Original scientific paper
http://doi.org/10.24867/JGED-2022-3-051

Visibility and legibility of five-letter words in different experimental conditions

ABSTRACT

The length of a word depends on the number of characters that make it up. Since we are constantly confronted with words (information), a suitable typeface should be chosen to make reading comfortable and easy. The number of characters can affect how visible a word is and, more importantly, how quickly the word can be read and understood. For this reason, we conducted tests with five-letter words randomly displayed at the four positions on the screen. The study examined the minimum time required to recognize five-letter words. Five different typefaces (Calibri, Georgia, Swiss 721, Trebuchet, Verdana) were included in the study to determine which of the screen typefaces read the fastest. The Georgia typeface performed the best regardless of the other conditions. The time to read upper-case letters was much shorter than lower-case and sentence-case letters. For words presented in the upper positions of the screen, the recognition time was shorter than for the lower positions of the screen. Different combinations of variables showed that some were better suited for on-screen use.

KEY WORDS
Reading time, typography, usability testing, visual performance

Primož Weingerl [1]
Uroš Nedeljković [2]
Nace Pušnik [1]

[1] University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles, Graphic Arts and Design, Ljubljana, Slovenia
[2] University of Novi Sad, Faculty of Technical Sciences, Department of Graphic Engineering and Design, Novi Sad, Serbia

Corresponding author:
Nace Pušnik
e-mail: nace.pusnik@ntf.uni-lj.si

First recieved: 14.3.2022.
Accepted: 23.5.2022.

Introduction

Information presentation is important aspect in everyday life, especially in advertising. Since the whole society is consumption-oriented, studies about information development are important. Products can be offered through different channels, television, web, social media, printed adverts, etc. (Jian, 2022). All approaches have certain requirements and benefits which can contribute to higher sale. Since our way of living is fast and we do not want to bother ourselves with things that take too much of our time or effort, commercial presentation should be as short as possible. For this reason, study of basic communication elements (colour, contrast, shape, position, duration) is quite important. For the reasons given, studying use of typography and time we need to see, comprehend, and remember the presented information (words, sentences) is important (Hohenstein & Kliegl, 2014). Many times, our focus is somewhere else, and this is not good for advertisers, especially if we are in surrounding where different disturbing factors are present (Karim & Kojima, 2010; Luccion & Caporusso, 2010). One of those environments could be use of computer (browsing the web) or watching television (either use of tv screen, computer screen or tablet/mobile screen) (Jessen & Jørgensgaard Graakjær, 2013). Advertisers are trying to serve products and sell them with affecting our subconscious. Fast commercials (banners)

which appear and disappear on the computer screen while searching web should be made in a way to attract our attention or affect our subconscious in a couple of seconds (maybe even milliseconds). To achieve public's attention, typography, position of presentation on the screen and time interval should be carefully examined (Ali et al., 2013). Probably all of us experienced fast, flashing commercials during web search. Those commercials appear suddenly and are present for certain time or until we close them. More interesting for our research is commercials which appear and disappear from the screen. They should be made in the way to subconsciously attract our attention and stay in our memory. In this way we are potential buyer/user of certain product or service (Aidin, Hamolton & Rohm, 2020).

Since legibility represents the ease of single character detection and it is measured with the recognition speed, use of typography is one of the most important factors (Arditi & Cho, 2005). Certain properties of typefaces can be advantageous for fast presentation and consequently perception (Cosky, 1976; Frase & Schwartz, 1979). It is known that typefaces which were designed for the screen should contain properties such as higher x-height, bigger counter form and clarity of shapes. But this cannot be the only reason for the word (sentence, slogan) to be recognized fast and correctly comprehend (Arditi & Cho, 2007).

