One hour of smartphone use induces ocular discomfort and reduces blinking in children

Ngozi C. Chidi-Egboka, Isabelle Jalbert, Blanka Golebiowski

School of Optometry and Vision Science, UNSW Sydney

Purpose

- Smartphone use by children is increasing rapidly, but the ocular impacts are unknown
- 83% of US children aged 15 years and 68% of Australian children aged 3–17 years own a smartphone [1,2]
- Daily screen time in children aged 5-7 years exceed WHO guidelines of 2 hours per day by more than 100% [3]
- Amount of Screen time in children exacerbated by COVID-19 pandemic, at-home education [4] and push to close digital divide and connect all students (K-12) in the US [5]
- Eye symptoms and visual discomfort (eyestrain, sore eyes and dry eye) have been reported following 1-hour smartphone use [6]; linked to poor blinking [7, 8] in adults

This study examined the effect of 1 hour of smartphone use on symptoms, tear film and blinking in children

Methods

- Prospective, single-visit intervention study
- 45 children with healthy eyes, (10.1 ± 2.6 yo, range 6-15 yo; 20M:25F), non-CL wearers, participated
- Children continuously played games [9, 10] on a smartphone for 1 hour
- Symptoms Assessment in Dry Eye (SANDE) [11], Instant Ocular Symptoms Survey (IOSS) [12], Numerical Rating Scale (NRS) [13], lipid layer thickness (LLT), tear meniscus height (TMH), and non-invasive tear break-up time (NIBUT) obtained before and after smartphone use
- Habitual *in situ* blink assessment (10 min baseline and 1-hour smartphone use) using wearable eye-tracking headset [14]

The wearable eye-tracking headset:

- monitors task compliance and captures all eye movements (Figure 1 and 2)
- displays each detected blink on a timeline (Figure 3) - ***Blink rate*** (blink frequency) and ***Interblink interval*** (time between the end of one blink to the start of another blink)
- improves detected blink quality post hoc [14]
- provides blink data instantly in excel csv files

Statistical Analysis

- Mean differences in symptoms and tear film variables at baseline and 1-hour smartphone use (Paired t-test)
- Blink rate and interblink interval compared between baseline and at 10 min intervals during smartphone use (Repeated measures ANOVA)
- Associations between outcome measures examined (Pearson bivariate correlation)

