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The case of autistic children and elderly

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Abstract. *Autistic children and presbycusis elderly are examples of 'specific' space users which altered perception of sonic ambiances in particular affects their relationship to the urban and architectural space. Our research is on crossroads of several disciplines. It focuses on analysis of stress levels for those particular populations in some daily situations in urban and architectural spaces, using Electro-Dermal Activity (EDA) tracking that evaluates the arousal via skin conductance measurements. The understanding of discrete situations of anxiety should be useful to find a balance between standard and quality in space design, taking sonic ambiances into account.*

Keywords: autism, presbycusis, ambiantal situations, EDA, stress levels

Introduction

Urban and architectural space has always been a prime mover in experiencing sonic ambiances. In fact, sound perception constitutes a constant communication link with the environment (Brown, 2012), critical to manage well-being issues. Thus, perceiving sound ambiances depends conjointly on the spatial context, the nature of sound sources and the psycho-physiological abilities of the person, resulting in a multisensorial dimension (Amphoux, Chelkoff, Thibaud, 2004).

Characterised by an interweaving of different factors influencing each other (Pallasmaa, 2005), urban and architectural space is frequently designed for presumed persons who do not suffer from any disability. This raises the question of why these norms discard people with special needs. Persons with physical and perceptual disabilities represent a large panel for 'specific' users who daily evolve in urban and architectural space. Incompatibility between the urban and architectural environment and the individual skills of space user can lead to stress situations (Saby, 2007).

We took part to targeting autistics children and elderly as a 'specific' study population of this research. Several cognitive and sensible disorders in brain development have been linked to auditory hearing disorders that appear at an early age, such as children with autism spectrum disorder. Also, hearing degradation at elderly, called presbycusis is directly linked to advanced age resulting specially on a

loss of high-tone acuity. When soundscape perception is altered, level of security and well-being for such space users is considerably affected and stress situations may occur. The Electro-Dermal Activity (EDA) is a mean, used in this study, to assess a human affective state. It is an objective measure of stress and has various applications in the field of medicine (Boucsein, 2012). Several studies focused on the relevance of such application of the EDA in detecting states of stress of different populations in specific situations (Picard, 2009; Hussein, Ghozi, Jaïdane, Péneau, 2016). This multidisciplinary study aims to characterize stress' states experienced by space users with an altered sound perception in a given stressful situation in order to correct it. A common objective of a 'shared accessibility of the city and the public buildings for all' has to be taken into consideration by designers. Thereby, a balanced sharing of space cannot be conceived without a balanced attunement to ambiances, recognized as a transforms operator of urban and architectural accessibility and social practices (Thomas, 2004).

Experimental protocol

There are three main parts to the experimental protocol applied for this study, which are organized as follows:

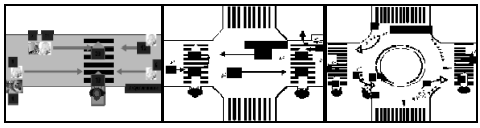
- A significant spatial configurations selection where our target population can be vulnerable and stressed.
- A panel of 'specific' space users which will perform commented walks in the selected fields of study. We will measure simultaneously their EDA.
- Audio or video recordings and analysis of the experienced sound scenes.

First experiment: urban level

Field of study

We selected three urban traffic crossings, known to be stressful and dangerous in the city center of Tunis. This selection is based on the field of accidents studies and statistics by identifying the urban configurations, which increase the incidence of accidents by applying a model known as 'a prototypical accident scenario' (Fleury, Brenac, 2001). Thanks to this model, we specified three critical configuartions to conduct the first experiment in the urban space:

- Road intersections: a simple crossing at an area called Bab El Falla, where the subject has to cross a two senses road, not regulated by traffic lights.
- Crossroads: a relatively complex and frequented urban configuration at the area of Lafayette, regulated by traffic lights.
- Traffic circle: a highly frequented and complex configuration regulated by traffic lights and policemen. It's at the area of Habib Bourguiba.



