

**EÖTVÖS LORÁND UNIVERSITY**  
**FACULTY OF EDUCATION AND PSYCHOLOGY**

**Barbara Keszei**

**The relationship between space syntax and  
environmental preferences**

**DOCTORAL THESES**

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BARBARA KESZEI

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DOCTORAL THESES

Doctoral advisor: Andrea Dúll, PhD, DSc, professor, ELTE PPK PI

Doctoral School: Eötvös Loránd University  
Faculty of Education and Psychology  
Doctoral School of Psychology

Head Zsolt Demetrovics, PhD, DSc, professor

Doctoral programme Socialization and Psychology of Social Processes

Program leader: Lan Anh Nguyen Luu, habill associate professor

Members of the Evaluation Committee

Chair: István Czigler, professor emeritus, ELTE PPK PI

Secretary: Orhidea Edit Kiss, habil. associate preofessor, ELTE PPK PI

Members: Dezső Németh, PhD, DSc, professor, ELTE PPK PI

Anikó Illés, habil. associate professor, MOME

Ágoston Török Ágoston, researcher, MTA TTK

Opponents: Anett Ragó Anett, egyetemi adjunktus, ELTE PPK PI

Bálint Kádár, senior lecturer docens, BME Faculty of Architecture

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## Introduction

The focus of my dissertation is on what people experience in the sociophysical environment, more specifically the environmental preference and the factors influencing this preference itself, with a special emphasis on examining space syntax and informational variables. In my research, preference appears as an attitude that includes the emotional, the cognitive and the behavioral factors. The latter rarely appears in studies exploring environmental preference, but in my research behavioral factors have a prominent role in the seat selection task. My work focuses on built environments and more specifically interior spaces. From a methodological point of view my main goal was to explore the extent to which stimuli presented through different media can be generalized to real environments.

The research presented in my dissertation consists of three steps:

1. examining the effect of the multimedia-stimuli
2. examining the relationship between space syntax, informational variables and preference
3. a qualitative study of the relationship between informational variables and preference

## Theoretical Background

The focus of my research is on environmental preference as a kind of attitude that represents a person's positive and negative feelings for the entire physical environment or parts thereof (Holahan, 1982). This preference can always be interpreted in a person-environment unit, in which the physical environment and the person within it interact and define each other, creating a sociophysical environment (Dúll, 2009).

### Information Characteristics

The informational variables introduced by Kaplan and Kaplan (1989) examine the environment from two aspects, defining four types of informational variables: whether access to the information is immediate or delayed; whether the observer understands the information or gets involved in the situation. These informational variables are all predictors of preference (Kaplan & Kaplan, 1989).

*Coherence* refers to how we perceive elements of the environment as interconnected, compatible. This information is immediately available and promotes better understanding of the environment. If an environment is coherent, we are able to organize intelligent units within the vast amount of information around us.

*Complexity* encompasses the richness of information in the environment, which is also information we have instant access to, but which primarily helps us become involved in the environment. An environment with intricate details enhances engagement and induces further exploration (Hartig & Evans, 1993).

*Legibility* shows how easily we can navigate during the supposed later exploration of the environment. Legibility is about finding structure and in the array of things we encounter – for example, a vantage point that gives us an overlook of a certain area can make us feel we may go further without getting lost (Hartig & Evans, 1993).

*Mystery* entails the information suggesting that if we were to further explore the environment, we could get more information. For example, a swinging stream that we only suspect the path of, holds the promise of further information. When it comes to mystery, small changes in the environment may result in large differences in its assessment (Kaplan, 1987). Although Stamps' (2004) meta-analysis managed to confirm the predictive effect only in the case of preference regarding mystery

#### Evolutionary Theories: Prospect-Refuge Theory

Appleton's (1975) prospect-refuge theory explains the preferences about landscapes and certain spatial layouts. According to the "seeing without being seen" principle, preferred spatial layouts allow the user of the environment to see things outside of the site and at the same time provide shelter. The perception of the environment is linked to the feeling of security that helps survival and also beauty. Although these decisions are not conscious, they still influence environmental choices

