GESTURE

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Final Report

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I. Theoretical Work

1. Definition and area of application

The hypothesis behind this research project is that a piece of architecture elicits, in those who experience it, a peculiar *gesture*, i.e. a series of walking and gazing movements (and correspondingly, a given set of emotions). This series of walking and gazing movements is the direct perceptive response to the stimulus that the architectural form enacts (visual, acoustic, tactile, and smell stimulus but also, proprioceptive stimulus that derive from the drive of perception). Being determined mainly by the architectural form *gesture* tends to be common to all those who experience the same piece of architecture.

In normal visiting circumstances, when one enters a commonplace homogeneous dimly lit room, if there is a door in the opposite wall, if the door is open, and if behind the open door the next compartment is illuminated, then the eye, after a general inspection of the dim room, will tend to focus on the door and on the illuminated environment behind the open door; and the subject, after his visual attention has been captured by the lit element, will feel the call to walk across the room towards the open door (whether or not he crosses the room and passes through the open door will depend on what he sees in the other room).

When one visits a large nave, if all the walls, ceiling and floor are even and homogeneous, if there are no peculiar light effects, but if in one of its walls there is niche with some ornaments, then, after a general inspection of the space, gaze will tend to concentrate on that niche; and if it reveals any sort of complexity or meaning, then the subject will tend to walk across the nave to come closer to that niche and examine it carefully.

Many architects contrive architecture in a likewise manner, as if to be seen during a walk, almost as if in a movie (one may recall the Corbusian concept of "*promenade architecturale*"), working on the light, the color, the ornament, as a process to engender that attraction and concentration on the visitor. They may also craft the compartments before and after the climax in order to produce certain emotional effects: surprise, relaxation, exaltation, experience of coziness or formality…

When a work is truly architecture – i.e. when it conveys an existential meaning that keeps it alive beyond its practical function, in such a way that it imprints itself on the consciousness and memory of the visitor as something irreplaceable in its existential content (Abreu 2001, 2007, 2007a, 2008, 2010, 2013, Heidegger 1951, 1957, 2001, Levinas, 1988, Crippa 1998) – when it is really architecture, all the sorts of effects formerly described are as if orchestrated, inducting something similar to a *slow dance*, from which results a sequence of perceptual data and feelings through which a message is conveyed – like in music (Abreu 2007). In fact, as in music, it is possible to say that an environment has a certain tone (cozy, formal, amusing, strict, luxurious…); and a certain rhythm as well (the size of the steps, a set of pilasters in gallery, a sequence of overtures in a wall…). As in music, tone and rhythm put together create melody – and a melody conveys a message, a sort of meaning that grows deep and imparts the level of life we call specifically human. Thus it is through the meaning that pervades *gesture* that architecture achieves its value and its place, at an anthropological level

This hypothesis implicates that each building (which reaches the level of architecture) brings along a perceptive pattern and that this pattern is intersubjective.

There is not much of a novelty in this hypothesis, however. Husserl waves at it when he says that place is understood by the kinesthesia that is its own: "Der Ort ist verwirklicht durch die Kinäesthese, in der das Was des Ortes optimal erfahren ist" (Edmund Husserl apud Casey, Edward S. – *The Fate of Place: a Philosophical History*, p. 206); Wittgenstein refers that one is compelled to answer to architecture with a *gesture*: "Remember the impression made by good architecture, that it expresses a thought. One would like to respond to it too with a *gesture*" (*Culture and Value* MS 156a 25r: 1932-1934); but, more importantly, Yarbus has empirically demonstrated the existence of such a perceptive pattern in paintings and drawings (Alfred L. Yarbus – *Eye Movements and Vision*, 1967, passim). So, what we largely intended to do in this research was to apply Yarbus' experiments in the realm of architecture.

Being true, this hypothesis would be especially useful in the events of architectural interventions on pre-existences.

THE PROBLEM OF INTER-SUBJECTIVITY IN THE INTERPRETATION OF A PIECE OF ARCHITECTURE

A serious problem in contemporary architecture is related to the need to operate on pre-existing architectures: which could vary between an intervention on an old house, on a historical monument or a new building on a plot of a consolidated urban tissue.

The ruling ideology in the Modern Movement stated that it was enough to ensure the architectural quality of the new work (that which is sometimes called a signed work). Such a line of thinking revealed itself, through many shocking evidences, to be wrong (Brolin 1976; Jenks 1977; Magatti 2007; Abreu 2008; Salingaros 2011; Serafini 2013).

Accepting, as in music, that matching a new orchestration or a new arrangement with a pre-existent piece does not depend on the author's style, it is also true that there are tangible factors (some objective, like rhythm, others subjective, but still inter-subjective, like meaning) that allow us to distinguish if the new intervention is symphonic or cacophonic in the regards of the pre-existence. Now, if it was possible to determine objectively the way in which a work of architecture is perceived – using the *gesture* pattern – something like a stave would be given. This stave would still allow for poetical freedom – as much as it does not establish any solution – but it would help enormously in clarifying the essence of the pre-existing piece with which the new intervention has to match, and the limits outside which incoherence takes place. Thus an interpretative inter-subjective substratum would be supplied, an objective referent to meaning in architecture.

(During the experiment that was conducted on the church of the Monastery of Alcobaça it was already possible to notice that certain interventions – as, for instance, artificial lightning – are highly disruptive of the normal path of gazing. We are allowed to think that this disruption will interfere in the process of reading the work of architecture and in the acquisition of its meaning.)

The research project that we are about to describe takes the first steps into the empirical assessment of the hypothesis presented above.

However, the "exploratory" nature of the present research project brings along some specificities that we are obliged to consider first.

2. About the "exploratory" nature of the research project

The hypothesis of *gesture* has been, within this research, far from being "proven": only a very small population sample was analyzed (only 50 individuals in all except one experiment), this population sample was not representative of the totality, as it is restricted to a very specific domain (students of architecture), and the behavior of this population was analyzed regarding only one building (as it has already been said, the church of the Monastery of Alcobaça). But proving fully such a hypothesis could not be the purpose of an "exploratory" research project anyway.

The "exploratory" nature of the research project shows itself mainly through the focusing in the constitution of the empirical processes – in designing the experiments – by which it would be possible to ascertain the scientific nature of the hypothesis. The design of the experiments had two levels: first, to formulate a proposition and its negative, which allow for two different domains of solutions: the one that ascertains the hypothesis and the one that contradicts it; second, to improve the effectiveness of each phase of each experiment and the connections between phases in order to allow for a smooth process. The second aspect will be tackled along with the description of the experiments. The first aspect will now be further developed.

THE CONCEPT OF "SCIENTIFIC THEORY" AND ITS ROLE IN EXPLORATORY RESEARCH

Karl Popper made very interesting remarks about the scientific status of a theory (Karl Popper – *Conjectures and Refutations*, London & New York: Routledge, 2008, and also *The Logic of Scientific Discovery*, London & New York: Routledge, 2008).

A theory is a statement that has the power to explain a set of events and, in consequence, to anticipate events of the same species. It has, in this sense, the nature of a rule: it permits some events and it forbids others.

It is normally assumed that a theory is born from observation: the rule that presides over a sort of events is logically induced from a recurrent event (explaining and forecasting each one of them). Yet Popper, following Hume, has established that *induction* is not a logical process: if one event occurs in the same way a thousand times it does not imply that the same event will surely happen in the same way again (Popper 2008a, p. 69 ss.). Thus one may not claim that the scientific status of a theory depends on the number of times the same event was observed or on the number of tests that obtained a positive answer (according to the hypothesis that was being tested in order to verify its scientific theory status). One may not even say that a scientific theory stems from observation. Popper says: "[…] in fact the belief that we can start with pure observation alone, without anything of the nature of a theory, is absurd;" (Popper, 2008a, p. 61). On what, then, does the scientific nature of a theory depend? According to Popper it depends on its "testability". He states: "the criterion of the scientific status of a theory is its falsifiability, or refutability, or testability" (Popper 2008a, p. 40).

A theory is a hypothesis, or better said a "conjecture". This conjecture claims the power to explain and foresee the sort of events it congregates (it intends to be the rule that presides over those events). Then one of the most significant scientific tasks accounts for the *design of the theory*, in a strict scientific manner.

Yet this is not enough to grant to a theory its scientific status – a scientific theory has to be able to be tested. The testability of a theory depends on several factors. For one it means that it should allow for the design of an experimental setting in which it would be possible to observe accurately what is foreseen. Other than that, it has to be able to predict, inside the experimental setting, a precise domain of occurrences that verify the hypothesis, but also a codomain of occurrences that allow for the refutation of the hypothesis if one should happen (the codomain represents what the theory forbids). This last aspect would stand for the "falsifiability" character of a theory that, according to Popper, is one of the most important in a scientific theory. The scientific status of a theory is, therefore, granted to a conjecture that, observing the former precepts, has not yet had any occurrence that refutes it. Once again quoting Popper: "[…] laws and theories are conjectures, or tentative *hypothesis* (a position which I have sometimes called 'hypotheticism'); […] The principle of empiricism ['which asserts that in science only observation and experiment may decide upon the acceptance or rejection of scientific statements, including laws and theories'] can be fully preserved, since the fate of a theory, its acceptance or rejection, is decided by observation and experiment – by the result of tests. So long as a theory stands up to the severest tests we can design, it is accepted; if it is not, it is rejected. But this is never inferred, in any sense from the empirical evidence." (Popper 2008a, p. 72).

The sequence of the aforementioned aspects was seriously taken into consideration in this research and accounts for most of its exploratory nature.

Despite of it not being possible – due to budget and time limitations – to extensively test the *gesture theory* (we allow ourselves to call it so after Popper's explanations) it was possible to create a number of testable hypotheses and to thoroughly design and probe several experiments that respond to the testability of the theory.

An array of conjectures of events was formulated, which, if they did not occur, would invalidate the *gesture* theory. Experiments were designed appositely to assess such conjectures. Those experiments were sampled, tuned in their procedures and then applied to the whole population.

(Since the results did not refute the conjectures – as it will be described later in this report –, we ought to consider the *gesture* theory scientific. It is true, though, that the amount of tests performed, especially in what concerns the number of buildings, was not relevant, considering the broad nature of the theory.)

3. Designed experiments

3.1. The experiments designed in the application for the research project.

Considering the reasoning of Popper, and also some technical issues, the experiments designed for the project application suffered some changes.

We intended to conduct just one experiment in which the joined trajectories of walking and gazing of the individuals would be tested, but due to software insufficiencies we had to divide this whole experiment into several parts. In the application we assumed that the eye-tracker software would be able to project the gazing vectors onto a 3D model, but unfortunately the software that the eye-tracker company provides can only process gazing data in 2D. It was not possible for the team members in charge of this area to overcome these software deficiencies (although previous research results in similar areas would lead us to expect it at the time of the application, and other attempts during the research period were made, as it will be described in the next chapter); neither in the specialized market nor in the Portuguese academic community was there any concrete possibility to solve this problem. (Nevertheless these difficulties open new research opportunities in the computational field that will be pursued in the future.)

At the time of the application we intended to work with only one population group of 30 individuals. First and second year students of architecture were chosen, since a sensitivity to architecture and availability to the experiment, without much of the mental framing that comes with graduation, could be expected.

The piece of architecture we elected was the church of the monastery of Santa Maria de Alcobaça. This church is the most exquisite sample of Portuguese Cistercian medieval architecture. For the first test of *gesture* theory we wanted a very simple clean and easily readable building, most likely to exhibit a clear pattern of *gesture* – if *gesture* theory did not work in such a building it would not work in any other. Cistercian medieval architecture ensures the legibility we were searching for and also displays a traditional environment that is expected to prevent from shocks and inhibitions. Besides, the church of the monastery of Alcobaça is widely considered a master piece, so it would be expectable that the sample population would easily relate with it.

3.2. Experiments executed

The executed experiments will be thoroughly presented in the next chapter – Empirical Work. Here we just want to present the main differences from the research project application, and correlate them with the train of logic of conjectures and refutations we gained form Popper.

For the executed experiments the place that was submitted in the project application was maintained. In opposition we changed the population and sectioned the experiment.

We used 3 groups of individuals. The first one consists of first year architecture students (39 individuals); this way, since we did most of the experiments in October and November and the academic year only began in late September, it was presumed that they were almost untouched by any architectural theory. We have also performed the experiment with a very small group (11 individuals) that had just completed their graduation in Architecture or were about to do so. These more mature students were specially intended to help with the interviews, giving more indications on their behavior during the experiment (we anticipated that the first year students would have more difficulties during the interview). It was also possible to make a small experiment with a large group of undetermined participants (about 500 individuals), random visitors of the church during the time span of our sojourn in Alcobaça.

As we said before we had to expand the one experiment foreseen in the application project. Instead of one, we performed three tests: one about the gazing pattern, another searching for a stopping pattern, and a third one, which was processed through a computational model, about the walking pattern. Other than that we correlated these main experiments – dependent on the data collected by the eye-tracker and the location cameras – with data from other sources: the interviews, drawings requested during the interviews, and the heart-rate data. We also performed an inquiry on the population of the first and second groups, which allowed us to characterize these populations and their degree of satisfaction with the conducted experiment.

Each one of these tests resulted from a specific conjecture and had a refutation proposition (that ensured its falsifiability)

3.3. Conjectures, domains of validation and of refutation

It was not possible to obtain a trajectory line for each individual that could be superimposed on the 3D church model for the gazing experiment purpose. So we conjectured that the architecture would have some "hot spots" which would attract gaze more often for a larger time span, and some “cold spots”, which would work inversely (less often and shorter duration). If the cold spots evidenced a larger or similar number of the gaze occurrences and a larger or similar time, the *gesture* theory would be refuted.

For the stopping test we assumed that there would be some places in the church that would concentrate most of the stops (we presumed that it would happen in the vicinity of the gazing “hot spots” and/or correlated with them). Our hypothesis was that, if a part of the building seriously attracts one’s attention, then this individual will stop for contemplation. In the absence of such privileged places for stopping, architecturally correlated, the *gesture* theory would be refuted.

The third test performed was about the behavior on when entering the church. It was expected that most part of the experimented subjects, after passing the main door, and after very brief inspecting looks (navigation looks) would feel the call of the lit apse, would feel the channeling effect of the nave and would proceed straight ahead through the main axis. The absence of a substantial majority of tested individuals that followed such a trajectory would refute the *gesture* theory.

It was not possible to process the data from the heart-rate monitor, the interviews and the drawings in the same manner, so this material assumed a more probing purpose, which would enact future experiments. The hypothesis behind the heart-rate test was that the moments of higher heart-rate that had no physical justification would link to emotional events that could be caused by the elements of the architecture. The absence of such a connection would invalidate the hypothesis.

(Another hypothesis was also studied: According to theory, an architectural environment makes people feel protected and at ease (Abreu 2001, 2007, 2007a, 2008, 2010, 2013, Heidegger 1951, 1957, 2001, Levinas, 1988, Crippa 1998), so it was admissible that lower heart-rate would mean an experience of comfort and coziness that may be linked to a deep experience of architecture. Again, the absence of correlations between the moments of lower heart-rate and privileged places where one would be allowed to expect such coziness would invalidate the hypothesis.)

In the interviews we search for some invariances from which we could draw some patterns to be investigated in future experiments. We also correlated some elements of the interviews and of the drawings with essential aspects of the *gesture* theory and other environmental perception theories.

The inquiry served mainly to get to know the tested population and ascertain if there were problems in the designed experiments that could affect the results.

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4. Literature Review

The bulk of our theoretical work – literature research included – was focused on hypothesis formulation and perfecting the experimental proceeding. There was, however, an extended part of the literature research that explored the theoretical fields in which our theory is rooted.

In this section, we frame *Gesture* both as a theory and as an empirical study, our literature research encompassed the theoretical as well as the practical realm.

On the theoretical field, we focused on the study of the classical theories of perception put forward by psychologists such as E. Brunswik and J. J. Gibson.

On the empirical field, we reviewed some of the most recent research on visual perception and gaze guidance, while trying to relate new scientific data to the results of our own experiment.

4.1 Review of the classical theories in perception

4.1.1. Introduction

Environmental psychology deals with environmental perception in daily life as one of its themes of excellence. Early in its history, Ittelson (1976) argued that traditional experimental psychology had exclusively investigated object perception, rather than environmental perception. He wrote that "One does not, indeed cannot, observe the environment: one explores it" (p.149). In other words, he emphasized the daily situation in which people perceive the surrounding environment, while actively moving in it. This emphasis still persists today in environmental psychology. For example, a major textbook (Gifford 2002) begins its chapter on environmental perception with: "We know a great deal about the perception of a one-eyed man with his head in a clamp watching glowing lights in a dark room, but surprisingly little about his perceptual abilities in a real-life situation" (Ross 1974, p.9).

The inability of environmental psychology to construct perceptual theories is attributed to two methodological problems. One is that the experimental conditions are designed without taking into consideration the dynamic nature of environmental perception. Most experiments have presented environments by using static displays (e.g. photographs), which provide experiences that are different from daily perception.

The other methodological problem is that most of the experiments only deal with subjective assessments, emphasizing the constructive nature of perception, which leads to neglect the environmental physical characteristics of the perceptive process (see Heft 1983). Most of the empirical support for constructivist theories have been gathered under controlled conditions. It should not be surprising that one would find evidence for perceptual inferences and constructions when information is presented in an equivocal manner and when opportunities for information pick up are limited. In light of the possible artificial nature of the supportive data, the validity of constructivism as a theory of perception comes into question (Turvey, 1977).

Note that in the *Gesto* project perception is analyzed in a real context (Alcobaça monastery) where the analysis is not only based on the mental representation of the environment, but also in physical variables, through sensorimotor experience. Therefore, in this project we will use the distal and proximal dimension of perception (as Brunswik's theory of probabilistic functionalism).

Our sensorimotor experiences results demonstrated that there is a uniform standard (commonality of the eye and footed route) in environmental perception. In the qualitative study presented herein we aim at understanding if the subjective construction allows to explain some of the sensorimotor experience characteristics. The purpose of this qualitative analysis is merely exploratory.

