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Recognition of cartographic styles based on landscape and human-made structures visualizations

GEO 511 Master's Thesis

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Abstract

The current work addresses the significance of different graphical characteristics in the visual representation of topographic maps, which are representative of a specific topographic style. The analysis of its importance is conducted by comparing the national cartographic styles in topographic maps of different countries. Focusing on the color and how the landscape and human-made structures are depicted by each National Mapping Agency while excluding the touristic Points of Interest (POI) and the toponymy, a survey with several maps and questions is designed to answer how the visualization of the landscape and human-made structures contribute to the identification of a topographic style by the map reader. The analysis stresses the supremacy of the landscape and human-made structures over the color in the recognition process. Even though the color was proven in most of the cases to be misleading, the right use of it along with the landscape and human-made structures can be enough to identify the origin of a topographic map.

Key Words: topographic map, cartographic styles, visualization, color, landscape, human-made structures

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Chapter I. Introduction

In the last few years, a number of attempts has been made to analyze the visual representation of topographic maps around the world. In many cases, the main goal was to identify the graphical characteristics which are representable of a specific topographic style. The importance of the visual salient information on the recognition of the national cartographic styles in topographic maps have not thoroughly be analyzed yet. By saying visual salient information, we mean as cited by Ory, J. et al. (2015) the graphic characteristics which are noticeable due to their colour and form or their spatial distribution. The analysis of its importance can be made by comparing the national cartographic styles in topographic maps of different countries.

The countries which are selected are Switzerland and France. According to a cluster analysis on stylistic diversity contacted by Kent, A.J. & Vujakovic, P (2009), the aforementioned countries have several different characteristics on their topographic styles despite of the fact that are neighboring countries. These countries are quite divergent which means that there probably exist substantial differences between the visual salient information depicted. I would like to focus on the color and how the landscape and human-made structures are depicted by each National Mapping Agency and exclude some of the signature information (common graphic characteristics: presentation of relief and touristic POI) and located information (toponymy and typography) as described by Ory, J. et al (2015). By following this procedure, we could get rid of signs that will probably help the map reader to automatically identify the origin of the map. The general results of usability research of maps have showed that participants regardless of the user group perform better when an icon comes with a label due to the fact that an icon have different meaning to different people (Kramers, 2008).

The purpose of such a procedure is to answer to a certain extend some questions. Firstly, I want to give an answer to the general question “Are cartographic styles generally recognizable by map users?” and more specifically “Can national topographic maps be recognized by the corresponded native people?” If yes, how do landscape and human-made structures contribute to that? Excluding the signature information and located information will make the task more difficult but at the same time more specific. Signature information and located information can help the map readers identify the origin of the topographic map without being familiar with the map itself. Finally, it would be vital to recognize if the prior knowledge of the map users on topographic styles determine the ability of identification.

1.1. Motivation

The fundamental motivation for this implementation is the fact that by broadening the analysis on topographic styles it could be possible to reach a bigger goal. The broad idea, which exceeds the goals of the current thesis, would be after recognizing the visual salient information of each country's topographic map to create a tool that can be applied to any national map and alter the visualization according to the user's preference. Assuming that the user is more familiar with his/her country's visualization standards, a foreign map with the latter information would be probably easier to be interpreted. In order to observe this assumption, we should measure the ability to recognize some topographic characteristics like the landscape and the human-made structures, as well as the time needed to do so through a user study.

The application of one's country characteristics on a foreign one would not be only useful for the readability of a foreign map by a common map reader, but it would also be helpful for cross-border projects and policies where at least two different topographic styles should be taken into account.

The reason for choosing only the visual salient information and not the other groups of information (signature information, located information, secondary information) is that latter information is extremely useful to the identification process which means that any change would be confusing and not helpful.

1.2. Research question

The question addressed in this thesis is how the visualization of the landscape and human-made structures contribute to the identification of a topographic style by the map reader. Based on the assumption that the visual salient information and especially landscape and human-made structures are essential for the uniqueness of a topographic map, we will try to gain answers through a user study. By saying landscape, we mean elements like mountains, lakes, rivers and as far as the human-made structures are concerned, we focus mainly on the pattern of roads and cities on small scale topographic maps.

Chapter II. Theory

2.1. Related Work

To begin with, several documents in the literature are discussing ways in which topographic styles can be analyzed so as to distinguish the characteristic of each one. Before analyzing these specific characteristics of a topographic map, we will underscore some main aspects of a map in general.

Maps are selective representation of a combination of real-world spatial relations and abstract symbols. The final visualization is used in a way that can communicate certain messages relying on the data depicted. For that reason, the task of a cartographer, who makes paper maps, is to find the optimal depiction for the intended message as long as there is no capability of interaction. A vital point in order to correctly create a map is the understanding of what visual thinking and visual communication are (Dibiase, D. et al., 1992, Nöllenburg, M., 2007).

Visual thinking is exploratory and refers to the mental information processing through images while visual communication is explanatory and is used to provide information and ideas using symbols and imagery. Humans communicate by using words, but these words are connected to our environment through vision. As Aristotle had said, the soul never thinks without a picture. The aforementioned quote can describe the connection between words and images. As far as topographic maps are concerned, the visualization should not aim to the creation of new images but to the use of existing images to generate the desired message (Dibiase, D. et al., 1992, Nöllenburg, M., 2007).

In the following subsections, we will briefly analyze some important aspects of maps. Firstly, the categorization of the maps will be underscored. In addition to that, the cartographic style will be analyzed along with its graphical characteristics, the color, the visual hierarchy, the landscape aesthetics and the spatial abilities. All these are vital aspects that should be taken into account when a map is designed.

2.1.1. Maps' categorization

According to the level of freedom of graphic expression, the maps can be divided into five (5) groups as it is cited in the table below.

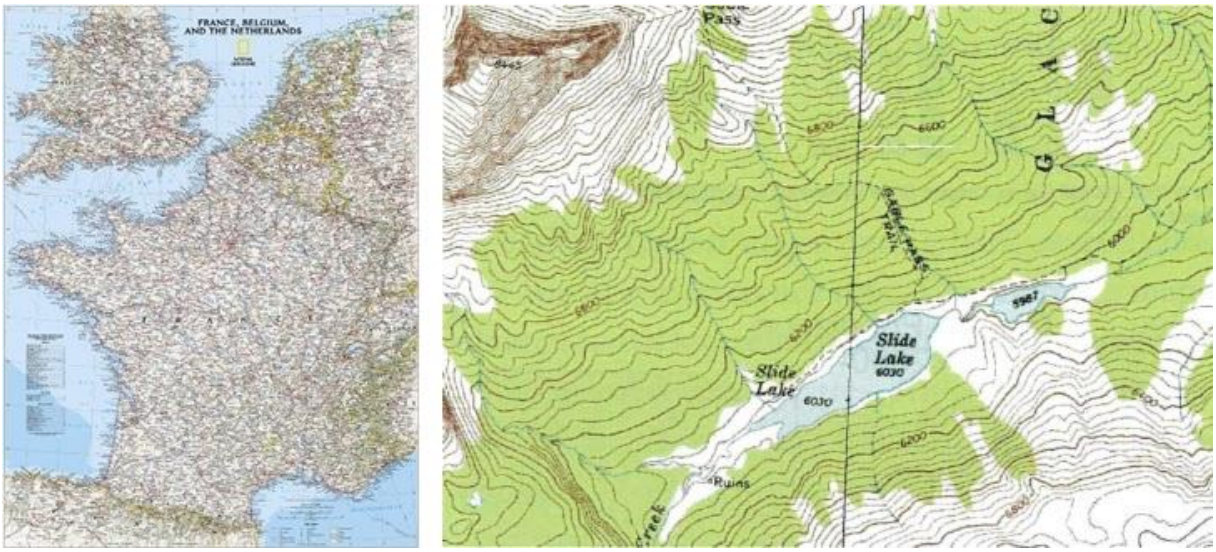
Table 1: Map's categoration -Graphic expression

Graphic expression & Maps
1.General Referene map
2.Topographic map
3.Thematic map
4.Navigation map
5.Cadastral plan

Source: Beconyte, G., 2005, ICSM, 2017

The first group is the general reference maps which are an accurate representation of the world, having high level of stadardization (e.g. touristic and road maps). General reference maps (Figure 1) are the type of maps used to emphasize the location of spatial phenomena and to depict many types of features. They emphasize the location and names of phenomena in the environment (e.g., road maps, maps found in atlases or on walls in classrooms, etc.) and show physical and human made features such as water bodies, rivers, coastlines, settlements, road networks or other environmental features (Slocum et al., 2008, Kimerling et al., 2009).

Figure 1: General Reference Map (on the left side) & Topographic Map (on the right side)



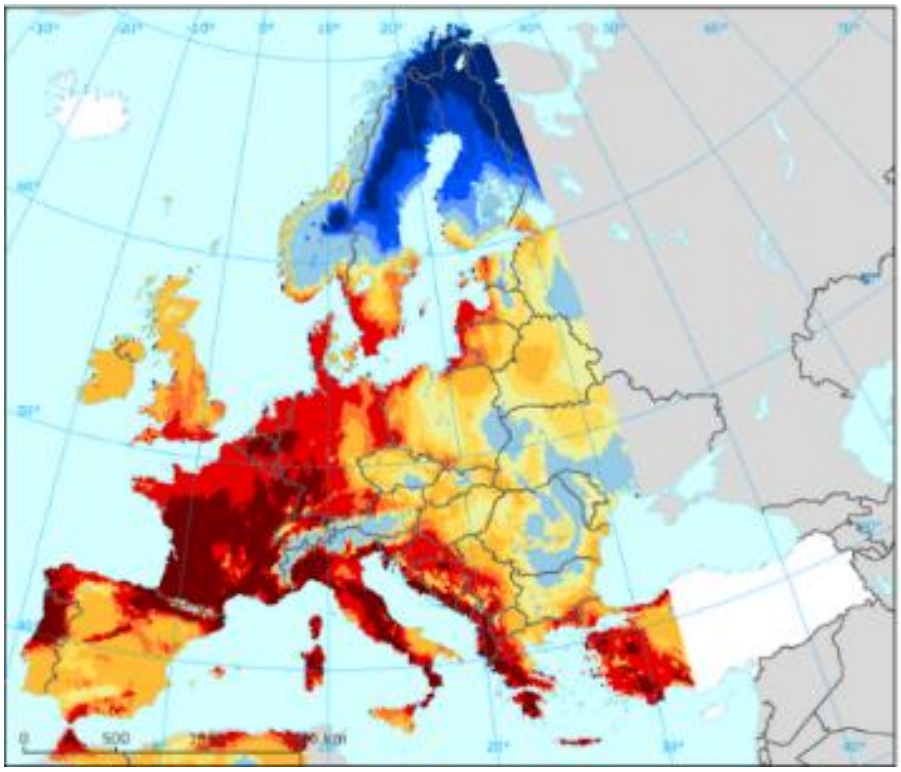
Source: www.abebooks.com, Kimerling et al., 2009

The second group consists of the topographic maps (Figure 1) which are similar to general reference map with the main difference that they use contour lines to portray the elevation and

the shape of the land while they are used by professional and recreational map users. Topographic maps show the physical and human made features on the earth's surface, including the shape and elevation of the land portrayed with contour lines. Topographic maps are typically produced by National Mapping Agencies (i.e., Swisstopo, USGS, OS, etc.) in as series at different scales. (Slocum et al., 2008, Kimerling et al., 2009).

The third is thematic maps which in comparison to the previous two groups are focusing to specific types of features. Thematic maps (Figure 2) are maps used to display the spatial distributions or patterns of themes or attributes in a particular area (e.g., temperature and wind speeds in weather maps, population distribution maps with census information, income distribution maps, etc.) (Slocum et al., 2008, Kimerling et al., 2009).

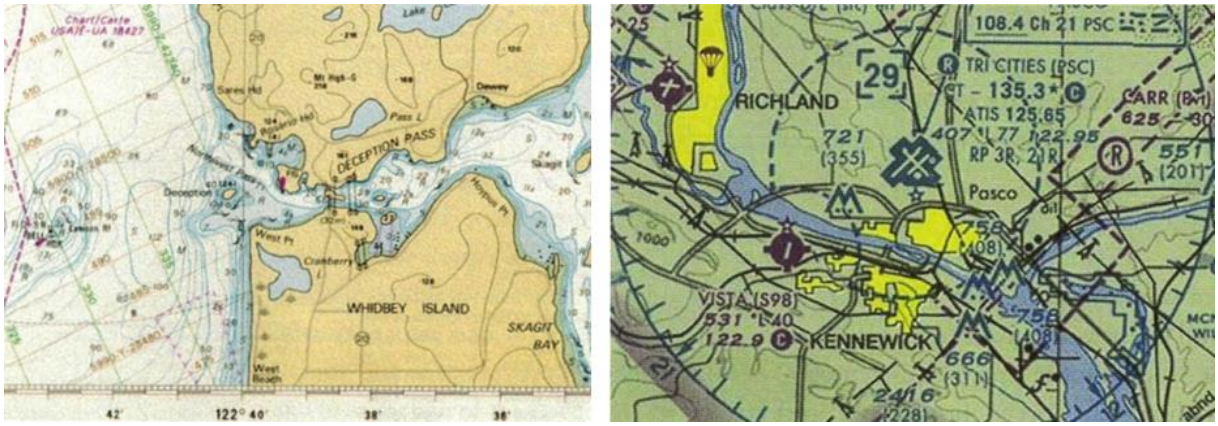
Figure 2:Thematic map



Source: www.eea.europa.eu

The next group is the navigation maps (Figure 3) which combine aspects of the aforementioned groups and are used as navigation aids in land, water and air. Many of these maps are called charts as they are designed to help navigators in ships, boats and aircrafts to follow a planned route (Slocum et al., 2008, Kimerling et al., 2009).

Figure 3: Navigation Maps (On the left Nautical chart and on the right Aeronautical chart)



Source: Kimerling et al., 2009

The last group is the cadastral plans and maps which are an accurate description of parcels of land and its property titles (Beconyte, G., 2005, ICSM, 2017).

There are three (3) main parameters in order to identify the map style of maps mentioned in the groups above. These are the decorativeness, the expressiveness and the originality (Beconyte, G., 2005).

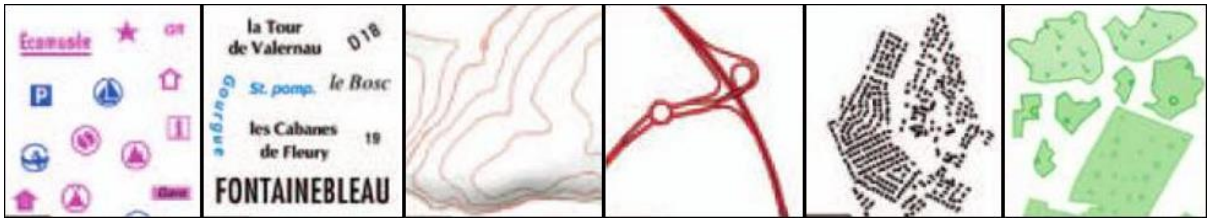
2.1.2. Graphical characteristics

Graphical characteristics are essential to the recognition of a topographic style not only by visual memory but also by visual perception. All characteristics depicted on a topographic map can be categorized as follows (Ory, J. et al., 2015):

1. signature information
   (representation of relief, touristic points of interest)
2. visual salient information
   (color or spatial distribution, representation of main roads, built-up areas and forests)
3. located information
   (toponymy, typography)
4. secondary information
   (the rest of graphical characteristics)

Among the aforementioned characteristics, according to a study conducted, the map reader finds vital for the stylistic recognition six (6) characteristics (Figure 4). These are the representation of touristic points of interest, the toponymy, the typography, the main roads network, the individual buildings and the forests. We should mention that graphical characteristics can be described as a visual stimuli which influences the map reader's visual perception and memory (Ory, J. et al., 2015).

Figure 4: Main six characteristics for stylistic recognition



Source: Ory, J. et al., 2016

2.1.3. Cartographic style

As far as the cartographic style is concerned, it can be considered as a tool to express something through it. The geographical information is rendered based on specific history, practice of cartography and available map-making technology. The content and the appearance are used in various combinations which are dependent on national landscapes, habits and cultural aspects. Each country has its own color schemes rules, contrast rules, as well as semantic rules (Christophe, S., 2011, Raposo, P. & Brewer, C.A., 2014).

Topographic maps produced by different National Mapping Organizations (NMOs) do diverse in style. This diversion can partly be explained by the fact that a topographic map is socially constructed and portrays ideas, beliefs, climate, vegetation and the economy of the corresponded country. At the same time, NMOs add their personal "signature" which makes the map unique by having their own generalization methods (Kent, A.J. & Vujakovic, P., 2009, Ory, J., Christophe, S. & Fabrikant, S.I., 2016).

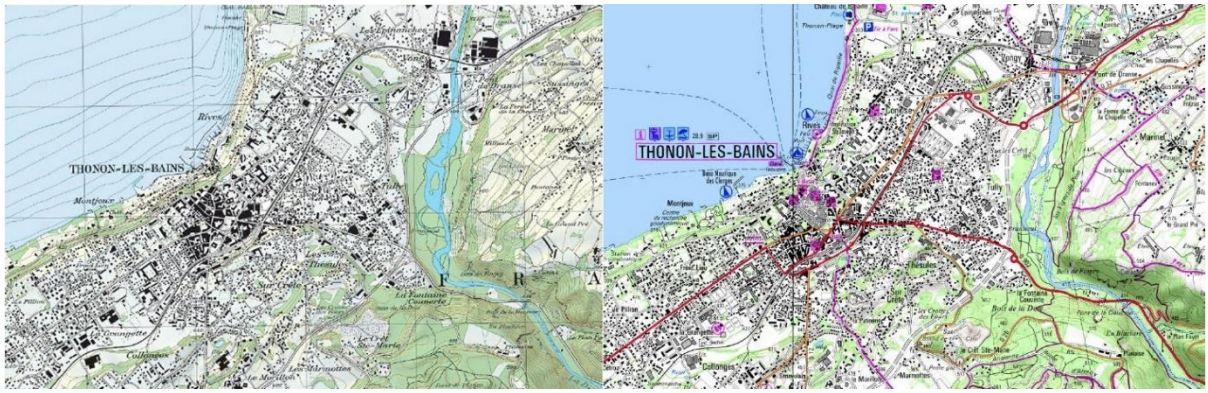
In any topographic map, there are some vital aspects that determine the cartographic style which are also related to the map user's preference. Some of them, which will be analyzed in the following sections, are the color, the visual hierarchy and the landscape.

2.1.4. Choice of color

The choice of the colors used is very crucial as even a small region of the map filled with a color can totally change the map's appearance. The different map color schemes can influence the likeability of a map and for cartographic expertise, they can trigger emotional responses if they are unusual. As cited by Christophe, S. (2011), "colours choices may disturb the reading and understanding of maps" (Kent, A.J. & Vujakovic, P., 2009, Fabrikant, S. & Christophe, S., 2012).

The color use intends to create a mental image of the characteristics depicted on the map. For instance, if the mental image of the forest for a map reader is green, then the colour used should not be too diverse by this mental image because it can disturb the reader of the map. Figure 5 below depicts a french region with two different visualizations. The right one is according to the IGN visualization's standards and the one on the left is according to the Swisstopo visualization's standards.

Figure 5: French region - IGN & Swisstopo



Source: Ory, J., 2016

Choosing correctly the correponding color does not mean that there would be a color harmony. Many criteria should be taken into account to create the right colours combinations. The color distances are vital to the map readability and according to a study conducted, the larger color distances do improve the map readability (Brychtova, A. & Çöltekin, A., 2014). In addition to that, being "informationally effective" is crucial as ambiguity issues can lead to map's unreadability (Kent, A.J., 2005, Christophe, S., Zanin, C. & Roussaffa, H., 2011).

In the figure below, the same region is depicted with different color schemes in order to underscore the major change that can be made on a map by altering the colors.

Figure 6: Same region with different color scheme

Source: Ory, J., 2016

2.1.5. Visual hierarchy

Except of the color's importance, visual hierarchy is fundamental to the map's appearance which is highly related to the country's characteristics (Kent, A.J. & Vujakovic, P., 2009). Having different visual hierarchy on a topographic map can really change the visualization and alter the cartographic style. The display design reflects on the viewing behavior and the response time while reading a map (Fabrikant, S.I., Hespanha, S.R. & Hegarty, M., 2010).

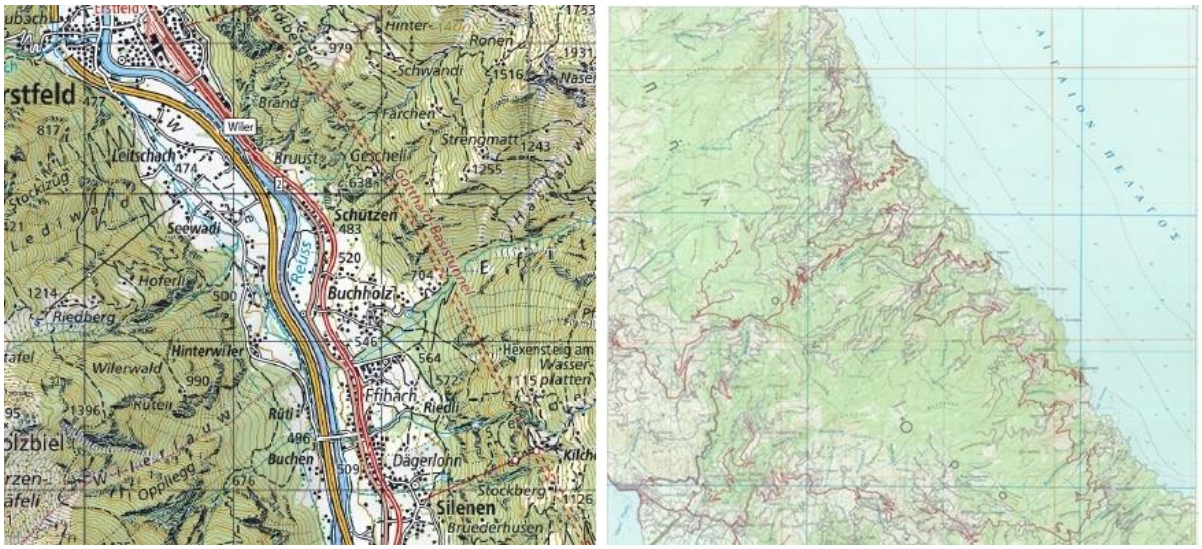
There are several examples of visual hierarchy rules that make topographic maps diverse to each other. For instance, on the one hand a country which has dense railway system, like Switzerland, does not highlight it while on the other hand, a country with a poor railway system, like Greece, does so. This differentiation in the railway network categorization but also in the cases of the road network or the labeling of regions do alter the overall visualization of a topographic map and establish a unique topographic style for each country. By having different categorization of roads or labels, the visualization differentiates in a very noticeable way. Figure 7 is an example of how labeling can highlight or not various regions of a country while Figure 8 depicts the different visualization of the road network in two different

Figure 7: Visual hierarchy - Labeling

Source: www.ordnancesurvey.co.uk

countries along other differences in the labeling and generalization despite of the same scale used.

Figure 8: Road network – Switzerland (left) & Greece (right)



Source: Swisstopo, HMGS

2.1.6. Landscape aesthetics

As far as the landscape aesthetics is concerned, Raposo, P. & Brewer, C.A. (2014) have mentioned that the person's culture and demography have an important role to the landscape preferences as well as some ecological and geomorphological aspects with which the person is familiar with. Diversity on the preferences are also related to different ethnicities, subcultures and to demographic features such as age and gender.

Furthermore, the landscape of the country depicted influences the visualization of the topographic map. The map is made in such a way that will highlight the landscape properly. As Kent (2005) have aptly mentioned "Topographic maps have the shape and pattern of the landscape as their subject".

2.1.7. Spatial abilities

Spatial abilities are an important aspect of human intelligence and vital for a number of professions such as physical scientists, architects, urban planners and engineers. All these professions need to visualize several objects to properly apply their work (Albert, W.S. & Golledge, R.G., 1999).

Spatial abilities are categorized as follows:

1. spatial orientation
2. spatial visualization and
3. spatial relations

Spatial orientation is the ability to imagine how a visual configuration looks like from different perspective. Spatial visualization refers to the ability to mentally manipulate a spatial configuration and spatial relations refer to the analysis of "patterns, shape, layout, hierarchy and linkage between individual stimuli within a visual configuration" (Albert, W.S. & Golledge, R.G., 1999, Hegarty, M. et al., 2010).

