# Pedestrian itinerary choice: between multi-sensory, affective and syntactic aspects of the street pattern in the historic quarter of Bejaia, Algeria

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# Pedestrian itinerary choice: between multi-sensory, affective and syntactic aspects of the street pattern in the historic quarter of Bejaia, Algeria

Sara Boumezoued[1*], Yassine Bada[1] and Hocine Bougdah[2]
*1 LACOMOFA laboratory, Department of Architecture, University of Biskra*
*2 School of Architecture and Cities, University of Westminster*
* Corresponding Author, Email Sara.boumezoued@univ-biskra.dz

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**Key words**: Pedestrian Mobility, Multi-sensoriality, Space Syntax, Itinerary Choice, Affectivity.

**Abstract**: Consideration of the five senses and emotions is not well explored in the urban environment. Different fields deal with the influence of the physical environment on human experience. However, the role of the multi-sensory experience and affectivity in selecting the itinerary for pedestrian mobility is not yet well studied. Several methods have been proposed to evaluate the correlation between pedestrian movement and the environmental configuration, where the visual parameter is the main determinant. Given that other senses could be used to select any itinerary, since the urban environment is perceived at a multisensory level, the aim of the present study is to investigate the relationship between people's multisensory experience and their navigation in an urban environment in terms of itinerary choice. This study is carried out on the streets linking the city centre to the seafront in Bejaia, Algeria. The investigation was based on qualitative and quantitative methods. The former consists of the organised walk with running commentary technique. The latter consisted of a syntactic analysis of the street pattern. The results show that people choose their itinerary not only on the visual aspect created by the spatial configuration, but also on several variables related to the affectivity and multi-sensory experiences of the urban environment. The findings will be discussed with regard to their usefulness for the design and development of urban publics spaces.

## 1. INTRODUCTION

Whether to go to work, walk for the sake of it or go shopping, walking is an integral part of our everyday life. However, the ever-increasing use of cars in the urban environment has strongly reduced the opportunity to enjoy walking for many people. In cities, the street is the cradle of social life (Chapman, 2017) and walking has several advantages for physical and mental health. For this reason, the developers of urban areas are working to encourage walking through the creation and modernization of pedestrian streets.

The field of pedestrian mobility covers various themes, such as pedestrian level of service (Nag & Goswami, 2019) and route choices. With regard to the latter, the research on pedestrian environment deals with the technical aspects rather than the role of landscapes and ambiances. The functional aspects such as the width of the sidewalks, the built environment and the presence of businesses have been widely studied in several works (Cervero & Kockelman, 1997; Desyllas & Duxbury, 2001). Furthermore, the notion of distance, in its different forms (the shortest, the fastest, with the least directional change etc.), is the focus of most studies on pedestrians' movement (Chiaradia, 2013). However, some researchers are against the idea of choosing the best pedestrian route based on the shortest route principle (Masson, 1998). Likewise, other researchers confirmed the usefulness of the latter criteria, in favour of other ones such as the ambiances (Piombini, Leduc, & Woloszyn, 2014). Therefore, the qualitative criteria tend to have a primary role in the determination of the itinerary choices. It seems that the mobility behaviours are intensely influenced by qualitative and quantitative factors. However, it is important to focus on subjective qualities, such as the emotions in the city, rather than simply considering the quantitative characteristics.

In order to identify the relationship between the pedestrian mobility, the itinerary choice and the urban spaces, research strategies tend to fall into two categories. The first one tends to correlate the spatial structure and the behaviour of pedestrians in terms of visibility (Hillier, B & Hanson, 1984) while the second one implies the understanding of the individual's perception of movement, including all the senses. The former is integrated in the spatial syntax developed by Hillier, B (1996). In his theory of natural movement, the author demonstrated that despite the presence of retail or other magnets, the configuration is the main generator of movement that he coined the natural movement concept. The urban movements, including vehicles and pedestrians are better shaped by the geometric and topological properties of the grid than by their metric properties (Hillier, Bill & Iida, 2005). Therefore, the vision is the main attribute (Hillier, B & Hanson, 1984). Several indices were proposed by the space syntax where the principal value was the integration (Ortega - Andeane et al., 2005; Hillier, B et al., 1993). Another geometrical aspect could be cited, such as the angular analysis (Dalton, 2001). Combined with other dimensions, space syntax has been used also in street quality measurement (Zhang et al., 2019). In parallel to the spatial configuration, there is a sensitive configuration, composed of ambiance and landscape. The second current of research is mainly based on perception and takes into consideration the critical experience regarding the understanding of the pedestrian behaviour.

While the research in this area is continuously progressing, considering the five senses and emotions related to spaces in the field of pedestrian mobility is not yet well explored. Senses and emotions are immaterial and subjective parameters which makes them difficult to analyse (Bailly, 2016). Therefore, they are mainly considered with minor importance in the city, due to the supremacy of a form of functional urbanism condemning affects (Hoch, 2006). Few studies considered the affectivity and multi-sensoriality in the city such as Feildel (2013) who confirmed the correlation between the affects and the places. Likewise, Manola (2013b)) proposed a new approach, the multisensory backpacks. Thomas (2004) developed a typology of pedestrian itineraries through the prism of the senses. To our knowledge, there seems to be little available data about the role of senses and emotions in the choice of the itinerary taken by the pedestrian, which is the aim of the

present study. In addition, the study is undertaken using a mixed method approach that recognizes the role of the senses, other than the vision, and their related emotions in influencing the pedestrian behaviour. In addition to the spatial configuration impact, we hypothesize that itinerary choice is affected by the sensory qualities of the urban environment. The spatial syntax theories concern the effect of the visual lines on the distribution of the pedestrian stream. However, the existent visual relations between the places have quantitative contribution and omit the real characteristics of the immediate environment (Foltête & Piombini, 2007; Osman & Suliman, 1994). Therefore, in this context the spatial syntax omits the qualitative aspect of landscape and ambiance, which are related to several sensorial characteristics of the itinerary as we consider the places with all our five senses. For this reason, this work combines the syntactic approach with a sensorial one. In doing so, the paper will contribute to a better understanding of the impact of the sensory experience of urban environments on pedestrians' itinerary choice using a mixed-method approach.