Here we present a brief summary of the most significant classical theories of perception, while taking into account their degree of proximity to environmental psychology fundamentals. This summary is important because it scopes the framework used in the subsequent classification of the justifications given by the sensorimotor experience participants.

4.1.2.1. INFORMATION PROCESSING APPROACHES

The major assumption of an information processing approach is that perception is not an immediate outcome of stimulation, but is the result of processing over time. Neither the perceiver's visual experience, nor his straight response are immediate results of stimulation. They are consequences of processes corresponding to a series of transformations of the information contained in internal representations of the stimulus. Haber & Hershenson (1980:293-294) claim that perception is not immediate, but instead involves a series of stages which serve to transform sensorial input, clearly marks information processing as a constructivist theory. Another distinctive feature of this approach is the view that there are limits on the amount of information that can be processed at any given time. Information processing channels are considered to have relatively fixed capacities for storing and handling input, and these limitations result in processing selectivity. The notion of a limited processing capacity has been employed by some psychologists (e.g., Milgram 1970) in applying the information processing model to the environmental stress area. The latter has suggested that many characteristics of urban life are a direct consequence of information overload. The individual is overwhelmed by the stimulation springing from social sources in the city and, since cognitive processes have limited capacities for handling input, the individual adopts strategies for coping with these conditions. Cohen (1978) has offered a more detailed description of the nature of information overload and its effects. In both studies, the analysis of environmental stress emphasizes characteristics of cognitive processes, and the consequences of stress are tied directly to limitations in information processing capabilities. The central role of cognitive variables as determinants of environmental stress has received further attention in Cohen (1980). Drawing on a variety of studies in this area, he concludes that stress is typically a result of interpreting a stimulus situation as being threatening, undesirable, or uncontrollable. It is Cohen's contention that "the meaning of a stimulus configuration is generally more important than its physical properties in producing stress effects".

A distinguishing feature of the aforementioned analyses is their focus on intra-organismic processes, while neglecting the objective environment. This cognitive orientation is a direct consequence of adopting an information processing approach. Applying this approach to an analysis of environmental stress leads to a focus on characteristics of cognitive functioning, while the environmental basis for stress is rarely examined, a peculiar omission for environmental psychology. In addition, the use of cognitive constructs as environmental descriptors draws investigators further away from an examination of objective, environmental conditions. In short, approaching this problem area from a constructivist perspective results in an emphasis on cognitive processes and, in turn, little attention is paid to environmental aspects.

4.1.2.2. PIAGET'S COGNITIVE THEORY AND ENVIRONMENT COGNITION

In Piaget's framework, knowledge is represented through cognitive structures, schemes, which are derived from the child's operations on the environment. These operations are initially motoric but, with subsequent development, they become symbolic. Schemes are viewed as the basis for all knowledge. Consequently, perception is seen as involving the assimilation of sensory data to existing schemes (Piaget 1969). From this perspective, an analysis of environmental perception would need to take into account the individual's concept of space, especially since spatial knowledge appears to undergo age-related changes (for reviews, see Hart & Moore 1973; Siegel et al. 1978; Moore 1979).

According to Piaget, the young child encodes spatial location in relation to himself (an egocentric system) rather than in terms of its relation to other objects in the spatial array (an objective frame of reference). The child progresses from a coding system based on the relationship of landmarks to his own body and own perspective, to a system in which landmarks become central features for a partial coordination of space (a fixed frame, topological in nature), and finally to a coding system based on abstract axes, thereby facilitating full coordination in space (i.e., to a coordinate frame of reference that is Euclidean in nature) (Siegel et al. 1978: 236-237). Piaget's theory is positioned in the constructivist camp. As we saw with the information processing approach, sensory input is considered to be modified and enriched by cognitive processes. From a Piagetian approach, the patterns of sensory stimulation are transformed through their assimilation to cognitive structures. In contrast, information processing models maintain a distinction between input and mental functions; input is enriched due to the cognitive operations performed on the former, rather than their being modified through assimilation to operations (schemes). However, because of their commonly held assumption about the indirect nature of environmental perception and, more particularly, about the role of cognitive processes in perception, both approaches can be seen as alternatives within the constructivist metatheory.

As we saw in our previous discussion on the information processing approach, the adoption of a constructivist framework focuses on cognitive processes, rather than on the environment.

4.1.2.3. GIBSON'S ECOLOGICAL APPROACH

Gibson (1966; 1979) rejects the assumption that several environment characteristics are not represented in the proximal stimulus and provides grounds for a theory of direct perception of the environment.

In contrast to constructivist theorists, who usually begin their analysis of perception by examining characteristics of the perceiver and, in particular, the two-dimensional qualities of the retinal surface, Gibson considers environment properties on the perception process, namely in visual perception. He notes that there are two different types of light: radiant light, which is light originating from an energy source, such as the sun, and ambient light, which is light reflected by environment objects' surfaces. Since those surfaces may differ in their orientation to the light source, as well as in shape, texture, pigmentation, and motion, ambient light will be structured in a manner corresponding to these characteristics. As a result, information specific to the layout of the environment will be carried in ambient light. In other words, structure in the environment is preserved in the ambient light and, consequently, information specifying the features of the environment is present in the medium. He points out that if there is information available in the medium which unequivocally specifies the structure of the environment, an animal with sensitivity to that structure could pick this information up directly. Constructive processes which supplement sensory inputs would be superfluous. Adopting an evolutionary perspective, Gibson argues that this is indeed the case. The evolution of species' perceptual systems is seen as a process of adaptation to that subset of information in the medium.

It is important to underscore that Gibson is interested in an analysis of perception as it occurs in a natural setting – the animal's ecological niche. This setting raises two additional issues.

First, natural settings are rich in available information. By contrast, perceptual investigations traditionally conducted their experiments in darkened rooms, where the available information is markedly reduced, or under conditions where the environmental information is deliberately obfuscated.

Second, subjects (animals) are mobile in their ecological niche. Gibson (1979) suggested that species' perceptual systems have evolved to enable animals to perceive functionally significant conditions in the environment. Those aspects of the environment, which have functional consequences for the animal, are called "affordances", and affordances are specified in the informational structure of ambient light.

The concept of affordance offers an alternative approach to the problem of meaning in perception. As we have seen, sensory stimulation is usually viewed as carrying physical or geometrical data, with meaning considered a quality added to this input by the perceiver. From the affordance perspective, the animal is seen to exist in an environment containing meaningful features, rather than in the meaning-free universe of physics and geometry.

Although this design is interesting, Gibson evolutionary trend was challenged. In fact, for animals and (pre-historical) men, perception is (was) a matter of affordance, corresponding to the fulfillment of their own, survival, needs. However, for a civilized man, the recognition and interpretation of space goes far beyond the survival needs.

Parallel to the theories put forward in the Environmental Psychology field, there have been a great number of experimental studies regarding human interaction with built and natural context, sometimes supporting/challenging those theories, sometimes pursuing independent lines of research. We will now analyze them.

4.1.3. Review of the empirical studies in perception

Although there are many recent studies that focus on the same topics addressed by our experiment – perception, eye guidance, visually attractive features of the environment – or use the same techniques – especially eye-tracking – we found no literature concerning architecture perception in a free, real-world setting.

Eye movements have been an aspect of the human behavior prominently featured in empirical studies, especially since the advent of eye-tracking techniques, which allow for an accurate recording of eye movements. Their value as empirical data lies in the fact that they are a roughly spontaneous exterior manifestation of the allocation of attention: eye movements offer insight on how the attentional system operates (Henderson 2003).

The vast majority of the research made about eye movements is primarily based on static images; usually, the experimental subjects have their head immobilized in a chin rest and their visual field is dark except for a screen. They are often instructed to fixate their eyes in a central point of the screen before an image appears for a limited amount of time. In these experimental settings, context is eliminated, and so is the participation of the other movements – walking around a space to choose a point of view, rotating the neck, tilting the head – which naturally participate in every-day navigation. Furthermore, sometimes the stimuli used consist of simplified pictures, rather than realistic ones. The models that emerge from such research are thus deeply conditioned by its artificial arranging. Steinman (2003) remarked that "the basis for achieving accurate gaze control lies in the human being's ability to call upon one or the other compensatory subsystem at different times and to varying degrees" and therefore restrictive settings can lead to fallacious assumptions.

Laboratory-based studies still can, nonetheless, give us some clues in predicting and understanding what happens in free, real-world exploration.

4.1.3.1. EARLY EYE-TRACKING RESEARCH AND "SCANPATHS"

Studies using the first eye-tracking devices showed that, when visually exploring complex scenes, there was a strong tendency to look at certain regions, while others were seldom fixated (Buswell 1935). Moreover, it was found that these visually attractive areas were similar between individuals (Buswell 1935; Yarbus 1967).

Noton and Stark (1971) analyzed the sequential nature of eye motion and, like Yarbus, saw those perceptual patterns, which they named "scanpaths". Each image suggested its own sequence, which was recognizable from subject to subject, with variations. Brant and Stark (1997) observed that these eye movements also occurred while imagining the image previously seen. These findings generated the assumption according to which "scanpaths" reveal inner mechanisms of object comprehension and memorization.

Such remarkable claim would need further testing, and the idea that "scanpaths" (or, more cautiously, scan patterns) support the memorization and recalling of a scene has been reinforced by later studies. Laeng and Teodorescu (2002) performed an experiment in which they restricted when participants could or could not move their eyes while inspecting and recalling visual scenes. They found that when participants moved their eyes during perception but had to keep them immobilized during imagery, their ability to recall the picture decreased.

Humphrey and Underwood (2008) implemented another recognition/imagery experiment in order to verify whether the "mental image" persists in time and if, when seeing the same image for a second time, the scan pattern changes. It was found that the scan pattern is sustained in time (two days after inspecting the image, the subjects roughly reproduced the same eye movements when recalling the image) and upon new visualizations of the same image.

The "scanpaths" or scan patterns the eye makes when looking at realistic pictures could offer an insight into how people explore three-dimensional space as well. In our study in the church of Alcobaça, we observed that, in the same way the eye repeatedly observes the same regions in a picture, it also seems to look at the same regions while exploring a work of architecture. Even though the perception of architectural space implies a more complex body response (walking, moving your head, hearing, smelling) it could be based on an analogous mechanism as picture viewing.

It is also worth noticing that knowing the stimulus does not change the subjects' response to it – the eye keeps fixating the same attractive regions, even if they are no longer novel. It seems to us that this stability over time also makes sense in architecture; in our experiment, we did not perceive significant differences between subjects who had already been in the church of Alcobaça and those who had not.

4.1.3.2. ATTENTIONAL CAPTURE – "SALIENCY" MODELS

One framework that tried to explain gaze allocation is known as "saliency" (Itti & Koch 2000). The literature had "demonstrated that basic visual features can capture and guide attention. If a target differs from a set of distractors in just a single feature dimension, such as color or orientation, it can be detected very rapidly" (Tatler, Hayhoe, Land & Ballard 2011). Visually attractive areas could thus be predicted through a "saliency map, a spatial ranking of conspicuous visual features that could be candidates for covert or overt attention". These maps were not trying to predict eye movements, but explain attentional capture. The underlying assumption was that "simple features are extracted pre-attentively at early levels of visual processing and that the special deviations of features from the local surround can, therefore, provide a basis for directing attention to regions of potential interest". This implied that visual exploration happens in a bottom-up way. However, this model and the "saliency maps" generated are biologically unlikely, since they don't account for the variable resolution of the retina – only the fovea region, which makes for only a small percentage of the retinal surface area, can distinguish fine details.

Moreover, tests to the "salience" theory found that it produced inconsistent results and, while low-level signals might help the brain to pick regions likely to contain interesting objects (Elazary & Itti 2008), semantically rich regions remain more attractive even when their low-level information is not significant. A blurred face, for example, is still visually striking (Nyström & Holmqvist 2008).

Other priority maps account for both bottom-up and top-down signals, which would combine to create "proto-objects ranked by cognitive relevance". In fact, models based only on early saliency were mostly abandoned once it was realized that salient regions of an image only attracted more fixations if they also corresponded to real objects. Nuthman & Henderson (2010), who recorded the eye-movements of 35 subjects while they viewed realistic images, found that "there was no evidence for a preferred viewing location when only saliency proto-objects that did not spatially overlap with annotated real objects were analyzed. Taken together, these results suggest that saccade targeting and, by inference, attentional selection in scenes is object-based. Saliency only has an indirect effect on attention, acting through its correlation with objects". There are a number of studies showing the same results, including Einhäuser, Spain & Perona (2008), who conducted a similar experiment and found that "fixations are predicted better by objects than by early saliency" although "object saliency predicts how frequently an object is recalled". Again, saliency seems be subordinate to recognized objects.

The failure of saliency models can perhaps shed light on some of our empirical results. Our initial expectations were that the four rose/apse windows, one in each extremity of the church (hot-spots A, B, C and D), would be strong focal points. This assumption was made partly due to the fact that these sun-lit windows are bright, i.e., that they are salient features. However, only regions A and B proved to be markedly more visually attractive than the control regions. The very bright south rose window (C) did not attract a significantly high number of fixations.

It could be the case that regions A, which includes the presbytery, and B, which includes the church's entrance door, received substantially more fixations when compared to others, because, in the church's context, they were perceived as being charged with deeper symbolic/religious meaning.

4.1.3.3. ATTENTIONAL CAPTURE – REWARD-BASED MODELS

The more promising theoretical frames seem to be reward-based. The reward system stems from other cognitive mechanisms; it is associated with many aspects of learning. Tatler, Hayhoe, Land and Ballard (2011) remark that "it has become increasingly clear that the brain's internal reward mechanisms are intimately linked to the neural machinery controlling eye movements" and that "eye movements are for the purpose of obtaining information, and this information is used to achieve behavioral goals".

Cristino & Baddeley (2009) exemplify that "people rarely look at the sky. Unless judging the weather or searching for airplanes, the sky rarely contains behaviorally important information" and therefore looking at the sky is not usually rewarded with new information.

This further reinforces the notion that there could be an underlying logic – probably based primarily on top-down dynamics – that governs perception. Moreover, our brain seems to be able to predict very accurately where in the environment to find the most interesting, i.e. rewarding, information.

One of the mechanisms that guide gaze is sometimes referred to as “scene-schema knowledge” (Henderson 2003); it accounts for the prior understanding one has of a specific setting – e.g. knowing that a stove can be found in a kitchen – as well as general knowledge – e.g. knowing that objects do not float on air – that impact our inspection and navigational behavior.

It appears evident that pre-conceived notions would be an even stronger factor in real-world perception. In our experiment, this factor might definitely have had an influence on the behavior of the individuals; the significance of knowing one was visiting a church came up frequently during the interviews. The meaning of a building – be it a church, a theater, a friend’s house, our own house – will inevitably affect our behavior. There is not a simple way to avoid the influence of prior conceptions when one sets an experiment in a real-world location. The fact that the presbytery was the most visually attractive region in the church is necessarily due both to its architectonical relevance and its known symbolic value.

4.1.3.4. TIME-BASED RESEARCH

Another research line is studying the “temporal aspects of viewing behavior” (Tatler, Hayhoe, Land & Ballard 2011), rather than just focusing on the spatial ones. That means that there is a focus on saccadic and fixation duration, as opposed to what region is being observed. The emphasis on time could help clarifying key aspects of perception since “fixation durations depend critically on the time required to acquire the necessary information for the current act”.

Quantitatively, there seems to be two distinct ways of looking: an “ambient” mode, with fixation duration of 90 to about 260 ms and saccades of more than 5 degrees, and a “focus” mode, with fixations longer than 260-280 ms and saccades mainly with the parafoveal region (Velichkovsky, Joos, Helmert & Pannasch 2005). Neurophysiology links the “ambient” mode with the dorsal processing – that reads our surroundings and allows us to navigate them – and the “focus” mode with ventral processing – that is able to build a richer representation of the stimulus and focus on their semantic meaning.

In our study, these two modes of looking, although not quantified, were also observed (see III.2. Gaze).

Some researchers are also looking closer at the first few milliseconds of visual inspection. The human visual system is able to "recognize de gist of a scene at over 80% accuracy after as little as 36 milliseconds of uninterrupted processing time" (according to research results published online by the Visual Cognition Laboratory of the Kansas State University). People are able to identify the gist of a scene within a single fixation due to their familiarity with the scene's category (e.g. living room, city, beach) and that recognition will condition subsequent eye movements. Furthermore, recent research shows that peripheral vision "was more useful than central vision for maximum performance (about equal to seeing the entire image)" (Larson, Loschky, Ringer & Kridner 2010).

We take note of the importance of peripheral vision in perception, which again advocates for the complete immersion of the subject in the studied environment. In architecture, there seems to be no valid substitute for perceiving and experiencing the place itself.

Getting the gist of a scene, however, does not translate neatly to real-world places, since there are no sudden onsets in real life. Places are revealed gradually. Furthermore, in our experiment, we observed that when entering the church, there were attentional solicitations that would not exist if subjects were merely looking at a picture taken from the entrance; because they were physically entering the building, they had to watch the steps, avoid colliding with other individuals, etc.

4.1.3.5. CRITICISM OF LABORATORY-BASED RESEARCH

Many authors (e.g. Tatler 2014) advise researchers not to rely on observations that emerge from laboratory settings and are not reproducible in natural conditions. It is now well known, for instance, that "there is a strong tendency to fixate the center of images on a monitor irrespective of the scene's content" (Tatler 2007), which means that any eye-movement model built upon monitor observations that doesn't account for this bias will be very deceptive. Another problematic aspect of vision experiments based on monitor picture viewing is that sessions are usually built as a series of images appearing and disappearing. "Sudden onset may, in itself, influence inspection behavior" (Tatler, Hayhoe, Land & Ballard 2011) and it is not easily applicable to natural vision, since, as we have seen, in real-world navigation scenes rarely appear suddenly in front of us. "Even opening a door to a room is not like a sudden onset: here, the scene still emerges as the door opens".

