DIS-ORIENTATION, SPATIAL ABILITIES
PERFORMANCE IN CENTRAL LONDON

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Abstract
This paper investigates the relation of Spatial Configuration with Orientation Performance of the individual in Urban Navigation. Spatial Orientation is defined as a function of the mind involving ‘awareness of place’ in the environment, and is a key aspect of Navigation in terms of maintaining a sense of where the subject is relative to its goal as it is moving. The aim of this paper is to shed light on Spatial Orientation performance and how it is linked to configurational and syntactical properties of space. This topic is intrinsic in the Space Syntax theory due its fundamental relation between spatiality and human activity.

The research method used was a set of questionnaires done in London specifically in Covent Garden and Soho areas, asking people to point to five Landmarks and North. The sample was 200 people interviewed in central London. The results were overlaid with spatial analysis and compared through directions diagrams and statistical data analysis. The findings show relations between the Spatial Configuration and the given Landmarks directions with grid angularity, grid visibility and familiarity with the place.

The discussion is developed by the research findings and theories of Navigation, Wayfinding and Spatial Cognition, putting forward varied interpretations related with the research topic and the selected areas. The paper concludes that the Spatial Orientation in Soho and Covent Garden is determined by the Spatial Configuration of the area and that the navigation system used in Central London is mainly Path Integration rather than Piloting or Landmark Recognition System. Then, it is argued that Landmarks act as primary organizers of spatial features in cognitive maps, followed by an environmental knowing and understanding of the Spatial Configuration that is translated in Path Integration.

Introduction
Spatial Orientation is a key aspect of Navigation in terms of maintaining a sense of where the subject is relative to its goal as it is moving. According to Montello (1991), it depends on three general aspects: perception of the environment structure, knowledge stored in memory, and on processes used to access that knowledge. Therefore, orientation skills would be influenced by individual memory for information obtained through sensory systems, facility with different

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spatial frames of reference, and the successful computation of directional vectors and distance judgments (Allen, 1999).

The assumption is that orientation and Spatial Configuration are linked through movement and environmental cognition. According to Passini (1992), architecture is a wayfinding support system in that it contains the necessary information to solve the wayfinding problem. The proposition however is that different levels of urban Disorientation are responses to different properties of space. In this sense, it can be claimed that there are several levels of Disorientation depending on how the individual is situated in the space and what the visual information available in the environment is (Gibson, 1979).

In terms of orientation and Navigation, several studies have been done, especially in Psychology, Neurology and Geography areas. Most of these studies are focused on two scales of spatial abilities research, the first concerns interactions between a stationary observer and an object, that are usually developed in laboratories (Allen, 1997; Loomis, 1999), and the second involves individuals within an encompassing environment, these are commonly orientation experiments in large geographical areas (Tversky, 2000).

The aim of this paper is to experiment a third scale in the urban environment, in a size that could be walkable for a daily user in order to explore the relation of architecture in Navigation and specifically orientation in the city. In order to develop the first assumption further a pilot experiment was conducted in two areas in London: Soho and Covent Garden (COGA).

The sites are bounded by the main commercial streets in London as Oxford Street, Tottenham Court Road/Charing Cross Road and Regent Street, and are surrounded by significant Landmarks such as Piccadilly Circus, Trafalgar Square, Oxford Circus and so on. What makes these areas interesting to be analysed is their centrality in relation to the whole of London and their apparently complexity in terms of Navigation and orientation. According to the Tourism Development Framework 2006-09, London is perceived by visitors as

![Figure 1: Study areas SOHO and Covent Garden. Black circles are landmarks and grey circles are observation points](image-url)
a relatively complex and inaccessible area. This can act as a barrier to further exploring the city, restricting the spread of the visitors’ spending and leading to over-dependence on the Tube.

In order to test the first ideas a pilot experiment was conducted including two observations points, one in each area. Subjects were 40 in total, 20 at each one of the testing locations. Pedestrians were stopped on the sidewalk at each one of the testing locations, 5 questions were asked about directions to surrounding Landmarks and north, and also a set of questions of personal information about their knowledge of the area.

The preliminary hypothesis, developed after the pilot experiment, was that people tend to correlate the direction of Landmarks with the closest street angle that fits better with the question, and people that are familiar with the place have higher errors pointing to Landmarks. The research design used to investigate this initial hypothesis involved gathering concrete data from subjects navigating in a naturalistic environment rather in a laboratory, and it tested their knowledge of several local Landmarks and cardinal directions. It includes a direct pointing measure of orientation rather than indirect methods such as map drawing. The subjects were selected randomly in the observation points, trying to pick people that look like local rather than tourist.

