Users Characteristic Influence on the Efficiency of Typographic Design

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Abstract. This paper investigates the efficiency of typographic design using Bertin's variables, both individually and combined. A user study was conducted in which two types of map users had to perform a search task. The first group consists out of participants who have been trained in cartography and who use maps on a daily basis. The second group of users are novices who have not got any previous education in cartography. Users' efficiency was calculated by measuring the consumed time to find the target label. The obtained data was analyzed statistically to compare the efficiency of users' performance regarding the applicability of visual variables on labels. Using ANOVA showed some significant differences between users' group and within users' groups ($P<0.05$).

Keywords: Typographic design, Users' efficiency, Users' group

1. Introduction

One significant map design challenges is setting the typographic symbols which involve choosing the appropriate visual properties for text on the map including text shape, size, colour, value, texture, and orientation. The nature of the cartographic text implies some design needs in the one hand and on the other hand, map use defines the way in which user appreciate map design. Bertin's visual variables are applied on text individually or combined to serve the functionality of both the cartographic text and its function (Deeb *et al.*, 2012). Visualization is the process in which a quantitative and qualitative data is processed and transferred into visual representation. The geospatial databases have meaningful and useful names that can assist data set access and analysis (MacEachern and Kraak, 2001). Fair-

bairn (1993) defined fifteen classes of cartographic text functions which increase the implemented geospatial dataset. The proper association between the function of the visualized object and its label design improve map reading and enhance the way users interpret the map. Visual variables are translated into text symbolization to serve the functionality of labels. In addition to that, the harmony between the text design and the visualized features contribute to map perception effectively. This connection to other features makes it so critical to the perception process which in turn addresses some textual design issues such as legibility, feature hierarchy and categorization, and harmony.

To communicate with his audience, the cartographer employs images and words, typically in contribution. Whether the text on the map was toponymic or non-toponymic, the Typographic design shall be compatible with the map design to serve the function of the cartographic text (Fairbarin 1993). This paper provides an empirical evidence of the efficiency (response time measurement) of the visual variable applications on the cartographic text expressed in Table 1. Due to the fact that user characteristics should be captured and taken into account during the design (Nielsen 1993, Rubin and Chisnell 2008, Haklay and Nivala 2010), the study has both a between- and within-user design. The efficiency of different label designs was tested considering different user characteristics (gender and expertise). The design of the user study is described in detail in the next sections.

Variable	Examples		
Size	Cartography	Cartography	Cartography
	Cartography	**Cartography**	**Cartography**
Value	Cartography	Cartography	Cartography
Texture within a word	Cartography	Cartography	Cartography
Texture in a group of words	CARTOGRAPHY Cartography cartography	CARTOGRAPHY Cartography *cartography*	CARTOGRAPHY *Cartography* Cartography
Colour	Cartography(red)	Cartography(green)	Cartography(blue)
Orientation	Cartography	*Cartography*	Cartography
Shape	Cartography	Cartography	Cartography

Table 1. The application of visual variables on the cartographic text.

2. Method

Because of the special nature of the cartographic text, four of visual variables were implemented in the study. Size measured in points and boldness, shape represented by fonts, orientation of the whole label, and finally the texture of the words employed in the hierarchal function of the cartographic text. These variables were all implemented individually or combined in the cartographic text design.

2.1. Experiment

2.1.1. Participants

In total, 50 participants followed the test, 25 were expert and 25 novice. Out of the 50 participants, 25 were female and 25 male. The novice participants have no previous training in cartography, while experts work on a daily basis with maps and have at least a master's degree in geography. Of the 25 experts, 13 were female and 12 male. And of the 25 novices, 12 were female and 13 males. The average Age of the expert group is 29.59 years and the novice group is 16.4 years.

2.1.2. Stimuli

The visual variables of size, shape, orientation and texture ware applied individually or combined to serve some of label functions (Bertin 1967). Both point and areal data were involved in the labels' design. The first section of the maps depicts features associated with point data and their labels. Urban and rural features at the scale of 1:100 000 were presented as background of the labels. The second section of the maps depicts features associated with areal data and their labels, where neutral maps with blank background were used. An example of both designs is illustrated in Figure 1. Fictive labels were used to assure that participants would not recognize the location and the targets and thus the biases regarding earlier knowledge is controlled.