Moreover, the absence of motor interaction with the scene in picture viewing is likely to strongly influence gaze deployment. "Much will be found under natural conditions that could not have been anticipated from what was known from research performed under the more common, much less natural conditions usually employed." (Steinman 2003)

It becomes clear that real-world visual behavior cannot be reliably understood in highly restrictive laboratory conditions, since "the principles governing saccade targeting decisions in the tasks used in picture-viewing paradigms are most likely different from those used when engaged in active, real-world tasks"(Tatler, Hayhoe, Land & Ballard 2011).

Dicks, Button and Davids' (2010) experiment is especially eloquent in stating the importance of having a realistic setting. The subjects for this study were eight professional goal keepers, plus one experienced penalty taker. They recorded the goal keepers' eye movements as they tried to intercept penalty kicks under five different circumstances, including: watching footage of the kick on a screen, responding with a joystick and facing the penalty *in situ* against the penalty taker, attempting to intercept it in real time. It was found that goal keepers made more saves in *in situ* conditions, and that there were "differences in the pattern of gaze for the distinct experimental task constraints". It is argued that experimental tasks should allow for a greater degree of freedom, particularly in navigation tasks, so that the individual has the opportunity to react to the setting, generating further prospective information.

4.1.3.6. VIDEO-BASED RESEARCH

An intermediate research stage between static picture viewing and free navigation has been the visualization of videos; even though it seems to be a step in the right direction, videos are still framed images presented in a monitor and suffer from many of the same problems as static settings.

Cristino and Baddeley (2009) conducted an experiment in which a video was produced by walking down in a busy street with a head-mounted camera. The footage was then modified with diverse filters and seven versions were produced, each with a different level of contrast. They found that "by far the most important single predictor of fixation density is where in the world the fixation is directed. This distribution is slightly shifted to the right as in most of our movies behaviorally important «content» (people, cars, etc.) was on the right-hand side of the picture (on the left often being buildings)".

Mital, Smith, Hill & Henderson (2011) ran an experiment in which participants visualized a collection of videos picked from conventional television broadcast; their results were similar: "participants continue to attend to the semantically rich regions even though these regions are heavily obscured, further suggesting that top-down factors such as object semantics are the main contributors to gaze allocation".

Here, as in static picture viewing, there seems to be a pervasive viewing strategy that privileges semantically rich regions. Jovancevic-Misic & Hayhoe (2009) remark that "although it has not been demonstrated directly that the acquisition of information per se is rewarding, all complex behaviors involve secondary reward of some kind".

In another video-based experiment (Dorr, Martinetz, Gegenfurtner & Barth 2010) subjects visualized a number of different videos, including footage of real-world scenes and professional movie trailers; the main purpose was to verify if gaze similarity between observers, as reported for static images, could also be generated by dynamic images. Results indicated that there was indeed some similarity, which was "even stronger for professionally cut Hollywood trailers".

It is interesting to notice that cinematic videos evoke greater gaze similarity between individuals than real-world scenes. This might be explained by the fact that works of art are more capable of guiding attention and creating powerful sensorial experiences.

Virtual reality has been another way of approaching navigation in a controlled way (e.g. Spiers & Maguire 2008). Although current simulators lack peripheral and binocular visual information and present a simplified version of the environment, they do allow for the study of navigation in large-scale settings in a controlled way.

As was said earlier, we do not consider that the architectonical experience could in any way be assessed outside the work of architecture itself. Virtual reality-based studies may be used to evaluate more abstract mental mechanisms, whereas the aesthetical appraisal implied in architecture perception can only happen *in situ*.

4.1.3.7. RESEARCH BASED IN REAL-WORLD SETTINGS

Most of the studies using free-movement, real-world circumstances are set around a specific task or activity, as, for example, playing squash (Hayhoe, McKinney, Chajka & Pelz 2012) or stepping on targets on the ground (Patla & Vickers 2003). One of the evidences that is revealed by these studies is how closely coordinated vision is with the rest of the body. The individual quickly adapts to the environment and situation, which is visible by the fact that, not long after the first moments of even an unfamiliar task, the eye tends to be a step ahead of other body movements, guiding them. Researchers suggest that we are very "sensitive to the probabilistic structure of the environment" (Jovancevic-Misic & Hayhoe 2009), which allows us to predict where we should look next. Hayhoe, Shrivastava, Mruczek & Pelz (2003) recorded the eye movement of subjects while they made a sandwich: "fixations are tightly locked to the task, and their role is well-defined. Fixations on task-relevant objects were typically close in time to their use in the task." Background items were rarely fixated.

These studies seem to confirm the idea of a very efficient task-oriented sensory-motor system.

In Jovancevic-Misic & Hayhoe's experiment, subjects walked along a track trying not to collide with other pedestrians, some of which were trying to force collision. They observe that "it is remarkable that subjects behave in such a similar manner (…). This suggests that the behavior we observe, and the rapid adjustment of gaze probabilities, reflect a stable and lawful property of natural gaze behavior."

It could be incautious to overemphasize the similarity of behavior across individuals, since similarity is in part caused by the task itself. It is however a topic that appears repeatedly, across innumerable experimental settings, with variable degrees of freedom. Tatler, Hayhoe, Land & Ballard 2011 remark that "the intimate link between vision and action is reflected in the consistency that is observed between individuals who complete natural tasks. Different individuals show a high degree of consistency in where and when they look at informative locations while engaged in natural behaviors." This consistency seems to show that "the decisions about where and when to allocate gaze must be governed by the same underlying principles in different individuals".

4.1.3.8. DISCUSSION

Investigation in eye guidance, which has been widely pursued for the past five decades, provided at least three of what appear to be solid empirical observations. They were detected by multiple researchers and emerged in almost every experimental setting; recent studies seem to support them and extend their scope.

Firstly, gaze is highly selective. It does not scan every area of a scene; instead, it picks a few locations and fixates them repeatedly, while others are seldom examined.

Secondly, the preferred areas seem to be those with either greater semantic value or, if the subject is completing a task, those that will be useful in that context.

Thirdly, there is a similarity in gaze behavior across different individuals. The same viewing strategies are followed when completing a task, and, when freely viewing complex scenes, individuals are attracted by the same features.

These observations are all consistent with our hypothesis. There is also evidence supporting the idea that works of art are particularly capable of guiding our senses and create an intense, coherent response in which meaning is conveyed in an especially compelling way.

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II. Empirical Work

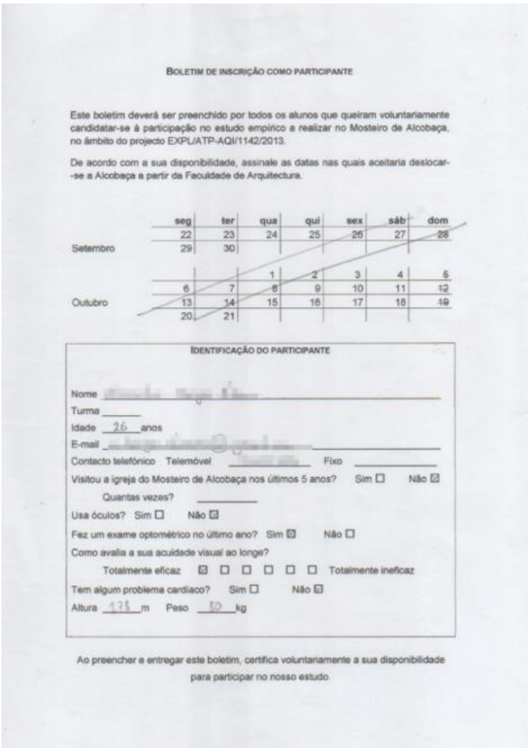
1. Main experiment

(For overall view of the experiment design refer to the data diagram on Appendix A.)

1.1. Procedures

1.1.1. Participants

Most participants were recruited from first-year architecture classes in the Faculty of Architecture, University of Lisbon. The project was briefly presented and the students instructed on how they could participate. Those who were interested filled a form with their personal data (such as name, age, visual acuity, etc.) and expressing voluntary consent to participate in the experiment (Figure 1).



BOLETIM DE INSCRIÇÃO COMO PARTICIPANTE

Este boletim deverá ser preenchido por todos os alunos que queiram voluntariamente candidatar-se à participação no estudo empírico a realizar no Mosteiro de Alcobaça, no âmbito do projecto EXPL/ATP-AQI/1142/2013.

De acordo com a sua disponibilidade, assinale as datas nas quais aceitaria deslocar-se a Alcobaça a partir da Faculdade de Arquitectura.

	seg	ter	qua	qui	sex	sáb	dom
	22	23	24	25	26	27	28
Setembro	29	30					
			1	2	3	4	5
	6	7	8	9	10	11	12
Outubro	13	14	15	16	17	18	19
	20	21					

IDENTIFICAÇÃO DO PARTICIPANTE

Nome ________

Turma ______

Idade 26 anos

E-mail ________

Contacto telefónico Telemóvel ______ Fixo ______

Visitou a igreja do Mosteiro de Alcobaça nos últimos 5 anos? Sim ☐ Não ☒

Quantas vezes? ______

Usa óculos? Sim ☐ Não ☒

Fez um exame optométrico no último ano? Sim ☒ Não ☐

Como avalia a sua acuidade visual ao longe?

Totalmente eficaz ☒ ☐ ☐ ☐ ☐ ☐ Totalmente ineficaz

Tem algum problema cardíaco? Sim ☐ Não ☒

Altura ___ m Peso ___ kg

Ao preencher e entregar este boletim, certifica voluntariamente a sua disponibilidade para participar no nosso estudo.

Fig. 1 – Recruitment form (previous inquiry)

Although 42 first-year participants completed the visit, three of the records were later disregarded due to technical or recording issues. Seven participants were recruited from fourth- and fifth-year architecture classes and five from post-graduate classes. Of this group, one visit had to be disregarded, due to recording issues. The results that were obtained are thus based on the remaining 39 first-year students and 11 older students – 50 subjects in total. Figures 2a-2d are an overview of some attributes of the experiment participants' universe. Participation was voluntary; no course credits or remuneration was given; transport from Lisbon to Alcobaça and back to Lisbon was made available to all participants.

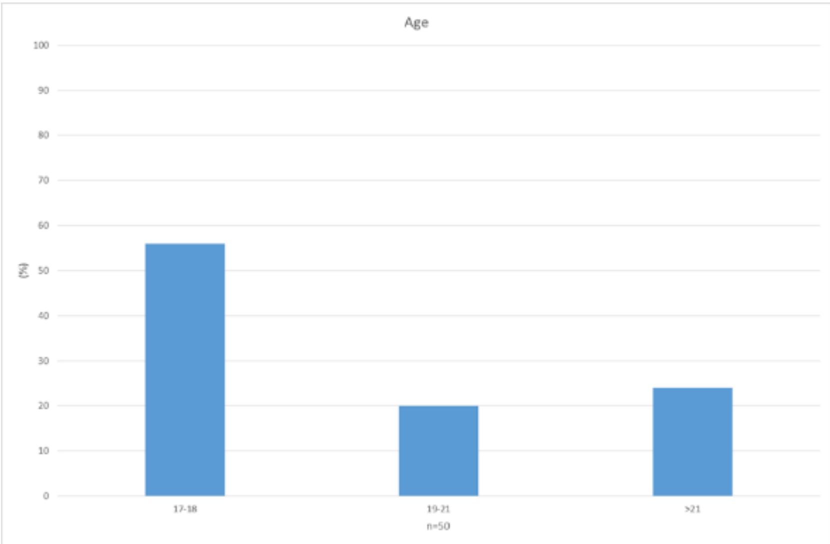


Fig. 2a – Participant's overview – age

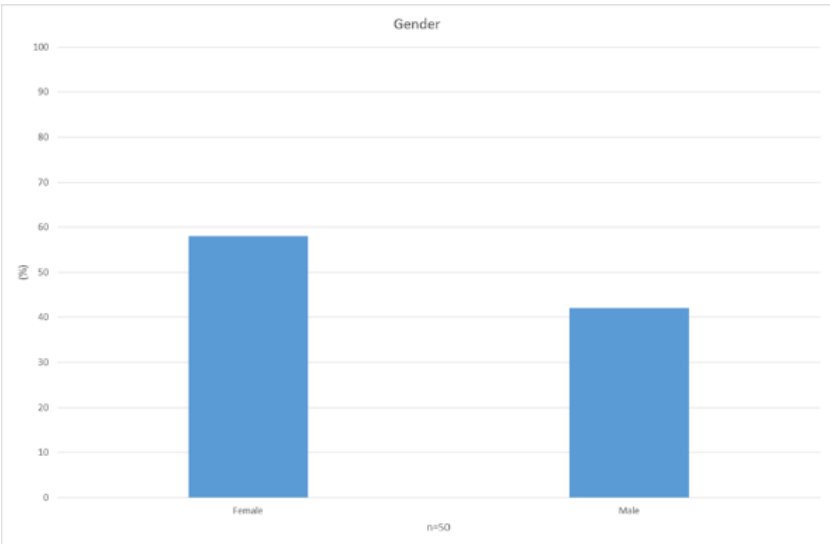


Fig. 2b – Participant's overview – gender

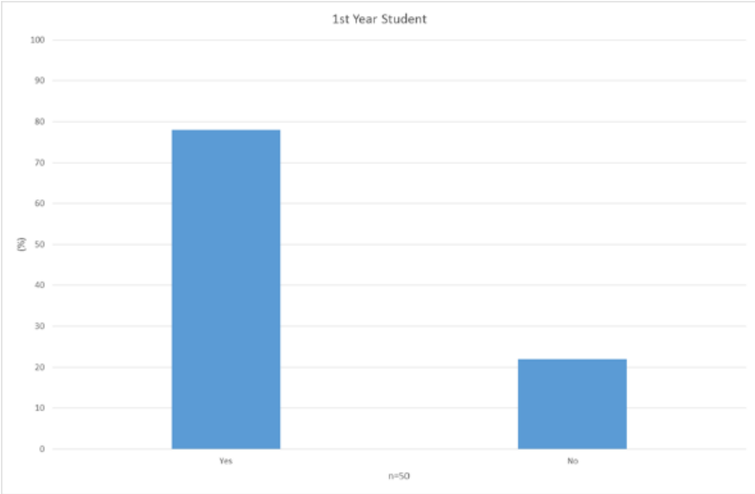


Fig. 2c – Participant's overview – 1st year student

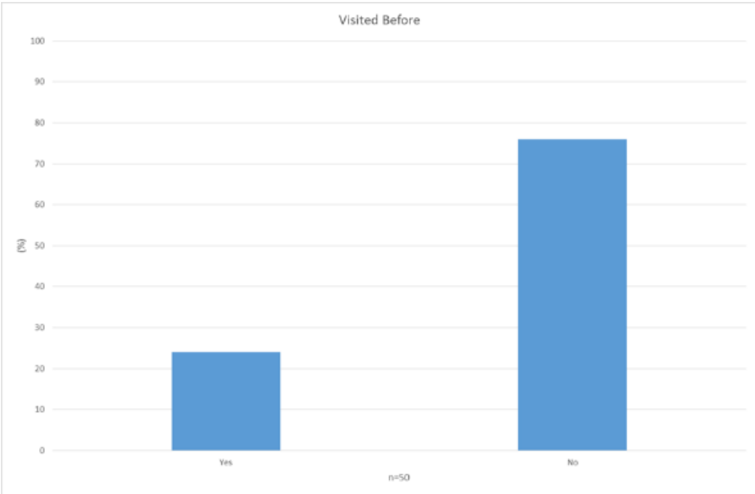


Fig. 2d – Participant's overview – visited before

1.1.2. Heart-rate monitor

Heart rate was measured using the Polar RS400 heart-rate monitor (Figure 3), a fitness wrist watch with a strap that fastens just below the chest. This strap has electrode areas that measure the heart rate and a transmitter which sends this data to the wrist watch. The option for this type of equipment was essentially due to power efficiency and to power and data recording autonomy. Any other portable system available at the time of the project (such as the Plux model) imposed a real-time data transmission from the equipment to a computer at a relatively short distance (that implied, for instance, that the participant would carry a small backpack with the necessary devices).

The heart-rate monitor was put on each subject before the visit. Subjects would wear it while visiting the church, but also for about 30 additional minutes, either before or after the visit, so that a longer sample of their heart rate could be registered.

One subject's heart rate could not be recorded due to technical issues.

Fig. 3 – Heart-rate monitor[1]

1.1.3. Eye-tracker

Monocular (right) eye position was recorded using Tobii Glasses Eye Tracker Smart IR, a portable device similar to a pair of glasses wired to a light pocket-sized recording assistant. This eye-tracker allows for an unhindered freedom of movement both of body and head (Figure 4).

Fig. 4 – Eye-tracker[2]

[1] Image from http://www.woot.com/offers/polar-rs400-running-series-heart-rate-monitor

[2] Image from http://eyetracking.me/

Tobii Glasses Eye Tracker uses the pupil-centered corneal reflection technique: a vector between pupil center and corneal reflection created by IR light is used to calculate gaze direction. Data rate is 30 Hz and the recording angles are 56° horizontal and 40° vertical. It creates a video recording of the visit from the point of view of the participant with an overlap of a moving cursor indicating what point in the scene is being fixated at each moment.

Prior to each visit, the eye-tracker was calibrated for the subject in a vacant room of the monastery which was used as the support station for the experiment. At this point, the subject was already wearing the heart-rate monitor. Calibration was system guided – 9 point grid – using an IR Marker against a neutral, flat surface (Figure 5). This step took about two to three minutes, although in some cases repetition was necessary in order to achieve the best tracking possible. After the calibration procedure, subjects were told to keep the recording assistant – the small device wired to the glasses – in their pockets or attached to their belts so as not to interfere with their movement.

Fig. 5 – Eye-tracker calibration

1.1.4. Action cameras

5 cameras (GoPro Hero 3, Silver and Black editions) were suspended from the ceiling of the church. They were lowered from the attic into the church through a hollowed pipe that existed in the keystones of the vaults – made for the lighting system, but just wide enough to let an action camera through. The cameras were fixed on a metallic pole (custom-made for this purpose) which

prevented them from swinging or rotating, and held the cable that connected the camera to the power source (Figure 6a-6c).

