DISSECTING THE VISUAL VARIABLES OF SPATIAL CONFUSION

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Rodrigo Mora

Escuela de Arquitectura, Universidad Técnica Federico Santa Maria

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Rodrigo Mora
*Escuela de Arquitectura,
Universidad Técnica Federico
Santa Maria,
Av. España 1680, Valparaíso
110v, Chile.
rodrigo.mora@usm.cl*

Abstract

This paper analyses the visual components of junctions in cities. By using a framework originally proposed by Peponis et al (1997), this paper explores the spatial consequences that a slight misalignment of blocks can produce in the spatial structure of a junction. The procedure is then tested in Hillier´s (1996) intelligible and unintelligible worlds. The results show how a timid movement of pieces has profound implications not only on how these worlds are perceived at a large scale, but also at the local scale where spatial decisions are undertaken.

Introduction

Human navigation in space occurs in most cases by virtue of vision. Although there is evidence that some visually impaired people can successfully navigate in space, in most cases is the information that comes visually what permits us to assess and select the ways towards our destinations. But this process is far from being simple. As we know by direct experience, at some locations one can "see more" of an environment and some spatial choices are presented more clearly, becoming in fact as "choice-places" where spatial decisions are taken. In cities these places are normally junctions. By definitions, junctions are places where two or more streets meet and travelers become spatial possibilities or disruptions that may affect their paths. The following article will review these spaces in depth, attempting to disclose the spatial components that affect human navigation. The first part of the paper will present the spatial components of a generic junction and how these components are altered once this junction becomes asymmetric. The second part of the paper will review how such components changes in two well- known space's syntax cases: the intelligible and unintelligible worlds. The last part of the paper will summarize the findings, proposing some dimensions for future work.

The Junction Problem

Let suppose that a subject is walking along a street 2 towards street 1. For the sake of simplicity, this junction will be orthogonal and defined by identical streets, as shown in figure 1a. As the subject walks along a street 2 to the junction, he suddenly enters a space where both streets overlap: the subject has reached the junction. There, our subject can assess all information regarding both sides of street 1 and see, for instance, if someone is coming. He can also see what happens on his own street as if he was inhabiting, at least visually, two spaces at once. Peponis defined these locations as S spaces (Peponis et al., 1997). But as we know by direct experience, sometimes it is not possible to enter S spaces. For example, zebra crossings in cities normally locate some meters before junctions themselves, leaving drivers with an incomplete picture of what happens in incoming streets. On these occasions we take spatial decisions based on information that permits us to diminish possible risks at crossings. A common practice is to examine what happens in neighbor corners (A and B, figure 1a), because it discards potentially dangerous hazards (e.g. a vehicle coming). Figure 1a exemplified this process by tracing two imaginary lines from A and B to the subject's closest corners.

Figure 1:

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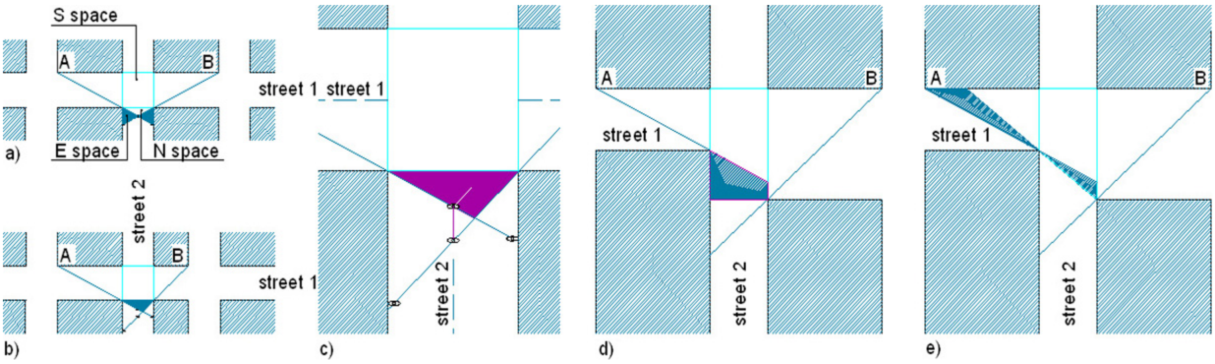
a) a generic orthogonal junction: S, E and N spaces,
b) N spaces in an asymmetric junction,
c) detail of an asymmetric N space,
d) non visible area of a junction according to Peponis´ definition of S spaces,
e) S` space in the same junction



