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What, how much and where: a syntactical decomposition of 136 representations of "village" in a GIS environment

Abstract

People are an inseparable part of space and the relationship between them develops through the experiences that human acquires in his attempt to understand the place which surrounds him. The traces of spatial experiences are imprinted within human and are inherent through episodic memory, developing his spatial perception. In the context of exploring the way people read and comprehend the space, the children's perception of the concept of "village" is being studied. Using statistics measures and techniques of spatial analysis, 136 paintings are mapped to a GIS environment, decoding the drawn elements and quantifying their basic characteristics. By drawing correlation matrix and interpreting the results, each child's choice is quantified and an average image of necessary elements of concept of "village" is constructed. Children seem to attribute the concept of "village" as a combination of the natural and built environment with sign of human presence. They believe that the villages are directly connected with the mountains and the view of houses, incorporating elements of public space. Through their choices, spatial trends are observed and relationships between individual elements are confirmed or revealed, the composition of those can create the image of the village, proving that even an occasional user can reproduce with great precision and detail the research environment.

Keywords: space syntax, spatial perception, children

Introduction

The perception of space focuses on movement and does not pay much attention to the visual. The degree and mode of people's movement in the environment is a guiding criterion and a means of reading it, playing a decisive role in the self-perceiving environment. For this reason, the image of each space depends on the user who has captured it (Hall, 1966; Çanakçığlu, 2015). A permanent user explores in greater detail the environment and his movement is characterized by repeatability. On the other hand, an occasional user limits his movements to the part where feels more familiar, recognizing key points in it. Both users perceive and shape an image, but each reflects a different aspect of reality, as they develop different experiences within it (Hillier, et al., 1987; AL-Ghatam, 2015).

If a representation of a specific space is requested, the personal knowledge in this space will be imprinted, which has formed through his experience (Kant, 2006). Through the spatial

experience, human understands what surrounds him, transforming undefined space into a living space and his own self into an inseparable part of it. Imprinting of this experience leads to the creation of an unconscious mental life, shaping the individual's inner reality and his personal view of each space (Ansermet & Magistretti, 2016). Thus, this difference in knowledge between users is a key to understanding the structure of each environment, because the degree of motion of the two different users in the same spatial environment differs appreciably, resulting in two different decoding perspectives of that space (Hillier, et al., 1987; Gann, 2003).

It is worthy of note that episodic memory refers to the ability to hold representations of specific personal experiential experiences that occur in a certain space-time context and can be experienced again through conscious recall (Tulving, 2002). She is the kind of memory that allows people to think on personal experiences, directly related to space and time (Wheeler, 2000; Steinvorth et al., 2005). Episodic memory expands as long as human recruits new images and experiences and acquires new experiences. Traces of each experience are imprinted on the unconscious and recorded at the same time as others disappear, altered or linked together, creating new correlations. Consequently, trace is dynamic, and each modification involves a change, directly linked to space and stage of personal spatial perception (Pallasmaa, 2006; Pilavaki, 2017). Certainly, at all stages of development of its spatial perception, human develops a set of symbols to design specific objects and to define relationships and space in his designs (Joyce, 2012). Whatever stage, he attributes the spatial representation of his knowledge through a painting, (Çanakçıoğlu, 2015) which can be analyzed in a GIS environment, using methods of space syntax.

Data & methods

The research is based on 136 children's paintings, which represent the concept of "village" and are collected from public schools and private art studios in Athens, Piraeus and Thessaloniki, in period September - December 2017. Participants aged 8- 10 years have to paint the village on an A4 paper, as they want and remember it, using whatever material they want. Upon completion of process, paintings are collected and organized in digital form as images.

In the first step of studying, data, which have been captured from whole sample, are cataloged and the existence of each entity in each painting is whiten down. Initially, 57 different entities are listed. Any data is presented in less than 5% of the paintings, regardless of how many times they appear in each, are grouped together. In this way, there are 36 entities, divided into 5 main categories (Table 1).

Table 1. Classification of categories and entities.