Fig. 6a – Metallic camera holder – process of placing cameras

Fig. 6b – Metallic camera holder – process of placing cameras

Fig. 6c –Metallic camera holder – process of placing cameras

These cameras where positioned in an attempt to cover the entire church (Figures 7), but because their functioning was not entirely reliable and sometimes prone to malfunction, in most sessions there are gaps in their recordings.

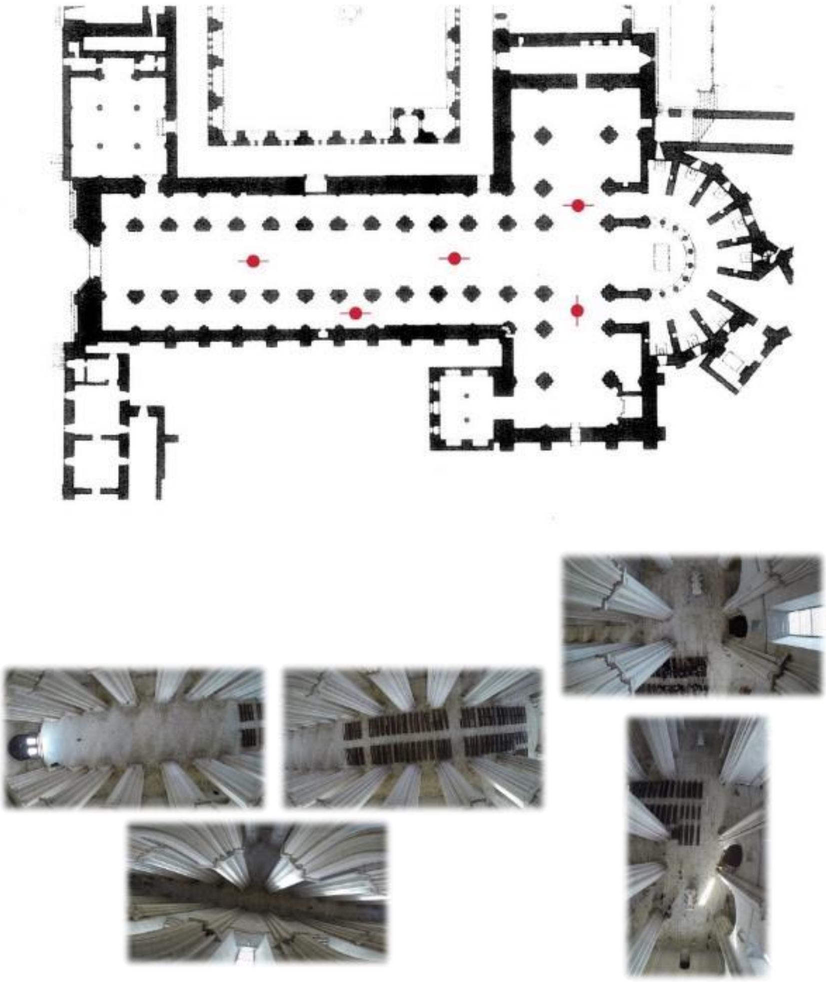


Fig. 7 – Location and direction of suspended cameras

1.1.5. Location devices

It was originally planned for us to use a GPS device to track the subjects' position. We found however that the thick church walls and ceiling blocked the GPS's signal, and had to abandon this idea.

We were also not able to carry this experiment with similar light conditions for every subject. The main experiment's data collection had to be delayed (see financial realization for details) and the desired sun conditions – dates near to the summer solstice and hours close to the sun's zenith – were not met. Unfortunately, this meant that different subjects experienced different lighting conditions. This was especially true in later hours or overcast days, when the artificial lighting was on. (As a consequence we devised a semi-manual procedure to determine the walking trajectories; see below *1.2.2. Stops*.)

1.1.6. Procedure

Experiment participants arrived at the Monastery of Alcobaça either with the research team or with bus and were escorted directly to the support station of the experiment without passing the church's main entrance (Figure 8 (A) and (C))

In the support station, the heart-rate monitor was equipped and within about 30 minutes the eye-tracker was equipped, adjusted and calibrated.

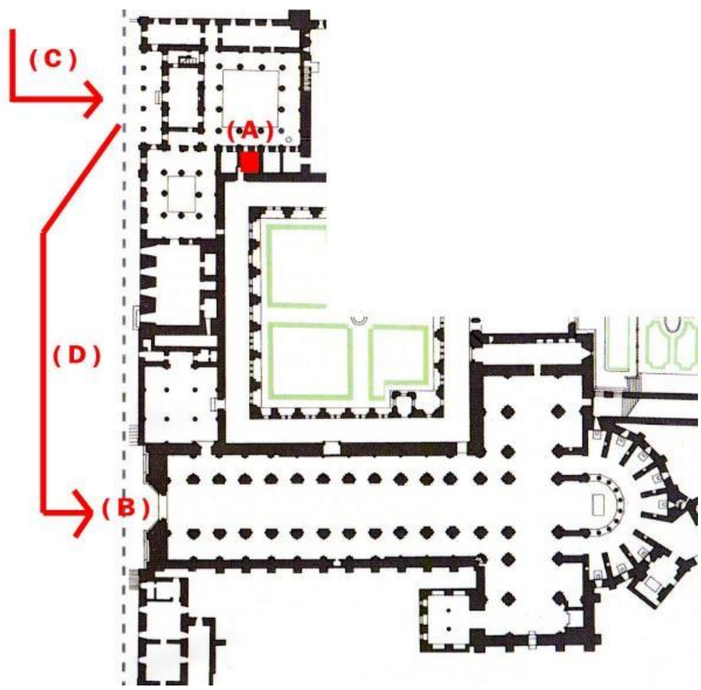


Fig. 8 – (A) Support station; (B) Church's main entrance; (C) Subject's arrival path; (D) Subject's escorted path to main entrance

After the calibration, each participant was accompanied to the main door of the church from the outside by a research team member through a lateral door of the monastery (Figure 8 (B) and (D)). While escorting the participant, the research team member answered any questions they might have and restated some instructions, namely: that there was no time limit for the visit; that the participant would exit the church by the same door by which they were about to enter and an experimenter would be awaiting them on the outside; that they should visit the church like they would in normal "touristic" circumstances; that they should try to abstract themselves from the apparatus they were carrying; and that they should try to abstract themselves from other visitors if there were any.

The participant then proceeded to freely visit the church (Figure 9). Upon their exit, the eye-tracker was removed and the participant brought back to the research support room.

Fig. 9 – Free visit of the church

Back in the research support area, the participants were given an inquiry to evaluate the emotional state/response to the experiment (Figure 10).

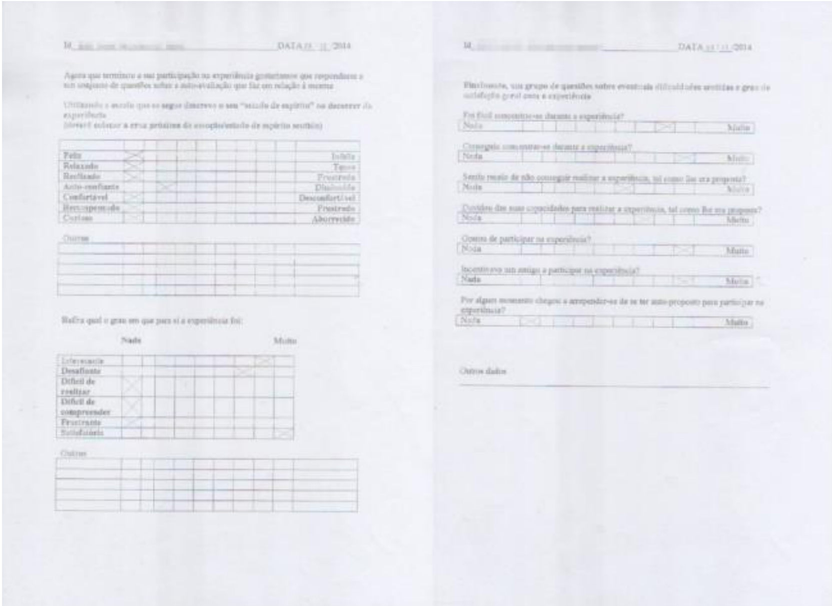


Fig. 10 – Emotional state/response inquiry

After the inquiry was taken, they were interviewed. During this open interview, each participant would draw a representation of their perceived path on a blank paper (example on Figure 11), and then talked about what they thought and felt at each stage of the visit. Some students were also able to draw a second picture that synthesized their experience of the church (example on Figure 12).

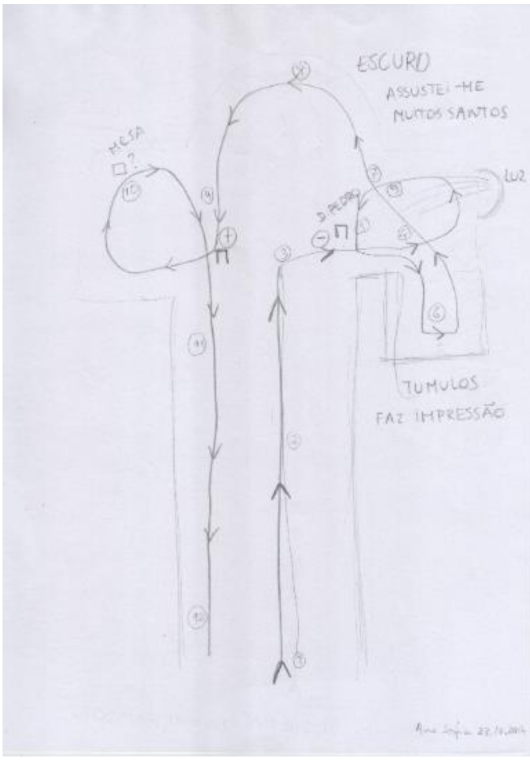


Fig. 11 – A participant's sketch

Fig. 12 – A participant's sketch

27 out of the 50 subjects were interviewed right after their visit. 21 others were interviewed as soon as possible – usually within a week or two of their visit. When the interview could not be made immediately after the experiment, the participant would still be asked to draw a representation of their perceived path, and that drawing was then used as a guide in the subsequent interview. Audio of 40 out of the 48 interviews was recorded.

2 of the subjects were not available for the interview.

1.2. Data Treatment

The following text describes the phase of Data Treatment and the creation of a database. In general, this step of the process follows that of data collection, during the Main Experiment, and precedes that of Statistical Evaluation. Although it must be stressed (and will be developed further on) that the apparent linearity of this process is subject to some regressions and repetition, the present description has been simplified and introduces a series of consecutive steps followed in an ideally linear succession of tasks that comprise this phase.

Data treatment was highly dependent from the type of data collected during the main experiment. The data stemmed from the equipment used by the participants during the experiment – an eye-tracker (Tobii Glasses Eye Tracker Smart IR) and a heart-rate monitor (Polar RS400) –, two inquiries undertaken by the participants, and video captured by action cameras hanging from the church vaults[3]. But it was also influenced by the analysis that was to be performed. As such, data sets pertaining the categories of **eye fixations (1.)**, **stops** in each participant's trajectory inside the church **(2.)**, **entry behaviour (3.)** of visitors and carried out **inquiries (4.)** were prepared. The present text's structure will respect the division into these four categories.

The participants in the main experiment were arranged in two main groups: one of first-year students of Masters in Architecture and Interior Architecture of the Faculty of Architecture of the University of Lisbon (from now on 1st year of MiARQ and MiAIRE), and another of fifth-year and graduated students of the same Masters (from now on 5th year of MiARQ and AGMiARQ). For each of the afore mentioned relevant data set categories (eye fixations (1.), stops (2.) and inquiries (3.)), data sets were prepared for 1st year of MiARQ and MiAIRE, for 5th year of MiARQ and AGMiARQ, and for the total of participants (the sum of both groups). The remaining data set category (entry behaviour (4.)) was prepared for the total of participants in the main experiment and a group of anonymous visitors of the church who were not involved in the main experiment.

Initial data treatment was performed using computer software Tobii Studio 3.2.2, Microsoft Excel, version 15.0.4737.1003 (Microsoft Office 365 ProPlus), AutoCAD LT 2012, version F.205.0.0 and AutoCAD 2014, version I.18.0.0 (Education Version).

As a means of facilitating information to all team members, a database lodged in the Faculty of Architecture's servers was created and shared *on the cloud*. All information resulting from data treatment (as well as from subsequent work phases and from previous ones, from this point on) was stored on this *cloud* (For further detail refer to Section IV.1.1).

It must be acknowledged that, due to experiment and equipment conditions the procedures followed in data treatment were heavily conditioned, annulling any possibility of automatism in this phase and imposing more manual and time-consuming practices and methods. These limitations became clear already at the moment of the main experiment when it was established that it was impossible to mount IR-markers efficiently in the church.

IR-markers are devices that, when detected by the eye-tracker, generate a marker in the captured data. During the phase of data analysis, they allow for the automatic delimitation and definition of areas of analysis. Since the maximum detection range

[3] Appendix A, items (A) - (G).

of these devices is 2,5m at a 0° angle (Figure 13) and the experiment was based on the premise that the participants, equipped with the eye-tracker, could move freely within the broad space of the church, this feature was useless and this automatism was out of reach.

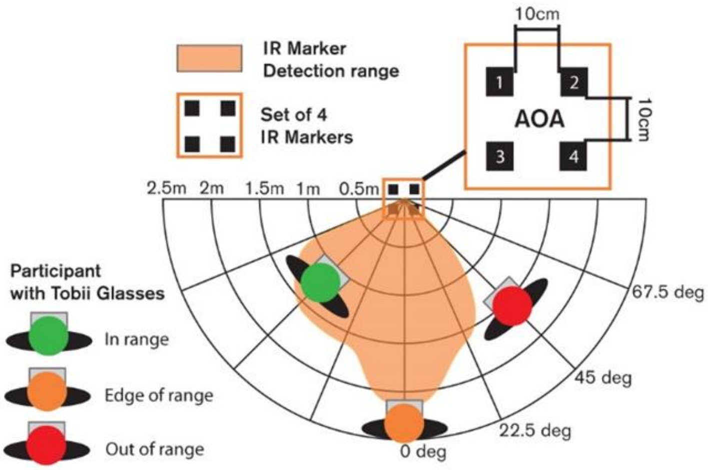


Fig. 13 – IR Marker range[4]

The inadequacy of the eye-tracker's proprietary data treatment software (Tobii Studio) in handling the type of data generated by the experiment– in opposition to its proficiency in the analysis of 2D-image viewing (Figure 14) – was also a detriment in the phase of data treatment. Tobii Studio was not able to dynamically display gaze and fixation data on a moving video basis, displaying all the information on a fixed frame of the available media. This was unsatisfactory once the dynamically displayed data was out of context from the static background image being displayed, so this feature could not be used.

Fig. 14 – Example of visualization of fixations in 2D image[5]

[4] Image from http://www.tobii.com/Global/Analysis/Downloads/User_Manuals_and_Guides/Tobii_Glasses_Field_Guides.pdf
[5] Image from http://www.tobii.com/Global/Analysis/Downloads/

This last instance together with the impossibility of defining areas of interest was a detriment for the use of this tool's full potential.

1.2.1. Eye fixations [var. = t(fixation)/m^2; nr(fixations)/m^2][6]

As was already mentioned in the theoretical foundation of the project, the first step in gaze and eye fixation study was the definition of eye fixation study areas (Figure 15): areas of expected gaze and eye fixation attractiveness, designated as *hot-spots* (A-E), and, in opposition to these, areas of expected less interest and gaze and eye fixation attractiveness, designated as *cold-spots* (X-Z). Data for adjacent surfaces to some hot-spots was also collected (AA-DD).

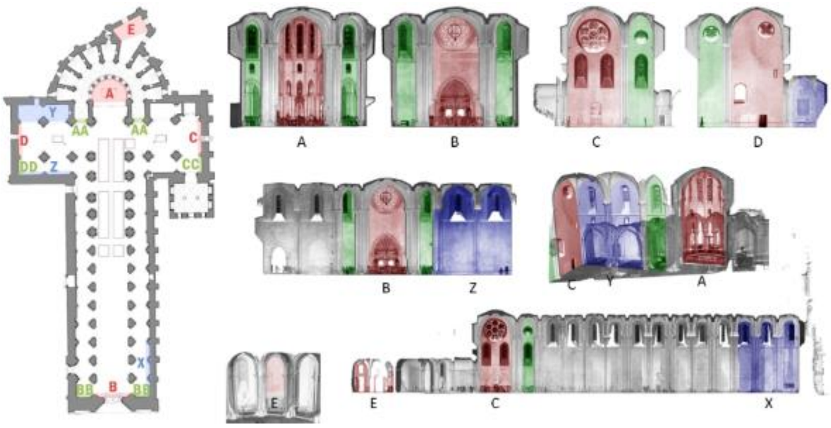


Fig. 15 – Eye fixation areas

In this data set category, data was collected essentially using the eye-tracking equipment. This equipment registers not only video from the perspective of the experiment individual, but also the gaze points of each participant superimposed on that video. As such, it was possible, for each individual, to ascertain how often and for how long their gaze focused on the hot- and cold-spots. The type of data collected for the study of eye fixations was, for each participant, the total duration of fixations (in milliseconds) and the number of fixations in each of the designated areas.

Due to the lack of automatism in this process, data collecting in this category implied viewing the eye-tracker video of each individual and inserting markers for the beginning and end of each event of interest (Figure 16a-16d). In this case, an event of interest

User_Manuals_and_Guides/Tobii_UserManual_TobiiStudio3.2_301112_ENG_WEB.pdf

[6] See also: Appendix A, items (A) Eye-tracker and (J) Plan/section basis.

took place whenever a participant's gaze entered or left an eye fixation area.