#### Space Syntax

Both environmental psychology and space syntax regard space as a sociophysical environment (Hillier, 1996; Dúll, 2009). However, space syntax focuses only the geometric characteristics of the physical space and mapping the relationship between these characteristics and human behavior (Hillier, 1996), but other information in the physical space is outside of their analytical framework. These factors may include, for example, attributes related to colors, materials, or other features concerning surfaces or textures (Losonczy et al. 2017), which, in turn, may affect the assessment of or behavior in an environment (Cohen & Trostle, 1990; Bellizzi & Hite, 1992).

The relationship between two separate spaces is syntactically direct if you have to cross a small number of intersecting spaces from the starting point to reach the destination and indirect if there are many spaces between the two units. A certain space is integrated if it has direct contact

with all other spaces within the building (Bafna, 2003). Interaction can also be measured with the help of the Depthmap program, by setting a value for each spatial point on the floor plan (Turner, 2004). Integrated spaces are more accessible, more visible, allow greater control to the user, and can therefore serve as a vantage point (Mumcu, Düzenli, & Özbilen, 2010)

The overlapping segment of space syntax and environmental preference research has so far been mainly focusing on exploring the emotional effect of spaces with the help of semantic differential scales (eg Wiener et al., 2007) and the relationship with prospect-refuge theory (eg Ostwald & Dawes, 2013; Dosen & Ostwald, 2013). 2016, 2017; Psathiti & Sailer, 2017; Keszei et al.)

## Studying the Effect of Multimedia-Stimuli

### Hypotheses Regarding the effect of Multimedia-Stimuli and Research Questions

The first stage of the research used building „C” of Corvinus University in Budapest as the research location. In the study, the subject of environmental preference, mystery and feeling of in and out were examined using four types of stimuli (on location; video; photo with people; photo without people)

Respondents were given a tour of 11 stations within the building either on site or via using online multimedia-stimuli. At each stage respondents were asked questions. Our research focused on analyzing which questions differed in the answers given to them regarding the multimedia-stimuli the respondents encountered the environment through.

### Hypotheses:

1. Significant differences occur between the 4 different media-stimuli: on site, video recording, photo with people and photo without people:

- In the case of mystery
- In the case of preference
- In the case of feeling of in and out (using adjective pairs)

2. Significant differences occur between 3 different media-stimuli: video recording, photo with people and photo without people:

In perceived realism (how much the subjects were able to imagine that they were on the location)

## Results of the Study Regarding the Effect of the Stimuli

### Sample

A total of 318 questionnaires were completed during the study. 212 of the participants in the study specified their gender (114 (54%) females and 98 (46%) males). Based on 207 participants' data of age distribution, the average age was 38.4 years (SD = 14.0 years; min. 18; max. 75). Participants were classified into categories of architect (13 persons) and non-architect (198 persons) regarding their profession.

### Results

1. Our results are unclear. Concerning mystery and preference, only half of the cases showed a significant difference with different multimedia-stimuli. Out of the 6 pairs of adjectives related to the perception of in and out, only two showed the expected result. In terms of preference, the most striking difference was found between the environmental conditions on spot and photos with people at station 11. In contrast to our expectations, it was not the photo without people that got values the furthest from on the spot evaluations, but the photo with people.

Among the pairs of adjectives related to on site perception, there was a significant difference in the stimulus-induced pairs that produced an unchecked and uncomfortable sense of exposure. For both concepts, participants gave scores for transparency and sense of security in field surveys. Perhaps these two pairs of adjectives capture the most emotional aspect of the situation (overview, sense of security). The two concepts (clarity, security) can be linked and mutually reinforcing. Underlying both may well be the sense of security and the sense of environmental awareness or lack thereof.

2. In the subjective assessment about how much the subjects were involved in actually being present in the environment, there was no difference in video, photo with people and without people in the photo.

