Mental effect of electronic blue light on eye saccadic movement by using observation EOG Activity test

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Abstract:

PURPOSE. The purpose of the research is to determine the EOG test as a diagnostic method for young participants, mental behavior is based on the movement of the horizontal saccs and to determine if blue light can be a cause of psychological change. METHODS. Ten participants ages of 21 years of the same health conditions undergoes with horizontal EOG saccade test in response to retina photic stimulation. Eye movements were recorded by use data acquisition instrument, sampling at 0.3-35 Hz. Analyze of the saccadic latency, peak velocity, duration, and amplitude after measurement competed. RESULTS. Mean saccadic latency was show significant differences value 0.004 (p<0.05) during first fixation on first right movement when compare with control, and same differences occur in latency, peak velocity and duration 0.04, 0.01, and 0.034 respectively in right blink. The notable change during left movement due to increase amplitude accuracy to be 0.013 (p<0.05) and the significant value continuous with differences in duration value 0.004 (p<0.05). CONCLUSIONS. Blue light for electronic devices influenced by saccadic latency, velocity, duration and amplitude. Each parameter has a different pattern of development and regression that probably relates to the way the part of the brain that controls each function develops, which is why we can rely on this technique to diagnose some mental imbalance due to the effects of blue light.

Introduction:

People nowadays are exposed to blue light specially during COVID-19 pandemic through electronic devices and thus it is indispensable to recognize the exposure dosage of blue-light effect on human eye physiology. (1), and It has been shown to delay our sleep time at night and affect our circadian rhythms and disruption, anxiety, stress, stigma, and xenophobia as well as psychological changes have been documented on mood changes. (2,3,4)

Basis of these disorders have also been studied, one of them is eye movement characteristics in subjects with explore of the neurobiological. (5)
One of the most useful types of eye movements are saccades in the evaluation of the movement disorders patient. (6)

For recording eye movements, electroculorgram (EOG) has been frequently used in patients because of its simplicity. This method has been useful for the diagnosis of neurological disorders and has provided helpful information about the pathophysiology causes (7,8)

Eye movements consists of two types of discharge a phasic (eye velocity command) and a tonic (eye position command). During saccades, the eye velocity command It consists of a high-frequency irritant pulse that rapidly moves the eyes against the forces of orbital viscosity. (9)

Electroencephalography can remain a highly applicable clinical method which can be widely applied to neuropathic patients, especially for recording tremor in the horizontal direction. (10)

The EOG saccades consists of a unidirectional excessive coordination (hypersymmetry) of the horizontal stirrups, with this extravagant in the opposite direction, and a deviation of the vertical sweepers toward the side of the hypermetria. (11)

The static EOG recording method, using a wide-verge electrode to allow for broad and stable contact with the skin, is as accurate as other techniques for saccade recording in neuropathic patients and may be more suitable for rapid recording in normal subjects. (12,13)

The EOG measurement depend on electrical features of the human eye. The corneo-retinal potential, 0.4 – 1.0 mV, is present between the front (cornea) and back (retina) of the eye. (14)

Neurological examination of the eye and recordings of eye movement may be useful in detecting early signs of drug-induced movement disorders. (15)

It is vague as of now to find the relation between blue light effects on behavior depend on saccadic eye movements (16), which is our goal in this study.

**Materials and Method:**
According to a survey for students in pharmacy college in Basra university after electronic study during COVID-19 pandemic, the 10 students with 21 years old and healthy conditions were demonstrating the type of electrical activity that occurs in the eye muscles while reading the subject by using observation Electrooculogram Activity (EOG) frequency 0.3-35Hz (IWork IWX/214 system and LabScribe software-USA). (17)

The subject must avoid any voluntary movements of head or body during the recording while sitting on a chair with straight back. Only the patient eyes be moving while reading according to saccades procedure. After clean and scrub the area with alcohol swab, the electrodes will be placed. Cut off the electrodes, then removed the plastic disc and apply it to one of the cleaning areas. Install the recording lead wires into the electrodes, so that the red wire (+1) is on the electrode next to the left eye. The black wire (-1) is on the electrode next to the right eye. The green wire (c) (ground) is on the electrode under the right ear. Drape the connecting wires for the electrodes on the person's shoulders to the base of the wire, which hangs freely under the person's back and over the chair. There should be no tension on the electrodes (figure 1).