Fig. 16a – Beginning of event (Tobii Studio)

Fig. 16b – Continuation of event (Tobii Studio)

Fig. 16b – End of event (Tobii Studio)

Fig. 16d – Example of a series of events on a video timeline (Tobii Studio)

The insertion of markers was performed using Tobii Studio (Figure 17) and afterwards data sets were exported into a spreadsheet format (Figure 18).

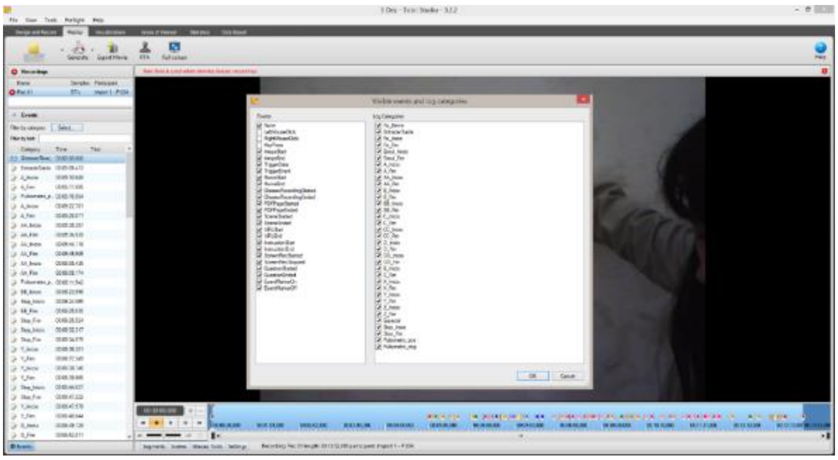


Fig. 17 – Markers and events (Tobii Studio)

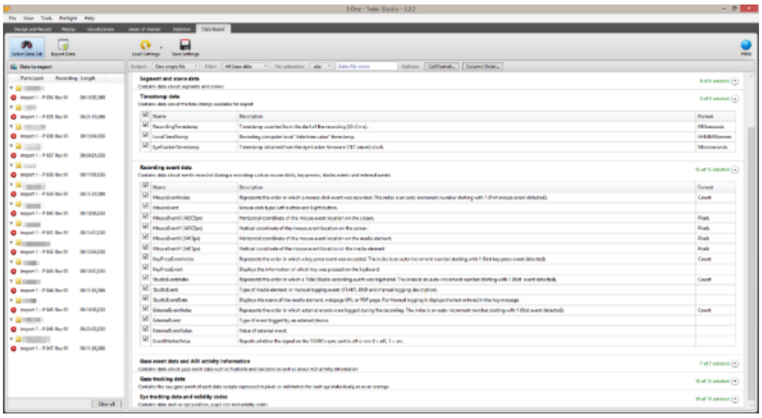


Fig. 18 – Data set export (Tobii Studio)

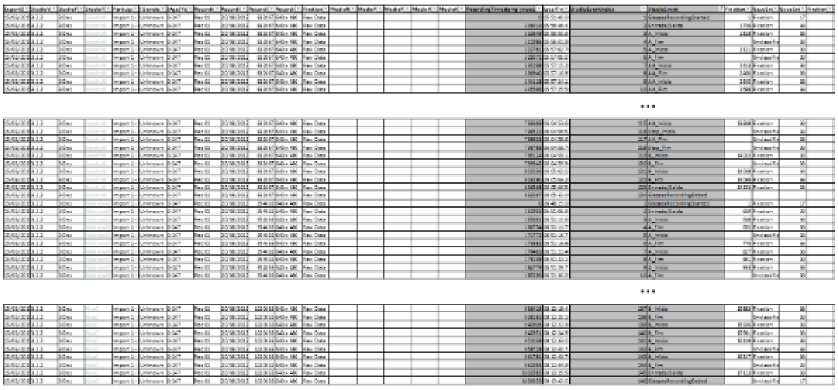


Fig. 19 – Data set import (Microsoft Excel)

Initial treatment of this data was executed in Microsoft Excel (Figure 19). For the treatment of such a vast amount of data, the tools provided by Microsoft Excel, such as filters, data sorting, conditional formatting, formulas and functions were vital, but the use of colour was also of great importance in the multiple verifications implemented (Figure 20). The various phases of initial data treatment were subsequently registered in saved versions of work files on the database that was created. This aided the verification process, as well as the eventual need to revert to previous or initial work states.

1	Y	1Y	a01	1272380	145	Y_Inicio									
1	Y	1Y	a01	1275245	146	Y_Fim	2865	1							
1	Y	1Y	a01	1275956	147	Y_Inicio									
1	Y	1Y	a01	1286061	148	Y_Fim	10105	1							
1	Z	1Z	a01	1324393	151	Z_Inicio									
1	Z	1Z	a01	1326012	152	Z_Fim	1619	1							
1	B	1B	a01	1341749	153	B_Inicio									
1	B	1B	a01	1348852	154	B_Fim	7103	1					7103	1	
1	B	1B	a01	1358743	155	B_Inicio									
1	B	1B	a01	1359732	156	B_Fim	989	1					989	1	
1	B	1B	a01	1368266	157	B_Inicio									
1	B	1B	a01	1369067	158	B_Fim	801	1					801	1	
1	B	1B	a01	1370003	159	B_Inicio									
1	B	1B	a01	1371489	160	B_Fim	1486	1					1486	1	
1	B	1B	a01	1377609	161	B_Inicio									
1	B	1B	a01	1378629	162	B_Fim	1020	1					1020	1	
1	B	1B	a01	1386044	163	B_Inicio									
1	B	1B	a01	1398633	164	B_Fim	12589	1					12589	1	
1	B	1B	a01	1416456	165	B_Inicio									
1	B	1B	a01	1424986	166	B_Fim	8530	1					8530	1	
1	A	1A							27053	4					
1	AA	1AA									8997	4			
1	B	1B											41327	10	
1	BB	1BB													1768
1	C	1C													

Fig. 20 – Use of software tools (Microsoft Excel)

As was already mentioned, for the eye fixation category, in a first phase the time of fixation for each participant in each area was accounted for, as well as the number of fixations.

In a second phase, given the need to compare areas of different sizes, the area of hot- and cold-spots was measured in m^2 (Figure 21) and, for the data acquired in the first phase, the time of fixation/m^2 and number of fixations/m^2 was calculated.

Area of Interest	Measure.(m^2)
A	346.1
AA	252.7
B	228.4
BB	216.6
C	202.6
CC	95.66
D	202.6
DD	95.66
E	240.9
X	331.7
Y	494.5
Z	292.3

Fig. 21 – Area of interest - measurements (Microsoft Excel)

In both phases the data was subsequently used in the statistical analysis[7] of eye fixations (Figure 22).

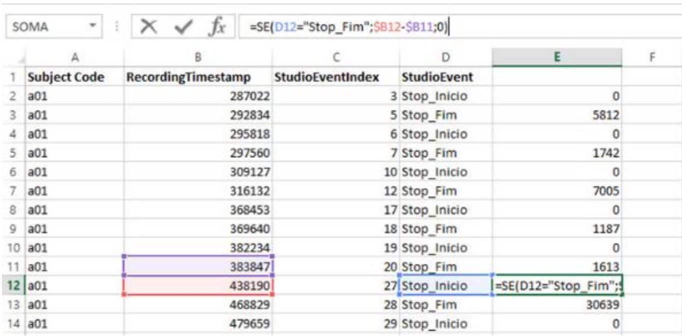
1stYearStudent	SubjectCode	InteriorFaçadeArea	SubjectCode-Area	Σt fixation/m^2	nr. occurences/m^2
1	a01	A	1A	78,165	0,01156
1	a01	AA	1AA	35,603	0,01583
1	a01	B	1B	180,941	0,04378
1	a01	BB	1BB	8,163	0,00462
1	a01	C	1C	27,384	0,00987
1	a01	CC	1CC	0,000	0,00000
1	a01	D	1D	28,366	0,01481
1	a01	DD	1DD	0,000	0,00000
1	a01	E	1E	60,909	0,00415
1	a01	X	1X	56,250	0,00603
1	a01	Y	1Y	43,822	0,01618
1	a01	Z	1Z	5,539	0,00342
1	a03	A	3A	104,478	0,06068
1	a03	AA	3AA	36,217	0,01979
1	a03	B	3B	135,687	0,03503
1	a03	BB	3BB	73,657	0,02770
1	a03	C	3C	65,192	0,01974
1	a03	CC	3CC	43,759	0,02091
1	a03	D	3D	10,143	0,01974
1	a03	DD	3DD	17,405	0,01045
1	a03	E	3E	22,395	0,01245
1	a03	X	3X	0,000	0,00000
1	a03	Y	3Y	33,090	0,00809
1	a03	Z	3Z	4,526	0,00342

…

Fig. 22 – Final data set for eye fixations analysis (Microsoft Excel)

7 Statistical analysis of eye fixations: Appendix B (final report) and Appendix F (without area measurements).

Data collection and initial data treatment for stops in each participant's trajectory inside the church is partially similar to that of eye fixations, namely in what concerns the use of eye-tracker video recording viewing of each individual's visit in Tobii Studio. So, in what concerns the steps of insertion of markers of events and data extraction from Tobii Studio to the calculation of duration of each stop in Microsoft Excel, the process repeats itself. In this case, however, relevant events are the beginning and end of each of these stops for each participant (Figure 23).


SOMA | =SE(D12="Stop_Fim";$B12-$B11;0)

	A	B	C	D	E	F
1	Subject Code	RecordingTimestamp	StudioEventIndex	StudioEvent		
2	a01	287022	3	Stop_Inicio	0	
3	a01	292834	5	Stop_Fim	5812	
4	a01	295818	6	Stop_Inicio	0	
5	a01	297560	7	Stop_Fim	1742	
6	a01	309127	10	Stop_Inicio	0	
7	a01	316132	12	Stop_Fim	7005	
8	a01	368453	17	Stop_Inicio	0	
9	a01	369640	18	Stop_Fim	1187	
10	a01	382234	19	Stop_Inicio	0	
11	a01	383847	20	Stop_Fim	1613	
12	a01	438190	27	Stop_Inicio	=SE(D12="Stop_Fim";	
13	a01	468829	28	Stop_Fim	30639	
14	a01	479659	29	Stop_Inicio	0	

Fig. 23 – Stop duration (Microsoft Excel)

However, two additional variables of space were associated to this variable of time: namely the X- and Y-coordinates (in meters) corresponding to the bi-dimensional point on the church plan in which each stop took place. The process of acquiring these coordinates involved, once more, viewing the videos from the eye-tracker in order to map each participant's trajectory. Each trajectory was registered using AutoCAD and superimposed on an existing plan of the church (Figure 24a-24b). In this format, it was possible to extract coordinates of some walking points in each trajectory, as well as of the stops (which were signalled by circles).

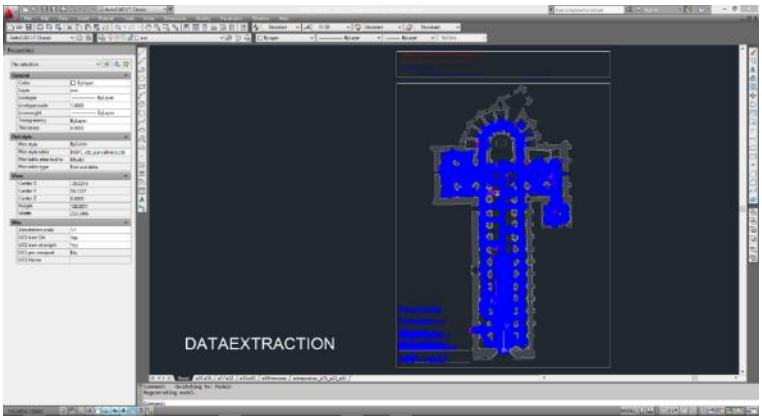


Fig. 24a – Mapping of trajectories (AutoCAD)

[8] See also: Appendix A, items (A) Eye-tracker and (J) Plan/section basis.

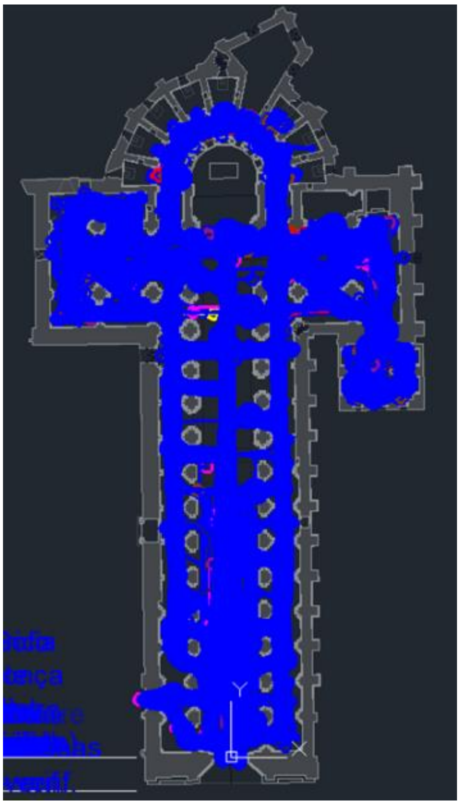


Fig. 24b – Mapping of trajectories -zoom (AutoCAD)

Since trajectory mapping involved side-by-side viewing of eye-tracker videos and manual registration of the trajectories by inferring the location of the participant inside the church given the spatial and physical cues apprehended by an investigator from the available media, it was deemed necessary to verify the reliability of this process of data collection.

It was confirmed by Tobii's representative in Paris that this method of trajectory mapping was already used in other instances and been considered reliable. But, notwithstanding this confirmation, the process was repeated by another investigator for a sample of participants, as suggested by research team member Zoï Kapoula, and the results were superimposed and compared (Figure 25). The differences between trajectory mappings were considered negligible and the process was considered valid.

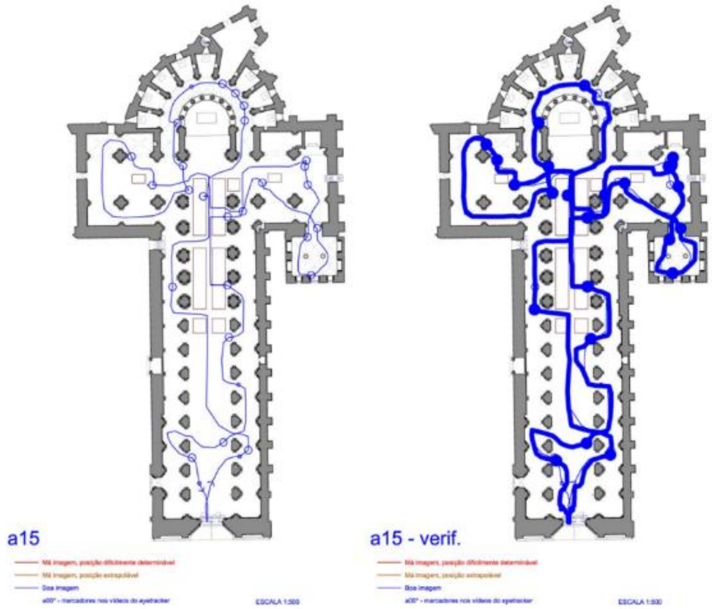


Fig. 25 – Example of trajectory mapping and verification (AutoCAD)

After this verification, the data of the coordinates were extracted from AutoCAD and imported into Microsoft Excel where the association of stop coordinates to stop duration was pursued. (Figure 26).

Count	Order	Name	Subject	Color	Coord X [m]	Coord Y [m]	Nr. Occurrence	Nr. Occurrence	Δt (milliseconds)	t(total visit)	t(stopped)	t(walking)
1	1	Circle	a01	ByLayer	8,3472	1,5404			5512			
1	2	Circle	a01	ByLayer	[illegible]	[illegible]			[illegible]			
1	3	Circle	a01	ByLayer	[illegible]	[illegible]			7005			
1	4	Circle	a01	ByLayer	5,7137	[illegible]			1157			
1	5	Circle	a01	ByLayer	7,7215	45,2522			[illegible]			
…												
1	[illegible]	Circle	a01	ByLayer	[illegible]	[illegible]			[illegible]			
1	[illegible]	Circle	a01	ByLayer	[illegible]	[illegible]			[illegible]			
1	[illegible]	Circle	a01	ByLayer	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
1		Line	a01	ByLayer	[illegible]	[illegible]	1	X	100			
1		Line	a01	ByLayer	[illegible]	[illegible]	1	X	100			
1		Line	a01	ByLayer	[illegible]	[illegible]	1	1	100			
1		Line	a01	ByLayer	[illegible]	[illegible]	1	1	100			
1		Line	a01	ByLayer	[illegible]	2,2207	1	1	100			
1		Line	a01	ByLayer	[illegible]	[illegible]	1	1	100			
…												

Fig. 26 – Association of stop coordinates and duration (Microsoft Excel)

Verification in this phase was also carried out by identifying repetition of points in trajectories (which, given the exported set of trajectory points, should not occur except for some selected instances) and with the aid of sorting of the occurrence of points in each trajectory. For each potential error detected, the coordinates from the spreadsheet were compared with the point coordinate in the AutoCAD file. This step in verification was done by picking the points in AutoCAD (Figure 27).

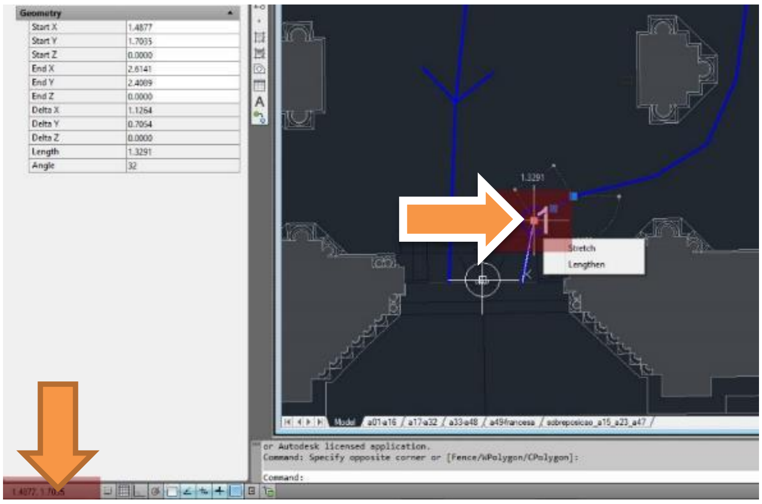


Fig. 27 – Picking points (AutoCAD)

Later on, a further verification was done by selecting a sample of trajectories and comparing the point coordinates in Excel and AutoCAD. The last verification was done by comparing the coordinates of the "stopped-points" registered in the spreadsheet with those in AutoCAD.

