INTEGRATION IN SIGHT

by

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Thank you to my family and friends.

Chapter 1 | Introduction

Introductory

Imagine we are given a task to draw a diagram with only lines and nodes in a piece of paper to represent our social lives. We then might draw our direct social ties by who we directly know, and, possibly, the people our friends know, as a graph starting from us. Although this forms a simple representation, it is probably rather “local.” How possibly can we know our strategic position, say, within a community, a vast organisation, or a country, which requires layers of relations to measure our social distance to all the others? Alternatively, imagine that we made an unexpected decision, how to tell if this impact is directly from people we know, or by the overall environment which contains information that is not necessarily social but might be well conveyed/explained/generated by this relational social network structure?

1.1 Background, Concepts and Theme

To represent a complex relational system like cities, axial map in Space Syntax, which is the longest and fewest straight lines that covers all spaces in an environment (Hillier and Hanson, 1984), was initially invented as the simplest reduction(Griffiths, 2014) of the built-form. To index strategic positions: integration and choice of spaces in this system, lines in the map are transformed as nodes and intersections as edges (representing change of direction of these straight lines) in an axial graph (Hillier et., al, 1993, p.34).

In this representation, a line's Choice (Figure 1-1) measures its likelihood of lying on the shortest paths (direction changes as costs) between all other spaces within a given network radius, thus indexing how likely it is to be passed through by movement.

The calculation behind choice (or betweenness), C, of an axial line i is:

$$C_i = \sum_j \sum_k g_{jk}(i)/g_{jk}(j < k)$$

(Eq. 2)

where $g_{jk}(i)$ is the number of shortest paths between line j and k containing i, and g_{jk} is the number of all shortest paths between j and k (Rashid 2017, p. 64).

Figure 1-1. An axial line's Choice calculation (D'Acci, 2019 cited Rashid 2017, p.64)

The calculation of Integration of axial line i is:

$$INT_i = \cdot \frac{\frac{\{n\left[log_2\left(\frac{n+2}{3}\right)-1\right]+1\}}{(n-1)}}{(MD_i - 1)} \qquad MD_i = \frac{1}{n-1}\sum_{j=1}^{n-1} d_{ij}, \quad i \neq j$$

d_{ij} is the shortest topological distance for vertex i (a street) reach vertex j;

n is the system's size;

MD_i (i.e. Mean Depth of line i) is its relative depth to all other lines in the graph;

INT_i is the Integration value of line i.

Figure 1-2. An axial line's Integration calculation (Al-Sayed, 2018 cited Hillier and Hanson, 1984, p.114)

Integration of a line indexes its depth to all other lines through the shortest topological paths concerning the graph's size (Hillier and Hanson, 1984). Figure 1-2 shows that the "closer" a space is from all other spaces in a system, the more integrated it is, and thus more likely to be reached (ibid.). It is associated with "to movement" and account for rates of social encounter and retail activities (Hillier, 1996). "Eliminating" other information (land use, attractors, aesthetic, and etc.), this representation treats urban street pattern itself as the generator of potential centralities (spatial accessibility also functional centralities) and potential flows (pedestrian and traffic movement)(D'Acci, 2019).

As the built-form encompasses substantially human experiences, how well would this representation account for our interaction within and with the environment? Intuitively, we can sense local properties of it: number of streets that pass through the street we are standing at (i.e., connectivity) and how far we can see through it. However, deducing more global properties: Integration and Choice, is almost impossible in such a "graph-like" state. It requires measures of relationships between each street to all other streets. Yet previous studies (Peponis, Zimring, and Choi, 1990; Emo, 2012, 2014; Javadi et al., 2017) showed that our spatial-decisions and brain responses also yield to global graph measures in the built-environment. This implies that the theoretical concept of intelligibility, indexing what is to be understood considering the system as a whole by what is seen/experienced directly (Hillier, 1996), functions in real-world egocentric perspectives. Then to what extent do we "see" the global centrality measure from anticipating it via its local centrality (connectivity), or much more complex, many-dimensional visual/sensational information at present as we move?

This study explores how spatial configuration as a probability assemblage of socio-physical information is knowable locally. Wayfinding tasks form a practical starting point to this discussion.

More precisely, (potential) movement, activity and interaction of/with the others (i.e. social affordance) acts as important environmental cues, as discussed in earlier studies (Beaumont et al., 1984; Peponis, Zimring, and Choi, 1990; Penn, 2003; Turner, 2005; Emo, 2012; Dalton, Hölscher, and Montello, 2019) yet lacks central research (ibid.). Speculatively, intelligibility of the built-form might be augmented by its social affordances. There might exist a multiplier effect on people's route choice (regarding different types of activities), which in-turn shape overall movement volume, and the usage and physical character of the built-form (Griffiths and Quick, 2005). In this sense, while our city is a complex socio-physical integrated system, if our perception of many-dimensional sensational information also corresponds to configurational measures, the graph might be used as one principle variable in environmental perception and cognition research as well.

Thus, in this study, two centrally concerned variables are the measure and effect of:

i. Spatial configuration
ii. Moving (Occupying) Subjects

The association between these two is of focus, which relates closely to the social wayfinding concept of people-space cues (Dalton, Hölscher, and Montello, 2019)

1.2 Research Question

Based on the above interests, research questions are phrased as follows:

QI. Can we "see" integration?

Can we "see and go for" integration of the upcoming streets in a local choice node, if up-coming streets' connectivity values are controlled at roughly the same?

Aim I: In line with previous research (i.e. Emo, 2012), examine how configuration explains individual spatial-decisions, which requires our interpretation of direct information in the environment.

QII. To what extent movement flow of the others informs our current position in the global network as we move?

Aim II: Examine how spatial configuration, through its generation of movement/social affordance, in turn shape individual choices and makes the global network knowable.

Served by research questions, the main hypothesis is that the association/agreement between movement volume, activity of people, and the network attributes as a probabilistic basis is an intrinsic aspect of spatial configuration's cognitive dimension (Peponis, Zimring, and Choi, 1991), by which the global environment is locally knowable.

1.3 Dissertation Structure

The next chapter contextualises this work in theories and explains how the above theme and hypothesis arise from gaps in existing empirical research. Chapter 3 presents detailed methods in the research design. Chapter 4 describes results from statistical tests of hypotheses in line with research questions. Chapter 5 discusses implications of the finding with respect to the border theme, referring back to thinking logic in Natural Movement theory (Hillier et al., 1993). Chapter 6 concludes and presents limitations and possible further research.

Chapter 2 | Literature Review

This chapter discusses fundamental research in Space Syntax in relation to the extensive theme: We "see" spatial configuration through its affordances in local viewsheds as we move, given by its (potential/anticipated) network effects[1]. The local-to-global property of a space, or that of multiple spaces – intelligibility of the area, can be perceivable in the real-world. Literature suggests this idea might be far from being new but still rather under-researched.

2.1 Seeing the network as a walker

Space Syntax's idea of Intelligibility is crucial in linking the objective network representation to human cognition (Figure 1-1) (Kim, 1999; Conroy Dalton, Holscher and Spiers, 2011; Penn, 2003). In spatial navigation, it relates to our ability to make inferences at strategic location to the global spatial structure that lies beyond our immediate surroundings (Charalambous, Hanna and Penn, 2017).

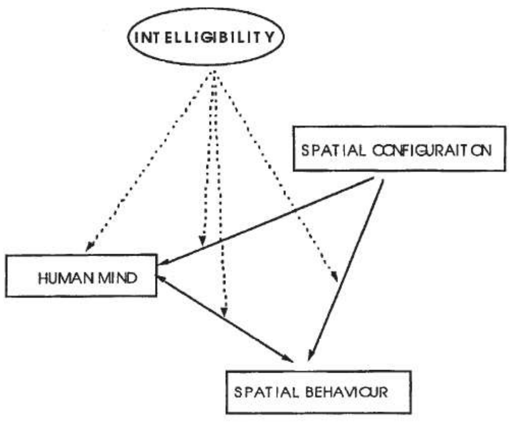

Figure 1-1. The relationship between cognition, the environment, and Intelligibility. (Kim, 1996)

To define, intelligibility can be a property of (all) systems of relations (e.g., could be social or spatial), measuring how a complex can be seen from its parts (Hillier, 1996, p. 245).

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[1] This study uses Network Effect when we only deal with data or aggregated output associated with the configuration, yet without anything subjective or psychological.

Theoretically, it is a knowability of such systems through our interaction with it: it relies on our logical synchronisation of information which is otherwise only available in an unsynchronised Spatio-temporal form in practice (Hillier and Hanson, 1984, p.44; Hillier, 1996, p.92-98) As a parameter, according to Hillier (1996), it is the degree of correlation between connectivity of lines, which is a local centrality measure and can be seen directly, and integration, which is a global centrality measure relating the line to the system as a whole and cannot therefore be seen from the line.

As this calculation is based on the axial graph, it does not incorporate any higher dimensional visual/sensational information. Meanwhile, while it might imply the difficulty in wayfinding as a "walker", it pre-requires manual definition of the boundary of the whole systems as a subset set of lines (Dalton, 2007), especially in cities, or an entire floor in a building, that "if we don't know the boundary of an area prior to finding the value of intelligibility then how might we define a measure that implicitly needs the boundary?" (ibid. p. 088-03)

Following discussion in Chapter 1, in Space Syntax, society and space are strongly relational systems, in that relations between actors are (at least) as concrete and important as discrete properties of things[2], also, we seek and need to reduce complexity to understanding the city and thus society (Hillier and Netto, 2002). To represent a given urban system relationally, squares and streets are rendered into two-dimensional and one-dimensional entities known as "convexity" and "axiality" (Hillier, 1989) and then form a graph in which these spaces themselves are nodes.

Among others, this representation relates to a walker's perceptive in two ways:

- The nodes co-responses to our experiences: we occupy and move across spaces. "If a convex space is a region around us where all points are visible and directly accessible from all other points, then axial lines inform points in other, perhaps remote, convex spaces which are also visible and directly accessible to us" (Hillier, 1989, p. 10)

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[2] Graph (configurational representation) describes relations at various scales. Such relations regarding its overall structure might be more important than elements' properties. Whereas in other schools of thoughts, like "field condition" (Allen, 1997), or fractal geometry, local order and self-similarity is repeated at all scales (Batty and Longley, 1994), that relations are dealt with a consistent local order.

- Both spatial and social systems as patterns of relations can be conveyed by the local-to-global structure, which is just like, seeing the graph from the viewpoint of a node (j-graph), versus seeing all j-graph together from “above.”

How to link these two aspects from a perceiver’s perceptive? Our understanding of the spatial system cannot be graph like: we may only deduce the graph structure through much more complex and higher dimensional local environmental cues which we can sense. Secondly, even if axial lines inform remote visible convex spaces, it is still a purely local representation: both the graph and theory tells us it is the global configuration properties, more than local ones, that give a place (line) its specific characteristic (Hillier et al., 1993)

2.2 Local Environmental Information and the Network

Following the above discussions, one thinking would be to integrate local environmental information with network attributes. Yet compared to this linkage, how these two factors separately impact individuals' emotional and behavioural responses are much more researched in broader fields besides Space Syntax, including environmental psychology, transport and geography, neuroscience, social computing, and etc.

- Regarding local/visual environmental information, e,g., using body sensors and GPS devices, Li et al. (2016) showed that higher value in visibility field within a space motivates positive emotions; Montello (2007) suggests that isovists (Benedikt, 1979), representing local environmental information, provoke psychological responses: "sense of privacy and social interactions stressfulness, and aesthetic judgments" (ibid., p.5) Using city-wide images of streets and crowdsourcing.
- Testing network values, Javadi et al. (2017) used graph centrality (degree, closeness, and betweenness) to represent changes of information at streets junctions as we move, and correlate these to human brain activities. Interestingly, brains response to local and global measures at the same time but in different regions: the right posterior hippocampus appears to be sensitive to connectivity, while closeness centrality is indexed by activity in the anterior hippocampus. (ibid.) Shatu, Yigitcanlar, and Bunker (2019)'s survey showed the shortest metric and angular distance explained 34 percent and 46 percent of individual daily routines.

These approaches provide insights into the relationship between subjectivity and the environment. However, one may identify that at the level of cause-effect impact of certain discrete qualities of the environment on individual-level responses, or enumeration of individual-level preference, there are just too many variables both in the environment and ourselves. (e.g., even for the same person, under different circumstances, route preferences would be very different.)s

In-between local information with the configuration, several directions are explored. Isovist measures, as Montello (2007) theorised: can be the nexus between cognitive models of people's motion and Space Syntax abstract representations. Isovist path (Turner, 2003), developed upon Benedikts (1979)' "Minkowski" model in Depthmap, could be seen as a corresponding analysis method. Emo's (2009) study suggests another novel direction: where higher-dimensional visual information, including sky and floor area percentage, visual connectivity, longest length of sight are parameterised by 360-degree photograph of three routes in City of London and tested against global segment measures. Integration RN correlates best to these local visual measures (r2 between 0.186 to 0.591)(ibid.). This actually implies interesting convergence of complexity of local information (bottom-up, emergence) and the spatial network (top-down, deterministic). Recent studies illustrate advanced methods to quantify the local visual information, which might help this thinking to go further. For instance, Law et al. (2018, 2019) used convolutional neural network to classify street frontage images with results tested by house price and graph measures; the "impression" of pedestrian movement flow is quantified from pedestrians' angle (Araneda and Gatica, 2017). The technics to quantify more aspects of physical and social environmental, besides isovist measures, could be further linked with the configuration to link people cognitive in motion, in line with Montello (2007) 's argument. Linking subjective responses, Quercia et al. (2014) proposed the shortest paths weighted by people's reported perception of happy, quiet, and beautiful. Emo's (2012, 2014) research suggested up to two-third of individuals' route choices are explained by integration, and eye-tracking data showed that people look into the longest line of sight available in the images during the decision-making processes. These might suggest intelligibility might functions across dimensions in the real-world. In this line, however, besides physical information, what exactly inform the global to the local, or, if seeking for integration is a side-effect of seeking higher local graph measure (connectivity, length of sight) might be worth further exploring.

2.3 The Natural Movement by Axial Line and the Natural Movement of Agent

The more objective versus subjective perspectives in Space Syntax, especially regarding its initial axial model, has been on-going discussed. (Hillier and Iida, 2005; Penn, 2003). Natural Movement theory explains that configuration constrains the probability movement volume, prior to "attractor", design aesthetics or land-uses (Hillier et al., 1993). Empirically, configuration along measures 60 percent to 80 percent of variance in movement rate where land uses are relatively homogeneously distributed (Penn, 2003, p.36). However, regarding its origin in the Social Logic of Space (1984)[3], axial line just the simplest representation of the voids left by buildings' vertices (Griffiths, 2014) and was used to calculate centrality measures. As simple as this, our movement is seems to be within allowed error as the probability is practiced out.

Later studies revealed the axial line or configuration's cognitive importance more explicitly: as a line of sight, or a reduction that capture the structure of inhabited space (Penn, 2003; Dalton, 2001, 2005). These studies include: The topology is the minimum cognitive information required to guide one through an environment (Kuipers et al, 2003); Cognition depends partly on local information, partly on memory of areas of building already explored, and partly on the ability to project or develop hypothesis about those yet to be explored so that exploration could maximise new information (Penn 2003); participants choose the straightest path with fewer turns then retrace the routes chosen implying our reduction of complexity to perceive space (Dalton, 2001); Penn (2001) defined cognitive space, as the space which supports our understanding of configurations more extensive than our current visual field, relating the intelligibility of the environment with the subject performance in urban movement. Peponis, Zirming and Choi (1991) argues that, configuration is a concept that refer to both spatial pattern and spatial effect upon the pattern of its (potential/anticipated) usage: space generates a

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[3] Despite deterministic representations, idea of spatial configuration is richer and involves our active interaction with it: "Logical space is an imaginary, many dimensional space created by and fields with systems of signs, symbols and representations. It exists neither purely in our heads, nor in real space outside but constitutes the medium through which the relation between the two is made. Logical space creates spatial or architectural space as one of a number of perceptual realities it interprets" (Hillier and Leaman, 1973, p. 510). Configuration deliver social information spatially.

probabilistically predictable presence of other people (and possibly the activities and activities types), and we seek these as we move as well.

Turner (2005) put these as:

- The Hillier position: Axial lines corresponds to an underlying physical structure by which any movement is constrained.
- The Peponis position: Axial line corresponds to an underlying cognitive understanding of the space in the subject, so that movement is correlated on the grounds that it is the means by which the subject navigates the space.

Peponis position is partly based on Virtual Community concept (Hillier and Hanson, 1984): that space generates its own "community" based on mutual awareness of where interaction is likely to occur. As people know a layout as a relational pattern, they also build expectations of probabilities of encounter (ibid.). In wayfinding, "Spaces that are not simply more integrated but. are also more populated may appear more attractive to searchers simply because they offer more opportunities for asking for information and more reassurance that help is available should any problem arise." (Peponis, Zirming and Choi, 1991, p. 574). Thus we seem to anticipate particular "network effect" of configuration as well, whether social, economic, or physical, in a locally perceivable domain.

Besides Isovist path (Turner, 2003), another methodology combining the local with the global in Space Syntax could be its agent-based analysis (Penn and Turner, 2001). It can use Visibility Graph as possible representation of external global environmental affordances, together with local rules. As Turner suggests, different from natural movement by axial graph, in agent-based analysis, we go by available affordances of objects within it based on natural vision (Gibson, 1979), and there is no abstract constraint, it depends on our position at present as we move.

"When no constraints are put on the visual system, we look around, walk up to something interesting and move around it so as to see if from all sides, and go from one vista to another. That is natural vision." (ibid., p. 1)

Practically various VGA (Turner et al., 2001) metrics could be calculated as global "affordances" then agents starts navigations in Depthmap agent based analysis (Penn and Turner, 2001; Koutsolampros and Varoudis, 2017). Although previous results show better performance only by local rule in a building's setting (Penn and Turner, 2002), this might be worth testing in other scenarios like in (organic) cities. Here network properties are used as directly perceivable by moving agent, intuitively, quite similar to how the "knowability" functions as we move in real world, if there is any.

2.4 How the Others Informs Our Spatial Decision-making

Decision making as an interactive and collaborative process has been extensively researched in fields such as in social science and policy making (Dalton, Holscher and Montello, 2019). For instance, Carpo (2011) discussed how participatory web opens possibilities for "wisdom in crowds" (Galton, 1907) at the expense of one authorship of, say, the architects. Yet spatial aspect of this collective decision-making is under-researched, as theorised by Dalton, Holscher and Montello (2019), that wayfinding is an cognitive activity both involve our interaction with the physical as well as the social environment. Concretely, recent study in social wayfinding proved that pedestrian navigation can be influenced by many environmental and social factors, e.g. decision of other group members, crowdedness, and their dependence on the spatial structure (Barišić et al., 2017; Li et al., 2019). For instance, in a wayfinding experiment in a station, a significant main effect of environmental structure (with/without market stalls) was shown on task efficiency, with an inconclusive interaction between environmental structure and group membership (on individual basis versus group of four) on task efficiency. Like in car navigation, dyads in pedestrian navigation tend to collaborate (Romanescu, Barisic and Holscher, 2018), and a naturally emerged role relationship in the process result in better performances (than as assigned follower and leader) (ibid).

On the other hand, while human relatedness constitutes intrinsic parts of environmental information[4], without configuration, social information by itself is probably quite local. Many previous studies within Space Syntax implies, without explicit focus though, that the social and physical aspects of the environment help us make sense of both these two factors. Adding local/social information on the graph structure can enhance its ability to predict human spatial behaviour, or even vice versa.

For instance, study showed that presence of other people was one of the cues followed by subjects in the navigation through a building (Beaumont et al., 1984). Evans et al. (1982)

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[4] The author discussed this argument with examples in more detail within an essay (Feng, 2019).

reported the effect of denser use upon the identification of buildings as landmarks in the urban context. People's presence are attractors in navigation tasks (Emo, 2012). Lu et al. (2009) shows nurse movement and activities in ICU turned towards patient beds more and targeted visibility analysis weighted towards the beds showed better correlation with movement, given the intensive social interrelatedness between nurses and ICU patients. Video games show in an immersed angle how other NPCs interaction with the player, which includes lead the player through spaces, acts against them and other variations (Koutsolampros and Varoudis, 2017), helps us complete navigation tasks. Turner (2005) suggested, our spatial learning may only requires to see the others. "It is the movement of other agents that gives the clues as to how the geometry of the city is laid out, to where one can go" (ibid., p.62)

Linking back to spatial configuration, the concept of "People – space cue" is recently theorised and thus provided more explicit framework for further research (Dalton, Holscher and Montello, 2019). Analogously, Sailer (2010)'s concept of Configuration in Usage implied a dynamic and interactive angle between the user (i.e. organisation and groups) and the configuration: that new information from the environment arises from their mutual interaction. Noteworthy, the research discussed above does not contradict with Natural Movement theory (Hillier et. al., 1993) in that configuration of physical environment can be the fundamental variable by which layers of representations could be added onto, and Virtual Community (Hillier and Hanson, 1984) concept, where configuration also provides a probability basis for social affordances.

2.5 Summary

Literature suggests as we navigate, we make linkage of the available information with probabilities afforded by the underlying network structure; as the others in the environment impact our spatial-decision making, they act as part of the cues that network informs us. Space Syntax's concept of Virtual Community might provide linkage between the social and the physical by its configurational representation in social wayfinding field.

Chapter 3 | Methodology

Given the extensive research interest, methods need to turn the ability of "knowing" into something more tangible that could be further compared. Referring to previous study (Emo, 2012), participates route choice is used as its quantifiable output.

Concretely, the aim is to test if we can sense, even simply by a quick glance of the environment, the global network properties of our city, and, by controlling certain variables caused by moving subjects within, if our ability to know is interfered. As two environmental factors are involved: Configuration and Movement, this study conducted a comparison test, with these two factors as independent variables, and participates choices as dependent variable. Space Syntax's axial and segment analysis of street network provides syntactic values to be tested against the subjective responses.

To cohere with the research question, following steps are involved in method design:

i. Selection of streets as choice-pairs in a way to makes it possible to test the impact of configuration beyond immediate local condition;
ii. Controlling the second variable considering the first one: assigning moving objects to streets and set test to represent route choices in real-world situations;
iii. Arrange and present choice-pairs, allowing more responses from participates within limited time scope;
iv. Analysing responses based on test design

Detailed operations are presented next.

3.1 Generating Choice Pairs

To generate a sample pool of route choice-pairs, following criteria are identified, in line with research aim:

- It requires pairs of intersecting streets with comparable axial connectivity value

  This is to delete main impact of local spatial factors and let global ones (to be main configurational variable) to be tested, and,

- Difference of global integration values of intersecting streets in choice-pairs should not be too minor

  Otherwise, the degree of network effect might be also very similar in a local viewpoint, then a much larger sampling of cases and participants may be required to see any tendency, and,

- Ideally these intersections should not be too far away from each other, to make a context for path choice.

Two areas are chosen accordingly with potential choice pairs[5]: one around Soho and one within City of London (CoL).

3.1.1 Choice Pairs around Soho

For street choice-pairs around Soho (Set 1 in this study) area, axial connectivity values are more strictly controlled. Under this circumstances, to avoid too scattered, limited choices, the difference of integration values of intersecting streets might not be as apparent as set 2.

Specific thresholds (Set 1) used are[6]:

i. IntHH R20 Difference/ IntHH R20 Average > 6% , and,

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[5] The process used Axial Analysis Component (Varoudis, 2019, modified by author) in Grasshopper. Analysis used syntactic values 25 km London model to reduce edge effect.

[6] Please see Appendix A for discussion on the thresholds and why not set connectivity values the same.

ii. Connectivity Difference/Connectivity Average < 0.3, and,

iii. Connectivity of street A and B >2

Possible combination of connectivity values of intersecting streets are: 3 with 3-4; 4 with 3-5; 5 with 4-6; 6 with 5 – 8; 7 with 6-9, and etc. (Figure 3-1). Figure 3-2 shows the process to visualise qualified street intersections given above mentioned thresholds.

Possible Combinations of Connectivity Values in Choice Pairs																					
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2																					
3	1	1																			
4	1	1	1																		
5		1	1	1																	
6			1	1	1	1															
7				1	1	1	1														
8				1	1	1	1	1													
9					1	1	1	1	1	1											
10						1	1	1	1	1	1										
11							1	1	1	1	1	1									
12							1	1	1	1	1	1	1	1							
13								1	1	1	1	1	1	1	1						
14									1	1	1	1	1	1	1	1					
15										1	1	1	1	1	1	1	1	1			
16										1	1	1	1	1	1	1	1	1	1		
17											1	1	1	1	1	1	1	1	1	1	
18												1	1	1	1	1	1	1	1	1	1
19													1	1	1	1	1	1	1	1	1
20													1	1	1	1	1	1	1	1	1
21														1	1	1	1	1	1	1	1
22															1	1	1	1	1	1	1
23																1	1	1	1	1	1

Figure 3-1. Possible Connectivity Values in Pairs (with value 1) in Set 1

The final selection of intersections is based on closer proximity, variation of connectivity values, and further check with Google map and site visit. Figure 3-3 shows intersections with axial maps (25 km) in Space Syntax colour range.