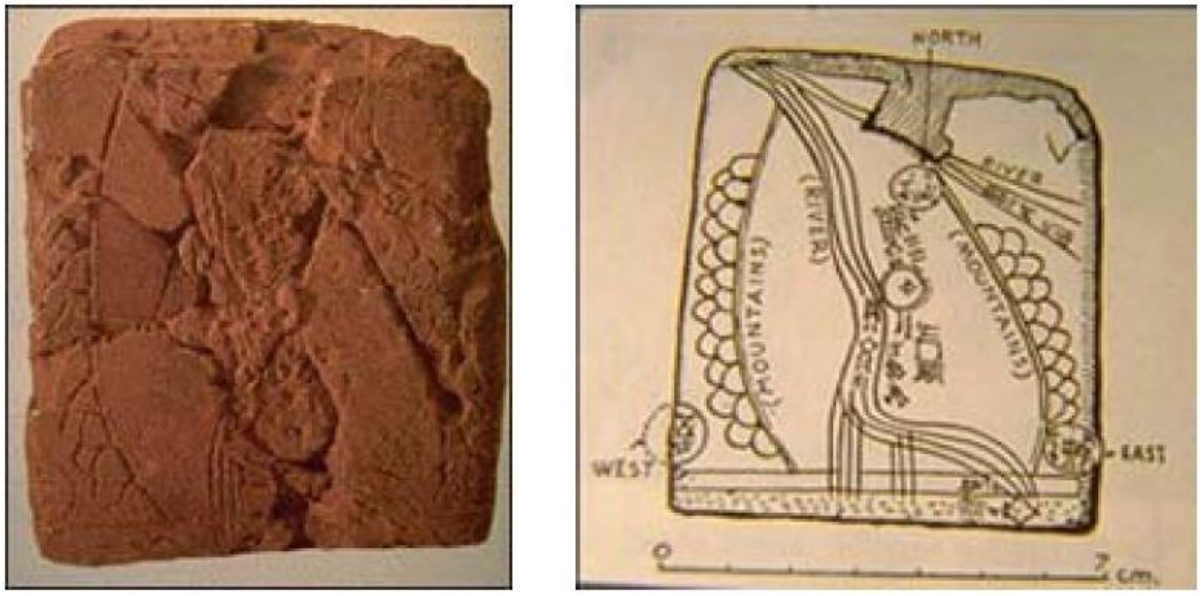
Spatial cognitive abilities can be a reason for the map user to easily identify a map due to the fact that the map reader might be able to easily remember the layout of a specific map and distinguish it among different maps. For that reason, we should always take into account what kind of map reader will use the corresponding map and not only try to augment the visualization. It is of major importance to also consider the type of spatial intelligence which is needed to read the map. According to the aforementioned way of thinking, a topographic map for civil use ought to depict the graphical characteristics and the symbols in an understandable way (Albert, W.S. & Golledge, R.G., 1999, Hegarty, M., 2010).

2.2. History of topographic maps

Before briefly present the history of topographic maps, it would be useful to analyze the term "topographic map". As we have already mentioned the definition of the map, we should only explain the term topographic which derives from term "topography". The term topography originated in ancient Greece and comes from the greek topos (in greek: τόπος) which means place and -graphia (in greek: γραφία) which means writing. In other words, topography is the written description of a place (Michaelidou, 2004).

Topographic maps date back thousands of years ago, but not obviously in the contemporary form we are used to. It is argued that the very first maps might appear before the discovery of Writing and it was a mean of communication for the primitive people. Maps were used by several civilizations such as Eskimos, Aztecs, Greeks and Romans. In the history of Cartography, the first samples of topographic maps are in Mesopotamia where the oldest map was found. The Akkadian map of Ga-Sur (Figure 9), as it is known, dates back to 2500 BC (Michaelidou, 2004).

Figure 9: Akkadian map of Ga-Sur – 2500 BC



Source: Michailidou, 2004

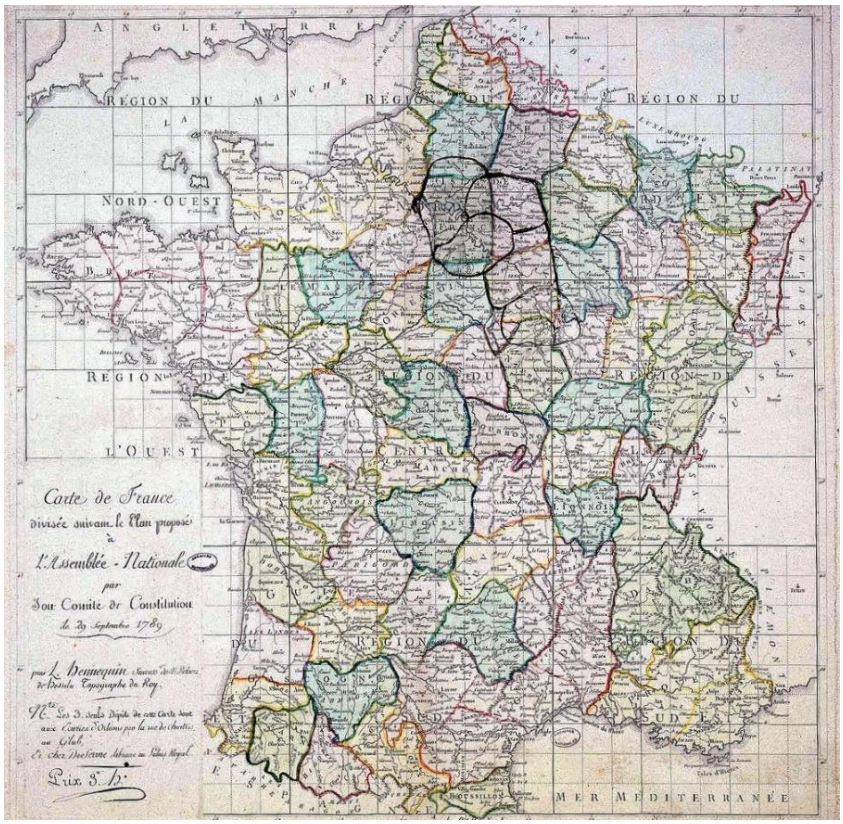
After the maps of Mesopotamia, maps were used in Egypt, Greece and Roman in a chronological order until the Renaissance of Cartography between 1400 – 1600 and the recent development after the 18th century until now (Michaelidou, 2004).

Having cited a short history of topographic maps of the world, we will have a brief overview of how and when the topographic maps of the two countries, that we will analyze, have been produced, would be essential before analyzing the methods. As you might notice below, the topographic map of each country, as it is mentioned in the literature review, has developed in different ways in comparison to other countries for many reasons. The two main reasons that are highlighted below are the time and the map-making technology available which diverse between countries.

2.2.1. French topographic map

In France, the first general maps are the Cassini maps made during the 18th century. Survey maps were produced between 1756-1789 and were published until 1815. In the following years, was Napoleon I who demanded new, more accurate maps which were made between 1825-1866. The scales chosen in these maps had to be changed at the beginning of the first World War as the former ones were not so convenient to read. In 1950, National Geographic Institute - IGN (in French: Institut Géographique National) produced the first topographic map in scale 1:50.000. As for now, IGN, which is a public state administrative establishment, is responsible for the maintenance and the update of the French maps (www.ign.fr, www.cartesfrance.fr).

Figure 10: Map of France from 1789

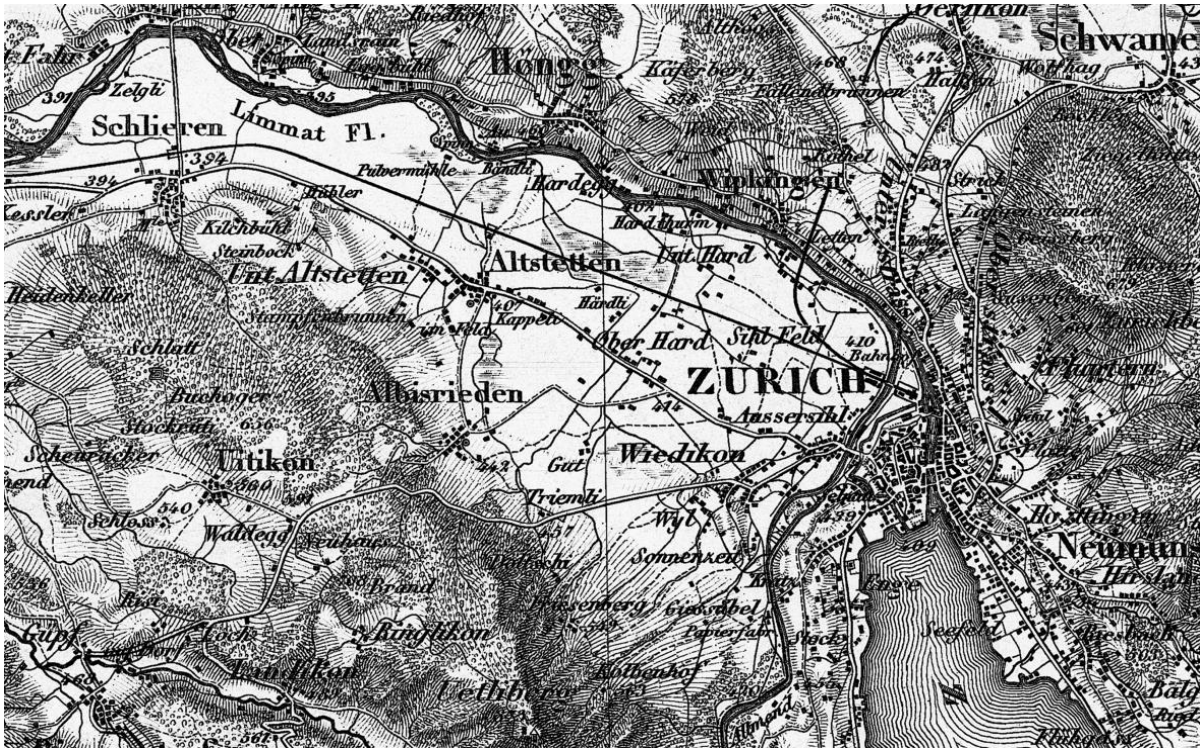


Source: www.cartesfrance.fr

2.2.2. Swiss topographic map

As far as the Switzerland is concerned, the first complete attempt for mapping and surveying the whole Switzerland began in 1832. The final map consisted of twenty-five (25) sheets at the scale 1:100.000. The first surveys were not so detailed and for that reason, Dufour, the Director of Surveys, conducted detailed surveys right after the general ones. All the maps and surveys were finished by 1861. From 1845 to 1865, all the copies of the topographical map of Switzerland were printed. The current mapping Agency of Switzerland is the Federal Office of Topography swisstopo (in German: Bundesamt für Landestopografie) (www.swisstopo.admin.ch).

Figure 11: Topographic Map of Switzerland from 1861



Source: www.swisstopo.admin.ch

Chapter III. Data & Methods

3.1. Data

The data used for the implementation of this project are topographic maps 1:50.000 in vector format for the countries of Switzerland and France. The vector data were provided by the National Geographic Institute in France and consists of three French regions and one Swiss region. The French regions are the commune Saint-Jean-de-Luz and the commune Bayonne in south-western France as well as the town Thonon-les-Bains with its surroundings in the Auvergne-Rhône-Alpes region in eastern France. The swiss region is the town Sursee with its surroundings in the canton of Lucerne.

As far as the initial vector data is concerned, the layers of the topographic maps were provided in shapefiles and the styles for the visualization in xml (Extensible Markup Language) format. The program used in order to design the maps was QGIS and as we have previously mentioned, toponymy and Point of Interest were excluded from the layers used. As long as the program QGIS cannot read xml files, all xml files for the styles had to be converted to sld (Styled Layer Descriptor) format which is compatible with QGIS. There is no automatic converter to implement this kind of conversion and for that reason the conversion had been made from scratch. The process followed was the comparison of an xml file to a sld file for QGIS. Having observed all the differences, we wrote a code to change accordingly all the files. The part of the files which were not readable by the program were added manually using the program interface.

The raster topographic maps of the two countries can be accessed via the website of Swisstopo (https://map.geo.admin.ch) for Switzerland and via the website of Gèoportail (https://www.geoportail.gouv.fr/carte) for France.

3.2. Methods

The evidences needed to understand the importance of the landscape and the human-made structures to the recognition of a topographic style are collected through a web questionnaire. The web page “www.onlineumfragen.com” was used to create the questionnaire and the respondents that I wanted to reach are mostly people who frequently interact with maps in their everyday life. For that reason, I aimed to reach geographers and engineers of the corresponding countries but also of other countries. By comparing and contrasting cartographic styles of Switzerland and France and answering to specific questions, I want to extract some vital outputs.

3.2.1. Overview of Web questionnaire

The web questionnaire is divided in the following four (4) parts:

1. Questions on Maps
2. Recognition of cartographic styles
   - Recognition of cartographic styles – Switzerland
   - Recognition of cartographic styles – France
   - Recognition of cartographic styles – Comparison using IGN
   - Recognition of cartographic styles – Comparison using Swisstopo
   - Recognition of cartographic styles – Roads & Buildings
3. Map Memory Test
4. Background questions

3.2.1.1. Questions on maps

Firstly, the participants will have to answer, in the part "Questions on maps", six (6) general questions on maps. The first two questions are about their profession in relation to maps in general, where the third is about leisure time and maps. After that, there are two (2) questions about preference and accessibility between general reference maps, thematic maps and topographic maps. The last question is about the topographic maps' usage frequency in their daily life.

The purpose of this part is to gain a broad idea on how familiar are the respondents with maps, in particular with topographic maps. The overall distribution of the answers will be used to partly explain the responses of the following part, "Recognition of cartographic styles".

3.2.1.2. Recognition of cartographic styles

Having collected some general data about the familiarity of the participant with maps, the main part of the questionnaire follows. The main part consists of the parts Recognition of cartographic styles – Switzerland, France, IGN, Swisstopo and Roads&Buildings. The order according to which these parts are presented to each participant, as well as the order of each question's answers, are randomized. Having all these four (parts) randomized eliminates the possibility to have a bias due to the order of the showed maps.

The parts "Recognition of cartographic styles – Switzerland" and "Recognition of cartographic styles – France" have the same structure. They are about landscape and color and how these two characteristics can help the participant identify the origin of a map. In these questions, there is another visualization of each country's map according to the color schemes of the other country, excluding toponymies and points of interests. For instance, one question has the original French map and another version of it with the swiss color schemes. The participants are asked if they know the topographic map of the country before they see the two maps and

afterwards they have to identify the original map among the two visualizations. In each part, there are four (4) questions with different regions depicted on the maps as well as a question where the participant can use a slider – swipe tool and change the visualization manually. In the end, they mark which geographic features and design elements helped them to identify the map.

The next two parts have to do with landscape and more specifically the lake and the ocean. In the part "Recognition of cartographic styles – Comparison using Swisstopo", a French map with the swiss style depicting a part of the ocean and a Swiss map depicting a part of a lake will be shown. In the part "Recognition of cartographic styles – Comparison using IGN", the same logic is followed using the IGN color schemes in both maps. In addition to that, in each part there are two more versions of the footprint chosen where the one depicts only mainland as well as a question with the swipe tool as it was used in the previous two parts. These questions aim to give an insight to what extent a lake and an ocean can be a reason to identify a region. Once again, in the end of each part, the participants mark which geographic features and design elements helped them to identify the map.

The last main part of the questionnaire, "Recognition of cartographic styles – Roads & Buildings", is about human-made structures and more specifically about city grids and road network. The participants have to assign the correct country between two maps on the screen where an area of each country will be shown in black and white having highlighted only the cities and the road network in-between. This part includes two questions about maps and two questions about which geographic features and design elements helped the responders to identify the map. For one more time, the goal of the question is to find out to what extent the pattern of the roads between the cities and the cities themselves can be a reason to identify a country without getting feedback from any color schemes.

As far as the position of the maps is concerned, we have arranged them one next to each other. The reason for doing that is while showing maps one after the other, there is a possibility that the phenomenon called "change blindness" might occur (Fish, C., Goldsberry, K.P. & Battersby, S., 2011). To eliminate the possibility that the responders are not able to detect visual changes of scene transitions, we will not use dynamic maps of the two countries, but we will position each map next to each other for the map reader to be able to compare and contrast.

In the end of the survey, the participant can see a score for this section. The total score is the number of maps which the participant identifies correctly minus the number which he or she

identifies incorrectly. The total number of maps is 20 which means that the score ranges from -20 to 20.

3.2.1.3. Map Memory Test

Having collected all the necessary data on the cartographic style recognition, the respondents will have to answer a spatial ability test on map memory. According to a study conducted by Wakabayashi (2013), "answering questions on large-scale topographic maps is entirely affected by the spatial abilities of the respondents" which highlights the importance of having such a measurement as a part of the questionnaire in order to eliminate any bias and subdivide if necessary the sample. The spatial ability test chosen is from "Manual for kit of factor-referenced cognitive tests" of Ekstrom, R.B.R. et al. (1976).

The Map Memory Test measures map memory by asking to identify maps, which were previously presented on a study page, among others. Initially, it was consisted of two parts where the respondent has three (3) minutes for memorizing and three (3) for testing. In order to fit the maps on the web questionnaire and avoid scrolling down the webpage, which might affect the ability to memorize the maps, we divided the parts in half. In addition to that, we randomized the order of the answers for each participant to prevent any bias effect. The new version consists of four (4) parts where the respondent has 90 seconds for memorizing and 90 seconds for testing. In total, it will last twelve (12) minutes plus one (1) minute for the example in the beginning where the procedure is explained. The total score will be the number of maps which the participant identifies correctly minus the number which he or she identifies incorrectly. Therefore, it will not be to her/his advantage to guess unless he/she has some idea of whether or not he/she has studied the map. The total number of maps is 24, of which 11 maps are correct and 13 are wrong. According to that, the highest score possible is 11.

3.2.1.4. General Questions

The last part of the questionnaire, "General Questions", is about general personal questions about gender, age, home country, country where they have lived most of their life, mother tongue, highest level of School and field of study.

The gender can always be a role of classification as it has been noticed in numerous relevant studies due to the fact that male and females have the tendency to perform differently in some tasks. At the question about the age, we used the most common categorization of ages groups in demography with 5-year interval avoiding having the participant specify their exact age. The reason for choosing age groups is that the participant would be more willing to answer such a

general question and it would be also suitable for our analysis process. After that, along with the question about the home country, we also ask about the country where they have lived most of their life as this can have an effect on the map relevant knowledge. Following up the sorting of this part, the mother tongue is also of major importance as the home country. Last two questions about the highest level of School and the field of study are one of the most important as they can influence, according to the literature, the ability to answer correctly questions related to maps.

All the aforementioned general questions along with the questions of the first part are necessary to detailly explain the answers of the main part of questionnaire as well as the score in the Map Memory Test.

In this part, there are two more questions on color blindness and about the device used to fill in the survey. The reason of choosing the aforementioned questions is that we want to exclude the participants, who have color blindness as the survey deals with color schemes and also those who have used mobile phone as the screen size is not adequate for the specific study.

3.2.2. Statistical approach

The statistical approach chosen will have the following steps. At the very beginning, an overview of the characteristics of the sample based on the part "Background questions" will be highlighted with the proper plots to gain a general overview of the sample. Along with the part "Background questions", the part "Questions on maps" will also be depicted.

Having a first look at the two aforementioned parts, the general results on the ability to recognize cartographic styles will be underscored based on the part "Recognition of cartographic styles". For each question of this part, the mean score of each participant will be calculated as well as the overall score of each part. The mean scores will be used to detect any significant difference or correlation in the results. Before any further analysis, the distribution of these mean scores will be checked to see if we have normally distributed data or not. After that, a comparison analysis of the mean scores will be run between the results of the ability to recognize cartographic styles and some of the general characteristics. In addition to that, the mean score of each part will be compared, having divided the sample based on the nationality, the gender and the field of study/work.

The next step will be to present the Map Memory Test results and if any significant results would be noticed, the sample will be again analyzed based on the new categorization. Furthermore, an analysis of the feedback provided by the responders on the geographic features and the design elements which helped to the identification of the maps. Last but not least, in the French and Swiss recognition as well as comparison parts, the usability of the slider will also be measured in comparison to the side by side comparison method. For all these comparisons, the corresponded analysis tool will be used based on the sample's distribution.

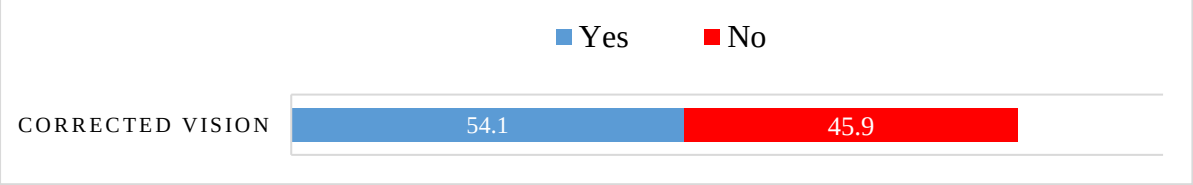
The programs used during the preparation of the data and the analysis are Matlab, QGIS, SPSS and GPower. Matlab was used for the preparation of the xml files for the maps, QGIS for the map-making process and SPSS along with the GPower for all the statistical analysis.

Chapter IV. Findings

4.1. Overview of the sample

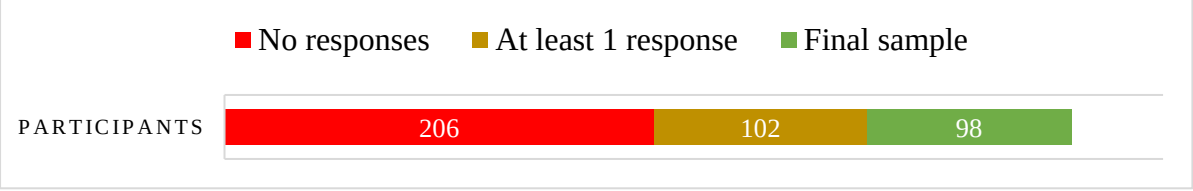
The web questionnaire, which is cited in the appendix, was online for the period 21.09.2017 – 17.10.2017. Four hundred six (406) people had opened the questionnaire but only two hundred (200) have answered at least one question. Some of the participants had to be excluded due to several reasons. Two participants used a mobile phone device to fill in the survey, which was not the proper screen size for this study, 1 participant had incorrect colors depicted due to screen deficiency and another could not open some links of the survey. Forty-five per cent (45%) of the participants used Chrome browser to fill in the survey and spent on average thirty (30) minutes to complete it. Fifty-four per cent (54%) of the participants have corrected vision but we only excluded from the final sample all the participants with color deficiency. Color is the vital part of the survey and participants with color deficiency are not suitable for this survey. Although according to a participant, someone might not know that has color deficiency, we have to assume that the answers given from the participants are valid.

Figure 12: Corrected Vision



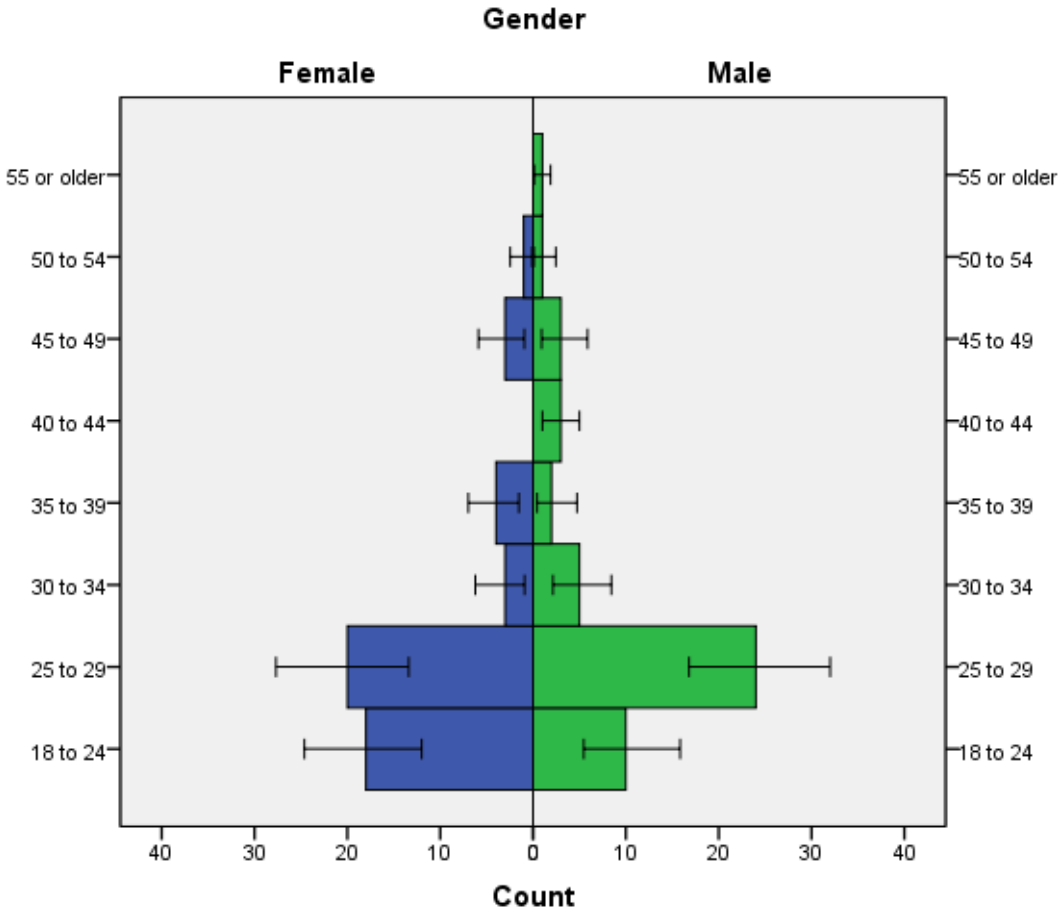
In the final analysis, we used only the rest ninety-eight (98) participants who have answered all the questionnaire's parts and almost every single question.