Another important aspect is presentation position (screen) of the displayed content (Stevens & Grainger, 2003). When we use computer screen for search of information, our focus is mainly on the top positions of the screen. The data that gives vital information or attraction is normally positioned in the top left corner of the screen (Dhou, Hadzikadic & Faust, 2018). If we are performing fast search of information, the so-called Z pattern of eye movements is the fact. We start to read/search in the left top corner of the screen, followed by the glance to the opposite side, then we move across the screen obliquely to the left bottom position and continue to the right bottom position. In this way our attention is spread across the screen and is likely to perceive information we are looking for (Zhou, Helander & Jiao, 2011). Another pattern is also known for information search, so-called F pattern. This way of information search is maybe not so popular any more since layout of web pages has changed in the past years and the information of importance is not always placed to the left vertical position of the screen. Nevertheless, if people follow the Z or the F pattern, first or second move is across the upper part of the screen and is basically similar within both patterns.

When the advertisement is placed on the screen for unlimited time, the web user will have enough time to see the advert (if the advert is in her or his interest). In many cases while searching the web you are forced to shut down the advertisement with the (mouse) click.

This kind of situation is not really something that would be in the greatest interest of our research. This situation of course affects our subconscious but not in the way we are trying to outline the situation. More interesting are fast commercials that appear and disappear automatically. When they flash on the screen our attention immediately goes to them for short period of time. Sum of all elements that are presented in couple of seconds is the area that especially interests us (Bock, Monk & Hulme, 1993). If the elements are built properly, they will attract our attention more and will have higher effect on our subconscious. It is true that bad design can also attract our attention but will not convince us to buy certain product or use service. So, the important thing is to make a good design and harmoniously assemble all the basic elements (Dyson, 2004).

Another aspect which we must consider is the length of presented words. Since banners are offering different products, we focused on sport equipment (Manchanda et al., 2006; Teng et al., 2021). If we for example take the sports brands that are popular and spread all around the globe, we can measure average length (average number of letters consisting of them) as the measure of word length. Brands such as Adidas, Asics, Benger, Diadora, Fila, Head, Kappa, Lotto, Mizuno, Nike, Oakley, Peak, Puma, Reebok, Wilson consist of 4 to 7 letters and the average word length is 5.2 letters. This can be a measure for word length of presented words. All the presented words in the research were 5 letter meaningful words taken out of Slovene language dictionary and are in everyday use.

Method

Studies on readability are concerned with the isolation of words (Bouma, 1971). For this reason, we decided to conduct an experiment in a laboratory setting. The procedure for performing the experiment proceeded in the same way as used in the article by Pušnik, Možina & Podlesek (2016a). Since we wanted to find out how the shape of the letters, their size and position affect the recall of the words presented, the experiment was conducted in such a way that no other distractions were present (Carlson, Hogendoorn & Verstraten, 2006; Carrasco, Giordano & McElfee, 2004). The environment of the laboratory was painted in grey colour so that there was no (or very little) amount of reflection; the walls of the laboratory were painted in grey colour according to the standard ISO 3664:2009 (E) (International Organization for Standardization, 2009). The reflectance of the monitor was in accordance with the standard ISO 9241-307:2008 (International Organization for Standardization, 2008) and was higher compared to the environment.

Since we were interested in how letter (word) shapes affect recognition and retrieval of presented words, we

decided to run tests with very short presentation times, measured in milliseconds (Sheedy et al., 2005). For this reason, we prepared a web application to automatically determine typeface and position. The pool of 200 words was prepared for each trial (lower-, sentence-, upper-case) and words were selected randomly without replacement; the position of the displayed word was also randomly determined. The typeface sizes were adjusted so that each word displayed took up approximately the same area (square) in terms of size (horizontally and vertically) (Treurniet, 1980; Pušnik, Podlesek & Možina, 2016b; Ohnishi & Oda, 2021). For this purpose, we used typeface sizes as listed in Table 1. Given these sizes, the typefaces displayed were the same size, so it was not possible to prefer any of the five typefaces (Moret-Tatay & Perea, 2011; Nazir, Jacobs & O'Regan, 1998).