The result is what Peponis called "e-spaces" or spaces where large amounts of environmental information are suddenly available. Figure 1a shows these spaces in dark grey. Unlike s-spaces, e-spaces permit subjects to stay physically in one space (street 1) but, at the same time, to visually access part of another space (street 2). They also permits subject to take spatial decisions in advance, without entering formal crossings and based on incomplete information. But as any driver may know, sometimes in cities one has to look at both directions (in order to estimate what is coming), or to assess the spatial possibilities of each part of the street. We will call these areas "Neutral spaces" (N-space), regions where one has the capacity to assess partially both sides of a street and therefore to take spatial decisions with some degree of information about what is currently happening on them. In practical terms, N-spaces are formed from the juxtaposition of two e-spaces. Figure 1a shows an N-space in an orthogonal junction. Peponis called these areas "kernel spaces", although his definition was not necessarily circumscribed at street junctions and did not involve a specific length of opposite facades.

However, sometimes N-spaces are not symmetrical. As figures 1b and 1c illustrate if, for example, some blocks are larger than others, an asymmetry in e- and N-spaces is produced. In other words, a person walking along one side of street 2 will enter his corresponding e-space before a person walking in the opposite sidewalk.

Spatial asymmetric is nonetheless not only restricted to block length. For example, figure 1d shows the changes in s-, e- and N-spaces if only one side of a street's width is increased. As it can be seen, the resulting N-space is "absorbed" by the s-space. In practical terms, this means that one no longer has the possibility to see points A and B of an incoming corner unless one enters the crossing. But as figure 1d depicts, even inside this s-space a traveler not necessarily will see point A. It seems therefore that the junction is smaller than its corresponding s-space insofar just part of its area visually belongs to both streets. A tentative solution for this problem is stated in figure 1d, in which a new s'-space is defined by linking the corners that compose the junction. Although part of this space still does not observe point A (dark grey in figure 1d), it results in an approximation of what we normally regard as junctions: regions defined by the intersection of incoming roads where one is able to observe at length two spaces at once. The fact has interesting implications for navigation. As one may expect, drivers coming upwards from street 1 will probably approximate to the s` boundary in order to cross street 2 (providing the fact that this crossing has no streetlight). The exact point of these stops will obviously depend on each subject, but an important issue can be stressed: once misalignments are created, a "grey zone" of incomplete information is formed.

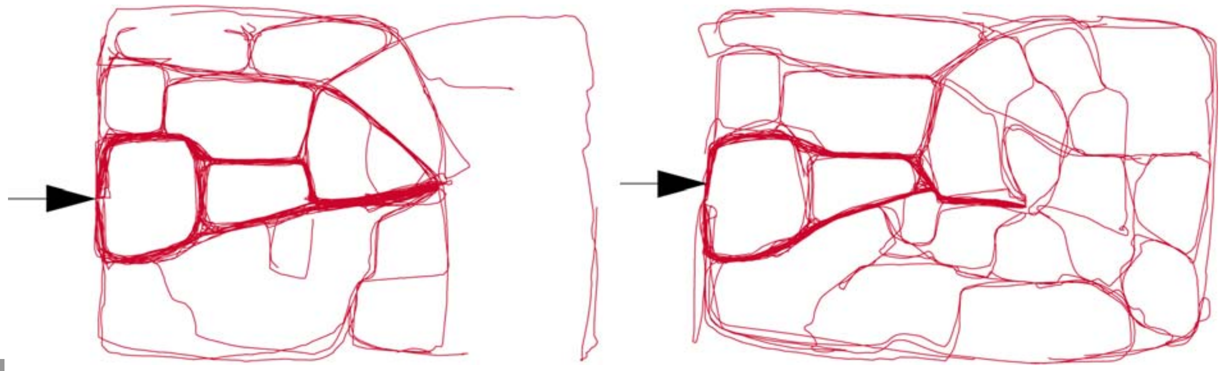
Dissecting the Visual Variables of Spatial Confusion

In the context of a doctoral research, Ruth Conroy-Dalton (2001) analyzed people navigation in several virtual environments. Among them, she tested the "intelligible and unintelligible" worlds proposed by Bill Hillier (1996), in which it is shown how a slight movement of pieces in an urban-like environment can produce important changes in their spatial configurations. The author tested 29 individuals, whose mission was to find a monument located inside their worlds and then to go back to their original positions. As figures 3a and 3b show, the participants started at the right of these worlds, moving freely inside them until reaching their objectives. The cumulative results of their trajectories showed two main effects:

- People´s trajectories in the unintelligible world were more random than in the intelligible world. No preferred street was detected and, once people reached their objectives, they were mostly unable to find their ways back. Figures 2a and 2b show how the area covered by people's in both worlds.
- People´s stops in the unintelligible world were also more randomly distributed, as if people were assessing environmental information on a more casual basis, rather than collecting it in a systematic way. People also paused less in the intelligible world due to, the author suggested, and fewer opportunities in which comprehensive environmental information could be grasped. Instead, people tended to continue moving along their trajectories, as if by they were expecting to find larger spaces to stop and evaluate their next steps.

Both aspects prompted the Conroy-Dalton to suggest that in the intelligible world people seemed to act as being lost and confounded. She also sustained that the absence of extended visual fields within the unintelligible world made the task of finding the ways back more difficult.

Here it will be argued that people's spatial confusion is not only related to a transformation of large visual fields (that affect people's self-positioning in a broader context), but also of the entire system of decisional spaces, affecting the process in which environmental information is perceived by the participants. A closer examination of S`, E and N spaces of both worlds will illustrate this point.



121-04 ***Figure 2:***

People's trajectories in the intelligible world (left), People's trajectories in the unintelligible world (right)
Source: Ruth Conroy-Dalton

The Spatial Components of Decisional Regions

Figure 3a and 3d show, respectively Hillier´s (1996) intelligible and unintelligible worlds. For the sake of simplicity, both worlds have been restricted in their contour, analyzing just the internal space in terms of their spatial components. Figure 3a and 3d also show their S´ spaces, following the procedure stated above. Please note that the central space of both environments has been exempted from the analysis because of its roundabout character. Figures 3b and 3e show respectively e-spaces in the intelligible and unintelligible worlds according to the one-block criteria stated previously. Figures 3c and 3f show N-spaces of these environments according to the same principle.

A visual assessment of both worlds show that the slight movement of pieces in the unintelligible world resulted in a constant asymmetry of junctions, like in figure 1d. As a result, less convex s´spaces are found and therefore less symmetrical e- and s´-spaces now exist. In order to test that, a study of all spaces in both worlds was carried out. The study consisted in calculating the area and perimeter of each s`-, e- and N-spaces at junctions in both intelligible and unintelligible worlds. When, for instance, a junction possessed more than one N-space (due to its four-corner composition), the area and perimeter of these spaces were measured.