## 2. THEORICAL FRAMEWORK

### 2.1 Pedestrian mobility and space syntax

By studying the impact of spatial configuration on pedestrian movement, Hillier, B (1996) developed the concept of natural movement which adopts the space as either a destination, referred to as "to-movement" or as a transition, known as a "through movement". Therefore, the movement is defined by the intelligibility of the network which is "the degree to which what we can see from the spaces that make up the system -that is how many other spaces are connected to it- is a good guide to what we cannot see, that is integration of each space to the system as a whole" (Hillier, B, 1996).

When walking, pedestrians are always facing moments of decision at any road bifurcation or junction. While the bifurcation offers two choices, the junction offers three or more choices. These spatial configurations are among the five elements of the city (Lynch, 1999). The bifurcation is defined, for each given route, such as the junction from which the observed route does not take the shortest path (Piombini & Foltête, 2007). In other words, this is what Foltête and Piombini (2010) translate into English as "deviation". The present study does not focus on the criteria of distance minimization since it is interested in both the itinerary chosen and the sensory experience of the pedestrian. Furthermore, the junctions and bifurcations were limited to three, due to the exploratory nature of the study.

The bifurcation and junction are composed of two elements: the moment which is the time at which we take a decision, and the sections among which one is chosen while the others are ignored. The definition of the bifurcation and junction moment depends on the contribution of the actual moment perception compared to the measurable stimuli that is directly observed in-situ. According to Piombini and Foltête (2007), the decision to take a specific route at any junction or bifurcation depends on the observed landscapes. The pedestrian who is not familiar with the city is, for a moment, motionless at a bifurcation or junction, taking time to see and feel the places around. The definition of bifurcation or junction sections depends on the anticipation of the coming places (Piombini & Foltête, 2007; Cauvin, 1999). However, when the pedestrians are familiar with the city, not only do they sense and feel the surroundings, they also make use of memory recall to

help them decide on the itinerary. These two hypotheses were discussed by Piombini and Foltête (2007) with reference to one sense only, vision, and were referred to as global choice and local choice hypotheses. The contribution of the present study lies in extending these hypotheses to all the five senses and applying them to an itinerary composed of a three-sections junction and two bifurcations. In connection with the above, it is imperative to define three notions inherent to the field of pedestrian mobility, namely spatial cognition, navigation and wayfinding. Spatial cognition is about "the study of knowledge and beliefs about spatial properties of objects and events in the world… spatial properties include location, size, distance, direction, separation and connection, shape, pattern, and movement" (Montello, 2001). Navigation is defined by Golledge et al. (2000) as "the processing of spatial information regarding position and rate of travel between identifiable origins and destinations summarized as a course to be followed". According to the same authors, wayfinding involves the selection of segments, among an existing network, and linking them to form a journey along a chosen path.

## 2.2 The multisensory and affective approaches to pedestrian mobility

The impact of the visual landscape on the choice of the pedestrian's itinerary is extensively discussed in the literature (Foltête & Piombini, 2007; Piombini & Foltête, 2007; Zacharias, 2001, 2006). While the role of vision in deciding the itinerary choice is paramount, the contribution of the other senses is yet to be fully discussed and understood despite the fact that all five senses are the first filter to the perception. According to Berthoz (1997, 2008), there is a sixth sense, which is the movement and confirms that the perception is multimodal in a way that is not possible to separate between the senses. Chelkoff (2001) reported that the ambiance is based on the five human senses, while Thomas (2004) proposed a sensitive ethnography of ambulatory experiences. Given that the way people decide on the choice of itinerary is affected by their perception and experience of the urban space, the affective approach to studying urban environments is relevant if not indispensable.

A number of scholars have approached the topic. According to Dellal (2010), the city is simultaneously perceived in rational and sensitive modes. Bailly (2016) argues that the five senses of the pedestrian generate sensations leading to emotions' arousal, which combine to create a state experienced by the body and mind. Martouzet (2013) makes a distinction between the sensorial and the affective when stating that sensoriality refers to the sensorial experience through the capacity of our senses to approach the real and the sensory. He adds that by sensing something via the senses, this is ultimately accompanied by an interpretation; a feeling (affectivity), which is the ability to be touched as described by Richir (1993). Berleant (2014) describes environmental sensibility as a state of enhanced sensory awareness engaging all the senses synaesthetically including the haptic sensory awareness, the kinaesthetic consciousness and the somatic apprehension of space, mass, movement, and directionality. There are two approaches in the emotional field; the discreet and the continuous approaches. In this paper, the discreet approach which concerns the emotion's nature and typology (Ekman, 1992; Ferrandi, Barnier, & Valette-Florence, 2002) was adopted. By recording a running commentary of the

pedestrians, a snapshot of their emotional experience during the walk is captured.

## 3. CASE STUDY AND METHODOLOGY

Bejaia is a Mediterranean city, on the North East coast of Algeria, at 220 km to the east of the capital. The city saw the passage of several civilizations including the Phoenician, Roman, Arabo-Islamic (Hammadite), Ottoman, Spanish and French. The legacies of these civilizations are still to be seen in the architecture and the remaining ruins. The site chosen for this study consists of a series of walkable streets between two points located in the historic quarter of the city centre, with its attractive historic squares and interesting urban activities with a rich sensorial diversity including man-made and natural elements (*Figure 1*). The starting point of the walk is at Medjahed Cherif Square (to be known from here onward as MC Square) located at the intersection of a pedestrian street and four urban streets with vehicular traffic. Three of these streets that are heading in the south east and east directions form the network of sections that create alternative routes leading to the destination on the seafront.