Figure 13: Web questionnaire



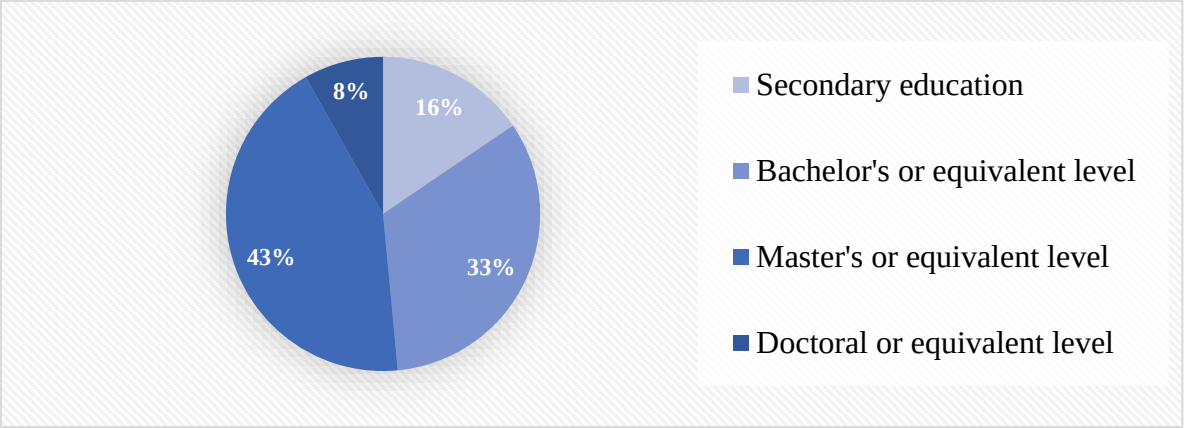
The gender proportion was equally distributed as we have 50% male and 50% female. In the population pyramid below, we can detailly observe the percentages of each age group. Most participants, as expected, are from 25 to 29 years old (44.9%) and another big porportion from 18 to 24 years old (28.6%). Taking this into account, we have 73.5% of the sample are under 29 years old. This can be explained by the fact that the web questionnaire was mainly answered by students.

Figure 14: Population pyramid



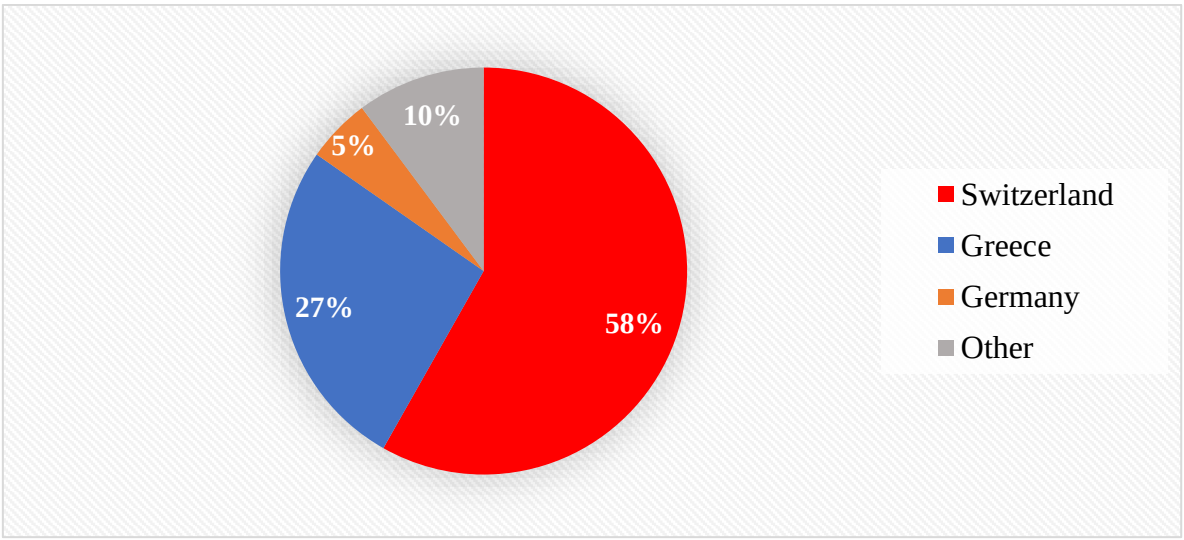
As far as the Level of School, that they have completed, is concerned, 33% have a bachelor degree and 43% a master degree. The 16% of the participants have finished secondary education and the 8% have a doctoral diploma.

Figure 15: Level of School



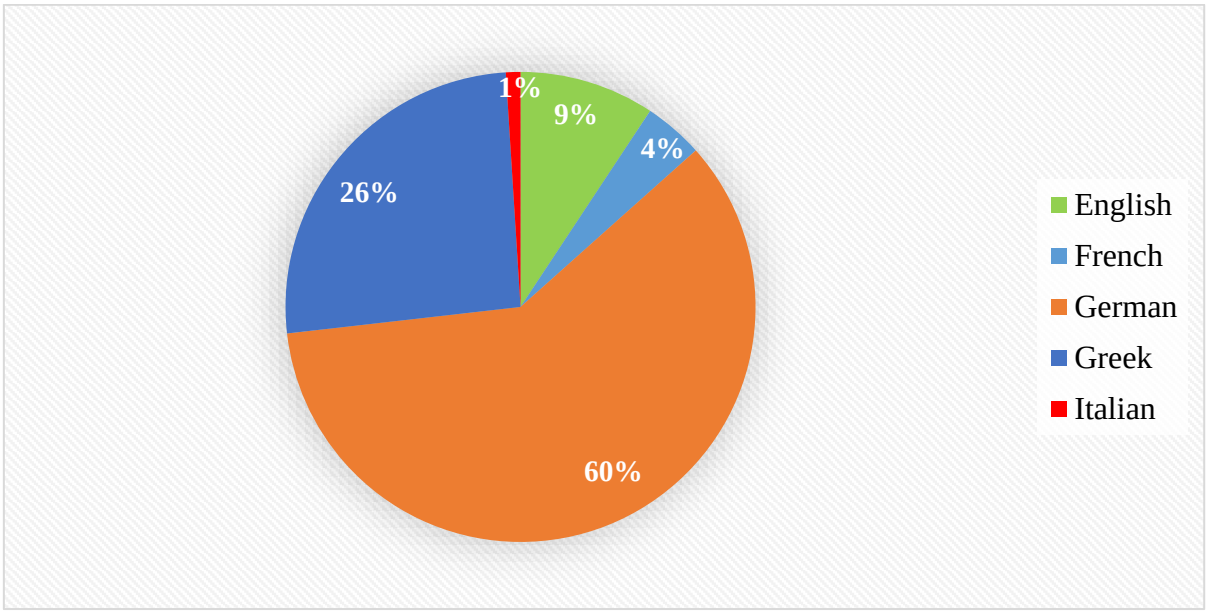
The home country and the country where they have lived most of their life are in most cases the same, expect of a few participants who have moved from Serbia and Montenegro to Switzerland. To be more accurate in the analysis afterwards, we will use the latter information as there is not significant difference and we assume that people know better the maps of the country where they have lived most of their life. As it is depicted in the graph below, most of the participants come from Switzerland (58%) and the second biggest proportion come from Greece (27%).

Figure 16: Country lived most of their life



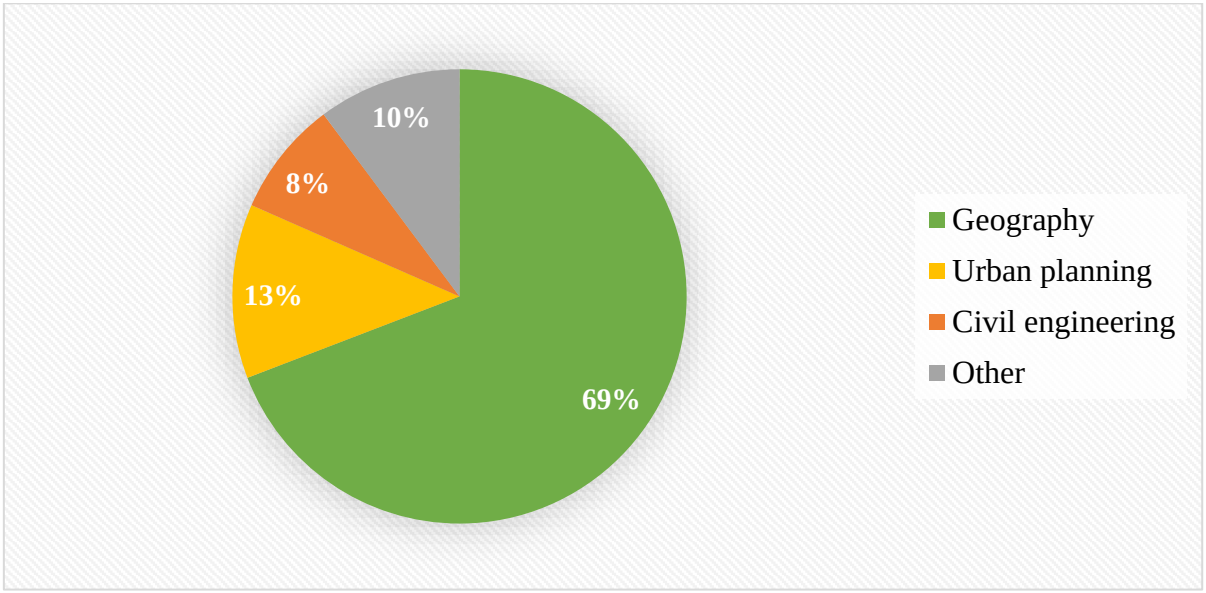
As far as the mother tongue is concerned, the distribution follows, as expected, the country of origin. This means that most of the participants speaks German (60%) and another big part of them speaks Greek (26%).

Figure 17: Mother tongue



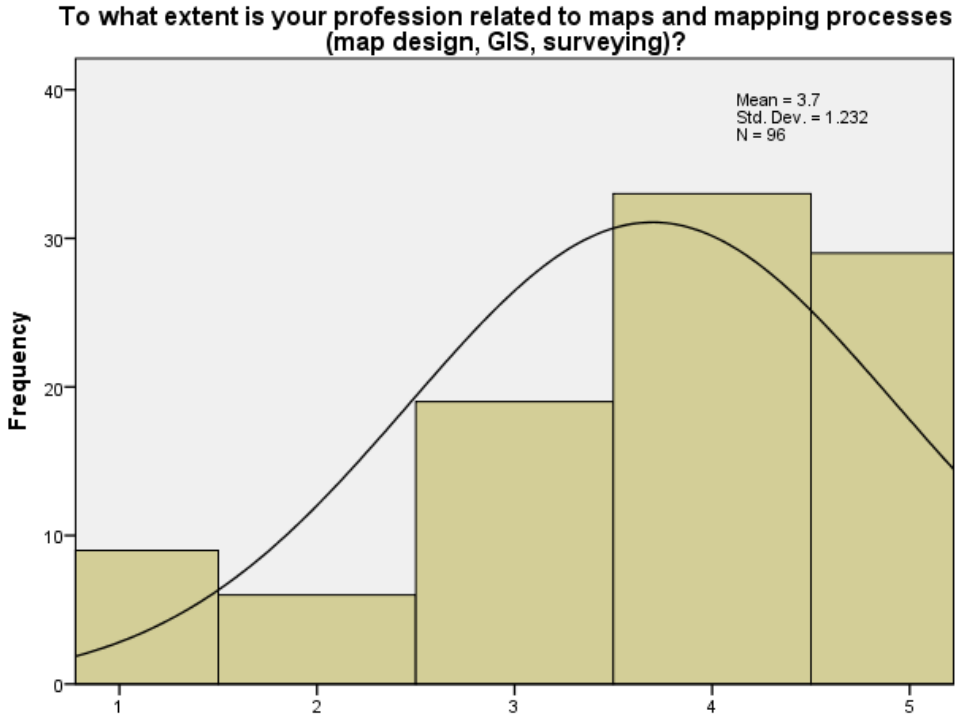
The field of Study or Work is Geography for the 69% of the participants. Urban planning follows with 13% and Civil engineering with 8%.

Figure 18: Field of Study/Work



Their professions are highly related to maps and mapping processes, as it is depicted in the three histograms below. In a Likert scale from 1 to 5, the mean for the relation between the profession and the mapping processes (Figure 19) is 3.7. The standard deviation is 1.232, which is quite high for the Likert scale, but the mean still stays on the positive side.

Figure 19: Profession – Map processes



In the second histogram about the frequency of map use in the profession (Figure 20), the mean is 3.66 with standard deviation 1.186. The tendency observed is similar to the previous histogram and once again positive. Even in the question about how often they use maps in their leisure time (Figure 21), the mean is 3.46 with standard deviation 0.893. According to these histograms, the sample consists of people, who interact with maps on a daily basis, which means that they are familiar to a certain extent with maps. That meets the goal of the questionnaire's design as we were looking for this kind of participants in order to be able to answer the questionnaire's recognition part.

Figure 20: Profession – map use

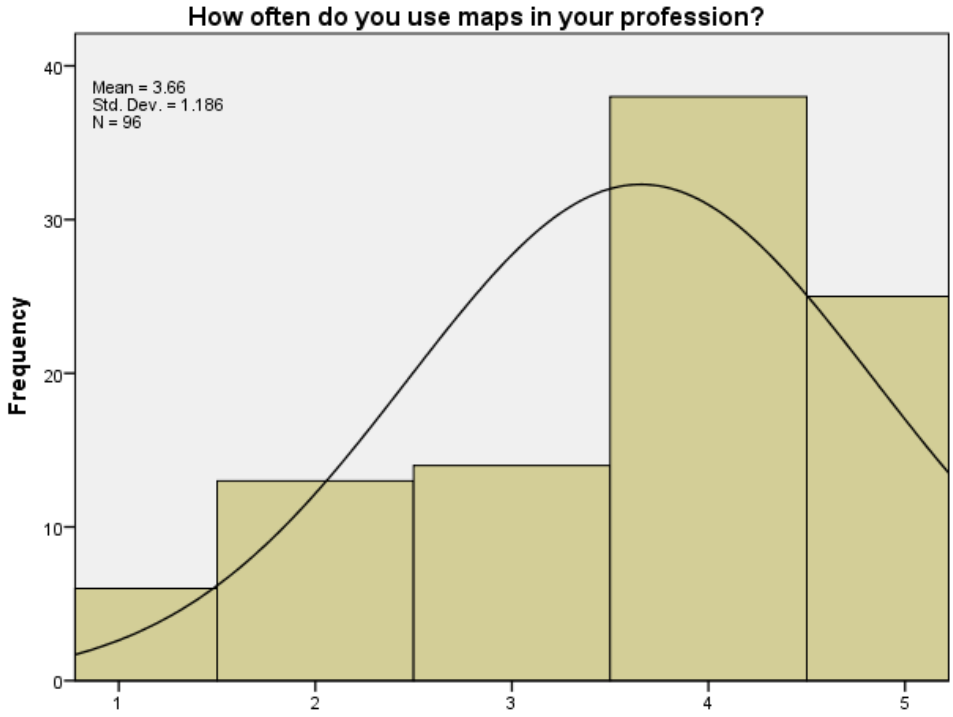
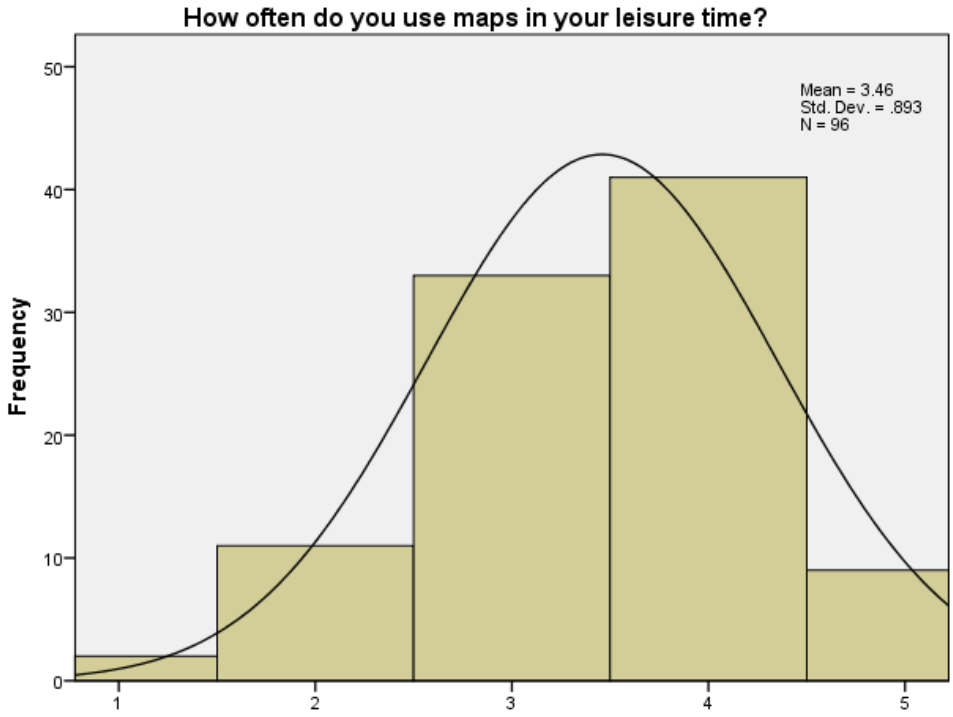


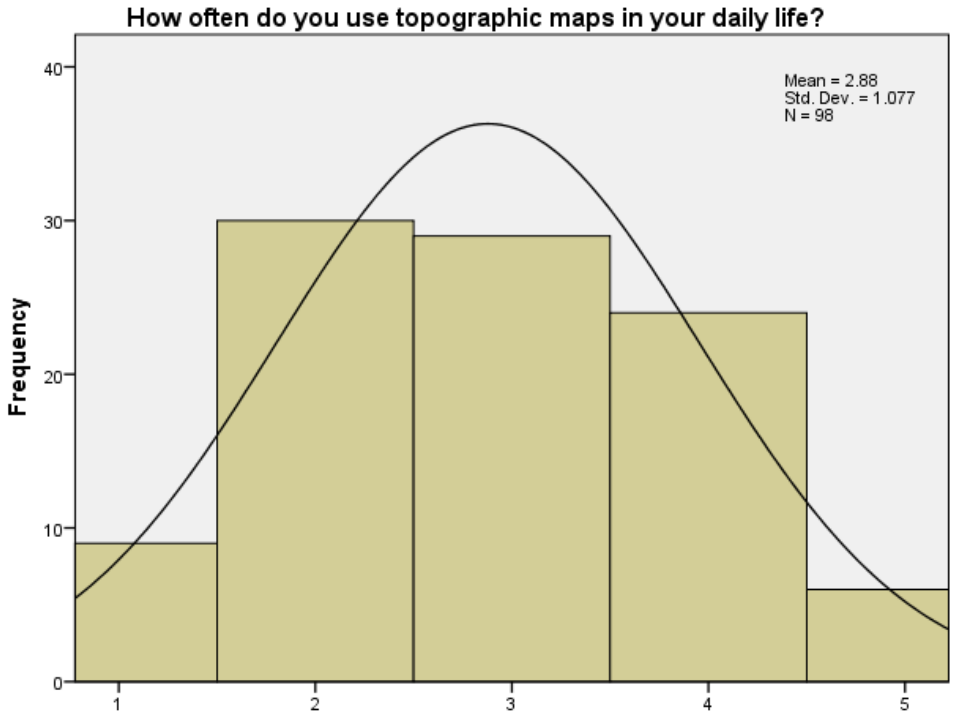
Figure 21: Maps – Leisure time



The distribution of the above histograms, as well as of the following one, is non-normal judging from the Shapiro-Wilk's test along with the visual inspection of the histograms, normal Q-Q plots and box plots. To detect any correlation between these answers and the scores in the main part, the Spearman correlation is the proper one. The Spearman's correlation coefficient is a non-parametric statistic, which is used for data like ours, which violate parametric assumptions such as non-normal distribution. We have not chosen Pearson correlation because the data are ordinal which makes the Spearman correlation more suitable.

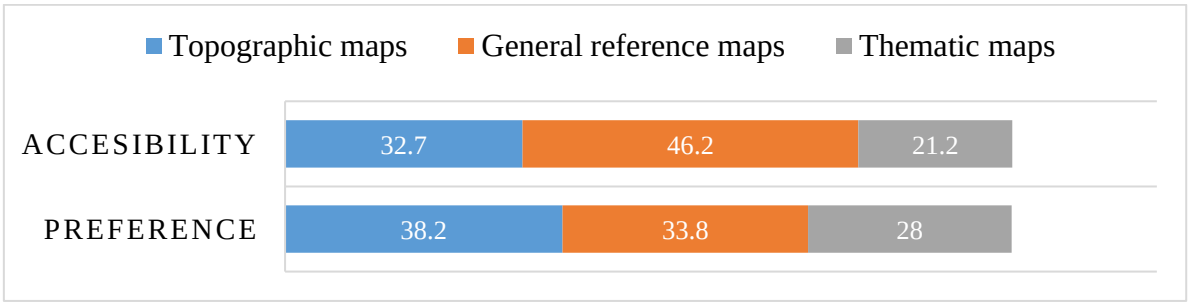
After running a Spearman correlation, we can observe that the frequency of use of topographic map in the participants' daily life positively influence the mean score in the total score (r = 0.282**, p = 0.006), especially the total recognition score (r = 0.242*, p = 0.018) and the Roads&buildings score (r= 0.223*, p = 0.030) (Appendix -Table 12).

Figure 22: Topographic maps – daily life



Among topographic, general reference and thematic maps, the participants have mentioned that General reference maps are more accessible, but they would prefer to have access both to Topographic and to General reference maps (Figure 23).

Figure 23: Maps – Accessibility - Preference



4.2. Recognition of cartographic styles

The research goal in the main part of the questionnaire is to observe the ability of the participants to recognize the origin of maps based on the landscape, the color and the human-made structures. To accomplish that, we created 3 groups of questions. Within these questions, the maps are differentiated according to the countries, Switzerland and France. The first group is the recognition, where maps with the same geographic footprint are presented while having different color schemes (the Swiss and the French color schemes). The second group is the comparison, where we have the same color schemes (in one case the Swiss and in the other the French one) but different geographic footprints. The last group is the Roads&buildings, where only the road network along with the city grid and some lines of the terrain is visualized in black and white.

Before starting the analysis of the aforementioned groups, we should check the distribution of the sample in all parts in order to select the proper analysis tools, parametric or non-parametric. The Shapiro-Wilk's test along with the visual inspection of the histograms, normal Q-Q plots and box plots for every single part showed that the scores are not normally distributed.

In the graphs below, the answers for Switzerland are presented.

Figure 24: Have you ever seen topographic maps from Switzerland?