The second experiment included 10 observations points, 5 in each one of the areas. Subjects were 20 pedestrians stopped at each one of the testing locations, with a total of 200 people in both locations between SOHO and COGA and they were asked to answer 5 questions about directions to surrounding Landmarks and one to north. The data was analysed and mapped in GIS and compared with syntactic and spatial analysis, then a series of new hypothesis appeared to be developed.

**Theory Background**

**Spatial Orientation**

Spatial Orientation is based on a subject and an arrangement of elements in the space. This space is too large to be perceived from one place so it must be integrated from different pieces of information that are not immediately comparable. According to Tversky we move in a ‘space of Navigation’ that is a set of places that are interrelated in terms of paths or directions in a reference frame. In order to conceive this space as a whole the environmental information must be linked through spatial inferences anchored in three basic elements: common reference objects, reference frames and perspectives.

Reference objects differ in the scale of the orientation, they could be cities, when orientating between two countries, or they can be urban Landmarks when used to structure routes and organize neighbourhoods. According to Allen, Landmarks serve as sub-goals that keep the traveller connected to both the point of origin and the destination along a specified path of movement (Allen, 1997). Reference frames are divided by Montello in egocentric, that code location relative to one’s body and allocentric, that code location relative to something outside of one’s body, a feature or place in the environment. The perspective of judgment is explained by Tversky as the point of view of the subject in relation within the area, depending of the knowledge of the place the subject could over estimate distance and size of remote areas adopting its own point of view.

In addition, to conceive the space of Navigation and to integrate the information, the human mind needs to draw a mental representation of its environment that is usually named as a Mental Map or Cognitive Map. Golledge defines the Cognitive Map as a representation that
encodes information to determine where one is at any moment, where specific encoded objects are in surrounding space, how to get from one place to another and so on.

Different conceptions of what a Cognitive Map actually exist. But, all conceptions recognize that, as for maps, not all the information is represented, and the information is schematized, simplified or idealized depending on the scale of the representation and organized in a Reference Frame (Tversky, 2000; Portugali, 1996; Golledge, 1999). According to Tversky, the linkage between elements and reference frame in cognition is approximate and it leads to consistent errors. These errors suggest that people remember the location of one spatial object relative to reference spatial entities in terms of an overall frame of reference from a particular perspective (Tversky, 2005).

It is commonly agreed that cognitive maps consist of five city elements that were defined by Lynch in ‘The Image of the City’: nodes, paths, districts, edges and Landmarks. According to Golledge (1999), landmarks act as a primary organizing feature in the cognitive map by dominating a spatial classification or clustering process to facilitate environmental knowing and understanding and also organizing features in a Wayfinding context.

In order to maintain the orientation the subject needs a combination of two classes of processes as they move about: Landmark based, and Dead Reckoning. Landmark based also called Piloting or Pilotage is defined by Montello as a process that involves orientation by recognizing features in the world, it requires having an internal memory that allows the feature to be recognized as a destination or as a key to other target.

On the other hand, Dead Reckoning does not involve the recognition of a specific feature, but it involves keeping track of components of Locomotion, combining knowledge of movement direction with knowledge of the extent of movement (Montello, 2005). The latter process suffers of ‘error accumulation’, any error in sensing or processing movement information accumulates over time. Then, Spatial Orientation becomes increasingly inaccurate over time.

Etienne defines Dead Reckoning as a basic prerequisite for landmark learning, each landmark being automatically assigned a particular position with respect to the subject’s own position. In this definition Dead Reckoning may be the most fundamental component of the representation of space (Etienne, 1999). In Contrast, Montello argues that Dead Reckoning requires knowing a start location and it is not useful to establishing orientation relative to places other than that from which recent movement was initiated, than Dead Reckoning combines with various strategies of landmark recognition to support updating and cognitive map formation (Montello, 2005).

The literature related with the Navigation Systems differs from one author to the other. However, for this paper ‘Orientation Performance’ of the subject is understood as a basic process and it could be related with both, Piloting or Path Integration. Then, an extension of the preliminary hypothesis is that Disorientation or ‘error patterns’ in orientation behaviour could be related with both processes and the Spatial Configuration could determine the degree in which the subject is able to be more or less orientated in respect to specific Landmarks depending on the System used to navigate.

