FINDING THE WAY BACK:
spatial variables in asymmetric route choice

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Margarita Greene
Escuela de Arquitectura, Pontificia Universidad Católica de Chile
Rodrigo Mora
Dep. de Arquitectura, Universidad Técnica Federico Santa María
Hernán Kirsten
Escuela de Arquitectura, Pontificia Universidad Católica de Chile
Daniel Wurman
Escuela de Arquitectura, Pontificia Universidad Católica de Chile

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Margarita Greene
Escuela de Arquitectura, Pontificia Universidad Católica de Chile
El Comendador 1916, Providencia, Santiago, Chile.
mgreenez@uc.cl
Rodrigo Mora
Departamento de Arquitectura, Universidad Técnica Federico Santa María
Av. España 1680, Valparaiso 110v, Chile.
rodrigo.mora@utfsm
Hernán Kirsten
Escuela de Arquitectura, Pontificia Universidad Católica de Chile
El Comendador 1916, Providencia, Santiago, Chile.
hekirste@gmail.com
Margarita Greene
Escuela de Arquitectura, Pontificia Universidad Católica de Chile
El Comendador 1916, Providencia, Santiago, Chile.
dwurman@uc.cl

Abstract

This study analyses the spatial variables involved in route choice through a frequent although rarely studied phenomenon: when a person consistently chooses a different route according to the direction of the trip. The article identifies spatial aspects affecting the cognitive processes that may lie behind this asymmetric choice. The study is based on a spatial cognition exercise applied to thirty MSc students. The assignment pointed towards the identification of spatial dimensions involved in an asymmetric route selection. Each student was asked to present, represent and explain –using syntactic methods– a case where he/she consistently took a different route according to the direction of the trip: to and from. The idea was that by comparing the to and m routes, it would be possible to identify significant decision points in the route, and that the analysis of the different choices recorded would give some insight in the negotiating process that we undergo while moving in built space. The paper analysis five of these cases, each of which emphasizes a particular aspect in the decision process of the route choice. Nevertheless, more than one factor is involved in each reported case. Some of the main factors identified in the paper are: metric distance versus topological complexity, visual assessment of metric and topological costs, the tendency to preserve linearity, the first leg theorem, the tendency to avoid backtracking as well as some environmental considerations.

Introduction

The process in which people perceive, memorize, encode and use spatial information for locating themselves and traveling in space has been, historically, the focus of spatial cognition. Commonly known as cognitive maps, it has been assumed that people form a map-like spatial structure of their environment that permits them to define their position in space and to define routes between different locations. In fact it has been assumed that cognition make orientation possible in real-world circumstances, and their existence would allow subjects to define alternative routes when connecting a pair of origins and destinations.

Since the eighties, cognitive literature has stressed the fact that cognitive maps are not necessarily realistic constructions but rather distorted transformed and exaggerated entities that somehow simplify reality. A common topic has been the variation in the perception of distance according to different contexts, such as the number of intersections, angles of incidence or amount of information available during the trip. Because of that, it has been argued, route selection is far from being defined solely by its metric implications; instead, other factors such as changes of direction or the amount of effort spend in traversing a route, play an important role. Most of these contributions have implicitly assumed that once a route is defined, its outward and return segments would be identical. In other words, it has been implied that *one goes the same way that one comes back*. Nevertheless, what if this is not the case?

Golledge (1995), for example, tested route selection of 32 subjects inside a university campus. Subjects were asked to traverse four different paths to and fro certain locations. The initial assumption proposed that both outward and return segments would be fairly similar and that route selection would be defined by metric and environmental factors. However, the findings showed that in most cases, people tend to define different routes according to the direction of travel, as if, instead of defining an optimal path for a given trip –which would be repeated in both directions– individuals assessed each segment independently and perceived it differently in terms of distance. This assessment, then, changed the choice per segment of the route, resulting in an asymmetrical route choice. As Golledge suggested "the real question is whether route selection criteria also changes: from examining the actual paths taken and recording response times, and other variables, it seems that they often do" [9:221].

In the same vein, Conroy-Dalton (2003) recently posed what she called “the British Library problem” in which two identical (metric and topological) paths link two destinations in a generic reading room. Because of their topological and metric symmetry, it could be expected that most people would select each path equally. The author suggested instead that most people tend to follow the “longest leg” providing the fact that this direction will not deviate them from their destination. Thus, a spatial effect from the order of the “coming leg” together with a psychological effect form the necessity to roughly navigate towards our goals will shape route paths beside metric implications.