Figure 3-2 Choice-pair selection process

Left: all axial lines (without values); Right: Streets that intersect & with above controlled connectivity and integration values are left, red dots are selected Choice-pairs

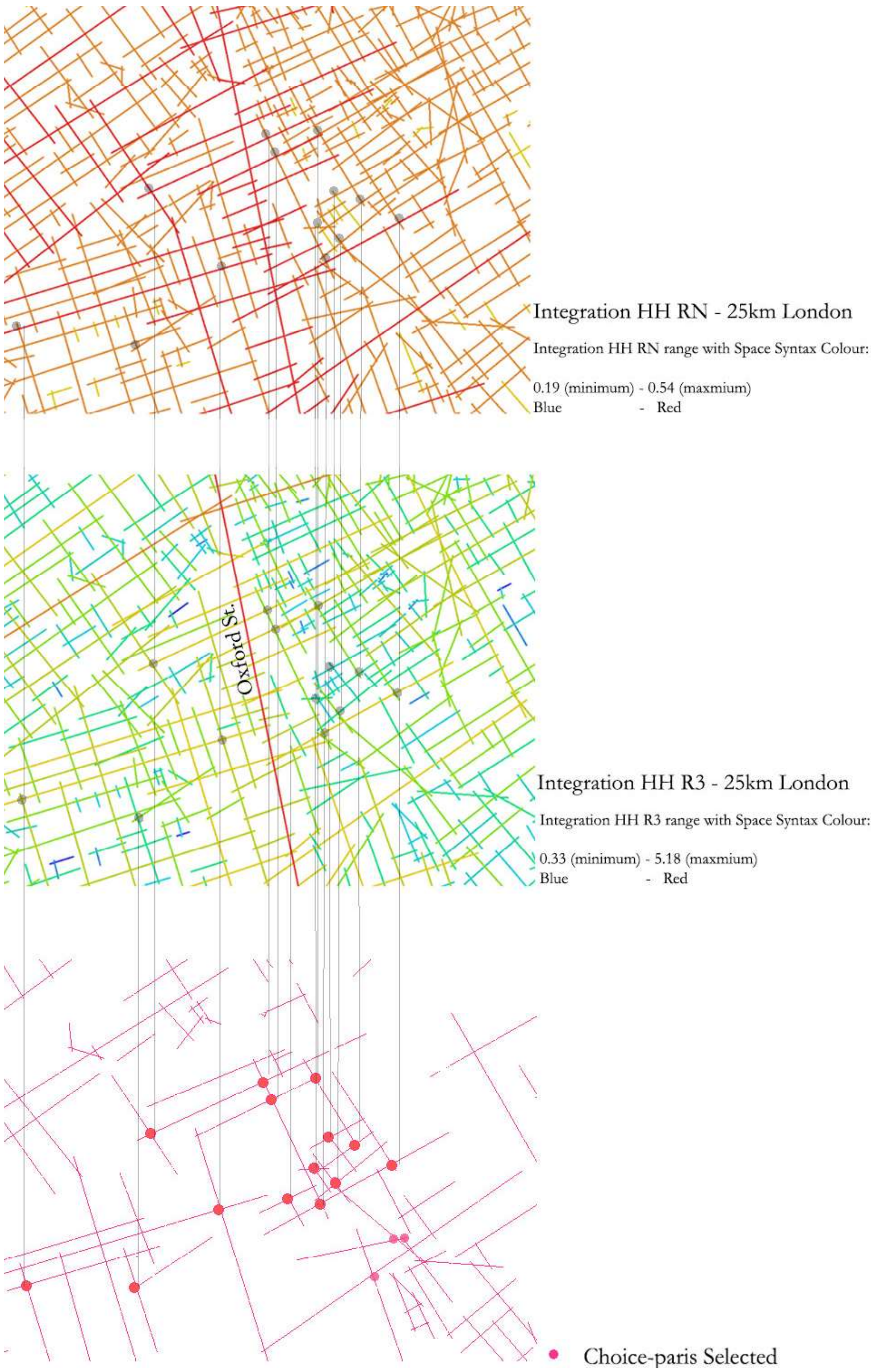


Figure 3-3 Choice-pairs of Set 1 with Space Syntax maps

3.1.2 Choice Pairs within CoL

In City of London, connectivity values are more loosely controlled, to allow higher difference in global integration. Extreme conditions are eliminated, which would result in bias in data: e.g., an alleyway with connectivity value of 3 or 4 connecting a major street like Leadenhall St.

Thresholds (Set 2) used here:

i. IntHH R20 Difference/ IntHH R20 Average > 7.5% , and,
ii. Connectivity Difference/Connectivity Average < 0.7, and,
iii. Connectivity of Street A and B >2

Final selection is based on proximity, variation of connectivity values, and further check with Google map and site visit, which gives a tendency towards certain areas. The chosen area, around Leadenhall St. in CoL shows different layout and context, generally, with Soho. These streets are just beside/starting from/facing several quite noticeable landmarks (i.e. the Gerkins, Leadenhall building). Initially this was thought as a drawback, yet it does not contradict with the aim of testing the influence of environmental information in purely physical environment versus that of moving subject (landmarks are just part of physical environment).

After several testing, this is considered as practical and comparable regarding local network property, to test the more "visual and sensible" aspects of local-to-global relationship in Space Syntax. These thresholds and issue of landmark in this study is only one practical solution, due to time scope and other practical reasons.

Figure 3-5 shows the intersection selection results and their locations, and axial and segment map in Space Syntax Colour Range in area within City of London (For practical reasons, some choice pairs also obey to Set 1 thresholds).

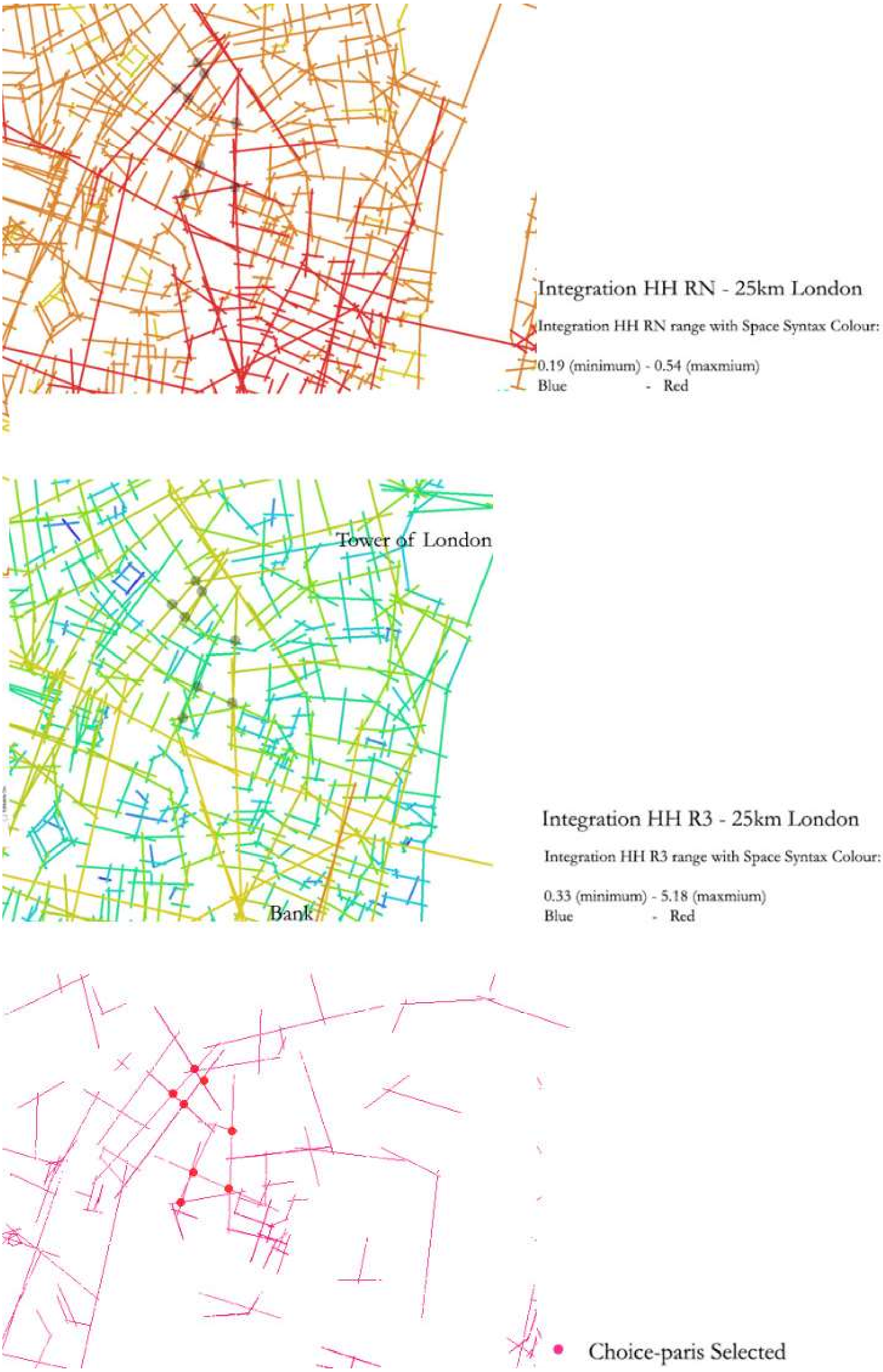


Figure 3-4. Choice-Pairs in City of London

3.1.3 Samples

The chosen intersecting streets as pairs are eliminated if:

- Mismatch occurs between axial map and site visits including changes
- Including construction facilities that disturb visual information too much
- Street segments towards dead/very short end where no people are going

When turning real street intersection into choice pairs:

- X shape intersection results in 4 choice-pairs at the junction by axial
- T shape results in 2 choice-pairs by axial
- V shape as 1 choice-pair

As would be explained next, choice-pairs that has not good photos due to any practical reasons (i.e. error from angle of lengths, weather, the location of photo taking changes too much, too much traffic that hinders photo taking, light, etc.) are eliminated in the final analysis. In total the above process gives 53 final choice pairs[7].

---

[7] Please see appendix B for the streets' names, syntactic values and more images.

3.2 Setting Wayfinding Test

3.2.1 Assigning Movement Conditions to Photos

This study uses photos taken at eye-level in three conditions of streets as representations of real-world scenarios. This method is largely based on precedent studies (Emo, 2009, 2012) where photos are taken at street intersections and let participants choose between two choices each time. Photo taking direction is considered to maintain similar sight length as the axial representation, and are taken approximately at where axial lines intersect when possible (because the selection and analysis are largely based it). Camera settings are compared and remained consistent. Photos are taken in mornings, weekend afternoons, and weekday mid-day to commute time in overcast days by the author in July.

To test the two variables: configuration and moving subjects, photos of choice pairs are prepared to create three scenarios: *EMPTY, OBEY*, and *CONFUSE* (Figure 3-5. a, b, c):

- *EMPTY*: Empty Streets[8]
- *OBEY*: Assigning streets with people and traffic. Impression of the volume of these obey Integration HH RN and R3 order in each pair. Thus the two focal variables agree with each other.
- *CONFUSE*: Assigning streets with people and traffic, and general volume of moving subjects takes the reversed order of Integration HH RN and R3 in each pair to use movement to "confuse" people.

Figure 3-5 a. A choice pair - *EMPTY* condition

[8] As empty as possible. When no moving subjects (moving cars) are identifiable, the street is considered empty.

Figure 3-5 b. A choice pair - *OBEY* condition

Figure 3-5 c. A choice pair - *CONFUSE* condition

As the 53 choice pairs has 3 conditions this result in 53 * 3 = 159 "questions" in this study.

3.2.2 The Questionnaire

3.2.2.1 Distributing Questions

Because testing the effect of moving subjects is of interest, participates should not know beforehand, or anticipate this aim as much as possible when conducting the test.

Considering the information available now:

i. Prepared images of streets are paired to represent what one can see at an intersection, and facing two choices each time to go one direction or another.
ii. Each participant should not see one choice pair more than once and each street as well to avoid them going back and forth and interfering their choices.
iii. In total there are 159 questions, and each choice-pair appears 3 times.
iv. As for X shape crossings, each street under 1 condition would appear twice. Similar are T shape crossings.

This study uses two groups of participates (demographic controlled by being current UCL student in Student Centre) * three conditions = six question-sets to avoid the influence of the above factors. Group A will evaluate 27 intersections, and Group B will evaluate 26 intersections. The aim is to ensure each participates only see one time and one condition of a street. Analysis is correspondent to this specific setting, and will be discussed later.

Also, three conditions are mixed in the three subsets of each group, and the streets and conditions are reordered to avoid repetitive pattern or anticipation from participates.

Figure 3-7 shows a diagram of distributing the questions.

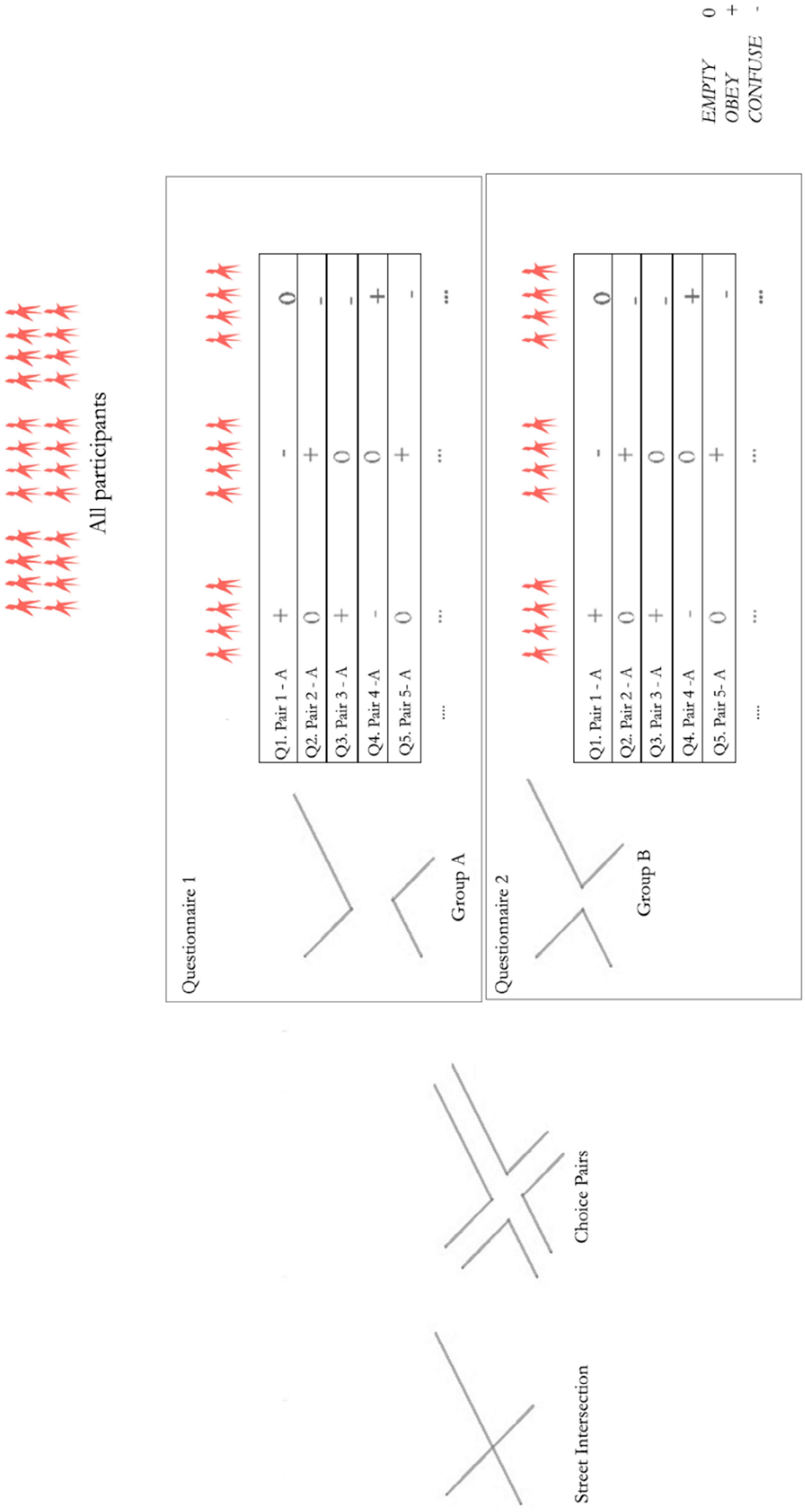


Figure 3-6. Diagram showing assignment of questions

3.3.2 Task instruction

To underlie the meaning towards higher integration, which might relate to local/global centres, and choice, which might relate to the quicker/better way to go to the centres, question asked in this study is:

Imagine you get lost. To find main streets and more central areas, which way would you go?

The below image shows the question setting and instruction in Google Form format.

*Required

You stand at street intersections, and choose which way to go when you are in a situation of being lost, and could not use your phone/maps etc. All information you have is just what you see. The task is to find main streets, central areas, or, i.e. a tube station - just what you would do to avoid being more lost.

There are three subsets of streets: set 0, set 1, set2. Please just choose one of them to finish. *

- ○ 0
- ○ 1
- ◉ 2

Figure 3-7. Instruction page of the questionnaire

Imagine you get lost. To find main streets and central areas, which way would you go?

*Required

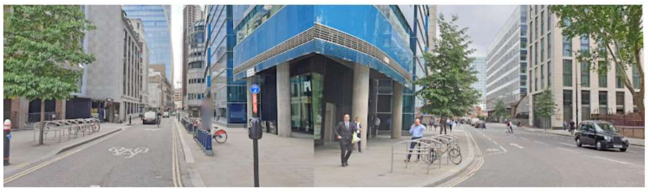
*

- ○ Left
- ○ Right

Figure 3-8. Questions with the task

*Required

*



Left

Right

*Required

*

Left

Right

*Required

*

Left

Right

*Required

*

Left

Right

Figure 3-9a. Example pages illustrating the questionnaires' format

Figure 3-9b. Example pages illustrating the questionnaires' format

Participants were UCL students in Student Centre using computers there or their lab-tops in July 26 -30, 2019. After getting their consents, each student is given the linkage to the Google Forms, and told to zoom full on their computer to do the survey. There are 234 participates in total (105 in Group A and 129 in Group B).

In the end participates are asked to describe how they think they made these choices, gender, and familiarity of the places.

3.3 Statistical Analysis

Statistical analysis uses either streets or choice pairs as units of analysis, as each street/intersection is evaluated under three conditions from participates which gives an average for each of them.

Raw results from the questionnaire as overviewed as follows:

- Sample size of wayfinding decisions = 53 (Intersections) * 3 (Condition) = 159.
- Total number of choices = Group A 26 intersections * 105 times evaluated + Group B 27 intersections * 129 times evaluated = 6213 decisions.
- Each condition has 6213/3 = 2071 decisions

Main analysis includes t-tests and repeated measures ANOVA to compare Means of results, separated into *EMPTY, OBEY,* and *CONFUSE* conditions. Pearson Correlation tests the overall impact of syntactic values in these three condition of all streets. These are discussed in accordance with research questions in the next Chapter.

Chapter 4 | Analysis and Results

In this chapter, research questions and methods are sorted into precise hypothesises that could be tested. Results are provided after a descriptive statistic of streets' syntactic values. In accordance with two major environmental factors discussed previously, the analysis uses these measures mainly:

- *CHOICE TOWARDS INTEGRATION*
- *CHOICE TOWARDS MOVEMENT*

The third main measure is *STREET'S WIN*. They will be explained later.

4.1 Analysis Overview

This part synthesizes analysis with detailed hypothesises.

4.1.1 Interest I: Global Network Information in Physical Built-environment

Associated Question	How global configuration attributes impact wayfinding? To what extent people get to know the global properties of spatial network by its physical appearance locally?
Test Condition	*EMPTY*
• Hypothesis **H1**	Although connectivity is controlled to a comparable range, people's choices can still follow global network value by information available in the empty streets.
Analysis	Compare Means of "*CHOICE TOWARDS INTEGRATION*" (measured by people's percentage of choice towards more integrate streets in all choices)
Statistics	T-test.

	"*CHOICE TOWARDS INTEGRATION*" in all decisions under *EMPTY* Condition conditions are tested againist a 0.5 probability (random).
Unit of Analysis	Choice pair (n=53).
Explanation	If the null hypothesis is failed to be rejected, the "more remote" network properties cannot reach locally enough by its effect on physical built-form, then we cannot sense that, which might indicate in wayfinding we relies on local spatial properties more (i.e. line of sight, connectivity, etc.)

- Hypothesis **H2** — If a street is has higher global syntactic values compared with all other streets, it is more likely to be chosen. That street's percentage of wins correlate positively with its syntactic values.

Analysis	Correlation between "*STREET'S WIN*" with its syntactic value.[9] "STREET'S WIN" means the percentage of times this street being chosen when it shows up as a choice.
Statistics	Pearson Correlation.
Unit of analysis	Street (n=106)

[9] In a choice pair,

"*STREET'S WIN*" of more integrated street = "*CHOICE TOWARDS INTEGRATION*";

"*STREET'S WIN*" of less integrated streets = 1 - "*CHOICE TOWARDS INTEGRATION*".

They are the same measure, when unit of analysis shift from choice pairs to streets.

Explanation	This might be interpreted as, if we are quite sure that a street is very central/towards that, the less need for us to refer the other choice and make comparison.

4.1.2 Interest II: the Effect of Movement of the Others on People's Sensing of Network Properties

Associated Questions	How the two factors: spatial configuration, and movement it associated informs our wayfinding? Does it re-inforce the previous results? How we only refer to Movement when we find our ways? To what extent moving subjects makes the built-form knowable to us or not: what happens when these two factors agree with (this could be similar to nature conditions in our daily experiences) & disagree with each other?
Test Condition	*EMPTY, OBEY, CONFUSE*
• Hypothesis **H3**	In *OBEY* condition, agreement between movement and integration will enhance participates' performance in "*CHOICE TOWARDS INTEGRATION*". In *CONFUSE* condition participants' performance would be inhibited.
Analysis	Test if Movement volume make significant difference on the Means
Statistics	Repeated Measures ANOVA (& Paired Sample T-test) "*CHOICE TOWARDS INTEGRATION*" in *OBEY* and *CONFUSE* condition are tested againist *EMPTY* Condition. Conditions are used as within-subject variables

Unit of Analysis	Choice pair (n=53).
Explanation	If physical environment offers rather close or blur cues, presence of the others people help us know what the places are about and how they are used, that brings network information closer to us. This relates closely to people – place/space cue (Dalton et. al, 2019)

- Hypothesis **H4** — If movement help makes the network properties more sensable, we might expect that the correlation between *STREET'S WIN* and its syntactic value would be slightly enhanced in *OBEY* condition, and inhabited in *CONFUSE* condition, in comparison with *EMPTY*.

Analysis	Pearson Correlation
Unit of analysis	Street (n=106)
Explanation	Ibid. (Similar to previous section.)

- Hypothesis **H5** — People's "*CHOICE TOWARDS MOVEMENT*[10]" will be significantly impacted by the factor of syntactic value. That obeying integration helps us choose streets with more movement.

---

[10] Again, the results received has two factors controlled for: 1. Integration 2. Movement
In *CONFUSE* condition, as these two are mismatched, the condition of choosing integration AND choosing higher movement volume at the same time cannot exist.
So in *CONFUSE* condition, "*CHOICE TOWARDS MOVEMENT*" = 1 - "*CHOICE TOWARDS INTEGRATION*"
In *OBEY* condition, "*CHOICE TOWARDS MOVEMENT*" = "*CHOICE TOWARDS INTEGRATION*"

Analysis	Test if Assigning of Integration make significant difference on the Mean of "*CHOICE TOWARDS MOVEMENT*"
Statistics	T-tests. "*CHOICE TOWARDS MOVEMENT*" in *OBEY* condition is tested with *CONFUSE* condition; "*CHOICE TOWARDS MOVEMENT*" in Confuse condition is tested againist a 0.5 chance.
Explanation	In daily situations of a street, we would suspect that if the physical form and movement we see do not seem naturally logical to us (that more integrated street has more people, traffic, etc.), we would fail to trust the crowd. In this sense physical environment helps make the crowd sensable as well.

To test gender and familiarity's impact, gender (*2) and degree of familiarity (*3) are tested with 3 conditions respectively using two-way repeated measures ANOVA. Degrees of familiarity are categorised as *Low*, *Medium* and *High* based on questionnaire.

To capture more aspects, participants are asked to give descriptions of their thinking process when seeing the images, which are separated into words and their frequency distributions are analysed[11]. Then words are categorised manually into groups of:

- "Physical Environment", "Social Environment", "Either" (may belong to physical/social). These rely more on external environmental information directly;
- "Perceptual", including familiarity, experience, feeling of safety, etc. or when seeking certain feeling becomes more important.