A trail of forty maps was presented to the interviewee on an online questionnaire. Two examples of the stimuli are displayed in Figure 1. A target label above each map is displayed.The target label is designed with a neutral font (OCR A Extended) and the upper case is used for the first letter only. The length of the target labels is either 6 or 7 letters. Names are carefully chosen taking into account the cap height, the X-height and including loops and ascenders in each name. The location of the target label within the maps is considerably chosen avoiding the centre of the map. For Comparison purposes (when studying cartographic text hierarchy), similar la-

bels were never asked more than twice in the map sequence provided long separations to control visuospatial working memory (Manginelli et al., 2012). Considering the variability of search strategies between users as Lleras and Mühlenen (2003) concluded and Arani et al (1984) modeled; some users followed systematic approaches and others followed intuitive approaches; target labels were distributed equally on all direction and covered the four corners (see Figure 2).

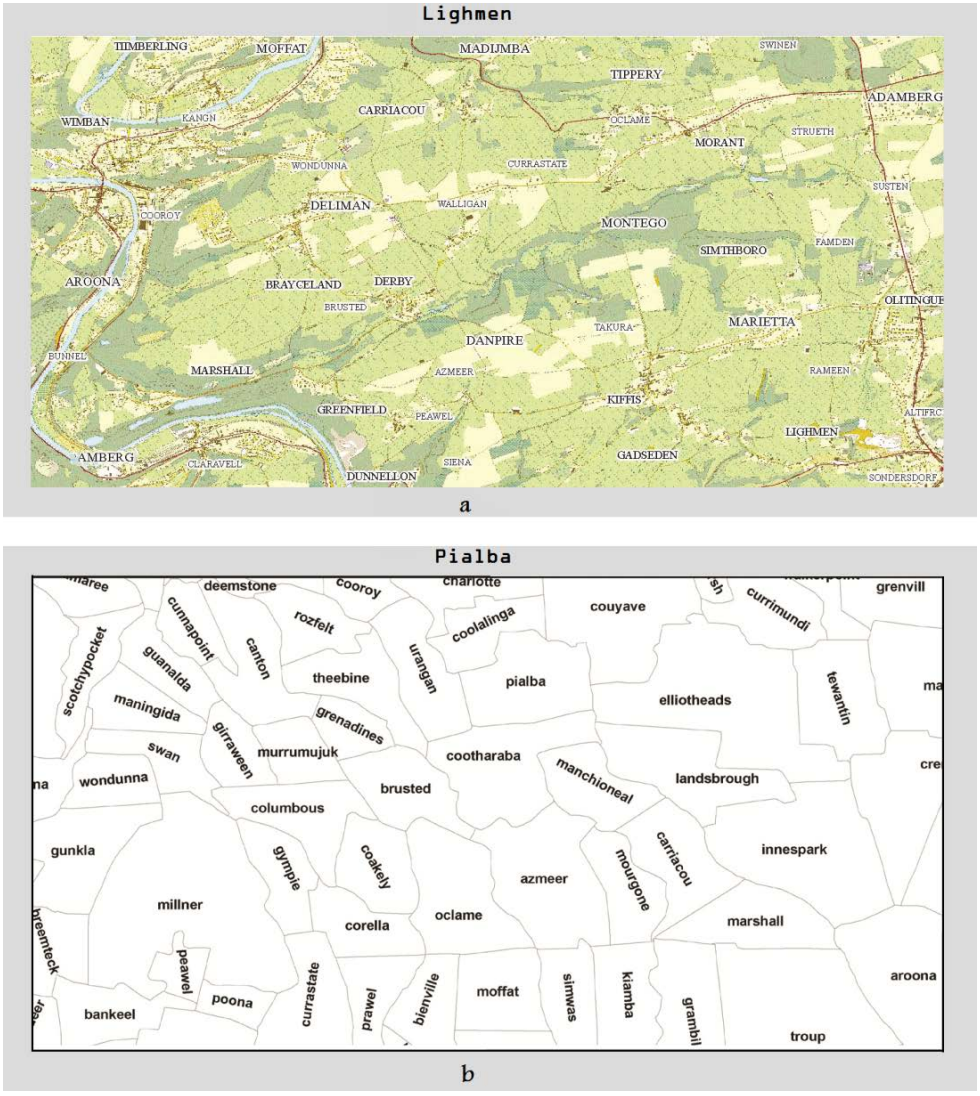

Figure 1. An example of stimuli, (a) point data (rural features), (b) areal data (neutral background).

Figure 2. An example of label target distribution of typographic map.

For each map the participants have to locate the target labels and thus their reaction time is measured and subsequently stored in a database. Once the user locates the label and clicks on it, the time is recorded and new map with new target appears afterwards. The results is a measurement of reaction time calculated in milliseconds. Each record indicates the efficiency of its designed label where different visualized graphical variables were involved to serve label functional design.