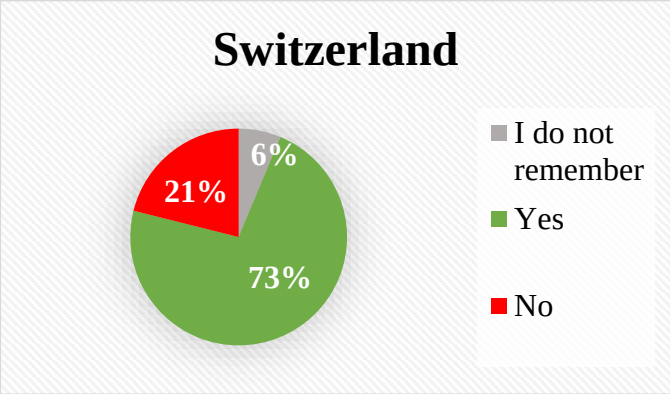


Figure 25: Switzerland recognition

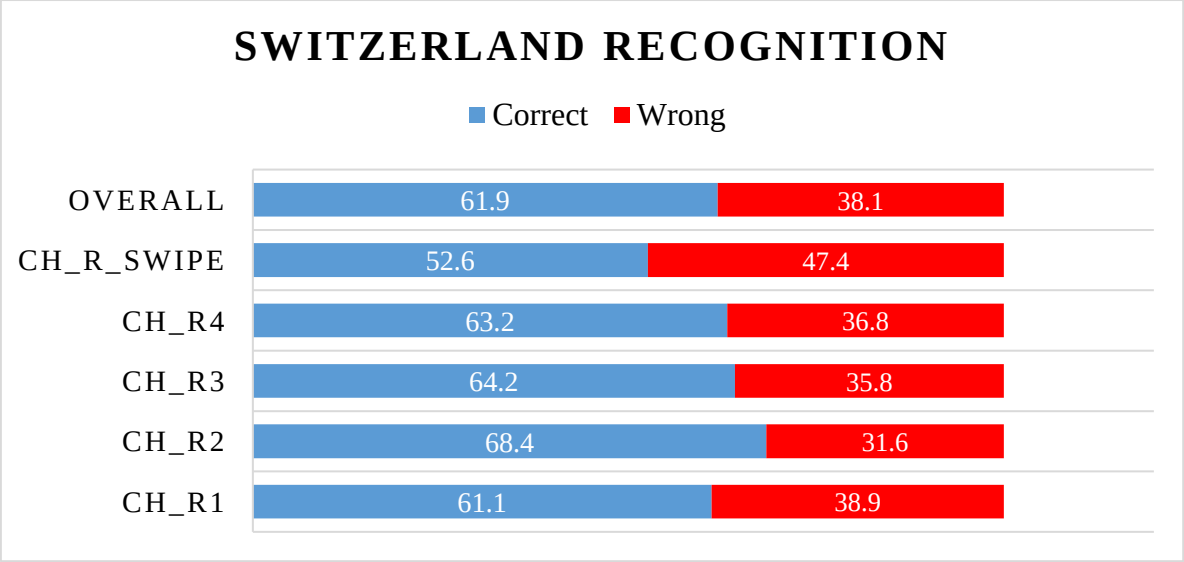
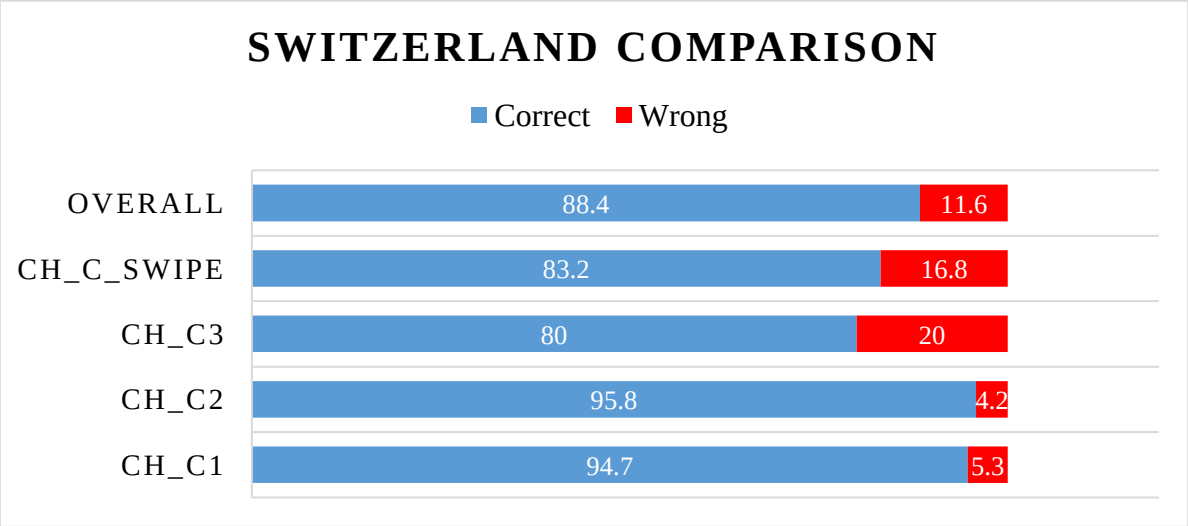


Figure 26: Switzerland comparison



In the Swiss recognition and comparison part, most of the participants have identified correctly the original map of the Switzerland. This can be partly explained by the fact that around 60% of the participants are Swiss and 73% have answered that they have seen a Swiss topographic map before. Although, most of them are Swiss and have seen a Swiss topographic map before, only approximately 62% have answered correctly the recognition part, which is not a high percentage as it is not so different from the fifty-fifty chances of guessing. Unlike the recognition part, the percentage of success in the comparison part is quite higher, where around 88% have managed to select the correct map.

The following graphs are summarizing the performance of the participants in the French part.

Figure 27: Have you ever seen topographic maps from France?

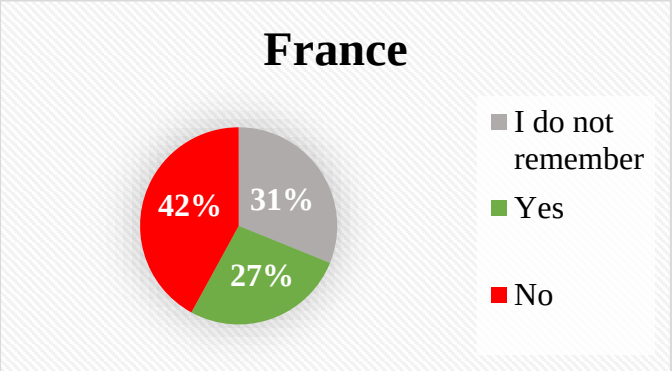


Figure 28: France recognition

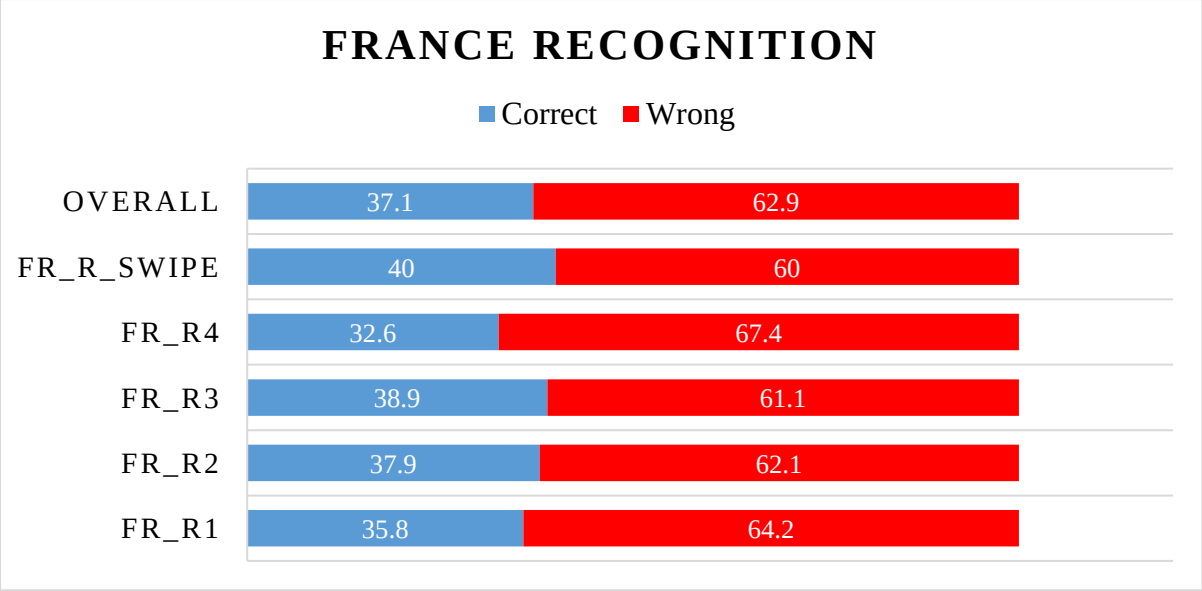
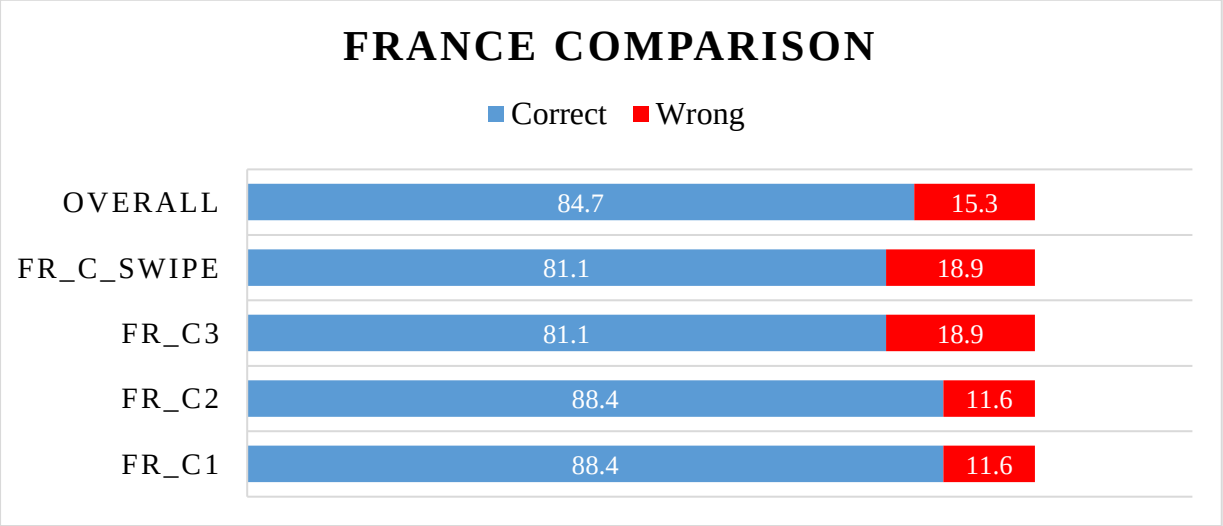


Figure 29: France comparison



On the other hand, in the French recognition and comparison part, we do not observe the same pattern. Although in the comparison part, the percentage of the correct answers is considerably high (84.7%), we do not see the same in the recognition part, where most of the participants were not able to recognize the French maps (37.1%). Taking everything into account, we can underscore that participants in both countries score higher in the comparison part than in the recognition part and they only fail to recognize the map in the French recognition part.

There is one logical explanation for the inability of the participants to identify correctly the French maps with the same geographic footprint and different colors. First of all, 42% of the participants had not seen a French map before but this is not the only reason for this failure. Approximately the same percentage of the Swiss and Non-Swiss participants mentioned that they have not seen or they do not remember a French map, which means that the low scores have not to do with the nationality of the participants.

If we have a closer look at the scores of Switzerland, the scores are extremely lower in the recognition part in comparison to the comparison part. This fact depicts that even for the participants who had seen a Swiss map before, the recognition based only on the color difference was more difficult than the comparison part where they have to observe mainly the landscape. In other words, the color was not enough to provide the necessary information for the participants to identify the map's origin and at the same time confusing. Participants tried to retrieve from memory the color used from each country as a few have mentioned in the comments. For instance, one participant has mentioned that he chose the maps based on his memory. He remembered that French maps have vivid color scheme, such as in the features of the road network and the forest, and made the selection accordingly. This procedure was

difficult as they had to mostly base on their memory and the differences between the color schemes which led in most cases to wrong answers.

On the other hand, having the color scheme fixed and depicting different geographic footprint was quite more helpful than changing only the color. The landscape in both cases combined with the same color schemes, regardless of the fact if we are dealing with Swiss or French maps, was enough for the participants to identify the origin of the map. For instance, some participants have mentioned that their choice was mainly determined by the difference observed on the water bodies (lake, ocean, river). In a nutshell, having the same color helped them to focus on the landscape and observe the differences.

In the Roads&buildings part, where only roads and buildings were shown in black and white, most of participants were able to recognize the origin of the maps (Figure 30), mentioning that the terrain as well as the geographic footprint were helpful hints to give the correct answer (Figure 31,32). Between the two questions of this part, once again the participants scored significantly higher in the question, where the lake and the ocean were depicted and not in the other question, where mainly the mainland along with the city grids and road network covered the larger part of the map. The difference between the responses in these two questions is significant ($p<0.01$, sig: 0.002) according to the Wilcoxon signed-rank Test with effect size 0.44 and power size 0.98. The reason for choosing this test is that we had two sets of scores to compare, which come from the same participants. In the appendix, the corresponded tables are cited (Table 20,21).

Figure 30: Roads&buildings

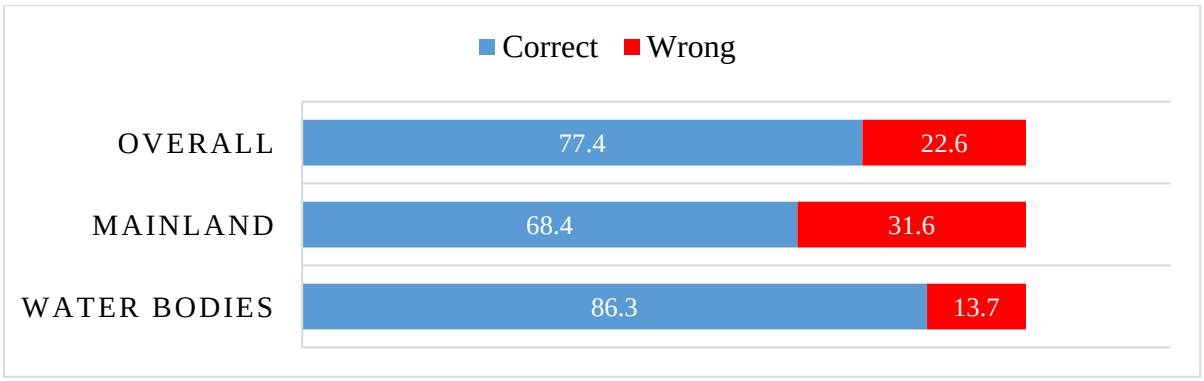


Figure 31: Which of the geographic features showed on the maps helped you to make your selection? (Roads&buildings)

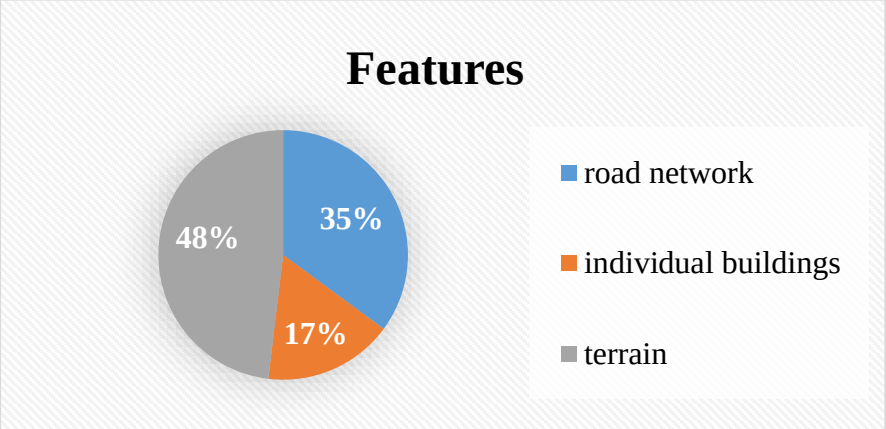
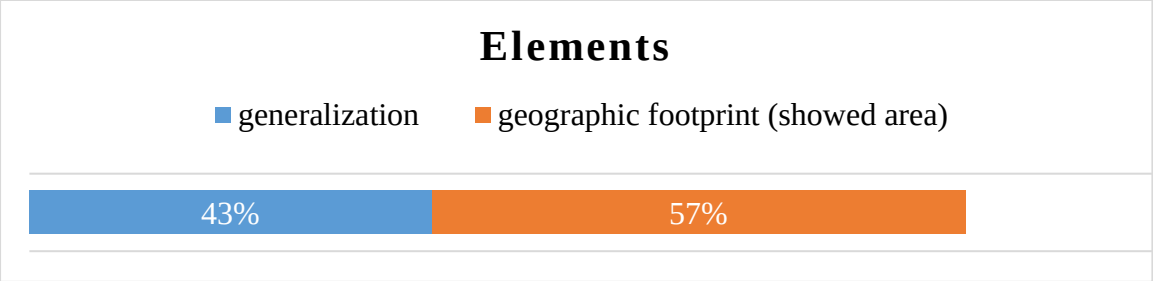


Figure 32: Which of the design elements showed on the maps helped you to make your selection? (Roads&buildings)



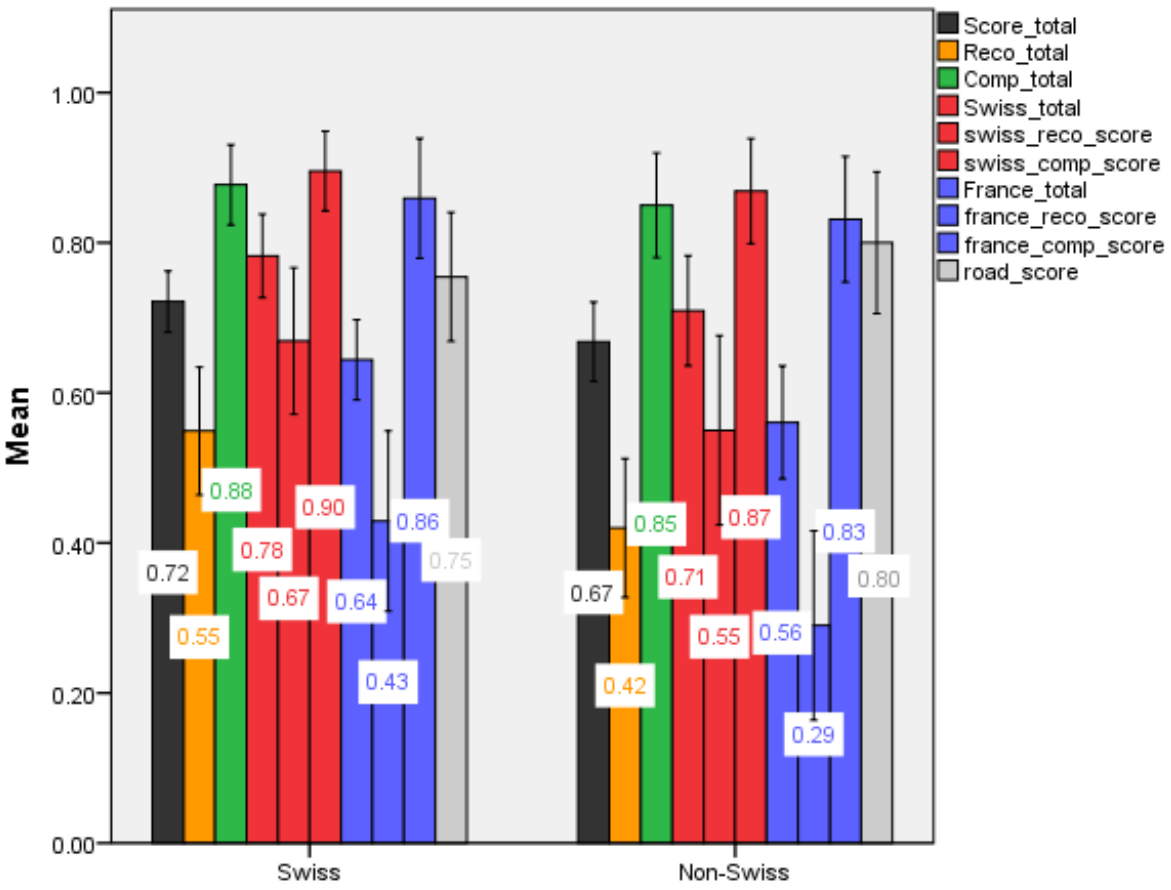
Judging only based on the percentages, we can observe a tendency to have higher performance when the maps' design is emphasized on patterns and the landscape without diverse color schemes, which can be distracting and confusing. First of all, in the recognition part, the lowest percentages were noticed. In this part, where only the colors were changing, only 61,9% and 37.1% of the participants, in the Swiss and French group of questions respectively, have correctly identified the maps. The percentage of success was higher in the Roads&buildings part, where only the road network and some lines of the terrain were depicted in black and white. 77.4% have also managed to select the correct answer. Adding fixed color scheme, like the maps in the comparison part, where only the landscape was changing with fixed color scheme, led to the highest level of success. 88.4% and 84.7%, in the Swiss and French group of questions respectively, have recognized the original map.

4.3. Groups and differences

In order to measure to what extent differences within the sample exist based on the country of origin, field of study, gender and Map Memory ability, a Mann-Whitney Test will be run for all these cases. The chosen test is suitable for non-parametric analysis as our sample is not normally distributed.

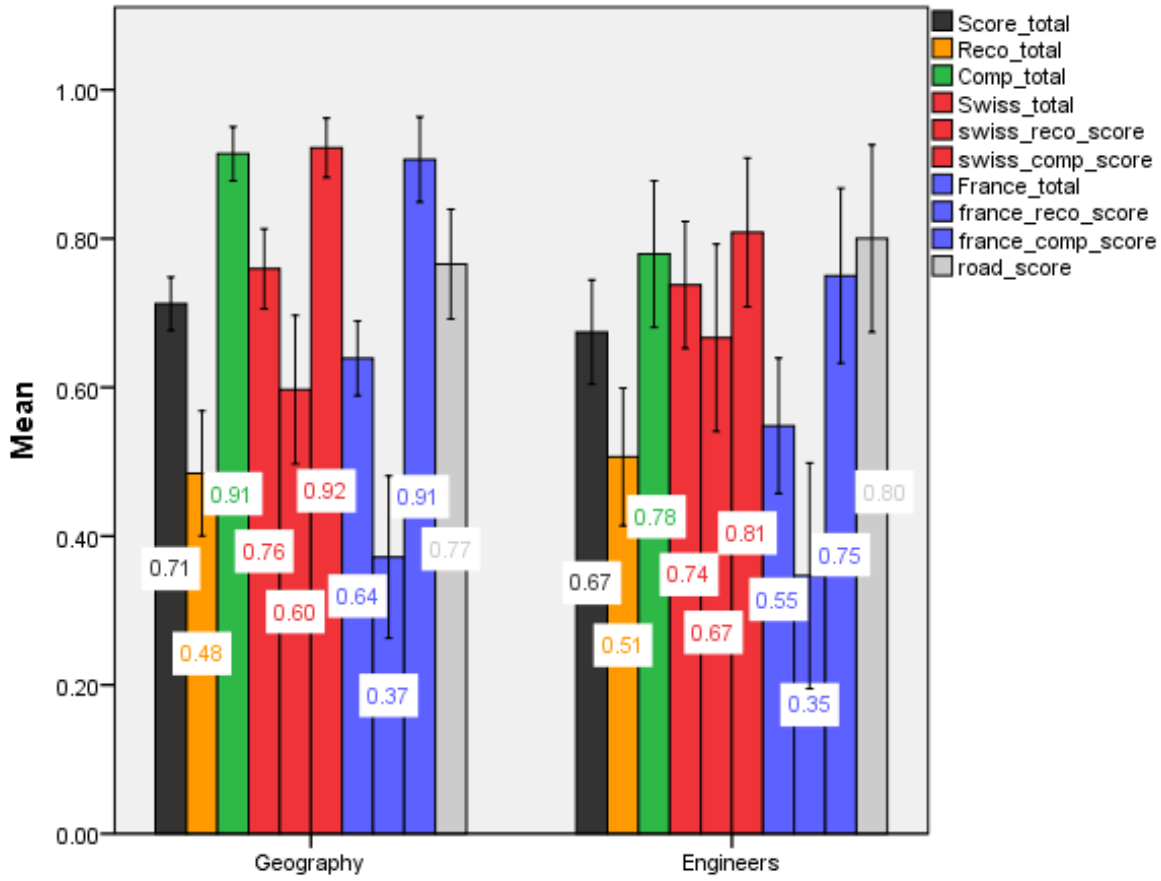
Having a closer look at the Swiss participants, we should mention that they have higher mean scores in all parts expect of the Roads&buildings part in comparison to the Non-Swiss, but with no statistical significance observed. We should mention that our sample consists of 55 Swiss and 40 Non-Swiss. The only case, where statistical significance exists, is in the difference between Swiss and Non-Swiss in the French total score ($p<0.05$, sig: 0.031). Even in this case, effect size is small ($d=0.474$) as well as the power size, which is 0.596 (Appendix - Table 2, 3). According to that, we can conclude that the differences observed between Swiss and Non-Swiss are not statistically significant.

Figure 33: Mean score for each part (Swiss – Non-Swiss)



The participants, who are geographers (N= 64), have scored significantly higher in all the comparison parts (p<0.01, sig: 0.008), especially in the French part (p<0.01, sig: 0.003), in comparison to all the other professions (N=34). The effect size in both cases is moderate (all comparison parts: d=0.635 r=0.302, French comparison part: d=0.568 r=0.273) as well as the power size, which is 0.79 and 0.70 respectively. A moderate power size provides the aforementioned observation with the adequate statistical power to reject the hypothesis that there is no difference between Swiss and Non-Swiss. The differentiation observed can partly explain the overall higher scores in the comparison part as long as the geographers are the approximately 70% of the sample. In addition to that, this can be seen in a way that the geographers can easily identify differences between landscapes as long as the comparison part mainly deals with the landscape (Appendix - Table 4, 5).

Figure 34: Mean score for each part (Geographers - Engineers)



4.4. Map Memory Test

In the Map Memory Test, 60% of the participants had quite high scores, which is correlated with the total score in the maps part (r = 0.321**) and mainly with the questions which had to do with the recognition (r = 0.227*), especially of Switzerland (r = 0.234*). The Spearman correlation table can be found in the appendix (Table 11).