*Figure 1*. The alternative routes from the start of the journey (O) to the destination (D)

These streets are characterised by minimal presence of road traffic to the point where some sections can be deemed pedestrian, making walking to the seafront easier. The route leading from the city centre to the seafront extends for a distance of around 1200 metres, that can be easily travelled by walking. These streets are also characterized by different urban landscapes, ambiances and activities that offer many alternative options to go from MC Square to the seafront. The street network has one junction and two bifurcations. Junction “J” is the starting point at MC Square, the bifurcation (B1) is at the townhall Square and the bifurcation (B2) is at the Sous-Prefecture Square, at which the pedestrians must make a decision to continue their movement. From the Junction J (at MC Square) three street sections start: S (*Rue Aissat Idir*), S' (*Rue Larbi Ben M'hidi*) and S'' (*Rue Hocine Hitat*). The extension of section S and S' leads to bifurcation (B1) located at *Town Hall Square*, that has two sections, S1, a public stairway, and S1' (*Rue Si El Haoues*). Likewise, at bifurcation B2, the intersection of the extension of section S and section S1' has two sections, S2 (*Rue Ali Rabhi*) and S2' (*Rue Amrani*). It is important to mention that these streets interconnect at some places. For

instance, S' and S" merge to form a common route before getting to B1. S bypasses the bifurcation B1 and arrives directly at B2 (*Figure 2*). During the walk, the pedestrian faces several available choices to move from the starting point of the journey to the destination, which is the city's historic quarter. The question is how pedestrians navigate in order to go from MC Square to the seafront, passing through several bifurcations and junctions.

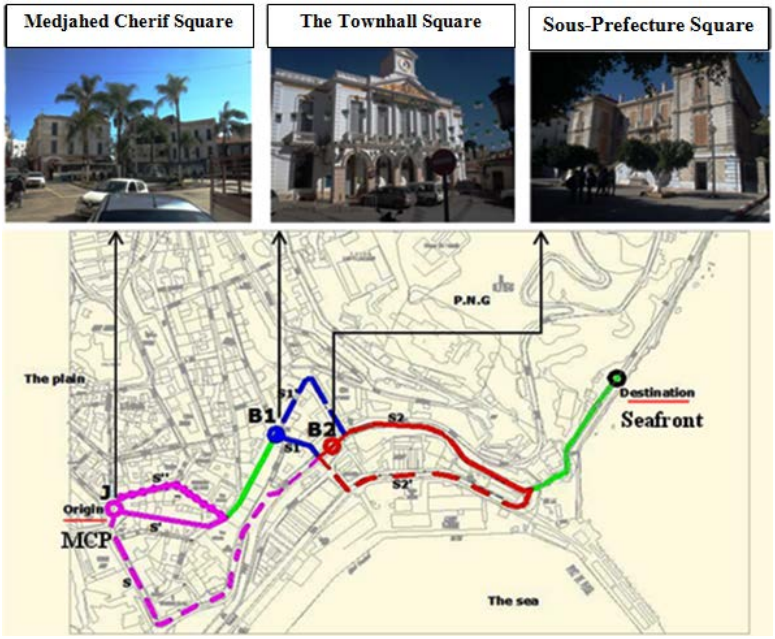


*Figure 2*. The alternative routes for the walk showing the junction J and the bifurcation points B1 and B2 with the respective sections

Given the need to explore the objective and subjective, local and global, as well as the quantitative and qualitative aspects of the walking experience and related decision making processes, the research was undertaken using a mixed method approach. In the first phase of the field work (*Figure 3*), a qualitative method, consisting of recording pedestrians' running commentaries during the walk (Thibaud, J. P., 2001) was used. This method was chosen for its ability to assess people's subjective multisensory experience of the urban environment in the streets. This was combined with a quantitative, method that of space syntax analysis, in order to consider the syntactic characteristics of the street pattern including visual and spatial configurations. The space syntax analysis was undertaken by means of an axial map, which has a global dimension and an isovist analysis, with its local dimension, using Depthmap, and considering some syntactic values such as integration, choice, connectivity and intelligibility. The choices made by the participants during the walk help identify some qualitative preferences of the urban environmental conditions including visual, sensory and affective ones. In the second phase, a quantitative method, using gate-count (Desyllas & Duxbury, 2001) was used to assess the number of pedestrians. This method was chosen over the people tracing or following method (Al-Sayed, 2018) for its ease of implementation, low cost and time saving nature.