These categories are loosely defined with inevitable intersection. For instance, the word "distance" is most directly an attribute from physical environment, but regarding how we perceive and interpret this, it might be well impacted by the social environment: we might see a boring, straight, and empty street as a bit longer, compared to more lively, interesting ones, and

[11] In *quanteda* (Benoit et al. 2018; R Development Core Team 2018).

we perceptually "prefer" certain combination of these objective factors (i.e. D'Acci, 2019). Typical responses in sentences are presented as complementary.

4.2 Descriptive Statistics

Descriptive account of streets' syntactic values in all choice pairs are shown here before they are associated with participates responses. Axial measures includes:

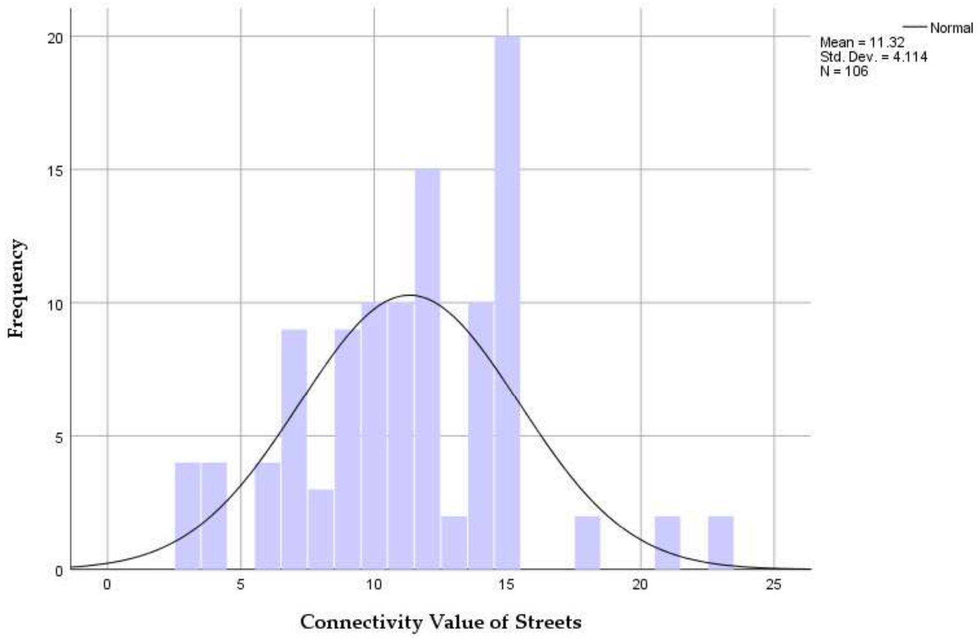
- Connectivity, forward- facing connectivity, Axial Line Length, Integration-HH-RN, Integration-HH-R3, Choice-RN, Choice-R3.

Segment measures[12] include:

- Segment line length, Angular-Segment-Integration-RN, R800; Angular-Segment-Choice-R9800, R800.

, representing attributes of the immediately upcoming street.

[12] Measured by "angular depth with metric radius" in DepthmapX 0.7.0 with T1024. Angular-segment-integration = $(\text{Node Count})^2/(\text{Total Depth})$.



	N	Minimum	Maximum	Mean	Std. Deviation
Connectivity	106	3	23	11.32	4.114

Figure 4-1. Connectivity Value Distribution

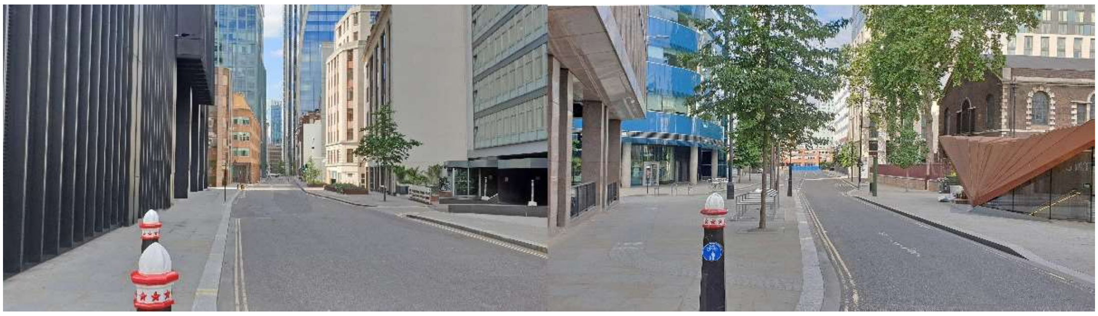
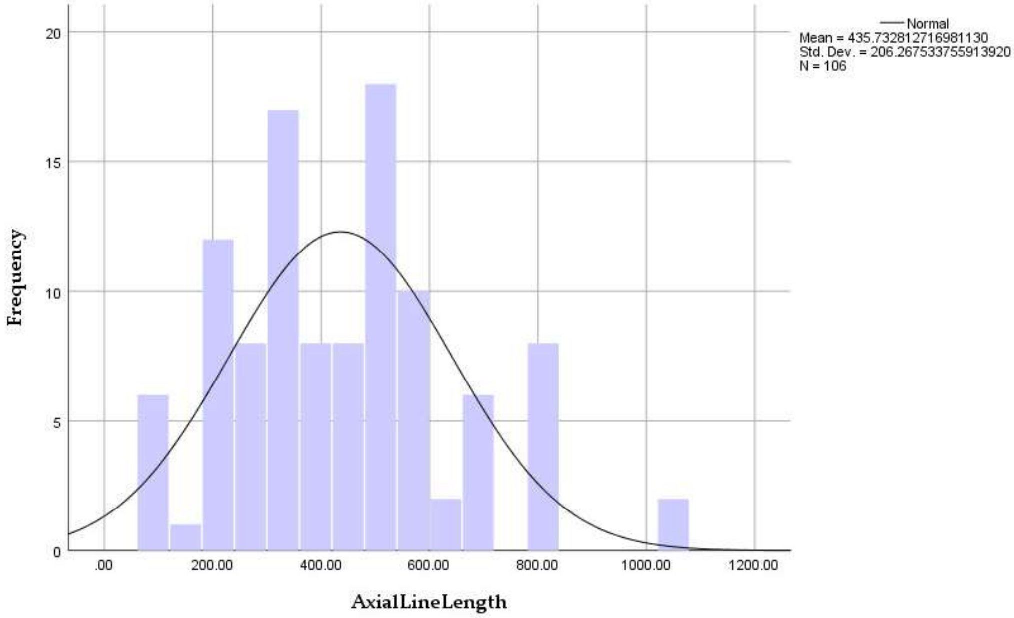


Figure 4-2 Example of Choice Pair with highest relative difference in Connectivity[13]

Connectivity values ranges from 3 – 23. In all pairs, the largest relative difference of Connectivity (Difference/Mean) happens between the connectivity value of 9 and 15 (Figure 4-2), which belongs to loosely controlled Set in City of London.

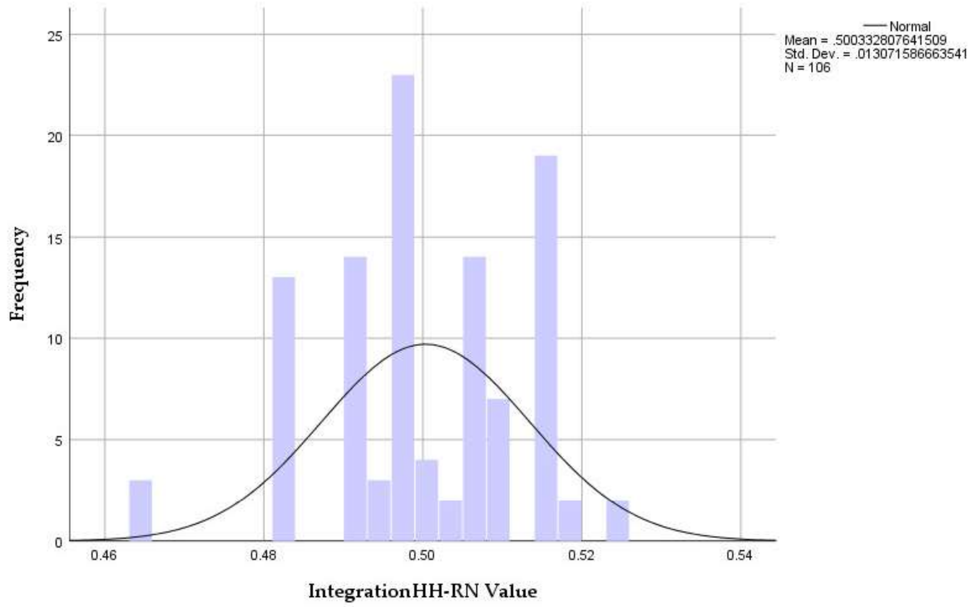
[13] As streets in T and X shape intersections are cut to form choice pairs, standing point of Choice pair is not equal to that of intersecting axial lines.

Following figures show that axial integration, connectivity and line length measures follows a pattern similar to normal distribution, yet Choice values are very skewed (Figure 4-6). Log10 (Choice) is used for further correlations (e.g. figure 4-8).



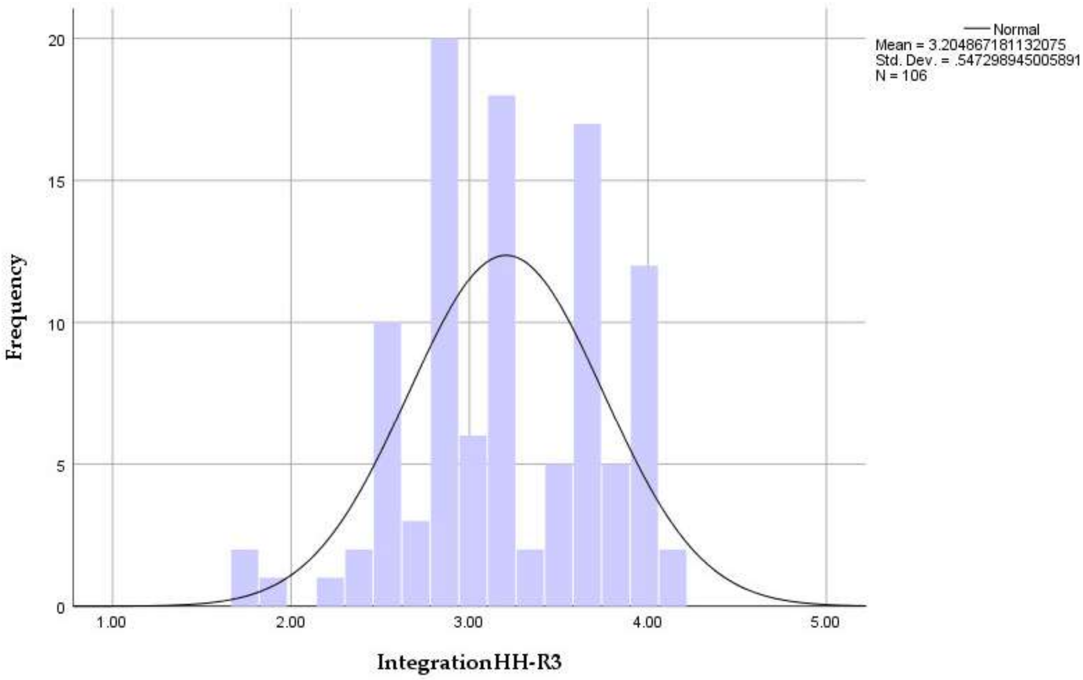
	N	Minimum	Maximum	Mean	Std. Deviation
Axial Line Length	106	99.115509	1032.332	435.732812	206.267533

Figure 4-3. Axial Line Length Distributions



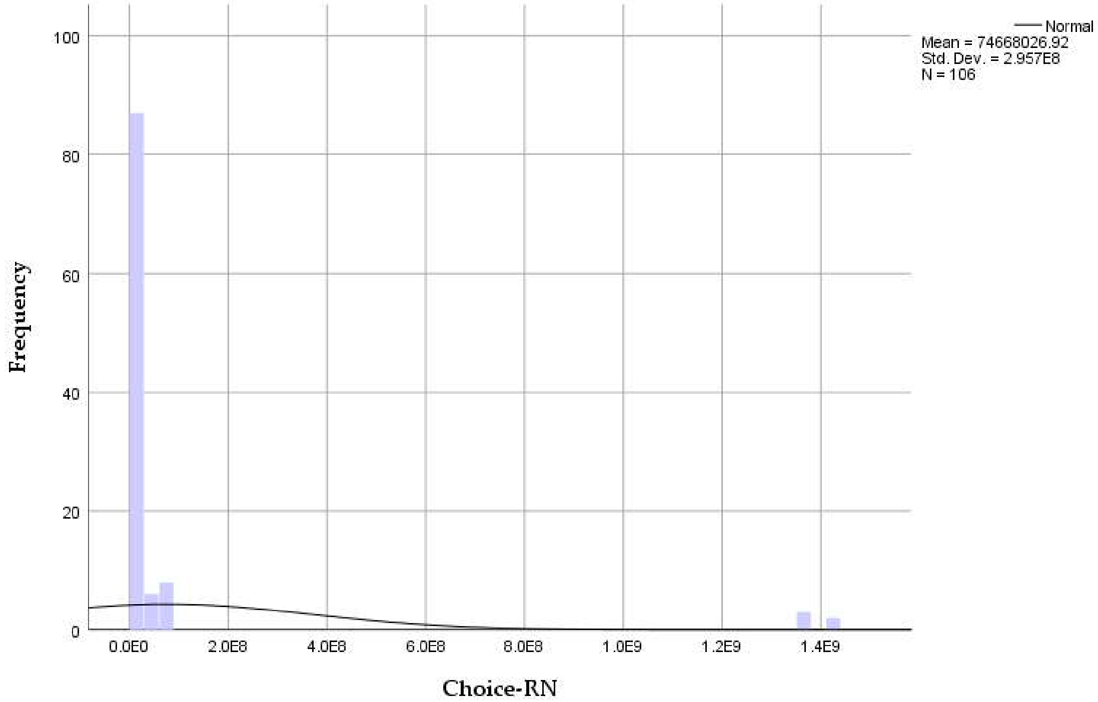
	N	Minimum	Maximum	Mean	Std. Deviation
Integration-RN	106	0.465207	0.525657	0.500332	0.013071

Figure 4-4. Integration-HH RN Value Distribution



	N	Minimum	Maximum	Mean	Std. Deviation
IntegrationHHR3	106	1.719577	4.165143	3.204867	0.547299

Figure 4-5. Integration R3 Value Distribution



	N	Minimum	Maximum	Mean	Std. Deviation
Choice-RN	106	8	1430000000	74668026.92	295697584.554

Figure 4-6. Choice RN Value Distribution

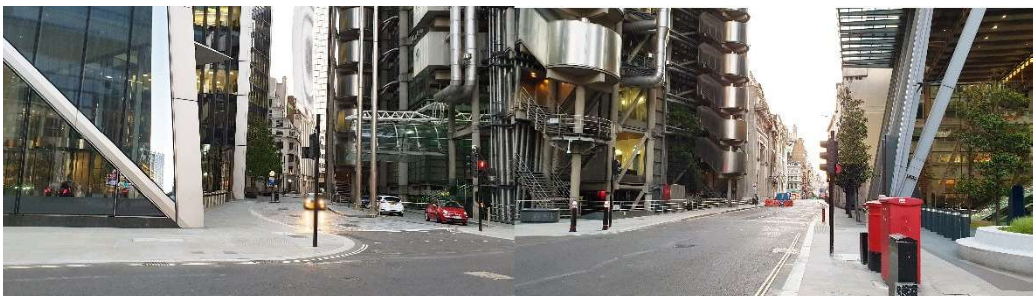


Figure 4-7. Leadenhall St. (Towards Bank, right side)

Please note some extreme conditions of choice value (Figure 4-7). This is associated with higher allowance of difference in connectivity in the selection process. Later these parts are separated to see its effect.

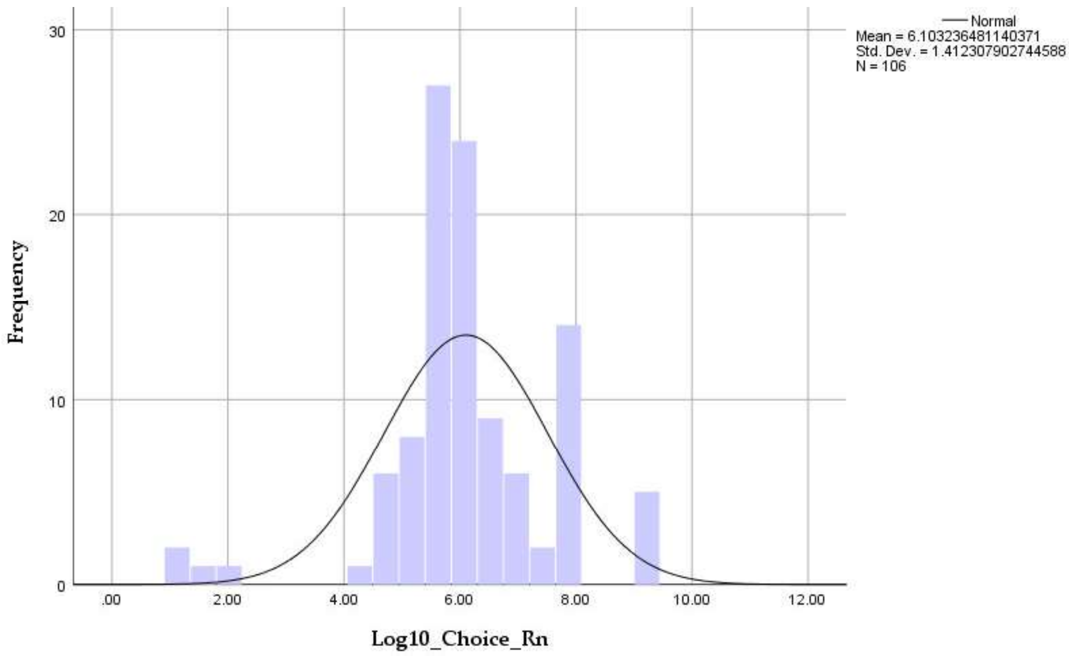
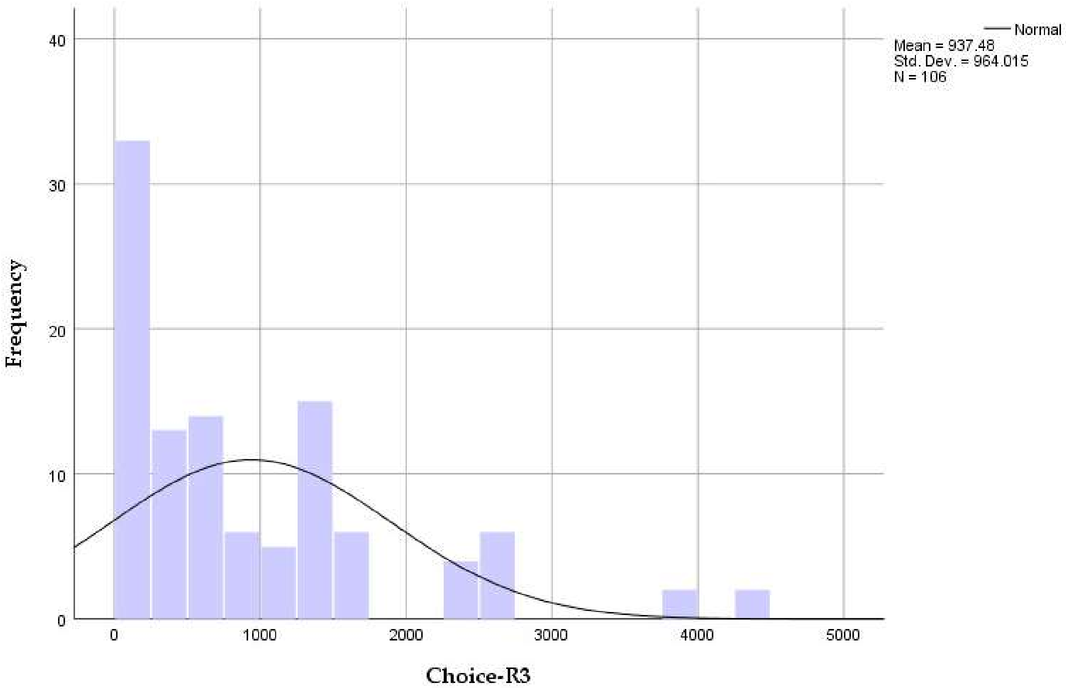
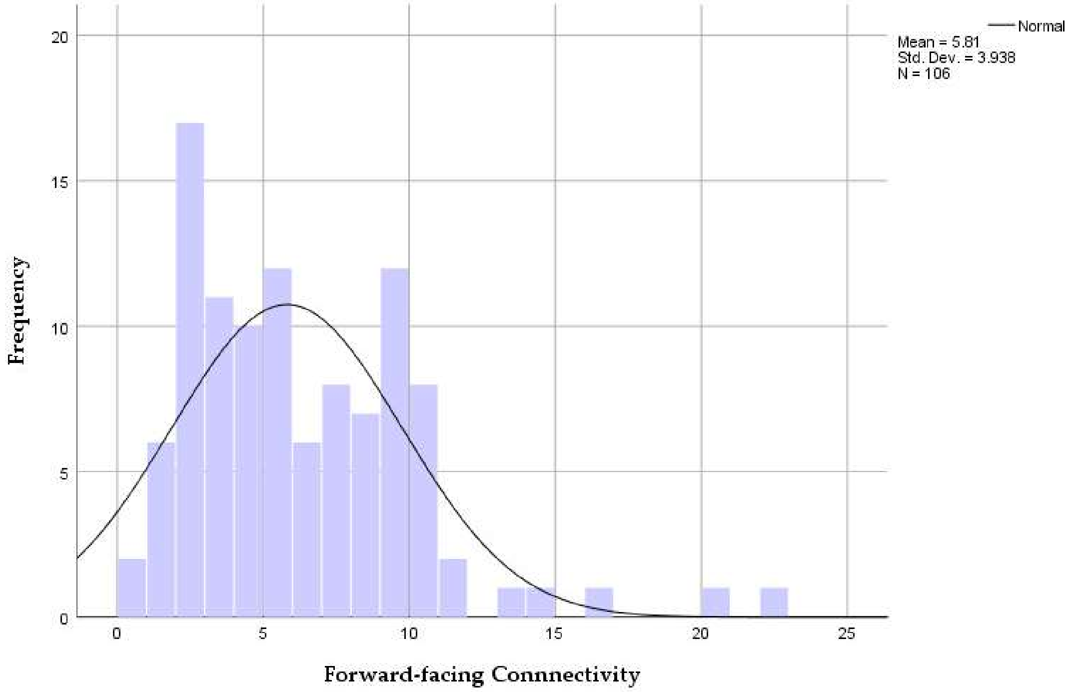


Figure 4-8 Log10 (Choice RN) Histogram



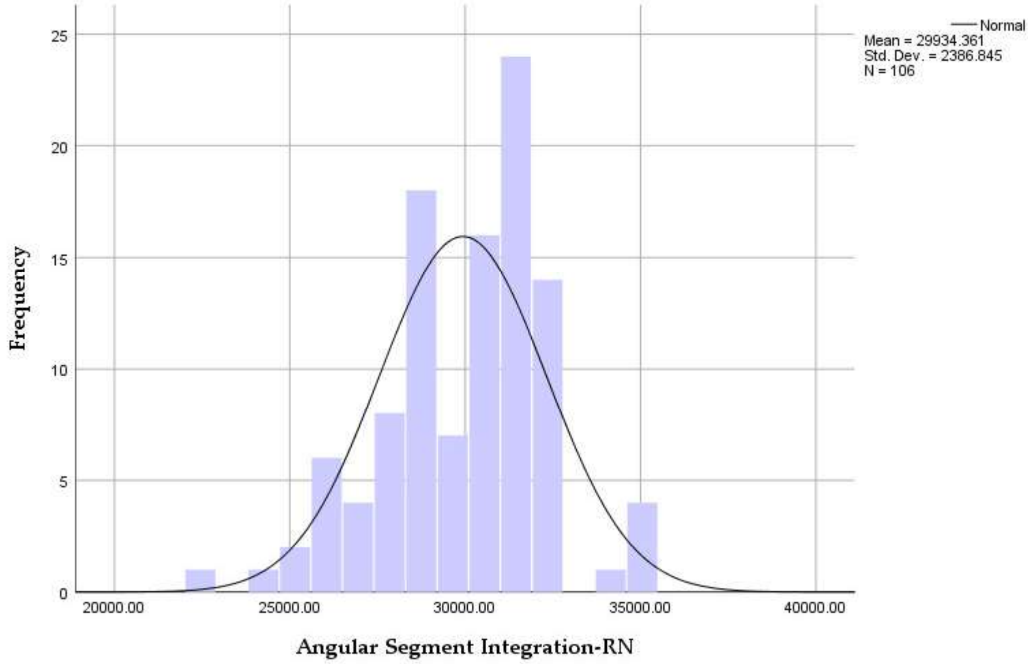
	N	Minimum	Maximum	Mean	Std. Deviation
Choice-R3	106	4	4325	937.48	964.015