Figure 35: Map Memory Test

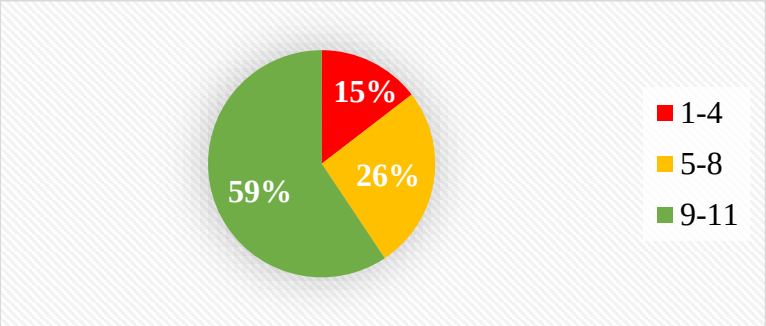
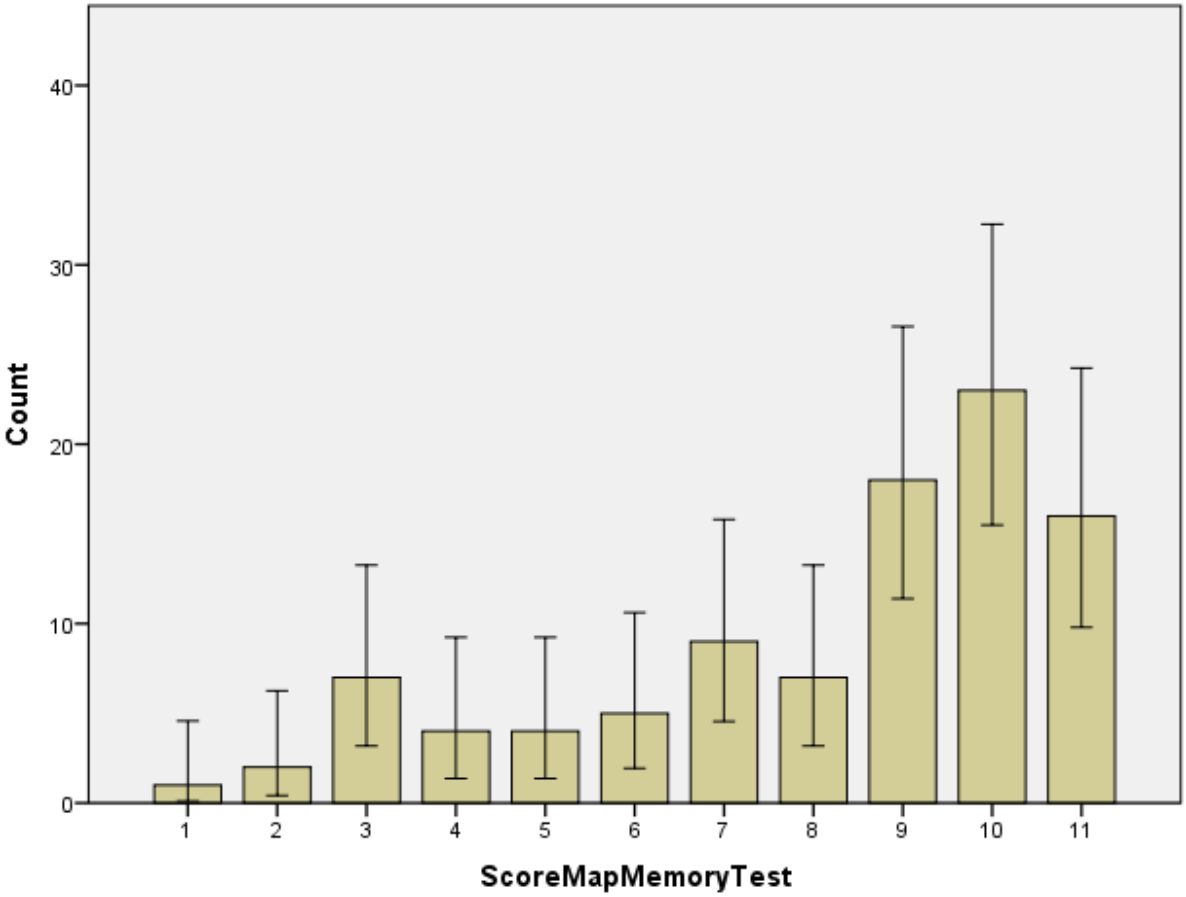
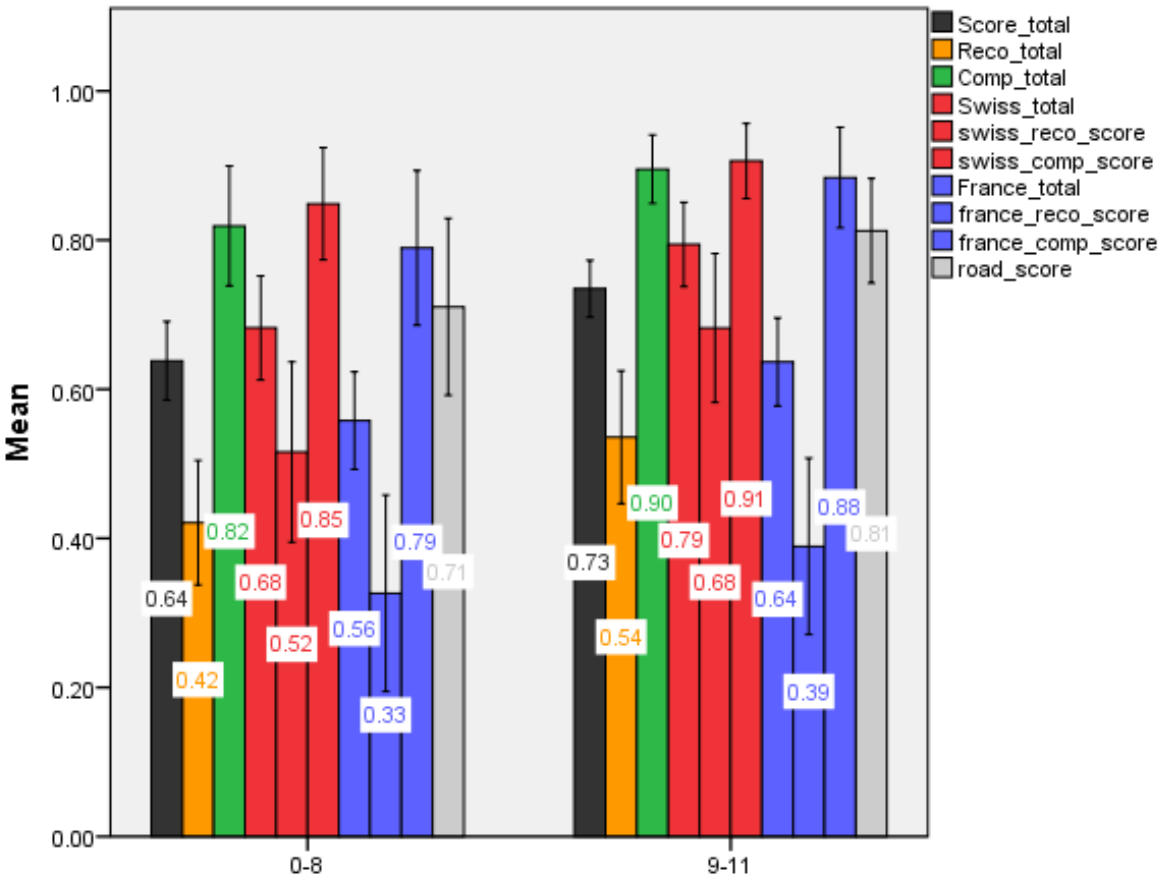


Figure 36: Map Memory Score Count

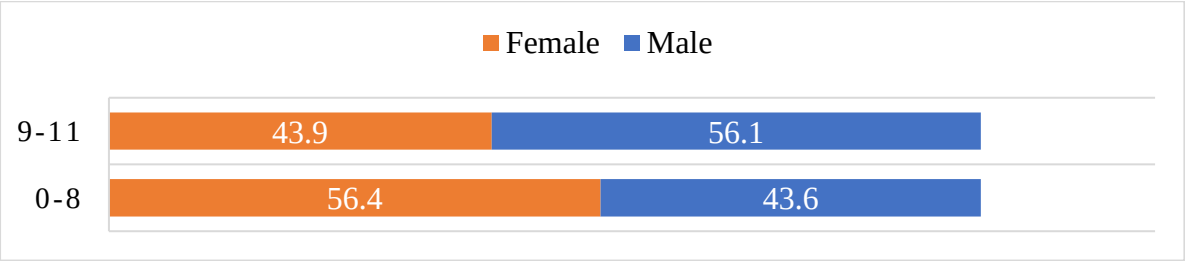


Dividing the participants into two groups according to their Map Memory test score, differences can be observed as depicted in the graph below. The first group, which consists of 38 participants, scored from 0 to 8 in the Map Memory test while the second group, which consists of 56 participants, scored higher than 8 out of 11. The second group have higher scores in all parts and the difference is statistically significant in the total score ($p<0.01$, sig: 0.006), in the French total score ($p<0.05$, sig: 0.038) and in the Swiss total score ($p<0.05$, sig: 0.014). Judging from the effect size and the power size, only the difference in the total score can be supported. The effect size d=0.638 and the power size is 0.84, which is quite high. On the other hand, the effect size for the French and Swiss total score is only 0.375 for the first one and 0.529 for the second, while the power size is 0.41 and 0.68 apiece (Appendix - Table 8, 9).

Figure 37: Low Map Memory vs High Map Memory

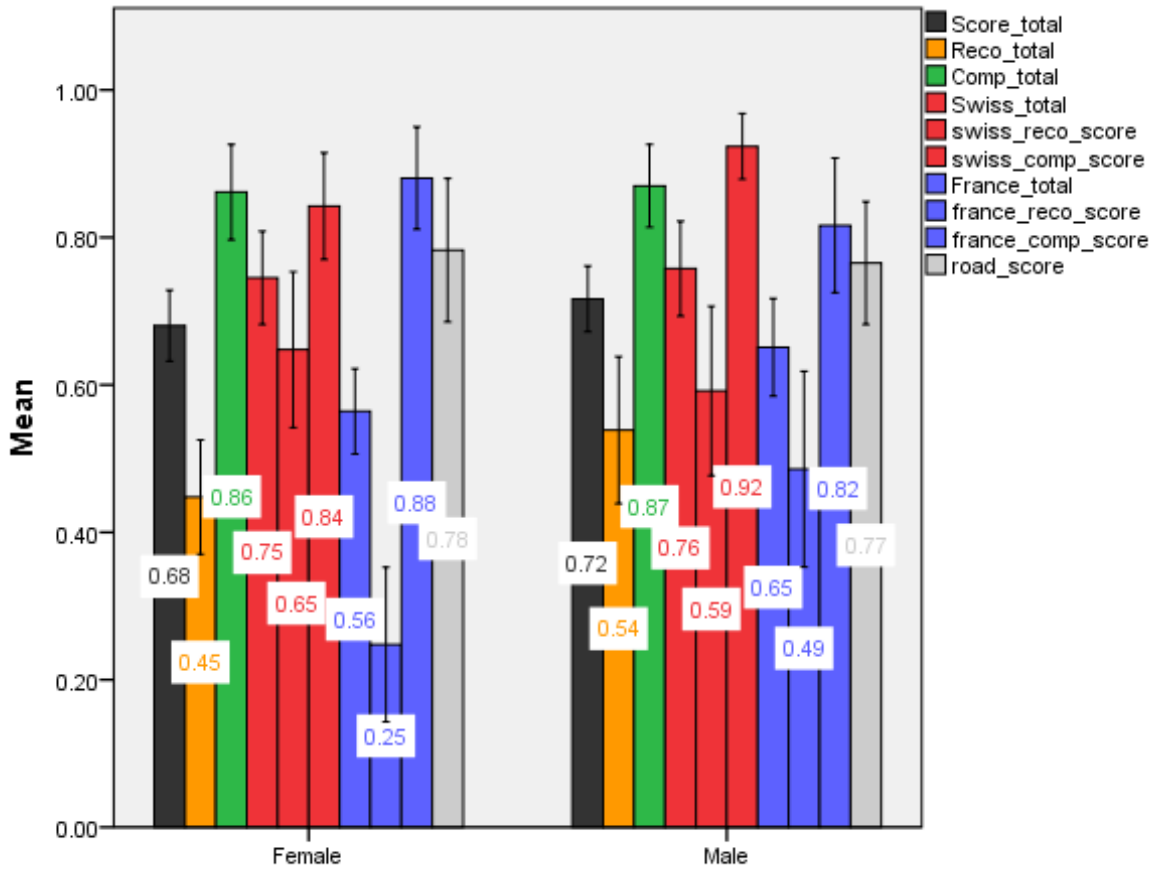


Within these groups, the following distribution is noticed. The high Map Memory group consists of more men than women and in the low Map Memory group, the exact opposite occurs. For that reason, the overall performance should also be analyzed from a gender perceptive.



Analyzing the scores in all parts from the gender perceptive, males performed better in all total scores, expect Roads&buildings part. The sample consists of 46 females and 49 males and the only difference, which was statistically significant is in the French recognition part ($p<0.05$, sig: 0.014). The effect size in this case is moderate ($d= 0.579$) as well as the power size (0.78) but statistically adequate to support the difference observed (Appendix - Table 6, 7).

Figure 38: Mean score for each part (Female - Male)



4.5. Feedback on features and elements

According to their feedback, in the recognition part features like the road network and the forest were more helpful than in the comparison part, where features like the terrain and the individual buildings had to be taken into account (Figure 39). In two cases, the road network and the terrain were of major important. As far as the elements, which were helpful, is concerned, the colors and the contour lines were extremely vital for the recognition process while in the comparison part the geographic footprint took considerable percentage over the two aforementioned elements, which were still important for the identification of the maps (Figure 40).

Figure 39: Which of the geographic features showed on the maps helped you to make your selection?

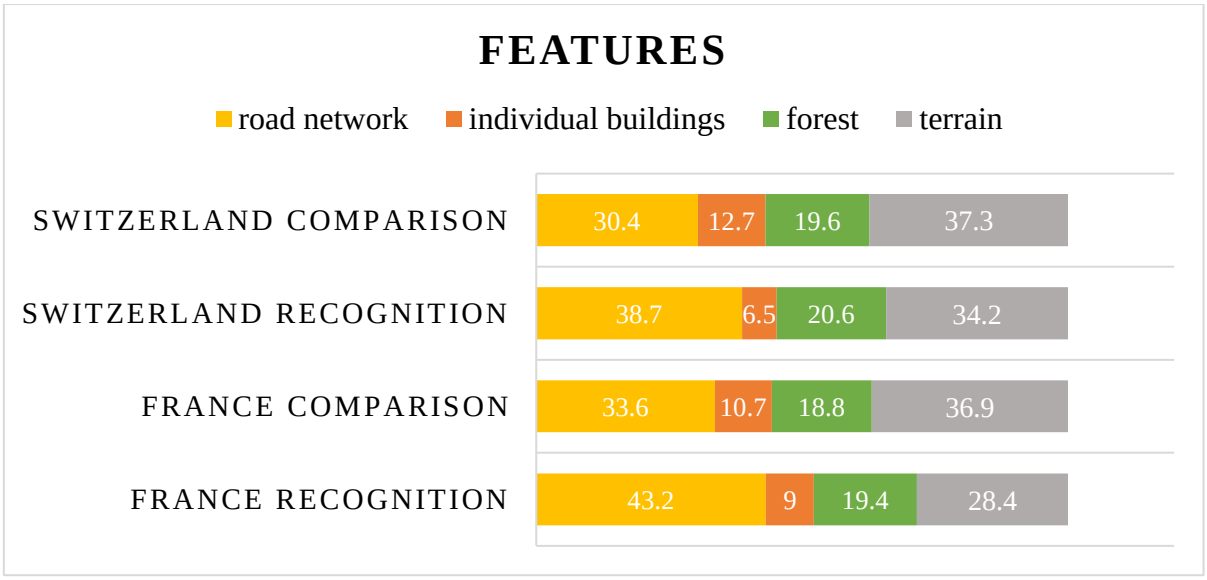
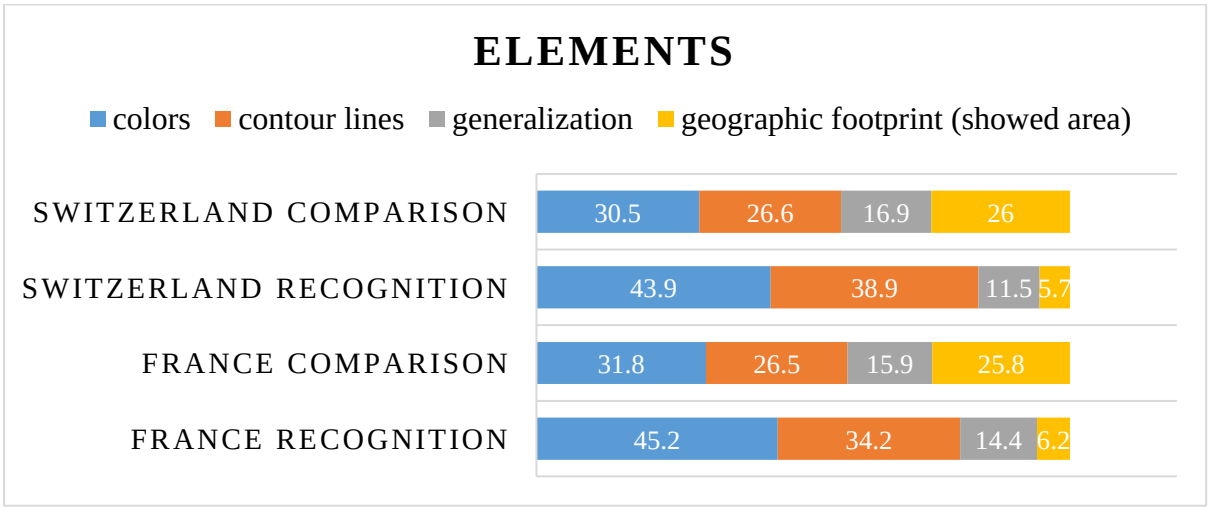


Figure 40: Which of the design elements showed on the maps helped you to make your selection?

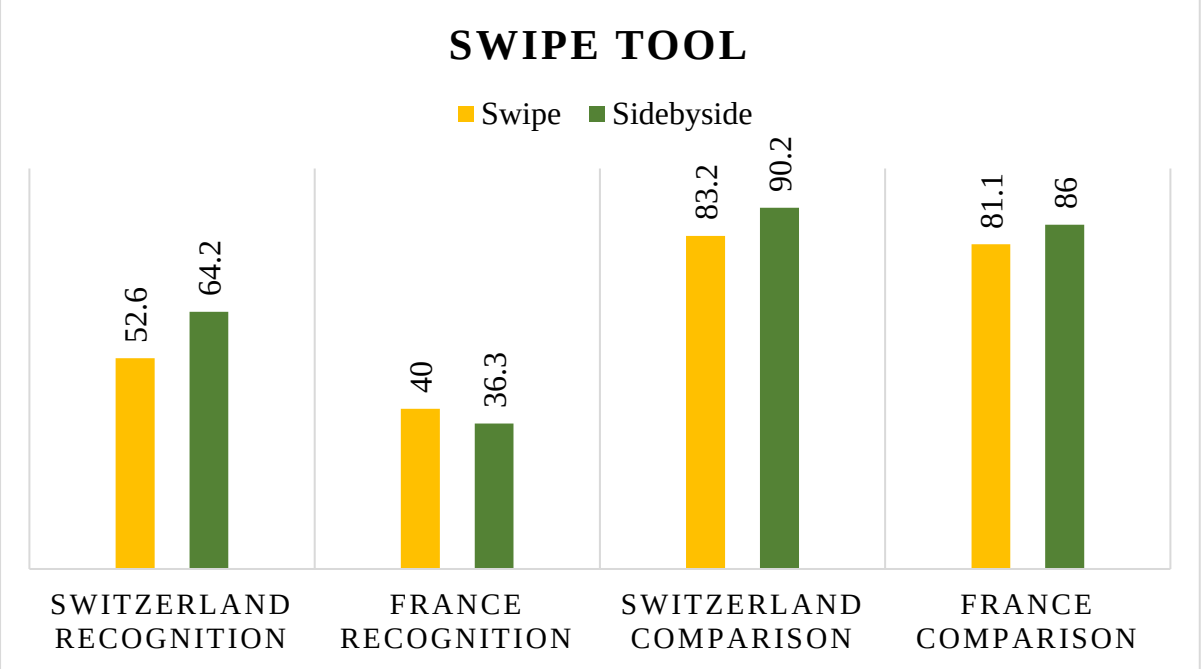


4.6. Swipe tool usability

The swipe tool was not helpful in the identification process in most of the parts, except of the French recognition part, where the percentage of correct answers was a bit higher than the one of the side by side comparisons (Figure 41). Although the differences exist, they are not statistically significant. In the only case, where the difference was significant ($p<0.05$, sig: 0.022), was in the Swiss recognition part but the percentages were lower than the side by side questions. In a nutshell, we could say that the swipe tool not only did not improve the scores but also gave lower percentages of success. The slightly better performance in the French recognition part, which was the part, where most of the participants could not recognize the origin of the map, cannot be mentioned as an observation due to the fact there is no statistically significant difference.

The Wilcoxon signed-rank Test was chosen for the aforementioned comparison. This test is a non-parametric test as our sample is non-normally distributed. The reason for choosing this test and not the Mann-Whitney Test is that we had two sets of scores to compare, which come from the same participants. In the appendix, the corresponded tables are cited (Table 12-19).

Figure 41: Swipe Tool



Chapter V. Discussion

The aforementioned section 2 suggests that the phrase “colours choices may disturb the reading and understanding of maps” attributed to Christophe, S. (2011) has been verified to a certain extent valid by the responses collected via the survey. The distinction between Recognition parts where the color of map is changing and Comparison parts where the landscape and the human-made structures are changing, leads to following conclusion: the landscape and the human-made structures rather than the color was easier to identify by the survey participants.To be more specific, in the Recognition parts, the scores were quite low in comparison to the Comparison parts, where the scores were high. Color in both countries, especially in the case where big proportion of participants had not seen a topographic map of the depicted country, was misleading and led to lower scores.

In the last section of the “Recognition of cartographic styles”, the one of Roads&Buildings, where the maps were presented in black and white, the following tendencies were observed: the scores were higher than the scores in the Recognition parts. Aparently, changing only the color seems to be like trying to create a new image, which is not the goal of the map. Maps are meant to highlight the existing features of the area depicted. In this way, focusing on the landscape and human-made structures can be helpful for the map readers to notice only the vital elements of the map and not the change or not of the color used. That pattern was observed in our survey as participants had higher scores in the parts where the map itself, the geographic footprint, was changing and not the color. These parts were the Comparison parts and the Roads&Buildings part, where regardless of the country depicted or the prior knowledge on the topographic map of the specific country, most participants had high scores.

According to the literature, there are two main factors that can differentiate the performance of the participants. These are the landscape preferences based on some ecological geomorphological aspects with which they are familiar and the spatial cognitive abilities. The former was corroborated in the results as Swiss participants performed better in the parts, which had to do with the landscape. That result could be partially attributed to the fact that, they can distinguish familiar patterns. In addition to that, it was cited and verified from the results that spatial cognitive abilities can be a reason for the user to easily identify a map because the map reader might be able to easily remember the layout of a specific map and distinguish it among different maps. The previous statement can be verified by the fact that all participants with high Map Memory score performed significantly better than participants with low Map Memory

score. In addition to the two factors cited in the literature, another differentiation was observed. Within this group of participants, Geographers, among other professions, had significantly higher scores in the comparison part, which can be seen in a way that the Geographers can easily identify differences between landscapes as long as the comparison part mainly dealt with the landscape and human-made structures.

The feedback provided by the participants underscored observations already mentioned in the literature review and proved the existing observations. Participants selected features and elements, which were highlighted as vital for the stylistic recognition in a previous study by Ory, J. (2015), as a very important hint during the process of identification. In our case, the road network, the individual buildings and the typography were mentioned as the most vital among all features and elements listed. Participants were able to know which characteristics have been helpful for them and they did not randomly choose a map. They had some criteria, which most of the time, led to correct responses.

Going further with the analysis, differentation between gender performance was also noticed, due to the fact that gender difference in the performance on spatial cognition tasks is common, as it is verified by the literature. Males had better scores than females in all parts, but only in the French recognition part the difference was statistically significant. This part was the most difficult one for all participants, which means that male managed to get significant higher scores not only in all parts but especially in the most demanding one.

In the survey, we included a different type of comparison between maps to notice if participants will perform better or worst. We used a swipe tool in each part so as to have another comparison method available and not limit the choices of the participants. As far as the Swipe tool is concerned, it was of no help in comparison to the side by side comparison method. Participants performed worst in all parts by using the Swipe tool and only in the French recognition part, where most of the participants could not recognize the origin of the map, there was a slightly better performance. This difference was not statistically significant and for that reason we should conclude that the swipe tool in our case was not a useful tool but rather confusing.