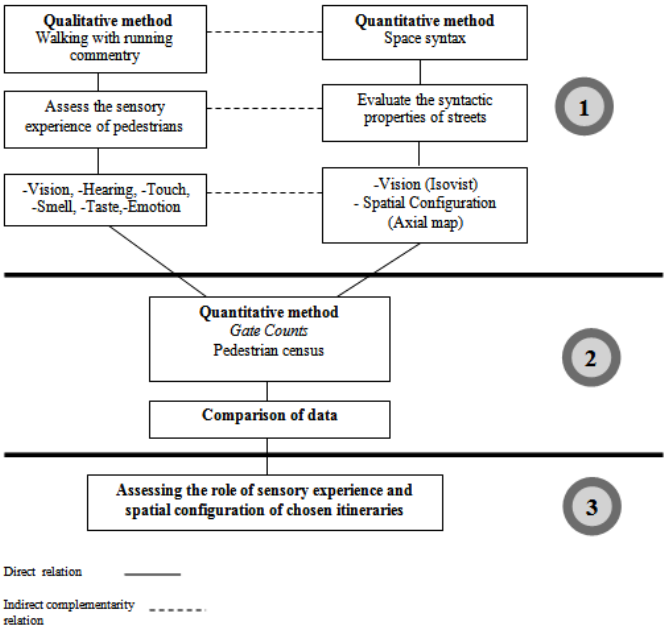


*Figure 3.* Research methodology framework

## 3.1 Gate count

The number of pedestrians walking through each of the 'gates' in the direction of the seafront was counted at specified intervals within predetermined times of day over a two-day period. The gate count was carried out over two days in May 2016. For each day, the count covered three time periods, 10:00-11:00, 14:00-15:00 and 17:00-18:00. For each counting period, a sampling interval of 10 minutes was made use of. It consisted of counting the number of pedestrians at each section in the general direction of the destination on the seafront. The gates were located on each of the sections and the counting was undertaken simultaneously by counting agents.

## 3.2 Space syntax

An axial map for the case study and its immediate perimeter, the historic centre of Bejaia, was generated using Depthmap (see *Figure 4*). To get enough data about decision making and what exactly motivates pedestrians to choose one of the alternative itineraries at each bifurcation and junction, we generated isovists at different punctual positions and exactly at the time of decision making (Benedikt, 1979). Using Depthmap, two isovists were generated. The first isovist was fixed at 360° while the second one was limited at 120° to resume the visibility, per displacement sense, of the pedestrians. The range of isovist was limited to 300 m which is the natural field of vision of the human being (Piombini, Leduc, & Woloszyn, 2014). An isovist of 120° was generated at Junction J covering the three different sections. An isovist of 360° was generated at B2 and B3 as from these bifurcations we can easily track, at a fixed position, with the naked eye the displacement of the pedestrians. However, at J we must move to clearly see the three sections (see *Figure 5*).

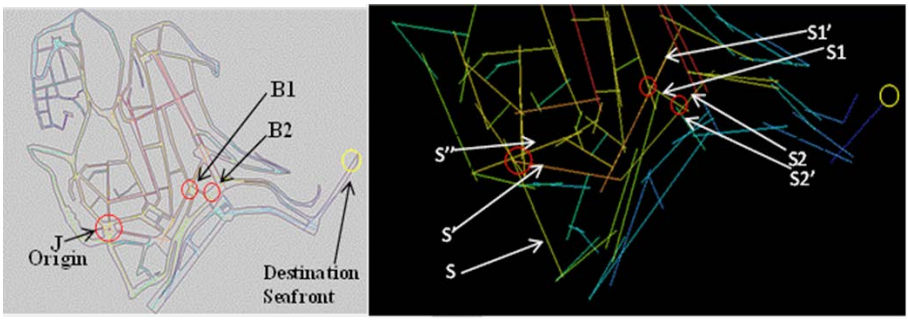


*Figure 4.* The axial map (fewest-line) showing the integration values of the different sections.


*Figure 5.* Isovists for Junction J and the two bifurcations B1 and B2, showing the visual depth for each section

## 3.3 Walking with running commentary

The objective of this method is to record the participants' comments during the walk in an attempt to capture their sensory experience of the urban environment and any sensations and emotions this is likely to generate. Nineteen pedestrians participated in this organised walk/survey. Four of these were familiar with the place and use the routes daily; seven were familiar with the place but use these routes occasionally, while six of them were tourists, not familiar with the place and two were visually impaired (blind). This range of selected participants that make up the sample helps capturing the impact of familiarity with the place on the choice of itinerary. The survey was conducted during 15 days from the 1st to the 15th of August 2016, when the weather conditions are most convenient for outdoor life and strolling along the seafront. We asked each participant to choose voluntarily their own itinerary and express their perceptions by describing the ambiances and landscapes observed from the start of the walk to the destination. The comments of the participants were recorded with a tape recorder by a person accompanying the participant. By the end of the itinerary, the participants were asked to describe the reasons for choosing the itinerary, their motivation for the walk, and the events experienced during the walk. Furthermore, they were asked to draw their itinerary (cognitive map).

According to Thibaud, J. P. (2001) and Ben Slama (2007), the method of walking with a running commentary lends itself to many variations. In this case, two of the walks were conducted at night in order to capture the contribution of the place temporality. Furthermore, two of the participants taking part in the day-time walks were blind as they are more receptive to sensory changes.

# 4. RESULTS

The following sections present the data obtained from the application of the chosen research approaches to the case study. The data is presented for both the quantitative approach (gate count and space syntax analysis) and the qualitative method (the sensory and affective evaluation of the street scene).

## 4.1 Quantitative results

The gate count results revealed that 80% of the pedestrians walked to the seafront from MC Square through J junction using S' section. At B1, 73% of participants chose S1, while at B2, 60% chose S2. Therefore, the most frequented itinerary was composed of the three sections, S', S1 and S2 (see *Table 1*).