In order to enquire on this issue, an experiment was set up in an architectural MSc workshop of 30 students. The students were asked to recall a personal experience where they consistently took a different route in the way to and fro between two destinations. They were then asked to analyze and try to explain the asymmetric route choice using syntactic tools. One interesting first observation is that all of them reported the occurrence of this phenomenon, although none of them had been aware of it until then.

The article presented here is an attempt to enquire further into the spatial variables that are affecting the asymmetric route choice using space syntax methodology and software. The paper refers to the findings of five cases, among the thirty students, that were selected and analyzed more thoroughly. Each one of them suggests a different possible cognitive explanation that may have affected an asymmetric route choice. The paper starts by describing and analyzing the five cases, and is followed by a chapter of discussion and another of conclusions.

Visual Assessment of Metric Distance

The first self-reported case of asymmetric route choice analyzed occurred between a student's workplace and the university. Both places are located in Providencia, one of the main commercial areas of Santiago, at a 15 minutes walk distance, approximately 12 blocks away.

As shown in Figure 1a, the student made a small variation in his route to and fro that meant the circumnavigation of a block according to the trip's direction. Both trips –to and fro– present several segments and turns. In the outward trip, at Point A (see Figure 1a), he chooses to turn left and to continue walking by the main road (Providencia), postponing the moment that he has to take the inner and less important roads. In his return instead, as soon as he crosses the river, he decides not to continue walking along the long straight segment, but instead he chooses to turn left, which in fact results in shortening the trip (1,249 metres versus 1,314 metres in the outward trip).

An initial conjecture suggested that the variation in the route was an attempt to save the traveler changes of direction or, in other words, that it offered a topologically simpler trip. Nonetheless, this conjecture is discarded by the fact that both trips are topologically equivalent, implying that other variables are also playing a role.

Why is the student producing a spatial circuit instead of defining a single path? In order to answer this question, a simple analysis on the route decision was carried out. Figure 1c shows a 180-degree isovist (reflecting the student's angle of vision) at the locations where the path changes (Points A and B in Figure 1b), that is, where the student decided to make turns.

In the trip towards the university, in Point A, the individual is confronted with two opposing spatial drives: one to follow the longest line of sight, in Conroy-Dalton's words (Conroy-Dalton, 2003) to "follow his nose"; and another to walk as accurately as possible towards his destination, which we will call "compass orientation". The decision is to continue along the longest line of sight until reaching the next street, where he turns again to his destination; nevertheless this could be influenced by the attractiveness of the main road, something that we will approach in other cases

In the trip back, in Point B, after having crossed the river, a large visual field continues along the subject's previous trajectory, encouraging him to continue along the same route. But instead, he declared to normally cross the street and turn left immediately after, continuing his trip at the adjacent road. In short, he did not "follow his nose", as one may expect if the topological cost were similar. However, a closer look reveals that by turning left and then taking the adjacent street the subject was saving some metric distance in the whole trip, somehow creating a minimal shortcut in an otherwise inflexible scheme.

The analysis of this case suggests that the desires to diminish metric distance and to preserve linearity are competing factors, and sometimes they result in an asymmetry between outbound and return segments. A possible hypothesis suggests that when a metric gain is perceived in a route there would be a tendency to sacrifice the preservation of linearity (providing the fact that both options are topologically equivalent), whilst when this is not the case (and one does not directly see a metric gain), this aspect is overlooked. In other words, the cost of assessing a potential metric gain when no spatial aspect is visually available may deter an individual of breaking a continued trajectory.

Lastly, it is important to signal that although in the way back from the university the shortening of metric distance seems to prevail over the inclination to "follow the nose", this knowledge is not enough to make him choose the same way in the following trip: it seems to be the case that the "seeing" the shortening is a requirement.

Figure 1:

Visual assessment of metric distance

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First Leg Theorem and Preservation of Linearity

Combining some of the factors, that seem to influence route choice – metric distance, topological distance, visual fields– an interesting and rather familiar case is reported here. Not only outbound and return routes varied, but also, according to the student's experience, there were variations in both the trip toward the destination and in the trip from it. Therefore, in this case, the route choice was a competition between to and fro but also among the to and among the fro.