2.1.3. Apparatus

To avoid biases in the answers due to resolution and size differences, all participants completed their test on a flat screen with a 1280×1024 resolution. Each participant followed the same order of maps in a sequence that lasted 10- 15 minutes. The latency of mouse registration time and the software registration were considered; therefore the test was run on hardwares that have similar properties and on the same browser (Google Chrome). Mouse properties were set to equivalent values as well as the brightness and contrast setting of all monitors.

2.2. Tasks, procedures, and data registration

The study is between-and within- user design which investigated users' efficiency of typographic design. Written and verbal instructions were given to participants. Users' performance at each display was recorded once the participant clicks on the target text on the map face. Therefore, the data base combined three categories of information were generated. First category

described the map and the tested visual variable. The second category registered users' reaction time measurements to the tested variable applications (in milliseconds). Finally the third category registered the data from a follow up questioner that describes users' characteristics.

3. Results

3.1. Size

Four consecutive Arial normal sizes were tested (8, 10, 12, and 14). Users' reaction time of locating targets of each size was registered. A statistical comparison between Novices and experts was made by using one-way ANOVA test was made considering the four sizes. No significant difference between both users' group were located (*F=0.793, P=0.374*). Within user's group analyses showed no significant difference in novices' efficiency (*F=0.255, P=0.858*), and a significant difference in experts' efficiency (*F=5.476, P=0.002*).

When considering the Arial bold sizes of 8, 10, 12, and 14 point sizes, a between group analysis showed no significant difference between novices and experts (*F=0.015, P=0.903*). However, within user's group analyses showed no significant difference in novices' responses (*F=0.279, P=0.841*), and a significant difference in experts' responses (*F=6.005, P=0.001*).

The normal sizes were tested in the italic form. This formed four sets of italic sizes (8, 10, 12, and 14) which were tested for both novices and experts. A between users analysis showed a significant difference of users efficiency towards the four italic sizes (*F=4.905, P=0.028*). Within user's group analyses showed no significant difference in novices' responses (*F=1.402, P=0.247*), and a high significant difference in experts' responses (*F=7.389, P=0.000*). Users' responses of size variable are illustrated in Figure 3, it shows the variation of users' efficiency over the four sizes and for the three designs (normal, bold, and italic).