Figure 4-9 Choice R3 Value Distribution



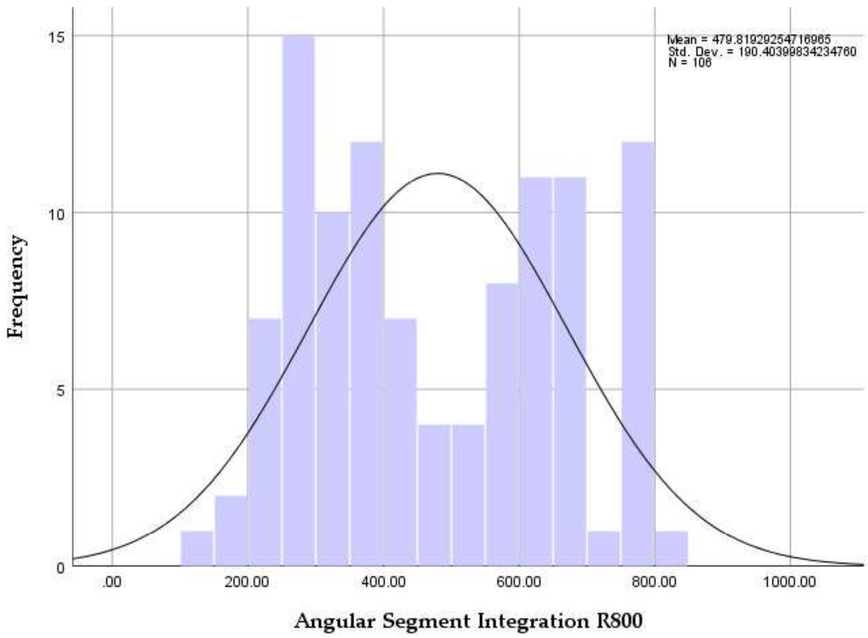
	N	Minimum	Maximum	Mean	Std. Deviation
Forward-facing Connectivity	106	0	22	5.81	3.938

Figure 4-10 (Axial) Forward-facing Connectivity Distribution



	N	Minimum	Maximum	Mean	Std. Deviation
Angular Segment Integration-RN	106	22279.711	35345.641	29934.36053	2386.844633

Figure 4-11 Angular Segment Integration RN value Distribution



	N	Minimum	Maximum	Mean	Std. Deviation
Angular Segment Integration R800	53	139.95485	824.28235	508.572389	212.389618

Figure 4-12 Angular Segment Integration R800 value Distribution

		Connectivity	Integration-HH-RN	Integration HH-R3	Choice-RN	ChoiceR3	Axial Line Length	Forward Facing Connectivity	Angular Segment Integration RN	Angular Segment Integration R800	Angular Segment Choice R9800	Angular Segment Choice R800	Segment Length
Connectivity	Pearson Correlation r	1	.691**	.750**	.310**	.787**	.761**	.630**	.556**	.475**	.152	.502**	.121
	Sig. (2-tailed)		.000	.000	.001	.000	.000	.000	.000	.000	.121	.000	.217
Integration-HH-RN	Pearson Correlation r		1	.920**	.353**	.760**	.624**	.500**	.684**	.388**	.251**	.398**	.174
	Sig. (2-tailed)			.000	.000	.000	.000	.000	.000	.000	.009	.000	.075
Integration-HH-R3	Pearson Correlation r			1	.223*	.829**	.800**	.487**	.659**	.328**	.204*	.325**	.253**
	Sig. (2-tailed)				.022	.000	.000	.000	.000	.001	.036	.001	.009
Choice-RN	Pearson Correlation r				1	.321**	.135	.365**	.336**	.294**	.515**	.323**	.007
	Sig. (2-tailed)					.001	.167	.000	.000	.002	.000	.001	.945
Choice-R3	Pearson Correlation r					1	.822**	.578**	.494**	.215*	.194*	.241*	.199*
	Sig. (2-tailed)						.000	.000	.000	.027	.047	.013	.041
Axial Line Length	Pearson Correlation r						1	.455**	.372**	.058	.099	.074	.255**
	Sig. (2-tailed)							.000	.000	.554	.313	.452	.008
Forward Facing Connectivity	Pearson Correlation r							1	.395**	.314**	.203*	.396**	.138
	Sig. (2-tailed)								.000	.001	.036	.000	.158
Angular Segment Integration RN	Pearson Correlation r								1	.705**	.499**	.634**	.116
	Sig. (2-tailed)									.000	.000	.000	.237
Angular Segment Integration R800	Pearson Correlation r									1	.219*	.840**	-.055
	Sig. (2-tailed)										.024	.000	.574
Angular Segment Choice R9800	Pearson Correlation r										1	.284**	.039
	Sig. (2-tailed)											.003	.692
Angular Segment Choice R800	Pearson Correlation r											1	.011
	Sig. (2-tailed)												.913

Figure 4-13 Correlation between syntactic attributes of selected streets – axial measures in blue box; segment in pink

Figure 4-13 shows in sampling streets, syntactic values generally correlates with each other well. Values are coloured when $r^2 > 0.5$, representing that more than a half of variance of one syntactic measure is explained by another. In all choice pairs selected, when a street has higher axial Integration RN, it always has higher axial Integration R3 (this was intentionally chosen in the selection process as well). These are very few pairs where Choice values has reversed order of Integration, which might account for failing of "*CHOICE TOWARDS INTEGRATION*" in some cases.

Thus, while a more precise association of syntactic values could be calculated, "*CHOICE TOWARDS INTEGRATION*" by a value measured by True (1) or False (0) before averages, gain a good proportion of agreement with all syntactic values.

4.3 Testing Hypothesises

- Testing **H1**

Under *EMPTY* condition, Test if Mean of "*CHOICE-TOWARDS-INTEGRATION*" > 0.5 to reject the null hypothesis that global syntactic value does not impact significantly participants' choices.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
EMPTY	53	0.61654	0.13681	0.01879

One-Sample Test

	Test Value = 0.5					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
EMPTY	6.202	52	.000	0.11654	0.07883	0.15425

Figure 4-14 Result from One sample t-test testing H1

T(52) = 6.202, p = 0.000, Mean = 0.61654

The result (Figure 4-14) shows a significant difference. So the null hypothesis is rejected. People are 11.7 percent more likely to go for streets with higher Axial Integration.

- Testing **H3**

Under *OBEY* and *CONFUSE* conditions, testing if Movement makes significant difference on Mean of "*CHOICE TOWARDS INTEGRATION*".

The results from paired sample t-tests are shown.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	*OBEY*	0.72824	53	0.12237	0.01681
	EMPTY	0.61654	53	0.13681	0.01879
Pair 2	*CONFUSE*	0.45381	53	0.18037	0.02477
	EMPTY	0.61654	53	0.13681	0.01879
Pair 3	*OBEY*	0.72824	53	0.12237	0.01681
	CONFUSE	0.45381	53	0.18037	0.02478

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	OBEY-EMPTY	0.11171	0.1336	0.01835	0.07488	0.1485	6.087	52	.000
Pair 2	CONFUSE-EMPTY	-0.16274	0.16141	0.02217	-0.20722	-0.1182	-7.340	52	.000
Pair 3	OBEY-CONFUSE	0.27445	0.14757	0.02027	0.23376	0.3151	13.539	52	.000

Figure 4-15 Result from paired sample t-test testing H3

- From *OBEY* condition to *EMPTY*, results of Means in "*CHOICE TOWARDS INTEGRATION*" :

  T(52) = 6.087, p = 0.000, Mean = 0. 1117

  ,shows that in *OBEY* condition people are 11 percent more likely to go for more integrated streets.

- From CONFUSE condition to Empty, results of Means in "*CHOICE TOWARDS INTEGRATION*" :

T(52) = - 7.340, p = 0.000, Mean = - 0.1627

, shows that in *CONFUSE* condition people are 16.27 percent less likely to choose more integrated streets.

P-value shows the impact by assigning of movement condition is not by chance.

Thus, movement makes significant difference on participates response to global syntactic value (Integration). In *OBEY* condition, up to 72.82 percent of choices goes for global integration (enhanced by 11 percent); in *CONFUSE* condition 45.38 percent of choices goes for integration (decreased by 16.27 percent), in comparison with *EMPTY* condition with a mean of 61.65 percent.

Following figures (16a, b, c) show distribution of "*CHOICE TOWARDS INTEGRATION*" in three conditions respectively.

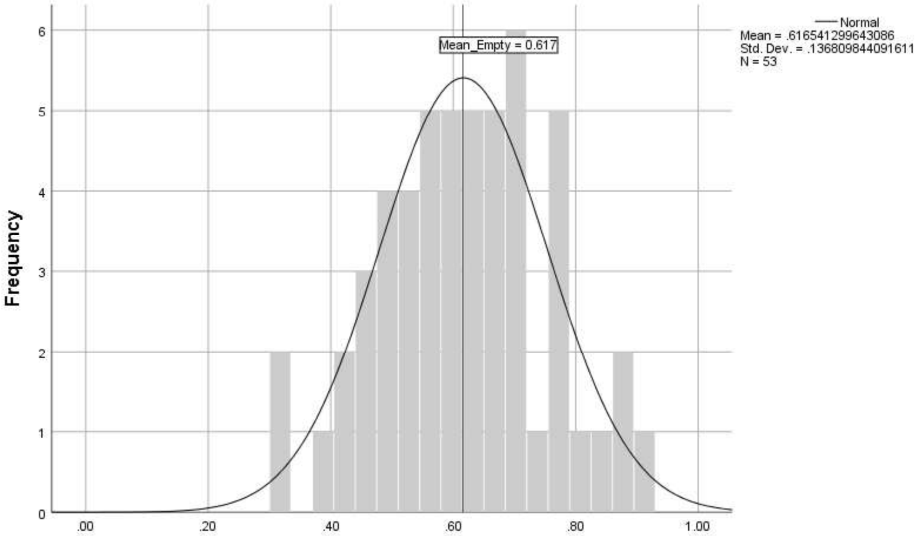


Figure 4-16a Histogram of "*CHOICE TOWARDS INTEGRATION*" - *EMPTY*

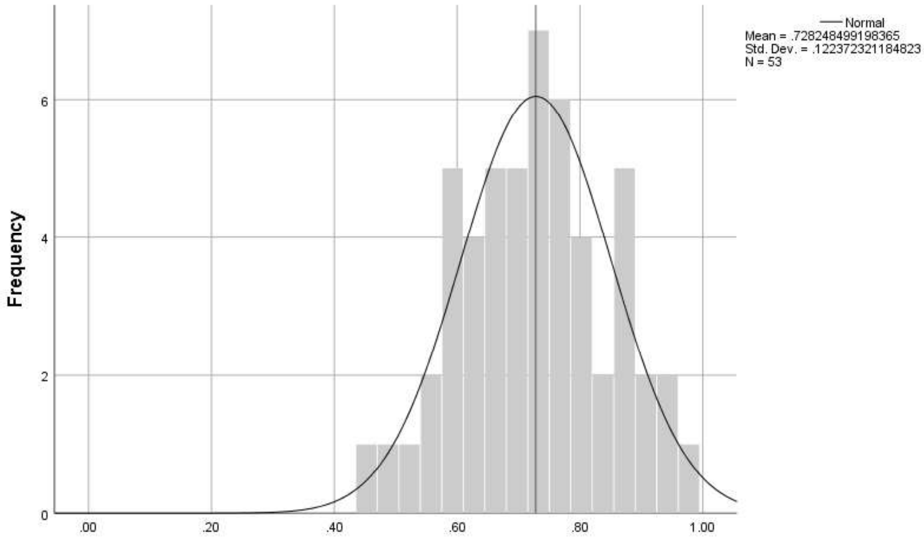


Figure 4-16b Histogram of "*CHOICE TOWARDS INTEGRATION*" - *OBEY*

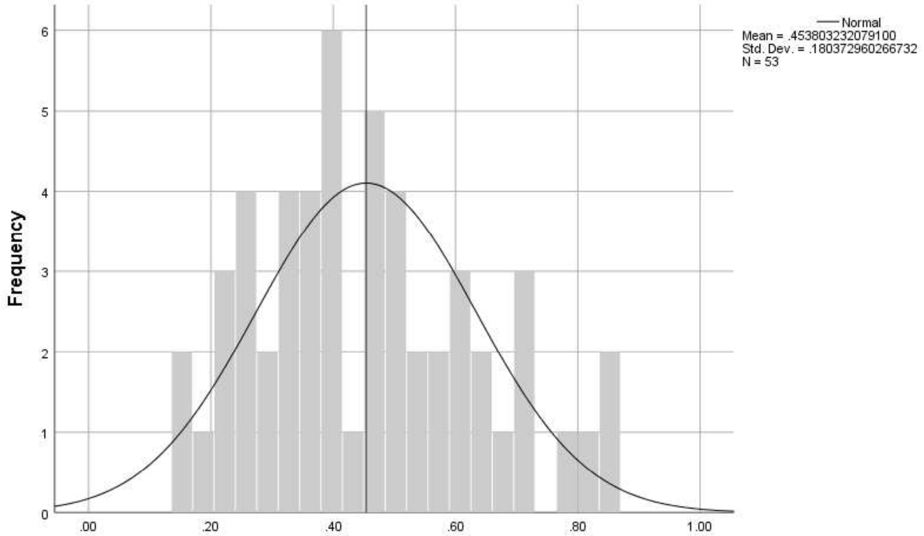


Figure 4-16c Histogram of "*CHOICE TOWARDS INTEGRATION*" - *CONFUSE*

Besides the fact that overall distribution moves towards the right from *CONFUSE*, to *EMPTY*, to *OBEY* condition, a tighter gathering around the higher means are also shown by Standard Deviation and range, especially from Confuse to Empty condition.

Measure: ***CHOICE-TOWARDS-INTEGRATION***

	CONUSE	*EMPTY*	*OBEY*
Standard Deviation	0.18037	0.13681	0.12237

Figure 4-16. d Standard Deviation of "*CHOICE-TOWARDS-INTEGRATION*" by conditions

In *CONFUSE* condition, there exist a few outstanding successful rate (more than 80 percent, Figure 4.15), suggesting strong information in physical environment already, and very low ones (less than 20 percent), and quite a proportion around 50 percent, meaning that people seems hard to make a choice. As these are averages from participates for each choice pairs, this means that people get larger disagreement, and individual level difference emerges more. Thus perception of its strategic importance agrees more when two factors co-responses with each other, or at least they don't contradict themselves. In upcoming sections, from qualitative descriptions of participants, a few hints could be found on how individual difference impact, and how participants say they deduce one factor based on the other at the same time.

Figure 4-17. The pair with more than 80 "*CHOICE-TOWARDS-INTEGRATON*" even in *CONFUSE* condition; Regent St. in the left

Figure 4-18 shows some examples of streets with participants' responses.

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Berners St.	P2_A	0.529	0.743	0.297	14	6722230	2576	0.5163762	3.9722073
Goodge St.	P2_A	0.471	0.257	0.703	13	1318224	1439	0.50326133	3.6234889

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Dukes PI	P81	0.886	0.735	0.459	15	44724664	1581	0.50651544	3.6465659
Towards Mitre Square	P81	0.114	0.265	0.541	9	184892	205	0.49051261	2.9033346

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Towards Dukes PI	P74_1_A	0.829	0.706	0.568	15	44724664	1581	0.50651544	3.6465659
Towards Stoney Ln	P74_1_A	0.171	0.294	0.432	12	613040	355	0.49050236	2.8554571

Figure 4-8 Examples of Streets' Win with axial syntactic values

Figure 4-19 shows synthesizes the results.

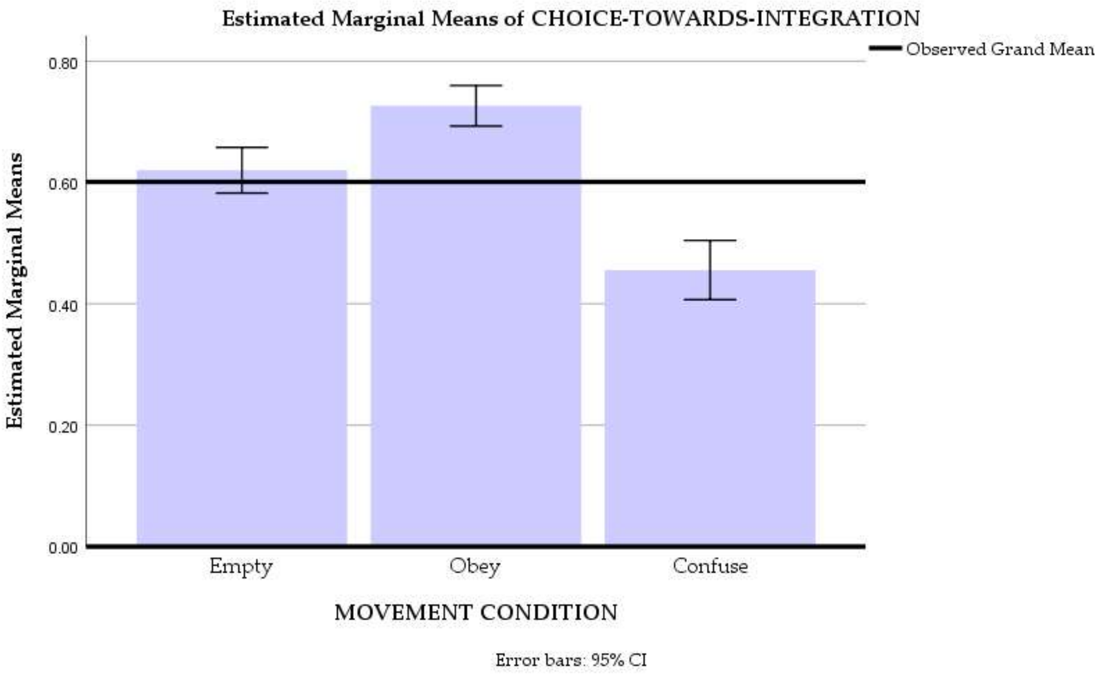


Figure 4-19. Plot of Means of "*CHOICE-TOWARDS-INTEGRATION*" in 3 Condition

- Testing **H5**

This section tests if participants just follow people, and whether assigning integration enhances that. As a complementary of **H3,** It uses the same method on *CONFUSE* and *OBEY* condition to compare Means of "*CHOICE-TOWARDS-MOVEMENT*", and Integration as a between subject variable with 2 levels of condition: -1 and 1 (wrong or right)

One-Sample Statistics – *CHOICE-TOWARDS-MOVEMENT*

	N	Mean	Std. Deviation	Std. Error Mean
CONFUSE	53	0.546197	0.180373	0.024776

One-Sample Test – *CHOICE-TOWARDS-MOVEMENT*

Test Value = 0.5

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper
CONFUSE	1.865	52	0.068	0.046197	-0.003520	0.095914

Figure 4-20 Test Mean of "*CHOICE-TOWARDS-MOVEMENT*" – *CONFUSE* – **H5**

Firstly "*CHOICE-TOWARDS-MOVEMENT*" is tested against 0.5 chance. The null hypothesis is that **$H5_0$**: Movement Volume under Confuse condition will not help us to choose towards it.

T(52) = 1.865, p = 0.068, Mean = 0.5462

Results show that while the mean is 4.6 percent higher than 0.5, that participants tend to goes for crowd just slightly more, the result is not statistically significant.

Then a paired-sample T-test is used to see if assigning Integration has significant impact on participants' "*CHOICE-TOWARDS-MOVEMENT*".

Paired Samples Test –*CHOICE-TOWARDS MOVEMENT*

		Paired Differences Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Pair 1	*OBEY - CONFUSE*	0.18205	0.27063	0.03717	0.10746	0.25665	4.897	52	.000

Figure 4-21 Test mean of "*CHOICE-TOWARDS-MOVEMENT*" from *OBEY* to *CONFUSE*

T(52) = 4.897, p = 0.000, Mean = 0.1821.

Thus participants are 18 percent more likely to go for the crowd, when Integration is assigned correctly. People have less doubt going for a "main" street when they get a busier street with higher global network value with a 73 percent choice.

The statistical results show how the agreement of both factors have an add-on effect on participants' wayfinding behaviour.

- Testing **H2** and **H4**

Following figures shows the correlation between "*STREETS WIN*" with syntactic attributes understand three conditions respectively.

Correlations of *STREET'S WIN* with street's syntactic value (1) – Axial Measures (n=106)

		Connec-tivity	Integration-RN	Integration-R3	Axial Line Length	Forward-Facing Connectivity	Choice RN	Choice R3	Lg (Choice RN)	Lg (Choice R3)
EMPTY	Pearson Correlation r	.241*	**.431****	**.415****	.240*	.190	.093	.344**	**.402****	.342**
	Sig. (2-tailed)	.013	.000	.000	.013	.051	.345	.000	.000	.000
OBEY	Pearson Correlation r	.285**	**.569****	**.541****	.303**	.265**	.202*	**.515****	**.509****	**.424****
	Sig. (2-tailed)	.003	.000	.000	.002	.006	.038	.000	.000	.000
CONFUSE	Pearson Correlation r	-.092	-.140	-.102	-.064	-.177	-.183	-.111	-.098	-.059
	Sig. (2-tailed)	.349	.153	.300	.515	.070	.060	.256	.315	.548

Correlations of *STREET'S WIN* with street's syntactic value (2) – Segment Measures (n=106)

		Angular Segment Integration RN	Angular Segment Integration R980	Angular Segment Integratio n R3	Angular Segment Choice R9800	Angular Segment Choice R800	Segment Length
EMPTY	Pearson Correlation r	.040	.217*	.116	.193*	.189	.040
	Sig. (2-tailed)	.687	.026	.235	.047	.053	.687
OBEY	Pearson Correlation r	.058	.221*	.095	.173	.171	.058
	Sig. (2-tailed)	.555	.023	.331	.077	.080	.555
CONFUSE	Pearson Correlation r	-.099	-.132	-.052	-.134	-.069	-.099
	Sig. (2-tailed)	.313	.178	.597	.171	.484	.313

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 4-22. Correlation of STREETS' WIN with axial and segment measures

- Under *EMPTY* condition, within syntactic values chosen, axial integration RN shows best correlation (r = 0.431, p = 0.000), followed by Integration R3 (0.415, 0.000), (Log10(Choice RN) (0.402, 0.000)) and choice R3 (0.344, 0.000). Statistically significant positive correlation can also be seen with axial line length, forward facing axial connectivity, and segment choice R9800 and R800, segment integration R9800. Global network measures outperform local ones in general.
- Under *OBEY* condition, r increases on all axial measures, where axial integration Rn (0.569, 0.000), R3(0.541, 0.000), choice R3(0,515, 0.000) perform best. 32.38 percent of variance in "Street's Win" can be predicted from axial integration RN.
- No significant correlation found in *CONFUSE* Condition.

Overall axial measures show better correlation in comparison with segment ones. (This is quite nature to think of that, in pictures or real world, we do not only see the condition of immediately upcoming street but longer)

Figure 4-23 shows Correlation of "*STREET'S-WIN*" in each condition with those in another.

Correlations of *STREET'S WIN* with each conditions

		EMPTY	OBEY	CONFUSE
EMPTY	Pearson Correlation r	1	.744**	.212*
	Sig. (2-tailed)		.000	.029
OBEY	Pearson Correlation r		1	.044
	Sig. (2-tailed)			.657
CONFUSE	Pearson Correlation r			1
	Sig. (2-tailed)			

Figure 4-23. Correlatoin of "STREETS'-WIN" in each condition with those in another

It shows that "*STREETS' WIN*" Under *EMPTY* and *OBEY* condition shows a high positive correlation (r = 0.744, p = 0.000). There is still weak positive correlation between *EMPTY* and *CONFUSE* (r = 0.212, p=0.000) conditions. This indicates that physical environmental information is not totally disturbed by movement, and this add onto with previous testing on if we just follow the crowd in *CONFUSE* condition. But agreement of these factors enhance our understanding of these places.

4.4 Gender, Familiarity, and Area[14]

4.4.1 Gender

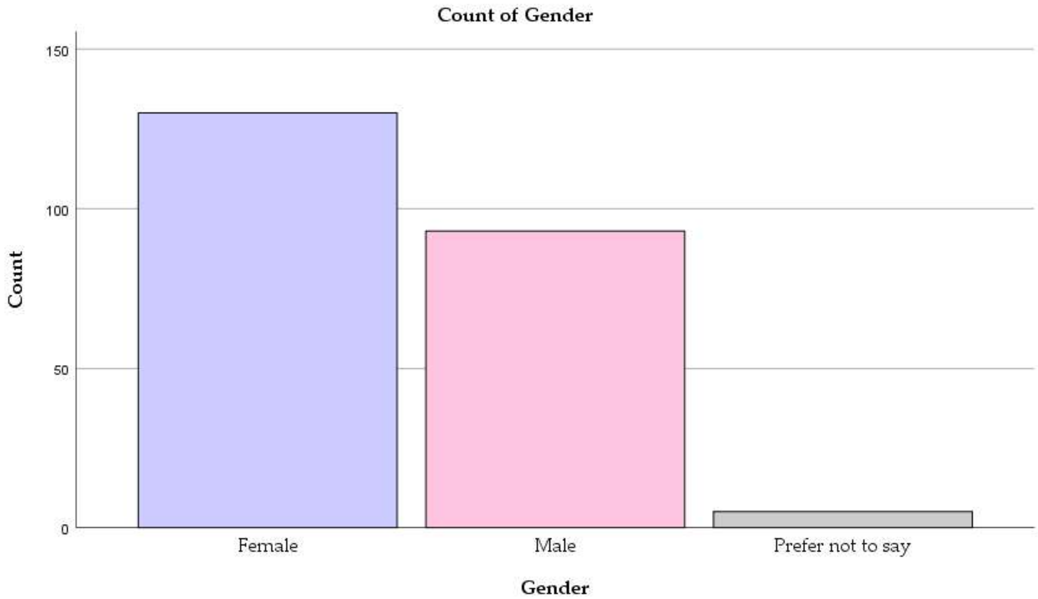


Figure 4-24. Participates' Gender Count

The following figures show the impact of Gender (*2) and Movement condition (*3) using two-way repeated measures ANOVA.

