Commented Walk, Segmented Walk: An Exploratory Study on The Relationship Between Urban Space and Sound Stress

Sana Layeb
sana.layeb@yahoo.fr
National school of Architecture and Urbanism ENAU
University of Carthage, Tunis, Tunisia

Mohsen Ben Hadj Salem
mohsenbhs@gmail.com
National school of Architecture and Urbanism ENAU
University of Carthage, Tunis, Tunisia

Abstract

Through interactions with environmental parameters such as sound, public spaces generate ambiances which provide a sense to the places. Subjective methods of analyzing and characterizing the complexity of the urban soundscape have to be associated with objective evaluations of emotional arousal. So we tried to approach our study with an experimental methodology of three components: spatial analysis, analysis of physical signals and the capture of emotions via a biosensor called Q-Sensor that evaluates the stress level via skin conductance. Our field of study was the downtown of Tunis. We tried to follow subjects during a specific walk and to capture their emotional states. In addition, we recorded both the audio signal and the associated comment of the person describing the sonic ambience. The results of this study showed that the perception of stress in public places is related to certain specific frequency band signal of the urban contemporary.

Keywords: Urban space, emotional states, Q-sensor, electrodermal activity, sonic ambiance, sense of place

1. Sensory exploration of the modern city or «the city of emotions»

1.1. The sound phenomena for analyzing pedestrian conducts

The public place is a flexible universe combined by physical properties and ambient real-life experience. It is perceived through our five senses. Among the phenomena that govern the relationship between Man and his environment, there is the sound phenomenon. They hold an important role in our experience, our perception and our representations of built space.

In return, the visual aspect relies on the choices of the town planners and the architects in their conceptions of the templates, the alignments and the aesthetics of facades. For lack of thorough knowledge, the noise situation in the city is often the result of a multitude of urban and architectural choices, where the acoustic aspect has not been taken into account. Here we seek tracks of reflections and action s from this sensory component.

Urban centers of Tunisia are far from being judged by the inhabitants or specialists as havens of silence. Until the sixties, most psychological researches done on urban noise were limited to the auditory effects. It is only after 1970's, with Gabriel Moser and Levy. C Leboyer that we started talking about the non-auditory effects of noise on human and social cost. These effects include first the notion of urban stress. This term has been frequently used in our daily modern life. It has become the primary concern of society. Everyone talks about it and we're all concerned.

1.2. The emotions as an object of architectural and urban research

Emotions are often thought of as private feelings or physiological changes. They are sometimes observed through physical reactions that betray them involuntarily, opening a window on a secret and intimate world. This conception justified the trend in the study of behavior in public to neglect the metrological dimension in the capture of emotions, often, in favour of a subjective vision of the question of emotions, especially the urban stress. Why not to think, conversely, that emotions such as stress exist in a first way as mediation between a user, a space and a sonic ambiance?

Several recent researches wonder about the way of capturing emotions and develop new daily physiological sensors to help in the understanding of emotions. For example, the studies of Bertrand Massot are particularly interesting. His researches focus on the design and realization of non-invasive and ambulatory sensors for detecting the activity of the autonomic nervous system. This thematic includes the development of on-board sensors'

networks and the study of physiological phenomena for the monitoring health status and emotional reactivity. The objective is to enable experimentation in environmental situations rather than in laboratory conditions, and the definition of relevant indicators in a complex and non-controlled environment, in which the individual evolves. The concerned fields of application include assistance to the autonomy (elderly, disabled people), monitoring of the driver, or the study of athletic performance.

As part of his thesis work Bertrand Massot has designed and realized EmoSense instrumentation for the on-board monitoring and real time skin temperature, heart rate, and electrodermale activity. This instrumentation allowed, as part of a study on the perception, representation and management of urban space for blind people, to define events and new relevant indicators to the objective measurement of stress among blind people on their displacement urban areas.

Diverse particular urban situations require in-depth researches, the situation of urban stress seems to be complex and interesting to explore according to a multidisciplinary methodology. At this stage, we question on the existence of links between the urban sound phenomenon, the stress of the user and the architectural and urban characteristics of lived space.

This question is the link between the physical, perceptual and morphological parameters implicated in any urban experience, namely: physical characterization of audio signal spread in the public space, perception and emotions relating to this signal, especially the stress feeling, and the configuration of the urban setting.

2. Space, acoustic and user speech: crossing three corpus

The observations on various dense urban fabrics show that the urban crossroads are real spaces of manifestation of the urban practices. They are places rich in events characterized by vehicular and pedestrian traffic in various configurations and generate various perceptual phenomena. Hearing is no longer “(...) this sense which gives us company of the street.” (Chelkoff 1996), but rather a real embarrassment and sound stress. The first condition for a rigorous analysis of the conditions of manifestations of this noise nuisance is a meticulous

exploration of the complexity of the sound situation on different aspects: physical, morphological, and sensory.