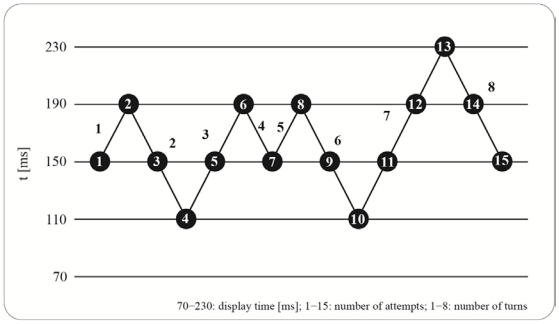
Table 1

Typeface size adjustments

Typeface	Size in points (pt)	Size in pixels (px)
Calibri bold	36	48
Trebuchet bold	33	44
Swiss 721 bold	32	42
Verdana bold	32	42
Georgia bold	33	44

The length of the first stimulus in the experiment was set to 150 milliseconds. After that, the presented word had to be typed into the field. If the presented word was typed in correctly, the next presentation interval shortened by 40 milliseconds and the new word was presented in a time interval of 110 milliseconds (the presentation duration increased by 40 milliseconds to 190 milliseconds if the word was not typed correctly or not typed at all). According of this dynamic, we wanted to achieve 8 turns and thus complete the experiment. Because the words were displayed in a very short time, participants needed several attempts to complete the experiment. Ideally, the experiment was completed in 15 attempts, but this was mostly not the case. Figure 1 is attached for a better understanding of the procedure.

In the procedure described above, we measured the recognition threshold of the displayed words under different experimental conditions (typeface, letter case, position). By using short display durations, we can determine how typeface, letter case, and position affect the visibility and recognition of the displayed words. The latter were displayed in black colour (Hex #000000; RGB (0, 0, 0)) on a light grey (Hex #cccccc; RGB (204, 204, 204)) background of the LCD screen. The white colour space of the screen was set to D65 and the luminance of the screen was between 80 and 160 cd/m².



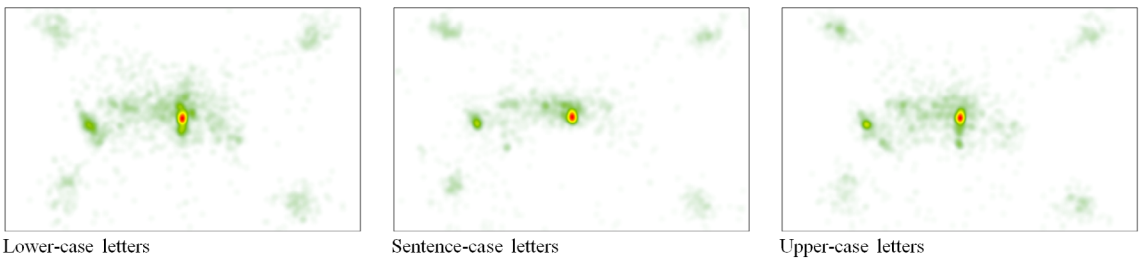
» **Figure 1:** *Web application operation*

Measurements were divided into three sessions based on letter cases: lower-, sentence-, and upper-case letters (see Table 2). Before each session, the procedure was explained to the participants, and they were able to get accustomed to the laboratory lighting conditions during this time. In addition, the instructions were displayed on the screen (in writing) before the start of each experiment.

The study included 30 participants for each of the three sessions. Their ages ranged from 20 to 30 years (M = 22.7 years). Since sports brands are popular among people between 20 and 30 years of age, we believe that the selected focus group was suitable for the experiment.

During the test, we also use an eye movement tracking device (TOBII X120) that allows us to monitor whether participants are following instructions and to evaluate the results obtained as objective (Rayner, Slattery & Belanger, 2010). Figure 2 shows the heatmaps illustrating the participants' eye movements for each set of words (lower-, sentence-, upper-case) displayed.