Spatial Orientation in Space Syntax

In the Space Syntax framework, several studies have demonstrated good correlations between perception of Spatial Orientation, Wayfinding, Environmental Cognition and Spatial Configuration. Haq’s
research about Wayfinding in an urban hospital in Atlanta, Georgia demonstrated a correlation of movement with environmental variables revealing that relational values have stronger correlation and among them, Syntax connectivity was the most significant (Haq, 1999). Peponis and Zimring studies concluded that the overall pattern of layout was important for predicting the search patterns of way-finders, providing clarity about the role of choice and complexity in buildings (Peponis et al., 1990; Zimring et al., 1998). Moreover, Conroy-Dalton (2001) and Saif and Haq (2005) have demonstrated interesting results between Wayfinding and Spatial Configuration not only in real buildings but also in virtual environments, showing that Spatial Configuration is the strongest predictor of both Exploratory and Wayfinding movement.

Although these studies were focused on Wayfinding, they present a relation between the decision making process in Navigation, which includes orientation performance, and the cognition of the Spatial Configuration. In addition, Hillier (2003), focusing in urban environments, has set up that a linearized grid serves as a cognitive model for negotiating spatial complexity of the urban type and that evidence of this could come from the simple facts of direction-giving.

In order to approach to an understanding of Disorientation problems it is necessary clarify that a subject can be orientated in varying degrees, with respect to several features and with respect to one or more scales of space. A subject may also be oriented in relation of their place of living and working but maybe not in relation to some places in the city that they don’t know precisely. Following Montello, everyone is potentially disoriented to some degree at all times, although it is possible for the subject to get to its destination successfully without being completely oriented. But in some situations or in certain degrees if the subject fails to maintain an adequate orientation, he can get lost (Montello, 2005).

Several authors explain different process by which a subject could be more or less disoriented in an urban area.

According to Portugali and Stern (1996), there is a relation between Familiarity with the environment and the use of global or local experience. They separate Familiarity in two components: ‘specific experience of given locality’; and ‘global experience of city structures’. These types of direct experiences are important but are only part of the individual’s total spatial knowledge. The other part is information indirectly acquired from maps, media, and so on. They also differentiate between two kinds of navigators in urban environments: A daily commuter, that mainly retrieve specific experience from associative memory and occasionally will complement it either with global experience or current information, and the visitor who would base Navigation decisions mainly on information, complemented by global experience. It is argued that, as the frequency of Navigation increases, the relative use of information and global experience decrease and the relative use of specific experience increases (Portugali and Stern, 1996).

In a similar explanation Loomis argues that people familiar with the environment tend to orient themselves and to navigate using their local experience through Path Integration to determine changes in location and heading (Loomis, 1999) rather than the global structure of the environment and Landmarks as external references (Etienne, 1999). However less familiar people use external references and the global structure for measuring direction and to orientate in relation to the travel origin.
According to Etienne the less precise the input variables are, the faster errors accumulate.

Another explanation of Urban Disorientation appears in the definition that Stern and Portugali (1996) does of the ‘steady state’ of the Cognitive Map. They argue that the ‘steady state’ of the map is used basically for the common movements of the people who do the same trajectories, and in this case the important values of the map are the lines or roads rather than Landmarks. But, on the other hand, people who do not know the place have a first version of the map (preliminary to the ‘steady state’) that contains less data but more remarkable as Landmarks.

In spite of the fact that Disorientation problems are related with the environmental information available for the subject and the frame of reference in which it performs, it is not very clear what the role of the Spatial Configuration is and what are the properties of the space that derive in Disorientation. Although Space Syntax research have demonstrated a relation between space and movement behaviour, in which Intelligibility appear as a key concept in the relation between the local and the global scale, few studies have been done in terms of the basic level of Spatial Orientation in real urban environments. Then, a consequence for this paper is to expand the initial hypothesis on the basis of the theories enunciated in the following way:

If Intelligibility has a relation between the spatial cognition and the performance in Wayfinding, is there any relation with the orientation performance in a local scale of an urban environment?

If the environmental information available for the subject is basically visual information, are the visual properties of the area related with the orientation performance?

If a linearised grid serves as a ‘cognitive model’ for negotiating ‘spatial complexity’ of the urban type, is the angularity of the grid related with different degrees of Disorientation?