“natural environment”	100	“built environment”	200
“sky”	101	“house”	201
“sun”	102	“shop”	202
“cloud – rain – rainbow”	103	“town hall – school – doctor”	203
“sea”	104	“church – belfry – cemetery”	204
“river – lake”	105	“coffee shop”	205
“mountain”	106	“pharmacy”	206

“ground”	107	“hotel – camping”	207
“green”	108	“farm”	208
“garden”	109	“castle”	209
“tree”	110	“household item”	210
“flower - bush”	111	“house with fireplace”	211
“public space”	**300**	**“transport network”**	**400**
“square”	301	“car – bike”	401
“bench – table – chair”	302	“airplane – hot air balloon”	402
“playground”	303	“boat”	403
“fountain”	304	“road”	404
“object of public space”	305	“sidewalk”	405
		“bridge”	406
“figures”	**500**	**“empty”**	**0**
“human”	501		
“animal”	502		

These raster data are inserted and georeferenced in a GIS environment and digitized on a vector normal grid basis, with exactly the same coordinates. The grid consists of 3264 polygons and divides the painting by about 0.4x0.4mm, corresponds to the size of A4 paper. Each polygon of grid gets a value that corresponds to the entity appearing internally. This process is not an automated process, but is done manually separately for each painting.

The value of each polygon is assign according to the following rules:

1. Polygon is characterized by the value of entity appearing inside it.
2. When elements of a different entity coexist, polygon is characterized by the value of entity that has been imprinted in a more specific way and in greater detail.
3. When elements of same category but of a different entity coexist, polygon is characterized by the value of entity with the smallest extent.
4. When entities of category "natural environment" (code 100) coexist with elements of another category, polygon is characterized by the value of the second category.
5. When entities of category "human environment" (code 500) coexist with elements of another category, polygon is characterized by the value of the first category.
6. In case of the coexistence of "sky" (code 101) or "terrain" (code 107) with another element, the polygon is characterized by the value of the other element.
7. In case of overlapping two elements, polygon is characterized by the value of element that is most forward or higher.
8. To qualify a polygon as "empty" (code 0), there must be absolutely no element inside it.

Upon completion of digitization, polygons are grouped by assigned value on each painting separately. As for the resulting polygons, their total area per entity and its appearance frequency are calculated. It should be note that the number that each entity has been painted on the paper, rather than the number of polygons, is calculated, because the corresponding entity may exist more than once in a polygon.

In order to analyze where each entity is placed, painting is divided to nine equal regions using the rule of thirds. These regions are used as a spatial criterion to explore the centralization of each entity, calculating his area into each of these nine. In this way, the probable position of each entity is calculated and visualized, analyzing its spatial behavior.

Results

First results relate to the way children envisage the representation of "village". A painting contains information about child's experience and knowledge, as well as about his attitude to the subject. A child who does not want or is not interested in the subject, will refuse to participate or will scribble/ sketch the image he has in his mind (Einarsdottir, et al., 2009). The meaning of sketchy in a child painting is not about the quality of lines, but about the drawn elements. When a child draws, he knows what he wants to draw and carefully chooses his materials, colors, patterns, plus the size and position of what he wants to draw (Farokhi & Hashemi, 2011).

It is observed that the majority of children use more than four (4) colors in their painting and only 26% using less: 13% one (1) color and 13% two - three (2-3) colors. Although there is a general finding that children use monochromatic combinations when they are going to capture patterns in their structure - especially pencil- (Canistra, 1991), this does not seem to be in this case. Children have captured the desired elements by clearly identifying either by adding verbal identification or characteristic details which may allow us to think that concept of "village" creates safety for children by giving them freedom and certainty to use various materials and combinations.

Another important point is related to three-dimensional elements in the painting. According to theoretical approach, the selected age group is able to attribute some elements in perspective, mainly elements that are very well acquainted and have assimilated their geometry. This does not mean that these elements are known within the village, but general knowledge of it as a self-contained figure and integrated form is sufficient. Therefore, we note that only 1 in 9 children has attributed the concept of perspective. It is worthwhile noting that, in the context of this research, in order to assume that there is a perspective in a painting, it is sufficient to have a three-dimensional representation of the central size and position element or of two or more other elements. On the contrary, 2 in 3 children attribute the sense of depth to their painting, which translates as an organization of elements by level, whether it occurs in sense of altitude difference or distance.