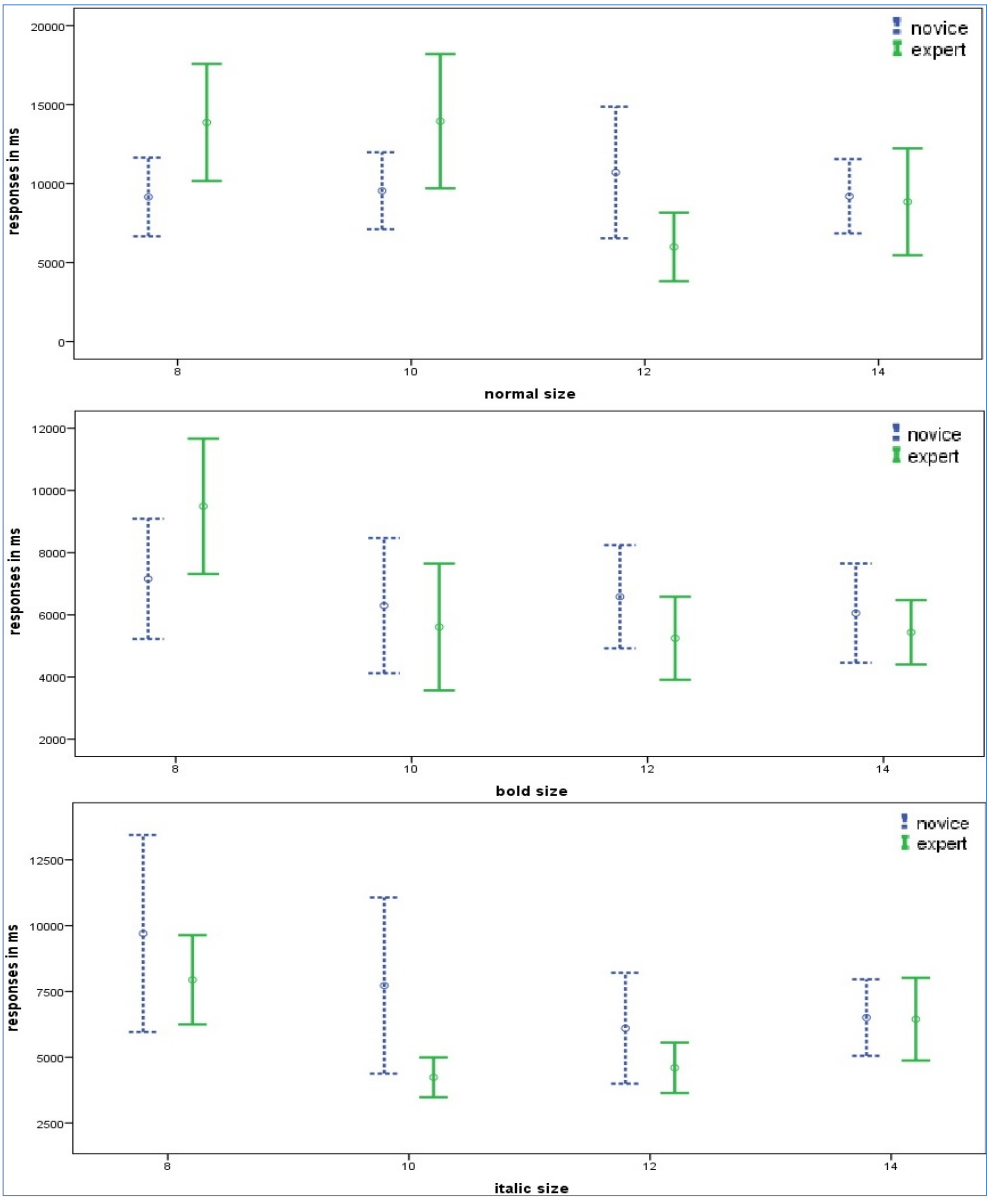

Figure 3. Both users' groups responses of the four tested sizes calculated in milliseconds.

3.2. Shape and Texture

Two basic shapes (serif and sans serif) were tested using size 12 of Arial and Times New Roman (TNR). Three textural designs considering case style

were implemented in this analysis (all letter lower case, first letter upper case, and all letters upper case). A between users' group analysis showed no significant difference of time consumed to locate any of Arial or TNR Targets (*F=0.091, P=0.763*). But, a within user's group analysis was near to significant difference in novices' responses (*F=2.168, P=0.061*), and it was significantly different in experts' responses (*F=4.939,* P=0.000). See Figure 4.

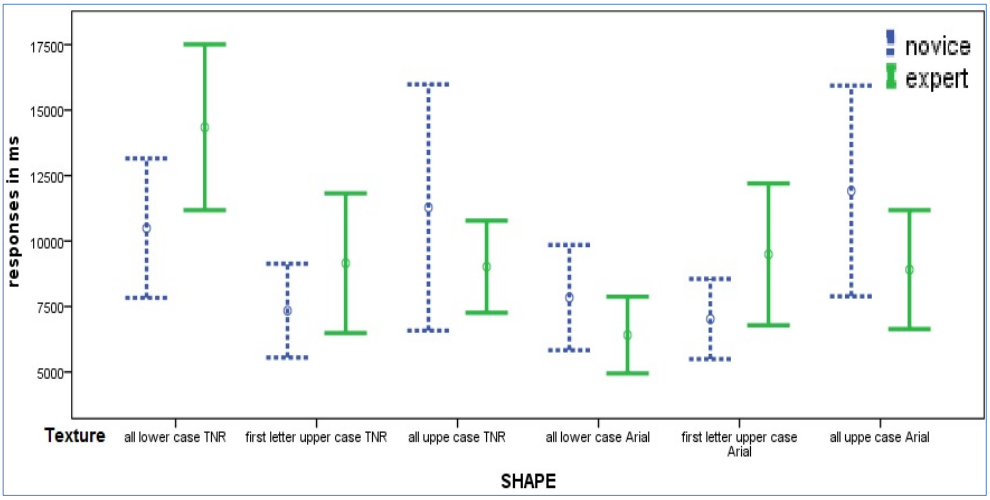

Figure 4. The efficiency measurement of both groups and the three case styles calculated in milliseconds.

Considering the texture of all letters in lower case style and shape differences (Arial vs. TNR), a between group analysis showed no significant difference between the efficiency of novices and experts (*F=0.865, P=0.355*). However, within group analyses showed no significant differences of Arial and TNR for novices (*F=2.692, P=0.107*) meanwhile it was significantly different between expert group (*F=22.043, P=0.000*).

The texture made up of first letter upper case style and Arial vs. TNR, showed that the efficiency between novices and experts was not influenced by the typographical shape as no significant difference occurred between groups (*F=0.000, P=0.993*). Within group analyses showed no significant differences of Arial and TNR for neither novices (*F=0.078, P=0.781*) nor experts (*F=0.034, P=0.885*).

Finally, the texture of all letters designed in uppercase style did not show a significant difference between novices and experts analysis (*F=2.588, P=0.111*). Within group analysis did not show a significant difference for

neither the novices (*F=0.045, P=0.834*) nor the experts (*F=0.007, P=0.936*).