## Studying the Relationship between Space Syntax and Preference with a Questionnaire

### Hypotheses and Research Questions of the Questionnaire

The second stage of the research is about exploring the relationship between space syntax (Hillier, 1999) and environmental preference, and informational variables (Kaplan & Kaplan, 1989). At this stage of the research, respondents explored a 5-room virtual space, the lounge of a research centre using a GIF animation. Interactions between space syntax parameters

(visibility, visual integration, total depth) informational variables and two types of preferences (seat preferences, behavior-based active preference, and preferences in aesthetics) were observed. In addition, the aim of the research was to investigate the relationship between the informational variables and the preferences in an interior setting.

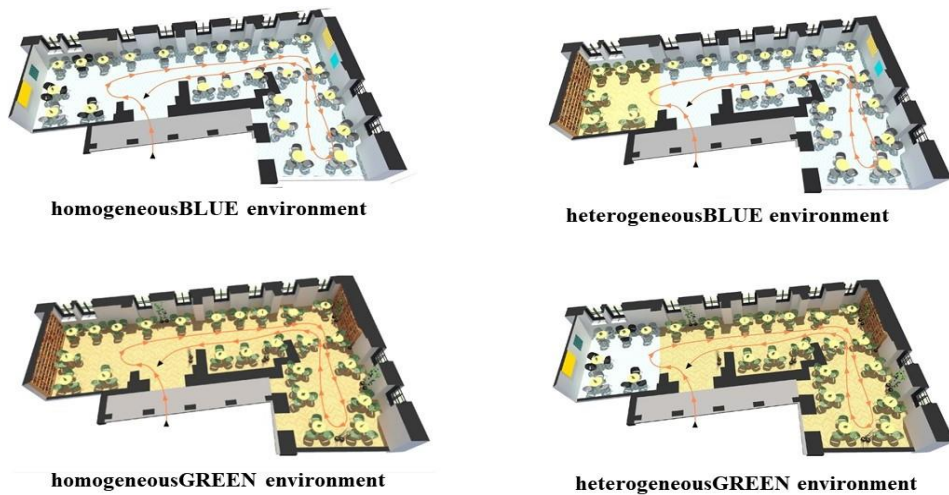
At this stage of the research, 4 variations of the virtual space were used. These environments had the same space syntax parameters, because they had the same floor plan and arrangement of furniture, but the non-geometry related factors of the environments were different. Two types of design were applied (see Figure 1 for BLUE design and Figure 2 for GREEN design) and their variations along the variable homogeneity-heterogeneity (see Figure 3 with the 4 types of environments used in the study)



*Figure 1: The BLUE design (looking to the left from the entrance)*



*Figure 2: The BLUE design (looking to the left from the entrance)*



*Figure 3: The 4 environments from above, showing the path of the GIF animation*

Respondents went through one of the 4 environments with the help of a GIF and had to pick a seat based on information features and preference questions. In addition, they were asked to assess the entire environment (not the individual chairs) with the help of 12 adjectives (cf. Sadalla & Sheets, 1993).



## The Relationship Between Space Syntax Measurements, Preferences and Informational Variables

### Hypotheses:

1. Significant correlation occurred between space syntax measurements (visibility, visual integration and total depth) in all 4 environments regarding:
  1. · Active preference (behavioral focus)
  2. · Preference (emphasis on aesthetic evaluation)
  3. · Legibility
  4. · Coherence
  5. · Complexity
  6. · Mystery
2. The information features have a significant positive relationship with preference and active preference. The strongest relationship with preferences is shown by mystery (Stamps, 2004)
3. Significant difference can be found in the evaluation of environment on the scale of the adjectives regarding the 4 environments

### Sample

256 people participated in the study, 166 women and 89 men (1 person did not respond), mean age 35.22 years (SD = 12.48, min. 18 years, max, 85 years). The sample consisted primarily of residents of Budapest (152 subjects).

### Results

1. Visibility and visual integration, in line with our hypotheses, coincided with coherence and legibility. However, the other information features (mystery and complexity) or the other two preference indicators did not show the expected relationship in all situations. Complexity alone did not correlate with visibility and visual integration in the homogeneous GREEN environment.