In sum, from this data collection and initial treatment resulted stop coordinates (X,Y) and their associated duration (in milliseconds). This data was subsequently used in the statistical analysis of stops (Figure 28).

1stYearStudent	Subject	Order	Coord X (m)	Coord Y (m)	t (msec)
1	a01	1	8,1472	1,5494	5812
1	a01	2	9,3008	4,6577	1742
1	a01	3	8,9983	8,1966	7005
1	a01	4	9,7197	34,811	1187
1	a01	5	7,7219	45,2522	1613
1	a01	6	13,7519	71,9613	30639
1	a01	7	16,5253	73,2383	17154
1	a01	8	16,8038	75,507	2726
1	a01	9	20,7009	79,3243	20152
1	a01	10	14,0138	78,9175	16495
1	a01	11	8,967	77,4259	897
1	a01	12	6,9359	86,4814	2020
1	a01	13	6,6403	89,8048	6704
1	a01	14	5,4165	92,4231	2978
1	a01	15	2,5849	95,1449	11914
1	a01	16	-1,2111	96,4899	17200
1	a01	17	-4,6037	95,0415	2356
1	a01	18	-7,5102	93,169	6446
1	a01	19	-10,6326	90,4316	20749
1	a01	20	-11,306	86,7155	11308
1	a01	21	-15,8108	76,0819	1280
1	a01	22	-16,7856	72,0204	5787
1	a01	23	-19,3059	72,7159	2823

• • •

Fig. 28 – Data set for stop analysis (Microsoft Excel)

In addition to the main experiment, a study of the entry behaviour of the church visitors was conducted. Using the action cameras suspended from the church vaults, most of the church area was captured in video. Monitoring the footage from the cameras covering the church entrance, different types of entry behaviours were coded (Figure 29).

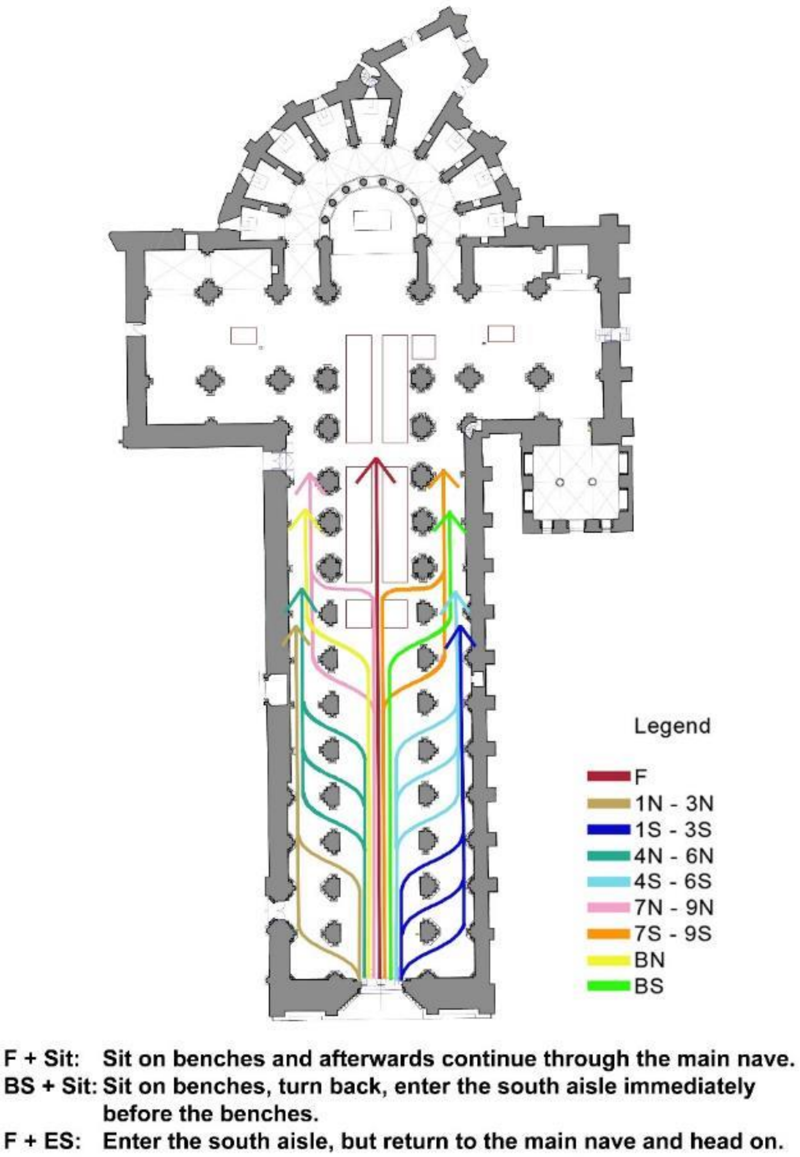


Fig. 29 – Different types of entry behaviour.

The entry behaviour types of 467 anonymous visitors of the church, as well as of the 50 experiment subjects, was classified according to these different types and entered into a table for each individual separately. Totals were calculated, as well as relative

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[9] See also: Appendix A, item (F) Suspended cameras.

values. This data was used in the subsequent statistical analysis of entry behaviour types (Figure 30).

Entry Beha	1 Person	2 People	3 People	4 People	5 People	6 People	Experiment Subjects	Not Experiment Subj	All Individuals
1N-3N	2,78%	1,71%	0,00%	0,00%	0,00%	13,33%	10,00%	1,93%	2,71%
1S-3S	5,56%	5,13%	9,88%	0,00%	0,00%	0,00%	22,00%	4,71%	6,38%
4N-6N	2,78%	0,43%	0,00%	1,79%	0,00%	0,00%	0,00%	0,64%	0,58%
4S-6S	5,56%	5,56%	0,00%	8,93%	3,33%	0,00%	4,00%	4,50%	4,45%
7N-9N	2,78%	3,85%	3,70%	5,36%	0,00%	6,67%	8,00%	3,85%	4,26%
7S-9S	2,78%	3,85%	3,70%	0,00%	0,00%	0,00%	2,00%	2,78%	2,71%
BN	13,89%	5,56%	0,00%	0,00%	0,00%	0,00%	4,00%	3,85%	3,87%
BS	5,56%	8,97%	8,64%	19,64%	6,67%	0,00%	4,00%	9,21%	8,70%
BS+Sit	2,78%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,21%	0,19%
F	52,78%	58,55%	74,07%	64,29%	90,00%	76,67%	34,00%	64,67%	61,70%
F+ES	2,78%	3,85%	0,00%	0,00%	0,00%	3,33%	12,00%	2,36%	3,29%
F+Sit	0,00%	2,56%	0,00%	0,00%	0,00%	0,00%	0,00%	1,28%	1,16%
	36	234	81	56	30	30	50	467	517

Fig. 30 – Data set for entry behaviour (Microsoft Excel)

1.2.4. Inquiries[10]

Inquiries were handed out to the participants at two different moments: before and after undergoing the experiment. The previous inquiry was aimed at the acquisition of general information about the participant (name, age, gender, eye sight acuity, etc.), the latter sought for the characterization of state of mind of the participant during the experiment, experiment evaluation and evaluation of experiment difficulty and satisfaction. The initial treatment involved importing the inquiry data into Microsoft Excel (Figure 31 & 32). Additional information concerning visit date, time, interview date, sunrise and sunset time (for the visit date) was added to the data tables in order to complement existing data from the inquiry (facilitating possible future studies in which this information may prove relevant).

Data from the latter inquiry complemented by information concerning each participant's age, gender, whether they were 1st year of MiARQ and MiAIRE or not and whether they had visited the church before were subsequently used in the statistical analysis of the inquiries.

[10] See also: Appendix A, item (C) Inquiries.

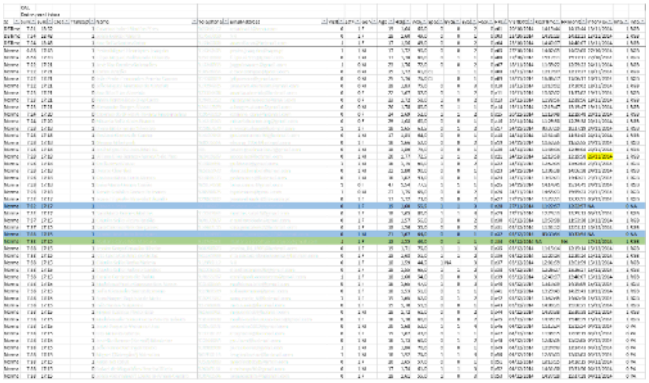

Fig. 31 – Previous inquiry and additional experiment information (Microsoft Excel)

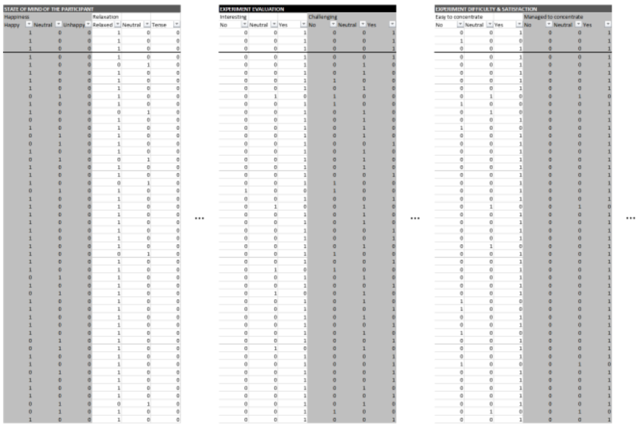

Fig. 32 – Latter inquiry (Microsoft Excel)

1.3. Statistical Data Analyses

In this summary, the Statistical Data Analyses carried out by CERENA and CIAUD teams under the GESTO project are described generally and some overall conclusions are drawn. All analyses were performed using the computing resources AnDad (CVRM/CERENA/IST 1989, 2002, 2012) and Microsoft Excel, version 14.0.7153.5000 (Microsoft Office Professional Plus 2010).

The general procedure is shown in Figure 1, stressing the plurality of retroactions that take place or that can take place in the different stages of statistical analysis (Murteira *et al.* 2010; Benzécri 1981; Cibois 1984; Escofier & Pagès 1998; Gomez & Castellanos 2004; Pereira *et al.* 2015). It should also be noted that the phases displayed in Figure 1 were only carried out when they were suitable to the data collected and available for analysis.

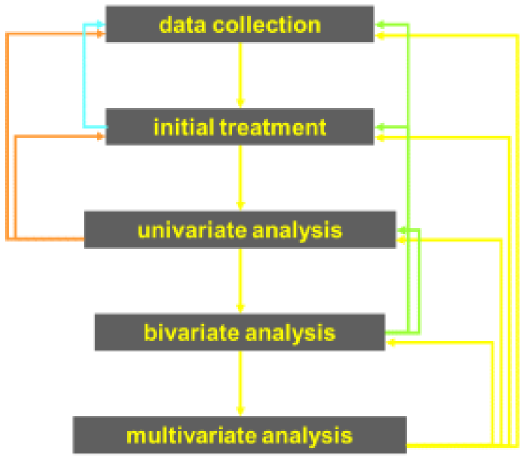

Fig. 1 – General procedure

The CERENA and CIAUD teams analysed data sets related to:

1. **Eye fixations** of the experimental subjects;
2. **Stops** of the individuals during their visit;
3. **Entry behaviour** of visitors (inside the church);
4. **Inquiries** carried out on the subjects.

1.3.1. Eye fixations[11]

With respect to the eye fixations of experimental individuals each group of individuals and their totality was analysed, with recourse to the complete procedure of Figure 1 using the principal component analysis as multivariate analysis technique. Exploratory analysis made it possible to identify church areas preferred by each group of visitors, in terms of number and duration of fixations. It was also possible to identify associations between different areas in each group of individuals. These associations allowed to typify the different areas of the church by creating groups of areas/individuals.

It should be noted that the results for the student group of the 1st year of MiARQ and MiAIRE are very similar to those of the totality of individuals, since these students account for about 80% of this total. In the same line of reasoning, it is important to note that the results for the subject group of the 5th year of MiARQ and AGMiARQ are negligible, since this group comprises a very small number of elements.

1.3.1.1. UNIVARIATE ANALYSIS, ALL INDIVIDUALS

In conclusive terms, it can be said that areas A and B are more attractive for individuals, both in time and in number of eye

[11] See also full report: Appendix B – Statistical Analysis – Eye Fixations.

fixations. However, whilst in area A there is a great number of individuals with a low number of fixations and meagre fixation times and few individuals with high values in both variables, in area B individuals are distributed more evenly amongst the different classes in both variables.

In opposition, areas CC, DD, X and Z are less attractive for visitors in both variables, with a distribution of values similar to that of area A, also in both variables. Areas E and Y although they are also faintly attractive for individuals, when regarded upon, are also sometimes deserving of evenly distributed times of observation.

Areas AA, BB, C and D have intermediate values both for number and duration of fixations per surface area. In these areas, values of both variables are differently distributed.

1.3.1.2. BIVARIATE ANALYSIS, ALL INDIVIDUALS

Areas A, B and C show the existence of a strong direct correlation between the variables of time and number of fixations, that is, as the number of fixations rises, so does the time of fixation. On the other hand, there is a week correlation between the variables of time and number of fixations in the remaining areas (AA, BB, CC, D, DD, E, X, Y and Z), denoting the inexistence of a patterned behaviour amongst the individuals.

There is also a strong direct correlation between the two variables when considering the sum of all areas. This fact is probably due to the relative weight of areas A and B.

1.3.1.3. MULTIVARIATE ANALYSIS, ALL INDIVIDUALS

Figure 33 is the synthesis of the main conclusions for this group of individuals. It shows the groups of areas/subjects that typify areas of the church (in order of importance).

Groups	Areas	Subjects
I	A, B, C, D	a08, a09, a11, a47, a15, a16, a11, a53
II	Z	a01, a05, a46
III	E	a26, a50, a51, a53
IV	X, Y	a11, a35, a53, a01, a20

Fig. 33 – Synthesis of factor analysis

1.3.2. Stops[12]

Regarding the time stops of experimental individuals, each group of individuals and their totality was also analysed, having

[12] See also full report: Appendix C – Statistical Analysis – Stops.

traversed the procedure of Figure 1 only up to univariate analysis. The study was complemented by a spatial modelling of the time stops and ordinary kriging estimation for the whole church (Figures 34a-36b).

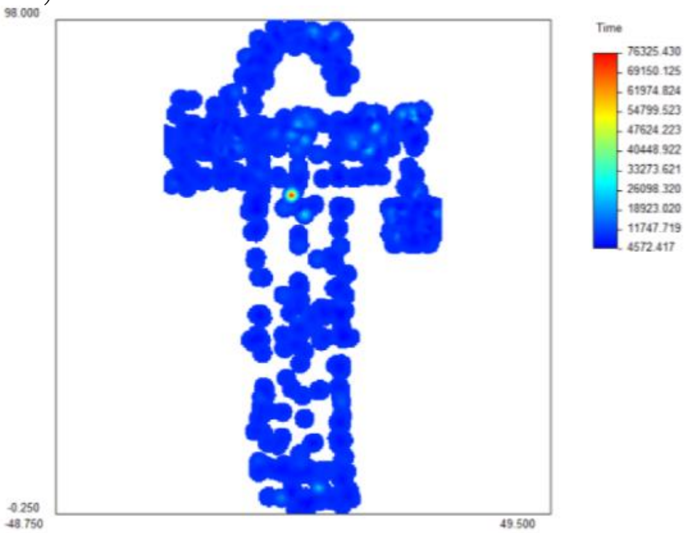

Fig. 34a – Estimation of stopping times for 1st year of MiARQ and MiAIRE individuals – linear scale

Fig. 34b – Estimation of stopping times for 1st year of MiARQ and MiAIRE individuals – logarithmic scale

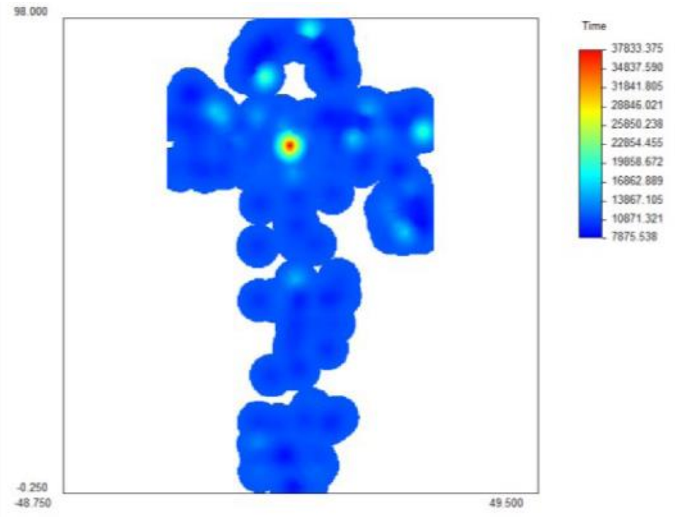

Fig. 35a – Estimation of stopping times for 5th year of MiARQ and AGMiARQ individuals – linear scale

