CO-081

THE INFLUENCE OF JACQUES BERTIN

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ABSTRACT

This paper investigates the applicability of Bertin's variables -both individually and combined - on texts and labels. A user study was conducted in which two types of map users had to express their preference towards the applicability of these variables on texts and labels. 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 non-experts who have not gotten any previous education in cartography. The obtained data is analyzed statistically to compare the level of agreement in the user's preferences regarding the applicability of Bertin's variables between both user groups. Using the Kappa test as a measure of agreement shows a significant marginal agreement ($\kappa < 0.4$).

Key words: Bertin's variables. User preference. Typeface variations.

BACKGROUND AND OBJECTIVES

Texts are indispensible map components for understanding the map's contents and its purpose. These texts, and more specifically the labels in the map image, can be considered the fourth symbol type in addition to points, lines, and areas which implies that certain rules should be applied in the typographic design (Fairbairn 1993).

Gerber (1981) has included reading labels as a midterm level of the reading process while Robinson and Petchenik (1976) defined the reading as an active process and a transaction between the individual and the environment. Therefore, it is important to know how much information is transferred to each reader. Variations in how the labels are presented on the maps -e.g. size, colour to indicate a hierarchy- facilitate the interpretation of the contents of the maps (Imhof, 1975). But when used wrongly, these variations in the label presentations may also influence the interpretation of the map's contents in a negative way. Therefore, it is necessary to know which type of variation can be used on map labels to bring the message across in an efficient way.

Bertin (1970) has defined six visual variables -size, shape, value, colour, orientation and texture- which can be applied to the symbols on the map to visualise properties of objects or links between objects: order, amount, binding and structure. The position of the symbols has been considered to be the 7th visual variable. Since text can be considered as the 4th symbol type, these visual variables should also be applicable in this case (Fairbairn 1993). The 'translation' of these visual variables to the text symbol type is described below and illustrated in Table 1:

1. Size as a variable is applied on text by changing the font size which consumes more space of the map for larger corpus and less space for smaller ones'. This variation in corpus may indicate levels of hierarchy among the different label classes.
2. Shape is represented by the different typefaces which can be applied on texts, such as texts with serif and without a serif and space in between the letters that reflect on the overall shape in addition to different letters drawing.
3. Text can also have different values, as defined by Bertin (1970): the various degrees between white and black.
4. Colour of text is usually used to differentiate between themes like using the blue for water surface and red for danger etc.
5. Unlike text on books, texts on maps follow many orientations as they go with the flow of the represented phenomenon like a river tilt or county shape.
6. Texture (or Pattern) is represented by a combination of different text characteristics systematically to serve the map purpose at the end. This property can be according to certain hierarchy or associated to distinct labelled themes.
7. The variable position is also applicable on texts since a label can be placed at a number of (fixed) locations relative to its associated objects. For example, Imhof (1975) described the four preference positions of labels associated with point objects: upper right corner –.lower right corner – upper left corner – lower left corner. The investigation of the optimal position for the labels is not discussed in this paper.

In this paper, a variable called arrangement of texts is also discussed. This variable is linked with the overall layout of the word like being italic, narrow letters, wide spacing of the letter and the length of cap/X height.

Table 1: Bertin's variable on text.

variable	Example 1	Example 2	Example 3
SIZE	cartography	cartography	cartography
CONTRAST (VALUE)	cartography	cartography	cartography
HUE (COLOUR)	Cartography(red)	Cartography(green)	Cartography(blue)
SHAPE	cartography	*cartography*	cartography
ORIENTATION	cartography	cartography	**cartography**
ARRANGEMENT	cartography	cartography	**cartography**
PATTERN(TEXTURE)	CARTOGRAPHY Cartography cartography	CARTOGRAPHY Cartography *cartography*	CARTOGRAPHY *Cartography* Cartography

Koch (2001) called Bertin's variable an application of The Gestalt laws these laws describe rules of similarity and of a good design and give it the task of organizing human visual perception. Kraak and Ormeling (2010) described the difference between texts in a book and on a map. Furthermore, they defined some rules for texts on maps to improve their readability and suggested herewith to use Bertin's variable to accomplish a more readable map.