An interesting result is that the two preference indicators did not show significant correlation with space syntax parameters in the same environments. Active preference showed a weaker relationship with visibility and visual integration. Active preference in homogeneous Blue and heterogeneous environments did not show any correlation with visibility or visual integration, while preference was not significantly associated with the above-mentioned space syntax in the heterogeneous environment, but in an

environment where the active preference did correlate with it, the correlation was significant

The total-depth-related-hypotheses was only partially confirmed, which may be due to the fact that the 5-room space is not large enough to show the predictive power of the measuring tool.

2. The analysis of the correlation between information characteristics and preferences also confirms what has been described above. That is, preference and active preference are similar in many aspects and are closely related in all 4 environments. However, small differences can be observed in their relationship with information features. Although both are closely related to legibility and mystery, coherence and complexity are in the reverse order of correlation tightness. The results of Stamps (2004) meta-analysis were only partially confirmed, although mystery is among the predisposing factors, but legibility showed the expected positive effect in all 4 environments..
3. A total of 5 adjective pairs showed significant differences between the 4 environments. This major effect was caused by a significant difference between the homogeneousBLUE and homogeneousGREEN environments, as well as the significant difference between the homogeneousGREEN and heterogeneous environments. The environments in which the BLUE design appeared were seen as cold, emotionless, non-intellectual, energetic, and coarse. A more nuanced interpretation of these differences is discussed with the results of the qualitative study presented in the next chapter.

## Examining the Relationship between Space Syntax and Preference with an Interview

The purpose of the interviews is to qualitatively reveal the background of the preference assessments and the rating of the informational variables seen in the questionnaire seen in the second stage of the research. A further aim of this stage of the research is to explore the characteristics, pros and cons of the usage of an FPS (First Person Shooter) virtual space.

The same 4 types of spaces were explored by the respondents as in the previous stage of the research, but think aloud method was used, which was supplemented with questions about informational variables and preferences. In the interview, the subjects were asked to imagine 4 types of social situations. In these situations the task was also to choose a seat. Two of the sessions were "refuge-demanding", so the person was looking for a place to focus on work,

while the other two situations were considered „prospect-demanding” in which the participants were looking for the company of others.

### Sample

The study included 10 people: 7 female and 3 male. The average age was 39.5 years (SD = 16.14; min. 18 years; max. 63 years). Each member of the sample was living in Budapest and had a university degree or a highschool education (the 18-year-old subject).

### Results

9 of the 10 interviewees explored the whole area, of which 7 were in motion in the virtual space during the entire interview. Participants were asked about the role of doors and windows that do not have a clear function in the virtual space, which suggests that the subjects were fully immersed in the environments. They explored their environment freely, perhaps even more boldly than they would have in real life, which was possibly due to the lack of peers.

8 of the respondents did not think that the assessment of information characteristics depends on social situations. According to these, they are more strongly tied to physical as well as social characteristics. The respondents gave answers similar to the results of the questionnaire survey. An interesting feature of the study is that the evolutionary aspects ("seeing without being seen") appeared spontaneously in the responses when the seat selection was justified.

When assessing the environments, the answers and the associations that came out were useful to understand the motivations of the space-user, for example, because they chose an environment because they didn't like it, so they thought they could concentrate on the job better. This stage of the research has confirmed that social situations and the purpose of the space-user play a major role in choosing a particular site (Losonczy et al., 2017). At the same time, we should note that the favorite place as a kind of topos appeared among the answers. In any case, further investigation is needed to find out when in the case of a long-term use of space (eg workplace canteen) it is possible to overwrite the idea of a "favorite place" and choose a place different from the usual one.

## Conclusions

During the research the environmental preference was examined as a part of the experience. Within this topic, we focused on the relationship between environmental preference and space syntax, information features and view-shelter –all the while keeping the methodological aspect in mind.

This research is special in that it examines environmental preferences in internal, built environments, as opposed to the external environmental emphasis prevailing in this subject. The relationship between space syntax and information features is also a rare research subject.