*Table 1.* Pedestrian number at each section and the sensorial characteristics

| Junction/ bifurcation | Section | Number of pedestrians | | Vision | Hearing | Smell | Touch | Taste |
|---|---|---|---|---|---|---|---|---|
| | | Gate count | During the walk | | | | | |
| J | S | 24 | 4 | 30* | 11 | 5 | 17 | 1 |
| | S' | 130* | 13 | 26 | 14* | 8* | 20* | 3* |
| | S'' | 9 | 2 | 21 | 8 | 4 | 15 | 2 |
| B1 | S1 | 31* | 11 | 11* | 5* | 2* | 6* | 0* |
| | S1' | 12 | 5 | 6 | 3 | 0 | 4 | 0 |
| B2 | S2 | 22* | 17 | 26* | 7* | 4* | 8* | 1* |
| | S2' | 15 | 2 | 8 | 2 | 1 | 2 | 0 |

(* indicates the best registered correlations )

The syntactic analysis of the axial map generated two type of results: numerical data, which is summarized in *Table 2*, and graphic data, summarized in coloured maps according to the chosen parameter value (*Figure 4*). For the natural movement, the key result is the integration (Hillier, B et al., 1993). Graphically, the values of line integration are represented by red for the most integrated and by indigo for the most segregated. By superimposing the axial lines with the sections of each junction or bifurcation, S' was the most integrated section of J with an integration value of 1.40 and the highest value in terms of choice, 1419 (see *Table 2*). For bifurcation B1, S1' had the highest integration and choice values, which were 1.43 and 1218 respectively. These parameters had values 1.28 and 2536 respectively for S2. At the junction J, connectivity had its highest value (9) at S". Bifurcation B1 had its highest connectivity (7) at S1', while this reached (8) for bifurcation B2 at S2. Furthermore, the longest lines were S', S1' and S2.

*Table 2.* Syntactic values: integration HH, choice and connectivity for each section

| Junction/Bifurcation | J | | | B1 | | B2 | |
|---|---|---|---|---|---|---|---|
| | S | S' | S'' | S1 | S1' | S2 | S2' |
| Integration HH | 1.28 | 1.40 | 1.38 | 1.28 | 1.43 | 1.28 | 1.03 |
| Choice | 985 | 1419 | 1307 | 499 | 1218 | 2536 | 1683 |
| Connectivity | 7 | 5 | 9 | 5 | 7 | 8 | 5 |

Intelligibility is a second-order value and varies between 0 and 1. It results from the combination of the two first-order values, integration and connectivity. The average of the intelligibility value of our urban grid was 0.46 (*Figure 6*). Thus, the street network of the present study was moderately intelligible. The values for the various sections and bifurcations are indicated by labels.

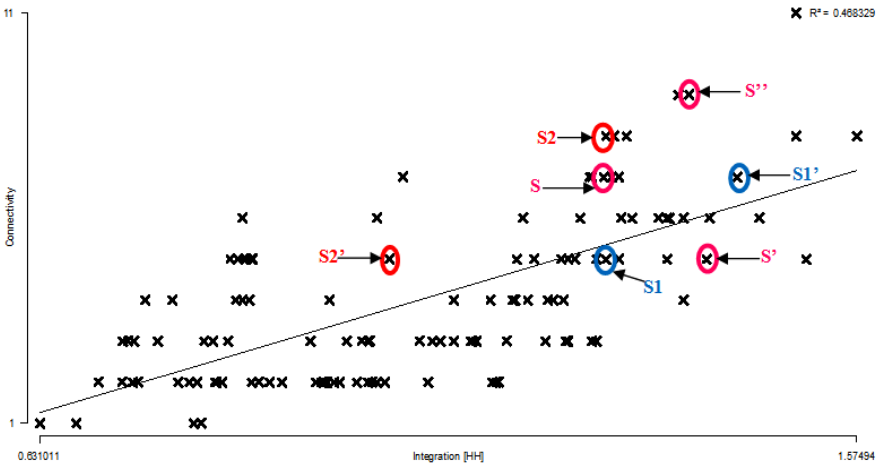


*Figure 6.* Intelligibility graph generated by Depthmap

## 4.2 Qualitative results

The results of the sensory experience of the participants while walking along the different routes (Manola, 2013a; Thibaud, J., P et al., 1998), revealed that section S' had the highest number for all the senses at junction J, except for the vision, which occurred at S. Likewise, S1 had high values for all senses at B1. Section S2 had high sensory values for the five senses. For the two night-time walks, S2' of the bifurcation B2, although it is not chosen by pedestrians during the day, is used during the night (*Table 3*). Each section stimulated all the senses with different intensities. Touch and hearing were the most involved senses after vision in the pedestrian's perception, followed by smell and taste (*Table 1 and Table 4*). To capture the emotions generated at each section while choosing a route, we used the comments of the pedestrians to generate a typology of affects according to the walk with running commentary method. To analyse the emotional results, we adopted the positive or negative valence of the emotions as criteria (Solomon & Stone, 2002). For each sense, we generated a list of the common sensory markers based on the participant's comments. Then, the data on the list were divided into two categories, the natural and man-made common sensory markers.

At J, S' was the most used by the pedestrians (*Table 1* and *Table 3*) due to its high sensorial values, except for the vision where S had the highest values. S' registered the highest number of emotions experienced (see *Table 4*), where these were all positive except for sadness. However, this latter was accompanied by nostalgia which made it a positive feeling. This combination of emotion is well known when visiting the historical centres. The meaning that we give to an alleyway or a place is always related to the past, present and future, making the nostalgia an important part of the pedestrian's feelings. It is interesting that the participants' emotions related to a specific place were influenced by an evocative power of the space,

which was due mainly to a combination of sensory experiences, not merely the visual ones. Therefore, we registered a heterogeneity of emotions at S' and a contrast in the sensations (freshness/heat) which are related to the sense of touch (*Table 4*). At S, we found the same positive emotions and sensation as at S' (freshness, heat, calmness, quietness, security, joy and happiness), except for freedom which was found exclusively at S. Rejuvenation, pleasantness, vivacity, fragrance, evasion, sadness/nostalgia, contemplation and astonishment were exclusively reported at S'. Freedom is an emotion that is related to the high values of vision (30) which was marked by the light and the clear view. The vision combined with touch and the sensations of freshness and warmth promotes this feeling of freedom, which is in turn accentuated by the sense of taste (sea salt). The combination of the three senses, vision, touch and taste created the emotion of freedom (*Table 4*). The sense of smell has a strong impression. Pleasantness was exclusively present at S' of J, due to the high values of smell that result from the sensation of good smell then the emotion of pleasant. The S'' is the least chosen and frequented section of J as participants experienced negative emotions (tiredness, lifeless, weariness, displeasure), except for calmness (*Table 4*).