It can be seen from the Figure 2, that participants followed the instructions. We notice that the greatest concentration of views (heatmaps) is in the central part



» **Figure 2:** *Heatmaps obtained with eye tracking device*

of the screen, as it represented the starting point for each trial. The fixation point was positioned at the height of the observer's eyes. The distance from the center of the screen to one of the four corners of the screen (upper-left, upper-right, lower-left, lower-right) where words were presented was in this case the same and it could not happen that the display of a word in a certain position could affect its better visibility and faster perception. In addition to the center, we see a greater concentration of views also to the left of the center; here was the place where the participants typed in the words shown.

Results and discussion

The hypotheses of the experiment were tested with an alpha error rate of 5%. Table 2 shows the recognition thresholds for five-letter words (i.e., the shortest times required to correctly recognize five-letter words) presented under different experimental conditions.

Using the data collected in Table 2, we can see that five-letter words were recognized correctly faster when they were presented in the upper part of the screen (i.e., the upper left and right parts of the screen). When comparing the average recognition time for the upper positions, we can see a small difference (the difference between the upper left and upper right positions was 0.5 ms, regardless of the typeface and its style). On the other hand, the average presentation time for word recognition when presented in the lower parts of the screen was almost 10 ms longer than when presented in the upper parts of the screen. When we compare upper-case and lower-case words, we find (Table 2) that the recognition time is shortest for upper-case words (it varies between 140.0 and 152.6 ms). On average, the recognition time for upper-case letters was 146.9 ms (regardless of position and typeface). On the other hand, the recognition time for sentence- (158.4) and lower-case (159.5) letters was on average between 11.5 and 12.6 ms longer (as before, independent of position and typeface).

Focusing on the presented typefaces, we see that Georgia was recognized the fastest, regardless of the letter-case (lower-case, upper-case or sentence-case) and position (upper and lower position). In second place (with the shortest recognition times) was Trebuchet when presented in sentence- and upper-case. Verdana typeface stands out when presented in lower-case. Position is exempt (similar as for Georgia) when comparing letter cases for Trebuchet and Verdana. Recognition times for words presented in Calibri typeface are not much longer compared to those for Trebuchet (lower- and sentence-case), but they are when Calibri is presented in upper-case. Among all conditions, the Swiss721 typeface has the longest recognition times and, according to the collected data, is the least suitable for fast recognition when presented on the screen.

The results of ANOVA, presented in Table 3, show that there is a statistically significant main effect of all three factors tested: letter case, position, and typeface. Since there is statistical significance, we can assume that there is a significant main effect on the recognition threshold. When comparing the combination of different factors (Table 3), we notice that there is no statistically significant interaction between them.

It was expected that performance would be best for upper-case letters, followed by sentence-case letters,

Table 2

Average recognition thresholds in milliseconds (and standard deviations in parentheses) needed for recognizing words in different experimental conditions

		Position				
Letter case	**Typeface**	**Upper left**	**Upper right**	**Lower right**	**Lower left**	**Total**
Lower	Calibri	157.7 (16.1)	154.2 (25.4)	163.7 (13.3)	158.7 (17.9)	158.6 (18.2)
	Trebuchet	154.7 (17.8)	156.5 (20.6)	165.7 (12.4)	162.5 (19.2)	159.9 (17.5)
	Swiss 721	162.0 (16.5)	161.0 (18.7)	165.3 (12.1)	166.7 (20.8)	163.8 (17.0)
	Verdana	157.8 (22.6)	155.5 (24.2)	162.7 (13.4)	158.0 (19.8)	158.5 (20.0)
	Georgia	150.8 (19.7)	153.8 (25.6)	161.2 (16.7)	161.5 (17.2)	156.8 (19.8)
Sentence	Calibri	152.2 (26.9)	154.7 (30.6)	160.8 (19.5)	162.3 (15.3)	157.5 (23.1)
	Trebuchet	151.0 (26.5)	154.2 (27.4)	160.7 (14.0)	163.2 (16.3)	157.3 (21.1)
	Swiss 721	157.2 (22.6)	163.8 (22.2)	164.7 (9.1)	168.7 (15.5)	163.6 (17.4)
	Verdana	154.3 (20.1)	159.2 (28.0)	159.7 (12.9)	164.7 (15.9)	159.5 (19.2)
	Georgia	148.8 (24.3)	147.7 (33.8)	160.2 (11.3)	160.5 (18.9)	154.3 (22.1)
Upper	Calibri	142.0 (25.4)	145.3 (26.1)	152.8 (17.4)	153.5 (18.8)	148.4 (21.9)
	Trebuchet	143.7 (23.7)	137.0 (33.5)	152.5 (17.6)	154.0 (18.9)	146.8 (23.4)
	Swiss 721	150.7 (24.2)	145.0 (27.3)	157.3 (13.8)	157.3 (17.3)	152.6 (20.7)
	Verdana	141.3 (24.9)	144.7 (26.7)	154.0 (15.1)	147.5 (21.1)	146.9 (22.0)
	Georgia	136.8 (28.6)	136.0 (30.7)	143.8 (19.3)	143.5 (25.5)	140.0 (26.0)
Total	Total	150.7 (22.7)	151.2 (26.7)	159.0 (14.5)	158.8 (18.6)	