Furthermore, for a Walker progressing according to determined direction, a path can be split into a number of sequences, each one constituted by a succession of 'sound levels' in which measurable signals interact with the built, and are so formatted before arriving at our ears. This "plan" is likely to be characterized objectively.

This work is based, essentially, on an experimental protocol of three components, which are simultaneously made: spatial analysis, analysis sound signals (acoustic metrology), and the capture of sound perception (commented walk / the detection of the stress).

2.1. Spatial analysis

Our field of study was an urban pedestrian walk situated in the city of Tunis, after the revolution of 2011. The first step made was collection of information and documentations on the chosen site. We completed this step by graphic surveys of the urban crossroads concerned (plans, spatial configurations...).Then we drew up urban profiles of browsed pathways. Then we updated the activities, function and epannelage maps. Finally, we described the morphology (rounded off, in hollow, meeting of two plans), materials and proportions of the architecture of angles of each browsed urban crossroads.

Through the reasoned choice of our field investigation, and after sweeping spatial and urban characteristics of the chosen urban path, we identified a variety of urban intersections by their clearances, buildings that enclose them, the functions they support, and the mode of traffic which take place there.

Presentation of the field of study

To answer the stake of the triple interaction of sound signals, configurations of the urban crossroads and the perception of the sound stress and after a stage of observation and search for the adequate ground, our choice has stopped on the neighborhood of little Sicily in Tunis (Figure 1). This district benefits of privileged situation in the agglomeration of Tunis. It is bounded in the north by the Avenue Habib Bourguiba, in the east by Avenue of the Republic, in the west by Avenue Carthage and south by the JALLEZ hill. Today the site appears as a pivotal district of the development of the city and a point of articulation of the urban growth of the capital southward and northward.

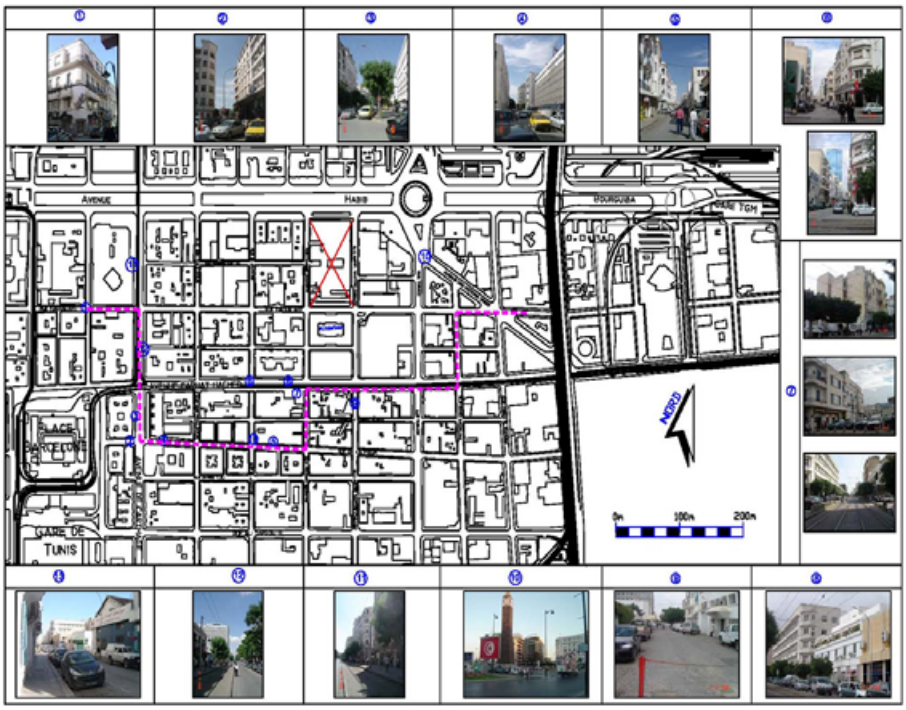

Figure 1. The selected path for the commented walk

We've chosen this path because of the variety of functions of its houses, and the sound sources available. When it was built, the residential function was confined to upper floors to make way for shops and services in the ground floors. The majority of buildings are home to a mix of functions varying between trade and services which are directly reflected on the soundscape recorded. We have also noted the richness of the building materials and architectural styles: Italianate, neo-classical or even said "modern style" with wall coverings made of granite and glass. The specificity of this site lies in the variety of treatments of angles which constitute it: loggias, balconies, and other more or less ornamented devices.

2.2. The sound perception measurements:

To address the relationship between stress and the urban soundscape, we have to start by highlighting certain peculiarities of sound phenomena. Urban sound identity interweaves permanently three components: sound sources, the spaces of propagation, and perceptions on the field of meanings, representations and social practices.

In summary, the sound system mixes sound material, spatial morphology (urban, rural, landscape, "natural" ...) and human communication. These three series of factors, physical, spatial and human, are in narrow interaction with each other.