![Figure 1: show placement of electrodes for recording an electrooculogram (EOG). A: top view, B: right side view.](image)

Selected paragraph from 10 lines long were subjected to read during EOG is recorded. The paragraph should. As you will find out, the number of words in each line, the length of each line, and the formatting of the paragraph will affect the shape of the EOG recording, then the charts are analyzing according to Figure 2 details.

The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of groups and patients depend on chart parameters.
Results:

In examining the saccades of students, we focused particularly on the relationship between latency, peak velocity, duration, and amplitude (17), as shown in Figure (2).

![Figure 2: show saccades parameters analysis according to latency, duration, peak velocity and amplitude](image)

A one-way ANOVA test was conducted to discover whether there were significant differences in the eye saccades test for first right movement as shown in Table (1).

**Table (1): One-way ANOVA test for first right side movement for eye**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency / Sec.</td>
<td>1.3691</td>
<td>0.65486</td>
<td>4.375</td>
<td>0.004</td>
</tr>
<tr>
<td>Peak velocity/mV</td>
<td>0.1885</td>
<td>0.12704</td>
<td>1.332</td>
<td>0.290</td>
</tr>
<tr>
<td>Duration/Sec.</td>
<td>0.2930</td>
<td>0.09965</td>
<td>1.937</td>
<td>0.116</td>
</tr>
<tr>
<td>Amplitude/Sec.</td>
<td>0.2355</td>
<td>0.11457</td>
<td>2.003</td>
<td>0.105</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.
Table (1) clarify the significant differences in latency reading for all selective patients when the eye start fixation movement on the right side, the F value was 4.375 with significant value 0.004 (P value <0.05). On the other hand, it does not appear any significant differences in velocity, duration and amplitude.

During test record for the second eye movement, the results of right blink were more significant than first right record as shown in table (2).

### Table (2): One-way ANOVA test for right side blink movement for eye

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency / Sec.</td>
<td>1.1113</td>
<td>0.63984</td>
<td>4.374</td>
<td>0.004</td>
</tr>
<tr>
<td>Peak velocity/mV</td>
<td>0.1290</td>
<td>0.08335</td>
<td>5.460</td>
<td>0.001</td>
</tr>
<tr>
<td>Duration/Sec.</td>
<td>0.2317</td>
<td>0.12565</td>
<td>2.792</td>
<td>0.034</td>
</tr>
<tr>
<td>Amplitude/Sec.</td>
<td>0.2102</td>
<td>0.17218</td>
<td>1.312</td>
<td>0.299</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

Table (2) shows accurately the significant differences in latency, peak velocity and duration readings for all selective patients during the right blink movement on the right side, the F value were 4.374, 5.460, and 2.792 with significant value 0.004, 0.001, and 0.034 respectively (P value <0.05), but it does not appear any significant differences in amplitude.

While in table (3) the results articulate the significant value (p value <0.05) in all parameters except in duration when compare it with first right side movement and the value were 0.002, 0.009, and 0.013 for latency, peak velocity and amplitude.

### Table (3): One-way ANOVA test for first left side movement for eye

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency / Sec.</td>
<td>1.2802</td>
<td>0.64144</td>
<td>4.924</td>
<td>0.002</td>
</tr>
<tr>
<td>Peak velocity/mV</td>
<td>0.1718</td>
<td>0.08358</td>
<td>3.785</td>
<td>0.009</td>
</tr>
<tr>
<td>Duration/Sec.</td>
<td>0.2634</td>
<td>0.07873</td>
<td>2.445</td>
<td>0.055</td>
</tr>
<tr>
<td>Amplitude/Sec.</td>
<td>0.1983</td>
<td>0.06418</td>
<td>3.527</td>
<td>0.013</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.
Intelligible outcome can be notice in table (4) for significant differences in duration; 0.044, and amplitude; 0.002 values (P value < 0.05).