The case occurred in a university campus between the main entrance and the student's classrooms. Figure 2a shows both trips (outbound and return) and their respective diversions. When going to his destination (see Figure 2b), the student follows a straight line up to the end of the road and then turns left until reaching his destination. However, he also reported that sometimes he made a shortcut that consisted in taking the diagonal of an open space and then turning right again to his final destination. Thus, while the former case implied a metrically larger but topologically simpler trip, the latter implied exactly the opposite.

In his way back, the student repeated the pattern, he initially chose the trip that offered the longest leg in the approximate direction of his destination, but he reported that mid way on the journey he sometimes chose to deviate from the topological simplest path and take the diagonal.

Figure 2b shows the deviation from the final destination by measuring the angle between the route taken and an imaginary straight line between origin and destination, which we will call a "compass line". In the starting point of his trip (Point A), the individual chose the route with the least angle of deviation from his destination (12 degrees against 46 degrees), which also offered the longest leg. Further down in Point B, where the student reported the optional diversion, the choice involved following the route with a deviation of 38 degrees from the compass line or the shortcut that would reduce the deviation to 12 degrees. Likewise, the first option involved more walking distance but less changes of direction, whilst the second option meant less metric distance but more changes of direction. A similar situation is repeated during the return (Figure 2c).

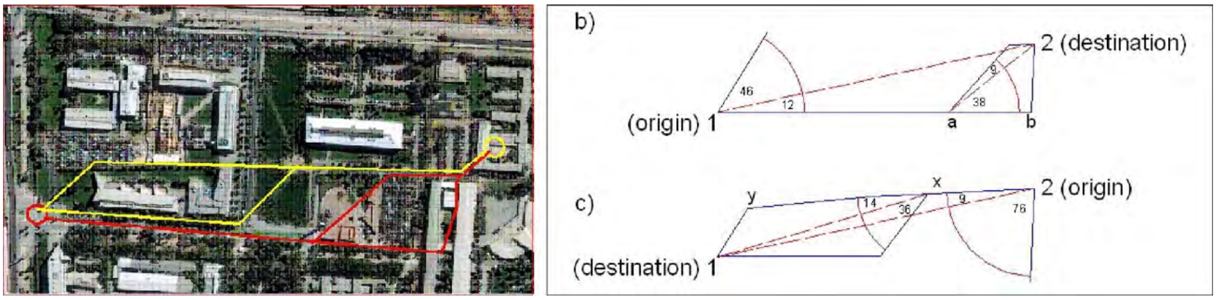


Figure 2:

First leg theorem and preservation of linearity
a) outbound and return trips within the campus,
b) angular cost of the outbound journey,
c) angular cost of the return journey

Sadalla and colleagues (Sadalla and Montello, 1997; Sadalla, 1980) have argued that the notion of distance is variable and may depend, among other factors, on the number of intersections in a route. In other words, people may change the criteria by which distance is estimated from metric to topologic depending on the circumstances. An initial conjecture may suggest that two aspects could be involved in the process described at the university campus: the time of the day in which each trip is carried out and the mental "capacity" available to accomplish a more complex route. During mornings, for example, the student may be more likely to prefer a metrically shorter path over a simpler route, in order to reach his destination on time. On afternoons, while returning home, his willingness to accomplish a longer trip (but less demanding in terms of changes of direction) may increase. The idea of an adaptive "internal compass orientation" capable of tracing an imaginary line towards a destination in order to select a possible route is seductive and could be explaining the present case.

Assessing Angles in a Multiple Choice Trip

A similar case of adaptive compass orientation is presented here. Unlike the previous example, this time there are few metric and topological gains in selecting any path. Figure 3a shows two paths between an origin (Location 1) and a destination (Location 2). In this case the origin is the student's home and the destination an attractive square with cafés and entertainment. According to the student, each journey offered four alternatives, one at every intersection, where each offered the continuation of the ongoing linear movement or a 90 degrees turn.

Figure 3b shows the outbound route using the same procedure as before: compass lines are traced between Location 1 and 2 and in each of the intermediate route points where deviations were reported (Points B and C respectively). Figure 3c depicts the same procedure but for the return trip.