Chapter VI. Conclusion

In the current thesis, I analyzed the importance of the visual salient information on the recognition of the national cartographic styles in topographic maps, as it has not been thoroughly analyzed yet. Its importance was analyzed by comparing national cartographic styles in topographic maps of Switzerland and France through a web questionnaire. The focus of the research was on the color, the landscape and human-made structures depicted by each National Mapping Agency.

Based on the responses collected, we can now answer to a certain extend the initial questions. Firstly, cartographic styles are generally recognizable by map users and national topographic maps can easily be recognized by the corresponded native people. As far as the landscape and human-made structures is concerned, the results have showed that they are extremely vital and more important than the color schemes. The color schemes used could be misleading for the map reader, but the landscape and human-made structures were the features that contribute to the map's identification.

Moreover, under the assumption that the user is more familiar with his/her country's visualization standards, a foreign map with the latter information would be probably easier to be interpreted. What it can be argued is that the country's visualization standards were not as important as some geomorphological features, which in most of cases were the reason for the map's identification. It was not the type of visualization that was used but the overall view of the geographic footprint along with the kind of landscape and human-made structures depicted.

Overall, it can be concluded that the visualization of the landscape and human-made structures contributes to the identification of map's origin by the map reader only as a pattern. The landscape and human-made structures are not recognized due to their color schemes but because of their footprint. The color scheme adds the necessary categorization and general outlook on the map, but it does not constitute the decisive element for the identification of the topographic map.

Future Work

Certain limitations arising from the nature of the study conducted pave the path for future works. In particular, the sampling size used in the current analysis was restrained to a maximum of two countries. The sample consisted mainly by Swiss participants and the one of the two countries chosen was Switzerland. Due to the previous limitation, we should suggest that further research should be contacted with several maps of different countries and participants to eliminate any bias in the results due to the maps chosen or due to the country origin of the participants.

A first step could be an empirical study, where multiple maps of more than two countries will be compared by numerous participants of different countries. In this process would also be essential to use an eye tracker for a number of participants. By using an eye tracker, useful data can be collected. For example, we can notice the features and the elements that participants pay attention to as well as the time that they need to compare maps depending on the elements and the features depicted. By knowing the time needed to compare maps depending on the visualization selected, the map design of several maps can be optimized by excluding unnecessary or misleading information. The feedback needed to implement an optimization process on the map design can only be provided by empirical studies, which are constantly updated. We should note that the interaction between maps and people itself alters as technology improves, which means that maps should be kept up-to-date to serve the contemporary needs.

Appendices

A. Questionnaire

Welcome

Master's thesis study of cartographic styles

Thank you for participating in my survey.

The survey investigates the ability to recognize cartographic styles of different countries.
It is divided into the following **4 parts**:

1. Questions on maps
2. Recognition of cartographic styles
3. Map Memory Test
4. Background questions

Please read all information carefully before responding to the questions.
Click on the button: "Save - next question!" to continue to the next question.
Please work with the survey on your own (do not consult with others and do not use search engines).
Complete the survey with no interruptions.

Your answers are highly appreciated and all of your responses as well as any detail on your identity will be treated strictly anonymously, and with complete confidentiality.

Duration
20min (plus/minus 5min)

Minimum system requirements
- Stable Internet connection
- Minimum display size: 10 inches

Have fun and thank you very much for your effort!

Author
Athanasios Karathanasopoulos, Department of Geography - University of Zurich

First question!

A.1. Questions on maps

In the following part, you will be asked to answer six (6) general questions about maps. In order to answer these questions, you should read carefully the following definitions.

Definitions

Topographic maps show the physical and human-made features on the Earth's surface, including the shape and elevation of the land, portrayed with contour lines. Topographic maps are typically produced by National Mapping Agencies (i.e.,Swisstopo, USGS, OS, etc.) in as series at different scales.

General reference maps emphasize the location and names of phenomena in the environment (e.g., road maps, maps found in atlases or on walls in classrooms, etc.). General reference maps show physical and human-made features such as water bodies, rivers, coastlines, settlements, road networks and other environmental features.

Thematic maps display the spatial distributions or patterns of themes or attributes in a particular area (e.g. temperature and wind speeds in weather maps, population distribution maps with census information, income distribution maps, etc.).

1.1. To what extent is your profession related to maps and mapping processes (map design, GIS, surveying)?

Not at all related ○ ○ ○ ○ ○ Extremely related

1.2. How often do you use maps in your profession?

never ○ ○ ○ ○ ○ always

1.3. How often do you use maps in your leisure time?

never ○ ○ ○ ○ ○ always

1.4. Which of the following group of maps do you prefer using?

Multiple answers possible - Maximum 2 answers

- ☐ Topographic maps
- ☐ General reference maps
- ☐ Thematic maps

1.5. Which of the following map type is accessible to you on a daily basis?

Multiple answers possible - Maximum 2 answers

- ☐ Topographic maps
- ☐ General reference maps
- ☐ Thematic maps

1.6. How often do you use topographic maps in your daily life?

never ○ ○ ○ ○ ○ always

A.2. Recognition of cartographic styles

Recognition of cartographic styles

This is the second part of this study.

It consists of **32** questions.
You will be asked to identify the topographic maps of either Switzerland or France.

Your score will be the number of maps which you identify correctly **minus the number which you identify incorrectly**.
Therefore, it will not be to your advantage to guess unless you have some idea of whether or not you have studied the map.

At the end of the survey, we will see your score!

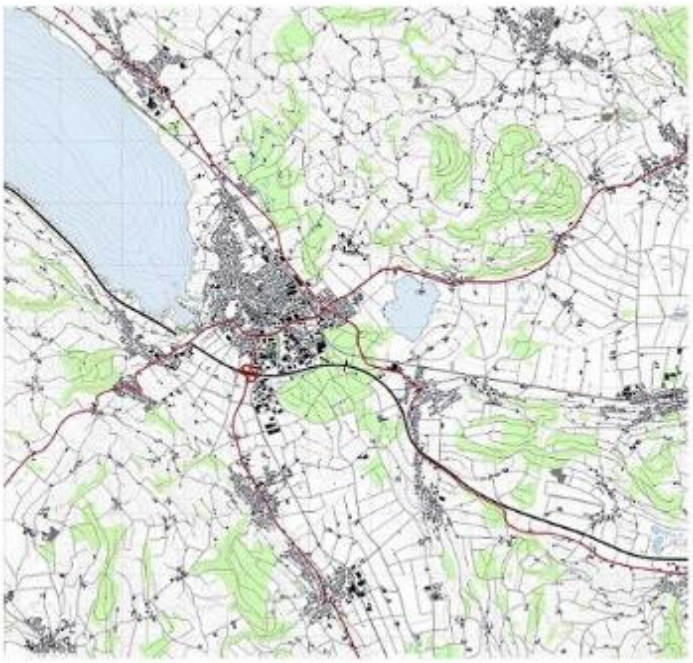
Let's start!

- **Recognition of cartographic styles – Switzerland**

2.1. Have you ever seen topographic maps from Switzerland?

- ○ Yes
- ○ No
- ○ I cannot remember

2.2. Which is the original topographic map of Switzerland?
Click on the map to respond.



-

2.3. Which is the original topographic map of Switzerland?
Click on the map to respond.

2.4. Which is the original topographic map of Switzerland?
Click on the map to respond.

2.5. Which is the original topographic map of Switzerland?
Click on the map to respond.

In the following question, you will be asked to use a swipe tool by clicking on a hyperlink. A new tab will open, where you can compare maps.
THEN PLEASE CLOSE IT, COME BACK ON THIS PAGE
AND ANSWER THE QUESTION BELOW

Which is the original topographic map of **Switzerland**?
Click on the link below to see the maps and use the swipe tool to compare:
Swipe tool

- ○ Map 1 (on the left side)
- ○ Map 2 (on the right side)

Which of the geographic features showed on the maps helped you to make your selection?

Multiple answers possible

- [ ] terrain
- [ ] forest
- [ ] road network
- [ ] individual buildings

Other features:

Which of the design elements showed on the maps helped you to make your selection?

Multiple answers possible

- [ ] contour lines
- [ ] colors
- [ ] generalization
- [ ] geographic footprint (showed area)

Other elements:

- **Recognition of cartographic styles – France**

2.9. Have you ever seen topographic maps from France?

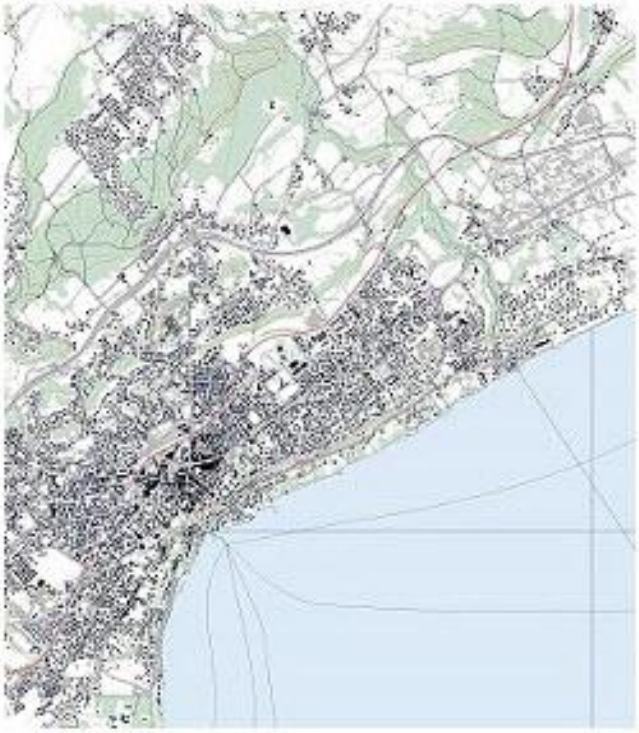
- Yes
- No
- I cannot remember

-

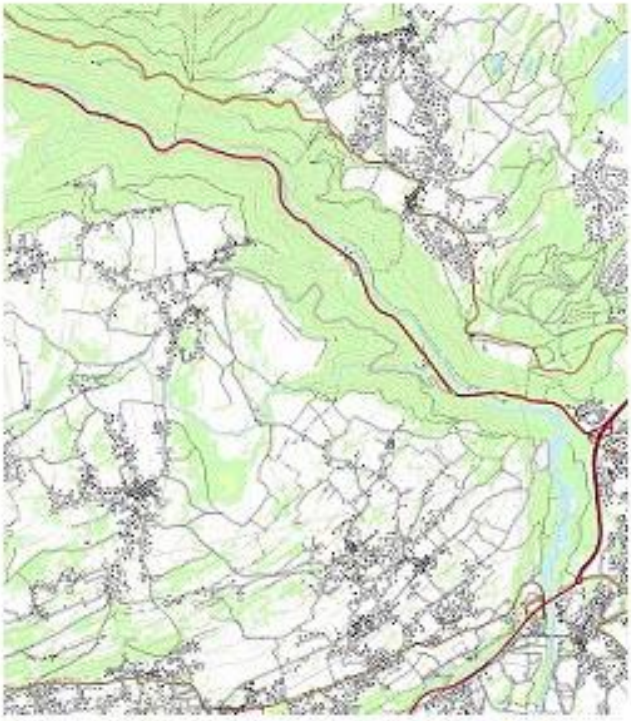
2.10. Which is the original topographic map of France?
Click on the map to respond.

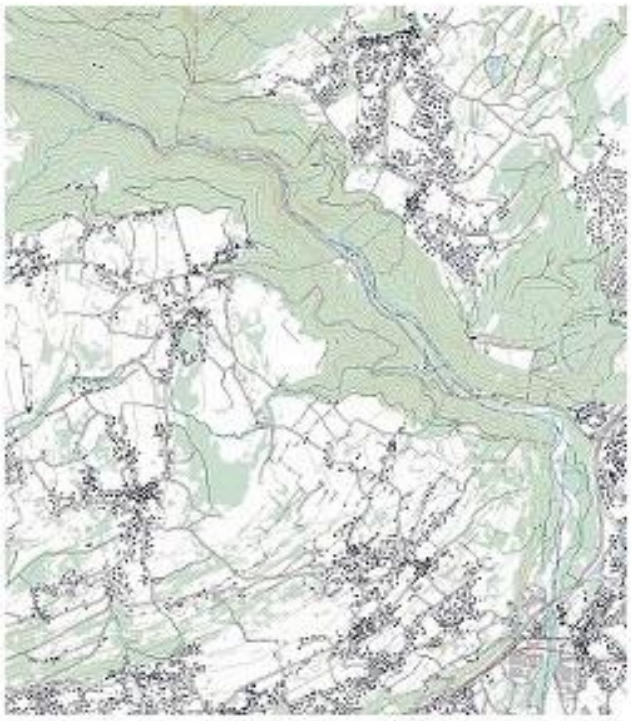
2.11. Which is the original topographic map of France?
Click on the map to respond.

2.12. Which is the original topographic map of France?
Click on the map to respond.



2.13. Which is the original topographic map of France?
Click on the map to respond.

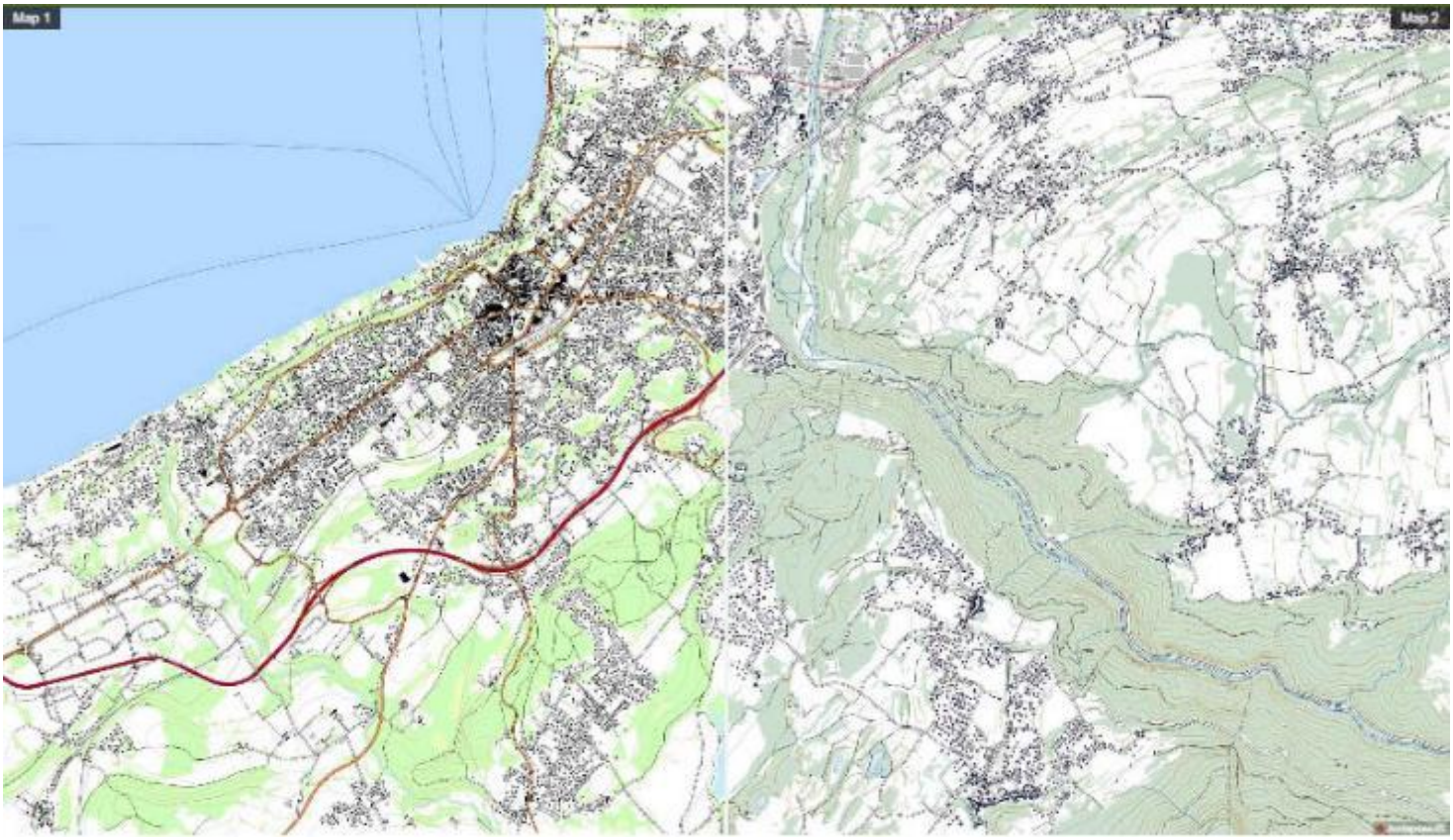




In the following question, you will be asked to use a swipe tool by clicking on a hyperlink. A new tab will open, where you can compare maps.
THEN PLEASE CLOSE IT, COME BACK ON THIS PAGE
AND ANSWER THE QUESTION BELOW

Which is the original topographic map of **France**?
Click on the link below to see the maps and use the swipe tool to compare:
Swipe tool

- ○ Map 1 (on the left side)
- ○ Map 2 (on the right side)



Which of the geographic features showed on the maps helped you to make your selection?

Multiple answers possible

- [ ] terrain
- [ ] forest
- [ ] road network
- [ ] individual buildings

Other features:

Which of the design elements showed on the maps helped you to make your selection?

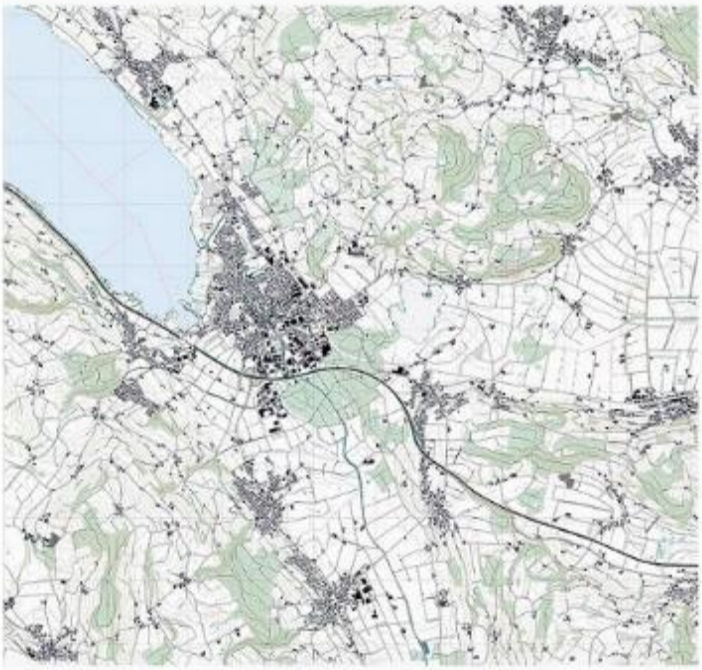
Multiple answers possible

- [ ] contour lines
- [ ] colors
- [ ] generalization
- [ ] geographic footprint (showed area)

Other elements:

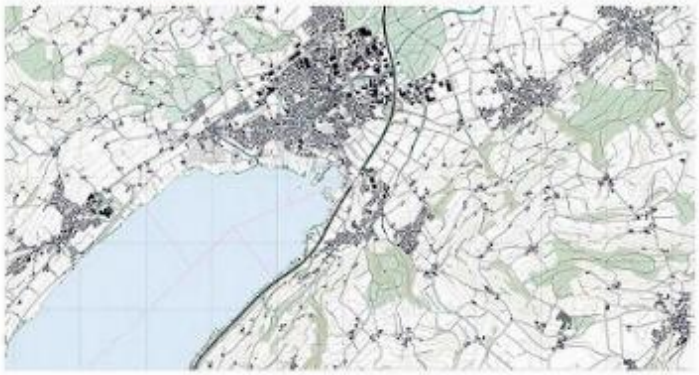
- **Recognition of cartographic styles – Comparison using Swisstopo**

2.17. The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **Switzerland**? Click on the map to respond.

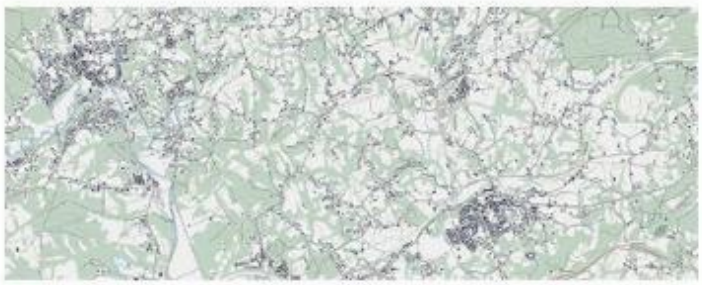


-

2.18. The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **Switzerland**? Click on the map to respond.



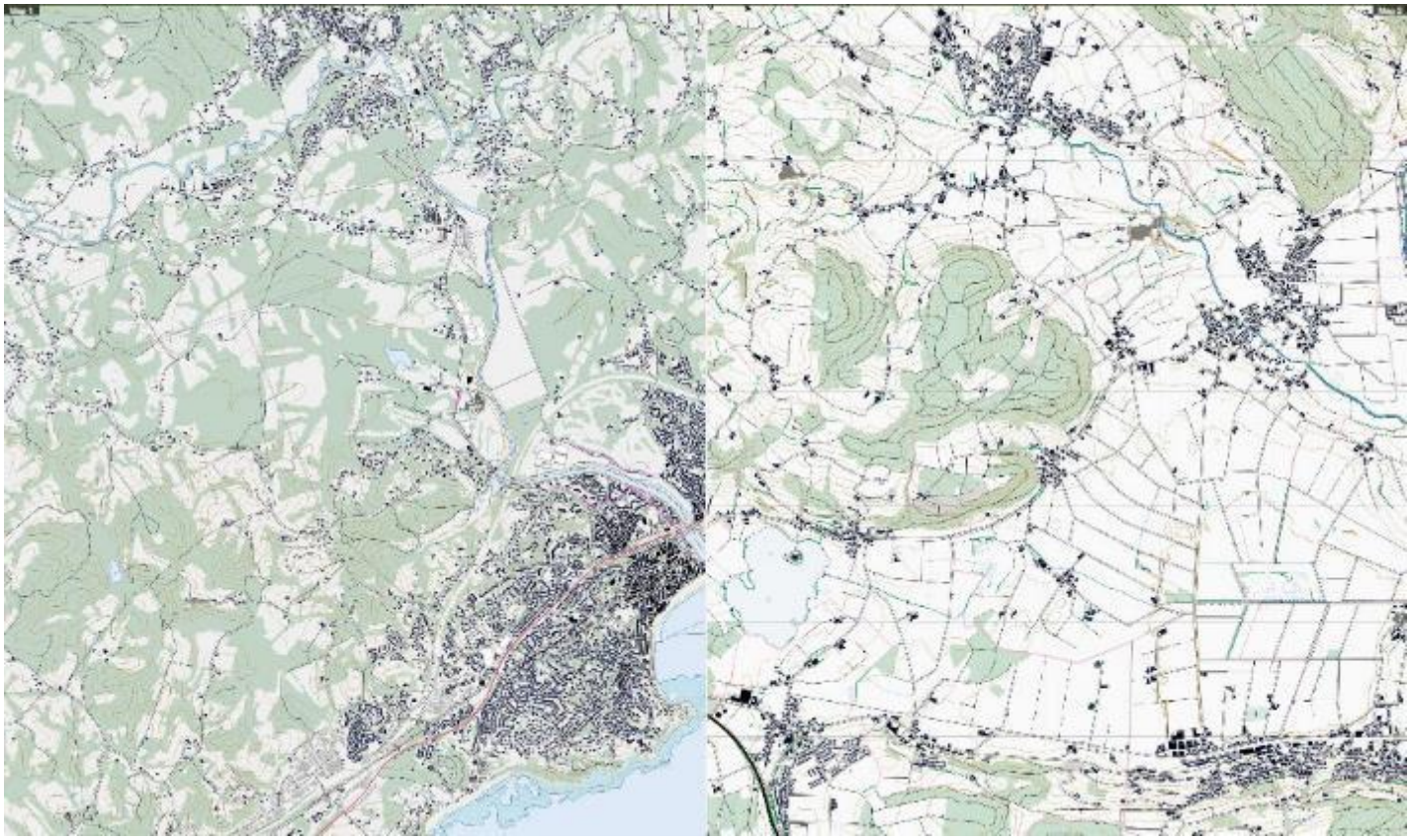
2.19. The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **Switzerland**? Click on the map to respond.



In the following question, you will be asked to use a swipe tool by clicking on a hyperlink. A new tab will open, where you can compare maps.
THEN PLEASE CLOSE IT, COME BACK ON THIS PAGE
AND ANSWER THE QUESTION BELOW

Which is the original topographic map of **Switzerland**?
Click on the link below to see the maps and use the swipe tool to compare:
Swipe tool

- Map 1 (on the left side)
- Map 2 (on the right side)



Which of the geographic features showed on the maps helped you to make your selection?

Multiple answers possible

- [ ] terrain
- [ ] forest
- [ ] road network
- [ ] individual buildings

Other features:

Which of the design elements showed on the maps helped you to make your selection?