The choice of pedestrian mobility

From the eighties and with the emergence of the notion of ambiance, we were witnessing a re-exploration of various crosses between social and spatial forms on one side and sound and visual landscapes on the other. Starting from the principle that the perception of space, that is architectural or urban, is poly-sensory, we can assert that the hearing as all other senses participates in the apprehension of space. By eliminating the vision, our ears can inform us about the nature of space: closed, open...This perception changes depending on the displacement mode in space.

Because I think that architecture will always remain at the scale of our senses, because the architecture exists only perceived, that's only when a person crosses a space, so, that we can really speak [...] about the experience of architecture. (Crunelle 1999)

The time of our movement is often sent to a fourth dimension.

In architecture, it is the user who moving into the building, looking under successive points of views, creates itself, so to say the fourth dimension. (Zévi 1959)

Feel and move have a relationship of interaction. As for the movement, the sound perception may also incite the user to micro-movements (turn the head), a change in speed, or even direction... But to understand an ambiance, it is necessary to know at first how to seize (measure) it. The method varies depending on the purpose of the investigator. We find ourselves, then, in a vast and very rich field of adopted approaches, divided into four categories. Either by treating the ambiance by behaviour (animal ethology), otherwise by the text (through comments), or by memory (the in vitro experience such as Pascal Amphoux's recurring observation) otherwise by action, that is by seeking the movement (the experiences are multiple, example the commented walk).

Because of the objectives of our research and the importance of walking to understand the different dimensions of the urban space which are: form, use and perception, we are going to attempt in what follows to use the chosen survey method: that is the commented walk of Jean Paul Thibaud.

This ambiantal approach allows us to grasp what is not usually sizeable. It highlights the sensitive dimension of our experience and allows us to identify sound sources.

To achieve these goals we use two approaches: the commented walk method and the capture of emotions through the apparatus of stress (Q sensor).We first start by the commented walk method. This approach was developed by Jean Paul Thibaud.

It has as objective to reach the sensitive experience of passers-by from the reports of perception in motion. It requests three simultaneous activities: walking, perceive and describe. This experience consists in making a path while describing what we perceive and feel according to the walk . (J.P. Thibaud, 2001)This method allows the user to describe the imme-

diate perception of the environment. Therefore, the description reveals the instantaneous perception in action (perception in motion).

For our experience, we have to fix at first the point of departure and of arrival from the chosen path.

We then specify the approximate duration of the walk, which will be for our case of twenty minutes, necessary time for the verbal records. Comments should be recorded using a portable tape recorder, by giving regularly spatial landmarks.

From the description, we pass to the analysis of records and interviews, which will be transcribed in the most possible faithful way. These comments will be analyzed in the manner of the description or the perception according to the spatio-temporal locations (eg: the station), perceptual transitions (it is quieter), the verbal field appearance (be cut, is melt) or even reflective formulation (I'm attracted to ...).

2.3. The capture of emotions or "sensitive metrology"

The second way to the perception of sound phenomena is to use an apparatus of stress capture called Q sensor . It is thanks to the cooperation project between the ENIT and the ENAU that we were able to have access to this device, coming from the United States, finalized in the laboratory of Affective computing, and representing a very recent advance in stress research.

It is used to indicate the skin conductance, the temperature and emotion for a recording period of 24 hours, which presents a revolution in the field. It is a thick bracelet with an electronic data acquisition board (pulse, sweating). Its data are easily transferable on computers using a USB port. Once recovered, these records are shown in a Cartesian diagram with specific moments (peaks) which represent signals marks corresponding to moments of emotion or stress reported by the subject. Our goal is to confirm the precise timing of the entry and exit of the stressful sound situations using this scientific instrument that is the Q sensor.

This dual approach (commented walk, capture of emotion) will serve to objectify the collections of perception of sound phenomena which will confront and superimpose the collections of two methods to objectify the results.

In the analytical part, we are going to cross the data collected with the four previous investigation methods: measurement of sound levels, frequency analysis, the commented walk and the capture of emotions.

Before starting our analysis, we would like to insist on the fact that the simple variation of the electrodermale activity is not a sign of stress. It is the SCR (skin conductance response) which denotes stress. The electrical activity on the surface of the skin depends on

the physiology and the psychology of the person, on the state of the Q Sensor's electrodes and even on its fixation on the wrist. Experiments have shown an ineffectiveness of the stress measures, if the skin is dry (and a low level of conductance). It requires that the skin has to be clammy (so that the person is not at physical or cognitive rest).So to ensure that the trace of the EDA is usable, it is necessary that the minutes of adaptation preceding experience are not a simple port of the Sensor Q. So, we must stimulate the cognitive activity of the person failing to make intense physical activity. For every survey, we are going to present at first our observations of the curve of stress provided by the software Q. This allows us to estimate the stress by quantifying it.

To detect SCR, three criteria are to be raised: a moment of descent of the curve of the EDA and a recovery time (usually longer in duration than the descent). The curve has to get back more than 63% of its initial amplitude (difference between the lowest and the highest point of the phase of the descent in μS).