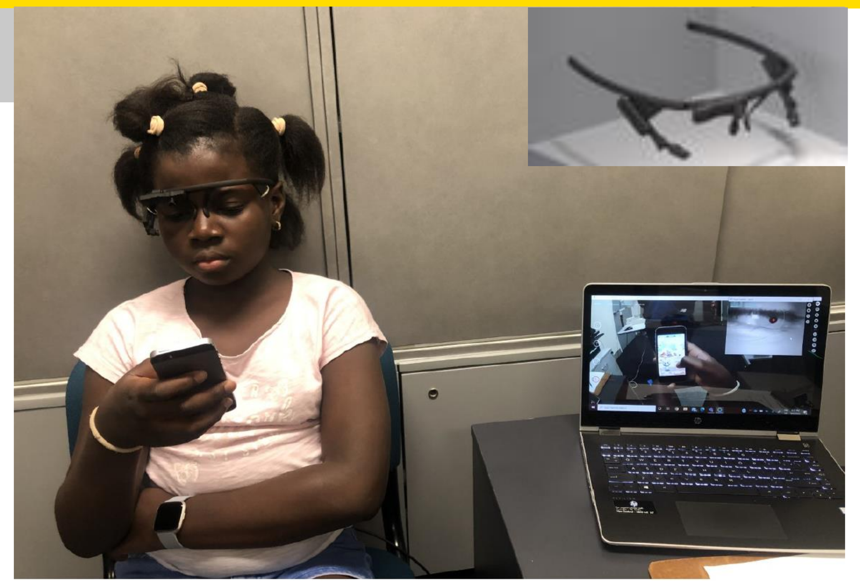


Figure 1. *The wearable eye-tracking headset display in use*

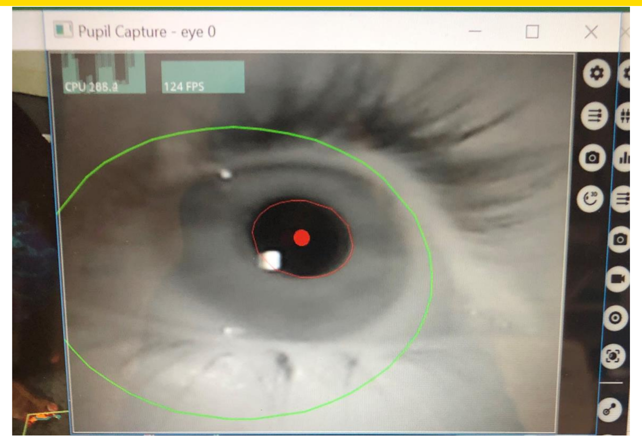


Figure 2. *The eye camera display of the wearable eye-tracking headset during video recording*

Figure 3. *Wearable eye-tracking headset player timeline example of blink rate and interblink interval detection for a 13-second recording of the right eye only, showing 8 blinks (plotted in green, with pink line above and below), interval between blinks (plotted as pink straight line below; bottom). The post-hoc predetermined blink detection onset and offset thresholds are shown in yellow lines (middle)*

Results

- Symptoms increased significantly following 1-hour smartphone use (Figures 4 and 5)
- Tear film remained unchanged with 1-hour smartphone use ($p > 0.05$) (Figure 6)
- Significantly reduced blink rate and extended interblink interval within 10min of smartphone use (Figure 7 and 8) and remained unchanged throughout 1 hour of smartphone use
- No significant associations between changes in blink rate, interblink interval and symptoms ($p>0.05$)

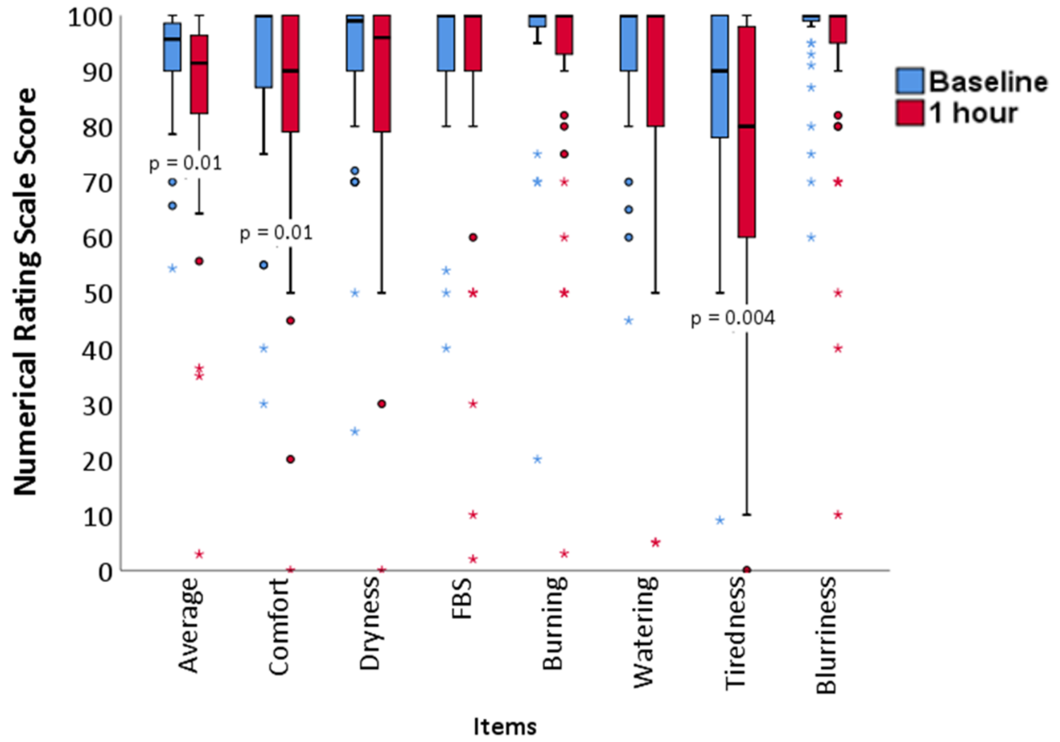


Figure 4. *Numerical Rating Scale (NRS) overall average score and each item score. Lower symptoms score indicates worse discomfort and vice versa. Red and blue circles/stars represent mild/extreme outliers. Extreme outliers were retained in this plot as the numbers are within the plausible symptom values of NRS scale. FBS denotes Foreign body sensation*