Multiple answers possible

- [ ] contour lines
- [ ] colors
- [ ] generalization
- [ ] geographic footprint (showed area)

Other elements:

- **Recognition of cartographic styles – Comparison using IGN**

2.23. The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **France**? Click on the map to respond.

-

2.24. The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **France**? Click on the map to respond.

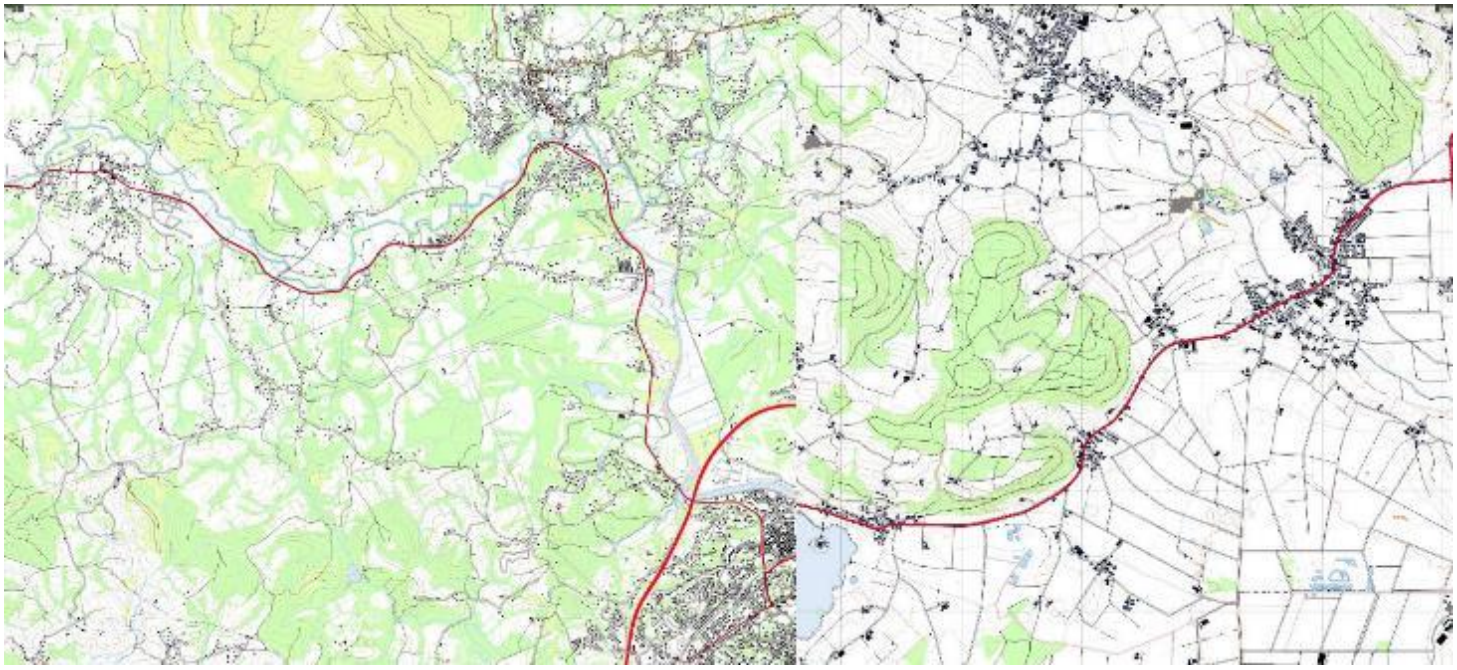
-

2.25. The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **France**? Click on the map to respond.

In the following question, you will be asked to use a swipe tool by clicking on a hyperlink. A new tab will open, where you can compare maps.
THEN PLEASE CLOSE IT, COME BACK ON THIS PAGE
AND ANSWER THE QUESTION BELOW

The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **France**?
Click on the link below to see the maps and use the swipe tool to compare:
Swipe tool

- Map 1 (on the left side)
- Map 2 (on the right side)



Which of the geographic features showed on the maps helped you to make your selection?

Multiple answers possible

- [ ] terrain
- [ ] forest
- [ ] road network
- [ ] individual buildings

Other features:

Which of the design elements showed on the maps helped you to make your selection?

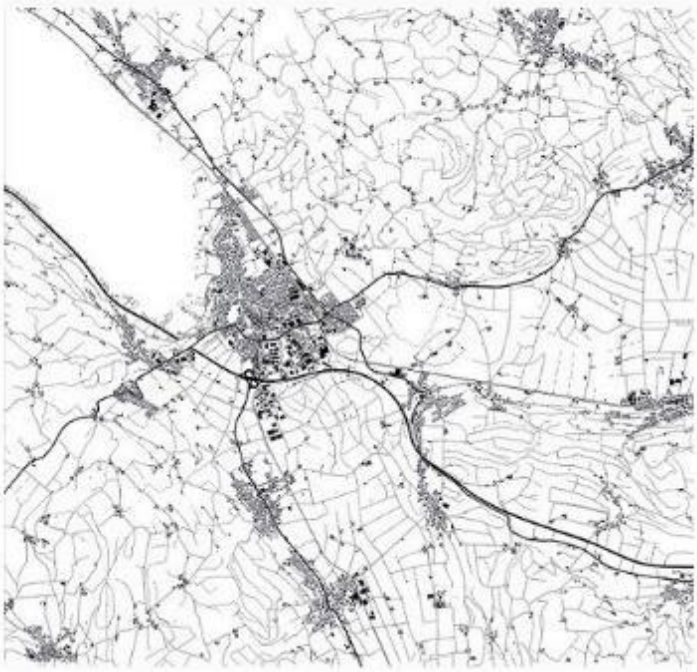
Multiple answers possible

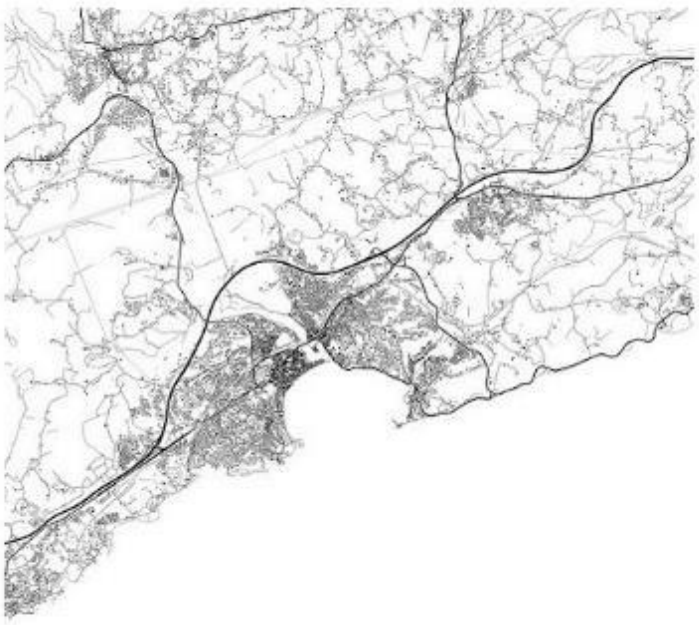
- [ ] contour lines
- [ ] colors
- [ ] generalization
- [ ] geographic footprint (showed area)

Other elements:

- **Recognition of cartographic styles – Roads & Buildings**

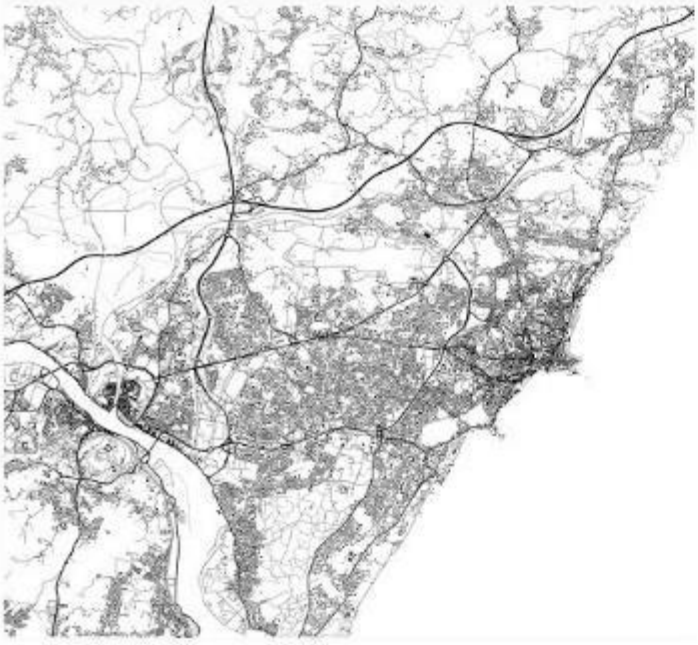
2.29. The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **France**? Click on the map to respond.





-

2.30. The following 2 topographic maps are from France and Switzerland.
Which is the topographic map of **Switzerland**? Click on the map to respond.



Which of the geographic features showed on the maps helped you to make your selection?

Multiple answers possible

- ☐ road network
- ☐ individual buildings
- ☐ terrain

Other features:

Which of the design elements showed on the maps helped you to make your selection?

Multiple answers possible

- ☐ generalization
- ☐ geographic footprint (showed area)

Other elements:

A.3. Map Memory Test

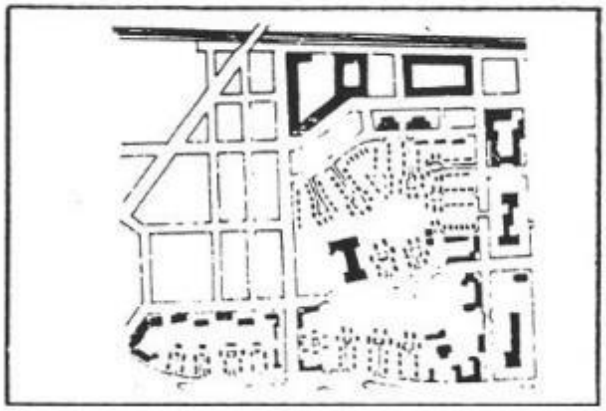
Map Memory Test

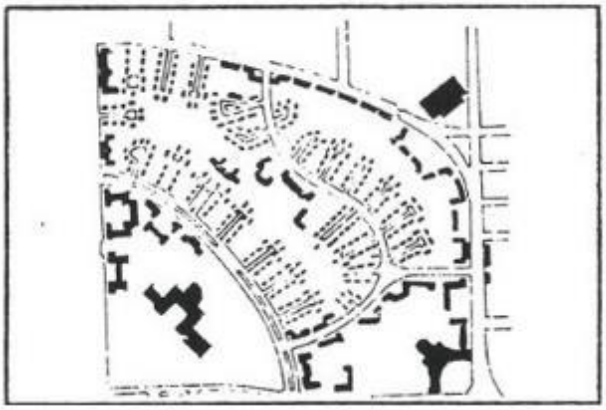
In the next pages, there is a test to measure your ability to remember part of a map so that you can recognize it when you see it again.

Before starting the main Map Memory Test, there will be **Sample test** on the following 2 pages where you can get familiar with the procedure.

Study the sample depicted.
You have **60 seconds** to memorize the samples and **60 more seconds** to answer.

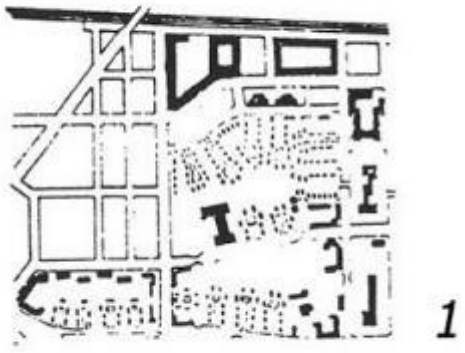
Please study carefully the 2 maps. (Study Page)

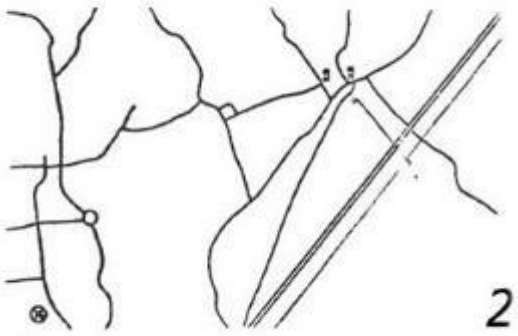


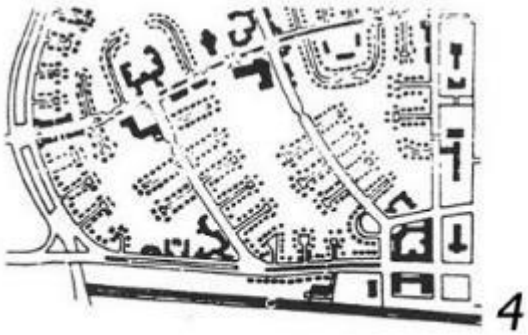


3.1. Which two of these four maps are the ones you saw on the study page? (Memory Page)

Multiple answers possible - Maximum 2 answers







Map Memory Test

Sample Test Answer:
You should have chosen **Map 1** and **Map 3** on the previous page.

Now the Map Memory Test starts

Each of the four parts of this test will have **2** sections:

(1) a Study Page for you to study for **90 seconds** and

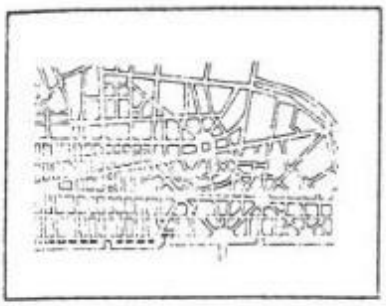
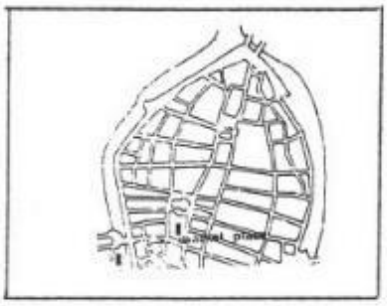
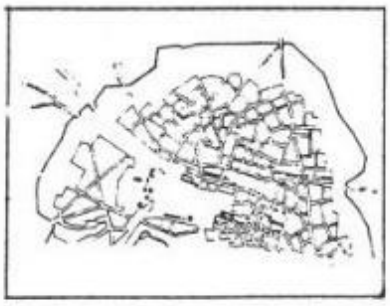
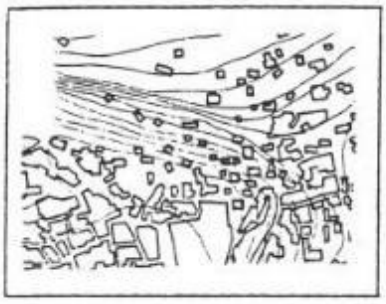
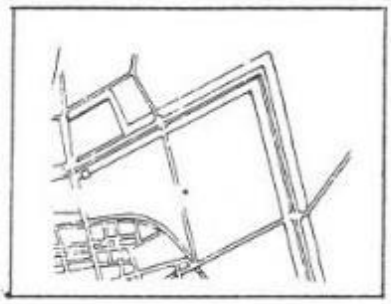
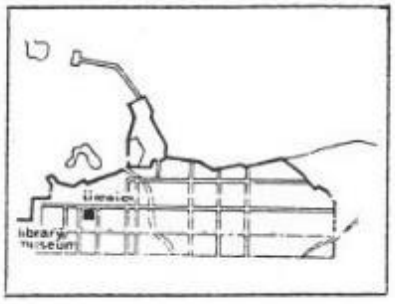
(2) a Memory Page which you will have **90 seconds** to complete.

If you need less than 90 seconds to memorize the maps, you can press the button "next question".

Your score will be the number of maps which you identify correctly **minus the number which you identify incorrectly**.
Therefore, it will not be to your advantage to guess unless you have some idea of whether or not you have studied the map.

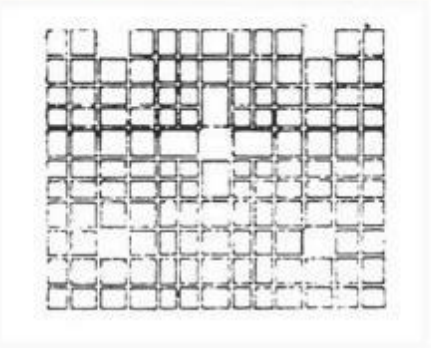
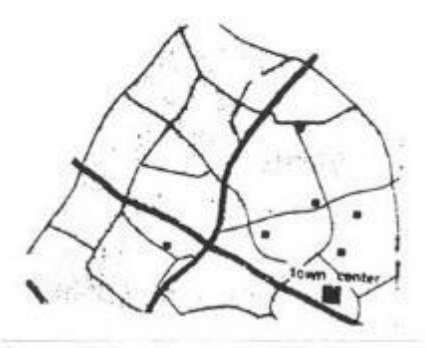
At the end of the survey, we will see your score!

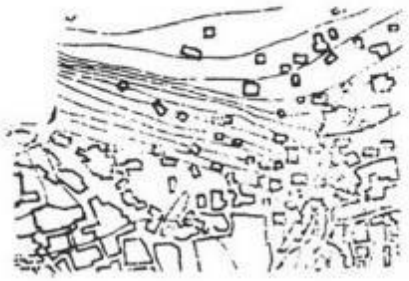
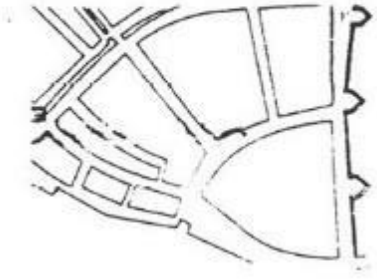
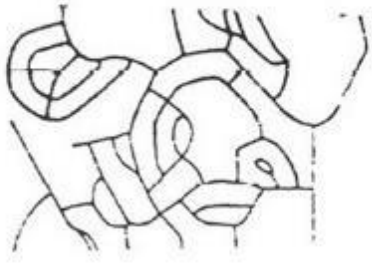
Please study carefully the following maps. (Study Page)

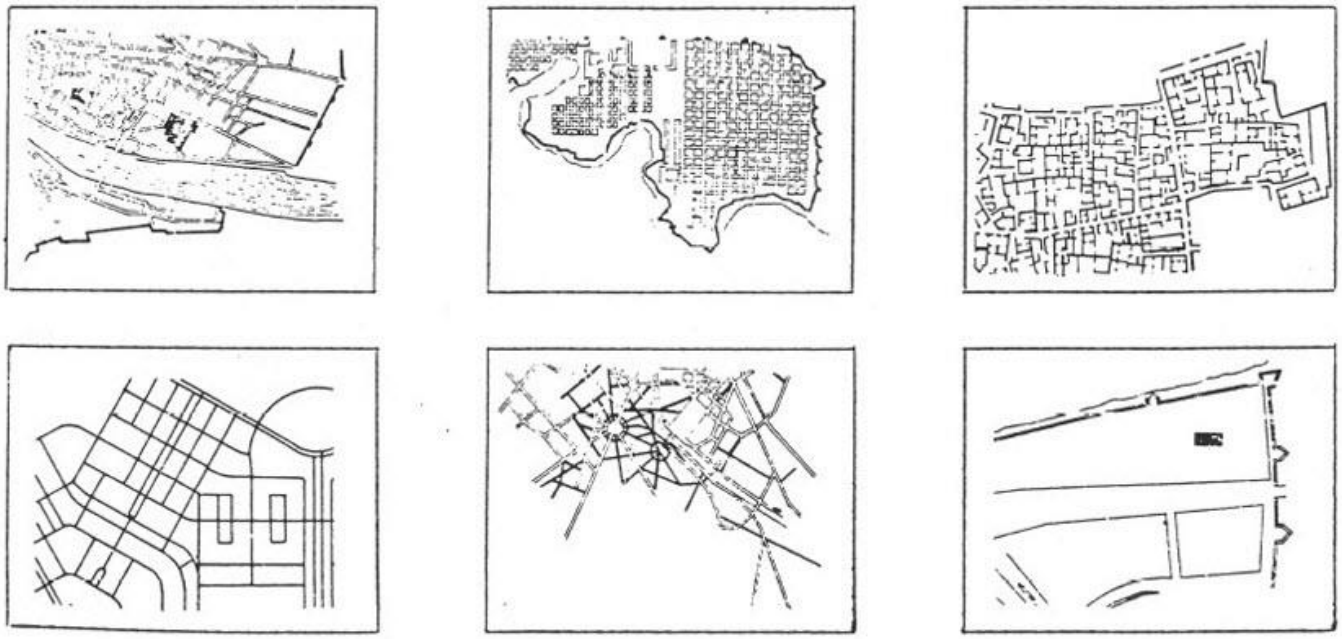
3.2. Which of these maps are the ones you saw on the previous page? (Memory Page)

Multiple answers possible

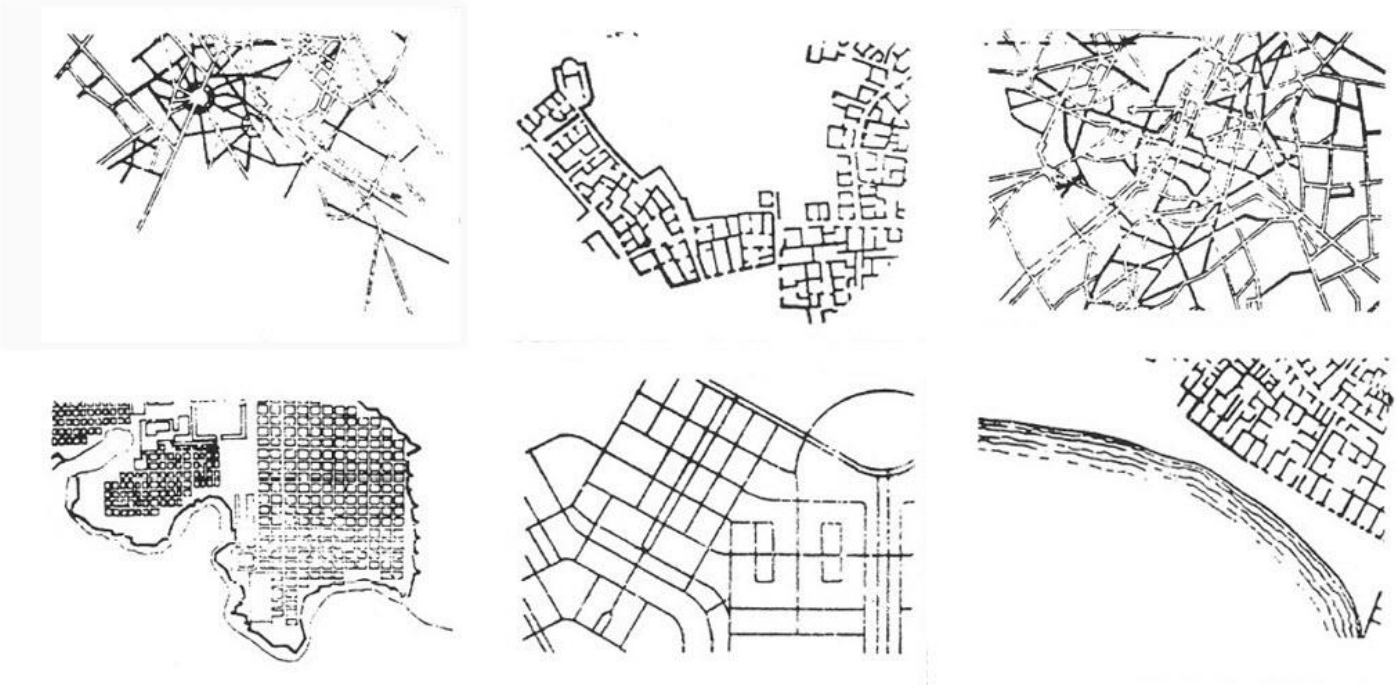





Please study carefully the following maps. (Study Page)