*Table 3*. Distribution of participants according to the chosen itinerary during the walk.

| Bifurcation/Junction | J | | | B1 | | B2 | |
|---|---|---|---|---|---|---|---|
| Section | S | S’ | S’’ | S1 | S1’ | S2 | S2’ |
| Participants with daily use of the site | 1 | 3 | 0 | 3 | 0 | 4 | 0 |
| Participants with occasional use of the site | 1 | 5 | 1 | 6 | 0 | 7 | 0 |
| Participants non-familiar with the site | 1 | 4 | 1 | 0 | 5 | 4 | 2* |
| Participants with complete visual impairment | 1 | 1 | 0 | 1 | 0 | 2 | 0 |
| Total | 4 | 13 | 2 | 10 | 5 | 17 | 2 |

* denotes walk during the night-time

*Table 4.* Common sensorial markers, felt emotions and sensations (marked*) for the various sections in Junction J

| **Junction** | **Section** | **Sense** | **Common sensorial markers** | **Sensations (*) and Emotions** |
|---|---|---|---|---|
| J | S | Vision (30) | Wide sidewalk, Light, Clear view, Sea, Kasbah, Former courthouse, Boats, Sparsely populated, Greenery, Theatre, Spanish colonial monuments, Seaport, Antiquated door frame, Absence of shops, Sarasine Gate | Freedom, Freshness*, Heat*, Quietness*, Calmness, Joy, Security, Happiness |
| | | Hearing (1) | Car noise, Background noise, Wedding motorcade, | |
| | | Smell (5) | Fuel smell, Sea air | |
| | | Touch (17) | Shadow, Sun, Wind, Breeze, Calm (wind) | |
| | | Taste (1) | Sea salt | |
| | S’ | Vision (26) | Many pedestrians, Shops, Car park, Trees, Boats, Sea, Horizon, Colonial buildings | Security, Joy, Rejuvenation, Pleasantness, Happiness, Vivacity, Fragrance*, Evasion, Freshness*, Quietness*, Sadness/Nostalgia, Heat*, Calmness, |
| | | Hearing (14) | Bird songs, Boats’ engines, Cars’ engines, Background noise, People’s whispers | |
| | | Smell (8) | Sea freshness, Traditional cakes, Food (restaurants), Coffee, Bread | |
| | | Touch (20) | Sun, Level difference, Building surfaces, Ground hump, Breeze, Shadow, Wind | |

| | | | | |
|---|---|---|---|---|
| | | Taste (3) | Traditional cakes, Bread, Food (restaurants) | Astonishment, Contemplation |
| | S'' | Vision (21) | Stairs, Mosque, Few shops, Sea, Sparsely populated, Old buildings, Dog, Florist, Boats | Calmness, Tiredness, Weariness, Lifelessness, Displeasure |
| | | Hearing (8) | Few cars' engines, Background noise, Birds' songs, Prayer call, Footsteps | |
| | | Smell (4) | Coffee, Paint, Pizza | |
| | | Touch (15) | Sun, Shadow, Breeze, Slope | |
| | | Taste (2) | Pizza, Ice-cream | |

At B1, S1 was the most chosen (*Table 1* and *Table 3*) due to its high sensory values compared to S1'. The felt emotions at S1 were positive, associated with a single sensation, freshness. In contrast, at S1' we registered negative emotions, where sadness was not associated to nostalgia, making it a negative feeling (*Table 5*). At B2, S2 was the most chosen and used section, due to its high sensory values and the positive emotions felt and the sensations, except for the bad smell. S2' was the least chosen due to its low sensory values and the negative emotions (*Table 6*). The itinerary S'-S1-S2 was the most used by the pedestrians to go from MC Square to the seafront. The feelings and positive emotions common at these streets were as follows; freshness, heat, calm, tranquillity, safety, joy, happiness and pleasantness. Each sense created a particular feeling and emotion depending on how it was stimulated. The interaction between the senses and their simultaneity was especially remarkable between the sense of smell and taste since they are naturally related (*Table 4*, *5* and *6*). At S2', the smell of dust was accompanied by a feeling of disgust. In some cases, a third sense intervenes, for instance the combination of heat and disgust created a feeling of suffocation (*Table 6*). In S of the first junction, the sea air gives the impression of eating salt (*Table 4*). In S2, hearing is an indicator of heat and accentuates this sensation (cicada sound and electricity), combined with hearing, the touch is intensified (*Table 6*).

*Table 5.* Common sensorial markers, felt emotions and sensations (marked*) for the various sections in bifurcation B1

| **Bifurcation** | **Section** | **Sense** | **Common sensorial markers** | **Sensations (*) and Emotions** |
|---|---|---|---|---|
| B1 | S1 | Vision (11) | Stairs, Handrail, Climbing plant, Crack(s), People jumping up and down | Freshness*, Calmness, Relief, Quietness*, Pleasantness, Joy, Fragrance, Happiness, Security |
| | | Hearing (5) | Background noise, Pedestrians, Footsteps, Cars' engines | |
| | | Smell (2) | Humid air, Jasmine | |
| | | Touch (6) | Handrail, Building surfaces, Breeze, Anti-skid coating, Shadow, Slope | |
| | | Taste (0) | | |
| | S1' | Vision (6) | Pavement, Corridor, Tree, Closed windows, Old buildings | Lifeless, Quietness*, Heat*, Confinement*, Security, Sadness, Regret, Displeasure, Inhospitable* |
| | | Hearing (3) | Total calm occasionally interrupted by cars' engines | |
| | | Smell (0) | | |
| | | Touch (4) | Building surfaces, Pavement, Sun, Shadow | |

