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Comparison of viewing distance between tablet and paper text in accommodative reserve measurement in presbyopes

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Summary. — The use of digital devices is increasing and widespread, especially among presbyopic subjects. This study investigated how the viewing distance of a paper text and a text contained in a tablet changes and how the use of these two different devices affects accommodative reserve in presbyopes. Indeed, the difference in brightness between a paper text and a text presented on a digital device could affect the measurement of accommodative reserve in presbyopes. The results showed that there were no statistical and clinical differences in the presentation of the two tests. The type of stimulus (paper *vs.* digital) would not seem to affect accommodative reserve in presbyopic subjects.

1. – Introduction

Nowadays, the use of portable devices is becoming increasingly common for all life activities. The use of digital devices has also become widespread in the older population, *i.e.*, those over 50 years of age. Indeed, aging presbyopic subjects suffer from progressive difficulty due to a reduction in the amplitude of accommodation [1]. The use of electronic devices compared with a paper text would not appear to significantly affect the accommodative response during proximal activity. On the other hand, in the optometric practice, the detection of accommodative amplitude, useful for detecting visual correction in presbyopes, is generally performed with paper tests. To date, there are only a few studies in the literature investigating focus distance differences in presbyopes using digital near tests. The purpose of our study was then to test whether and how accommodative reserve changes in presbyopic subjects by comparing reading a text on a digital device and on a paper support.

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2. – Methods

Participants were selected according to the following inclusion criteria: explicit consent, age exceeding 45 years, no eye disease, and not having undergone eye surgery. The study was conducted in accordance with the principles of the Declaration of Helsinki. Seventeen subjects were enrolled; thirteen of these participated in the study, while four were excluded due to ocular trauma, pathology and ineligible age. Those who agreed to participate signed a declaration in which they agree to the treatment of their personal information. The sample (7 women), with a mean age of 54.9 ± 4.2 years, had a best corrected visual acuity range (BCVA) from 0 to -0.20 logMar, a visual errors range that ranged from -7.50 D to $+2.75$ D and an addition for near sight with a range $+1.25$ D to $+2.50$ D. A tablet (iPad 2), a paper text created by the researchers and the phoropter cue needed to measure the distance were used for the study.

2·1. *Brightness measurements*. – The first step in our investigation consisted in assessing the brightness conditions of the tablet and selecting the working conditions for the optometric exams. For this purpose, following the cleaning of the tablet screen, a white page was set by deriving the HTLM code of the color used (white #fff). Optical power measurements were made by means of a power meter (Ophir model Starlite) under various illumination conditions: since the collection geometry is fixed, this power is proportional to the luminosity, hence related to the perceived brightness. The background level was measured with the ambient light off, yielding readings from a minimum of $0.18\,\mu$W to a maximum of $0.19\,\mu$W. Five different position were inspected on the tablet screen: at 5 cm, 7 cm, 12 cm, 17 cm and 19 cm with respect to the position of the camera, taken as a reference. Measurements were repeated five times at each point, with the power meter head always in physical contact with the screen. The measurements were acquired for three different brightness conditions, at 100%, 41% and 0%, respectively: these correspond to three easily reproducible positions of the slide ruler setting the screen brightness. The corresponding results are reported in fig. 1: based on the builder's specifications, the 41% setting corresponds to a luminosity of $171\,\text{cd/m}^2$. Good homogeneity is found across the screen.

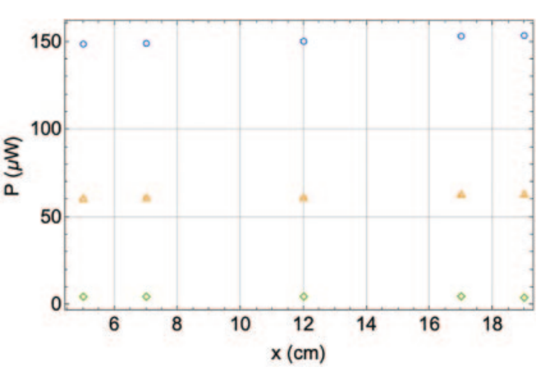

Fig. 1. – Power as a function of the distance x on the screen. Circles: 100% brightness. Triangles: 41% brightness. Squares: 0% brightness. Standard deviations were used for the error bars. The data show a very modest increase of the luminosity with the position on the screen.

2˙2. *Optometric measurements.* – The optometric tests consisted in the measurement of the reading distance for three different texts:

1) text in paper format;

2) text on tablet with 41% brightness;

3) text on tablet with 100% brightness,

presented in this order to reduce the possibility of glare in sensitive individuals. In all cases, the text was written in Arial font, with 6 point size, chosen for its good reproducibility in print and on screen and for its lack of serif, improving readability. The size was taken from a standard paper near-sight optotype (Shamir Innovation), corresponding to 0.63 logMAR. Refractive condition was assessed before testing, with all subjects wearing their usual correction (spectacles were required to the participants). After the measurement of the interpupillary distance for distance and for near, monocular visual acuity (MVA) and binocular visual acuity (BVA) were measured as a check for the correction for distance, while the accomodative amplitude, measured using the push-up method, was used as a check for the near with an objective method. Following these optometric measurements, each subject was asked to place the text for comfortable reading with the close-up correction worn on test goggles: each subject was asked to read the presented text aloud, and as the subject read, the reading distance was measured with the phoropter cue with three measurements per each text. The subjects were not made aware of the purpose of the study, so as not to induce psychological effects that could have altered the results. Statistical analysis was conducted assuming normal distribution of the data, and employing Student's t-test.

