

SPACE SYNTAX AS A DETERMINANT OF SPATIAL ORIENTATION PERCEPTION¹

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Abstract

This paper shows space syntax as a useful tool for the evaluation of buildings and its relationship to environmental perception. With this methodology, the spatial organization of a building was measured, obtaining a quantitative description of the relationships among the spaces within the building, which is measured in terms of how closely each space of the building is connected with the rest. We analyzed the relationship between the level of integration of each space and the perception of the settings in terms of way finding, communication and ease of movement. The results show that the spatial configuration of the building explained 27% and 39% of the variance of dynamic and static orientation respectively. It suggests that space syntax measures could be helpful in predicting how people perceive spatial orientation.

Introduction

Spatial orientation is understood as people's ability to identify their location, so they can navigate to any destination in the environment, both cognitively and behaviourally (Prestosky & Roskos-Ewolsen, 2000; Rovine & Weisman, 1989; Passini, 1984).

There are some designs features that may influence the way people find their way inside a building. There are four factors that facilitate space orientation within a building, according to Gifford (1997): a) Landmarks and counting number systems,

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b) the visibility of the destination, c) spatial discrimination and d) the general layout of the building.

Therefore, when people are looking for a destination, they not only obtain information from landmarks, but also from the environment as a whole, including architectural and spatial characteristics of a setting. The way in which the architectural characteristics of a building shape the spaces has an important influence on how people orientate themselves within it.

Weisman (1981) asked his participants (undergraduates) to report the manner in which they usually find their way in buildings when they are taking classes. He also showed judges several architectural plans, among them the plans of the campus, modified so their spatial characteristics were easily perceived, in order for the judges to evaluate them regarding: a) Preference, b) simplicity, c) how easily they could be described to other person, d) how easily they could be memorized, and e) the ease of way finding performance in a building with the same shape as the plan.

Weisman discovered that when a building plan was evaluated for its ease of way finding, the participants also reported that they move easily within it. Weisman's research suggests that space configuration has an important influence on way finding. However, his conclusions are limited because he used subjective impressions of spatial configuration and by the fact that only one item was used to measure the perception of orientation. Nevertheless, Weisman established a relationship between spatial configuration and way finding. O'Neill (1991) found that the complexity of a setting (the quantity of possible paths between the number of nodes in a system) has an influence on way finding abilities, such that the more complex the setting is, the more difficult way finding will be.

Legibility is understood as the characteristic of a setting that makes it easy to get relevant environmental information and thus contributes to a global knowledge of the setting. Rovine and Weisman (1989) agree with Passini (1992) and give their definition of legibility as "the level in which a building helps people's own way finding ability" (p.189).

Way finding within a building is easier if each part of it can be seen from any other place in it. Garling, Lindberg and Mantyla (1983) carried out a study in which they showed that a building giving less opportunity for visual access to other places in it has an influence on way finding. Some questions arose: Do the advantages given to people being able to see any place from other place in the building make it easier to learn about the configuration of it? Can people's way finding be improved if people can see another place in the building?

The participants were paired in two groups; one of them had limited visual access by wearing special glasses that made side and front sight inaccessible, beside the fact that they were unable to see through windows and along corridors. The groups had to do a number of trips through the building, and when the participants had partial vision of the setting, their way finding was very poor. Partial deprivation of visual access in a setting was found to be crucial for way finding. In these terms, legibility may be facilitated or limited, depending on how places are distributed in a building, lessening or increasing people's optimum way finding.

There are other spatial elements that contribute to spatial orientation in a setting. Passini (1992) reported that buildings having a central open space are usually better understood, allowing people to draw clear cognitive plans. Such an open space gives visual access to other places in the building, as well as to different levels. It also allows the person, at least in one way, to perceive the size of the building or of some other place within it. While people navigate within the main open spaces of the building, they can perceive some relationships among the places. He used different colors at different times, for the participants to draw plans of the building, where a way finding task had been carried out. They found that the size and centrality of an open space was usually exaggerated. It was exaggerated because the open space was the focal element of the mental images, as it was drawn first and then the rest of the places were drawn around it. They reported that, somehow the mental images are made by some spatial organization principles. This situation was observed not only when participants drew the plans

but also when they made oral descriptions, which revealed that, spatial organization principles were playing part in the way finding processes.