Mackworth (1944) compared the legibility of two different languages then in 1970 Bartz carried out a series of experiments in which participants have to locate names on a map. Foster and Kirkland (1971) studied the association between text and different colours. Phillips and others (1977) compared users response time of different text characteristics.

The previously mentioned studies have investigated the legibility of labels using the amount of time a map user needs to read it. But none of them has considered Bertin's variables and its implementation on textual information on maps as well as its influence on the legibility of the map. All of these studies used paper maps to study different individual text variables and fixation time measurement to indicate the best visualisation text use. Furthermore, no link was made with the application of Bertin's variables to texts. This paper aims to extend these studies by measuring user preferences when applying Bertin's variables to texts, taking into account two different user groups. The main goal of the research is thus to increase the map perception and cognition through better insight of texts and labels using Bertin's variable as a measurement of variation. Since the background knowledge of user's may have an influence on their preferences, two user groups are selected: experts and non experts. The outcome of the study thus reveals whether the cartographic training and practice influences the preference on the readability of labels on maps. This allows differentiating in the variables used on maps according to whom the map is addressed.

The experiment described in the next sections is a user study in which the user has to choose one of two maps which have variations in how the labels are presented (cfr. Bertin's variables). The objective of the whole experiment is answering the following questions:

1- What size do the audience prefer in its ratio to the general space of the map?

2- What is the influence of multivariate typeface on the audience preference?

3- What kind of typeface does the user tend to accept more according to it is whole format which thus is a representative of shape?

4- What kind of associative variables could be applied on different typefaces?

5- What is the influence on one typeface and mixed –typeface maps on user preference in their associative group?

6- Do all users look in the same manner at maps to view and to read?

THE METHODOLGY

Participants

An experiment was constructed to examine whether Bertin's visual variables have the same implementation on texts as other graphical variables. The study is a compression between two groups of users to test whether the influence of these variables is the same on both groups. One group includes 50 non expert map users who have just started their geographical education and have not gotten any previous education in cartography. The other group is formed of 30 experts of map use who work with maps on a

daily basis and have at least a master degree in geography. Having these two groups aims to indicate the difference in map perception and the influence of cartographic education on map readability and legibility.

Task and stimuli

A number of maps are presented to the users during the experiment, which can be subdivided in a number of themes. The first series of the experiment involves maps populated with point data and their associated labels. The graphical variables of size, shape, arrangement and pattern are applied to these map labels to visualize the level of importance in the labels and thus in the associated objects Figure 1. During the second series of experiment, variations in the size, shape, arrangement and orientation of labels associated with areal objects are investigated. Two maps of these experiments are illustrated in Figure 2. Bertin's variables were applied individually and in integrated coherent structure to both series. In order to avoid biases in the answers due to resolution and size differences, all participants had taken their test on a flat screen with a 1280x1024 resolution. Each participant has to follow the same order of maps in a sequence which lasts 20-30 minutes.

These trials are embedded in an online questionnaire in which two maps appears on the screen simultaneously where the participant can indicate the ranking which is subsequently stored in a database. The result is an ordered list of the maps for each participant, indicating his/her preferences on the readability of the maps for the different visualized graphical variables. Thus a series of paired data has been statistically analyzed and other comparisons have been formed.

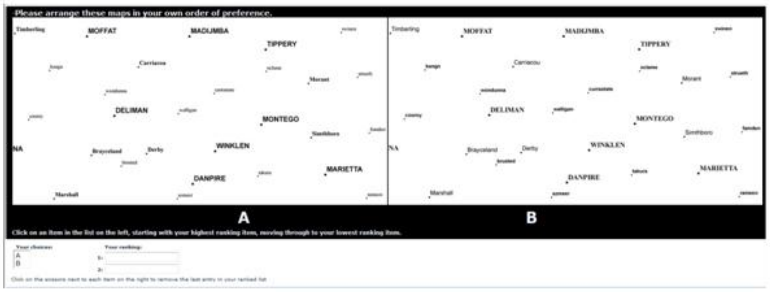


Figure 1: Example of the ranking task for point data (variable: pattern).