Table 3

Results of ANOVA of recognition thresholds.

Source of variability	SS	df	MS	*F*	*p*	η_p^2	Results of post hoc comparison
LC	58,066.75	1.86	31196.47	31.17	.000	.52	Upper < Sentence, Lower
Error (LC)	54,018.25	53.98	1000.74				
P	28,384.50	1.96	14508.95	5.19	.009	.15	Upper left, Upper right < Lower left, Lower right
Error (P)	158,548.83	56.73	2794.60				
T	16,613.69	3.14	5286.31	20.89	.000	.42	Georgia < Trebuchet, Calibri, Verdana < Swiss 721
Error (T)	23,067.14	91.14	253.09				
LC × P	2605.25	4.01	649.10	1.26	.290	.04	
Error (LC × P)	59,936.42	116.40	514.94				
LC × T	2087.14	5.29	394.73	1.71	.133	.06	
Error (LC × T)	35,494.53	153.34	231.48				
P × T	1843.97	7.77	237.42	0.74	.649	.03	
Error (P × T)	71,918.53	225.23	319.31				
LC × P × T	3955.86	11.74	336.94	0.89	.559	.03	
Error (LC × P × T)	129,319.14	340.48	379.82				

and that performance would be worst for lower-case letters (longest recognition thresholds). The results confirmed our conjecture, but with small differences. Upper-case letters were processed the fastest, but there was no significant difference in processing times for lower-case and sentence-case letters.

To find the reason why lower-case and sentence-case letters were processed (recognized) more slowly, we performed a typographic tone value (TTV) measurement (Table 4). TTV is defined as the relative amount of ink per square inch, centimeter, or pica.

Table 4

Average TTV* (%) of presented words

	Upper case	Lower case	Sentence case
Calibri	20.3	15.7	15.8
Trebuchet	23.3	18.2	18.3
Swiss 721	27.5	21.1	21.2
Verdana	28.1	24.1	25.0
Georgia	21.4	19.1	19.3
Average	24.1	19.6	19.9

**Typographic Tonal Value*

Upper-case letters stand out with the highest average TTV of 24.1%. The TTV for lower-case and sentence-case letters is much lower than that for upper-case letters; on average, the TTV for lower-case letters was 19.6% and for sentence-case letters 19.9%. %. In average TTV for lower- and sentence-case letters was smaller for between 4.2-4.5%. We can still see that sentence-case letters have a slightly higher TTV compared to lower-case letters. The reason for this is the use of a capital letter in each word. Nevertheless, the average percentage for sentence-case letters is still much smaller compared to upper-case letters. The difference in TTV may also be one of the reasons that the recognition threshold (processing times) for words is longer when they are presented in lower-case or upper-case. The highest TTV leads to shorter processing times (recognition threshold), while a lower TTV consequently leads to longer processing times (recognition thresholds).