(a) (b) (c)

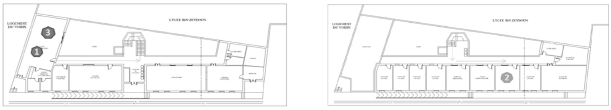
Figure 1. Sketches and illustrations of the three urban configurations: (a) Bab El fella (BF), (b), Lafayette (LF), and (c) Habib Bourguiba (HB).

Population
Our target population is composed by twenty presbycusis persons, equally devided into men and women, suffring from different levels of auditive degradation. One third of them are equiped with hearing aids. All subjects are in healthy mental conditions and can walk without aid.

Data collection
Commented walks (Thibaud, 1998) in the three identified traffic crossings were performed by the twenty subjects. EDA data were measured too during each walk which lasts about six minutes. Arousal capture was done via a biosensor called 'Q-Sensor' (Poh, 2010). This device quantifies via the skin conductance the arousal levels, the temperature and the deambulation speed of the user. Each audio scene were recorded and elderly behaviours were analyzed.

Second experiment: architectural level

Field of study
To test another spatial level, we select for the second experiment an architectural space: a care center for autistic children. We selected a typical walk that traces the daily life of an autistic child in the center from the morning to lunchtime, alterning confined and open spaces (educational room, activities room, staircases, corridors, garden etc.). The center is called Special Education Center of Testour, Tunisia. We have to notice that this architectural space was build to accommodate an autistic population but our architectural analysis reveals that no qualitative and ambiantal consideration were taken. Some spatial standards are applied.



(a) (b)

Figure 2. Architectural drawings of care center for autistic children at Testour: (a) first floor, (b) second floor

Population
Five autistic children took part to our experiment. They suffer from over-sensitive issues due to some sensory input. To participate to our experimental protocol, we have to mention that our population was relatively presenting few brain disorders and can express some of their needs.

Data collection
We used audio and video recordings to follow each subject when evolving in the care center from the moment of his arrival until his departure. EDA was measured thanks to the same biosensor used in the first experiment. A typical daytime of an autistic children at this Special Education Center includes educational exercises and some physical and playful activities. The child is permanently assisted by a special educator. Some interviews with the parents of our autistic population were done in order to know more about the sensitive background of each subject.

Eda analysis results

Arousal state characterisation

Preliminary observations, after visualising EDA curves and analysing them, lead us to detect stressful situations on each studied spatial configuration. Figure 3 represents sample records of EDA measurements of two presbycusic female subjects with and without hearing aid while crossing the three urban traffic configurations (a) and two autistic children with different degrees of autistic disorders while evolving in the same architectural space (b).

We notice that in all sites in the urban space, the presbycusis pedestrian with a hearing aid is experiencing a lower level of arousal. The correspondent curves have monotonous shapes and show almost no stress peaks. The same observations can be done for the EDA curves of the autistic children in the architectural space where the most disturbed one correspond to the child with severe behavior disorders.

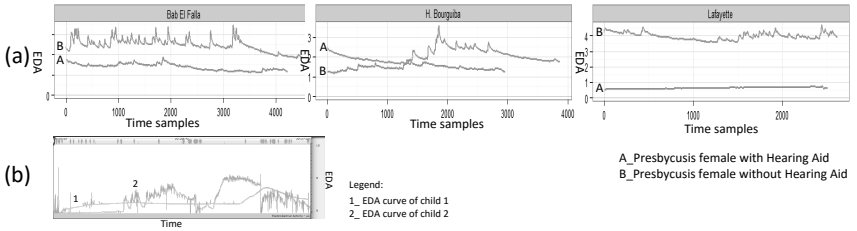


Figure 3. Sample records of EDA measurements of two presbycusic female subjects in urban space (a) and two autistic children in architectural space (b)

At a first sight, we can say that arousal states are linked to the perceptual degradation (hearing loss for elderly and behavior disorders for autistic children). The space configurations do not seem to be related to the stress level at this stage. We have to correlate several levels of analyzed data in order to explain phenomena.