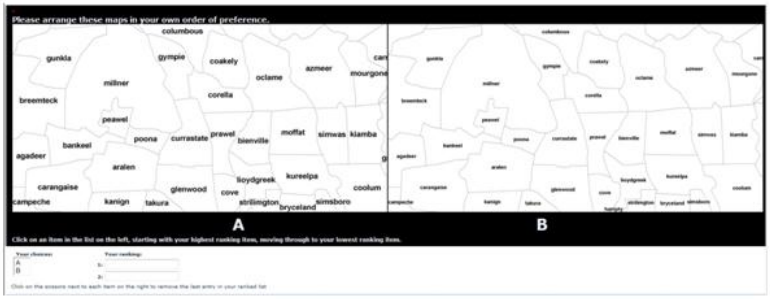


Figure 2: Example of the ranking task for areal data (variable: size).

RESULTS AND DISCUSSION

Size, shape, arrangement, pattern and orientation have been involved in criteria to criteria comparison in each of which frequency of responses was recorded. Statistical analysis investigate if the null hypotheses 'no difference between both user groups' can be accepted. A varying typeface was tested in some maps and combined with other variables to test their influence. The data was gathered in 2×2 contingency tables for comparison and furthermore it has been aggregated to be compatible to each studied variable. Measuring the agreement between the two groups on each compared pair has shown a marginal agreement ($\kappa < 0.4$). The detailed results, grouped per graphical variable, are depicted in Table 2.

Table 2: The results of kappa test analysis for a number of studied variables.

VARIABLE	CHARACTERISTIC	KAPPA
SIZE	Arial 8 bold versus Arial 8 not bold.	0,103
	Arial 10 bold versus Arial 10 not bold.	0,135
	Arial 12 bold versus Arial 12 not bold	0,014
	Arial 14 bold versus Arial 14 not bold	0,036
ARRANGEMENT	Arial 8 italic versus Arial 8 bold italic	-0,022
	Arial narrow 8 bold versus Arial 8 bold	0,114
	Arial 10 italic versus Arial 10 bold italic	-0,03
	Arial narrow 10 bold versus Arial 10 bold	0,21
	Arial 12 italic versus Arial 12 bold italic	-0,126
	Arial narrow 12 bold versus Arial 12 bold	0,066
	Arial 14 italic versus Arial 14 bold italic	-0,095
	Arial narrow 14 bold versus Arial 14 bold	0,01
PATTERN	Arial all capitals versus Times New Roman all capitals	0,07
	Arial all smalls versus Times New Roman all smalls	0,052
	Arial first letter is capital versus Times New Roman first letter is capital.	-0,111
	Arial bold 1-2-3/ Arial bold 1-2-2.	0,026
	Times New Roman bold 1-2-3/ Times New Roman bold 1-2-2	-0,139
	Arial 1 bold-Arial 2 not bold- Times New Roman bold 3/Arial 1 Bold- Times New Roman not bold 2- Times New Roman not bold 3.	0,006
	Arial 1 bold-Arial 2 not bold- Times New Roman bold 3/ Times New Roman 1 bold-Arial bold 2-Arial not bold 3	0,119
	Arial bold 1-Arial not bold 2- Times New Roman bold 3/ Times New Roman 1-Arial not bold 2-arial bold 3	0,024

Size

A fixed size has been proposed to each group presented in both bold and not bold. The results of this experiment are illustrated in Figure 3. The comparison of both user groups shows that the experts and the non experts have an incompatible viewpoint of the bold and the not bold. This was also visible in the Kappa value from Table 2 where the test values ($\kappa<0.4$).