And finally, if the frame of reference is a key factor in the Navigation performance, is the scale of the frame a variable in Disorientation? Are the cardinal directions parts of an orientation frame in a local scale?

Methodology

A ‘point-to’ methodology similar to the one applied by Garling (1986) has been selected for the first experiment, conducted in June 2006. In this methodology the subject is asked to ‘point-to’ to several surrounding Landmarks in order to measure its Spatial Abilities in relation with the Spatial Configuration. Looking for an objective analysis, the errors between the subject’s estimations and its true orientation were calculated and compared with spatial analysis, in order to extract relations at the individual level with patterns of Spatial Disorientation.

The second experiment was conducted during July with 5 locations for each one of the areas and a total of 200 people surveyed. Ten observation points were selected, five in each one of the areas. The selection criteria was to find locations with high rate of movement, different geometrical properties of their grids, and without physical or visual connection with the selected Landmarks in order to avoid visual orientation.

Four Landmarks were defined in the surroundings of both areas; Nelson’s Column in Trafalgar square, Centre Point Building in Tottenham Court Road, Piccadilly Circus, and Covent Garden Tube.
Station, these spatial references were chosen because they represent objects and area Landmarks that are familiar for most of the people.

A questionnaire was designed with two sets of questions. The first one about personal issues to test the relations about familiarity and orientation sense and the second one about the position of four Landmarks and North, to test the relations between orientation performance and spatial configuration. Subjects were asked about how confident they feel with their answers and also to give a route to get to each one of the landmarks, in order to test the differences between path integration and landmark recognition.

A protractor was drawn in the sheet, and the subject was asked to point to the landmark direction taking the circle centre as the point base. This method gave the best results because the subject tended to correct the line directions drawn by the experimenter, making the data more accurate. Finally, the real North direction was also drawn in the map, after its verification with a compass, in order to verify each of the answers with an objective reference.

**Data Process**

All the direction lines were translated as absolute angles from the lines drawn in the questionnaires in relation with North, and recalculated taking as '0°' the correct landmark direction, 1°to 179° if it was to the right of the landmark and -1°to -179° if it was to the left of the landmark. All the direction lines were drawn in GIS. A standard matrix was done in order to automate the queries for each one of the locations, adding to each direction answer the data about Male-Female, Age and questions 7 to 11. Then the line was retraced in GIS with the values of each one of the answers from the first set attached to it. Then, the GIS tables were exported to a data analysis Software to produce numeric tables in order to calculate difference and deviation factors between line angles.

**Hypothesis Verification Procedure**

a) Familiarity and disorientation

To analyse the first assumptions about familiarity and disorientation, the dataset from familiarity answers was compared with the 'Average Error' and 'Mean Error' values.

b) Frame of reference, cardinal directions
The ‘Frame of Reference’ as a factor in the Navigation Performance was investigated comparing the cardinal directions with the subject answers in pointing to North.

Figure 3:
Summary of answers about north direction. Black lines represent mean error in each observation point; darker grey represent north direction and lighter grey represent the error area. Most of the answers are influenced by the street grid.

c) Grid angularity

c.1) Grid angularity and street lines

-In order to analyse if people tend to point in the line direction of the street rather than the correct direction of the landmark, the results from the ‘Mean Error’ angle was compared with the closest street angle.

c.2) Grid angularity and orthogonal relations

In terms of grid angularity the ‘Mean Error’ results were compared with a ‘Difference Factor’ between Oxford Street angle and the predominant street angle in SOHO and COGA, looking for a correlation between the error patterns and a linearised grid derived from Oxford Street Orientation. This process has been done through an analysis of the angular patterns of the grid with a GIS plug-in produced by Space Syntax Limited®.

d) Routes knowledge versus Landmarks knowledge

To analyse the relation between Landmark Direction and Routes directions, the two set of data were compared looking for the different performance in the whole set of data and later in the Familiar-No Familiar group.

e) Visibility and Spatial Orientation

The ‘Visual Relation’ between the directions answers and Spatial Configuration properties of locations was analysed comparing the error patterns with Visibility Graph Analysis (VGA) through Depthmap®.

f) Intelligibility and Spatial Orientation

The relation between Intelligibility of the area and the error distribution in pointing to Landmarks was analysed through the data of error
patterns and Intelligibility values extracted from Intelligibility and Synergy measures through Webmap$.\textsuperscript{9}$

g) Back Bearing and Spatial Orientation

An experimental analysis was done looking for the relations between the back bearing of the landmark directions and the polygons that the intersection of the back lines produce.