They observed that the participants who drew a coherent map, verbally expressed a clear image of the building and could also express some spatial organization notions. These notions include ideas about the spatial organization linked to the relationships among spaces; so, when people can read some spatial organization principles of the setting, they can get a clear mental image, and so they can have a coherent cognitive map of the place, which will improve their way finding.

There is another spatial element that could affect way finding: the edges of a setting. When the limits of a building are not coherent with the spatial organization within it, the making of mental representations of it is very difficult. Passini (1992) reported that in a badly planned shopping center, people avoided going to there, because of fear of getting lost in it. The limits of that building were mainly a rectangle, while the circulation system was a triangle. He reported that people that understood the circulation system of a building as well as its borders didn't have trouble when they made mental representations; furthermore, they drew clearer plans and did not have problems with way finding tasks, than people that could not achieve a good understanding of the spatial configuration of the limits and circulation system, who in some cases were not able to draw anything; or they drew a symbolic circle, representing their own frustration at moving in circles. In this way, contradictions between the spatial disposition of the setting and its delimitation can produce confusion and trouble for people when they try to make their mental representation and navigate through the environment.

Spatial continuity is an element that influences the understanding of settings and therefore, has an influence on way finding. The environmental information that people get from cognitive plans allows them to structure behaviors in order to arrive at their destination. In order to achieve this goal, the cognitive plans should represent a continuous spatial system. Nevertheless, there are times when the environmental characteristics of a setting do not allow for a good development of mental plans: When there is not continuity among environmental characteristics of

the setting, partial cognitive plans are made with disconnected images that do not integrate the setting as a whole, so difficulties arise in achieving an optimum orientation.

The lack of continuity can be observed in buildings where it is impossible to perceive easily the relationship that exists among the spaces. Passini (1992) reported a case where the offices of a building were below ground level. The building lacked information on the environment that could relate the upper part of the building to its other areas therefore people had only a partial image of the building.

Continuity of the environmental characteristics of a building has to be extended to its exteriors. Passini (1992) asked the participants to point to a target in the city when they were outside the building. Usually the participants did it well. However, when they were inside the building and were asked to point out the target, they failed dramatically; there were total changes in the directions they pointed to. Thus, Passini concludes that door and window location is important to make more accurate mental representations.

SPACE SYNTAX AND SPATIAL ORIENTATION.

Space syntax is a theory of architectural space, which has developed its own methodology. Space syntax was conceived at University College, London by Bill Hillier, June Hanson, John Peponis, John Hudson and Richard Burdet. Space syntax methods offer accurate quantitative descriptions of the way a setting's built spaces are organized. The space syntax method emerged from a particular conception those researchers had about architecture. Hillier and Hanson (1984) considered architecture should be more than giving shape to a material. They said, when architects shape materials, they also are shaping spaces where people move and dwell. Architecture, in this way, has a direct relationship with social life, because when materials are shaped, the spatial organization where people exist is also shaped. This spatial organization will establish the conditions for people to move in the settings as well as to meet or to avoid each other; having a strong influence on social relationships. Undoubtedly architecture plays an important role in daily

life through a kind of influence beyond the visual properties of architectural forms. Space syntax proposes a method to talk about the relationships between social patterns and spatial organization, to be more specific, the relationship between variations on spatial forms and variations of social order. According to Hillier and Hanson (1984), the social meaning of the environment comes from spatial organization. Their hypothesis addresses the concept that the topological structure of an environment is an essential part by which a society produces and establishes roles, developing some kind of social relationships instead of others. Therefore constructed environmental spatial patterns integrate and give shape to social patterns.

Space syntax focuses on the topology of a setting and its patterns created by the relationships between spaces, but not on its size or its shape. The main finding of their research on space syntax is that global organization acts as a mechanism that generates people's patterns of movement within spaces. Studies had shown that spatial organization – apart from its location, facilities and density- has an extremely important effect in the way people move through spaces, thus, on the way people could meet other people by chance. Spatial configuration promotes people's encounters as well as makes it possible for them to avoid each other, shaping social patterns (Hillier, Hanson, Peponis, Hudson & Burdett, 1983; Hillier & Hanson, 1984).

