Viewing distance and eyestrain symptoms with prolonged viewing of smartphones

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1. Introduction

A smartphone is a handheld computer which allows the user to make telephone calls, access the Internet and email, store data and play computer games. Bababekova et al (Bababekova, Rosenfield, Hue, & Huang, 2011) report that smartphone users 'normally' hold the device at a close viewing distance (mean = 36.2cm for reading text messages and 32.2cm for Internet viewing). This is a closer viewing distance than that typically used for viewing desktop, laptop and tablet computers (Long, Rosenfield, Helland, & Anshel, 2014). Although smartphones are usually used for brief periods, there is evidence that some people may use their phone for more than one hour at a time (Falaki et al., 2010). This increases the visual demands while using the device and may lead to visual discomfort.

The purpose of this paper is to investigate:

1. Whether using a smartphone for 60 minutes is associated with an increase in eyestrain symptoms.
2. The viewing distance adopted by subjects during a 60 minute viewing period.
3. If there is a relationship between eyestrain symptoms and change in viewing distance.

The outcome measures (dependent variables) are a change in eyestrain score and a change in viewing distance after using a smartphone for 60 minutes. The fixed independent variable is time spent viewing the smartphone.

2. Methods

This study included four phases: visual function screening, a pre-experiment symptom survey, one hour reading from a smartphone (referred to as "the experimental procedure") and a post-experiment symptom survey.

The inclusion criteria were:

- Age 18-40 years, experience using a smartphone, self-reported good health, no history of eye surgery, eye trauma or eye injuries, no self-reported back or neck pain when using a smartphone.
- Absence of gross accommodative dysfunction and binocular vision disorders.
- A score < 21 on the Convergence Insufficiency Symptom Survey (CISS). The CISS was administered to identify potential participants highly symptomatic of eyestrain or with a lack of concentration when reading.(Borsting et al., 2003)

The pre- and post- experiment symptom survey included seven questions related to common eyestrain symptoms. The questions used common descriptors given by patients for eyestrain, and corresponded to symptoms associated with close viewing distances (Sheedy, Hayes, & Engle, 2003).

Subjects were seated and were instructed to hold the smartphone "where they would normally hold it" and read an extract from a recently published novel. The English text was embedded with 280 Dutch words spaced approximately one screen page apart. Subjects were asked to read any embedded foreign words aloud when seen. These words were marked off a pre-prepared list of Dutch words by the experimenters as a way of monitoring the subject's attention and indirectly, their fixation.

Subjects wore a headband with a scale, which was used as a reference for calculating the viewing distances of the subject's eyes to the smartphone. A photograph was taken of their posture every one minute.

The Wilcoxon Signed Rank Test (W) was used to analyse changes in viewing distance and in pre- and post- symptom scores.

A Spearman's correlation coefficient (ρ) was calculated to analyse any relationship between subjects' viewing distance and symptom survey score.

3. Results

Data from 18 subjects (12 male, mean age = 21.5 +/-3.3 years) were included for analysis. The mean viewing distance over 60 minutes was 29.2 cm (SD = 7.3). The mean viewing distance during the first 10 minutes of the experiment (30.6 cm, SD = 7.3cm) was significantly greater than during the last 10 minutes of the experiment (27.8 cm, SD = 7.7cm) ($W = 35$; $p = 0.028$).

The mean symptom score was significantly greater post-experiment (score = 8.06) than pre-experiment (score = 3.56) ($W = 3.5$; $p<0.001$).

A significant correlation existed between the change in symptom score and the change in viewing distance; that is, subjects who decreased their working distance more over 60 minutes demonstrated a larger increase in symptoms ($\rho = -0.508$, $p = 0.031$).

4. Discussion

The results show that eyestrain symptoms are greater and the viewing distances closer at the end of the 60 minute reading period. The average viewing distance for the first 10 minute reading period (30.6cm) was shorter than that reported by Bababevoka et al (Bababekova, et al., 2011), and even shorter during the final 10 minutes of the reading period. Therefore Bababekova's estimates are likely to be an overestimate of the viewing distances adopted for handheld smartphones.

The results of this study indicate that users should consider reducing their viewing time when using a smart phone or using an alternative device which allows larger size font and hence longer viewing distances.

Smartphones of the future may have greater functional capacities and more diverse uses. The implications of short and long-term use are important for developing user guidelines, especially for a general population where individuals may have underlying uncorrected binocular vision disorders.

Smartphone designers should also take into account the length of time people spend using these devices and incorporate features that will reduce the risk of eyestrain symptoms.

References

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