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**Figure 4:**
All locations pointing to Piccadilly Circus colored by confidence value

**Figure 5:**
All locations mean error and correct direction in pointing to landmark

**Figure 6:**
Grid predominant direction 50 degrees NE-SW
Oxford Street direction -100 degrees W-E / difference factor -50 degrees
Concepts and Formulas

- The first step was to draw the Direction Lines in GIS. The angles of the lines were calculated from $0^\circ$ that is the correct direction to $180^\circ$ that is the opposite direction.

- Two columns of angles were added in the table. The first one (col. 1), with the absolute angle value, from $0^\circ$ to $180^\circ$ in both directions. The second one (col. 2), with the angle value in positive (+) if it was to the right of the landmark, or negative (-) if it was to the left of the landmark.

- An ‘Average Error’ was calculated with absolute values from ‘col.1’. This number shows an average error in pointing to the landmark from all the subjects in the data set, but it does not represent a direction line average in the map.

- A ‘Mean Error’ was calculated with angle values from ‘col.2’. This number shows a mean error in pointing to the landmark from all the subjects in the data set considering (+) and (-) values. It represents a direction in the map, which is the mean error in pointing to the landmark.

- A ‘Standard Deviation’ was calculated with angle values from ‘col.2’. This number shows probability distribution of the set of angles and is defined as the square root of the variance.

- A ‘Standard Error’ was calculated from the ‘Standard deviation’ to obtain a representative angle that could be draw as a line direction in the map. The ‘Standard Error’ value with the ‘Mean Error’ value will define an area in the map, to compare the relation between the error in pointing to landmarks with the grid angles.

Findings

Two hundred subjects were interviewed in total, considering ten locations, five in each of the areas and twenty subjects in total per each area. The average age in both places is between 31.7 and 32.7 years old. In general people said they were Familiar with the area with
32.5% of people in SOHO and 26 in COGA, also 25 people answered they “Daily Visited’ the area in SOHO as well as in COGA.

The Orientation performance was slightly better in COGA than in SOHO. The ‘Mean Error’ in COGA was 2.83º and the ‘Average Error’ 29.8º. In SOHO the ‘Mean Error’ was -3.65º and the ‘Average Error’ 30.3º. The higher error was in question 1 (point to North) in both areas with a ‘Mean Error’ of -17.69 º and an ‘Average Error’ of 36.53 º in SOHO and a ‘Mean Error’ of -11.69 º and an ‘Average Error’ of 36.85 º in COGA.

The average confidence (form 0 to 10 in terms of confidence with the answer) was 7.4 in SOHO and 7.2 in COGA, that means people were very confident in average of their responses. The data analysis shows a better performance of Right Handlers over Left Handlers, comparing their ‘Average Error’ and also, in both places Females have a higher Mean and Average error compared with Males subjects.

In terms of familiarity and disorientation, the error distribution was a finding that appeared in the first and second experiments. Having analysed the data, people who were familiar with the area had a lower performance in pointing to landmarks than people who were not familiar with it. This finding is explained by Stern and Portugali (1995) arguing that as the frequency of navigation increases, the relative use of information and global experience decreases and the relative use of specific experience increases. Then familiarity is highly related with spatial experience of the subject and the more the subject navigates the environment the less global information is used in the process.

However, the results differ from the preliminary assumptions in terms of subject orientation performance in relation with landmarks. Having analysed the data from ‘grid angularity’ and ‘knowledge of routes’ hypothesis they revealed that people fails in pointing exactly to landmark orientation, but rather they answer correctly when they are asked about street direction to get to the landmark. That means that, in average, the subjects know were they are, and they know how to get to places, but they are not using only a landmark system to navigate the environment. According to Loomis people familiar with the environment tend to orient themselves and to navigate using their local experience through Path Integration to determine changes in location and heading (Loomis, 1999) rather than the global structure of the environment and Landmarks as external references (Etienne, 1999). Then, the path integration navigation system could produce accumulative errors in the heading of the subject, but they are still able to correct them and keep oriented in the environment.

Although the error in pointing landmarks is not high in average, (the higher ‘Mean Error’ is no more than 10º) several subjects pointed in more than one ‘step angle’ (more than 22,4 º from the correct landmark direction). This error is explained by Tversky as an induced error by schematization that is corrected in practice, ‘A turn that is actually 60 º may be described ambiguously as a right turn or remembered incorrectly as 90º but the schematization will not matter as the actual environment will disambiguate the vagueness of the expression and will not allow the error to be enacted’ (Tversky, 2005: 14).