Space syntax provides an assortment of tools to analyze and describe the spatial configuration of settings. Studies have explored whether the different measures that space syntax provides could be related with way finding. One way to measure spatial relations is through the *integration* measure. Integration quantifies the level in which spaces are related direct or indirectly among each other. A connection between two spaces is direct, or shallow, when few spaces have to be crossed to get from one place to another. On the other hand, when a great number of spaces have to be crossed to get to a specific point, it would be an indirect or deep connection. A space is *integrated* when the other spaces have a relative shallowness in relation to it. It is said that a space is *segregated* when the other

spaces have a relative depth in relation to it.

The calculation is shown in figure 1, the value is a number between 1 and 0. If a space is nearer to 1 it is said it is more segregated, if the space is closer to 0, the space is more integrated.

PLEASE INSERT FIGURE 1 HERE

Peponis, Zimring and Choi (1990) used the space syntax methodology to study the relationship between the integration values of all the spaces of a hospital and way finding tasks. Fifteen participants were asked to explore a hospital in a “free exploration task” and then they were asked to look for several destinations in a “directed exploration”. Researchers drew the routes that were taken in both stages and they found that integration is a reliable predictor of behavioral patterns that were used during the exploration stages. The participants, during both explorations, used the more integrated spaces more frequently. They found that people tend to travel through more integrated spaces when they know the setting, as well as when they are looking for a destination. The researchers were able to find a rule on way finding: When people get lost, they usually go to more integrated places.

This study suggests that the spatial configuration of a setting is important to predict behavior patterns during way finding tasks. It also suggests that people tend to look for more accessible, less hidden and better-connected places, during their exploration of the building. Such findings show how important spatial organization is for way finding.

Haq (1999a) in a later study, focused on the influence of certain variables on way finding. He asked 31 participants to move inside a large urban hospital. They were asked –as Peponis and his associates did in their study- to look for an assortment of destinations within the hospital. Participants’ movements through the hospitals were recorded on plans, and the integration values of the spaces in the hospital were obtained. These values were obtained at three levels: local (from each one of the spaces), relation values (that provides a value for the spaces that can be seen from a specific space), and global values (that takes into account the setting as a

whole). He found that the participants tended, during their explorations through the hospital, to go toward places where they could have better visual access to other spaces. This was called the expectation to explore by Haq. The expectation for exploration is understood as the tendency to go towards places that allow a better chance to have an optimum visual access to other places within the same setting, when people look for their destination.

Ortega, Jiménez, Jiménez, Mercado and Estrada (2001) conducted a similar study, where integration values were obtained within a college setting. Participants were asked to explore the setting and then they were set a directed exploration task. The results were similar to those obtained by Peponis, Zimring and Choi (1990): People tend to use integrated spaces more often when they are getting acquainted with the place as well as when they are looking for a destination.

Space syntax techniques were used in all the studies we have reviewed in order to analyze settings. Objective values were obtained for the spaces of the setting. More specifically the connections among the spaces were evaluated with the integration syntax measure. Researchers were able, thanks to these values, to link the spatial characteristics of settings to way finding performance. These studies measured behavioral aspects of way finding through the execution of tasks.

The study reported in this paper is focused on the relationship between the integration of spaces and the cognitive aspects of orientation (perception of orientation) similar to Weisman's study (1981), but instead of maps, we used a self-report instrument.

Method

The purpose of this study is to explore the relationship between the spatial configuration of the interior of a building and the spatial perception orientation that people have about their work places.

Setting

This study was carried out at one of the buildings – including its four levels- of the School of Psychology at the Universidad Nacional Autonoma de México. The spaces in the setting include library services, administrative areas, laboratories, professors'

offices, classrooms and rooms for various uses (see figure 2).

PLEASE INSERT FIGURE 2 HERE

Sample

This study used stratified sampling. The stratification of the spaces was made taking into account the results of the “integration values” analysis, of the 136 spaces that make up the building. The 136 “integration values” were distributed in quartiles, selecting 14 spaces from each quartile. This decision was taken according to the number of spaces that each level of the building has. The library and the first floor were the two levels with less space. The first floor was chosen because its spaces were more representative of the whole building than the library whose spaces have more specific functions. From the 20 spaces of the first floor corridors, stairs and toilets were excluded, because these places do not have permanent users. For this reason, it was decided to select 14 spaces from each quartile. The 14 spaces were chosen according to the following criteria:

- To avoid as far as possible including spaces that have the same “integration value”.
- When spaces had to be chosen including the same “integration value”, the spaces with a longer distance between them were chosen.
- When going to a chosen place a minimum of three times (at different times and days) and no people were found there, the space was replaced by a closer one having the same “integration value”.