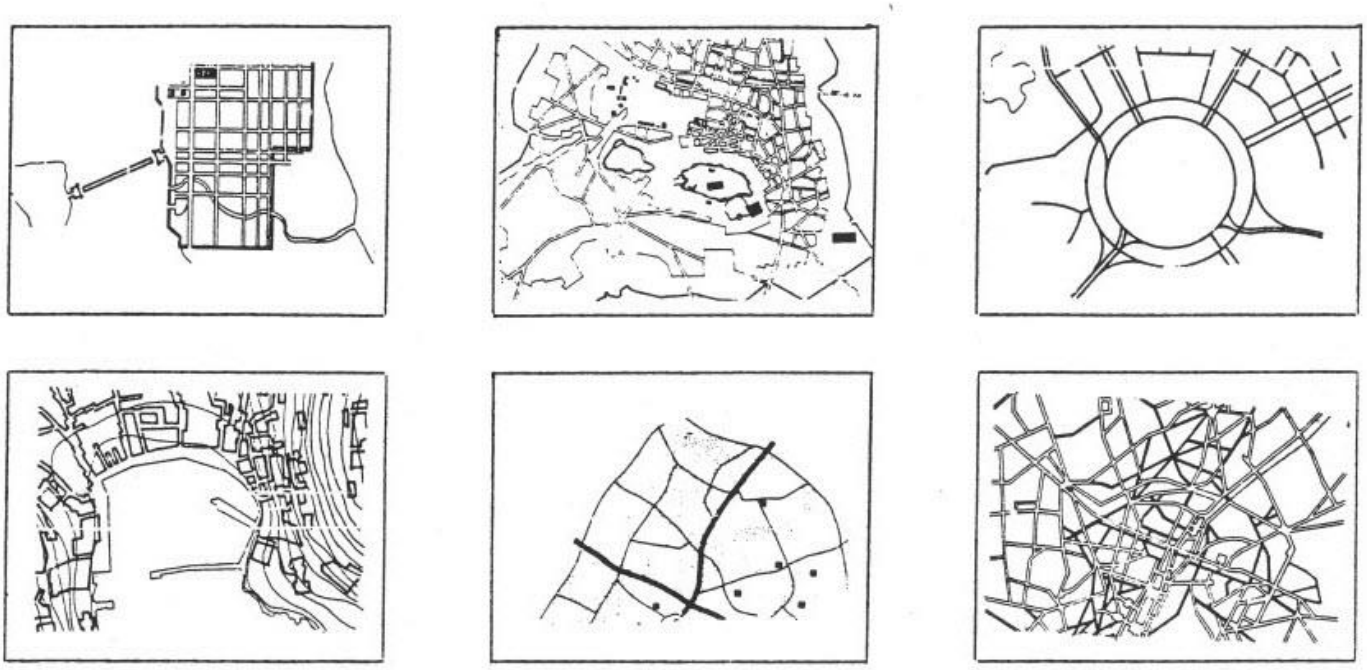


3.3. Which of these maps are the ones you saw on the previous page? (Memory Page)

Multiple answers possible

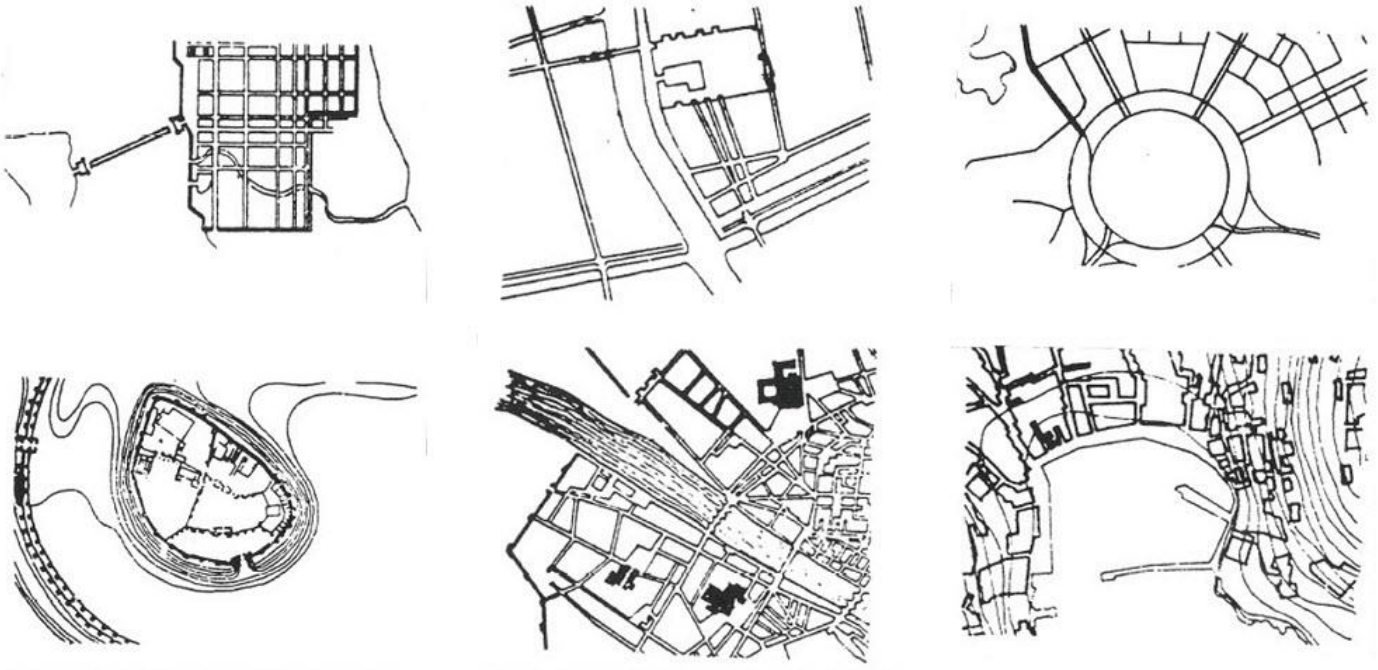


Please study carefully the following maps. (Study Page)

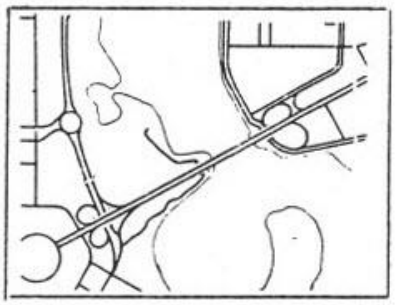
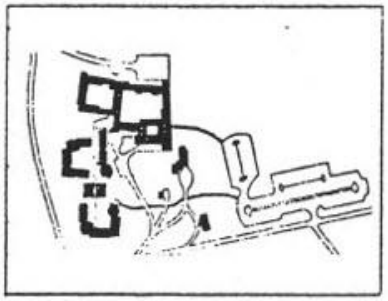
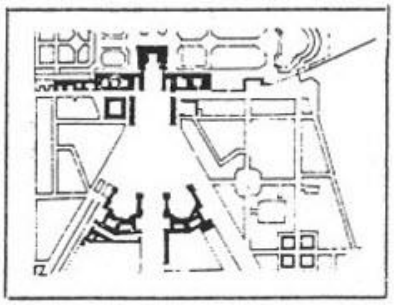
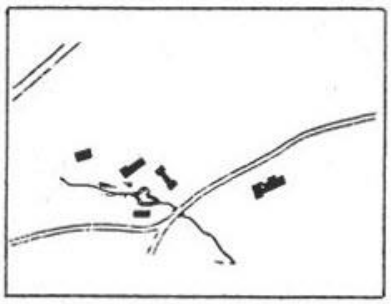
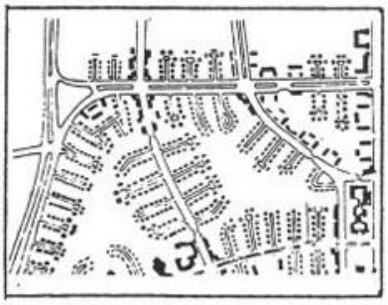
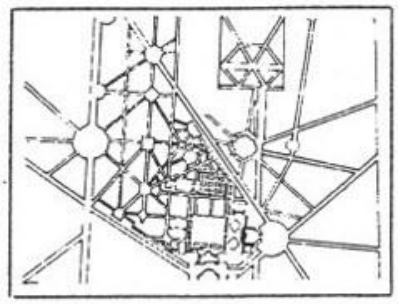


3.4. Which of these maps are the ones you saw on the previous page? (Memory Page)

Multiple answers possible

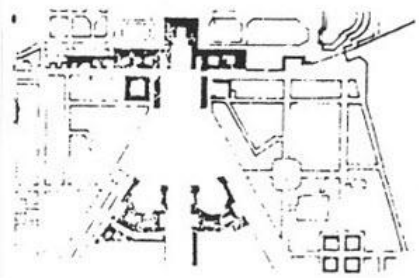
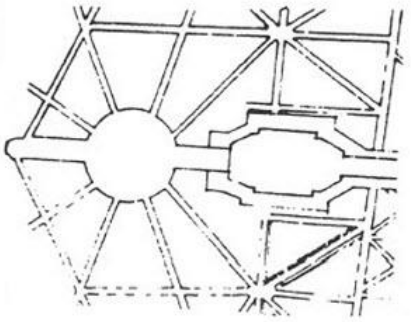
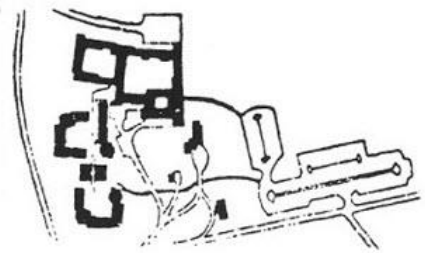
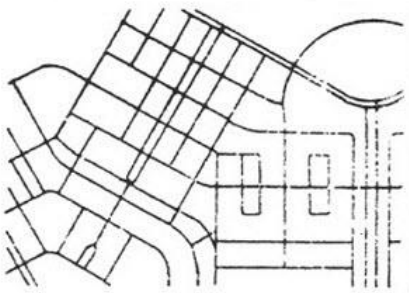
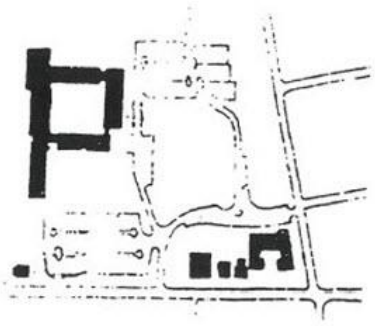


Please study carefully the following maps. (Study Page)

3.5. Which of these maps are the ones you saw on the previous page? (Memory Page)

Multiple answers possible

A.4. Background questions

Background questions

You have reached the last part of the questionnaire.
You will be asked **11** general questions about yourself.

Press the button below to start!

4.1. Have you been diagnosed with color vision deficiency?

- Yes
- No

4.2. Do you have corrected vision (eyeglasses or contact lenses)?

- Yes
- No

4.3. Are you wearing your eyeglasses/contact lenses at the moment?

- Yes
- No

4.4. What is your gender?

- Female
- Male

4.5. What is your age?

- 18 to 24
- 25 to 29
- 30 to 34
- 35 to 39
- 40 to 44
- 45 to 49
- 50 to 54
- 55 or older

4.6. What is your country of birth?

Please fill in the following fields:

Country -----

4.7. What is the country where you have lived most of your life?

Please fill in the following fields:

Country -----

4.8. What is your mother tongue?

- English
- French
- German
- Greek
- Italian
- Russian
- Spanish

Other:

4.9. What is the highest level of School that you have completed?

- Secondary education
- Bachelor's or equivalent level
- Master's or equivalent level
- Doctoral or equivalent level

Other:

4.10. What is your field of study/field of work?

- Architecture
- Cartography
- Civil engineering
- Geography
- Geomatic engineering
- Mechanical engineering
- Urban planning

Other field of study/work:

4.11. Which type of device have you used to fill in the survey?

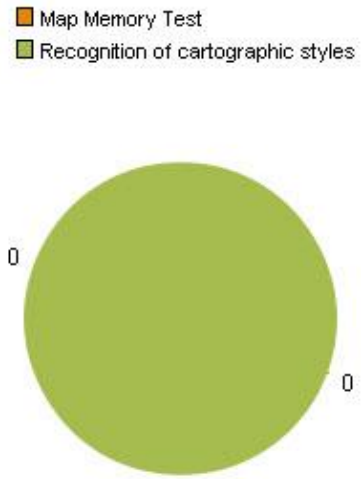
- Smartphone
- Tablet computer
- Laptop / desktop computer

Feel free to add any comments about this study

Please leave an email if you are interested in the results of this study

Thank you!

Dimensions	Points
Map Memory Test	0
Recognition of cartographic styles	0



Highest possible Score:
11 (Map Memory Test)
20 (Recognition of cartographic styles)

Thank you for taking the time to complete this survey. We truly value the information you have provided. Your responses will contribute to our analysis. We hope you enjoyed it!

Author
Athanasios Karathanasopoulos, Department of Geography - University of Zurich

B. Statistics

Table 2: Group Statistics (Swiss – Non-Swiss)

	Swiss – Non-Swiss	N	Mean	Std. Deviation	Std. Error Mean
swiss_reco_score	Swiss	55	.6691	.36152	.04875
	Non-Swiss	40	.5500	.39419	.06233
swiss_comp_score	Swiss	55	.8955	.19656	.02650
	Non-Swiss	40	.8688	.21917	.03465
road_score	Swiss	55	.7545	.31729	.04278
	Non-Swiss	40	.8000	.29526	.04668
france_reco_score	Swiss	55	.4291	.44459	.05995
	Non-Swiss	40	.2900	.39471	.06241
france_comp_score	Swiss	55	.8591	.29566	.03987
	Non-Swiss	40	.8313	.26182	.04140
Score_total	Swiss	55	.7215	.15131	.02040
	Non-Swiss	40	.6680	.16519	.02612
France_total	Swiss	55	.6441	.19773	.02666
	Non-Swiss	40	.5606	.23567	.03726
Swiss_total	Swiss	55	.7823	.20569	.02773
	Non-Swiss	40	.7094	.22939	.03627
Comp_total	Swiss	55	.8773	.19763	.02665
	Non-Swiss	40	.8500	.21780	.03444
Reco_total	Swiss	55	.5491	.31557	.04255
	Non-Swiss	40	.4200	.28930	.04574

Table 3: Mann-Whitney Test (Swiss – Non-Swiss)

	swiss reco score	swiss comp score	road_ score	france reco score	france comp score	Score total	France total	Swiss total	Comp total	Reco total
Mann-Whitney U	901.000	1055.000	1020.000	906.500	988.500	877.000	825.500	915.000	1034.500	864.000
Wilcoxon W	1721.000	1875.000	2560.000	1726.500	1808.500	1697.000	1645.500	1735.000	1854.500	1684.000
Z	-1.551	-.415	-.702	-1.543	-1.023	-1.684	-2.154	-1.413	-.539	-1.802
Asymp. Sig. (2-tailed)	.121	.678	.483	.123	.306	.092	.031	.158	.590	.072

Table 4: Group Statistics (Geographers – Engineers)

	Geography - Engineers	N	Mean	Std. Deviation	Std. Error Mean
swiss_reco_score	Geography	64	.5969	.39919	.04990
	Engineers	30	.6667	.33767	.06165
swiss_comp_score	Geography	64	.9219	.15983	.01998
	Engineers	30	.8083	.26816	.04896
road_score	Geography	64	.7656	.29505	.03688
	Engineers	30	.8000	.33733	.06159
france_reco_score	Geography	64	.3719	.43624	.05453
	Engineers	30	.3467	.40661	.07424
france_comp_score	Geography	64	.9063	.22930	.02866
	Engineers	30	.7500	.31486	.05749
Score_total	Geography	64	.7125	.14363	.01795
	Engineers	30	.6743	.18759	.03425
France_total	Geography	64	.6391	.20084	.02510
	Engineers	30	.5483	.24335	.04443
Swiss_total	Geography	64	.7594	.21563	.02695
	Engineers	30	.7375	.22854	.04173
Comp_total	Geography	64	.9141	.14583	.01823
	Engineers	30	.7792	.26401	.04820
Reco_total	Geography	64	.4844	.33675	.04209
	Engineers	30	.5067	.24766	.04522

Table 5: Mann-Whitney Test (Geographers – Engineers)

	swiss reco score	swiss comp score	road_ score	france reco score	france comp score	Score total	France total	Swiss total	Comp total	Reco total
Mann-Whitney U	900.500	773.000	870.000	958.500	665.500	892.000	705.500	920.500	661.000	871.000
Wilcoxon W	2980.500	1238.000	2950.000	3038.500	1130.500	1357.000	1170.500	1385.500	1126.000	2951.000
Z	-.500	-1.868	-.853	-.013	-2.931	-.553	-2.145	-.325	-2.654	-.732
Asymp. Sig. (2-tailed)	.617	.062	.394	.990	.003	.580	.032	.745	.008	.464

Table 6: Group Statistics (Female - Male)

	Gender	N	Mean	Std. Deviation	Std. Error Mean
swiss_reco_score	Female	46	.6478	.35574	.05245
	Male	49	.5918	.39991	.05713
swiss_comp_score	Female	46	.8424	.24358	.03591
	Male	49	.9235	.15482	.02212
road_score	Female	46	.7826	.32748	.04829
	Male	49	.7653	.29051	.04150
france_reco_score	Female	46	.2478	.35323	.05208
	Male	49	.4857	.46188	.06598
france_comp_score	Female	46	.8804	.23416	.03453
	Male	49	.8163	.31777	.04540
Score_total	Female	46	.6802	.16202	.02389
	Male	49	.7165	.15506	.02215
France_total	Female	46	.5641	.19448	.02867
	Male	49	.6510	.23083	.03298
Swiss_total	Female	46	.7451	.21289	.03139
	Male	49	.7577	.22437	.03205
Comp_total	Female	46	.8614	.21767	.03209
	Male	49	.8699	.19592	.02799
Reco_total	Female	46	.4478	.26055	.03842
	Male	49	.5388	.34690	.04956

Table 7: Mann-Whitney Test (Female -Male)

	swiss reco score	swiss comp score	road_ score	france reco score	france comp score	Score total	France total	Swiss total	Comp total	Reco total
Mann-Whitney U	1071.000	938.000	1062.000	815.500	1034.500	1056.000	981.500	1068.500	1108.500	950.500
Wilcoxon W	2296.000	2019.000	2287.000	1896.500	2259.500	2137.000	2062.500	2149.500	2333.500	2031.500
Z	-.431	-1.721	-.564	-2.455	-.839	-.530	-1.128	-.441	-.150	-1.331
Asymp. Sig. (2-tailed)	.666	.085	.573	.014	.402	.596	.259	.659	.881	.183

Table 8: Group Statistics (Low – High Map Memory)

	Map groups	N	Mean	Std. Deviation	Std. Error Mean
Score_total	0-8	38	.6382	.16010	.02597
	9-11	56	.7348	.14239	.01903
France_total	0-8	38	.5579	.19908	.03229
	9-11	56	.6366	.22064	.02948
Swiss_total	0-8	38	.6822	.21252	.03448
	9-11	56	.7942	.21073	.02816
Comp_total	0-8	38	.8191	.24436	.03964
	9-11	56	.8951	.17152	.02292
Reco_total	0-8	38	.4211	.25379	.04117
	9-11	56	.5357	.33272	.04446
swiss_reco_score	0-8	38	.5158	.36799	.05970
	9-11	56	.6821	.37324	.04988
swiss_comp_score	0-8	38	.8487	.22912	.03717
	9-11	56	.9063	.18807	.02513
road_score	0-8	38	.7105	.36077	.05852
	9-11	56	.8125	.26220	.03504
france_reco_score	0-8	38	.3263	.40114	.06507
	9-11	56	.3893	.44218	.05909
france_comp_score	0-8	38	.7895	.31583	.05124
	9-11	56	.8839	.25210	.03369

Table 9: Mann-Whitney Test (Low – High Map Memory)

	swiss reco score	swiss comp score	road_ score	france reco score	france comp score	Score total	France total	Swiss total	Comp total	Reco total
Mann-Whitney U	789.000	919.500	926.500	1027.000	874.000	706.000	806.000	748.000	875.000	855.500
Wilcoxon W	1530.000	1660.500	1667.500	1768.000	1615.000	1447.000	1547.000	1489.000	1616.000	1596.500
Z	-2.188	-1.357	-1.231	-.302	-1.776	-2.764	-2.071	-2.465	-1.585	-1.627
Asymp. Sig. (2-tailed)	.029	.175	.218	.763	.076	.006	.038	.014	.113	.104

Table 10: Correlation Map Memory score – Recognition score

			Score Map Memory Test
Spearman's rho	**swiss_reco_score**	Correlation Coefficient	.234*
		Sig. (2-tailed)	.023
		N	94
	swiss_comp_score	Correlation Coefficient	.083
		Sig. (2-tailed)	.425
		N	94
	road_score	Correlation Coefficient	.188
		Sig. (2-tailed)	.069
		N	94
	france_reco_score	Correlation Coefficient	.080
		Sig. (2-tailed)	.441
		N	94
	france_comp_score	Correlation Coefficient	.133
		Sig. (2-tailed)	.200
		N	94
	Score_total	Correlation Coefficient	.321**
		Sig. (2-tailed)	.002
		N	94
	France_total	Correlation Coefficient	.212*
		Sig. (2-tailed)	.040
		N	94
	Swiss_total	Correlation Coefficient	.235*
		Sig. (2-tailed)	.022
		N	94
	Comp_total	Correlation Coefficient	.081
		Sig. (2-tailed)	.439
		N	94
	Reco_total	Correlation Coefficient	.227*
		Sig. (2-tailed)	.028
		N	94

Table 11: Recognition score – Background characteristics

		To what extent is your profession related to maps and mapping processes (map design, GIS, surveying)?	*How often do you use maps in your profession?*	*How often do you use maps in your leisure time?*	*How often do you use topographic maps in your daily life?*
swiss_reco_score	Pearson Correlation	.121	.183	-.072	.220*
	Sig. (2-tailed)	.249	.078	.492	.033
	N	93	93	93	95
swiss_comp_score	Pearson Correlation	-.108	-.157	.021	-.007
	Sig. (2-tailed)	.305	.134	.844	.948
	N	93	93	93	95
road_score	Pearson Correlation	-.051	-.022	.091	.223*
	Sig. (2-tailed)	.625	.837	.385	.030
	N	93	93	93	95
france_reco_score	Pearson Correlation	.041	.054	.051	.157
	Sig. (2-tailed)	.700	.609	.626	.129
	N	93	93	93	95
france_comp_score	Pearson Correlation	-.088	-.154	.189	.024
	Sig. (2-tailed)	.401	.141	.069	.817
	N	93	93	93	95
Score_total	Pearson Correlation	-.001	.012	.102	.282**
	Sig. (2-tailed)	.996	.912	.331	.006
	N	93	93	93	95
France_total	Pearson Correlation	-.017	-.047	.172	.170
	Sig. (2-tailed)	.870	.657	.099	.100
	N	93	93	93	95

		To what extent is your profession related to maps and mapping processes (map design, GIS, surveying)?	*How often do you use maps in your profession?*	*How often do you use maps in your leisure time?*	*How often do you use topographic maps in your daily life?*
Swiss_total	Pearson Correlation	.053	.084	-.052	.187
	Sig. (2-tailed)	.614	.426	.618	.069
	N	93	93	93	95
Comp_total	Pearson Correlation	-.114	-.184	.140	.013
	Sig. (2-tailed)	.276	.078	.182	.901
	N	93	93	93	95
Reco_total	Pearson Correlation	.101	.149	-.008	.242*
	Sig. (2-tailed)	.333	.155	.938	.018
	N	93	93	93	95

Table 12: France Recognition - Wilcoxon Signed Ranks

		N	Mean Rank	Sum of Ranks
normal – Swipe	Negative Ranks	11[a]	21.36	235.00
	Positive Ranks	17[b]	10.06	171.00
	Ties	67[c]		
	Total	95		

a. normal < Swipe
b. normal > Swipe
c. normal = Swipe

Table 13: France Recognition - Test Statistics[a]

	normal - Swipe
Z	-.741[b]
Asymp. Sig. (2-tailed)	.459

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Table 14: France Comparison - Wilcoxon Signed Ranks

		N	Mean Rank	Sum of Ranks
normal - Swipe	Negative Ranks	12[a]	8.08	97.00
	Positive Ranks	12[b]	16.92	203.00
	Ties	71[c]		
	Total	95		

a. normal < Swipe
b. normal > Swipe
c. normal = Swipe

Table 15: France Comparison - Test Statistics[a]

	normal - Swipe
Z	-1.537[b]
Asymp. Sig. (2-tailed)	.124

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Table 16: Switzerland Comparison - Wilcoxon Signed Ranks

		N	Mean Rank	Sum of Ranks
normal - Swipe	Negative Ranks	14[a]	9.39	131.50
	Positive Ranks	15[b]	20.23	303.50
	Ties	66[c]		
	Total	95		

a. normal < Swipe
b. normal > Swipe
c. normal = Swipe

Table 17: Switzerland Comparison - Test Statistics[a]

	normal - Swipe
Z	-1.895[b]
Asymp. Sig. (2-tailed)	.058

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Table 18: Switzerland Recognition - Wilcoxon Signed Ranks

		N	Mean Rank	Sum of Ranks
normal - Swipe	Negative Ranks	14[a]	22.61	316.50
	Positive Ranks	31[b]	23.18	718.50
	Ties	50[c]		
	Total	95		

a. normal < Swipe
b. normal > Swipe
c. normal = Swipe

Table 19: Switzerland Recognition - Test Statistics[a]

	normal - Swipe
Z	-2.286[b]
Asymp. Sig. (2-tailed)	.022

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Table 20: Roads&Buildings - Wilcoxon Signed Ranks

		N	Mean Rank	Sum of Ranks
Mainland - Waterbodies	Negative Ranks	24[a]	16.00	384.00
	Positive Ranks	7[b]	16.00	112.00
	Ties	64[c]		
	Total	95		

a. Mainland < Waterbodies
b. Mainland > Waterbodies
c. Mainland = Waterbodies

Table 21: Roads&Buildings - Test Statistics[a]

	Mainland - Waterbodies
Z	-3.053[b]
Asymp. Sig. (2-tailed)	.002

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

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Personal declaration

I hereby declare that the submitted thesis is the result of my own, independent work. All external sources are explicitly acknowledged in the thesis.

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