Eyelid movement in evaluating psychomotor performance.

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INTRODUCTION

Saccadic eye movement is an objective measure of the pharmacodynamic effects of psychotropic drugs on psychomotor performance (Glue, 1991). During saccades, eyelid movements show similar motion patterns and speed profiles, suggesting a common generator in the Central Nervous System (Becker and Fuchs, 1988). Blinking is also considered to be a marker of the integrity of CNS functioning (Manning and Evinger, 1986).

Eyelid movements may be subdivided into spontaneous, reflex and voluntary blinking, and eyelid movements which follow the saccadic movements of the eyes themselves.

Blinking, the opening and closing of the upper eyelid, is controlled by the elevator and orbicular muscles, and is also influenced by downward-directed passive tension due to the mechanical properties of the eye system (Kennard and Glaser, 1964).

Spontaneous blinking is not caused by external stimuli but by signals from the brain (average frequency 15 per minute).

Frequency increases in conditions of stress and immediately before demanding tasks, but decreases during periods of intense concentration (Gregory, 1990).

Reflex blinking may be evoked by noise, stimulation of the corneal mucosa, and electric stimulation of the supraorbital branch of the trigeminal nerve. The interaction of some substances with particular districts of the brain (nucleus of the trigeminal nerve, reticular matter, nuclei of the base, brain stem and cortex) may give rise to alterations of the latency and other characteristic parameters such as speed, duration and acceleration/deceleration of reflex blinking (Griffiths et al., 1984; van Stevenick et al., 1991; Ball et al., 1991).
Becker and Fuchs (1988) have shown that saccadic movements of the eyelids have the same activity profile already described for ocular saccadic movements, and therefore called them palpebral saccadic movements. Measurements of their duration, maximum speed, accuracy and acceleration/deceleration supply an index of the activity of the nervous structures generating them (Ball et al., 1991; Konrad, 1991).

The aim of this experimental study was to verify the suitability of the infrared technique used for measuring eyelid movements, tested in conditions in which sedative effects were induced by drugs. The study included both traditional control and comparative psychometric tests.

MATERIALS AND METHODS

Drugs and placebo were administered according to a single-dose, double-blind, balanced, three-way, cross-over design. Treatments were separated by a wash-out period of one week.

Twenty-one healthy volunteers, fifteen male and six female, aged 20-38 years (mean 27, sd=5.18) were recruited as subjects. All gave their informed written consent to the experiment, and agreed to refrain from taking any form of medication, except oral contraceptives, during the period of participation in the study.

Placebo and drugs were administered with fruit juice. The three experimental treatments were: placebo, lorazepam 0.007 mg/Kg, and lorazepam 0.036 mg/Kg, all administered in a 20-mL solution.

The following devices for studying blinking and saccadic movements were used: infrared detector (United Detector Technology SC-50); amplifier (Tektronik AM502); function generator (Tektronik AM501); recorder (Kyowa RTP 501); oscilloscope (Hameg 1007); board (IEEE 488); PC for programmable visual stimuli; PC for signal processing and statistical analysis.

Eyelid position was recorded by an infrared detector receiving a signal from a miniature light emitting diode (LED) placed at the center of the upper eyelid. Subjects were examined seated, with their chins resting on a support 60 cm from a monitor presenting a luminous dot as target. The movement detector, located laterally, recorded eyelid movements which were amplified, sent to the oscilloscope, digitalized, recorded, and later processed by specially created software. Spontaneous blinking and saccadic movements were studied. The following parameters were obtained from eyelid position measurements: maximum velocity and acceleration of upward and downward eyelid movement; duration and amplitude of movement; overshoot and undershoot.
The other psychomotor tests: Critical Fusion Frequency (CFF) (Rey and Rey, 1964); Critical Tracking Test (CTT) (Jex and McDonnell, 1966) and Choice Reaction Time task (CRT) (Sternberg, 1969) were computer-controlled employing either an Olivetti M300 or a Macintosh Classic II personal computer.

Tests were performed 1, 2, 4 and 7 hours after drug (or placebo) intake.

RESULTS AND CONCLUSIONS

The technique adopted here turned out to be suitable for recording eyelid movements and calculating the trend of the derivates speed and acceleration. Figure 1 gives an example of the track from a spontaneous blink in a subject at baseline (before drug intake).

Preliminary analysis of these tracks, as regards both saccadic movements and spontaneous blinks, showed slackening of speed and acceleration after intake of the sedative. Figures 2 and 3 show two typical tracks of saccadic movements in the same subject, before and 2 hours after intake of the higher dosage of lorazepam.

Although complete evaluation of the study is still under way, preliminary results indicate that the higher dose of lorazepam impairs most of the variables investigated, both on traditional psychometric tests (CFF, CTT, CRT) and on eyelid movements. The technique may therefore be considered as a potential new evaluating tool of the pharmacodynamic effects of psychotropic drugs on psychomotor performance.

The advantage of this type of examination over traditional tests lies in its greater objectivity, since it is not conditioned by learning processes or emotional factors. Once they have been initiated, palpebral movements are not under voluntary control and therefore can be neither slowed down nor accelerated. Variations in the parameters thus supply an index of the effect of psychoactive drugs on central nervous structures, with minimum cognitive interference.

REFERENCES


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