In all three stages of the research a great emphasis was put on ecological validity. In the first stage of the study at Corvinus University, this aspect was selected with a careful attention to the media. For this purpose all the photo and video material was produced with great care and recorded on the location.

In the second and third stages of the research, architects assisted to produce the two designs fitting the social situations that the subjects encounter in their daily lives. In terms of design, this means that architects were asked to create environments as realistic and close to their work practice as possible. So in the two types of designs and in the 4 social situations we did not work with clearly defined variables. This makes it difficult to interpret data and results, but these environments and social situations are more believable and realistic for test subjects.

During the research, the hypotheses were not confirmed in all cases. The analysis of the relationship between stimuli and preference and information characteristics with space syntax requires further research.

The results of the study of the effects of stimuli show that there is no significant difference between the variables we investigate (mystery, preference, connotative meaning) whether on-site data collection was used as stimuli or video recordings. The results of our research are in line with the results obtained in virtually simulated environments, according to which even minor differences in simulated and real-world responses may appear in connotative reports, but the patterns are the same (Bishop & Rohrman, 2003) and we can generalize these stimuli to real environments.

However, on-the-spot data collection have brought more notable differences. An interesting result of the study was that the values obtained with the photo without people were not

significantly further from the results of the on-site survey than with the variation of the photograph with people. This may also be due to the fact that photographs without people are more common when judging an environment or building than with people in the picture next to the building to be assessed. For a better understanding of the topic, it would be worthwhile to examine the effect of media (especially with people) on the perception of environments in the context of internal and external spaces

Comparative analysis of the effects of media can serve as an important methodological background research for environmental preference research, and as such, it would be worthwhile to broaden the range of media (GIF, FPS, VR) used to present the stimuli. It is definitely worthwhile to pay more attention to exploring whether or not a self-initiated motion gives a positive experience during a survey. The exploration of what captures the participant's attention during a visit to a certain environment can also contribute to exploring and understanding spatial behavior and the underlying processes. In this research, verbal data was collected using an interview method. However, comparing verbal reports and eye movement tracking could provide useful information on what appears in verbal reports from what a person actually looks at.

In the third stage of the research, the interviewees explored a virtual space in which there was no other person besides them. Participants spontaneously highlighted in their responses that they would influence their seat choices if others were in the room.

This includes the selection of media in the first phase of the research, with the conscious selection of media with and without other people present, because in sociophysical environments, the presence of people in most built environments is unavoidable, so it would be worthwhile to systematically use this in field studies as a variable.

In the analysis of the information characteristics, results show that legibility, mystery, coherence and complexity are very closely linked, at least in small-scale environments such as in this study.

This coincidence casts doubt on the meaning of the theoretical framework for modeling preference in natural environments (Kaplan & Kaplan, 1989) for the 5-room quadrant that was investigated. The question whether the test subjects understand the constructs also arises - especially after the interviews. In the interview, almost all of the subjects asked what it means to "see as a system" used to describe coherence. Several interviewees noted that they cannot distinguish between "seeing as a system" (coherence) and "easy to navigate" (legibility).

The difficulty of distinguishing between the constructs of the information features is also indicated by the fact that in the interview, subjects often questioned the interviewer about each of the 4 information characteristics

In the second phase of the research, the impression created by the adjective pairs was the same as in the third stage of the research, with the overall image that emerged during the interviews. The environments in which GREEN design was significant, the warm, emotional, intellectual, soft, restrained members of the adjective pairs were prevalent, which was consistent with the description of the environment in the interviews: cozy, safe, warm, and so on.

By analyzing the relationship between information characteristics and preferences, we could only partially confirm the results of Stamps' (2004) meta-analysis. Legibility predicted both preference and active preference, while mystery in the 4-environment layout only showed the expected significant relationship and a strong tendency ( $p = .052$ ) in three instances. Preference and active preference coincided with each other in each of the 4 examined environments, but there are slight differences in the role of complexity and coherence in their relationship with information characteristics.