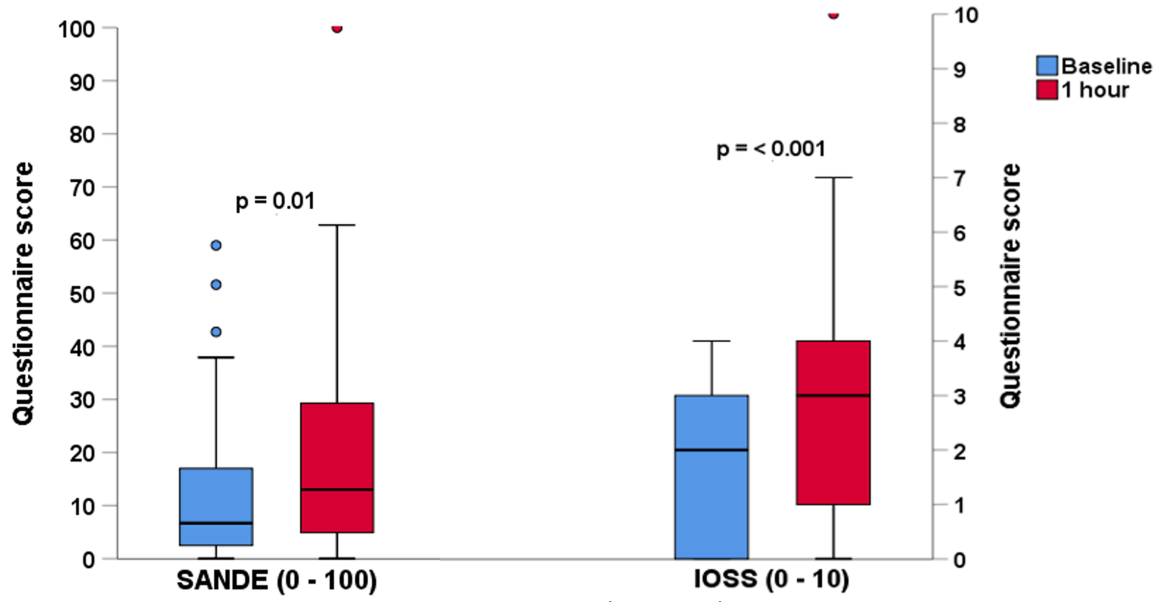
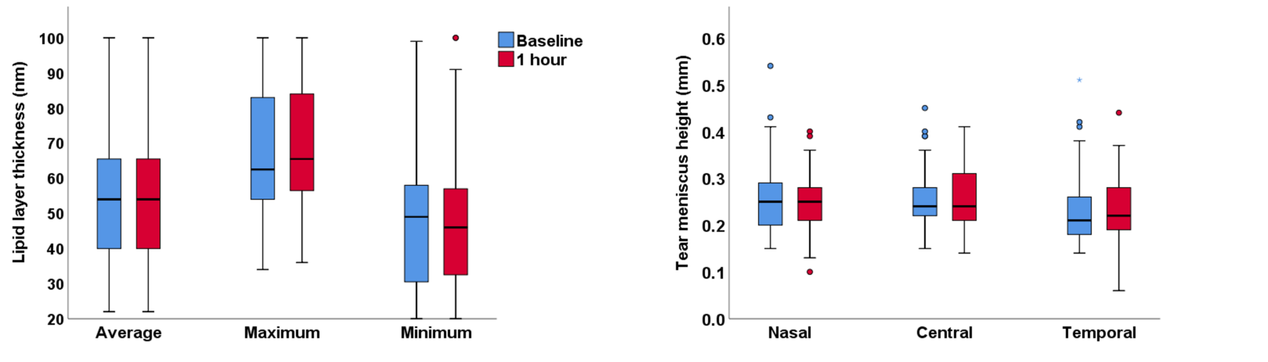