We then seek the correspondence of each variation with other data from our experimental protocol. We reveal the soundscape such it was perceived by the subjects as well as his feelings and emotions related to the ambiance (discomfort, uneasiness, stress, satisfaction, appreciation).

Then, we confront these psychological and physiological data with physical measures (the measurement of sound level).If the SCR detected denotes a sound stress, we turn to the analysis of verbal reports of the subject. If this sound stress is verbally verified, the next step will be the frequency analysis of the sound sequence that caused the stress of the investigated person. This method will allow us to check the frequencies and sound sources that cause stress to this user. It is only through this crossing method that we can verify the existence of links between the urban configuration and felt and emotions on one hand; And between the stress perception and physical characteristics of the signal on the other.

3. Multi-parameters crossed analysis:

Once the crossroads of sound stress will be identified through the analysis of physiological (Q sensor) and psychological (commented walk) data, we pay particular attention to their spatial configurations and more specifically sound phenomena.

The last part of our in situ survey includes an analysis of physical sound signals. This component is divided into three parts: the measurements of the sound levels, records of the audio signal of the sound scene and analysis of spectral compositions.

The measurement of the sound levels informs us about the quality of the space. So it allows us to evaluate the acoustic comfort of a space. The used unit is noted dB (A). These measures will be made by a son meter (sound level meter).

In addition to the measurements of the sound intensities we will also measure the equivalent sound level (Leq). This index is the energy equivalence. It is often used for road noises. It consists in capturing the dynamics of sound intensity over a period of several minutes.

Given that the comments (describes) of the users are always influenced by the individual social and psychological factors; we have to correlate our surveys by sound records of the chosen path. These records will be made according to our progress. They will allow us to detect sound sources (a train, noise of a market, horns of cars at the traffic light...). This frequency dynamic along the path will allow us to be situated in the space through sound marks and to provide a sound identity of each analyzed crossroad.

We will complete this part by the last component of metrological surveys which is the analysis of spectral compositions . It's the technique of superimposing and segmentation of urban sequences and audio records to detect changes of atmosphere (ambiance) in the urban path. It identifies all variations of physical signals through the graphical representation of the frequency spectrum. Frequency analysis of these spectral compositions identifies areas of qualifications, which may be significant in relation to the frequency bands (low, medium, high frequency). This probably generates ambiantal effects (discomfort, comfort, stress, embarrassment...).These analyses will be correlated to the verbal data of the last part of our experimental protocol: the seizure of the sensitive perception of sound phenomena.

4. Validation of the experimental protocol

4.1. Walking, perceiving and describing

We would like to point out that there is sometimes an ambiguity in the events. The sound signal is not always the only source of urban stress. Indeed, following our experience, we've noticed that the factor "habit" acts on the way we perceive the space. The regular subjects tend to anticipate events and evoke memories. The same for the type of human presence, two surveyed on five female expressed their dislike and even her sense of insecurity. They also stated that the discomfort has nothing to do with the noise intensity. It's not then a sound stress but rather a psychological and social stress (Figure 2) due to the type of human presence (males, mechanic work, café…)

(…) If we must turn right, I'd rather not pass in front of the café terrace. I prefer to bypass the news-stand. I avoid men sitting at the terrace. I move fast; I do not like the gatherings of men. (Subject 6)

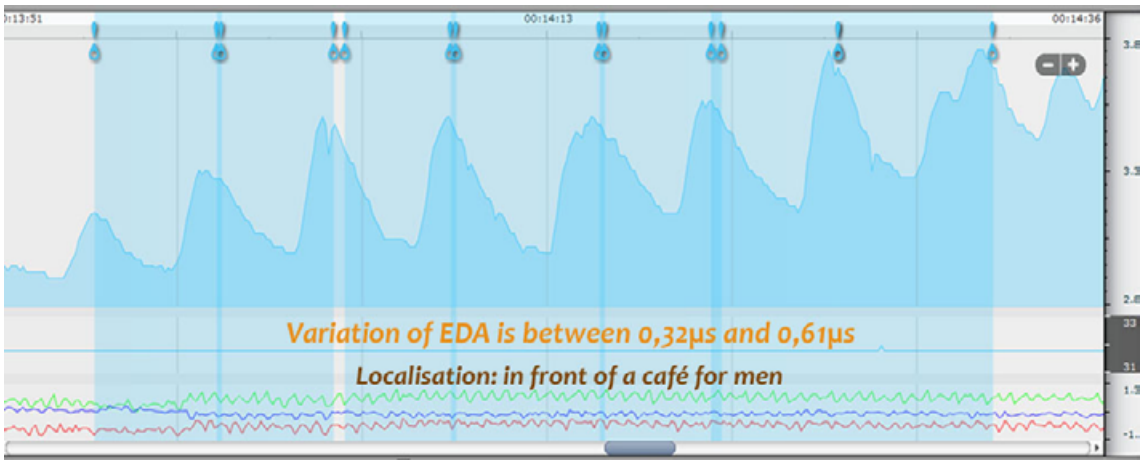

Figure 2. Variation of the EDA level (The stress detected is due to the social habits)

We also noted that the increase in the sound level is not always synonymous of stress increase. Indeed, a high sound level does not reveal the same reactions from the part of our subjects.