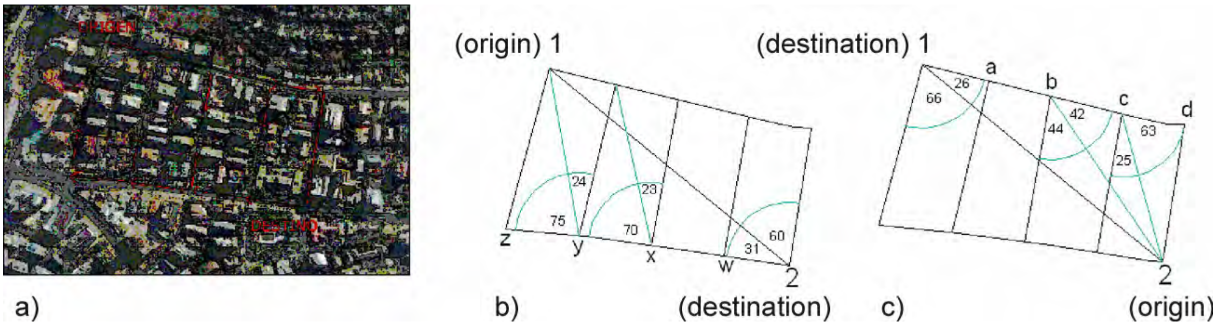
In the first part of the outbound journey (from 1 to 2) the individual chose the longest leg that coincided with the choice that offered the minimum deviation from his destination (measured by the angle between the route taken and the compass line). As he approached Location 2 (Points B and C), the difference between the angles diminishes, and the individual has to face the decision of turning right at one of these intersections, or postponing the necessary turn for the final part of his journey (Point D). If at the starting point the decision was fairly obvious (it offered 26 degrees of deviation from the destination versus 66 degrees), in Point B it is equivalent to the naked eye (42 versus 44 degrees), and in Point C the strongest option would be to turn (63 versus 25 degrees).

The process is repeated in the return journey, from Location 2 to 1, although this time the "angular gains" of making turns in advance are higher due the increasing distance between segments.

These results coincide with the phenomenon described in Conroy Dalton's theorem of the British Library (2003), where she stated that between two equally metric and topologic segments, people will select the one that provides the "longest leg" and, at the same time, does not deviate them from the destination. This seems to be the case at the beginning of both outbound and return trips, where the subject chose the path that offered the longest leg. Nevertheless in this case, the orthogonal grid offers the possibility of reassessing the initial choice at each intersection. Once there, individuals might evaluate their choices, negotiating the necessity of maintaining a "compass orientation" (a path that roughly directs them to their destination), against the topological simplicity of each path.

Figure 3:

Assessing angles in a multiple choice trip
a) outbound and return trips,
b) angular cost at each stop during 1-2 path,
c) angular cost at each stop during 2-1 path



Environmental Factors in Route Selection

An intriguing case that involved topological and metric distance, as well as a "compass orientation" phenomenon, was reported in a school environment. In this case, the student claimed to have repeatedly traversed the route in two different ways according to the direction he was heading. In the fist part, when going from origin (the school entrance) to destination (the gymnasium), the subject walks until reaching Point B and then takes the diagonal, crossing an open space and turning right again in Point A until reaching the destination. In the opposite direction, he opted for a simpler trip in which he made only one change of direction. As a result, the outbound path is metrically shorter (85.49 m) but topologically more complex (2 turns) than the return one (98.35m, 1 turn).

An initial conjecture may suggest that this example only involves metric and topological factors in the route choice. However, the predominance of metric over topological factors during the outbound journey and an opposite situation during the return journey as a reported repeated phenomenon allows for further speculation. What other factors may have affected this route decisions?

A possible explanation to this phenomenon may lie in visual variables not mentioned in the previous examples. During the outbound journey (see Figure 4b) the subject walked until reaching Location B, where he is presented with two spatial choices. Because there is no direct route from this point to the destination, each of them, will deviate him from his destination. If he decides to go straight on, the path will deviate 39 degrees from the compass line, but if he decides to take the shortcut across the open space, his trajectory will only deviate him 17 degrees from the destination. In the outbound trip, he traversed the space diagonally, sacrificing topological simplicity but saving metric distance. On the opposite direction, nonetheless, the situation is less clear. By choosing a two-step journey, the person not only increased the metric length of the trip, but it also deviated him more from his destination in angular terms (see Figure 4b). Therefore, this choice implies the advantage of a topologically simpler path although at the cost of a metrically more demanding trip.

As was explained initially, the focus of this paper has been in identifying the spatial factors that influence route choices. Factors such as the attractiveness of some places over others (because of its aesthetics or protection from environmental conditions for example) were not initially taken into account.