Progressing the analysis, average value of count of painted figures is 19, with fewer than 5% of paintings bearing more than 90 elements. According to the categorization of entities, 36 different entities emerge, with 8 being shown on average per painting. The resulting ratio between painted elements and content entities, about 2.5: 1, may be due to children's tendency to repeat identical elements and use patterns.

A key point in the research is the question of how alive is considered the village by children. In the current context, existence of "figure" (codes 501, 502), mean of transport (codes 401, 402, 403) and "house with fireplace" (code 211) is considered a sign of life. Child tells a story through his painting, so elements are selected in which could be observed movement at the next moment. In fact, the existence of a "figure" can express the connection between space and specific human or animal, the means of transport are about the way child himself or people around him arrives or moves into the village and the "home with fireplace" indicates the existence of someone inside of it. These criteria may be expanded by adding other elements, but it was preferable to limit them to give more conservative results. In this

direction, we observe that 3 in 5 children capture life in theirs paintings, using 5 elements on average per painting. It is worth noting that paintings with sign of life have not more painted figures. The average of total data they carry is same as this of general sample and part of these data is indicating existence of life. In fact, the probable position to place one of these elements is in the middle of painting, specifically in central and lower region. The lower right corner follows, showing the smallest chance of occurrence in the rest of painting.

In order to calculate the dependency relationship that entities may have on each other, a correlation matrix based on existence of each one per painting and one based on coverage of each one occupy. The Pearson's correlation coefficient is used to calculate the table – variables examined follow a normal distribution- which yields the mean correlation between two variables.

Table 2 summarizes the strongest correlations based on existence, indicating some logical relationship between "complementary" entities, such as "sky" - "sun", "ship" - "sea" and highlighting some others. A good example is the positive correlation between "pharmacy" and "coffee shop", "square" and "bench - table - chair" and the negative correlation between "house" and "house with fireplace", gathering that children choose to capture only one of two types of house.

Table 2. Correlation of entities based on existence.

	positive	**negative**	**zero**
strong	202-207 | 104-403	-	0-102 | 0-210 | 202-402
moderate	101-102 | 105-406 | 202-206 | 202-501 | 204-502 | 205-206 | 205-301 | 205-302 | 206-301 | 206-302 | 207-401 | 207-305 | 208-502 | 301-302 | 301-401 | 305-501 | 401-404	0-101 | 101-404 | 201-211	

In Table 3, the strongest correlations based on coverage are presented, by noting a negative correlation between elements of "natural environment" and "empty", as they are elements who can fill a painting. There is a positive correlation between "shop" and "hotel - camping" interpreting them as a tourist partition and among "coffee shop", "pharmacy" and "bench - table - chair". In addition, there is a correlation between "church - belfry - cemetery" and "playground", as they can be combined as activities or places by children.

Table 3. Correlation of entities based on coverage.

	positive	**negative**	**zero**
strong	205-302 | 402-403	0-101	111-208| 206-403
moderate	102-403 | 104-301 | 109-210 | 111-406 | 202-207 | 204-303 | 205-206 | 206-301 | 206-302 | 208-502 | 302-305	0-106 | 0-108	

Subsequently, with the purpose of identifying the dominant entity, whole sample is analyzed in terms of coverage and frequency of existence of them. Entities' classification tables are created as separate elements based on possibility of existence and extent. So, the entity that occupies the largest area is "empty", and entity "house" is following, showing the highest occurrence rate. Entities of category "natural environment" follow, by entity "mountain" displaying the highest levels of size and appearance. Entities of category "figures" are highly

likely to appear on a painting, but do not occupy much space. Correspondingly, "road network" and "house with fireplace" are not likely to appear on a painting, but if they do, they occupy a large area.

Before studying how entities spatially behave, a correlation matrix of nine regions is constructed, based on total area of each entity. Area is chosen as a considered variable, as it contains information about the existence of each element. According to the results, all regions have a significant positive correlation with each other, as the index does not get below 0.500. However, there is a relationship who is superior to others, and it appears as the painting is separated into two main parts, one consisting of the three upper regions and one of the rest (middle and bottom).