Sometimes it has a negative (Figure 3) and bothersome factor.

But here it starts to fuss. Drawing near the crossing with the street Ibn khouldoun, the noise increases, we approach the source of the noise, so, necessarily the tension rises. (Subject 8 for 69dB)

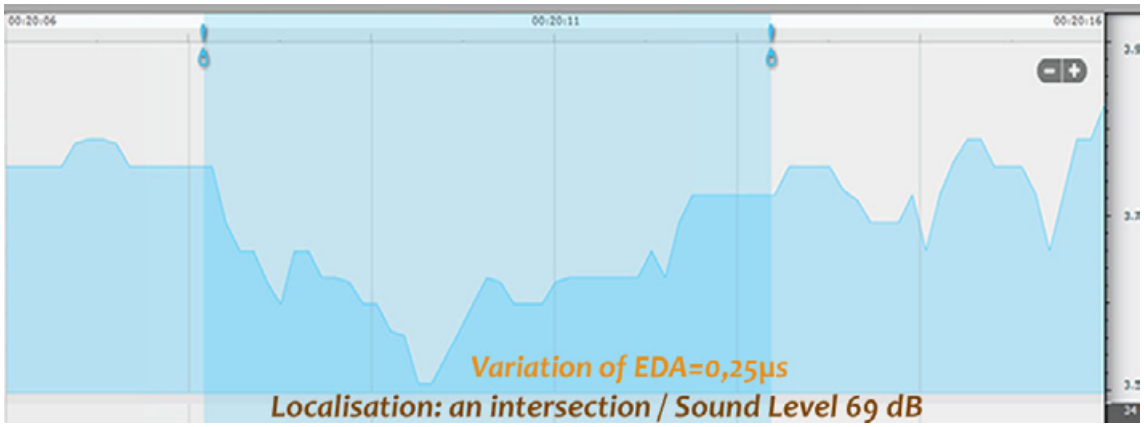

Figure 3. Variation of the EDA level (The stress detected is due to high sound level)

But, sometimes it becomes unnoticed and often it is taken as a sign of assurance and integration in the crowd. (Figure 4)

There are only cars here (…) I feel that it is a matter of habit. So I'm always on road and drive for several years now, the road noise goes unnoticed. (Subject 7 for 79 dB)

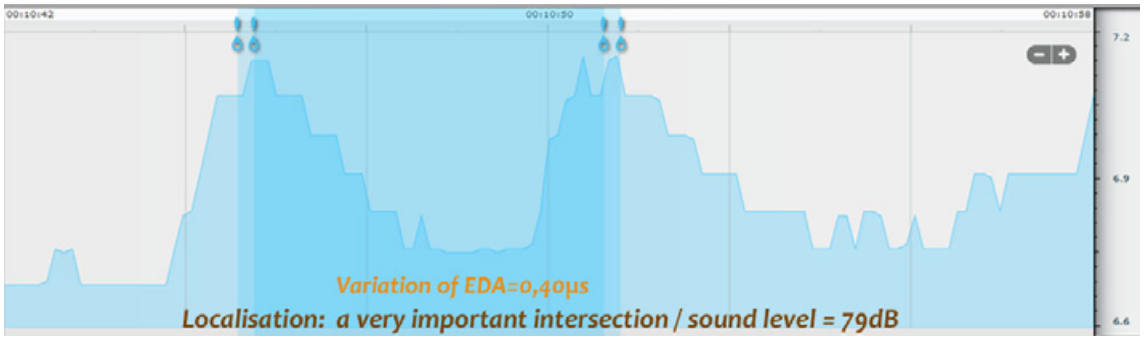

Figure 4. Variation of the EDA level (The SCR detected is not a sound-related stress)

The same for calm; It is not always appreciated by the investigated persons. It can sometimes be translated for the users by feelings of insecurity and routine (Figure 5) and at other times by comfort and relaxation.

(…)But once you get through it is a bit monotonous. This is annoying. I feel like sleeping. I do not feel motivated to stay long. I want to move to a busier area. It's quiet monotone. (Subject 8)