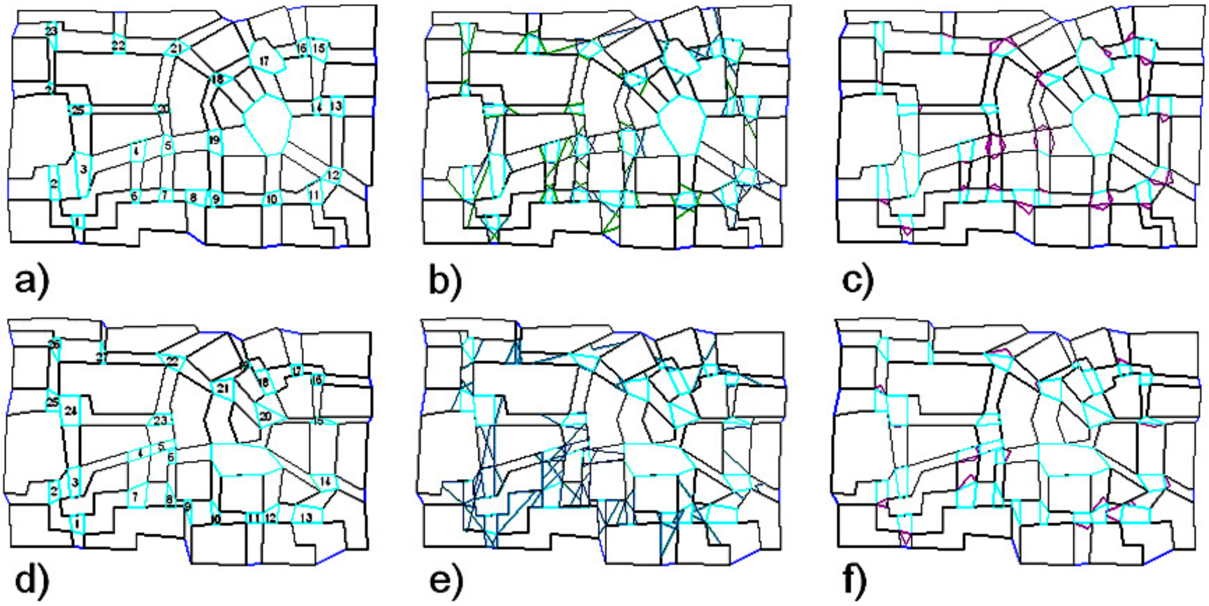
The results are shown in table 1. As it can be observed, there are more s`spaces in the unintelligible world (27) than in the intelligible one (25). This is due to the slight misalignment of blocks which have resulted in some "twin" s-spaces: spaces in which two decisional spaces are adjacent to each other. Although s´-spaces in both worlds have a similar in size and perimeter, their appearance is now different. Column 5 of table 1 shows the measure of jaggedness (Wiener and Franz, 2004), a measure that reflects the degree of convexity of their shapes[i]. This value jumps from 17.9 in the intelligible world to 20.6 in the unintelligible one, indicating that s´-spaces are no longer convex (as in figure 1a) but rather triangular (as in figure 1d). In other words, in the unintelligible world one now frequently encounters junctions where information of only one side of the incoming road is presented. But perhaps the most important change has occurred to e-spaces. As one can see in table 1, N-spaces have drastically diminished in the unintelligible world to 19 spaces (from 32 in the intelligible). The average area of these spaces is also smaller (0.52), showing that the "amount of space" where one can see in advance what is coming from an street has shrunk dramatically. As a result, the total area corresponding to N-spaces has plumbed from 14.14 to 9.48 in the unintelligible environment.

All these factors may explain why people seemed spatially confounded when navigating in Conroy-Dalton´s (2001) unintelligible world. On the one hand, the scarcity of clearly defined choice points may have affected people's detentions, encouraging them to keep walking until more useful location were found. These "grey zones" of incomplete and asymmetric visual information may have also produced a rather homogeneous pattern of detentions, as reported by Conroy-Dalton. This effect also may have resulted in the diffuse use of space detected by the author, and the absence of well-defined major roads.

Not being able to see what is coming can be a distressing event, in which one tends to move along in order to reach a more informative place. In that respect, movement becomes a symptom of confusion rather than a symptom of spatial awareness. In short, the slight movement of pieces seem to have altered not only how the environment is perceived at a large a scale (the extended visual fields that may permit to recognize distance places and favor a continuous movement), but also the small chain of events in which spatial decisions are taken.

Figure 3:

a) S` spaces in the intelligible world
b) E spaces in the intelligible world
c) N spaces in the intelligible world
d) S` spaces in the unintelligible world
e) E spaces in the unintelligible world
f) N spaces in the unintelligible world



	s-SPACES					e-SPACES			N-SPACES		
worlds	Num (*)	total area	av area	per (**)	jagg (***)	num	total area	av area	num	total area	average area
intelligible	25	64.71	2.59	6.52	17.9	81	86.48	3.46	32	14.14	0.57
unintelligible	27	65.64	2.52	6.79	20.6	83	85.69	2.2	19	9.48	0.52

(*): number
(**): perimeter
(***):jaggedness. Its is calculated by dividing a polygon´s squared perimeter by its area.

Table 1:

Comparison between intelligible and unintelligible worlds

Conclusions

Overall, the results show how a slight misalignment of blocks in the intelligible world have not only affected large space visual properties of this environment (in terms of shortening axial lines and diminishing visual fields), but also the entire chain of choice locations that individuals use for navigation. Such spaces now inform subjects about their environments in a partial way, forcing them to move or to cross streets in order to gain information about unseen scenarios. It seems therefore that spatial confusion comprises both large scale and small scale dimensions. While the former may be explained by well-known syntactic properties (the idea of intelligibility and synergy proposed by Hillier and Hanson (1984)), the latter seems to be produced by small misalignments of blocks at decisional points. An interesting area of research may study, for example, how these interact in human navigation in cities and buildings.

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i. Jaggedness was a measure proponed by Wiener and Franz and is calculated by dividing a polygons´ squared perimeter by its area