3. – Results

A modified response to the electronic support with respect to paper would become patent if a difference in the viewing distance is observed. For each subject, the distances were taken as the average values of the three repetitions, as summarised in the table in fig. 2. The value of the distance d_1 measured for the paper support is then compared with those assessed for the tablet, d_2 for the lower brightness, and d_3 for the higher brightness. For this purpose, we calculated the parameters $\Delta_{12} = \frac{d_2 - d_1}{d_1}$ and $\Delta_{13} = \frac{d_3 - d_1}{d_1}$. For both variables, average and standard deviation were obtained: the results are reported in fig. 3, showing no structure as a function of the distance d_0.

Subject	d_1 (cm)			d_1 average (cm)	d_2 average (cm)			d_2 average (cm)	d_3 (cm)			d_3 average (cm)
1	33	31	30	31,3	29	28	30	29,0	27	26	27	26,7
2	39	38	37	38,0	27	29	30	28,7	31	31	32	31,3
3	36	36	33	35,0	33	35	34	34,0	35	35	35	35,0
4	27	29	30	28,7	40	39	40	39,7	41	43	43	42,3
5	36	36	37	36,3	35	35	35	35,0	36	36	35	35,7
6	40	35	34	36,3	43	44	45	44,0	41	39	39	39,7
7	40	42	42	41,3	38	37	38	37,7	39	37	38	38,0
8	45	47	48	46,7	43	39	39	40,3	46	44	43	44,3
9	37	36	36	36,3	35	36	36	35,7	38	38	36	37,3
10	36	36	36	36,0	37	40	39	38,7	38	38	37	37,7
11	37	37	37	37,0	38	37	36	37,0	36	35	35	35,3
12	45	44	45	44,7	40	41	39	40,0	38	38	37	37,7
13	34	35	34	34,3	35	35	34	34,7	35	35	34	34,7

Fig. 2. – The values of all measurements taken for reading distance, every three columns there are the average values of measurements.

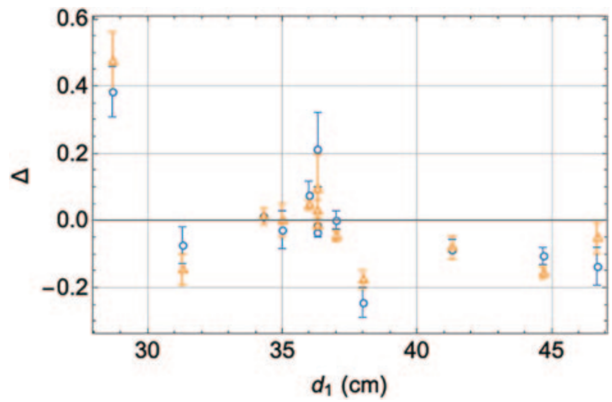

Fig. 3. – Plot of Δ_2 (circles) and Δ_3 (triangles) as a function of the initial distance d_1.

There is an indication that, on average, the use of an electronic support has no significant impact on the reading distance. In order to check this intuition, we performed a Student's t test to assess whether the observed deviations from 0 are significant: we find the values $t_{12} = 0.039$, and $t_{13} = 0.094$, yielding a p-value exceeding 0.05.

4. – Conclusions

At the end of this study, it is possible to state that no significant differences were observed between the viewing distance of a paper text and the viewing distance of a text presented on a tablet. Although the method of text presentation is indifferent to the level of statistical significance, these conclusions still call for further corroboration due to the small number of the sample examined. In fact, several studies have claimed otherwise. For example, there are studies investigating whether visual problems were related to the use of smartphones and digital devices in general and had positive results regarding closer distances [2]; in fact, they noted fatigue, accommodation lag, and blurred vision at close range. Other studies, on the other hand, went right to comparing paper tests with digital tests and noticed better results in the paper tests, leading to the idea that specific thresholds should be used for each digital test [3-5]. Finally, another study looked at two groups, one of them consisting of presbyopic subjects, aiming at comparing the viewing distance of the smartphone with very interesting results: a high variability was observed in both groups with no relation to other factors, it was found that viewing distances can vary for the same person depending on the activity performed [6]. Even in the study we conducted, one subject drastically changed viewing distance by switching from paper to the text presented on the tablet, moving the tablet further away when the brightness was increased. It would be necessary to understand what the incidence of subjects with disorders unrelated to visual defects (*e.g.*, photophobia) to assess whether they influence proximal distance.

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REFERENCES

[1] Lupelli Luigi, *Optometria AZ: dizionario di scienzo, tecnica e clinica della visione* (Medical Books) 2014.
[2] Bababekova Yuliya *et al.*, *Optom. Vis. Sci.*, **88** (2011) 795.
[3] Chu Christina *et al.*, *A Ophthalmic Physiol. Opt.*, **31** (2011) 29.
[4] Hue Jennifer E.*et al.*, *Work*, **47** (2014) 303.
[5] Campo Dall'Orto Giada *et al.*, *J. Optom.*, **14** (2021) 133.
[6] Boccardo Laura, *J. Optom.*, **14** (2021) 120.