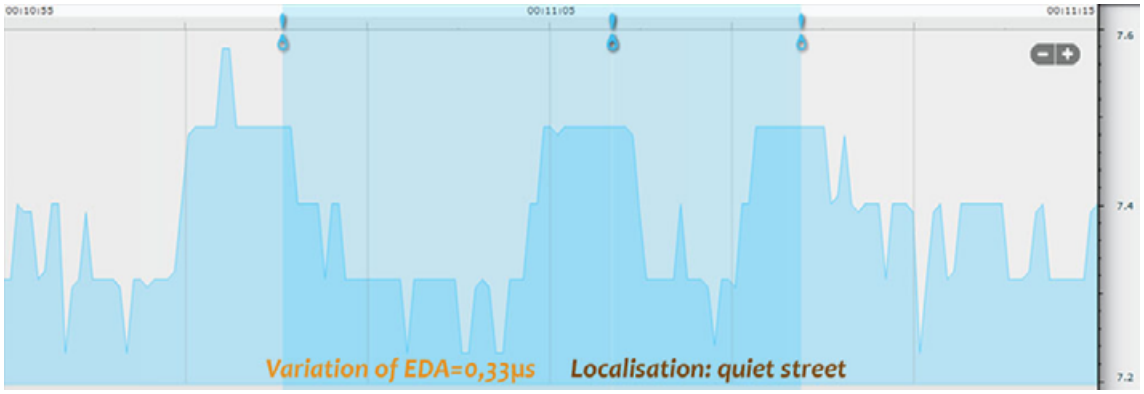

Figure 5. Variation of the EDA level (The low noise level is considered boring)

We have then come to an analogy between the variation of the sound recording, the variation of the electrodermal activity of the investigated subjects and their description of the situation.

We proved that the perception of stress in the public space is related to certain physical characteristics of the sound signal (Figure 6) and more exactly, specific frequency bands of the signal of the contemporary urban soundscape (space): police man's whistle (4KHz), vehicle horns (8KHZ, 12kHz ...), acceleration and vehicle noise which is a urban permanent background sound (10KHz) ....

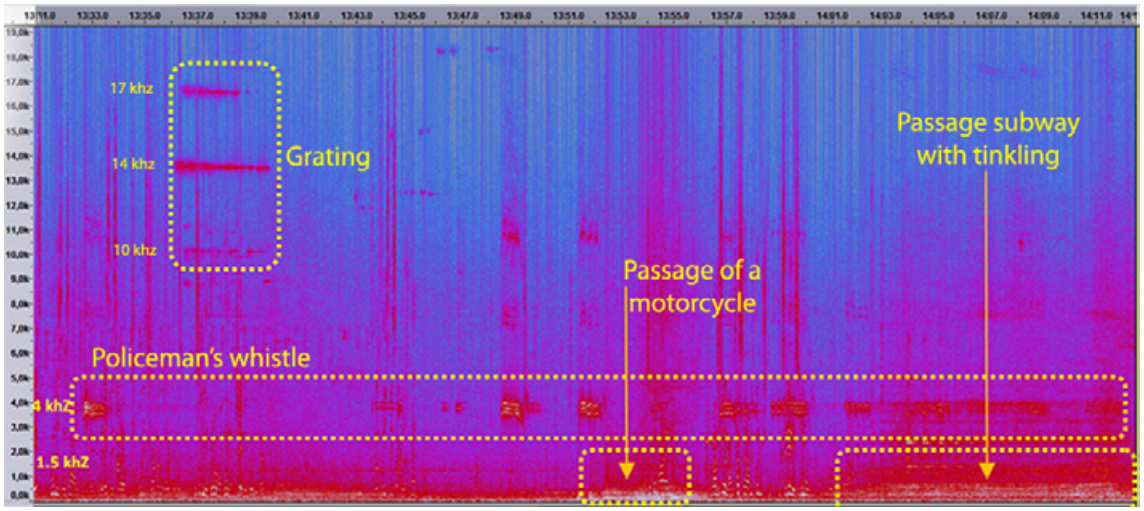

Figure 6. Analysis of the Audio spectrum recorded for subject 8 during her passage through the crossroad of Avenue Farhat Hached and Turkey Street

In several other cases we found that the SCR detected is not due to sound factors but olfactory factors "it stinks!" or "it smells bad! or geographical or weather condition" What a heat!", or politic climate (Figure 7):

Look soldiers, I feel uncomfortable. You know after revolution even if all goes well, we are always stressed and in panic. (Subject 10)

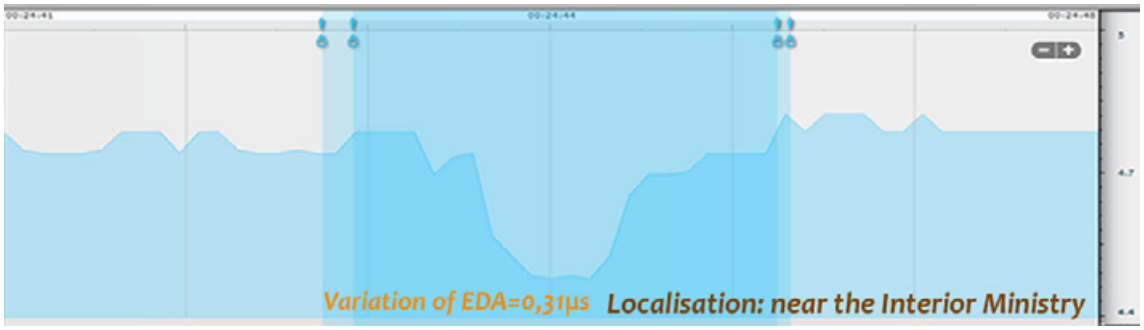

Figure 7. Variation of the EDA level (The stress detected is due to political climate)

In other cases we are faced with an ambiguous explanation, where the sound detected physiologically stress is not synonymous of a stress expressed verbally.