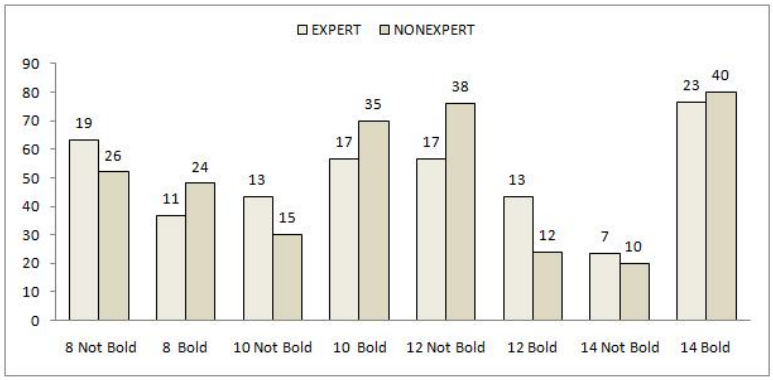


Figure 3: The difference between the expert and the non expert users in their choice of maps at a fixed dot size.

Arrangement

Both of these experiments focuses on simple arrangements (SA; only one formatting type for the texts) and complex arrangements (CA; more than one formatting style of letters occurs). For these experiments the experts have scored higher ratio for the simplest arrangement which rises as the size rises (mean expert= 50 vs. mean non expert =45). For the complex arrangement the results were similar for both groups. This is depicted in Figure 4 as the box plot represents the expert and the non expert users in their choice of map arrangement at a fixed dot size (italic not bold versus italic bold). Simple arrangement (at the left) and complex arrangement (at the right).This figure shows a wide variation between the experts in their choice of complex arrangement (expert CA) unlike the simple arrangement (expert SA). This goes the opposite for the non experts (the variance of non experts choices is much larger for the simple arrangement SA than the variance of non experts complex arrangement CA). In Figure 5 the difference between the expert and the non expert users in their choice of map arrangement at a fixed dot size (italic not bold versus italic bold) is illustrated as a simple arrangement. As well as in Figure 6 the difference between the expert and the non expert users in their choice of map arrangement at a fixed dot size for complex arrangement.

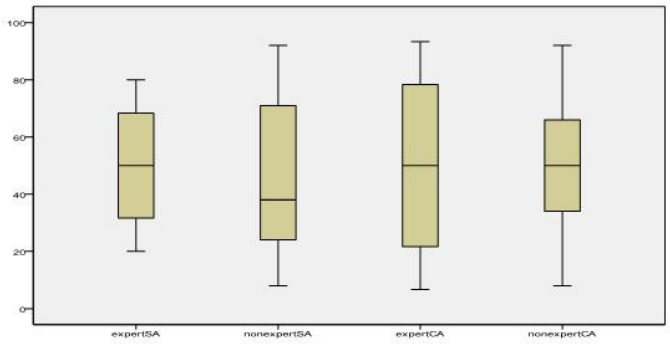


Figure 4: The box plot for expert and the non expert users in their choice of map arrangement.

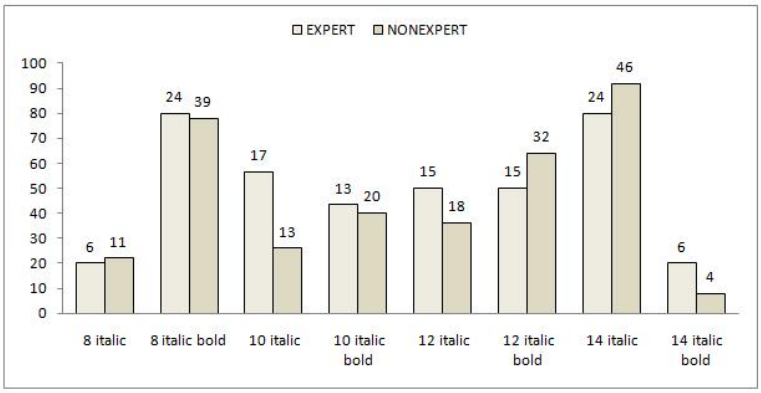


Figure 5: The difference of arrangement choices for a simple arrangement.