Tests of Within-Subjects Effects – Gender and Movement

Measure: *CHOICE-TOWARDS-INTEGRATION*

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
MOVEMENT	Sphericity Assumed	4.317	2	2.159	95.819	.000
	Greenhouse-Geisser	4.317	1.910	2.260	95.819	.000
	Huynh-Feldt	4.317	1.981	2.179	95.819	.000
	Lower-bound	4.317	1.000	4.317	95.819	.000
Error(MOVEMENT)	Sphericity Assumed	2.343	104	.023		

[14] Analysis in this section is only indicative considering difference in number of participates with gender and familiarity categories.

	Greenhouse-Geisser	2.343	99.323	.024		
	Huynh-Feldt	2.343	103.017	.023		
	Lower-bound	2.343	52.000	.045		
GENDER	Sphericity Assumed	.060	1	.060	4.050	**.049**
	Greenhouse-Geisser	.060	1.000	.060	4.050	.049
	Huynh-Feldt	.060	1.000	.060	4.050	.049
	Lower-bound	.060	1.000	.060	4.050	.049
Error(GENDER)ssss	Sphericity Assumed	.774	52	.015		
	Greenhouse-Geisser	.774	52.000	.015		
	Huynh-Feldt	.774	52.000	.015		
	Lower-bound	.774	52.000	.015		
MOVEMENT * GENDER	Sphericity Assumed	.020	2	.010	.669	**.514**
	Greenhouse-Geisser	.020	1.971	.010	.669	.512
	Huynh-Feldt	.020	2.000	.010	.669	.514
	Lower-bound	.020	1.000	.020	.669	.417
Error(Crowdedness* Gender)	Sphericity Assumed	1.540	104	.015		
	Greenhouse-Geisser	1.540	102.506	.015		
	Huynh-Feldt	1.540	104.000	.015		
	Lower-bound	1.540	52.000	.030		

Descriptive Statistics

	N	Mean	Std. Deviation
EMPTY_FEMAIL	53	.640472	.169933
EMPTY_MALE	53	.59124	.172614
OBEY_FEMALE	53	.745519	.153173
OBEY_MALE	53	.724254	.148015
CONFUSE_FEMALE	53	.456784	.200848
CONFUSE_MALE	53	.444664	.196689

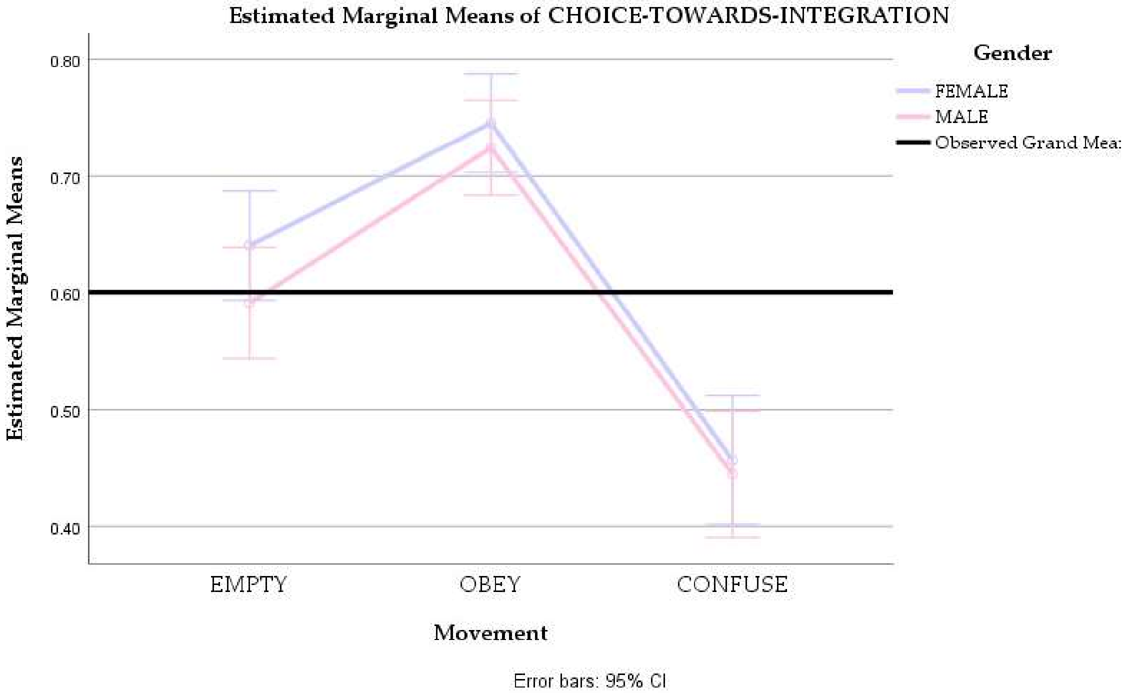


Figure 4-25. Results and Illustration testing Gender and Movement's effect on "*CHOICE-TOWARDS-INTEGRATION*"

Result from two-way repeated measures ANOVA shows that gender have a significant impact main on "*CHOICE-TOWARDS-INTEGRATION*". ($F(1, 52) = 4.050$, $p = 0.049$). Females outperform males slightly overall (Figure xx).

There is no significant main impact of Gender on "*CHOICE-TOWARDS-MOVEMENT*". ($F(1, 52) = 0.081$; $p = 0.777$)

4.4.2 Familiarity

Familiarity are categorised into High, Medium, and Low (Figure 4-25).

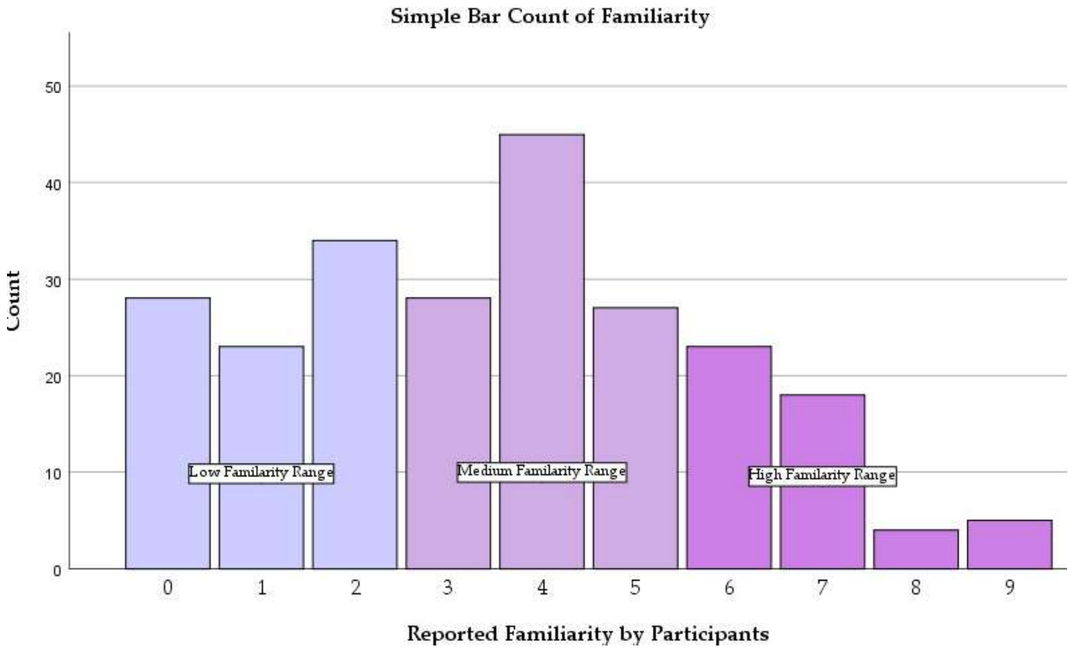


Figure 4-26 Participates' Familiarity Count within Low Medium, High Range

Following figures show the impact of Familiarity (*3) and Movement condition (*3) using two-way repeated measures ANOVA on *CHOICE-TOWARDS-INTEGRAION.*

Tests of Within-Subjects Effects

Measure: *CHOICE-TOWARDS-INTEGRATION*

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
MOVEMENT	Sphericity Assumed	6.421	2	3.210	94.603	.000
	Greenhouse-Geisser	6.421	1.920	3.344	94.603	.000
	Huynh-Feldt	6.421	1.992	3.223	94.603	.000
	Lower-bound	6.421	1.000	6.421	94.603	.000
Error(MOVEMENT)	Sphericity Assumed	3.529	104	.034		
	Greenhouse-Geisser	3.529	99.829	.035		
	Huynh-Feldt	3.529	103.573	.034		
	Lower-bound	3.529	52.000	.068		

FAMILIARITY	Sphericity Assumed	.211	2	.105	5.118	**.008**
	Greenhouse-Geisser	.211	1.849	.114	5.118	.009
	Huynh-Feldt	.211	1.914	.110	5.118	.008
	Lower-bound	.211	1.000	.211	5.118	.028
Error(FAMILIARITY)	Sphericity Assumed	2.143	104	.021		
	Greenhouse-Geisser	2.143	96.138	.022		
	Huynh-Feldt	2.143	99.526	.022		
	Lower-bound	2.143	52.000	.041		
MOVEMENT * FAMILIARITY	Sphericity Assumed	.020	4	.005	.222	**.926**
	Greenhouse-Geisser	.020	3.702	.005	.222	.915
	Huynh-Feldt	.020	4.000	.005	.222	.926
	Lower-bound	.020	1.000	.020	.222	.640
Error(MOVEMENT*FAMILIARITY)	Sphericity Assumed	4.627	208	.022		
	Greenhouse-Geisser	4.627	192.492	.024		
	Huynh-Feldt	4.627	208.000	.022		
	Lower-bound	4.627	52.000	.089		

Descriptive Statistics

	N	Mean	Std. Deviation
EMPTY_HIGH_F	53	.566307	.223193
EMPTY_MEDIUM_F	53	.611923	.182384
EMPTY_LOW_F	53	.628586	.178803
OBEY_HIGH_F	53	.689691	.191155
OBEY_MIDEUM_F	53	.726543	.144052
OBEY_LOW_F	53	.745403	.159898
CONFUSE_HIGH_F	53	.416851	.216232
CONFUSE_MEDIUM_F	53	.451114	.222992
CONFUSE_LOW_F	53	.444911	.200709

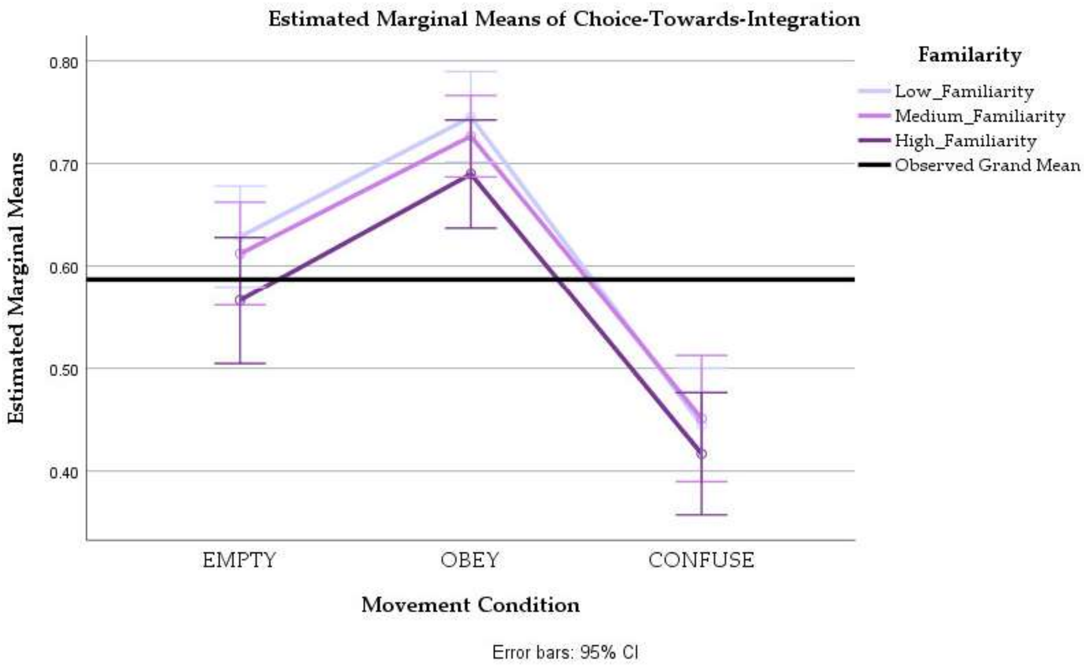


Figure 4-27. Results and Illustration testing Gender and Movement's effect on "*CHOICE-TOWARDS-INTEGRATION*"

Result from two-way repeated measures ANOVA shows that familiarity has a significant impact on "*CHOICE-TOWARDS-INTEGRATION*" overall. ($F(2, 104) = 5.118$, $p = 0.008$). The graph shows a slight inhabit on overall performance as familiarity goes higher, indicating that we refer less to external environmental factors when we are very familiarity with the places. There is no significant main impact of familiarity*Movement on performance of "*CHOICE-TOWARDS-INTEGRATION*".

Figure 4-28 shows performance of "*CHOICE-TOWARDS-MOVEMENT*" under familiarity conditions.

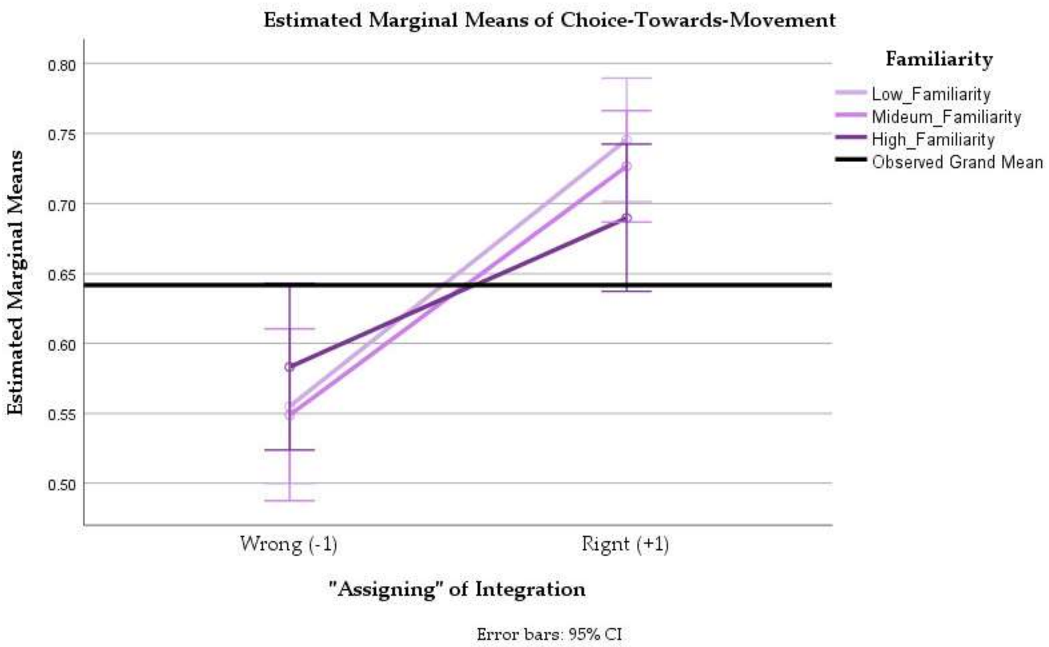


Figure 4-28.

Illustration of Familiarity and Integration's effect on "*CHOICE-TOWARDS-MOVEMENT*"

There is no significant main impact of Familiarity on "*CHOICE-TOWARDS-MOVEMENT*" (F (2, 104) = 0.317; p = 0.729). With high familiarity, *CHOICE-TOWARDS-MOVEMENT* is not impacted as much by street network values (seems more steady).

4.4.3 Area and Connectivity

As described in Chapter 3, 11 out of 53 choice pairs belongs to Set 2, where difference of connectivity values are allowed to be larger in a choice pair. The rest 42 choice pairs belongs to Set 1 where connectivity are controlled more strictly. CoL area consists of 22 choice pairs, and all loosely controlled pairs are from CoL.

This part only gives a brief description of the impact that might due to connectivity difference itself, as well as the area's context.

Figure 4-29 shows the correlation of "*STRESTS' WIN*" with syntactic value in CoL and Soho sets respectively.

Correlation of "*STREETS' WIN*" with Axial measures – ***CITY OF LONDON*** (n=44)

		Connectivity	Integration-HH-RN	Integration HH-R3	Choice-RN	Choice-R3	Axial Line Length
EMPTY	Pearson Correlation r	.472**	.535**	.608**	.136	.469**	.547**
	Sig. (2-tailed)	.001	.000	.000	.378	.001	.000
OBEY	Pearson Correlation r	**.577****	**.694****	**.787****	**.315***	**.620****	**.702****
	Sig. (2-tailed)	.000	.000	.000	.037	.000	.000
CONFUSE	Pearson Correlation r	-.267	-.259	-.290	-.379*	-.348*	-.230
	Sig. (2-tailed)	.079	.090	.056	.011	.021	.133
Connectivity	Pearson Correlation r	1	.754**	.812**	.398**	.919**	.835**
	Sig. (2-tailed)		.000	.000	.007	.000	.000
Integration-HH-RN	Pearson Correlation r	**.754****	1	.804**	.625**	.813**	.748**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
IntegrationHH-R3	Pearson Correlation r	.812**	.804**	1	.450**	.864**	.956**
	Sig. (2-tailed)	.000	.000		.002	.000	.000
Choice-RN	Pearson Correlation r	.398**	.625**	.450**	1	.605**	.460**
	Sig. (2-tailed)	.007	.000	.002		.000	.002
Choice-R3	Pearson Correlation r	.919**	.813**	.864**	.605**	1	.902**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
Axial Line Length	Pearson Correlation r	.835**	.748**	.956**	.460**	.902**	1
	Sig. (2-tailed)	.000	.000	.000	.002	.000	

Correlation of "*STREETS' WIN*" with Axial measures – ***Soho surrounding*** (n=62)

		Connectivity	Integration-HH-RN	Integration HH-R3	Choice-RN	Choice-R3	Axial Line Length
EMPTY	Pearson Correlation r	.120	.398**	.337**	.214	.275*	.125
	Sig. (2-tailed)	.351	.001	.007	.095	.031	.332
OBEY	Pearson Correlation r	.144	**.529****	**.443****	**.455****	**.463****	.164
	Sig. (2-tailed)	.265	.000	.000	.000	.000	.204
CONFUSE	Pearson Correlation r	-.031	-.101	-.042	-.071	-.022	-.020
	Sig. (2-tailed)	.809	.436	.746	.582	.865	.877
Connectivity	Pearson Correlation r	1	.664**	.784**	.696**	.811**	.938**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
Integration HH-RN	Pearson Correlation r	**.664****	1	.967**	.591**	.754**	.656**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
Integration HHR3	Pearson Correlation r	.784**	.967**	1	.638**	.820**	.790**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
Choice-RN	Pearson Correlation r	.696**	.591**	.638**	1	.912**	.701**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
Choice-R3	Pearson Correlation r	.811**	.754**	.820**	.912**	1	.826**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
Axial Line Length	Pearson Correlation r	.938**	.656**	.790**	.701**	.826**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 4-29. Correlation of "*STREETS' WIN*" with Syntactic values in CoL and Soho

Noticeably higher correlation within Streets' Win and axial measures descript in previous sections can be seen in area within City of London that around Soho, suggesting syntactic values explains better participants' responses in each choice pairs in CoL.

Figure 4-29 compares Connectivity Sets: Set 1 and Set 2 with Means of "*CHOICE-TOWARDS-INTEGRATION*"

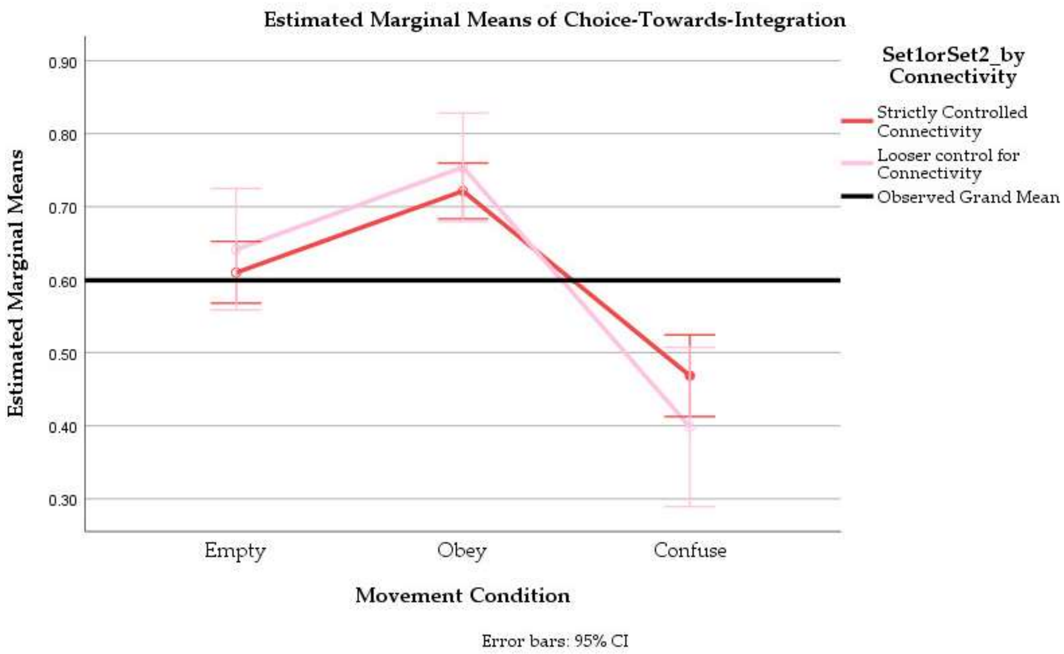


Figure 4-29. Illustration of Connectivity Sets and Movement's effect on "*CHOICE-TOWARDS-INTEGRATION*"

Descriptive Statistics of "Choice-Towards-Integration" under
Different Movement Conditions and Connectivity Sets

	N	Minimum	Maximum	Mean	Std. Deviation
EMPTY – Larger Connectivity Difference	11	0.32558	0.88571	0.64153	0.14916
OBEY – Larger Connectivity Difference	11	0.59184	0.95349	0.75403	0.12172
EMPTY – Lower Connectivity Difference	42	0.31429	0.89583	0.60999	0.13454
OBEY – Lower Connectivity Difference	42	0.45714	0.97143	0.72149	0.1231

Figure 4-30 Means of "*CHOICE-TOWARDS-INTEGRATION*" by Control of Connectivity

No significant impact of connectivity set on means of performances overall according to sampling. (Actually there are only 11 choice pairs in loosely controlled set, where highest relative difference of connectivity happens between 9 and 15). The plot suggests as connectivity varies larger (pink line), the means tend to get further from 50:50 chance. (We can think of connectivity as one most of the most "direct" spatial properties.) But for Set 1, means under

EMPTY and *OBEY* condition show there is still clear tendency towards integration ($mean_{EMPTY\_Set1} = 0.61$; $mean_{OBEY\_Set1} = 0.72$).

4.5 Qualitative Evidence

This section records participants' description from a perspective other than path choice result. As described in Chapter 3, descriptions are recorded as categorised single words.

- Words categorised into *Physical Environment* is based on their largely independence of either "liveness" or "our thinking/deduction/feeling". The highest frequency goes to the word "Build" (including building(s)) which appears 27 times, and then "end" (18), "sign" (14), "Shop" (7), "Landmark" (6), Distance (5)…"Construct" (5),.."angle" (2) "restaurant", "Design", "Architecture" "bend" "logo" "shortest" "rubbish"…etc. Figure 4-31 shows the distribution.