Figure 5. *Symptoms Assessment in Dry Eye (SANDE) and Instant Ocular Symptoms Survey (IOSS) scores (median and IQR) at baseline and after 1-hour smartphone use. Higher symptoms scores indicate worse discomfort and vice versa*



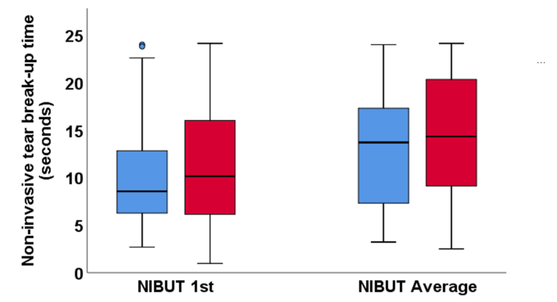


Figure 6. *LLT avg, max and min; TMH nasal, central and temporal and NIBUT 1st and avg break (ALL median and IQR), at baseline and after 1-hour smartphone use. No significant differences detected. Red and blue dots represent mild outliers*

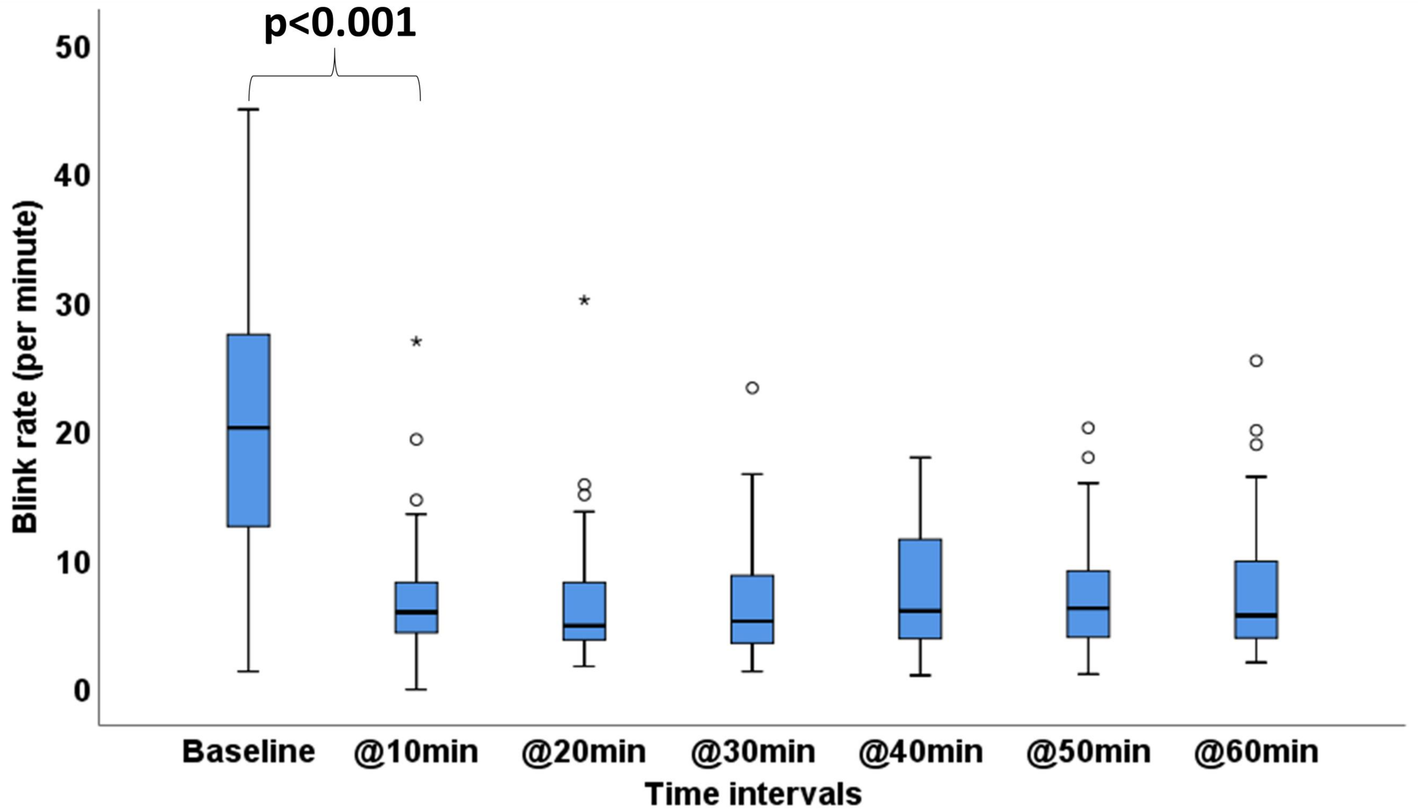


Figure 7. Blink rate/minute (median and IQR) at baseline and during 1-hour smartphone use. Dots/stars represent mild/extreme outliers

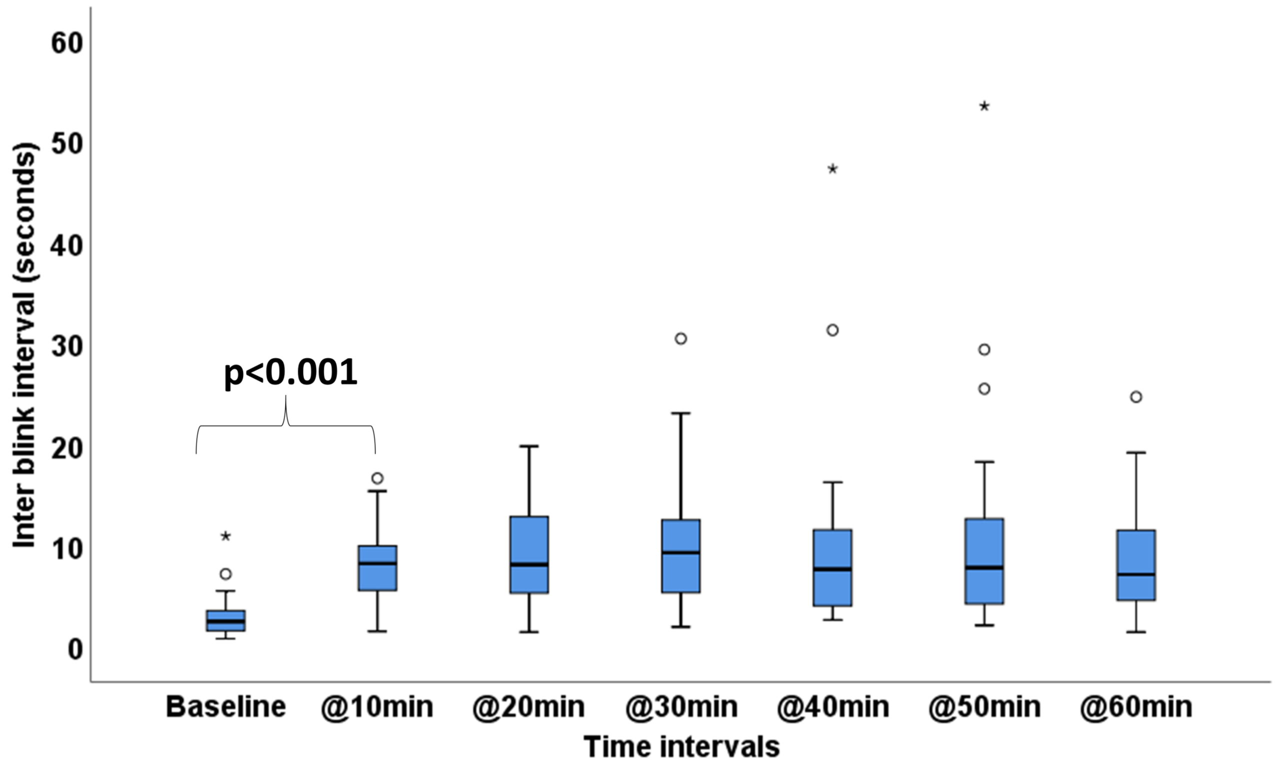


Figure 8. *Interblink interval in seconds (median and IQR) at baseline and during 1-hour smartphone use. Dots/stars represent mild/extreme outliers*