3.3. Orientation

The orientation was studied with areal data, therefore labels were placed horizontally over the district shape, with the diagonal of the district shape (tilted), and finally both were used (mixed). Figure 5 shows users responses of horizontal, tilted, and mixed label orientations. A between users' group analysis showed a significant difference of users' efficiency (*F=5.246, P=0.023*). But, within user's group analyses was near to significant difference in novices' responses (*F=3.022, P=0.055*), and it was not significantly different in experts' responses (*F=2.306*, P=0.107).

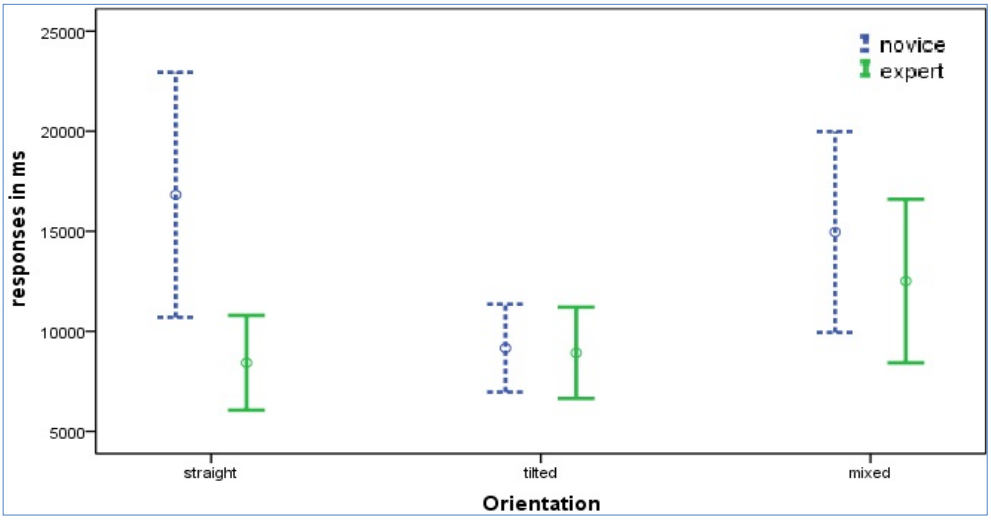

Figure 5. The orientation influence on the efficiency measurement of both novices and experts.

4. Discussion

When visual variables were applied on the typographic design, users' efficiency was influenced by the design of labels. It worth noting that the variable size including both normal and bold did not implement any significant difference between users' groups over the four tested point sizes (8, 10, 12 and 14) but the italic size design did. Besides, size (normal, bold, and italic) showed significant differences within experts users' but there were not any differences in novices' efficiency. This could be a result of the training that experts have received and thus their responses were affected by the different sizes. In addition to that, the efficiency of bold and italic sizes was high-

er than the efficiency of normal sizes. Notice the response scale in Figure 3. This issue stress the fact that both bold and italic made the symbols stand out and more obvious and thus users were able to locate the target faster.

The application of the visual variable shape on typography has a wide range of choices. To limit these choices to the study target, the authors chose Arial as representative of sans serif shapes and Times New Roman as a representative of serif shapes. Both shapes did not influence users' efficiency over the three textural designs. At this stage of research it can be said that the value of shape influence on users' efficiency is negligible, spatially that studying different textures made up of these shapes showed no significant differences between users' groups. In spite of the fact that some significant differences within groups has occurred, further analysis shall be made to set proper explanation of the typographic shapes which can influence users' efficiency.

The orientation of label influenced users' efficiency significantly since experts showed higher efficiency than novices over horizontal, tilted, and mixed orientation. This is highly probable because of the lack of practice that novices have in comparison with experts who use map on a daily base.

This study demonstrates on the efficiency differences between two map users' group considering their level of experience. Therefore further studies need to be undertaken to explain the differences between different users groups based on their gender and age. Besides that, differences in typographic efficiency shall be studied in view point of the use of maps and display medium.

5. Conclusion

Four of Bertin's visual variables were studied to illuminate on two users' group efficiency towards the typographic design. Both size (normal and bold) and orientation showed significant differences over novices' and experts' efficiency, meanwhile shape and texture did not have any significant influence on different users' groups. The study results indicate the needs to modify the typographic design according to users' characteristics to acquire higher efficiency. However, it would be interesting to extend this work to the other two visual variable applications on cartographic text (colour and value), and to investigate situations when it is necessary for cartographer to use colour and different values to indicate functional cartographic elements.

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