Focusing on entities, the probability of being placed in each region is calculated. Their spatial behavior is analyzed according to five types of spatial footprint (Figure 1):

- *Point*: entity is centralized at one region, without affecting the surrounding regions.
- *Center*: entity is centralized at one or two neighboring regions, affecting the surrounding regions.
- *Zone*: entity is centralized at successive regions, creating a zone.
- *Area*: entity is centralized at neighboring regions, creating an area and affecting the surrounding regions.
- *Random*: entity is centralized at random non- neighboring regions.

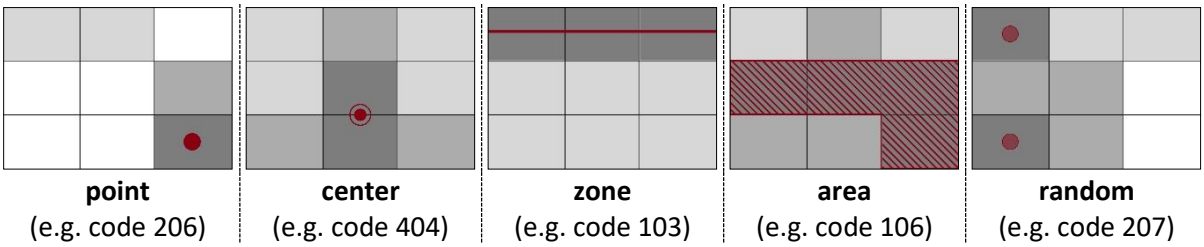

Figure 1. Types of entity's spatial footprint

Most entities spatially behave like a *center*: "square" and "tree" are placed in the geographical center of painting, "car – bike" and "animal" are centralized at the lower center region and "house with fireplace" in the middle, while "road" and "human" are placed in the bottom of paper, being closer to child. Entities "coffee shop", "bench – table – chair", "boat" and "pharmacy" behave as *point*, being placed on the lower left region the first and on the lower right region the last one. Entities "sky" and "cloud – rain – rainbow" create a *zone* in upper regions and "river – lake", "ground" and "green" in lower regions. Entities "mountain", "house" and "shop" are extended almost in the whole painting, creating individual *areas*.

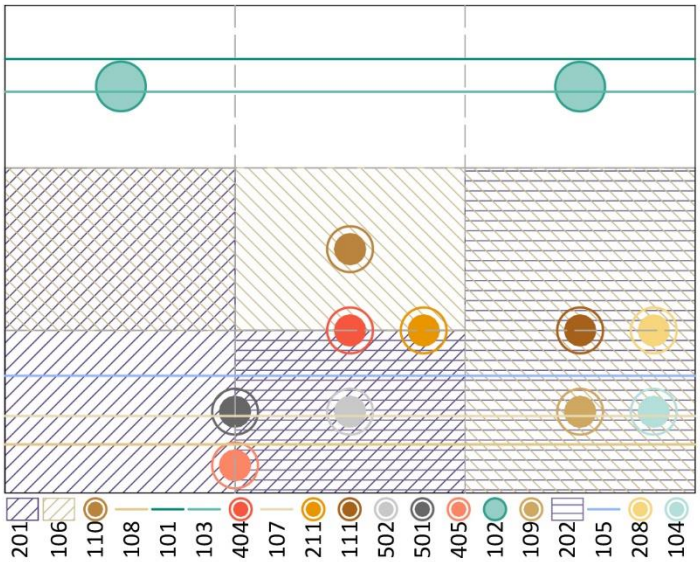

Figure 2. A qualitative image of *ideal village.*

“Sun” and “household item” do not feature spatial continuity, characterized as *random* type of spatial footprint.

In broad terms, this can be defined as a way to each entity be translated as a point, line or polygon into space based on its spatial behavior, maintaining its characteristics. This conversion implies on us to compose a qualitative image of the *ideal village* (Figure 2). The ideal village consists of 19 elements, which result from classification of the extent (e) of each entity. Entity’s j extent (e_j) is defined as the product of entity’s j mean area (a_j) by coefficient (ce_j), which is calculated in proportion to probability of entity’s existence and has value between 0 and 1.

The majority of elements are centralized at the bottom of the image and only elements relating to weather conditions are placed on top. It is interesting to mention that “house” and “mountain” extend to one third of image and “tree” is exactly in the center of it. “Human” is located in the lower center region and elements of categories “natural environment” and “transport network” surround him.