This reported case seems to be an example where the attractiveness of a visible option encourages the person in choosing a route that is not only metrically longer, but that also deviates him more from his destination than the other option. A careful revision of the environment reveals that segment 2C is, in fact, a protected corridor that cannot be seen from the entrance. In the outbound trip, one may hypothesize; spatial variables over unseen environmental variables are preferred, whereas in the way back, the seduction of a "perceived" comfort reigns over a metric gain.

It is interesting to note here that the case described is one of a student of the referred school, therefore a person that has previous knowledge of the corridor and the comfort it offers. Nevertheless –as in the first case where the shortening of metric distance had to be visually assessed– the comfort offered by the route has to be visually offered; knowledge by itself is not enough to over ride the metric advantage.

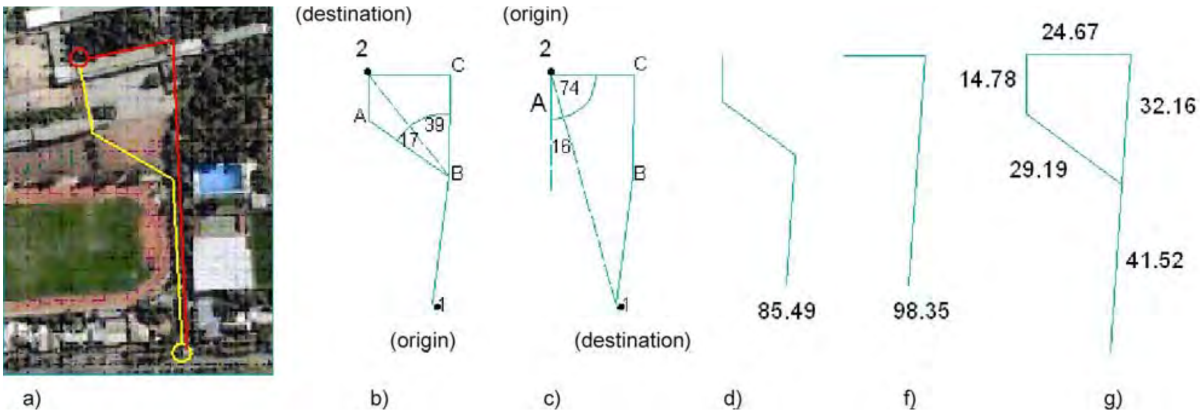


Figure 4:

Environmental factors in route selection
a) outbound and return trips at the school environment,
b) angular cost at each stop during 1-2 path,
c) angular cost at each stop during 2-1 path,
d) metric cost of 1-2 path,
f) metric cost of 2-1 path,
g) metric cost of each segment

Avoiding Backtracking

A curious but highly suggestive case between a student's home and a bus stop is presented here. Like in previous cases, both outbound and return trips are different. Unlike them, however, the comeback has a detention (a bakery), where the student used to stop before going home. As a result, the return is divided in two segments; one between the bus stop and the bakery (segment 1) and from this location to the subject's home (segment 2). Figure 4a shows all segments.

A particular characteristic of this example is the importance of street crossings. According to the student's report Street 1 (see Figure 4a) was fenced forcing the pedestrian crossings in well defined points. In order to cross the street, and follow his route the student had to make four turns and backtrack a few meters from the junction in order to cross at the crossing.

Because outbound journey was *per se* different from the comeback (in terms of having an extra stop), the analysis of this problem should focus in the comeback *from the bakery.* In fact, once there, the student had two alternatives: he either took segment 2 route (by using a diagonal street and then going back to his home, see Figure 4c), or he took route A, which backtracks some meters at the beginning and then takes two large orthogonal segments until reaching the destination. Both choices demand 11 changes of direction. However, while the first choice involves walking 388.5 mts, the second choice implies a walk of 453.8 mts. The contest then seems clear: the first alternative involves less walking and a postponed backtracking; while the second alternative implies a longer walk and to backtrack at the beginning of the journey. Predictably, the subject chose the first.

But the problem does not finish here. As it may have been detected, the metric gain derived from taking route A would have favored its use during outbound journeys as Figure 4d simulates for route B. Compared to the original outbound journey, route B implies only 415 mts (against 453.8) and 10 changes of direction (against 11). Nevertheless it implies two backtracking situations: at the beginning of the trip and at the end of the trip. The student reported not to have taken this route frequently.

