repeatable (stereotypical) parameter in the human motor system. Figure 3 shows the accumulated plot of eye movement in response to a step change of the fixation point position.

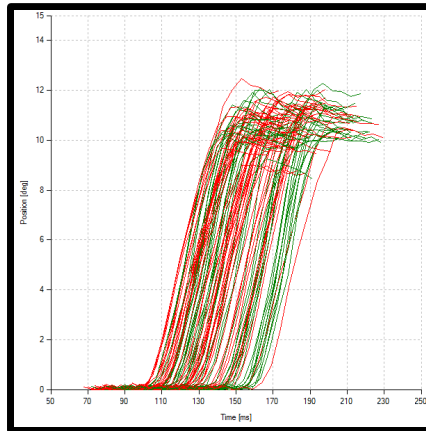


Fig. 2. Usual distribution of the saccadic latency, 100 saccades.

Mean latency - 128.9 ms

Standard deviation = 16.4 ms

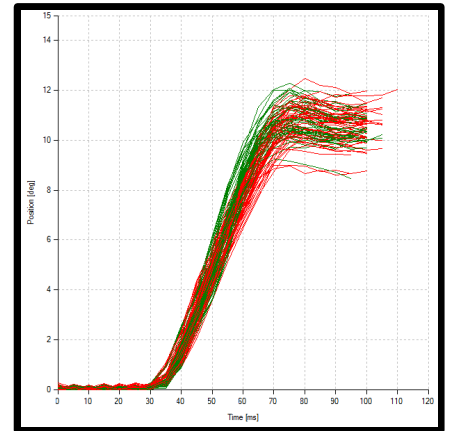


Fig. 3. Accumulated plot of eye movement in response to stepwise change of fixation point position

Mean duration - 50,7 ms

Standard deviation - 3,7 ms

Mean peak velocity - 398,2 °/s

Standard deviation - 54,4 °/s

A system for measuring saccadic refixation response

The Saccadometer system is the result of cooperation between Polish Academy of Sciences IBBE-PAS, Cambridge University, and Ober-Consulting Poland. It is an example of good cooperation between scientific and technical community, ending with a novel and technically advanced product.

The aim of the workgroup is to equip all general practitioners with the Saccadometer device. It should allow them to detect central nervous system disturbance at the most early, pre-symptomatic phase of disease development. It is expected that in the perspective of next few years the Saccadometer will become a diagnostic device comparable to the stethoscope.

The Saccadometer provides a complete laboratory for eye movement diagnostic, yet fits into the palm. It includes the possibility of individually modifying the diagnostic experiments. It also allows the immediate statistical analysis of the results of an examination and their presentation in a simple form that is clear for the physician and the patient.

Twelve of the current test version of the Saccadometer system have been manufactured, and they are currently being used in the leading medical institutes of Maastricht (Netherlands), Melbourne (Australia), Innsbruck (Austria), New York (USA), Karachi (Pakistan), Southampton, London and Cambridge (England) - and in 2007 also on the peak of the Mount Everest!

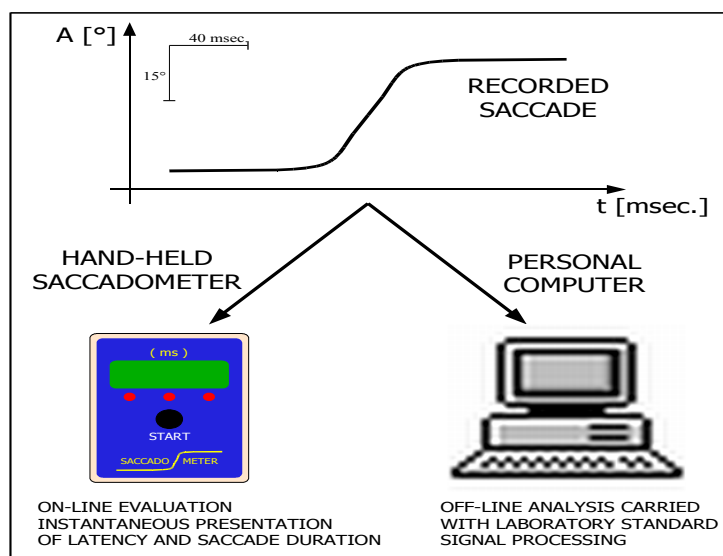


Fig. 4. Immediate verification of the results and advanced off-line diagnostic.

For further information please contact:

Ober Consulting Poland sp. z o.o., tel/fax: +48 61-8621-683
e-mail: janober@mareimbrium.org, website: www.ober-consulting.com