The analysis of the positions shows that there is a statistical significance when comparing the upper and lower positions on the screen (Table 2). Namely, when the words were presented in the upper positions of the screen, the recognition times are shorter and comparable for the left and right positions (Table 2). A similar observation occurs when comparing recognition times for the lower positions on the screen. Regardless of the lower left or right position, the recognition times were longer than those for the upper left and right positions (Table 2). As it turns out, we have internalized the way we search for information online or on a cell phone. All-important data is usually displayed at the top of the screen when browsing web pages (regardless of screen size). We can assume that this is the reason why participants were more inclined to see the information in the upper part of the screen than in the lower part of the screen. Banners that appear and disappear on the screen are in many cases placed in the upper part of the screen.

The comparison of the typefaces shows that the shortest recognition times are achieved with Georgia, regardless of upper- and lower-case and the position of the letters (Table 2). The longest recognition times are achieved with the typeface Swiss721 (independent of upper- and lower-case and position). For the other typefaces (Calibri, Trebuchet, Verdana), the recognition times vary. From this we can conclude that it is more difficult to highlight the differences between linear typefaces when measuring and evaluating their usefulness in cases where words appear and disappear quickly. It is perhaps somewhat unusual that Verdana does not stand out among

the linear typefaces tested, as it is known for its open strokes, strong lines, and larger counter shapes (white).

The results from ANOVA of the recognition thresholds confirm our result based on the average recognition times (Table 3). If we must rank the usability of the typefaces, we can see that the Georgia proved to be the best, followed by Calibri, Trebuchet and Verdana, and the last one is Swiss 721. Despite the general opinion that typefaces belonging to the group of linear typefaces are better for screen display, our experiment showed the opposite. It looks like the serifs, which are part of the Georgia typeface, helped to better perceive the spacing between adjacent letters. Another reason why the Georgia typeface stands out from others is due to the stroke width or the difference in stroke width that is present in the Georgia typeface. Letters with serifs tend to have slightly larger spacing between letters, which can prove helpful for readers/users when reading short words (assuming that five-letter words can still be considered as short words).

Conclusion

Study of five-letter words shows how letter case, typeface, and position on the screen are affecting word recognition which is consequence of processing speed. Based on obtained results, the recommendation for displaying short inscriptions (company names, slogans, other promotional expressions) to be presented on the screen would be to place the words at the upper positions (left or right) on the screen. As for the properties that should be used for such titles, we recommend using upper-case letters and typefaces with distinct design features such as difference in stroke thickness, inclusion of serifs, greater counter-form, etc.

Based on recent research it would be advisable to use typefaces with a higher typographic tonal value (TTV); in our case tested typefaces were all presented in bold style which have higher TTV compared to regular, medium, or other styles. It would be maybe interesting to make comparison between bold and extra bold style.

Recent experiment included only five-letter words. We assume that participants who participated in experiment subconsciously used peripheral vision to obtain presented five-letter words. Since word presentation was given in milliseconds, there is a small chance that the participants were able to catch and see the displayed words with their eyes. Based on this we assume that there was little or no cases when participants directed their gaze to the stimuli.

Based on research performed by Ito (2012), saccades to an unexpected stimulus normally take around 200 ms to be triggered and then typically last about 20-30 ms during reading. In our case the average recognition threshold was less than 160 ms (more precisely 154.9 ms). Similar research, performed by Pušnik, Možina & Podlesek (2016a) where three-letter words were presented shows that in that case average recognition threshold was also less then 160 ms (more precisely 155.9 ms). We can see that average recognition threshold for five-letter words compared to three-letter words is 1 ms shorter. Perhaps we can justify this with greater surface coverage and greater typographic tonal value; both are higher with longer words (words consisting of more letters).

When different ads appear on the screen, addressing us with the help of words, they are displayed for a longer time, measured in seconds and not milliseconds. Due to the longer display time, users also have more options to direct their gaze to the displayed caption, view it and bring it to the level of recognition. Nevertheless, due to the fast display, we can conclude about the properties that are useful for the fact that the captions are processed and brought to the level of recognition in the shortest possible time.