Discussion

- Ocular surface symptoms, clinical signs and blinking with smartphone use were examined in one experiment for the first time in children
- Increase in symptoms of ocular discomfort, tiredness, and dryness after 1-hour of smartphone use and no change in tear function consistent with earlier findings in adults [6-8]
- A change in clinical signs (NIBUT) with symptoms was previously reported with extended smartphone screen view (up to 4 hours) in adults [15]
- Reduced blink rate within 10min smartphone use in this study contrasts with increased blink rate within 6min of reading from a Tablet in adults [16]
- Reduced blink rate throughout 1-hour smartphone use found in this study aligns with previous reports in adults [6, 8]
- Reduced blink rate and extended interblink interval enables imbalance of the ocular surface homeostasis, thus causing increased ocular surface discomfort [17]
- Future research may build on the findings of the current study to conduct longitudinal studies on the effects of prolonged and/or repeated use of smartphone on children

Conclusions

- Blinking in children can be successfully assessed *in situ* using a wearable eye tracking device
- Smartphone use quickly resulted in dry eye symptoms, slowed the blink rate to one-third, with much longer open eye periods between blinks
- In the short-term, changes in ocular symptoms and blinking were not accompanied by disturbances to the tear film

References

1.Telstra. Kids' smartphone usage rampant. 2015. p. www.smh.com.au
2. Rideout VJ, Robb MB. The common sense census: Media use by tweens and teens; Common Sense Media; 2019
3. Straker et al. Conflicting Guidelines on Young Children's Screen Time and Use of DigitalTechnology Create Policy and Practice Dilemmas. *J Pediatr.* 2018;202:300-3
4.The conversation, 2020 www.theconversation.com/forget-old-screen-time-rules-during-coronavirus-heres-what-you-should-focus-on-instead-1350537
5. Fazlullah A. Huge Win to Connect Kids and Teachers at Home. Common sense media.2001 www.commonsensemedia.org/kids-action/blog/huge-win-to-connect-kids-and-teachers-at-home
6. Jaiswal et al. Ocular and visual discomfort associated with smartphones, tablets andcomputers: what we do and do not know. Clin & Exp Opt. 2019;102:463-77
7. Golebiowski et al. Smartphone use and effects on tear film, blinking and binocularvision. *Curr eye res*. 2020;45:428-34
8. Park et al. Influence of Cellular Phone Videos and Games on Dry Eye Syndrome in UniversityStudents. *J Korean Acad Community Health Nurs.* 2014;25:12-23
9. Despicable Me: Minion Rush - Google Play Trailer 2017
10. Race Penguin.2015
11. Schaumberg et al. Development and Validation of a Short Global Dry EyeSymptom Index. *Ocul Surf*. 2007;5:50-7
12. Boga et al. Daily fluctuations in ocular surface symptoms during the normal menstrual cycle andwith the use of oral contraceptives. *Ocul surf* 2019;17:763-70
13. Papas et al. Estimating a just-noticeable difference for ocular comfort in contact lens wearers. *IOVS* 2011;52:4390-4
14. PupilLabs. Pupil Core. https://docs.pupil-labs.com/core/#_1-put-on-pupil-core Assessed 13 July 2020
15. Choi et al. The influences of smartphone use on the status of the tear film and ocularsurface. *PloS one* 2018;13:e0206541
16. Benedetto et al. E-readers and visual fatigue. *PLoS One* 2013;8(12):e83676
17. Belmonte et al. TFOS DEWS II pain and sensation report. *Ocul surf*. 2017;15:404-37.

Disclosures: None Contact: Ngozi Chidi-Egboka | Email: n.chidi-egboka@unsw.edu.au