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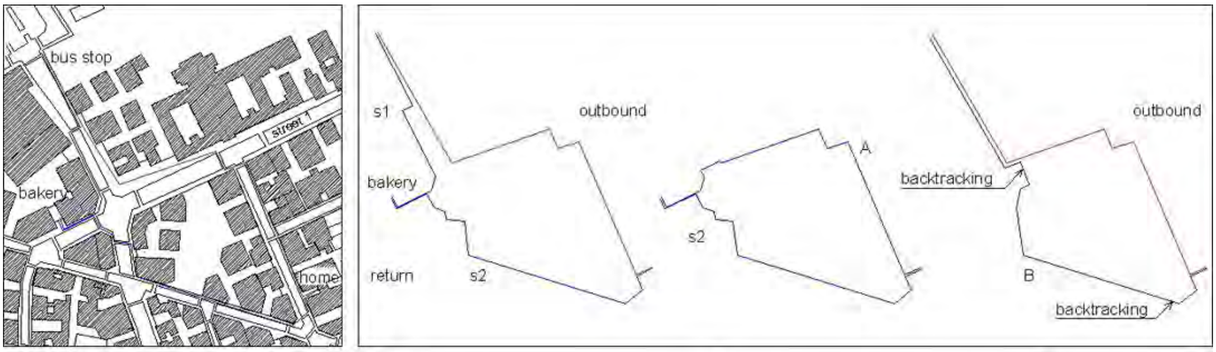
The example poses interesting questions in relation to our willingness to backtrack, and more specifically, about our willingness to execute this behavior at different stages during a path. It seems that the “cost” of backtracking is perceived as higher at the beginning of a route or when this becomes “explicit” (in terms of being able to observe the entire situation). On the contrary, backtracking at the end of the trip or when the process is not seen directly, it seems to be less costly. In other words, it seems to be easier to backtrack when concluding a trip or when the whole path is not visible (at it often occurs when one has to circumnavigate an urban block).

Figure 5:

Avoiding backtracking
a) outbound and return trips,
b) outbound and return segments,
c) competition of return segments,
d) competition of outbound segments



a) b) c) d)

Discussion

Table 1 shows a matrix of the five cases presented crossed with eight factors detected in the thirty cases analyzed, marking in dark gray when the factor was present in the case in a strong way and in light gray when its effect was less important. Briefly and succinctly the eight factors may be summarized as follows:

- Backtracking: a natural instinct to avoid retracing steps.
- Topological versus metric: negotiating process that individuals undergo negotiating distance against route complexity.
- Compass orientation: a natural instinct towards the orientation of the destination.
- Route inertia: routes have an inertia that has to be broken by an external stimulus
- Unstable environments: urban space changes during the day and so offers a different choice during the day or season (for example car parks or traffic)
- To and fro programs: the way towards a destination is less liable to be affected by secondary programmes, while the return trip looses urgency and is easily diverted (ort at least the minimum distance axiom looses importance)

- Visibility fields: length and area of visual fields affect the decision making process in route choice, although they can affect it in opposing ways (attracting or detracting alternatives)
- Longest leg: the visible longest leg in direct route is more attractive in the route choice
- Order and priority: perception of metric or topological costs vary according to the position in a path: a metric gain is perceived as more valuable at the beginning or a topological cost is perceived as less important at the end of the trip.

Table 1:

matrix of asymmetric route choice cases and spatial factors involved

Theme/Name	Backtracking	Topological vs. Metric	Compass Orientation	Inertia	Unstable Environments	To and Fro Program	Visibility Fields	Longest Leg	Order and Priority
Visual assessment of metric distance									
First leg and preservation of linearity									
Assessing angles in a multiple choice Trip									
Avoiding backtracking									
Environmental factors in route selection									

Maybe one of the main observations to be pinpointed from the matrix above is the variety of factors intervening in the process, how they tend to be interwoven, and the little we know about them. Although the cases presented have not been tested in a scientific manner (becoming part of what is normally called “anecdotal experience”), there are grounds to support some of the findings mentioned previously.

First, there is evidence that people travel differently according to the direction of the trip (Golledge, 1995). This asymmetry may be related to how distance is perceived (Sadalla and Magel, 1980; Sadalla and Staplin, 1980), the nature of the trip, or certain unconscious behaviors in people, such as the preference for the preservation of linearity (Conroy-Dalton, 2003).

Second, the fact that these are repeated behaviors somehow validate them as patterns rather than as sporadic conducts. Furthermore, because none of the students were aware of these patterns until they were encouraged to think about them, it may imply that they obey to unconscious principles rather than to explicit rational thoughts. A more methodological and systematic approach is then necessary to undercover the internal processes that may influence route decision in real-world scenarios.