Surface coverage seems to play a crucial role in the fast perception of words. In the future, it would be good to find out what the minimum surface coverage is when we are still perceiving words and what it is when we are unable to recognize words (or have difficulties to see and remember them). In addition, it would be interesting to see how different colour combinations between the background and the typeface used can help to process words faster, e.g., brands, slogans, and other written advertising material.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Aidin, N., Hamilton, M. L. & Rohm, A. J. (2020) Impact of message design on banner advertising involvement and effectiveness: An empirical investigation. *Journal of Marketing Communications.* 26 (2), 115-129. Available from: doi: 10.1080/13527266.2017.1393767

Ali, A. Z. M., Wahid, R., Samsudin, K. & Idris, M. Z. (2013) Reading on the Computer Screen: Does Font Type has Effects on Web Text Readability?. *International Education Studies.* 6 (3), 26–35. Available from: doi: 10.5539/ies.v6n3p26

Arditi, A. & Cho, J. (2005) Serifs and font legibility. *Vision Research*. 45 (23), 2926–2933. Available from: doi: 10.1016/j.visres.2005.06.013

Arditi, A. & Cho, J. (2007) Letter case and text legibility in normal and low vision. *Vision*

Research. 47 (19), 2499–2505. Available from: doi: 10.1016/j.visres.2007.06.010

Bock, J. M., Monk, A. F. & Hulme, C. (1993) Perceptual grouping in visual word recognition. *Memory & Cognition*. 21 (1), 81–88. Available from: doi: 10.3758/BF03211167

Bouma, H. (1971) Visual recognition of isolated lower-case letters. *Vision Research.* 11 (5), 459–474. Available from: doi: 10.1016/0042-6989(71)90087-3

Carlson, T. A., Hogendoorn, H. & Verstraten, A. J. (2006) The speed of visual attention: What time is it?. *Journal of Vision*. 6 (12), 1406–1411. Available from: doi: 10.1167/6.12.6

Carrasco, M., Giordano, A. M. & McElree, B. (2004) Temporal performance fields: visual and attentional factors. *Vision Research*. 44 (12), 1351–1365. Available from: doi: 10.1016/j.visres.2003.11.026

Cosky, M. J. (1976) The role of letter recognition in word recognition. *Memory & Cognition.* 4 (2), 207–214. Available from: doi: 10.3758/BF03213165

Dhou, K., Hadzikadic, M. & Faust, M. (2018) Typeface size and weight and word location influence on relativesize judgments in tag clouds. *Journal of Visual Languages & Computing.* 44, 97–105. Available from: doi: 10.1016/j.jvlc.2017.11.009

Dyson, M. C. (2004) How physical text layout affects reading from screen. *Behaviour & Information Technology*. 23 (6), 377–393. Available from: doi: 10.1080/01449290410001715714

Frase, L. T. & Schwartz, B. J. (1979) Typographical cues that facilitate comprehension. *Journal of Educational Psychology.* 71 (2), 197–206. Available from: doi: 10.1037/0022-0663.71.2.197

Hohenstein, S. & Kliegl, R. (2014) Semantic preview benefit during reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition.* 40 (1), 166–190. Available from: doi: 10.1037/a0033670

International Organization for Standardization. (2009) ISO 3664:2009 (E). *Graphic technology and photography – Viewing conditions.* Geneva, International Organization for Standardization.

International Organization for Standardization (2008) ISO 9241–307:2008. *Ergonomics of human-system interaction – Part 307: Analysis and compliance test methods for electronic visual displays.* Geneva, International Organization for Standardization.

Ito, M. (2012) *The cerebellum: brain for an implicit self.* Upper Saddle River, Pearson Education.