According to the results of the research, space syntax indicators (visibility and visual integration in the present research) were relevant at the scale of the five-room layout, the actions of the persons of the survey were precisely predictable in terms of legibility and coherence. So these two information features are best suited to predict how we can navigate in a given space. People stay oriented in space if we see as many points as possible. In terms of complexity, the results were not unanimous, but these metrics also proved to be a good predictor for this feature. However, in the case of mystery in the same environment where significant interaction between the perception of mystery and space syntax indicators (heterogeneousBLUE) appeared, there was a contradiction to our expectations. The reason for this is that the mystery construct implies that such environments are not completely translatable and visible, because unseen things are the ones that hide the essence of the construct: the environments to explore. All in all it was surprising that in the heterogeneousBLUE environment there was a significant positive correlation between mystery and the space syntax of both visibility and visual integration.

Perhaps, in this environment, one can experience the fact that in the interviews and alongside the adjective pairs, a cozy, warm, safe, soft, inviting image of the GREEN environment is attractive to the subjects, especially if it is possible to opt for the BLUE design. So, other than

the rest, the GREEN “E” room - based on the interviews - was chosen primarily because of the contrast with the BLUE design.

Therefore it can be concluded that it is not only the site's configuration that influence environmental preference judgments – not only non-geometric variables (colors, materials), but also their combination. In both heterogeneous environments, room E was different from the other 4 rooms, but it became the preferred room only if the design was more desirable. It is up to the person's purpose to determine which design is appropriate for the subject. eg. they are looking for a cosiness in the GREEN design or are motivated to work more in the BLUE

The active preference judgments in the homogeneous GREEN environment coincided with both visibility and visual integration indicators, and the preference in this one environment did not significantly correlate with these space syntax indicators. The differences in seat preferences for active preference and preference in the 4 environments also suggest that design plays a major role in location selection. In addition, attention is drawn to the fact that the person's purpose is even more influenced by the person's purpose than preferences.

It is also supported by the results of the interviews that the subjects were greatly influenced by the fact that they were in a situation with a need for prospect or refuge. In the former case, they chose chairs with high visibility and visual integration space syntax indicators, and spontaneously signaled in the interview to see the largest extent of space and key points (eg entrance) from the chosen seat.

In summary, space syntax indicators predicted the legibility and coherence of the information characteristics very reliably. In the case of complexity, the indicators are also good predictors, however, space syntax did not systematically correlate with the mystery of the information characteristic

The results were mixed with respect to preferences. While preference (with the exception of the heterogeneous environment) was a reliable predictor of visibility and visual integration, in the case of active preference, it was precisely the heterogeneous environment in which significant interaction with the said space syntax indicators occurred. Thus, preference judgments, which could be interpreted as aesthetic judgments, were better predicted in our study as space syntax indicators than an active preference for behavior. These results are of particular interest because

the paradigm of space syntax primarily seeks to predict behavior and not aesthetic judgments (Hillier, 1996), so we can expect the accuracy of predicting behavioral responses. However, this also confirms that the situation and the purpose of the space user should be monitored in further studies

Think aloud method is a good method for exploring the potential processes behind seat choices, but it does not provide a complete picture of what is happening in the subject's mind. One of the reasons for this can be our tendency of not being conscious of our environments (Ittelson, 1978), which makes it difficult to verbalize our experiences with our physical environment

In order to predict user opinions, it may be useful to present sites in a simulated virtual space, even for potential clients of architects. However, methodological studies should also include the extent to which these simulated spaces are in a state of realization, the extent to which they can be generalized in the simulated environment and the areas in which they can be generalized (eg the question of color identity). In conclusion, the examination of the interaction of space syntax indicators with other preference indicators can be fruitful.



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### Key publications related to the dissertation

- Keszei, B.; Halász, B., Losonczy, A., & Dúll, A. (2019 – megjelenés alatt). Space Syntax's Relation to Seating Choices from an Evolutionary Approach. *PERIODICA POLYTECHNICA ARCHITECTURE*
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