Generally, our findings demonstrate that children's predominant preference is category "natural environment", occupying more than one-third of the paper and showing the highest appearance frequency (Figure 3). Indeed, it is the only category who occupies 100% of a painting. Category “built environment” occupies one fifth of the painting and presents almost equal frequency probability. The other categories show the smallest percentages, by category “transport network” occupying the same area as the sum of the other two and category “figures” showing a fairly high frequency, in proportion to its size. Category “empty” has an equally large percentage of coverage, but a very low appearance frequency due to the way it is calculated.

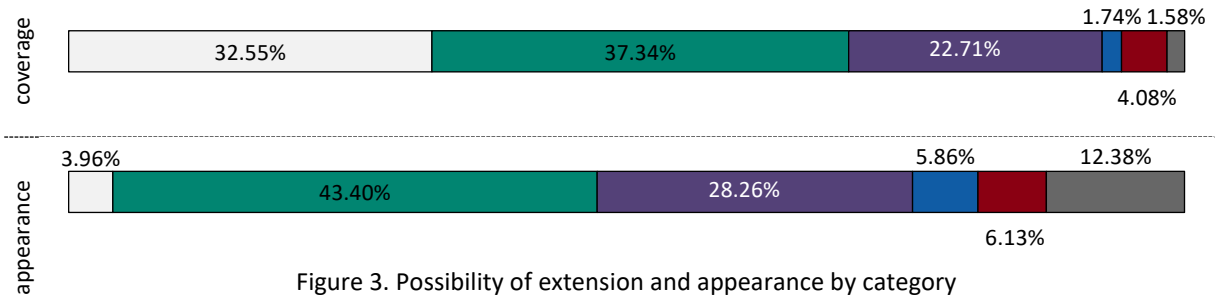

Figure 3. Possibility of extension and appearance by category

Categories “transport network” and “figures” exhibit the same spatial behavior, placed on the lower center as center. In the geographical center of the painting, category “public space” is located, around of which category “built environment” extends, creating an area. Category “natural environment” is placed in right side, but it does not feature spatial continuity, characterized as random type of spatial footprint.

According to the results, "village" is a delightful painting, based on the research sample. Children do not refuse to participate in the painting activity, and indeed appear to pay special attention to what and how they will attribute the concept. This fact provides encouragement for the relationship between child and village without, however, being a self-evident proof of a strong connection between them.

Conclusions & further research

In context of the relationship between people and perceptual space, this research focuses on the way in which human, as an occasional user, understands the space. The concept of "village" is chosen as a case study, analyzing 136 children's paintings. This choice goes hand in hand with the logic of mental maps, leaving more freedom for the child, as if map is concerned, child focuses on movement and access to space.

This research proves that 8-10 year old children are able to explain and draw the image they have in mind with great clarity and detail. It is worth mentioning that the question is not an image of their everyday life, but a recall of their episodic memory with spatial identification of the village. Therefore, the high level of responding can be seen as a result of significance and strength of episodic memory and / or of the actual connection of child with village.

The evidence from this study are based on bibliographic research and on the paintings collected and processed through the chosen methodology. The choice of methodological tools and techniques is successful, but without being considered as efficient as a process. This inefficiency is identified in the following points:

- Collecting paintings is a fairly time consuming process, as being difficult to access to a school environment.
- All the required information, such as the name of painted village, was not collected during the collection of paintings.
- The digitization stage is a painful process as it is done by manually digitizing a large amount of data.

These difficulties that may be identified can be overcome by digitally collecting paintings and automating the process. Creating a platform, in which the user could represent the concept of "village" in a defined environment, can produce the desired results. Thought this progress, all the required information will be collected and there can be a correlation between the represented village and the real one. Indeed, a preliminary attempt to create a pilot platform in which user / visitor can represent the village using a toolbox has already been made. Tools provided are redesigned items, which are traced to the paintings, retaining typical details. When saving the created image, all necessary information will be required to build the desired database.

Last but not least, in addition to chosen methodological tools, nearest neighbor analysis and point distance analysis are deemed necessary and for this reason they have already been completed. Through these techniques applied in a GIS environment, entities' spatial identity is explored and correlations between them are calculated. In this way, the logic of reading a place will be understood and the remarkable scene of each place will be virtualized.

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