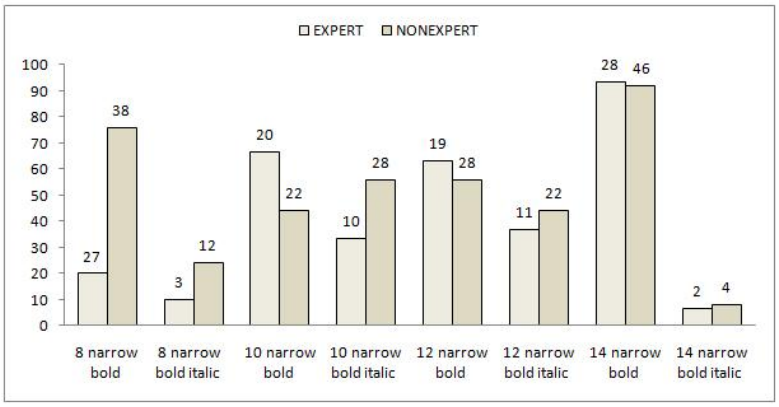


Figure 6: The difference of map arrangement choices for a complex arrangement.

Orientation

Text can be fixed in a horizontal way which resamples reading text of books and it has been a custom this way but in some cases bending the text might be recommended therefore it has been investigated in different shaped areas. In this experiment experts preferred the traditional typical way of alignment. 15-20% difference is expected between the two groups.

Table 3: The difference of expert-novice orientation choices.

Orientation	% Expert	% Non expert	% Difference
Horizontal	83	68	15
Horizontal then Straight	3	18	-15
Straight	14	34	-20

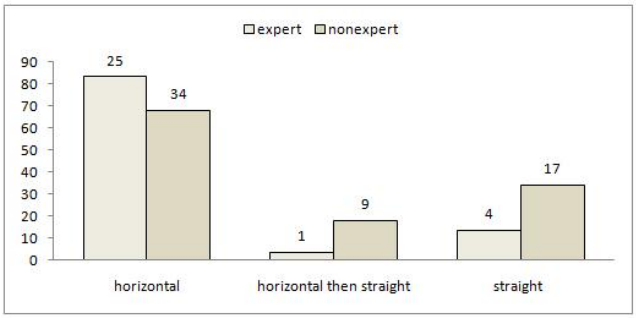


Figure 7: The difference between the expert and the non expert users in their choices of map orientation.

Shape

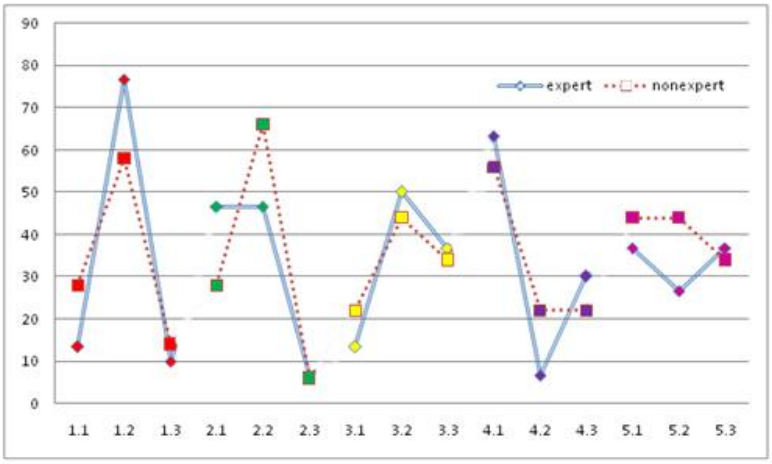
An ANOVA test was used for the purpose of knowing the variance in response for each group towards the items of fonts as the data is formed in threes (Kappa test is not applicable because data are 3×2). Furthermore, it gives more information about the variation within each group and between groups. From this analysis no indication that different fonts results in different preference for both user groups.

Table 4: The ANOVA test for the group of shape.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Expert	Between Groups	,000	4	,000	,000	1,000
	Within Groups	6266,667	10	626,667		
	Total	6266,667	14			
Non expert	Between Groups	129,067	4	32,267	,082	,986
	Within Groups	3933,333	10	393,333		
	Total	4062,400	14			

A more detailed inspection of the preferences within each group shows a trend, which is depicted in Figure 8. The two groups don't coincide at most of the typeface but the overall trend is the same.