Jessen, I. B. & Jørgensgaard Graakjær, N. (2013) Cross-media Communication in Advertising: Exploring Multimodal Connections between Television Commercials and Websites. *Visual Communications.* 12 (4), 437–458. Available from: doi: 10.1177/1470357213497665

Jian, Y. C. (2022) Reading in print versus digital media uses different cognitive strategies: evidence from eye movements during science-text reading. *Reading and Writing.* 35, 1549-1568. Available from: doi: 10.1007/s11145-021-10246-2

Karim, A. K. M. R. & Kojima, H. (2010) The what and why of perceptual asymmetries in the visual domain. *Advances in Cognitive Psychology.* 6, 103–115. Available from: doi: 10.2478/v10053-008-0080-6

Luccion, R. & Caporusso, G. (2010) The effect of the context on the anisotropy of the visual field. *Review of Psychology.* 17(1), 7–11.

Manchanda, P., Dubé, J.-P., Goh, K. Y. & Chintagunta, P. K. (2006) The Effect of Banner Advertising on Internet Purchasing. *Journal of Marketing Research*. 43 (1), 98–108. Available from: doi: 10.1509/jmkr.43.1.98

Moret-Tatay, C. & Perea, M. (2011) Do serifs provide an advantage in the recognition of written words?. *Journal of Cognitive Psychology.* 23 (5), 619–624. Available from: doi: 10.1080/20445911.2011.546781

Nazir, T. A., Jacobs, A. M. & O'Regan, J. K. (1998) Letter legibility and visual word recognition. *Memory & Cognition.* 26 (4), 810–821. Available from: doi: 10.3758/bf03211400

Ohnishi, M. & Oda, K. (2021) The effect of character stroke width on legibility: The relationship between duty ratio and contrast threshold. *Vision Research.* 185, 1–8. Available from: doi: 10.1016/j.visres.2021.03.006

Pušnik, N., Možina, K. & Podlesek, A. (2016a) Effect of Typeface, Letter Case and Position on Recognition of Short Words Presented On-screen. *Behaviour & Information Technology.* 35 (6), 442–451. doi link: 10.1080/0144929X.2016.1158318

Pušnik, N., Podlesek, A. & Možina, K. (2016b) Typeface comparison – Does the x-height of lower-case letters increased to the size of upper-case letters speed up recognition?. *International Journal of Industrial Ergonomics.* 54, 164–169. Available from: doi: 10.1016/j.ergon.2016.06.002

Rayner, K., Slattery, T. J. & Belanger, N. N. (2010) Eye movements, the perceptual span and reading speed. *Psychonomic Bulletin & Review.* 17 (6), 834–839. Available from: doi: 10.3758/PBR.17.6.834

Sheedy, J. E., Subbaram, M. V., Zimmerman, A. B. & Hayes, J. R. (2005) Text legibility and the letter superiority effect. *Human Factors.* 47 (4), 797–815. Available from: doi: 10.1518/001872005775570998

Stevens, M. & Grainger, J. (2003) Letter Visibility and the Viewing Position Effect in Visual Word Recognition. *Perception & Psychophysics.* 65 (1), 133–151. Available from: doi: 10.3758/BF03194790

Teng, L., Xie, C., Liu, T., Wang, F. & Foti, L. (2021) The effects of uppercase vs. lowercase letters on consumers' perceptions and brand attitudes. *Journal of Business Research.* 136, 164–175. Available from: doi: 10.1016/j.jbusres.2021.07.013

Treurniet, W. C. (1980) Spacing of characters on a television display. In: Kolers P. A., Wrolstad M. E. & Bouma, H. (eds.) *Processing of visible language.* New York, Plenum Press, pp. 365–374.

Zhou, F, Qu, X., Helander, M. G. & Jiao, J. R. (2011) Affect prediction from psychological measures via visual stimuli. *International Journal of Human Computer Studies.* 69 (12), 801–819. Available from: doi: 10.1016/j.ijhcs.2011.07.005

© 2022 Authors. Published by the University of Novi Sad, Faculty of Technical Sciences, Department of Graphic Engineering and Design. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license 3.0 Serbia (http://creativecommons.org/licenses/by/3.0/rs/).