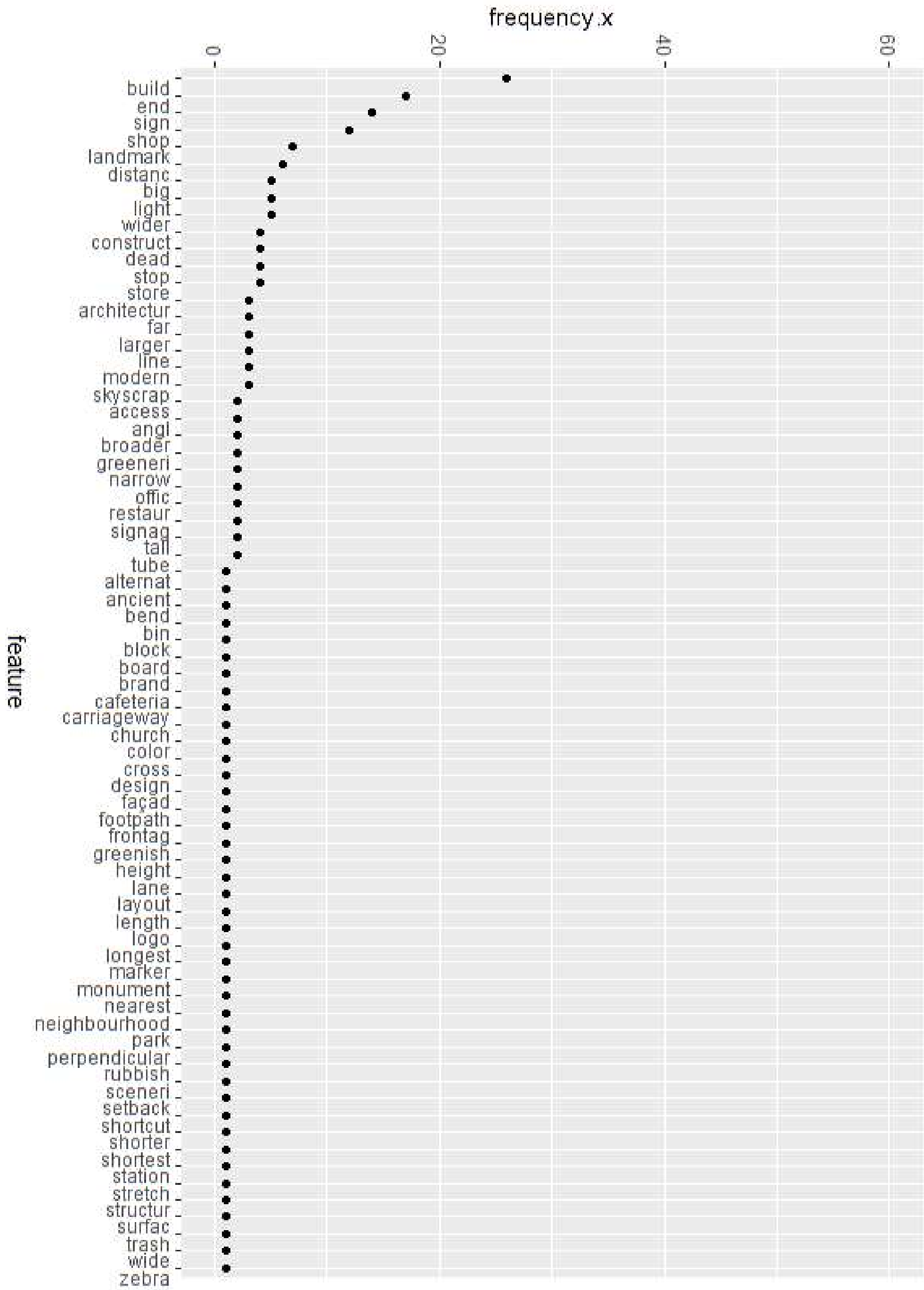


Figure 4-31. Keywords' frequency distribution - "Physical Environment"

It seems Space and Geometry (indicated by: long, short, width, shortcut, narrow, width, bend, angle, far, end, height and etc.), "Attractor" (indicated by: skyscraper, landmark, café & restaurant, etc.), Design/architecture (indicated by: ancient, modern, green, trash, façade, signage, etc.) are all described as cues.

- Words categorised into Social Environment is based on its dependence of "liveness" yet not too much relying onto "our thinking/deduction/feeling". The highest frequency goes to the world “people” (58 times, the highest in all categories at the same time), followed by “car”, “crowd”, “busy”, “traffic” etc. Interestingly, there involves some anticipation of real social activities, indicated by “help”, “ask, speak” , etc. (Figure 4-32)

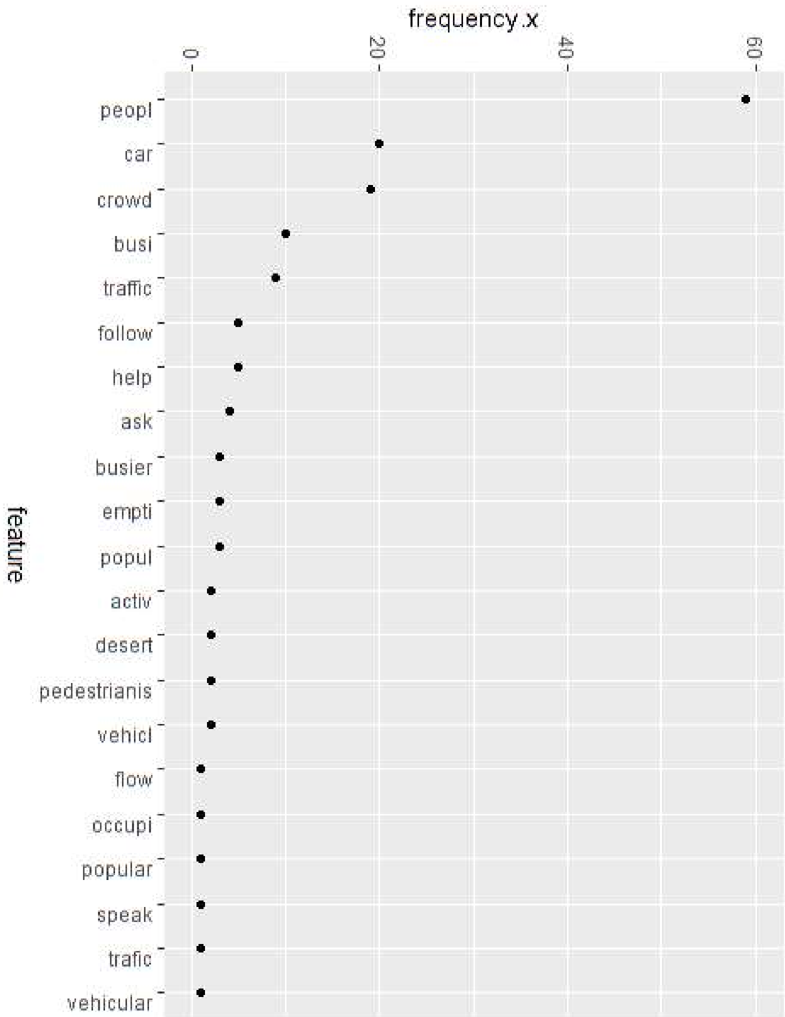


Figure 4-32. Keywords’ frequency distribution - “Social Environment”

- Words categorised into “Perceptual” are based on their dependence more towards our knowledge or interpretation, rather than what is directly visible. These can be divided into predominant subcategories of “familiarity” (“familiar”, “know”, “knowledge”, “recognise”) and “perceived quality” (“important”, “main”, “public”, “private”, “safe”, “fun”, “bore”, “interesting”, ”relax” etc.) (Figure 4-33)

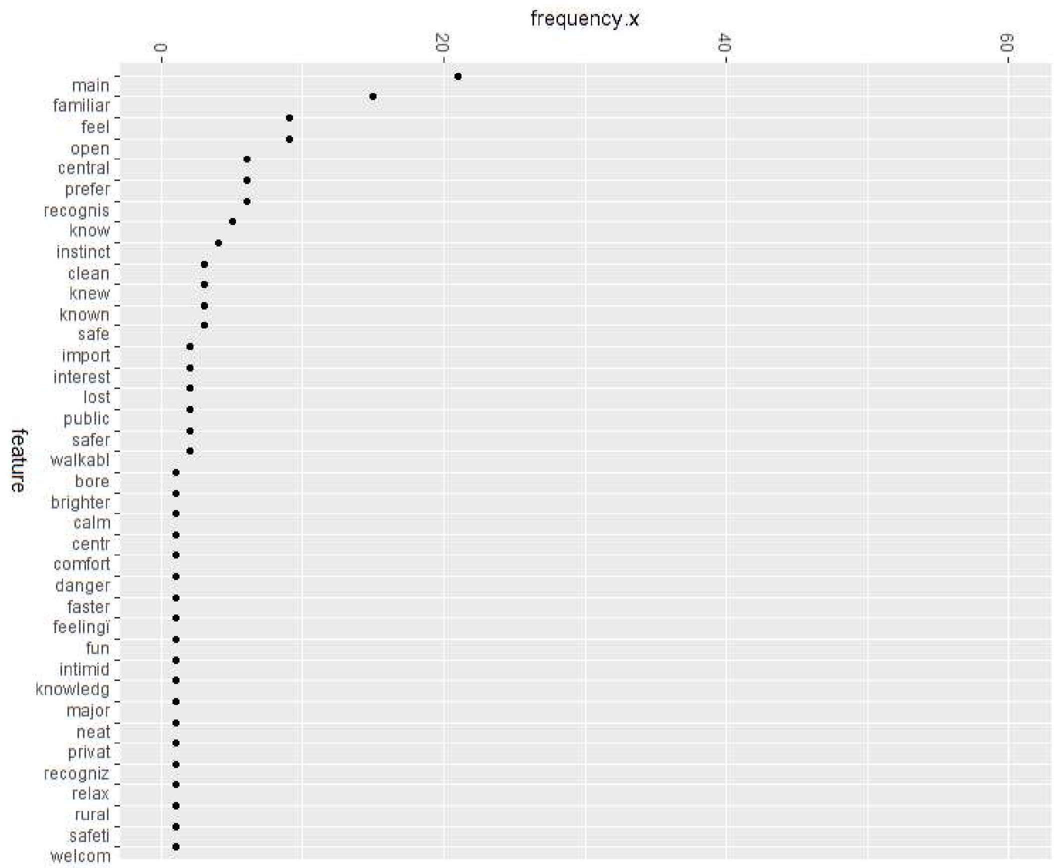


Figure 4-33 Keywords' frequency distribution - "Perceptual"

Figure 4-34 shows the summation of occurrence of all words based on categories. Physical cues slightly outweigh Social and Perceptual ones in people's description. Their degrees of importance are quite comparable.

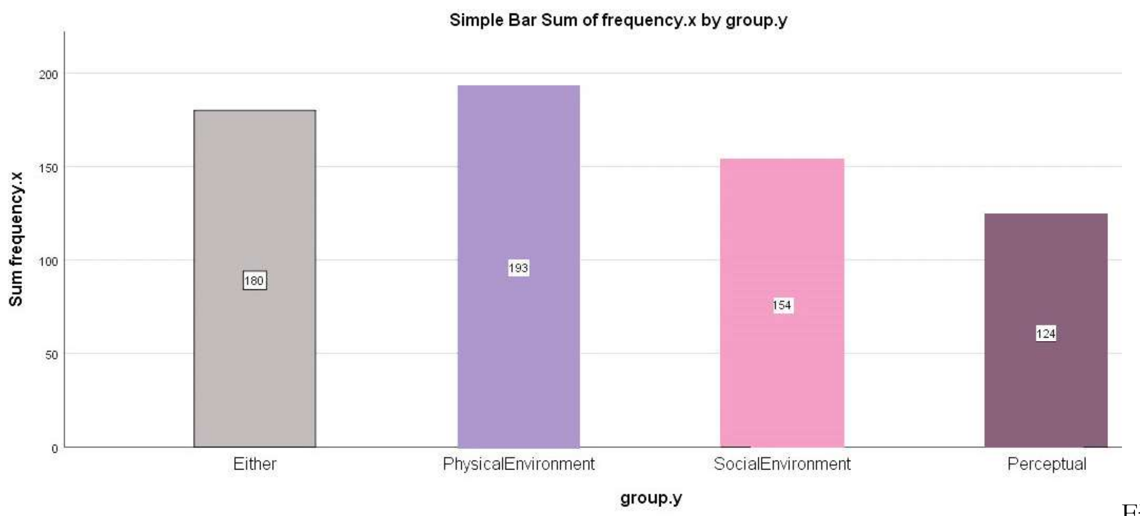
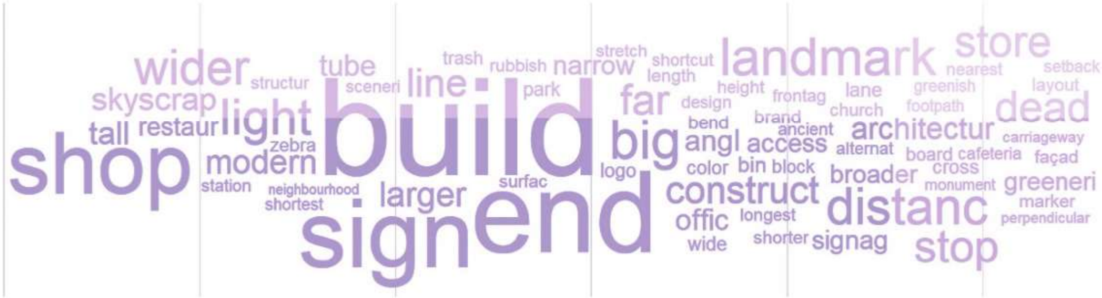


Figure 4-34. Summation of word frequency by categories

Figure 4-35 illustrates word frequency by categorized into word-cloud.



Words in Physical Environment

Words in Social Environment

Words in Perceptual Group

Figure 4-35 Word-cloud of keywords by categories, the larger the size, the higher the frequency.

Full descriptions of participants show individuals combine these factors in their interpretations mostly. Interestingly, these categorised are perceived by participates not only as cues of the wayfinding task, but as cues for each other as well:

> *"I picked the option that looked more busy/had shops/looked safer (so that I could find people and ask them for help/directions) I avoided areas that looked empty or dangerous"*

"Number of people and the direction they're from. Cars parked and the direction they face away from. Presence of high-rise buildings or spires in the background (means more people/ places of interest)"

"I try to find indicators of non-residential areas, which are likely to be close to main streets and landmarks. For example, big or two directional roads, a crowd of people, monuments, or skyscrapers."

"See the crowds and traffic direction – 2 way is prefered"

Some features, like crowdedness and length of coming streets, are considered mostly a positive factor, while some individuals explicitly saying they would avoid this. (We would expect that most people would follow the crowd and avoid dead-end). It seems shorter upcoming streets provides the chance for a quicker second selection.

"I just chose the shortest walk to another street which will help me find out where about am I. If the end is all the way down the street I would chose the image that has the nearest end of the street."

Also, some descriptions directly mean spatial wayfinding: *"(I choose).. People and clear route through the street"* which suggest connectivity (or forward-facing connectivity); Whereas for some participate this is avoided *"By less amount of further choice"*, and "*I prefer to choose the longest sight of line, which might be the main reason for navigating*" which suggest length of sight.

The following figure shows a detailed account. Please refer to appendix for full records.

nental Information | **Social Environment and Movement** | **Perceptual**

Word cloud of Categorised Keyword, size based on Frequency of Appearance of the words in Participates' description

e, not a dead end"	"Whatever seemed busier"	"follow my gut"
h two-way lane"	"I tend to choose open space with more people, cars and bus in particular"	"I prefer the one that looks more comfortable and safe with more colours."
at kind of buildings I	"largely based on the flow of people"	"some randomly and some by knowing the roads"
sume it would be a	"find a street where have more people or car"	"Streets that were brighter and with less trash (basically ones that looked less intimidating)"
	"I think I chose the less crowded options"	
	"More inclined to choose the occupied pedesrrian street"	
ibility to cars"	"availability of others to ask questions/find solutions faster"	

d surface I prefer it. If the route is very deserted or

& the type of buildings - eg if skyscrapers it is more d a way out."

ection, i assume you go somewhere central. Also, some dnt choose them"

"Main streets, busy streets, and other streets with economic activities appears to be a better choice"

"The intuition and some generic judgement like the way crowds are movin towards, and the distribution of the buildingsss in images."

"most of the time i look towards the amount of people and always when u see a tree or more greenish there is a relaxing feel so i choose more greener ones"

"Visual clues, Familiarity of place, People and clear route through the street."

"Crowd, length of street, no entry signs, pre-existing knowledge of place"

"intuition > road width > look of buildings at the far end > following the crowd"

"it was mainly based on the width of the street and presence of crowd where I will feel safe if I get lost"

d onto a main road. Or if I could spot any landmarks in the picture-would choose this option. Avoided any direction that appeared to lead to a dead end"

e. Somewhere you might know or be able to direct yourself from. Look for areas that look pedestrianised as these are often central areas. Sometimes look for openings either under a bridge or through a shortcut."

at looked more busy, had more light, less construction going on and generally looked more cleaner as that what my mind perceived as safer."

"If there is a greater possibility of public transport (i.e buses, tube etc) or general information points present"

ı one-way road). Presence of people. Visual markers suggesting limited access avoided. A structure at the end of the current road could imply that there is

4.6 Summary of Results

61.65 percent of choices ($p = 0.000$) is towards Global Configurational Properties with purely physical environment cues. This result is enhanced when the two factors agree (+ 11.17 percent, $p = 0.000$), and reduced when they contradict (- 16.27 percent, $p = 0.000$), with no significant preference towards either Movement Volume or Integration.

Streets' chance of being chosen correlate best with Axial Integration RN and R3 among syntactic measures; these positive correlations enhance when two factors agree with each other and are disturbed by their contradiction.

Qualitative evidence assists the proposition that: while individual preference differs, correspondence of related factors results in a more agreed pattern of choices. Familiarity reduces participants' choice towards Configurational cues, while further testing associated with familiarity and intelligibility of the area is meaningful.

Chapter 5 | Discussion

5.1 Discussing Results

Above results supports Emo (2012)'s finding that global and local integration measures 76.9 percent ($p < 0.01$) and 71.2 percent ($p < 0.01$) of individual spatial-decisions, outperforming choice measures in such settings (ibid.). As in this study controlled connectivity, the degree of difficulty to make decisions in certain choice pairs seemed to be enhanced, in comparison with Emo (2012)'s finding, that only 62 percent of decisions goes for integration without movement as cues. In this sense, local centrality seems also important for egocentric spatial-decision makings. . Qualitative results also agree with the proposition that people goes to integrated space with anticipation of social co-presence (Peponis, Zimring and Choi, 1990).

Regarding gender's effect, previous studies showed gender inequality of a country is predictive of gender differences in navigation ability (Coutrot, et al., 2018); females pay more attention to landmark and legend as local cues (Wang, et al., 2019); and men were more likely to use orientation strategy (a sense of their own position in relation to environmental reference points) (Lawton, 1994). However, in this study female out preformed male ($p < 0.05$). Besides navigation ability itself, the results might be given by participants' demographic range (age, education, and etc.) and task setting, which weight mostly on static visual information.

It could be argued that one main suggestion of this study is to make the Peponis proposition (Turner, 2005) more explicit: that configuration provides a basis for our anticipation of affordances of a space. In a natural evolved urban context or larger spatial settings, the agreement of various layers of Network Effects, which are locally identifiable, and thus with the configuration, makes the inference of our global position possible. But as the configuration is the primary driver in this condition, it does "constrain" possibilities.

5.2 Referring to Natural Movement Theory

Referring the thinking logic of Natural Movement theory (Hillier et al., 1993), this study raises the issue of how two closely associated factors: Spatial Configuration and Movement Flow impact the third subjective factor - our wayfinding path choice – which can feedback into and explains the aggregated statistical representation of movement.

Thus the linkage between the subjective and objective might be: the aggregation of data actually acts as clues that the underlying network informs us, in support of Space Syntax theory and methods.

Figure 5-1 shows a theoretical framework of natural movement theory (Hillier et. al., 1993), it shows how the three factors: attractor (physical), movement, and configurations asymmetric influence on each other.

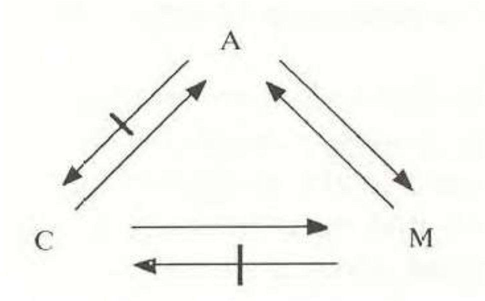


Figure 5-1. Attractor (A), Configuration (C), Movement (M)'s asymmetric relationship (Hillier et al, 1993)

Result of this study could be explained in a similar way, by changing:

a. Attractor from physical beings in the built environment, to movement flow itself, and

b. Movement from a collective pattern to individual's route choice.

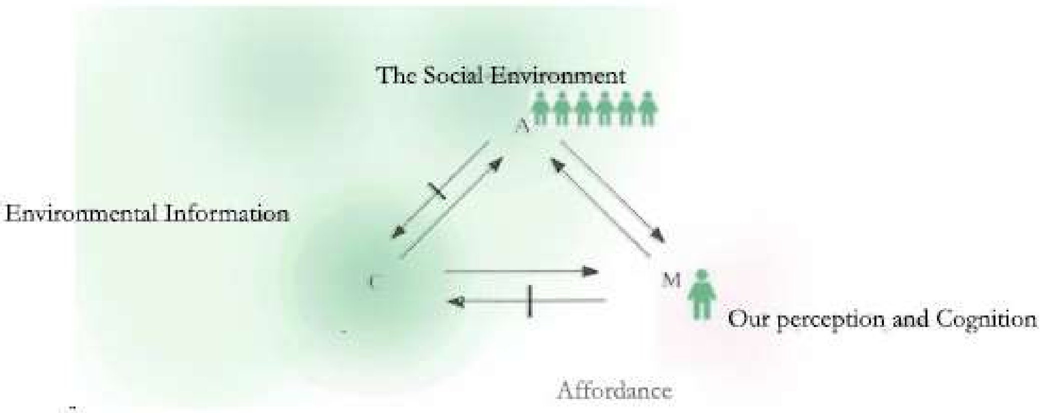


Figure 5-2. Asymmetric relationships between Movement Flow as Attractor (A), Configuration (C), and one's spatial navigating decision-making (M);

Regarding the asymmetric of direction, considering the immediate response when we navigate, and the relationship between environmental information and the individual (e.g. as discussed by Griffiths and Quick, 2005) the directions in the diagram might be explained as:

i. Configuration as the fundenmental variable (it is the more stable factors, and cannot be impacted immediately in route choice situations);

ii. Movement flow/activities, co-presence, virtual community,

iii. One's understanding and perception of the environment, where affordances takes meaning

iv. One's movement, or other spatial behaviour

v. Our behaviour turns into the information of this environmental system again, as cues for others to make their decisions.

vi. Goes back to step ii.

This interrelation might account for how a moving subject is related/contributing to the others and the overall socio-economic network effect. In this way an underlying configuration explains cognition related behaviours/responses. This also suggest further testing into if the built-form or spatial configuration of cities, which in Space Syntax theory a principal factor for aggregating socio-economic factors, are also a fundamental factor in social wayfinding and other cognitive behaviours in cities (Figure 5-2 illustrates this hypothesis, the darker the colour, the more likely this factor is representative for other factors in the environment).

Chapter 6 | Conclusion

To summarise, this study uses pictures of real intersecting streets in City of London and Soho area to mimics situations when we are choosing upcoming paths to go. It aims to test whether spatial configuration carries any cognitive effect. Intersections are selected based on control of axial connectivity, aiming to eliminate extreme conditions and the configuration's local effect. This method argues for the proposition that it is more global configuration properties that give a place its characteristics (Hillier et al., 1993), and through "network effect", physically and socially, the global network properties can reach as far to our local field of view, and helps us understand our position within the relational system. Finding shows participates' coherent responses beyond individual-level differences: 62 and 73 percent decisions follow global configuration property (i.e. integration), especially when the external factors in the built-environment agreement with each other and thus with the configuration. An add-on effect of spatial configuration and its socio-physical network effect on our cognition is inferred: while we understand the built-form of our city by movement volume, flow, activities, and presence of others within it, the physical built-form also help us make sense of and trust the crowd.

6.1 Limitation

Possible enhancement of the existing method is given, mainly due to time scope allowed:

- Strict control of variables regarding photo taking, including lens angle, weather, and location;
- More careful designed sampling of participates to see if the result can be generalizable, especially with regard to the impact of gender, familiarity, and areas' context;
- Larger sampling of choice pairs;
- More precise assigning of movement volume to streets to represent such impression.

Accordingly, possible alternative methods are discussed along with further research next.

6.2 Further Research

Further explorations could be:

- Online images (e.g., Google Street View) could be used to generate a much larger pool of choice pairs within different neighbourhood, cities, or countries. Digital platform (i.e., websites or app) can allow much wider and larger participants across cities, countries, cultures, and other demographic backgrounds.
- More precise representation of the "impression" of movement flow, e.g., referring to Araneda and Gatica's method (2017), could be explored given more time, together with other possible automatic methods e.g., object detection in computer vision, to quantify the "Network Effect" in images.
- Direct integrating/weighting local environmental information (e.g., could be visual, audio, and etc.), which takes a step further to our sensation with Space Syntax's network values to create a "sensable configuration" for route planning. Referring to Quarcia's (2014) method, various quantifications of visual measures (e.g. using methods discussed in the above point) could be used as edge weight on Space Syntax's network, and thus "best suitable" path from origins to destinations for different daily scenarios could be calculated to help individual route planning.
- Further exploration into the relationship between route choice performance and the areas' intelligibility. For instance, given test settings similar to this study, one possible hypothesis would be that an area with higher intelligibility would show higher wayfinding performances, and, less disturbance on participants' responses when adding factors to disturb the existing environmental information.