At S1', when the sense of vision was stimulated with no sensory values for smell, the corridor effect of a long visual perspective with values of integration and high choice (*Table 2*) of the street generated a confinement and security feeling. This feeling was negatively experienced, since it generated negative emotions (*Table 5*). It would seem that of all the senses, smell is the one that creates the strongest impression in humans. This is explained by the fact that it is the "sense of affects and their mysteries… Smell shakes the psyche more deeply than hearing or seeing" (Corbin, 2008). Conversely, when the view was combined with the other senses at S2, confinement and security were followed by positive emotions (*Table 6*). The heterogeneity of sensory stimuli, which were a mixture of visual, auditory, olfactory, tactile and gustatory, created heterogeneity in the generated emotions. This corresponds to "the city of the eyes" and "the haptic city" by Pallasmaa (2005). The first is that of distance and exteriority, while the second is that of closeness and interiority.

However, monotony of sensory stimuli generated negative emotional monotony. It is important to mention the influence of the temporality of the chosen place. Most of the sensory relationships registered in the present study can change according to the seasons and the special events such as the new year and the month of fasting (Ramadan). Two organised walks with running commentaries took place during the night. Unlike during the day, S2' was selected during the night (*Table 3*). We found that at S2', sensory values, emotional and sensory markers widely changed, where the low values and negative emotions were replaced by high values and positive emotions (*Table 6*). Because S2' was not chosen during the day, we suggested to the pedestrians who avoided it (five of them) to redo the commented route using this alleyway, which we allowed in order to understand the sensory and emotional characteristics that meant it was avoided. Therefore, the multi-sensoriality and affectivity of a route are not fixed elements and change according to the temporality of the site. The sensorial markers were divided into natural and man-made ones. For the sense of vision, we found that the man-made aspect was the dominant in the three most used sections, S', S1 and S2 (*Figure 7*, *8* and *9*). While the man-made elements dominated vision, the hearing, smell, touch and taste were tightly related to the natural elements such as birds singing, insects, the rustle of trees, the smell of moisture and the taste of sea salt in the air.

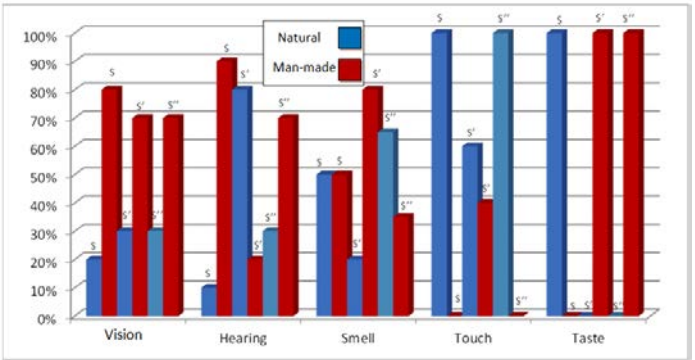


*Figure 7.* The origin of the common sensorial markers at J sections

*Table 6.* Common sensorial markers, felt emotions and sensations (marked*) for the various sections in bifurcation B2

| Bifurcation | Section | Sense | Common sensorial markers | Sensation (*) and Emotion |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| B2 | S2 | Vision (26) | Many pedestrians, Trees, Pigeons, Bin, Stone wall, Sarasine Gate, Hammadite remains, Seaport, Construction site | Heat*, Freshness*, Pleasantness, Calmness, Quietness*, Moral rest, Odour*, Fragrance*, Confinement*, Astonishment, Joy, Rejuvenation, Happiness, Security |
| | | Hearing (7) | Electricity sub-station, Rustling trees, Insect (cicada), Cars' engine noise, Background noise | |
| | | Smell (4) | Flowers, Tree leaves, Urine | |
| | | Touch (8) | Breeze, Tree, Sun, Cladding, Shadow, | |
| | | Taste (1) | Prickly pear | |
| | S2' During day | Vision (8) | Sarasine Gate, Seaport | Heat*, Suffocation *, Disgust, Lifelessness, Discomfort, Displeasure, Inhospitable |
| | | Hearing (2) | Cars' engine noise, Construction site noise | |
| | | Smell (1) | Dust | |
| | | Touch (2) | Cladding, Sun | |
| | | Taste (0) | | |
| | S2' During night | Vision (10) | Seaport, Sarasine Gate, Light, Darkness | Freshness*, Calmness, Joy, Quietness*, Pleasantness, Evasion, Fragrance |
| | | Hearing (4) | Background noise, Boats, Cars' engine noise | |
| | | Smell (5) | Sea air, Fish, Alcoholic drink | |
| | | Touch (4) | Breeze, Cladding | |
| | | Taste (2) | Fish, Alcoholic drink | |