In a broader context, to discover the spatial aspects that encourage people to make circuits rather than to use the same path when coming back from a location may help us to understand how maps are ultimately created in people’s minds. Traditional cognitive theory (Downs and D., 1977; Golledge et al., 1985; Thorndyke and Stasz, 1980) has sustained that survey knowledge is acquired sequentially, first by learning paths and its corresponding landmarks and then by tracing the linkages between different routes. Although some authors propose that survey knowledge is in fact developed from the beginning when a new environment is presented (Montello, 1998), it is less clear though how and why people decide to traverse new routes, so as to make the spatial assemblage possible. Thus, the fact that people explore new routes has been left unanswered, as if it were only originated by the intrinsic curiosity of the people involved or by specific requirements. By looking at the influence of space in the route decision process, this gap may be bridged, helping in the construction of a more comprehensive theory of spatial development.

Conclusions

In spite of the anecdotal nature of what has been presented does not allow us to extract definitive conclusions regarding the spatial components that affect wayfinding, the analysis of asymmetric route choice suggests the emergence of certain patterns and some new perspectives of approaching the subject.

A first conclusion to be signaled is that although the aim of the exercise presented in this paper was to focus on the spatial aspects affecting the route choice, some subjective, physical and cultural factors influencing the choice –such as aesthetics, time of the day, environmental protection or perception of security– could not be avoided. In fact the exercise demonstrated that the route decision is a process of constant negotiation between nonspatial and spatial aspects.

A second observation, related to the previous is that although the aim of the study was to concentrate on wayfinding –as opposite to navigation– a certain component of navigating is inserted into many trips (mostly in the return trip) affecting the decision making process. Wayfinding is normally understood as a trip with a destiny, where the individual is trying to minimize the costs of the trip, while navigating –associated to *flaneur*– involves maximizing the benefits of the trip. More so, while in wayfinding an important consideration in the cost assessment is time, in navigation time is not considered a cost; it may even be considered a benefit. This will most definitely affect the route decision in the way to and in the way from a destination.

Among the spatial aspects affecting the process, metric distance, topologic simplicity and angular deviation seem to be playing a decisive role in selecting a path. But this is not the end of the story.

On the one hand, metric and topological distances seem to interact with two implicit spatial principles: the desire to preserve linearity and the desire to not deviate from the destination, as Conroy-Dalton suggested (2003). All these factors are in most cases assessed unconsciously at several locations along a journey, especially at certain decision points offered by the route, where individuals can continue or modify their trajectories. The changing position of people in space constantly recalibrates this model, forming different spatial alternatives to pairs of origin and destination.

On the other hand, visual information on the spot seems to prevail over knowledge from previous experience. This means that individuals will minimize distance and deviation from their vantage point, which does not necessarily coincide with the minimum of the whole trip. Since a way to and fro offers different visual fields the individual will many times take a different option in each way. And again this is not the end of the story; nevertheless we want to finish this paper not with and end but with a proposition that involves a hypothesis and a method.

There is no doubt that the visual field offered at decision points has an important role to play in the route choice. Nevertheless, it tends to be considered only as an operative means of assessing the situation (in metric distance, topological costs or compass orientation). But, what if the visual field itself is an attractor or detractor of a possible route?

Previous experiments on the relation between spatial aspects and the feeling of insecurity showed that the visual fields were significant in affecting the feeling of (in) security in urban space (Sillano, Greene, Ortúzar, 2006). Nevertheless the variable seems to have a back lash effect: while in most contexts a visual field will tend to increase its attraction as it becomes longer and wider, when the vision offered has a negative connotation (i.e. dangerous, ugly, menacing) the opposite will occur, becoming a detractor.

Based on the above observations, we wish to end this paper proposing the incorporation of two measurements of visual fields in the analysis of route choice: visual length and visual mass. The visual length is already a measurement provided by Depthmap and reflects "how far" one can see; measured by the longest ray of an isovist. On the other hand, the visual mass reflects "how much" one can see of an environment and it is reflected in the value of "drift". Proposed originally by Conroy-Dalton (Conroy-Dalton, 2001) drift is a vector that links an isovist's origin and directs people to the "centre of gravity" of what they observe. The task of testing and contrasting these dimensions in empirical terms is left to be done.

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