From the 56 chosen places, the sample was completed with only 50 places; 11 spaces belonged to the first quartile, 13 to the second quartile, 12 to the third quartile, and 14 to the fourth quartile. An “Orientation Perception Scale” was applied to 50 users of these spaces.

The participants (users) included: 28 academic and 12 office workers, and 10 students, from which 64% were women and 34% were men, and the mean value of the number of years people had worked there was 13 years with a standard deviation of 9 years.

Instruments

Building plans:

Four plans of the building were made for this study, one for each level, which are shown in the description of the setting (see figure 2). On the maps only the spaces of the building (136 spaces) appear with the location of its entrances. The calculation of the integration values was made from these plans.

Scale:

An "Orientation Perception Scale" was developed ex profeso for this study in order to measure how participants perceive the orientation of their work places. This scale has 10 statements, each one with a scale 0 to 10 from where 0 were the absence of the measured characteristic and 10 a total presence. The scale measured how accessible, hidden, communicated and easy to find are the work spaces of the users.

Procedure

Integration values from the spaces in the building were calculated following Hillier and Hanson(1984). This calculus was for the 136 spaces.

Once the integration value of each space was obtained, 50 spaces were chosen according to their integration value. At least one user (academic, office worker or student) for each space answered the "Orientation Perception Scale".

Results

In order to determine the validity of the "Orientation Perception Scale", a main components factor analysis with oblimin rotation was used, providing two factors with eigen values greater than 1.00 that explained 65% of the total variance of the instrument as one can see in table 1.

PLEASE INSERT TABLE 1 HERE

These two factors show congruence and clarity in the content of the items. Factor 1 is identified as "*the perception of dynamic orientation*" that the users have about their work places; the items express movement within the building. Factor 2 is identified as "*the perception of static orientation*" that the users have about their work places; the items refers to the location of a space, as well as the perceived

complexity.

Two linear regression analyses were applied, using the enter method, with the integration values (RA) as the independent variable and the "*perception of dynamic orientation*" and "*the perception of static orientation*" as dependent variables. The dynamic orientation has a $R^2 = .27$ and static orientation factor a $R^2 = .39$.

This analysis shows that the integration values predict the perception of the dynamic and static orientation that people have about their working places.

Discussion

Results confirm the existence of a relation between the spatial configuration of a work setting and its users way finding perception in both static and dynamic components.

Static way finding perception involves an ability to determine the person's location inside a setting; however, taking in account our results, by itself, static way finding does not build up a complete cognition. For a complete way finding cognition a dynamic construction is needed, it is not only that the person may be able to achieve a mental image of the setting, but also the person must visualize himself or herself within it, as well as including an action plan or strategy which he or she will take to get to some place. The latter is what is measured by the dynamic way finding perception factor, the active process of imagining in order to find a place. These processes should not be considered as mutually exclusive, but on the contrary, they should be seen as a complementary.

The results showed that space integration measures are positively correlated with both static ($r=.62$) and dynamic way finding perception($r=.52$). So, when a space is integrated (it is more directly connected with the rest of the building spaces), this is perceived as more visible, accessible and communicated, having more probabilities of being found.

It is interesting to observe that according to Passini (1992), the feeling of being lost inside a setting occurs when the person lacks static and dynamic way finding. Here we find that the presence of integrated spaces is associated with both kinds

of way finding, which contributes to a person's ability to locate and plan behavior to find destinations.

The studies about way finding which have used spatial syntax have been centered on the behavioral aspects of way finding (Peponis, Zimring & Choice, 1990; Ortega, Jiménez, Jiménez, Mercado & Estrada, 2001). In them, an association was found between integration measures and the movement of people, in other words, users use integrated spaces more frequently as they explore the setting. In this study, the emphasis was not on behavioral aspects but on the cognitive ones of static and dynamic way finding, considering that people had to develop a understanding of spatial organization in addition to their experience determined by their spatial location in the setting, just like the achievement of a place to deal with the spatial configuration of a building, according with Gifford (1997).