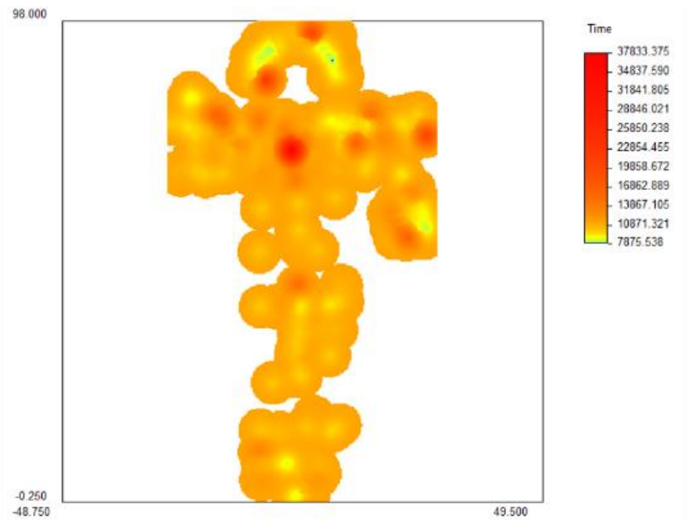

Fig. 35b – Estimation of stopping times for 5th year of MiARQ and AGMiARQ individuals – logarithmic scale

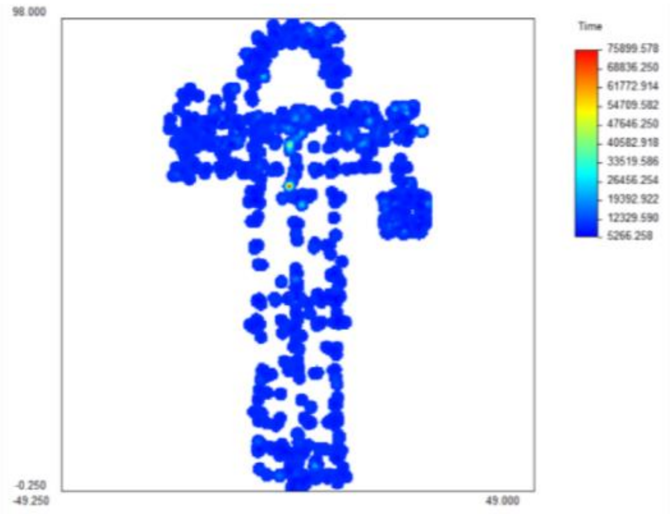

Fig. 36a – Estimation of stopping times for all individuals – linear scale

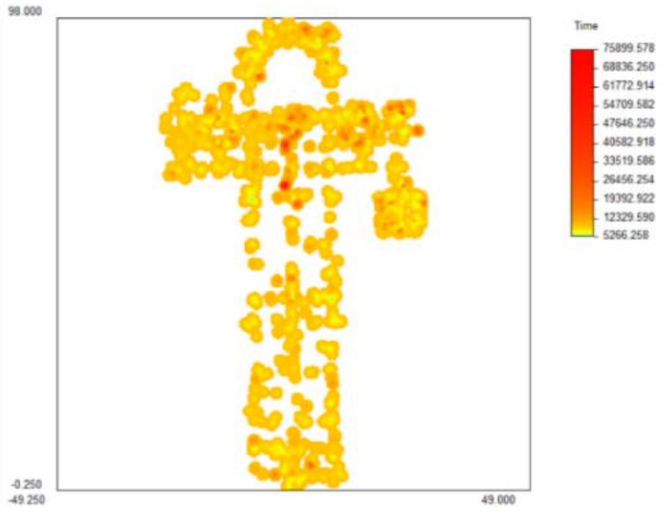

Fig. 36b – Estimation of stopping times for all individuals – logarithmic scale

Data for the individuals of the 5th year of MiARQ and AGMiARQ reveal greater spatial continuity and hence are more structured than the data of the students of 1st year of MiARQ and MiAIRE, allowing for the estimation of most of the area of the church. Although records for the 5th year of MiARQ and AGMiARQ subjects are few, it is clear that there are differences between the two groups of individuals with regards to church areas where they made major and minor time stops.

1.3.3. Entry behaviour[13]

Finally, data on the entry behaviour of the totality of experimental subjects and a group of anonymous individuals were analysed. It was found that these two groups of individuals have different behaviours.

The different types of entry behaviour observed are shown on Figure 37.

[13] See also full report: Appendix E – Statistical Analysis – Entry Behaviour.

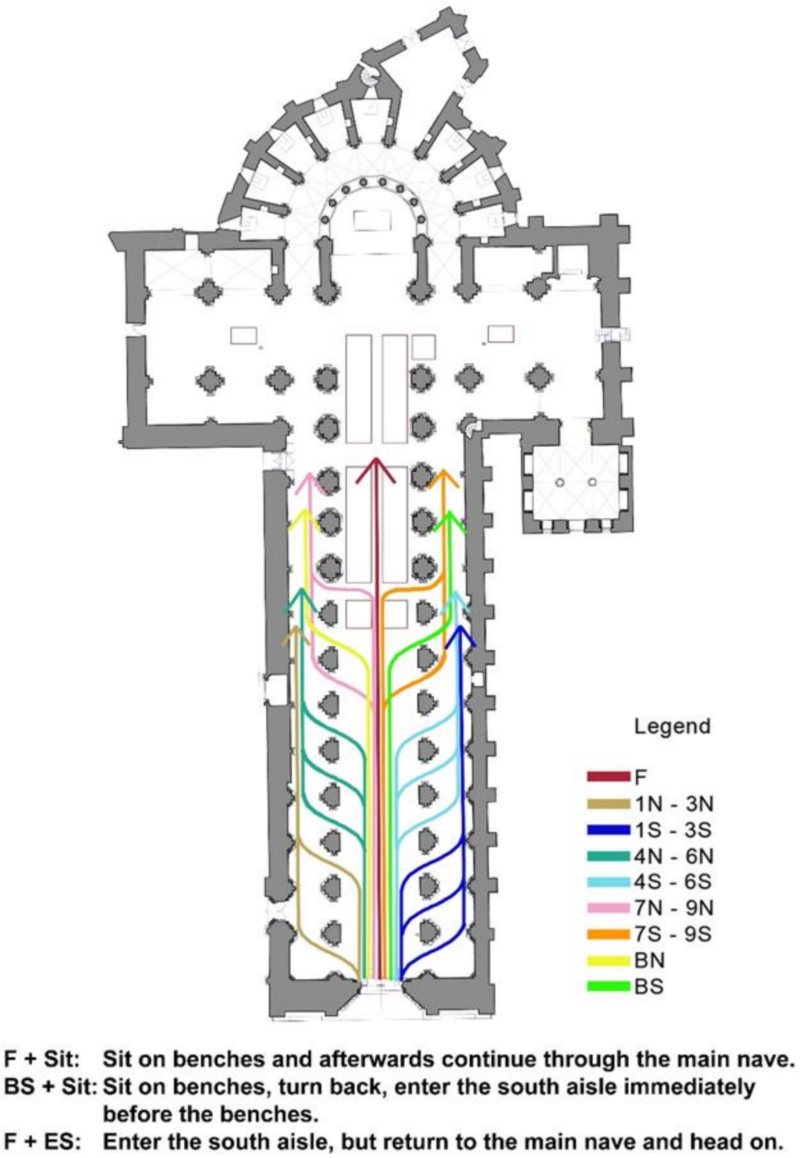

Fig. 37 – Different types of entry behaviour.

1.3.3.1. UNIVARIATE ANALYSIS, EXPERIMENT PARTICIPANTS

The majority of individuals in this group takes the directions F and 1S-3S upon entering the church. The following preferential directions are F+ES, 1N-3N and 7N-9N. No individuals adopt entry behaviours type 4N-6N, BS+Sit and F+Sit.

1.3.3.2. UNIVARIATE ANALYSIS, NON-EXPERIMENT PARTICIPANTS

The majority of individuals in this group takes the direction F upon entering the church. The entry behaviour type BS follows at a great distance. All other directions are only taken by a very small amount of individuals.

1.3.3.3. UNIVARIATE ANALYSIS, ALL PARTICIPANTS

The majority of individuals in this group takes the direction F upon entering the church. The entry behaviour types BS and 1S-3S follow at a great distance. All the remaining directions are only taken by a very small number of individuals.

1.3.3.4. COMPARISON OF BOTH GROUPS

Considering the values for the non-experiment participants as expected values and the values for experimental individuals, a hypothesis test was used to verify whether these are two independent groups. The outcome was $Q_{obs} = 160.95 > 19.675$ for $\alpha = 0.05$ with 11 degrees of freedom. So, with 95% confidence, it can be said that the two groups of individuals are independent, i.e. the entry behaviour of these two groups are different from one another.

It should be noted, however, that these results do not negate the fact that both groups reveal a primary tendency to take the direction F – in that respect there is a coincidence in their behavior.

1.3.4. Inquiries[14]

The inquiry data were treated by group of individuals and in their entirety. Each data set also underwent the procedure shown in Figure 1, except for the bivariate analysis. The multivariate data analysis technique applied was the correspondence analysis. The exploratory analysis allowed for the characterization of the individuals participating in the experiment, as well as their attitude and feelings towards the activity.

The responses to the survey reveal a similarity between the two groups of individuals, noting a slight indifference towards the experiment in the group of the 5th year of MiARQ and AGMiARQ individuals. It should also be noted that the results for the students group of the 1st year of MiARQ and MiAIRE are very similar to those of the totality of individuals, since they account for about 80% of this total. In the same line of reasoning it is important to note that the results for the group of the 5th year of MiARQ and AGMiARQ individuals are negligible, since this group comprises a very small number of elements.

Multivariate analysis allowed to synthesize each of the three data sets, establishing groups of categories of variables mutually associated and with which individuals identify.

[14] See also full report: Appendix D – Statistical Analysis – Inquiries.

1.3.4.1. UNIVARIATE ANALYSIS, ALL INDIVIDUALS

In conclusive terms, it may be stated that the individuals had no difficulty in participating in the experiment. They were satisfied in partaking in it, were satisfied, comfortable and pleased by it. In terms of state of mind, there are no unhappy, tense, frustrated or uninterested subjects. In terms of evaluation of the experiment, no individuals were frustrated by it or unsatisfied with it. As to experiment satisfaction, there are no individuals with difficulty in concentrating, no individuals that did not enjoy participating and no individuals that would not recommend participating in this experiment to others.

1.3.4.2. MULTIVARIATE ANALYSIS, ALL INDIVIDUALS

Figure 38a is the synthesis of the main conclusions for this group of individuals.

Groups	Categories	Subjects
I	CHAy	
II	22+, 1STn, HAPx, REWx, CURx, INTn, INTx, CHAn, FRUx, SATx, ECOx, MCOx, EPAx, UFPx	a07, a10, a25
III	ACCx, SCOx, SCOn, COMx, ECOy	a18, a19, a23, a41, a43, a51
IV	ACCy, SCOy, REWy, DIAy, ECOn	a15, a46
V	1718, 1STy	a34, a44
VI	DIAx, DIUx, FUNy	a09, a14, a26
VII	1921, VISn, Gfem, FUNx, DOAx	a21, a30, a35, a37, a47
VIII	VISy, Gmal, HAPy, CURy	a04, a05, a22, a49

Fig. 38a – Synthesis of factor analysis

GENERAL DATA	Age	17-18	1718
		19-21	1921
		>21	22+
	Visited Before	Yes	VISy
		No	VISn
	1st Year Student	Yes	1STy
		No	1STn
	Gender	Female	Gfem
		Male	Gmal

Fig. 38b – Categories – General data

STATE OF MIND OF THE PARTICIPANT	Happiness	Happy	HAPy
		Neutral	HAPx
		Unhappy	HAPn
	Relaxation	Relaxed	RELy
		Neutral	RELx
		Tense	RELn
	Accomplishment	Accomplished	ACCy
		Neutral	ACCx
		Frustrated	ACCn
	Self-confidence	Self-confident	SCOy
		Neutral	SCOx
		Diminished	SCOn
	Comfort	Comfortable	COMy
		Neutral	COMx
		Uncomfortable	COMn
	Reward	Rewarded	REWy
		Neutral	REWx
		Frustrated	REWn
	Curiosity	Curious	CURy
		Neutral	CURx
		Wearied	CURn

Fig. 38c – Categories – State of mind

EXPERIMENT EVALUATION	Interesting	No	INTn
		Neutral	INTx
		Yes	INTy
	Challenging	No	CHAn
		Neutral	CHAx
		Yes	CHAy
	Difficult to accomplish	No	DIAn
		Neutral	DIAx
		Yes	DIAy
	Difficult to understand	No	DIUn
		Neutral	DIUx
		Yes	DIUy
	Frustrating	No	FRUn
		Neutral	FRUx
		Yes	FRUy
	Satisfactory	No	SATn
		Neutral	SATx
		Yes	SATy

Fig. 38d – Categories – Experiment evaluation

EXPERIMENT DIFFICULTY & SATISFACTION	Easy to concentrate	No	ECOn
		Neutral	ECOx
		Yes	ECOy
	Managed to concentrate	No	MCOn
		Neutral	MCOx
		Yes	MCOy
	Fear of unaccomplishment	No	FUNn
		Neutral	FUNx
		Yes	FUNy
	Doubt of own ability to accomplish	No	DOAn
		Neutral	DOAx
		Yes	DOAy
	Enjoyed participating	No	EPAn
		Neutral	EPAx
		Yes	EPAy
	Urge a friend to participate	No	UFPn
		Neutral	UFPx
		Yes	UFPy
	Regrets participating	No	RPAn
		Neutral	RPAx
		Yes	RPAy

Fig. 38e – Categories – Experiment difficulty and satisfaction

1.3.5. General conclusions

Overall it can be said that:

- The group of 5th year of MiARQ and AGMiARQ individuals has a small size, allowing for unimportant conclusions;
- The group of 1st year of MiARQ and MiAIRE students has significantly different gaze, stop, attitude, and behaviour from the group of 5th year of MiARQ and AGMiARQ individuals;
- Individuals show their individuality during the visit to the church, revealing only "unanimity" in their attitude towards the experiment that was conducted.

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2. Other experiments

2.1. Heart-rate data

2.1.1 Assessing heart-rate as an emotional indicator

2.1.1.1. COLLECTION

One of the outputs of our Data Collection task was the heart-rate monitor record. The device used was Polar RS400, a fitness wrist watch with a strap that fastens below the chest; the strap has electrode areas which measure heart rate and a transmitter to send this data back to the watch, which displays it.

Subjects were equipped with the heart-rate monitor while visiting the church for an additional 30 minutes (approximately), either before or after the visit. We were thus able to collect an extended sample of each subject's heart rate.

2.1.1.2. DATA PROCESSING

The record's output consisted in an alphanumerical table like the one shown on Figure 1.

Time	HR bpm
00:00:00	75
00:00:01	75
00:00:02	74
00:00:03	71
00:00:04	71
00:00:05	70
00:00:06	69
00:00:07	69
00:00:08	72
00:00:09	74

Fig. 1 – Heart-rate record (Microsoft Excel)

That table was translated into a graphic such as the one shown on Figure 2.

Fig. 2 – Heart-rate graph (Microsoft Excel)

This graph expresses one of the subject's heart-rate during the entire time they wore the monitor, which includes the visit to the church.

In order to identify what portion of the sample corresponded to the visit, we needed to synchronize the heart-rate monitor with the eye-tracking device. To do this, we used the eye-tracker's scene camera to film the watch's dial, usually right before the visit started, as illustrated on Figure 3.

Fig. 3 – Synchronizing heart-rate monitor and eye-tracker

If, for example, the heart-rate's dial marked 05 minutes and 40 seconds and the eye-tracker's record up to that point had been 3 minutes long, we would know that the heart-rate-monitor was 2 minutes and 40 seconds ahead of the eye-tracker record. Knowing this number, we were able to calculate which moment, in the heart-rate monitor record, corresponded to the beginning and the end of the visit. We only had to watch the eye-tracker video, take note of the exact times at which the subject entered and exited the church, and then convert them to match the heart-monitor's time.

Using the same example, if we observed that the subject entered the church at 03:30 (eye-tracker time), it would have corresponded to 6 minutes and 10 seconds in the heart-rate monitor record. The same procedure was used to calculate when the subject exited the church. Having determined the start and the end of the visit, a graphic like the one in Figure 4 was obtained.

Fig. 4 – Heart-rate graph in blue, with entrance and exit marked red. (Microsoft Excel)

We decided to treat this data qualitatively. Our intention was to verify whether there was a correlation between heart-rate peaks and visit events, i.e., if there was evidence of an emotional response to certain events or features.

In order to do that, we located the five highest heart-rate peaks of each subject that occurred during the visit (Figure 5) and found out to what event they were correlated. We took into consideration the moments leading up to heart-rate increase, to account for the normal response delay.

Fig. 5 – 5 highest heart-rate peaks while visiting the church (Microsoft Excel)

2.1.1.3. RESULTS

Our results were unconvincing. There was not one single event or type of event associated with increased heart rate. About 27% corresponded to basic navigation, while 23% were associated with the contemplation of different architectonical features. A smaller percentage corresponded to sculpture examination and there were even a few peaks associated with signage reading.

There are at least three plausible causes for this lack of coherence. On the one hand, it is quite possible that the Monastery of Alcobaça is not the most exhilarating work of architecture; its simple form and repetitive rhythm were meant to induce serenity rather than excitement – which while emotionally valuable, is not likely to increase heart-rate. On the other hand, some peaks in heart-rate were necessarily related to increased physical activity – a faster pace, for example – and were not reflective of emotional status. There are also fortuitous events which could prompt an increase in heart-rate – for example, an interaction (even visual interaction) with other visitants or a misstep.

Monitoring heart-rate could, due to these challenges, be a thorny method of emotional assessment in real-world conditions. We do not mean to discard it altogether, but in future projects it would be necessary to devise a better approach for its use.

2.1.2. Qualitative analysis alternative

For additional data treatment and qualitative analysis of the experiments that were conducted in Alcobaça, a work template based on the video capture from the eye-tracker was created. This work template contained synchronized information collected from three distinct sources: eye-tracker, heart-rate monitor and interviews[15]. The template displayed simultaneously the following contextual information: the video capture from the eye-tracker including eye-fixation markers; following the participant's trajectory, their current location on the church's plan; the current reading of the participant's heart-rate on a graph; audio snippets from the interviews focusing on relevant observations about thoughts and feelings the participants brought up during the interview (Figure 6).