The supposition of relation between grid angularity and an orthogonal mental image of the city was not proved in the verification process. Although some of the points show similar values with the difference factor, the results in average do not fit with the initial hypothesis. The frame of reference as a factor in the Navigation Performance was investigated comparing the cardinal directions with the subject answers pointing North. Findings show that people do not use a large
scale frame as cardinal directions to navigate in the local environment and, although there is an intuition of where North is, the answer is largely influenced by the grid direction. According to Montello the knowledge of cardinal directions maybe more strongly tied to knowledge of the local street system when a dominant rectilinear grid is coinciding with the cardinal directions, especially in the absence of any highly salient landmark.

In terms of visibility and orientation performance the findings do not show a correlation between higher orientation performance and locations with bigger clustering coefficients or higher Integration values. However, Conroy-Dalton, in her VR an experiment shows that the points in were the subjects stop to scrutinise the environment (to orient themselves) where points with maximum visual, local and global information about the environment and that could cumulate into aggregate patterns of movement. Maybe the difference between both experiments is based in the two different process of navigation, pilotage and path integration. Landmark recognition requires an internal memory that allows the feature to be recognized as a destination, path integration combining knowledge of movement direction with knowledge of the extent of movement. (Montello, 2005) Then, a subject orientation could be more or less affected by the grid structure or the visibility properties of the space, but is highly related with the his visual memory and the integration of the observation point with the global frame of reference. In other words the knowledge used to move in the environment would differ from the knowledge the subjects need to orientate in a static point.

Further considerations suggest a clear distinction between Landmark and Path Integration navigation systems. The literature differs in the definition of both concepts, as has been presented in the literature review, and some authors as Etienne propose that path integration is 'the most fundamental component of representation of space. In this view the hippocampus contains a synaptic matrix for path integration, to which view-point-specific landmark information becomes secondarily bound by associative learning' (Etienne, 1999). However, as the outcomes of this research have demonstrated, the landmark navigation system is primary in the formation of Spatial Knowledge, and Path integration appears to be developed in a secondary stage when the subject is more familiar with the spatial configuration.

Conclusion

This paper has shed light in the relation of Spatial Configuration and Orientation Performance in the individual Urban Navigation. The preliminary assumption about landmarks position and grid orientation has been tested and showed that people tend to fail in answering about a specific landmark location, and their answers are highly influenced by the grid configuration. A relation between familiarity and Orientation Performance has been showed in the findings, where people more familiar with the area have a lower Orientation Performance in average. The new hypothesis developed after the pilot experiment was examined by different methodologies to analyze the gathered data. Although a relation between visibility properties of space and orientation has not been verified, it could be argued that the knowledge the subject needs to navigate the environment differ from the knowledge needed to orientate in a static point. The subject perspective of judgment is changed when he is asked in a location that maybe is not familiar for him, and then different levels of errors could be produced trying to estimate its location and adopting its own point of view.

As a general conclusion, although Landmark recognition is a key factor embedded in the navigation process, in the case of study
SOHO and Covent Garden the findings show that people failed in pointing to a specific landmark or North position, but they know how to reach their destinations. Then, the navigation system used in Central London would be closer to a Path Integration System rather than a Piloting or Landmark Recognition System.

It could be argued that the most used navigation system in central London is based in Path Integration rather than Landmark Recognition. Moreover, when the frequency of navigation increases and people are more familiar with area the key system is related with Path Integration, but when subjects are not familiar with the areas their navigation system is closer to a Landmark Recognition. This finding has been demonstrated by the low performance of subjects in pointing to landmarks when they are familiar with the areas, but a higher performance in indicating routes through the areas.

Limitations of the present paper are related with the variables about Orientation and Navigation processes that are not possible to analyze with the present methodology. Although the paper shows a relation between Orientation Performance and Spatial Configuration, the inclusion of a cognitive map analysis would be useful to compare the relation of the mental image of the City Structure with the patterns of Dis-Orientation, looking for the associative memory as a part of the Orientation Performance.

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ii. In a similar definition Loomis consider dead reckoning or path integration as the process of Navigation by which the traveler’s local translations and rotations, whether continuous or discrete, are integrated to provide a current estimate of position and orientation within a larger spatial framework. [Loomis 1999]
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