4.2. Analysis of physical signals

The analysis of the variation of the sound levels according to the crossed urban intersections, confronted with the results obtained in the first part (crossing of the physiological, psychological, and physical methods), shows that the causes of the sound stress are related to three behaviors from the sound signal:

- Stress due to high sound level
- Stress due to sound level jugged as low
- Unnoticed stress nor satisfaction

Here are their locations relative to the selected urban path (Figure 8).

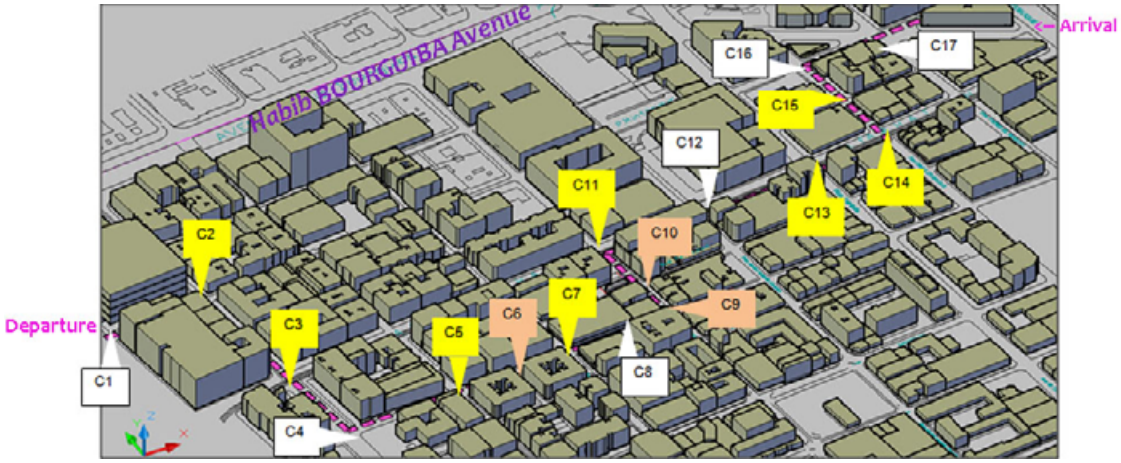

Figure 8. Synthesis map of the location of the urban crossroads according to their classifications

We must recall that our initial problem explores the links between the characterization of urban sound phenomena, the stress of the user and the morphology of the building. Then we supposed that the architectural and urban specificities of the crossed walk present an explaining factor of the manifestation of sound stress.

4.3. Analysis of urban space

Let's analyze the architectural and urban specificities of these crossroads. Let's take the example of the Om Koulthoum Street (Figure 9), a vehicular to one direction of traffic, we report three types of perception.

Figure 9. Synthesis map of the location of the urban crossroads according to their classifications (eg of Om Koulthoum street)

We note in an intersection of four buildings in the shape of a cross (+):

- A manifestation of sound stress due to a high sound level for crossroads C5 and C7.
- A manifestation of sound stress due to a sound level judged as monotonous and reduced for crossroads C9 and C10.

Similarly for the urban configuration in the form of (T), for the crossroads C6 and C8. For the same configuration, we note two different behaviors:

- A sound stress due to the reduced sound level for the crossroad C6.
- Unnoticed reaction.
- So, we can assert that the urban configuration of buildings of angle does not explain the manifestation of stress in the studied urban crossroads.

The multiplicity of sound sources (pedestrians, vehicles) the intensity of the noise, the intensity of road and rail traffic and the type of frequentation (police, pedestrians, men...) are at the origin of the change in the sound level in urban crossroads and consequently the manifestation of stress for surveyed persons. This is confirmed by crossroads C5 and C7, despite

their similarities with other intersections on the same street, these intersections present a source of sound stress, for the investigated persons, because of the great animation and presence of people in the shops that are settled in the ground floors of buildings which form the crossing.

5. Urban configuration and sound Stress: limits and perspectives

We then demonstrate that the urban configuration of the studied crossroads doesn't explain the manifestation of the stress. Indeed, for the same urban configuration we detected three different reactions to the investigated (sound stress due to the intensity or to the frequency or unnoticed reaction). We concluded then that urban configuration is neither determining nor explanatory factor of the manifestation of sound stress. Only the types of the sound sources, the animation of streets and the psychology of the investigated are the decisive factors in the manifestation of the sound stress.

We also noticed that the increase of the sound level is not always synonymous of increased stress. Indeed, a high sound level does not reveal the same reactions to our investigated. Sometimes, it presents a negative and annoying factor. But, in other times it is taken as a sign of assurance and integration in the crowd. The same for calm, it is not always appreciated by the investigated. It can be sometimes translated as a feeling of insecurity and routine and at other times as comfort and the relaxation.