**Table (4): One-way ANOVA test for left side blink movement for eye**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency / Sec.</td>
<td>1.0274</td>
<td>0.82539</td>
<td>1.740</td>
<td>0.157</td>
</tr>
<tr>
<td>Peak velocity/mV</td>
<td>0.1272</td>
<td>0.15637</td>
<td>1.275</td>
<td>0.315</td>
</tr>
<tr>
<td>Duration/Sec.</td>
<td>0.1759</td>
<td>0.13422</td>
<td>2.594</td>
<td>0.044</td>
</tr>
<tr>
<td>Amplitude/Sec.</td>
<td>0.1368</td>
<td>0.10648</td>
<td>4.922</td>
<td>0.002</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

**Discussion:**

Saccades are fast eye movements between fixations. During a saccade both eyes have the same amplitude and direction during normal viewing. (18). The eyeball is relatively light and mobile, and therefore the metabolic cost of frequent and fast movements is low (19).

Saccadic latency is phenomena that capture our attention and depend on time between the stimulus onset and the start of the saccadic eye movement. (20,21). The interference between the fixation point and target stimulus increases the latency to 220 ms (22), according to results there were a significate difference in mean of latency which give indicate for sleep deprivation and varies with circadian rhythm. (23), this overlap between latency and peak velocity clarifies the disengagement of attention was not a result of decreased alertness as for impairment of the orienting attentional system or could be explained with failures of sustained attention (24).

The eye accelerates to its peak velocity, after which the movement decelerates until the movement stops and the eye fixates again the peak velocity of the saccade is reached at the point of the maximum firing rate of the burst neurons. (25)

The duration and the peak velocity of the saccades depend on the saccade amplitude; this relation is called “main sequence”. (26). Peak velocity during blinking rate is lower during reading than in rest (27), additionally the blink amplitude and peak velocity of the eye closure decreases (28) and its sensitive to sleepiness and suitable like driver’s sleepiness (29). However, peak velocity depends on the saccade amplitude and simulate real-life situations and the
changes in saccade parameters (peak velocity, amplitude, and duration) can be the result of in viewing strategy, and sleepiness related deceleration (30).

Short latency due to the effect of exposure to blue light on eye movements and intentional disengagement, and can enhance the speed of eye movements. (16)

However, the exposition to long blue-enriched polychromatic light Affects symmetric sleep regulation, through the first non-rapid eye movement episode (31).

Saccadic eye movement changes appear to have a role in psychiatric disturbances and may be considered a potential marker of some disorders and may help to pursue a complex therapeutic course. (32)

Asymmetric saccades may be hyperasymmetric 'a sign of cortical cerebellar or deep nucleus involvement' or underdevelopment 'a sign of cortical, basal ganglia or cerebellar damage'. Hypermetria Saccadic reflections to multimetric saccades, which occur in some normal subjects after fatigue, aging, hemispheric damage, and cortical lesions. (11, 33)

**CONCLUSIONS and RECOMONDITION.**

The effect of blue light of electronic devices on slow latency, maximum speed, duration, and amplitude. Each parameter has a different pattern of evolution and regression that may relate to the way the part of the brain that controls each function and which controls each function develops, so we can rely on this technique to diagnose some mental disorders due to the effects of blue light and exposure time because this method depends on reading or direct observation, and thus it allows the possibility of analysis and diagnosis in a short period to show mental states and give a future result for cases of loss of balance, nervousness, dizziness and others.
APPENDIX:

Figure 3: show EOG horizontal graph for participate with amplitude/mV and time/sec.
References:


24. B. Wachowicz et al., (2015).“Different types of errors in saccadic task are sensitive to either time of day or chronic sleep restriction,” PLOS ONE, vol. 10, no. 5, p. e0126502.