6.3 Contribution

This study could contributes to the following aspects:

Practically, it provides initial explorations of methods, which could be compared with and further developed in the interdisciplinary field of urban/architectural design, network analysis, and environmental cognition.

Methodologically, it supports the possibility of Space Syntax's reduction of the built-form (i.e., axial map or other graph-based representations) being as well one principle factor in cognitive dimensions in built-environment research. Similarly, it might support linkage of local rules and global representations (i.e., graph centrality measures) in modelling of movement in (organic) urban settings, where layers of network effects are well integrated into the configuration in time.

To relate aggregated statistical representation with individual's reactions, this study argues for and provides initial evidence on how these two aspects are closely associated. It explains spatial configuration's cognitive meaning from an aspect. In essence, this study might actually suggest the strength of a sociological approach (like Space Syntax) in explaining subjective responses, in comparison with phenomenological ones or approaches focusing on discrete environmental qualities and the enumeration of cause-effect impacts, in line with previous research (e.g., as discussed by Hillier and Leaman, 1973).

References

Al-Sayed, K. (2018). *Space Syntax methodology.* A teaching guide for the MRes/MSc Space Syntax course. Bartlett School of Architecture, UCL: London, UK.

Araneda, C. and Gatica, B. (2017). 'Mapping the Crowd from Within'. In *Proceedings of the 11th International Space Syntax Symposium*, 11, pp. 164-1. Instituto Superior Técnico, University of Lisbon, Portugal.

Barisic, I., Thrash, T., Schinazi, V.R. and Hoelscher, C. (2017). 'Social wayfinding in complex environments'. *CogSci*, p.3675.

Beaumont, P.B., Gray, J., Moore, G.T. and Robinson, B. (1984). 'Orientation and wayfinding in the Tauranga departmental building: a focused post-occupancy evaluation', *Environmental Design Research Association Proceedings*, 15, pp. 77-91.

Benedikt, M.L. (1979). 'To take hold of space: isovists and isovist fields'. *Environment and Planning B: Planning and design*, *6*(1), pp.47-65.

Carpo, M. (2011). *The alphabet and the algorithm*. Cambridge: MIT Press.

Charalambous, E., Hanna, S. and Penn, A. (2017). 'Visibility analysis, spatial experience and EEG recordings in virtual reality environments: The experience of 'knowing where one is' and isovist properties as a means to assess the related brain activity'. In *Proceedings of the 11th Space Syntax Symposium*, 11, pp. 128-1. Instituto Superior Técnico, University of Lisbon, Portugal.

Conroy, R.A. (2001). *Spatial navigation in immersive virtual environments*. Ph.D. thesis, University College London.

Coutrot, A., Silva, R., Manley, E., De Cothi, W., Sami, S., Bohbot, V.D., Wiener, J.M., Hölscher, C., Dalton, R.C., Hornberger, M. and Spiers, H.J. (2018). 'Global determinants of navigation ability'. *Current Biology*, *28*(17), pp.2861-2866.

Dalton, N. (2007). 'Is neighbourhood measurable'. In *Proceedings of the 6th International Space Syntax Symposium*, 88, pp. 1-12. Faculty of Architecture, Istanbul Technical University, Istanbul, Turkey

Dalton, R C. (2005). 'Space Syntax and Spatial Cognition'. *World Architecture,* pp. 107-111.

Dalton, R.C. (2003). 'The secret is to follow your nose: Route path selection and angularity'. *Environment and Behavior*, *35*(1), pp.107-131.

Dalton, R.C., Hölscher, C. and Montello, D.R. (2019). 'Wayfinding as a Social Activity'. *Frontiers in psychology*, *10*, p.142.

depthmapX development team. (2019). depthmapX (Version 0.7.0) [Computer software]. Retrieved from https://github.com/SpaceGroupUCL/depthmapX/releases/tag/v0.7.0

Emo, B. (2009). *The visual properties of spatial configuration*. MSc thesis, University College London

Emo, B. (2012). 'Wayfinding in real cities: Experiments at street corners'. In *International Conference on Spatial Cognition*, pp. 461-477. Springer, Berlin, Heidelberg.

Emo, B. (2014). 'Seeing the axial line: evidence from wayfinding experiments'. *Behavioral Sciences*, *4*(3), pp.167-180.

Evans, G.W., Smith, C. and Pezdek, K. (1982). 'Cognitive maps and urban form'. *Journal of the American Planning Association*, *48*(2), pp.232-244.

Galton, F. (1907). 'Vox populi (the wisdom of crowds)'. *Nature*, *75*(7), pp.450-451.

Gibson, J.J. (2014). *The ecological approach to visual perception: classic edition*. Psychology Press.

Griffiths, S. (2014). 'Space syntax as interdisciplinary urban design pedagogy'. *Explorations in urban design: An urban design research primer*, p.157.

Griffiths, S. and Quick, T. (2005). 'How the individual, society and space become structurally coupled over time'. In *5th international space syntax symposium proceedings*. *Techne Press, Amsterdam*, 1, pp. 447-458.

Hillier, B. (1989). 'The architecture of the urban object'. *Ekistics*, pp.5-21.

Hillier, B. (1996). "Cities as movement economies". *Urban Design International*, 1(1), pp.41-60.

Hillier, B. and Hanson, J. (1989). *The social logic of space*. Cambridge: Cambridge university press.

Hillier, B. and Iida, S. (2005). 'Network and psychological effects in urban movement'. In *International Conference on Spatial Information Theory*, pp. 475-490. Springer, Berlin, Heidelberg.

Hillier, B. and Netto, V. (2002). 'Society seen through the prism of space: outline of a theory of society and space'. *Urban Design International*, *7*(3-4), pp.181-203.

Hillier, B., & Leaman, A. (1973). 'The man-environment paradigm and its paradoxes'. *Architectural Design,* 78, 507–511.

Hölscher, C., Tenbrink, T. and Wiener, J.M. (2011). 'Would you follow your own route description? Cognitive strategies in urban route planning'. *Cognition*, *121*(2), pp.228-247.

Javadi, A., Emo, B., Howard, L., Zisch, F., Yu, Y., Knight, R., Pinelo, J., and Spiers, H., (2017). "Hippocampal and prefrontal processing of network topology to simulate the future". *Nature Communications,* 8:14652, pp. 1-12.

Kim, Y. O. (1999). *Spatial configuration, spatial cognition and spatial behaviour: The role of architectural intelligibility in shaping spatial experience*. Ph.D Thesis, University College London.

Koutsolampros, P. and Varoudis, T. (2017). 'Assisted agent-based simulations: fusing non-player character movement with space syntax'. In *Proceedings of the 11th International Space Syntax Symposium*, 11, pp. 164-1. Instituto Superior Técnico, University of Lisbon, Portugal.

Kuipers, B., Tecuci, D.G. and Stankiewicz, B.J. (2003). 'The skeleton in the cognitive map: A computational and empirical exploration'. *Environment and behavior*, *35*(1), pp.81-106.

Law, S., Seresinhe, C.I., Shen, Y. and Gutierrez-Roig, M. (2018). 'Street-Frontage-Net: urban image classification using deep convolutional neural networks'. *International Journal of Geographical Information Science*, pp.1-27.

Lawton, C.A., (1994). 'Gender differences in way-finding strategies: Relationship to spatial ability and spatial anxiety'. *Sex roles*, *30*(11-12), pp.765-779.

Li, H., Thrash, T., Hölscher, C. and Schinazi, V.R. (2019). 'The effect of crowdedness on human wayfinding and locomotion in a multi-level virtual shopping mall'. *Journal of Environmental Psychology*, *65*, p.101320.

Li, X., Hijazi, I., Koenig, R., Lv, Z., Zhong, C. and Schmitt, G. (2016). 'Assessing essential qualities of urban space with emotional and visual data based on gis technique'. *ISPRS International Journal of Geo-Information*, *5*(11), p.218.

Lu, Y., Peponis, J. and Zimring, C. (2009). Targeted Visibility Analysis in Buildings. Correlating targeted visibility analysis with distribution of people and their interactions within an intensive care unit. In *Proceedings of the 7th International Space Syntax Symposium,* 68, pp. 1-10.

Montello, Daniel R. (2007). 'The Contribution of Space Syntax to a Comprehensive Theory of Environmental Psychology'. In *Proceedings 6th International Space Syntax Symposium*, 1–12. Faculty of Architecture, Istanbul Technical University, Istanbul, Turkey.

Penn, A. (2003). 'Space syntax and spatial cognition: or why the axial line?'. *Environment and behavior*, *35*(1), pp.30-65.

Penn, A. and Turner, A. (2002). Space syntax based agent simulation. Springer-Verlag.

Penn, A., 2003. Space syntax and spatial cognition: or why the axial line?. *Environment and behavior*, *35*(1), pp.30-65.

Peponis, J., Zimring, C. and Choi, Y.K. (1990). 'Finding the building in wayfinding'. *Environment and behavior*, *22*(5), pp.555-590.

Quercia, D., Schifanella, R. and Aiello, L.M. (2014). 'The shortest path to happiness: Recommending beautiful, quiet, and happy routes in the city'. In *Proceedings of the 25th ACM conference on Hypertext and social media*, pp. 116-125.ACM.

Romanescu, V., Barisic, I. and Hoelscher, C. (2018). 'Determining the Influence of Dyadic Role Relationship on a Dyad's Pedestrian Wayfinding Performance'. In *14th Biannual Conference of the German Society for Cognitive Science: Computational Approaches to Cognitive Science (KogWis 2018), Darmstadt, Germany.*

Sailer, K. (2010). *The space-organisation relationship. On the shape of the relationship between spatial configuration and collective organisational behaviours*. Ph.D. Thesis, TU Dresden.

Shatu, F., Yigitcanlar, T. and Bunker, J. (2019). 'Shortest path distance vs. least directional change: Empirical testing of space syntax and geographic theories concerning pedestrian route choice behaviour'. *Journal of Transport Geography*, 74, pp.37-52.

Turner, A. (2003). 'Analysing the visual dynamics of spatial morphology'. *Environment and Planning B: Planning and Design*, 30, pp.657-676

Turner, A. (2005). 'Being in space and space in being'. In *5th International Space Syntax Symposium Proceedings*, 1, pp. 57-63.

Turner, A. and Penn, A. (2002). 'Encoding natural movement as an agent-based system: an investigation into human pedestrian behaviour in the built environment'. *Environment and planning B: Planning and Design*, *29*(4), pp.473-490.

Turner, A., Doxa, M., O'sullivan, D. and Penn, A. (2001). 'From isovists to visibility graphs: a methodology for the analysis of architectural space'. *Environment and Planning B: Planning and design*, *28*(1), pp.103-121.

Varoudis, T. (2019). Unweighted axial analysis in Grasshopper.

Wang, C., Chen, Y., Zheng, S. and Liao, H. (2019). Gender and Age Differences in Using Indoor Maps for Wayfinding in Real Environments. *ISPRS International Journal of Geo-Information*, *8*(1), p.11.

Appendix A Selecting Choice-pairs

Several thresholds are tested before the final ones regarded as more reasonable and practical for this study.

Following images show initial tries when controlling connectivity value in a choice pair to be exactly the same. Practically it is not very necessary - i.e. connectivity 11 and 12 suggest very similar local network property, and realistic - results in very limited and scattered options.

(0703) criteria:

a. pairs of intersecting streets with the same axial connectivity value
b. the difference of integration (R3 R10) values should not be too minor
c. not too far from each other, to make a context (i.e. SOHO, or City of London) for path choice experiment.

Figure A-1 all axial lines around Soho, Covert Garden and City of London areas

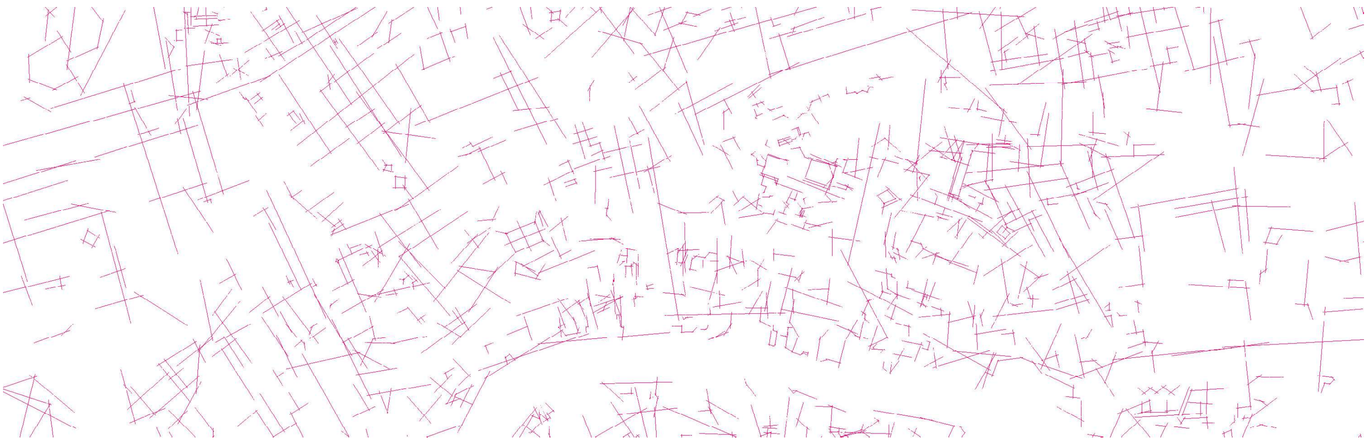


Figure A-2 Axial lines that: intersect, and have the same connectivity value are firstly selectedsss

These selected axial lines should ideally have not too similar Integration R3 (According to Hillier and Iida (2005), sssssssssIntegration R3 is better than other measures (including segment or axial RN) in predicting pedestrian movement, based on case study then), and more global integration, which represent global picture of network properties.

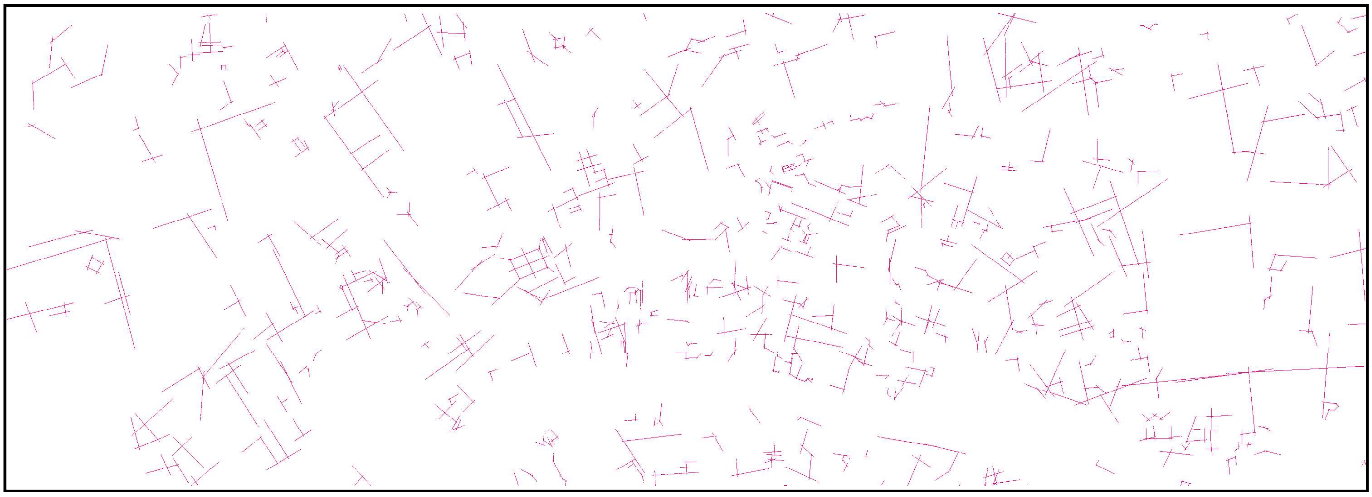


Figure A-3 These intersecting axial lines have the difference on integration R3 values more than 10% of their average.

Figure A-4 These intersecting axial lines have the difference on integration R3 values more than 16% of their average.

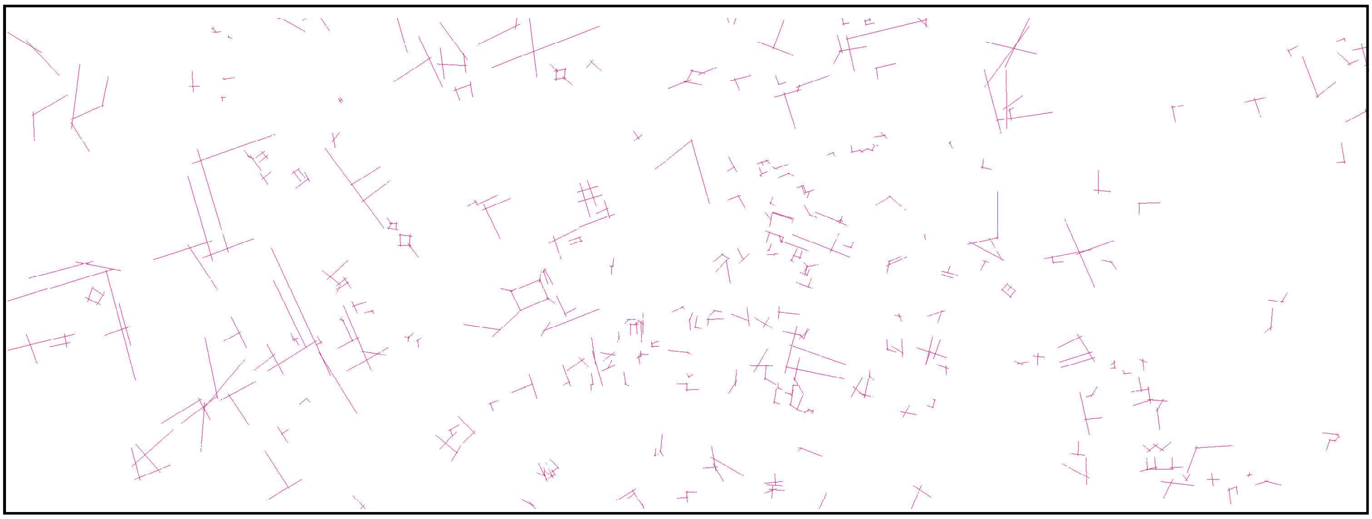


Figure A-5 These intersecting axial lines have the difference on integration R10 values more than 8% of their average.

Figure A-6 These intersecting axial lines have the difference on integration R10 values more than 10% of their average.

As can be seen, when setting connectivity value all the same, the final choice-pairs would be likely have very low connectivity values. And their locations are very far away. It would be more reasonable to have connectivity values that vary, rather than all be 2, which would be likely to happen if the ratio of difference continue to increase. This situation can be imagined that, two very short street, one connected directly to a very busy street, while the other is not.

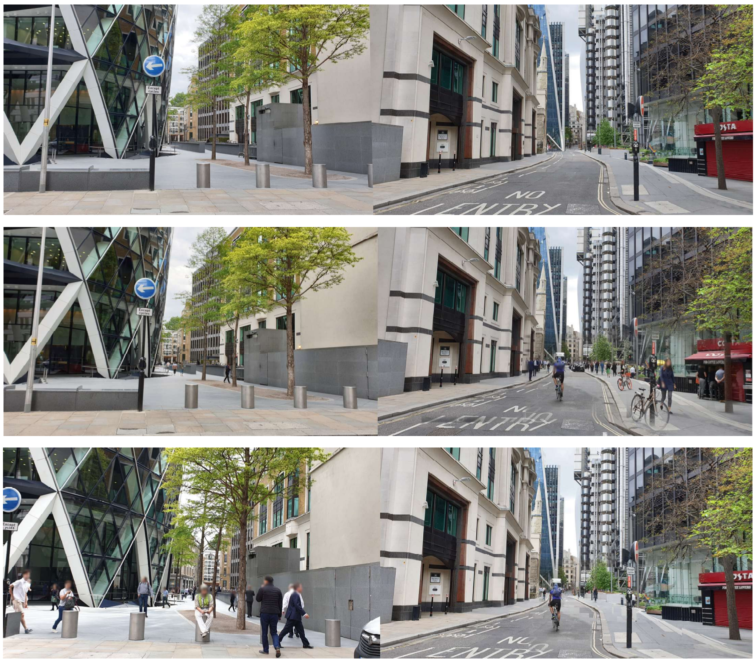
Appendix B. Streets' syntactic values, responses, and images[15] (Pairss from Group A as example)

[15] Images from left to right with order of EMPTY, OBEY and CONFUSE

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Noel St.	P5_1	0.685	0.735	0.162	14	6722230	2576	0.5163762	3.9722073
Benwick St.	P5_1	0.314	0.264	0.837	11	427910	534	0.49809176	3.2018096

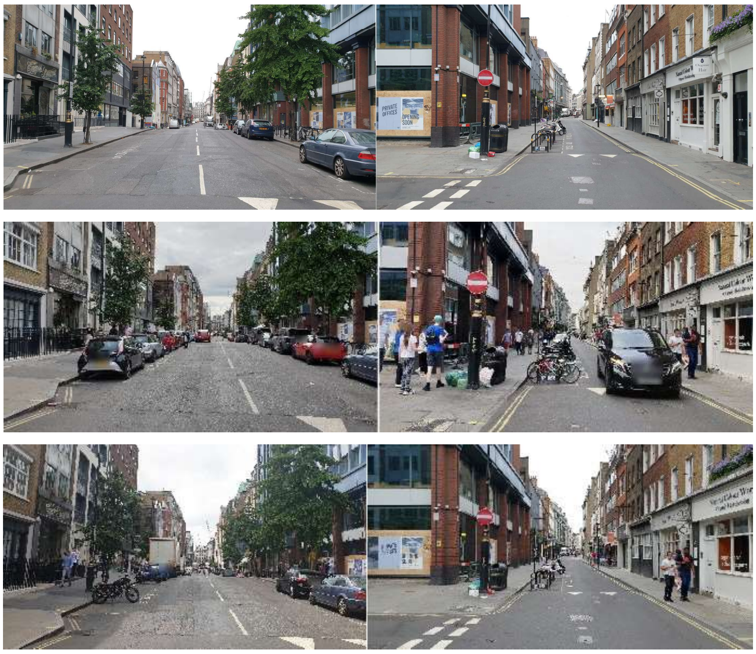
Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Houndsditch St.	P83	0.588	0.702702703	0.457	15	64924464	1281	0.50768703	3.645442
St. Botolph St.	P83	0.411	0.297297297	0.542	9	184892	205	0.49051261	2.9033346

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
St. Mary Axe	P54_1_A	0.702	0.714	0.382	15	1781736	913	0.5104835	3.1821134
(Towards_Bury St.)	P54_1_A	0.297	0.285	0.617	9	40549	127	0.49378565	2.5731819



Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Foubert's PI	P27_1_A	0.648	0.647	0.4	7	731740	178	0.49796808	2.8125131
Kingly St.	P27_1_A	0.351	0.352	0.6	6	282843	116	0.48118067	2.502295

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Poland St.	P7_1_A	0.314	0.559	0.486	10	2972311	1420	0.5163033	3.883311
Great Marlborough St.	P7_1_A	0.686	0.441	0.514	11	427910	534	0.49809176	3.2018096



Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Devonshire St.	P24_1_A	0.618	0.865	0.600	12	1936310	594	0.49884349	3.2689393
Bridford Mews	P24_1_A	0.382	0.135	0.400	10	747025	454	0.48175588	2.8607197

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Poland St.	P7_2_A	0.765	0.943	0.784	10	2972311	1420	0.5163033	3.883311
Noel St.	P7_2_A	0.235	0.057	0.216	11	427910	534	0.49809176	3.2018096

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Portland PI	P25_A	0.714	0.588	0.676	7	418307	183	0.50008875	3.2117844
Duchess St.	P25_A	0.286	0.412	0.324	7	219051	148	0.48302644	2.6361959

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Berners St.	P2_A	0.529	0.743	0.297	14	6722230	2576	0.5163762	3.9722073
Goodge St.	P2_A	0.471	0.257	0.703	13	1318224	1439	0.50326133	3.6234889

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Broadwick St.	P12_A	0.486	0.486	0.235	10	1249825	418	0.4982008	3.0336995
Carnaby St.	P12_A	0.514	0.514	0.765	8	457880	190	0.48116446	2.485739

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Towards Dukes PI	P74_1_A	0.829	0.706	0.568	15	44724664	1581	0.50651544	3.6465659
Towards Stoney Ln	P74_1_A	0.171	0.294	0.432	12	613040	355	0.49050236	2.8554571