The results of this study provide evidence of the predictive value of integration. This spatial characteristic can be of great importance for design, and could be used to design spaces and locate them according to their function in different levels of integration or segregation.

The correlation between space integration and space way finding perception suggests the existence of a relation between the spatial organization of the building and the users cognitions of them. However, the cognitive mechanisms by which syntax information is processed and stored are still open to future research (Peponis & Wineman, 2002).

Previous studies, like the ones mentioned in the introduction, were interesting because of the multiplicity of spatial elements involved in the cognitive processes of way finding. Some of them, as in Weisman's study (1981), studied spatial relations in a very simple way or they were based on very specific aspects of the setting, as in the building delimitation study of Passini (1992). However, these spatial elements were not well integrated in a conceptual framework. We believe that space syntax provides such an integrate framework and according to Haq (1999b) when he refers to space syntax as a useful theory and methodology for understanding the role of environmental form in environmental cognition.

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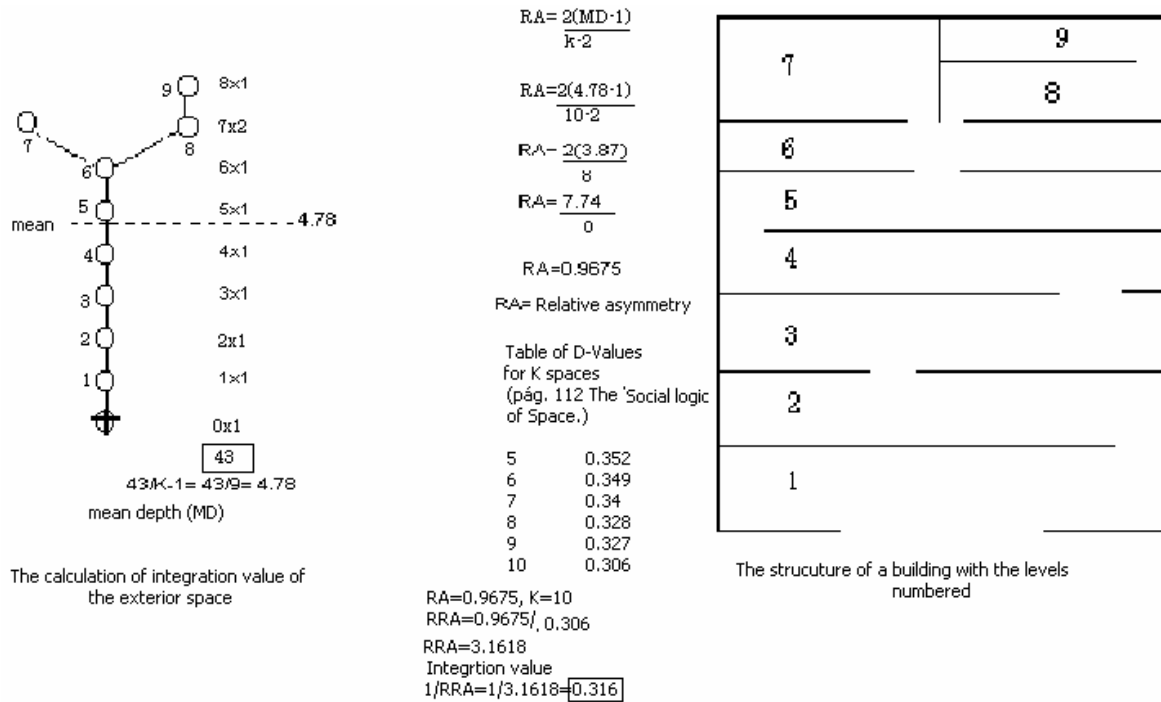
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- **Figure 1. Calculation of the integration value of the space 0 (exterior)**