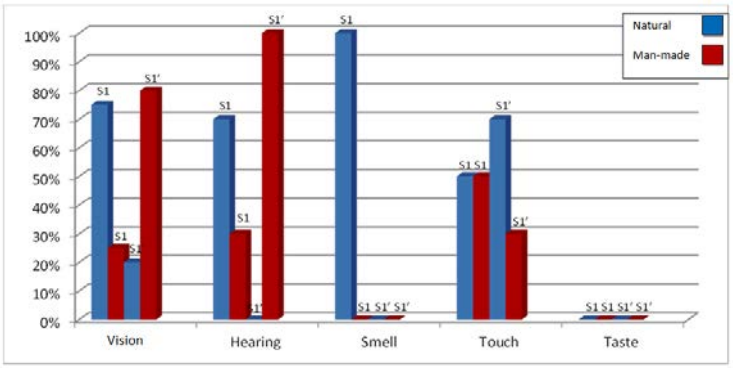


*Figure 8*. Origin of the sensorial markers at B1 sections

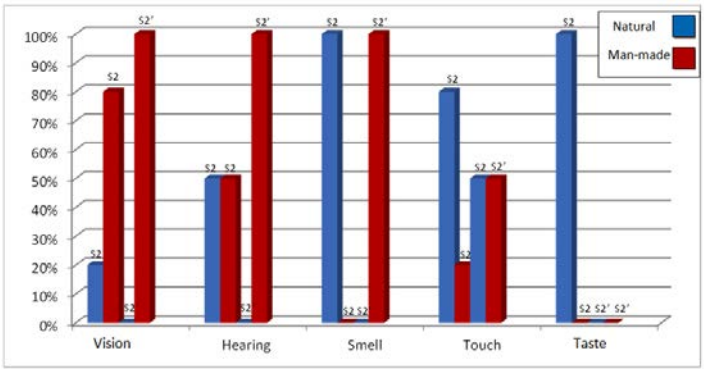


*Figure 9*. Origin of the sensorial markers at B2 sections

## 5. DISCUSSION

The data collected by the various methods including the gate count, the organised walk with running commentary and the syntactic analysis (axial map and isovists), showed significant levels of correlation between each other. Section S' was the most used by all categories of pedestrians and has a higher integration value (syntactic) compared to S and S''. Contrary to expectation, the pedestrians using this section experienced more sensory characteristics of hearing, smell, touch and taste than vision. This latter was more reported at S. At S', we registered a high number of positive emotions. Thus, S', namely *Rue Larbi Ben M'hidi*, is a go through space, a get to space and a space organizing navigation in the system as an intermediary to other spaces, and as a destination.

The configuration of S' stimulated the five senses and awakened many positive emotions so that the pedestrians were sensing and feeling the city and not merely seeing and feeling it. Such a multi-sensory experience, when combining the five senses helps the pedestrian to positively perceive the space and thus confirms the hypothesis of the sections. Section S1 had a lower value of choice and integration but higher sensory values compared to S1'. Furthermore, S1 was the most used by either familiar or occasional pedestrians. Therefore, the choice of the itinerary by the pedestrians was not solely based on vision related matters, but implied other sensory and emotional modalities. S1' had a value of choice of 1218 and integration of 1.43 which were higher than the values reported at S1. The latter is the longest way and offers a good visual experience. Furthermore, S1' is more helpful for the pedestrians who do not know the site because its choice is based on the visual sense, which confirms the hypothesis of the moment of bifurcation. However, pedestrians who used S1' seem to have a negative sensory experience that led to them describing it as an empty space that they want to leave as soon as possible. This statement confirms that the values of the sensory evaluation of S1' were lower than those of S1. For bifurcation B2, S2 was the most used section by the pedestrians. It had higher syntactic, sensory and affective values as pedestrians found it more attractive than S2'. This latter was described as more repulsive. Tables 5 and 6 show that negative emotions are present in sections S1' and S2'. At the same time, those sections are the least used by pedestrians, according to gate count results (*Table 1*). This can then be explained by the fact that negative emotions can constitute a repulsive factor of the spatial use; that is not conducive to using a given space if there are other alternatives. In addition, just as the sensitive properties of the streets are linked to the temporality of the site, so are the emotions (*Table 6*).

Therefore, to select itineraries at bifurcations and junctions, we use not only our vision, but a combination of the five senses to generate an emotion and feeling that will be related to the chosen route. Comparing the familiarity with the place, we found that the pedestrians unfamiliar with the site were more attracted by the routes that offer a high visual interest and a long visual perspective, which is in accordance with previously published research (Piombini, Leduc, & Woloszyn, 2014). However, the pedestrians who are familiar with the site selected the itineraries according to their previous sensory experience, using their five senses in combination. Thus, the visual experience is not always the decisive factor for the pedestrian to walk around the place. Furthermore, the quality of the routes in terms of moods and affects influences their choice. From the above statements, we conclude that the design of bifurcations and junctions should take into

account the visibility of the sections, combined with the quality of the urban environments using the five senses.

The intelligibility graph (*Figure 6*) has shown that the street network, within which are the sections making up the case study, has an average intelligibility from a visual point of view. This is something based solely on the spatial configuration. In parallel to this, the urban environment is experienced through all five senses. This raises the question for the need to consider sensorial intelligibility that goes beyond the mere spatial configuration used by space syntax analysis. This leads us to conclude that such an approach, on its own, is not enough to describe the process by which pedestrians make decisions when walking around the urban environment.

## 6. CONCLUSIONS

Most of the research work related to pedestrians in the urban environment tends to be based on the use of either qualitative or quantitative methods. Recently, however, this dichotomy is beginning to be bridged (Bendjedidi, Bada, & Meziani, 2019). In a similar way, the present work makes use of a mixed-method approach (qualitative and quantitative) to explore the correlation between the ambient conditions of the urban environment, the sensory experience of pedestrians and their choices in navigating through a given itinerary.

The urban environment affects us positively when it stimulates the five senses in combination. The nature of the sensory markers affects pedestrians' experience of urban spaces, and consequently their mobility, in terms of itinerary choice. Therefore, people navigation is not dependent on the street patterns' configuration only, as proclaimed by space syntax theory, but also on its ambient qualities that affect much of people's sensorial experience and behaviour.

While the approach used in this work is innovative and could be repeated for studies exploring similar conditions, the development of a fully structured method is outside the scope of the present work and would require further sampling and data analysis. It is our ambition to see this work further developed, in the future, using what virtual reality can offer in terms of simulation of pedestrians' sensory experience in the urban environment.

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