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Regent St.	P14_A	0.571	0.757	0.457	14	4455702	2463	0.51629424	3.9488254
Great Marlborough St.	P14_A	0.429	0.243	0.543	11	427910	534	0.49809176	3.2018096

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Great Portland St.	P20_1_A	0.559	0.730	0.571	21	18856942	4325	0.51719326	4.1651435
Margaret St.	P20_1_A	0.441	0.270	0.429	18	783232	1107	0.49908963	3.4633379

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Argyll St.	P15_A	0.595	0.657	0.382	3	61596	138	0.5161829	3.6849225
Little Argyll St.	P15_A	0.405	0.343	0.618	3	35	9	0.49797308	2.7320461

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Leadenhall St.	P52_1_A	0.459	0.618	0.257	23	1.43E+09	3780	0.52565795	3.9381936
St. Mary St.	P52_1_A	0.541	0.382	0.743	15	1781736	913	0.5104835	3.1821134

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Dukes Pl	P81	0.886	0.735	0.459	15	44724664	1581	0.50651544	3.6465659
Towards Mitre Square	P81	0.114	0.265	0.541	9	184892	205	0.49051261	2.9033346

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Leadenhall St.	P52_2_A	0.471	0.457	0.216	12	1.37E+09	1160	0.51576048	3.5101964
Lime St.	P52_2_A	0.529	0.543	0.784	15	1781736	913	0.5104835	3.1821134

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
PathwayTowardsLeadenhall St.	P58_A	0.618	0.757	0.371	9	989089	227	0.51047635	3.0265956
Undershaft	P58_A	0.382	0.243	0.629	8	62516	69	0.49518955	2.5517466

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Foubert's Pl	P27_2_A	0.559	0.784	0.200	7	731740	178	0.49796808	2.8125131
Kingly St.	P27_2_A	0.441	0.216	0.800	6	282843	116	0.48118067	2.502295

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Houndsditch St.	P75_1_A	0.865	0.971	0.647	15	64924464	1281	0.50768703	3.645442
Stoney Ln	P75_1_A	0.135	0.029	0.353	12	613040	355	0.49050236	2.8554571

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
St. Mary Axe	P54_2_A	0.676	0.914	0.471	15	64924464	1281	0.50768703	3.645442
Undershaft	P54_2_A	0.324	0.086	0.529	9	184892	205	0.49051261	2.9033346

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Carnaby St.	P31	0.784	0.882	0.800	4	32831	26	0.48103601	2.302964
Little Marlborough St.	P31	0.216	0.118	0.200	3	8	4	0.4652074	1.7195774

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Dukes PI	P74_2_A	0.784	0.794	0.714	15	44724664	1581	0.50651544	3.6465659
Towards Creechurch Ln	P74_2_A	0.216	0.206	0.286	12	613040	355	0.49050236	2.8554571

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Devonshire St.	P24_2_A	0.486	0.588	0.243	12	1936310	594	0.49884349	3.2689393
Hallam St.	P24_2_A	0.514	0.412	0.757	10	747025	454	0.48175588	2.8607197

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Noel St.	P5_2_A	0.588	0.838	0.657	14	6722230	2576	0.5163762	3.9722073
Benwick St.	P5_2_A	0.412	0.162	0.343	11	427910	534	0.49809176	3.2018096

Street_Name	Choice_Node	StreetWin_EMPTY	StreetWin_Obey	StreetWin_CONFUSE	Connectivity	Choice-RN	Choice-R3	Integration-RN	IntegrationHH-R3
Houndsditch St.	P75_2_A	0.429	0.676	0.595	15	64924464	1281	0.50768703	3.645442
Creechurch Ln	P75_2_A	0.571	0.324	0.405	12	613040	355	0.49050236	2.8554571

Appendix C

Participants' Descriptions

ID-time	What is your major/occupation?	....Tell a bit how you make your selections? (optional)
7/26/2019 12:08:54	Student - MSc. Urban Regeneration	Based on design, greenery and number of people on the street
7/26/2019 12:35:17	student	feelings
7/26/2019 12:55:04	student	according to my travel experience in London
7/26/2019 12:58:30	building environmental design	
7/26/2019 13:08:07	student	how busy the area looks
7/26/2019 13:16:01		
7/26/2019 13:33:00	student	Logically, seeing people, cars
7/26/2019 13:40:50	student	Instinct
7/26/2019 13:58:16		Signages
7/26/2019 14:06:04	Student	
7/26/2019 14:17:29		
7/26/2019 14:21:30		
7/26/2019 14:22:09	International Public Policy	In terms of the quantity of people and their direction; and the quantity of shops
7/26/2019 14:27:55		
7/26/2019 14:28:11	Sustainable resources	width of the streets/the number of vehicles and pedestrians/the height of the buildings
7/26/2019 14:28:38	student	
7/26/2019 14:29:16	student	
7/26/2019 14:32:35	student	Logo
7/26/2019 14:36:40	Student	
7/26/2019 14:40:15	Student/Architect/	Based on the number of people, walkability and a possible geo-localisation.
7/26/2019 14:56:57	Student	I looked for people, and I tried to see if it's a road or a footpath
7/26/2019 15:12:44	Student (Sustainable Heritage)	See the crowds and the traffic direction (2-ways is prefered)
7/26/2019 15:24:25	engineer	
7/26/2019 15:25:36		
7/26/2019 15:28:44	acadenuc	intuitive
7/26/2019 15:28:45		Mainly the spatial characteristics, but the number of people will influence my choice sometimes
7/26/2019 15:33:59	Student	Gut-decision
7/26/2019 15:39:17		
7/26/2019 15:40:36	Energy Systems and Data Analytics	Streets I knew or wider roads is how I picked :)
7/26/2019 15:46:17	Student	Mostly based on the layout of roads, number of people, dead end roads, type of buildings
7/26/2019 15:54:46		
7/26/2019 16:02:01		
7/26/2019 16:22:41		Depends on Cars & people

7/26/2019 17:09:33	Student	
7/26/2019 17:17:04	Student	1. The number of passengers. For example, large population indicate the popularity of the place. Hence, the way finding should be well managed. Also, you can easily get help. 2. The direct feeling about the street. For example, you are unwilling to pass by a narrow and boring street. or some of the places may seem like private and not welcoming 3. Safety also is a issue. 4. I could recognise landmark building in some pictures, so you could know where you go next
7/26/2019 17:28:19	energy	broader road and crowded people
7/26/2019 17:45:16		
7/26/2019 17:48:03	Researcher	I mainly selected the most populated streets
7/26/2019 17:49:30	Student	More inclined to choose places with more people, more cars, cleaner buildings, well known brands (e.g. Pret), streets that were brighter and with less trash (basically ones that looked less intimidating)
7/26/2019 17:53:58	student	the places that look like roads that would be leading or coming from central places
7/26/2019 17:58:47	LLM	I guess that some of those areas may be places that I have been to
7/26/2019 17:59:13	Student-Intern	I chose the most croweded place or the most commercial place
7/26/2019 18:02:37	Mental health	Based on the number of people and cars on the street
7/26/2019 18:05:58	Law	
7/26/2019 18:06:21	Student	¯_(ツ)_/¯
7/26/2019 18:06:36	Software Engineer	Number of people and the direction they're from. Cars parked and the direction they face away from. Presence of highrise buildings or spires in the background (means more people/ places of interest)
7/26/2019 18:29:36	ucl student majored in applied linguistics	the surroundings, which road has more people and cars
7/26/2019 18:32:32	Student	Looking for trafic and people, not going down pedestrian only roads or deserted roads
7/26/2019 18:32:37	education	rely on traffic lights, ancient architecture, unique store outlook, trees, etc
7/26/2019 18:40:09	ethnographic documentary film	the street that are more crowded, more capacious and there are more people
7/26/2019 18:43:25	student	by intuition
7/26/2019 18:54:26	Architectural Engineer	Number of people, places I recognize, open spaces
7/26/2019 19:05:51	Medicine	I recognised the architecture in some of the pictures as different parts of London. I could also see some familiar skyscrapers in the background for some. I looked at the direction some people and cars were going and the volume in the photos. I also looked at how run down an area was/ any construction (these were areas I would avoid).
7/26/2019 19:22:51	student	
7/26/2019 19:23:01		some places were familiar but the majority was based on guessing
7/26/2019 19:29:36	Student	
7/26/2019 19:29:48	Student (Mathemtics)	Preference for busier strees with people and streets with signs (e.g. road signs or shop signs
7/26/2019 20:05:17	MSc student - Business Psychology	Chose the photos that had more people, moving cars and stores
7/26/2019 20:08:09	Human-Computer Interaction	i looked for pictures where i could see all the way down the street, chose ones without the red signs or things blocking the road
7/26/2019 20:22:39	student	availability of others to ask questions/find solutions faster
7/26/2019 20:30:19		
7/26/2019 20:35:05	Global Health	Where was busy or looked familiar, which had businesses or people that would orient me. I imagined being on my bike so didn't go onto one ways.
7/26/2019 20:41:09	student postgrad. (chemistry)	
7/26/2019 20:42:04	arts and sceinces	people light
7/26/2019 21:10:23	student	
7/26/2019 21:14:10	Urban Design and City Planning	The Landmark
7/26/2019 21:14:21	student	more people, restaurants

7/26/2019 21:15:11		
7/26/2019 21:15:12		
7/26/2019 21:32:28	Law	The direction, the buildings, the area, the photo angle?, the environment
7/26/2019 21:32:40		
7/26/2019 21:44:38	Student	1.modern buildings 2. zebra crossing and road sign 3. more people 4.more shops
7/26/2019 21:47:50		view
7/26/2019 21:54:01	student	
7/26/2019 21:59:39	student	intuition
7/26/2019 22:04:44	student	by instinct
7/26/2019 22:07:51	student	
7/26/2019 22:09:38	Medicine (undergraduate)	I picked the option that looked more busy/had shops/looked safer (so that I could find people and ask them for help/directions) I avoided areas that looked empty or dangerous
7/26/2019 22:17:08		
7/26/2019 22:29:08	dentist	
7/26/2019 22:29:46		
7/26/2019 22:32:42	Transport Engineering	
7/26/2019 22:35:12	Dentist	
7/26/2019 22:43:17	English linguistics masters student	
7/26/2019 22:49:04	student	modern way to go, resemble way to go
7/26/2019 22:51:23	English Linguistics	
7/26/2019 22:51:51		
7/26/2019 22:59:46	Law	
7/26/2019 23:02:37	Student	By recognising parts of the city, where more people, etc
7/26/2019 23:11:02	Student	If the route is pedestrianised or has shred surface I prefer it. If the route is very deserted or calm, I would avoid it.
7/26/2019 23:11:26		
7/26/2019 23:20:02	Language Science	More people, traffic lights, well known establishments, larger roads, more cars
7/26/2019 23:22:25		
7/26/2019 23:30:46	Student	I'm looking for the main road and people.
7/26/2019 23:31:28		
7/26/2019 23:32:21	Biomedical Sciences	More people heading towards the direction, larger roads, familiar shops/signs
7/26/2019 23:35:02		
7/26/2019 23:41:25		follow my gut
7/26/2019 23:41:37	Postgrad student	To get to central London if I get lost, I would look at streets with these features: more people, main landmark buildings, less walkable more transited by cars, less "no entry" signs and looks less residential.
7/27/2019 9:26:10	Student	
7/27/2019 10:50:31	Medical student	Big roads (e.g. single carriageway, not a one-way road). Presence of people. Visual markers suggesting limited access avoided. A structure at the end of the current road could imply that there is another perpendicular road, instead of a long stretch of road, which you can't get easily out of.
7/27/2019 11:26:35	Student	
7/27/2019 14:08:33	Architect	Light, people, people's direction, known buildings, width of street, cleanness, visibility/visual line
7/27/2019 18:51:57		familiar
7/28/2019 10:12:43	Architect / Researcher	

7/29/2019 15:17:41	Student	
7/27/2019 13:16:38	Architect-Planner	to whichever street looks busier, more important or shorter
7/27/2019 13:19:29	Urban Planner	I looked at the width of the streets, if there are any landmarks in the end , If I can see very far so not choosing the ones with bends, the ones which had more people and less construction, some which seemed like the end of the street is closer on one side than on the other side.
7/27/2019 13:26:14	Urban design	
7/27/2019 13:29:42		
7/27/2019 13:31:41	Account Manager, Sales and Marketing	I decided on which streets to take based on the number of pedestrians, if vehicles were allowed or not, if it looked safe or not, if the place was neat or not, whether it looked like it was taking me to a main road or not etc
7/27/2019 13:34:04	currently btec graduate	most of the time i look towards the amount of people and always when u see a tree or more greenish there is a relaxing feel so i choose more greener ones
7/27/2019 13:44:21	Architecture	More inclined to choose the occupied pedesrrian steet
7/27/2019 14:08:38	March design for performance and interaction	Choose a sence with better scenery
7/27/2019 14:47:07	Street	More people, more stores, colorful streets, greenery etc
7/27/2019 15:54:20	Management	Based on openess of area.
7/27/2019 15:57:57		
7/27/2019 15:58:25	Clinical Mental Health Sciences	I would go for more prominent buildings or if I saw a bus route or bus stop
7/27/2019 16:04:31	Accountant	Where there is an open road with accessibility to cars
7/27/2019 16:04:38	Smart cities	
7/27/2019 16:04:58	Biochemical Engineering	Mainly on traffic signs and the number of pedistrains
7/27/2019 16:05:21	Medical Student	If there is a greater possibility of public transport (i.e buses, tube etc) or general information points present
7/27/2019 16:05:59	Student	
7/27/2019 16:10:12		
7/27/2019 16:16:19	Digital media	Based on the width of the road and what's at the end of the road, as well as the amount of people on the street :)
7/27/2019 16:17:10	Chemistry	
7/27/2019 16:18:15	Infrastructure	Feeling
7/27/2019 16:20:08		
7/27/2019 16:28:27	Physics	I look for traffic signs, how many cars on the road, how far in the distance the buildings are at the end of the road, how busy the pedestrian areas are, how clean the streets are (the more rubbish, the more tucked in the roads are and further from the main roads), bus routes.,)
7/27/2019 16:31:19	Chemical Engineering	Busy/Tall Buildings/Areas that look like central london
7/27/2019 16:32:54	Data science	depend more on how many people and shops in the street
7/27/2019 16:35:17	Researcher	Sign board and people in the pictures
7/27/2019 16:38:23		
7/27/2019 16:40:38	Student	Tried to choose the wider streets and those which appeared to be more populated
7/27/2019 16:44:41	Post-doc Research Associate	Signs on the street
7/27/2019 16:49:31	ENGINEERING FOR INTERNATIONAL DEVELOPMENT	FIND A STREET WHERE HAVE MORE PROPLE OR CAR
7/27/2019 16:54:05	Library and Information Studies	I think I chose the less crowded options
7/27/2019 16:55:10	medicine	Interesting
7/27/2019 17:01:58	Data Science Mentor	Usually go where there is transport options such as bus stops.

7/27/2019 17:05:47	psychology	if there was a crowd of people, or if it was a place that was familiar and I knew that it led to a main street
7/27/2019 17:06:47	UX DESIGNER	I just chose the shortest walk to another street which will help me find out where about am I. If the end is all the way down the stree I would chose the image that has the nearest end of the street
7/27/2019 17:09:58		
7/27/2019 17:12:08	Publishing	By instinct
7/27/2019 17:15:28	I am Master full-time student	I have selected places that looked familiar, and pics where mostly I could see the end of the street, or where I spotted an historic building on one side, or shops, or again streets where there were people (I could ask for some help), generally speaking I have chosen places that I thought were more reassuring.
7/27/2019 17:20:37		Looking for large roads, or recognizable features
7/27/2019 17:28:41	student - machine learning	intuition > road width > look of buildings at the far end > following the crowd
7/27/2019 17:33:54	Student	I try to find indicators of non-residential areas, which are likely to be close to main streets and landmarks. For example, big or two directional roads, a crowd of people, monuments, or skyscrapers.
7/27/2019 17:42:44	MSc Civil Engineering	The intuition and some generic judgement like the way crowds are movin towards, and the distribution of the buildings in images.
7/27/2019 17:49:33		
7/27/2019 17:54:19	Space syntax	instinct
7/27/2019 18:03:55		Choose a more crowded place/bigger street
7/27/2019 18:04:19	Sales assistant	Just choose
7/27/2019 18:05:50	Epidemiology MSc student	I recognise a lot of the places
7/27/2019 18:08:29	Student	By assuming which roads would lead to more crowded places or taking crowded roads. Alternatively, by following familiar paths
7/27/2019 18:08:34	DOCUMENTARY film	
7/27/2019 18:11:59		
7/27/2019 18:14:37	I study English and Classics at UCL. I will be beginning my second year of undergrad this Fall.	
7/27/2019 18:29:42	Medicine	I tried to pick the places that looked more busy, had more light, less construction going on and generally looked more cleaner as that what my mind perceived as safer.
7/27/2019 18:30:03	Geography	The main rationale for my selection is based on the openness of the street and the traffic
7/27/2019 18:40:21		
7/27/2019 18:43:22		
7/27/2019 18:49:52	machine learning	surroundings humans and cars or bus stop
7/27/2019 18:54:06	Chinese / Graphic Designer	Just feeling
7/27/2019 18:56:44	Designer	follow my heart and intuition
7/27/2019 19:03:11	laws	I prefer the one that looks more comfortable and safe with more colours.
7/27/2019 19:06:17	Engineering	What seemed familiar, more crowded
7/27/2019 19:07:23		
7/27/2019 19:13:01		
7/27/2019 19:14:04		
7/27/2019 19:22:02	Accountant	some randomly and some by knowing the roads
7/27/2019 19:24:23	Organizational Psychology at Uni	If there are lots of people, red busses, big office-looking like buildings, big streets. Ans streets where no cars are allowed (mainly for pedestrians).
7/27/2019 19:37:45	economics	how should have i ?

7/27/2019 19:42:31	Medicine - student	Either places I am familiar with or streets that look like they would lead to the main road
7/27/2019 19:50:37	Engineer	
7/27/2019 19:54:17		Visual clues, Familiarity of place, People and clear route through the street.
7/27/2019 20:05:02		
7/27/2019 20:24:15	Photography politics and media	I chose the one that looked like it led to a more open area / was a more main street
7/27/2019 20:24:35	Dance, geography and drama	If there are buildings at the end or the streets are narrow or not.
7/27/2019 20:40:21	Neuroscience	Number of people and shops
7/27/2019 21:47:58		
7/27/2019 21:55:24		
7/27/2019 22:01:03	law	shops, rubbish bin
7/27/2019 22:06:04	MSc cardiovascular science	it was mainly based on the width of the street and presence of crowd where I will feel safe if I get lost
7/27/2019 22:43:03	MSc at UCL	Preference to crowdy or wider streets
7/27/2019 23:09:12	Student - space syntax	Main streets, busy streets, and other streets with economic activities appears to be a better choice
7/27/2019 23:28:37	Designer	Line of sight Distance, amount of people, angle of image, more fun place
7/28/2019 0:27:39	Architectural Computation	i prefer to choose the longest sight of line, which might be the main reason for navigating
7/28/2019 9:14:16	Student	By less amount of further xhoice, landmarks and people.
7/28/2019 11:08:31	student	Crowd, length of street, no entry signs, pre-existing knowledge of place
7/28/2019 11:14:03	Economics and Policy of Energy and the Environment	familiarity with the locations
7/28/2019 11:16:29	MSc Economics and Policy for Energy and the Environment	Whatever seemed busier
7/28/2019 11:21:58	architecture	more people, wider road
7/28/2019 11:25:54	telecommunication	ppl, car, crowd
7/28/2019 11:30:49	pharmacy student	look where there are people, big buildings, signs on the road
7/28/2019 11:31:44	Law student	What feels like it leads to a broader space, not a dead end
7/28/2019 11:36:21	public policy	
7/28/2019 11:37:24	human computer interaction	large no. of people, larger street, modern / familiar buildings
7/28/2019 11:40:38	MSc Student	I generally chose wider roads and those that had more pedestrians.
7/28/2019 11:40:42	Teacher	Look for bigger buildings in the distance. Somewhere you might know or be able to direct yourself from. Look for areas that look pedestrianised as these are often central areas. Sometimes look for openings either under a bridge or through a shortcut to get to possibly get to a main area.
7/28/2019 11:44:44	Medicine	Based on how many people are around & the type of buildings - eg if skyscrapers it is more likely to be city centre and so likely to find a way out.
7/28/2019 11:47:45	student	no
7/28/2019 11:53:48	medicine at ucl	number of people/cars, shops, if i know the place, stay away from the rural looking/empty roads with no cars
7/28/2019 11:54:32	Physiotherapist	I chose places that were more crowded because I thought I might be able to ask somebody for help. I also picked familiar neighbourhoods and less spooky ones. I tired to choose open spaces or streets that I know where they would lead. I tried to avoid going in empty streets or places where there was no public space (i.e. cafeteria, restaurant, shops).
7/28/2019 12:00:18	law	more people
7/28/2019 12:02:54	architect	i look at building setbacks and signage
7/28/2019 12:04:57	My major is law.	I will look for the road with the bus stops or the road with two-way lane.

7/28/2019 12:05:50	clinical neuroscience	what direction looked like it would lead onto a main road. Or if I could spot any landmarks in the picture-would choose this option. And avoided any direction that appeared to lead to a dead end
7/28/2019 12:06:07	Smart Cities and Urban Analytics	
7/28/2019 12:11:25		I wouldn't choose it if it looked like a dead end. Some photos looked like main streets I recognised so I chose them as where I would go (because it seems that that is already the main street)
7/28/2019 12:12:34	Economics	Knew some of the areas
7/28/2019 12:13:00	psychology student	largely based on the flow of people
7/28/2019 12:18:16	Medical student	
7/28/2019 12:21:23	Medicine	How busy the streets were; how wide the roads were; whether there was a clear route to follow in the distance; if I recognised the place
7/28/2019 12:43:34	Criminology	If i see many people going towards a direction, i assume you go somewhere central. Also, some steets had signs that said no entry, so i didnt choose them
7/28/2019 12:45:25	Urbanisation	Going by what I see at the end of the road, human traffic, vehicular traffic, avoiding places where there are construction works
7/28/2019 12:58:30	literature/student	the amound of shops and crowds at the end of the road
7/28/2019 13:05:19		
7/28/2019 13:05:21	MSc Urban Design and City Planning; Part-time graphic designer	Chose places where either there is a tube station, more activity density or a greater architectural mix
7/28/2019 13:15:52	student	feeling：）
7/28/2019 13:16:22	International Politics	by how familiar the pictures look :)
7/28/2019 13:18:56	Finance	Based on how many buildings I see at the far end and whether there are many people on the street. The number of cars in the pictures are also very important.
7/28/2019 13:34:03	Sales	Feeling
7/28/2019 14:25:46	urban design	intuition
7/28/2019 14:25:52	economics	feeling
7/28/2019 14:27:07	Aerospace Engineering	By looking to the distance and seeing what kind of buildings I see. e.g if its tall office buildings then i assume it would be a main road
7/28/2019 14:34:09	PhD Anthropology	based on how crowded the roads are, how open they are and the amount of traffic
7/28/2019 15:02:58	Luxury brand management	Depending on stores, number of people and buildings like churches..
7/28/2019 15:05:28		
7/28/2019 15:08:12	chemical engieering	most busy/ least open
7/28/2019 15:11:58	Scientist	Intuition entirely, tried to find a reason but couldn't
7/28/2019 15:14:15	interpreting	I tend to choose open space with more people, cars and bus in particular.
7/28/2019 15:42:13	Law student	
7/28/2019 15:51:18		
7/28/2019 15:54:49	MSc space syntax	The distance i'd have to walk; the frontages; many cases the image was already of a central street;
7/28/2019 17:34:57	Architect	Clean street ,shop ,people, cafe
7/28/2019 18:30:14	Architecture and city planning	I was more likely to choose the places i could identified, but for the areas that I could not, my selection was based mainly on the cleanliness of the street, the amount of people(whether or not the street is more pedestrian friendly, or more vehicle dominated). Also I think because i have loved in the city for a while, i am more likely to choose streets that are less busy (be it with people or traffic).
7/28/2019 19:17:00	Government Policy Advisor	If the end of the street is lighter at the end, I think that makes me think there is a bigger street at the end. Vans and lorries indicate that it might be a dead end or service street, not a main road. I like being able to see the next junction, indicating main roads ahead, rather than a street disappearing round a corner.
7/28/2019 20:15:27		

7/28/2019 22:15:08	PhD in Health Data Science	More people, the amount and type of shops, presence of hire bikes, presence of bus/bus lanes, no. of vehicles and how easy it is for a car to drive through, can indicate main/central areas. Road signs e.g. no entry or dead end, narrow spaces indicate non-central areas.
7/28/2019 23:36:05		
7/29/2019 11:40:57	M.Sc Architectural Computation	Landmarks, broad streets and clearly marked street signs
7/29/2019 12:06:32		Instinct
7/29/2019 14:31:27	Architecture Computation	Mostly with my commen sense, I would say the wider Road is probably connected with the main road. While some Road have a sign at the conner which influences my choice.
7/29/2019 14:32:19		