This part still remains developing and what is interesting is to understand how to master the acoustic comfort? Is there any relationship between the frequency composition and the quantity of stress? And how does this report, if it exists, change from one user to another? And from one time to another (day and night). So many questions that other researchers will have to answer and remain to be developed.

Also, it's important to note that focusing on the soundscape doesn't exclude the fact that the sensorial components of the ambiance have a major role in defining the full situation in which the subject is immerged in.

Finally, we propose the figure below (Figure 10) which simplifies the triangulation of the applied methods which allows us to identify the links between the three parameters: the morphology of the built, the sound signal and the perception.

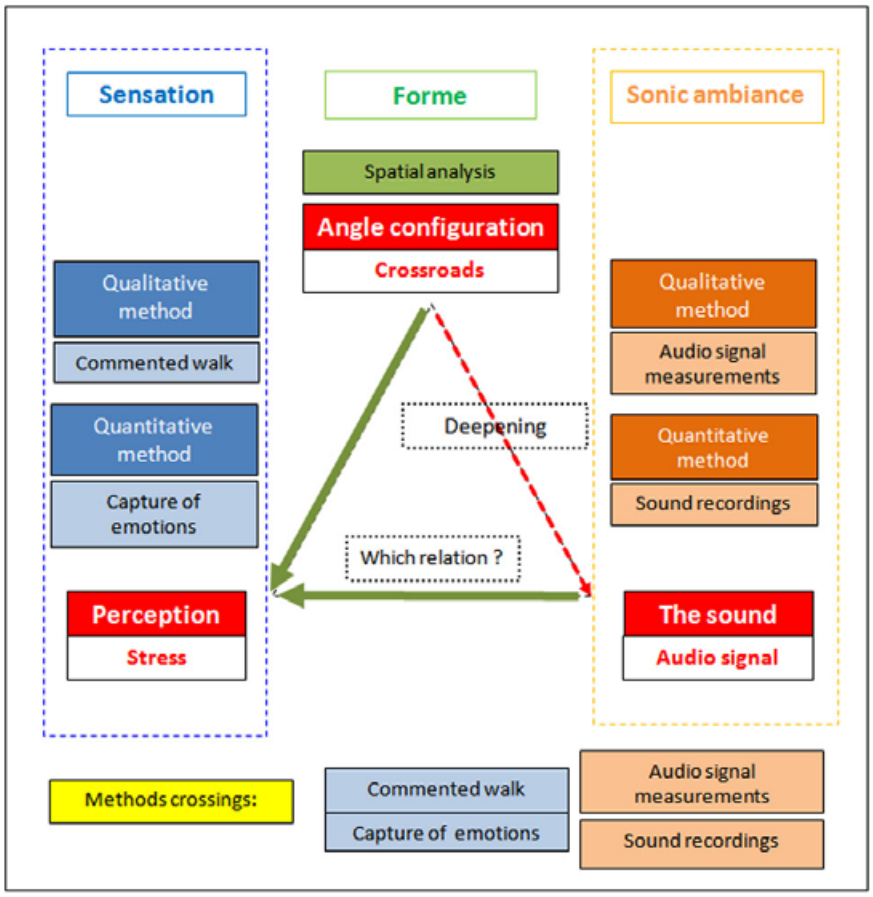

Figure 10. Recapitulative diagram.

Acknowledgments. I'm particularly grateful to Professor Jean Pierre PENEAU for framing this work and Professor JAIDANE Meriem from U2S (Unité de recherche système et signaux) of the National School of Engineering of Tunis (ENIT).

My sincere gratefulness goes to Doctor Faten HUSSEIN and Yosra MZAH for examining the analysis of EDA and frequency data.

REFERENCE

Ammar Leila and Panerai Philippe. Tunis d'une ville à une autre Cartographie et histoire urbaine 1860-1935, Tunis : Espace Diwan, 2010.

Bouscein, Wolfman. Electrodermal activity, New York: Springer, 2012.

Camillo, Sitte. L'Art de bâtir la ville, l'urbanisme selon ses fondements artistiques, Paris : Edition Seuil, 1996.

Grosjean Michèle and Thibaud Jean P. L'espace urbain en méthode, Marseille : Edition Parenthèses, 2001.

Layeb, Sana. Parcours commenté, parcours segmenté : une recherche exploratoire entre les configurations urbaines et le stress sonore en milieu urbain, PhD diss., University of Carthage, 2012.

Massabuau, Jacques P. Eloge de l'inconfort, Marseille : Editions Parenthèses, 2004.

Massot, Bertrand. Conception, réalisation de capteurs non-invasifs ambulatoires et d'exocapteurs embarqués pour l'étude et le suivi de la réactivité émotionnelle, PhD diss., University of Lyon, 2011.

Moser, Gabriel. Les stress urbains, Paris : Armand Colin, 1992.

Regnault B., Cécile. Les représentations visuelles des phénomènes sonores, PhD diss., University of Grenoble, 2001.

Strauss, Erwin. Du Sens des sens. Grenoble: Millon, 1935.