Fantasy	1.1	shape differ in the overall characteristic
Formal	1.2	
Srtistic	1.3	
Spacing 0	2.1	shape differ in the spacing between letters in the world from the least to the highest spacing interval
Spacing 1	2.2	
Spacing 2	2.3	
Serif 0	3.1	shape differ in the strength of serif of letters from the least to the strongest serif
Serif 1	3.2	
Serif 2	3.3	
Serif and spacing 0	4.1	shape differ in the spacing and serif of letters from the least to the strongest
Serif and spacing 1	4.2	
Serif and spacing 2	4.3	
Without serif and spacing 0	5.1	shape differ in the spacing and sun serif of letters from the least to the strongest
Without serif and spacing 1	5.2	
Without serif and spacing 2	5.3	

Figure 8: The difference between the expert and the non expert users in their choice of label fonts at a fixed dot size.

Pattern

Pattern is a complex variable to study. It could be a simple pattern for one variable or for mixed variables in on map. Having the experiment for one shape at a comparison between serif (TNR: Times New Roman) and without serif typeface (ARI: Arial) and the case of letters. No agreement between expert and novice in their preference of pattern was found Table 2 that ($\kappa < 0.4$) for all observations. This result could be explained by the cartographic training that influences the experts choice in one hand and on the other hand the majority of the experts group chose the without serif patterns which is considered as un identical choice for a crowded labelled map.

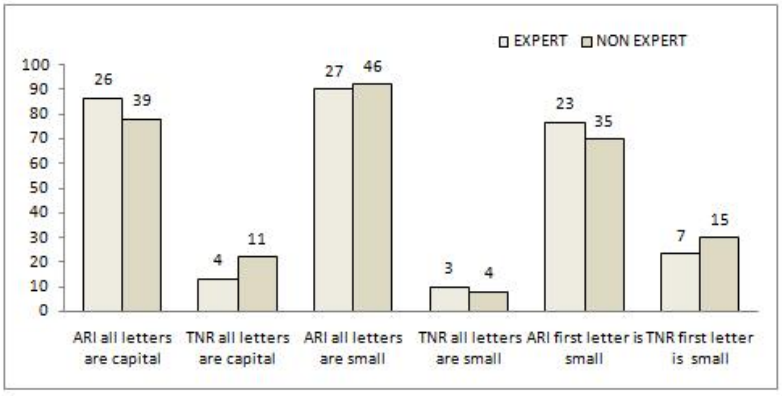


Figure 9: The difference between the expert and the non expert users in their choice of map patterns.

CONCLUSION AND FUTURE PRESPECTIVES

The preference for the studied group (experts and non experts) unsystematically varies between the groups and according to the studied variable. A significant difference was indicated for each pair of text criteria, so no agreement between the expert and the non expert users on a 'best' variable to be considered as a

standard text variable. which in turn assess for the rules of designing map typography in the aspect of addressing the map to different groups of audience.

Size, arrangement, pattern and orientation tests proved that each group have different aspect of typography preference but still the preference of different shapes followed almost the same trend for both groups. The other variables related to text simplicity or complexity showed a difference in the preference trend for each group. In many cases the cartographic education can explain why the non expert goes for the other choice more often.

Both point pattern and area pattern have confirmed the results that different audience requires different usage of text variable, therefore further experiments are on progress that aims to define the criteria each audience prefers according to education, age, gender, culture, etc. Thematic maps with a coloured background will be investigated as well to check if Bertin (1981) theory of "only one variable in addition to the position should be presented on a thematic map" still available on text.

Furthermore, future experiments will include other graphical variables and the influence of dynamic interaction (e.g. panning, zooming) on the map elements. As well as response time measurements will also be implemented in future experiments since they give better insights in the efficiency of the user when working on the maps on which different graphical variables are applied to the text symbols.

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