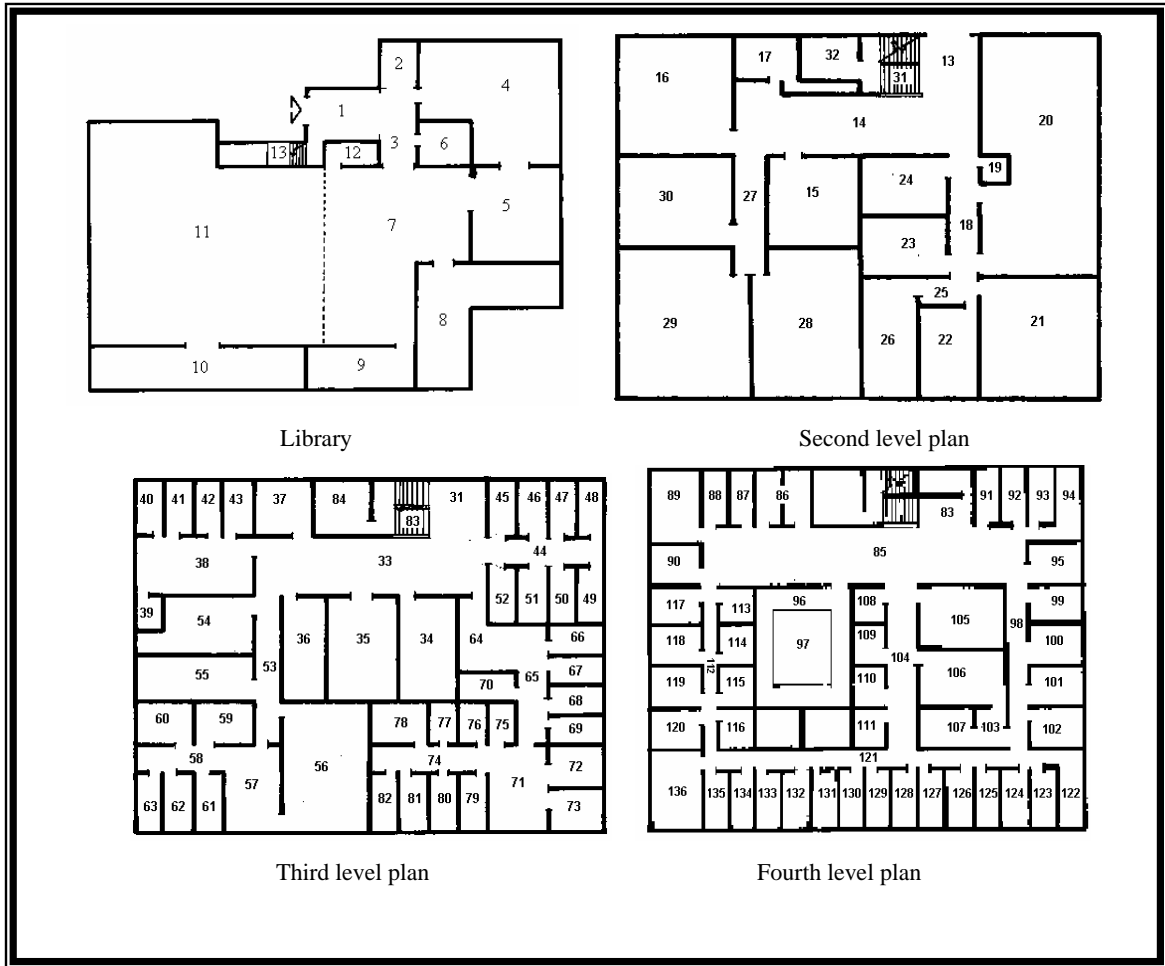


Figure 2. Plans of the building levels

Items	Factorial Weight (Factor 1)	Factorial Weight (Factor 2)		
Getting to your work place, from any part of the building is (difficult – easy)	.873	.457		
Getting out of the building, from your work place is (complicated-simple)	.857	.283		
People who want to reach my work place often arrive (difficulty – easily)	.681	.627		
Moving from my work place to any other space in the building, in general terms, is (quick – slow)	.630	.571		
My work place, from any part of the building is (accessible – inaccessible)	.614	.822		
My work place is (communicated – not communicated) with the others spaces in the building.	.506	.796		
My work place is (easy to see - hidden)	.523	.789		
If a person who does not know the building wants to find my work place, she/he would more probably (get lost – find the place)	.388	.785		
Giving instructions to another person in order to find my work place is (easy – complicated)	.308	.759		
Factor	Eigen Values	% of variance	Accumulated %	Reliability
1. - Dynamic orientation perception	4.863	54	54	.80
2. - Static orientation perception	1.121	12.5	66.5	.86

Table 1. Psychometric characteristics of "Orientation Perception Scale".