Urban versus architectural stress levels interpretation

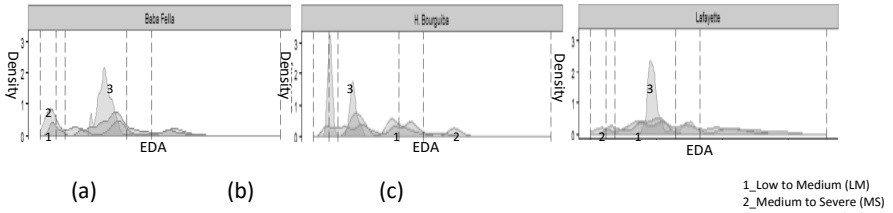


Figure 4. The empirical distribution of EDA measurements in the three sites according to the degree of presbyacusis

In order to further deepen the level of EDA analysis, we consider first a group EDA analysis of all EDA curves of our twenty presbycusis pedestrian evolving in the city. We applied a clustering method of the EDA signal (Bahri, 2014) in order to obtain

levels of stress correlated to its density. In that respect, we observe in figure 4 global empirical distributions of EDA data in the three sites of studies where a multi-modal characteristic appears according to the complexity of the urban configuration. Population with a severe to deep hearing loss presents important variations in their EDA's empirical distributions in the three studied sites. Presbycusis pedestrian with a Low to Medium or Medium and Severe hearing degradation have constant curves and seem not to be anxious due to cars while crossing any of the three urban configurations, regardless of their structural and urban complexity. If we consider safety parameter of the study, we suppose that a well-designed crossing, having enough visual and sonic complexity and associated with traffic lights, invokes several levels of alertness and arousal.
From a point of view of an individual EDA analysis, we consider the case of an autistic child in the architectural space (from confined to open space in the care center). Figure 5 illustrates the EDA variation rate of an autistic child while evolving in the care center and going from a space to another, especially in transition areas.

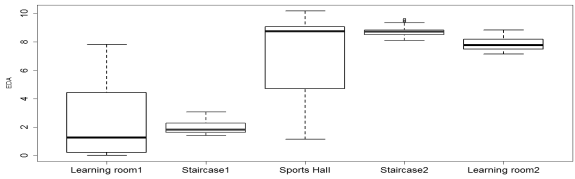


Figure 5: The density distribution of the EDA signal in the architectural space, case of an autistic child

This experience reveals the importance of the architectural organisation as well as architectural devices on the well-being of the children; not only in closed spaces (classrooms) and open spaces (play areas) but also in the transition spaces (in between). We note that the change rate for electrodermale reactions in transitions spaces is much reduced mainly in staircases. It is explained by states of relaxation for the autistic children. Indeed, in situ observations have shown that some educators avoid crossing the stairs and take the elevator, which make the child anxious and nervous. From a well-being corner, we suppose that a well-designed architectural space for autistic children, having enough stereotypic and rhythmic visual and sonic complexity, invokes few levels of alertness and stress.

Conclusion

This study highlights results of an arousal states characterisation linked to the spatial configuration for a population whom perception is altered by cognitive and perceptive disorders. The approach revealed that various spaces have induced different levels of stress among users depending on the degree of the perceptive alteration. As well, spatial configurations play a major role in creating situations of anxiety and danger for our subjects. Indeed, we tend to prove that the manifestation of these effects on elderly or autistic children depends on the urban and architectural aspects.

In that regard, we are aiming to propose corrective urban, architectural and acoustical models for an improved daily living of these particular populations. Such models will contribute to introducing sonic ambiances at the first conceptual stages of an urban or architectural project in order to transform our spaces and societies. In addition, this work could be useful in spatial safety indicator and well-being evaluation. However, we cannot dissociate the different environmental factors that define the situation. We have to take into consideration the fact that each experience is multisensorial in order to achieve the objective of a balanced sharing of space, which definitely cannot be conceived without a balanced attunement to ambiances.

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Faten Hussein is a doctor in architecture and Sana Layeb is a Ph. D student in architecture. Both authors are affiliated to the Research Team on Ambiances (ERA) from the National School of Architecture (ENAU), Tunisia. Their interests are on the altered perception in the urban and architectural space and the complexity of soundscapes.