Through the analysis of this sort of material, that aggregates information, some observations on the prominence of events of a higher level of excitement may be validated. Events of a higher level of excitement coincide with those moments where higher heart-rates are registered that are not related to an increase of effort due to physical activity (that may occur during normal motion through space). When the situations where the individuals' actions justify this increase are discarded, the remaining heightened points may correspond to alterations of their emotional state. For those heart-rate peaks (for which an emotional justification is assumed) a confirmation is sought for in the interview.

In the present example (Figure 1) the higher excitement moments without physical justification are the moment of ingress into the church (Figure 6 – (a)), the viewing of the smaller tombs (Figure 6 – (b)), the moment of viewing the entry axis and the rosette from the ambulatory (Figure 6 – (c)) and the moment of egress from the church (Figure 6 (d)).

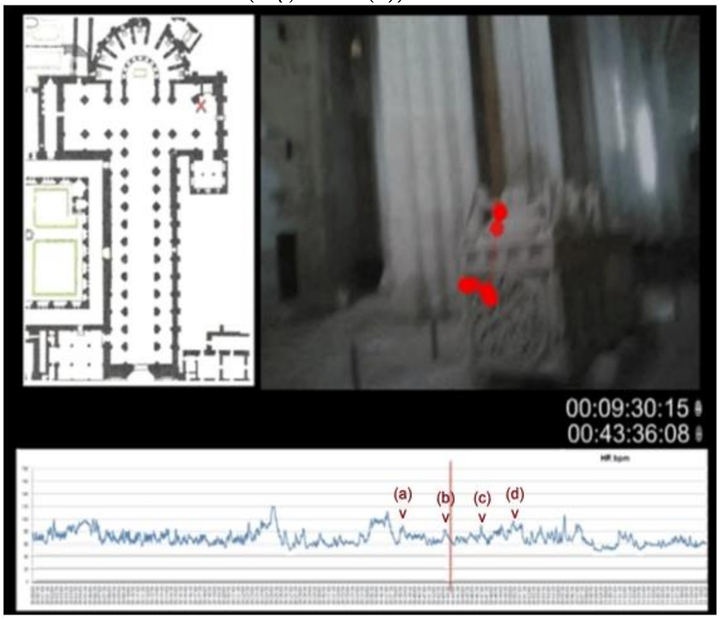

Fig. 6 – Side-by-side viewing of video capture (top right), location of subject on church plan (top left) and heart-rate graphic (bottom).

[15] See also: Appendix A, items (A) Eye-tracker, (B) Heart-rate monitor and (D) Interviews.

It was not possible to perform this type of processing for all individuals.

2.2. Interviews and drawings

2.2.1. Gesture Case Study[16]

2.2.1.1. TYPE OF STUDY

The present case study is of a data driven type, starting from data to the construction of theory. It is explained in the theoretical section why the Alcobaça monastery serves theorizing.

It is not because there are no theories of perception that it is justified to carry out this case study. The fact is that previous theories are not sufficiently enlightening, especially in the context of environmental psychology (see I.4.1.2. Classical Theories of Perception).

2.2.1.2. METHOD

The data used while attempting to explore how the sensorimotor experience and cognitions influence each other, giving rise to environmental perception, came from interviews. Each interview was based on the sketch of pedestrian routes performed by the participants. That sketch was drawn by the participants themselves right after they concluded their visit to the monastery. The interview was performed immediately after the sketching task in 27 cases and a few days later in 21 cases. Two experimental subjects were not interviewed. The main consigne contained in the interview protocol was as follows: based on the layout you have just drawn, can you say what have you thought and felt that might have influenced the choices on the chosen route.

Since this was an exploratory interview, other questions arose following the responses, in order to understand the perceptive dynamics. The tasks difficulty (sketch and recall of route decisions) was also assessed.

We had a total of 50 participants of which 48 were interviewed – although only 40 of those interviews were recorded. Around 20 hours of speech were taped during the interviews and every statement related to the architecture or the architecture's experience was transcribed verbatim. In total, 208 quotes were collected. This selection left out the participants' observations on other aspects of the church, such as the royal tombs and statuary. (This was a deliberate choice – even if, in some cases, the participant talked more extensively about the tombs than the architecture itself. The aim of this study was neither to dwell on the

[16] See also: Appendix G – 3. GESTO Case Study

tombs or statuary nor to establish a comparison between their significance and the architecture's in the overall visiting experience.)

2.2.1.3. DATA ANALYSIS

Data analysis was performed using a methodology that assumes multiple perspectives in the analysis and interpretation of information (Gioia, Corley and Hamilton, 2013). As noted by Gioia et al. (2013), the relevance of such multiple classification is justified by the increased accuracy granted by the conjunction of two perspectives: "*the tandem reporting of both voices – informant and researcher – allowed not only a qualitatively rigorous demonstration of the link between the data and the induction of this new concept, sensegiving, but also allowed for the kind of insight that is the defining hallmark of high-quality qualitative research*" (p.18).

In the analysis according to the perspective of informants or participants, the experimenter merely identifies the main reasons given by the participants themselves, classifying the former according to their similarity, by means of a classical content analysis, avoiding any kind of interpretation of theoretical nature. In the analysis by the experimenter's perspective, data is analysed based on pre-existing theoretical explanations and other explanations emerging from data.

The internal validity of this analysis if provided through inter-rater agreements (among experimenters), the triangulation of theories to interpret data and the use of Gioia's methodology.

2.2.1.4. RESULTS

Figure 7 depicts what Gioia et al. (2013) described as "data structure". It shows how the second-order themes (in this case the justifications regarding perception) originated from first order concepts (justification for walking route options).

First order concepts: Content analysis results (participants' perspective)			Second order themes: Content analysis results (researchers' perspective)
Thoughts categorization	**Emotions categorizations**		**Categorization based on existing and emergent theories**
(1) find a protected position or protect himself from physical stimuli and emotional meanings; (2) Explore the whole and explore details; (3) meet historical and symbolic elements (4) evaluate from the aesthetic point of view; (5) get snatched and taken by the symbolic appeal of space; (6) a quasi-unconscious physical experience / no justification / cannot recall.	melancholy ache curiosity dazzle admiration relaxation amazement satisfaction fear relief amazement sadness rapture (the love story) inferiority	→	**Control the information** **Assimilation of perceptive content to pre-existing mental scripts** **Determinism of space by recognizing their intrinsic meaning** **Call on GESTO**

Fig. 7 – Data structure for content analysis: from the justification for walking route options (participants' perspective) to the justification regarding perception (researchers' perspective)

The results from content analysis in the participants' perspective are as follows: (1) find a protected position or protect himself from physical stimuli and emotional meanings; (2) explore the whole and explore details; (3) meet historical and symbolic elements (4) evaluate from the aesthetic point of view; (5) get snatched and taken by the symbolic appeal of space; (6) a quasi-unconscious physical experience / no justification / cannot recall. These categories represent the main explanations of walking routes given by participants.

A content analysis of feelings/emotions evoked by the participants was also performed. These feelings/emotions were classified into 15 categories and revealed both a positive and a negative connotation.

The analysis performed on the researchers' perspective classified the justifications of the walking routes based on the theories of perception. One of the major results is the emerging of the *gesture* theory as a need to justify the interaction between sensory-motor experience and cognition.

The following table presents arguments to justify that walking routes are associated with explanations from the main perceptual theories. (see I.4.1.2. Classical Theories of Perception).

Categorization	Theoretical perspective	Main postulates
Control the information (1) find a protected position or protect himself from physical stimuli and emotional meanings; (2) Explore the whole and explore details	**Information Processing Approaches** (Haber & Hershenson, 1980; Schmidt & Keating, 1980)	Perception is not a direct result from environmental stimulation but from information cognitive processing capacity
Assimilation of perceptive content to pre-existing mental scripts (3) meet historical and symbolic elements (4) evaluate from the aesthetic point of view	**Piaget's Cognitive Theory** (Piaget, 1969) and **Environmental Cognition** (Lynch, 1960)	It is the cognitive modeling of the environment that determines the interpretation of the real environment and therefore the behavior The perception results from the assimilation of sensory stimuli to cognitive structures
Determinism of space by recognizing their intrinsic meaning Determinism of the space by the recognition of their intrinsic meaning (5) get snatched and taken by the symbolic appeal of space	Affordance theory by Gibson (1979);	The perception results from the recognition of the value and the intrinsic meaning of the physical environment
Call to GESTO (6) a quasi-unconscious physical experience / no justification / cannot recall.	The GESTO Theory (Abreu, 2010)	The perception results from the look and walk prior to recognizing the space meaning or attribution of meaning to the space It is the suggestion of certain gestures, certain "e-motions" that architecture begins by entering into a relationship with us, manifest in his being-for-me.

Table 1 – Theories and their main postulates that explain options for routes

The following tables exemplify, with participants' speech excerpts, the aforementioned classifications.

Categorization	Examples of participants speeches
Control the information to process Tries to control the information reaching him to control over its processing; protect themselves, want to find out, want to try (touch, feel) analyzed	A21: Went to the church aisle because it is a larger shelter experience, being closer, despite the equal height A18 [went to the pantheon because] "I felt more welcome here than in the transepts, being a smaller space, more suitable to human proportion" A17: [did not go beside the altar] "It would take to moments of contemplation and reflection and at that moment I was not much turned to that side" A05: I approached to feel more present to the story of Pedro and Inês A06: I wanted to see the pictures of the graves, watching all those details A23: I was curious about the door, but got frustrated because I could not exploit it A43: In the ambulatory my attention was caught to the decor and I wanted to jump the barrier to be able to see more

Table 2 – Examples of representative speeches of perception as control of information processing

As shown in Table 2, environmental perception results from the information processing capability. Indeed, efforts are presented by some participants to restrict or enlarge the perceptive window in order to be able to process the information. In entrance, for example, is particularly noticeable the attempt to restrict the information to be processed. This need justifies why some participants choose to move to the aisle. Elsewhere, such as for example next to the tombs, door, columns and sword, are made contrary efforts, namely to broaden the information to be processed.

Categorization	Examples of participants speeches
Assimilation of perceptive content to pre-existing mental scripts Try to understand the symbolism and unravel the meaning Hypothesis testing about space	43: I went to see the tombs attracted by history and mystery A21: I confirmed the symmetry A21: I made a noise to realize the acoustics of the church A21: The Tomb of Inês reminded me to Queen Beatrix of the Netherlands and my past (my colleagues from 3 years) A21: I rang the bells to feel the density A21: I looked at the spine and stood beside the pillar to measure the height of the church; around 18m. A24: I went to see the graves to see who the people were A26: [such] as I would address a person's home, I could not get inside, I preferred to take refuge on the side A26: of course I kept the route not to turn my back to the householder A29: Wow sculpture work. Looking for a sense. A29: the door of sacristy remind me nature and the entrance to a garden A30: I looked down the aisle and I thought about my church in Funchal in Christmas festivities

Table 3 – Examples of representative speeches of perception while assimilating the perceptive content to pre-existing mental scripts (cognitive theory)

Another justification for the walking routes that may also warrant the perception was the attempt to understand the symbolism and unravel the meaning of space based on the evocation of pre-existing cognitive structures

As we can see in table 3, participants report that they have posed hypotheses about place and later they test them. They explain that ware the hypothesis they pose the main condition to the chosen walking routes.

In this sense, perception does not depend only on the information processing capability (as supported by information processing theories – see I.4.1.2.1. Information Processing Approaches) but also depends on the capability of associating information to previously cognitive structures. In both theories environment has a minor impact on perception; actually perception is a constructivist process. Note that this type of perception arises from church ornaments and not from the architecture itself.

Categorization	Examples of participants speeches
Determinisms of space The architectural features and recognition of their intrinsic meaning determine the options Ravishness before the space	S10: I felt slow down when I got to the transept area A18: do not pull up as the ship's space because the arches cut a bit upright (...) I became to feel the certain scale A08: a desire to quickly go there to the bottom, to go direct because everything is up front is that it attracts, here there is nothing behind A13: I follow the side but felt the need to return to the center A26: the steady pace of the columns gave me the direction

Table 4 – Examples of representative speeches of perception as affordance

Corroborating affordance theory, we can observe that sometimes perception comes from the recognition of certain attributes of the space itself, which allow satisfying subject needs. For example, when one of the participants stated that he had "a desire to quickly go ahead because everything there attracted him, while behind there is nothing", he is clearly recognizing the sacred significance associated with the altar and the will to reach it.

Categorization	Examples of participants speeches
Call to GESTO before they could assign / project any meaning or recognize the significance of space, individuals are driven to act, that is, explore the space with the eyes and walk	A16: [on entrance] I felt like dancing A1: It is not so much the emotions felt and the thoughts I had that made me hold the space but the fact of going there to see I felt a circulation boost to see all A12: I have a hard time remembering, did the route he had to do ... I feel like walking and going to see and went A14: it was more contemplative than striking (...) but when I looked at her I felt the need to go in that direction A18: I was always following the main nave almost as if I could not deviate myself from that predetermined route through the building, it seems that leaves not divert our sense

Table 5 – Examples of representative speeches of perception as *gesture*

Although *gesture* is "almost automatic", and therefore hardly accessible from the interviews, there are participants who refer an "impetus to circulation", emphasizing that they were conducted by the look and not exactly by some sort of decision making rationale about the adopted trajectory, therefore being something spontaneous.

Although the interview was performed (in most cases) shortly after the walking route took place, participants found it difficult to reconstruct it (by means of a sketch) and recall the corresponding decision-making processes. In our view this is a clear evidence of the quasi-automatic *gesture* feature.

During the interviews, in an immediate reading, a significant difference between the contributions of the 1st year students and all other participants was noticed, namely in what concerns the vocabulary that was used and the diversity of observations that were made. These two groups are differentiated by the apparent ease with which 5th year students express themselves, their thoughts and feelings, verbally[17]. In contrast it was immensely more difficult accessing meaningful content in the interviews performed on 1st year students.

2.2.1.5. FURTHER ANALYSIS

Interviews were not only assessed regarding perception theories. We were also interested in finding out if there was a

[17] It should be noted that all but one of the 11 older participants were in some degree familiar with the *gesture* theory.

perceptive pattern induced by the church of the Monastery of Alcobaça which could be expressed by words during the interview.

Reading the quotes, some trends regarding the description of space and experience were detected – for example, a general awareness of verticality and directionality. In order to organize the quotes, we then proceeded to arrange them according to these trends; namely, verticality, directionality, centrality of the crossing, simplicity, scale and tranquillity (see Table A).

TABLE A. INVARIANTS

Verticality	"the height, it is puzzling", "it's really tall" (a05) "the impact of scale, of verticality" (a08) "tall" (a10) "everything points upwards", "until I got to the end [of the nave, my impressions were mostly related to] those height elements" (a14) "a sense of the verticality of those columns perfectly aligned (...) such verticality is quite breathtaking" (a18) "[I was] exhilarated because it was so tall" (a21) "all along the way, I noticed the height" (a25) "the height of the ceiling, grandiose" (a35) "the vaults, the height of the wall… something grandiose" (a42) "a very ample space, of great height" (a43) "And the height. The columns were gigantic." (a45)
Directionality	"long corridor" (a02) "I felt it was long" (a04) "not only the vertical scale, but also the depth of the space" (a08) "a will to quickly go forward, to go there directly" because "what is appealing is ahead, there is nothing here" (a09) "rhythmic and funnel-like" (a10) "a focus on the apse" (a14) "[while in the forward side of the nave, I repeatedly looked at the apse] because it was very bright and it was a gentle, comfortable white, and so it was my focal point" (a14) "[the west rose window] was more contemplative that alluring [but in looking at it] I wanted to pursue that direction" (a14) "striking perspective" (a15) "[I felt from the beginning that] I could have gone straight ahead" (a17) "I went along the central nave almost as if I couldn't stray from a course pre-determined by the building; it seems as if we can't divert our attention" (a18) About the perspective of the nave seen from the ambulatory: "there is a consonance between that perspective and the bay's shape. It forms a tube. (…) It was the most powerful thing I felt while I was there." (a26)

	“[in the central nave] the focus is either backwards or forwards” (a26) “[the space has a regular] texture of passing pillars [which, along with the sense of the axis forms a] base rhythm” (a26) “a long corridor leading to the [apse]”, “as if it was somewhere I had to get to”, “that corridor was going to lead me to a specific place” (a27) “the big corridors, right at the entrance” “it was long” (a36)
Centrality of the crossing	“we have more control over space, we understand better what goes on in there and we can see the two light spots” (a08) “I stopped there for a while, because the space really opened up”, “I see more things, more direction options” (a14) “I stopped in the crossing area”, “there is a sense of centrality there” (a18) “[by the apse] there is an intrinsic feeling, and I don’t mean in terms of culture, that that is the main space and the most important” (a18) “[in the crossing] i looked right round°” (a21) “[reaching the transept, I felt that] I was in the center of it all” (a22) “[in the crossing] I wanted to align myself with the altar and the church” “there, I felt more integrated in the church’s structure” (a44)
Simplicity of form	“interior simplicity, contrasting with the exterior” (a03) “simplicity”, “a pureness that comes from the building”, “it is the essential, it is the elementary that is there, and it is also conveyed to us” (a07) “it is all very white, it is all very poor, in the sense that in it very simple” (a14) “it’s a very strong thing, but very clear at the same time”, “very precise”, “an accuracy and a cleanliness of outlines” (a15) “so empty” (a18) “very simple” (a23) “[the apse was] completely different from what you usually see in churches, very simple, but at the same time it had all that was needed, the essential” (a27) “very beautiful because it was simple” (a34) “I expected it to be more decorated… it was simple” (a37) “very naked” (a40)
Scale	“very large”, “an ampleness of space” (a02) “upon entering I felt that [the church] was large” (a04) “grandiosity” (a04) “grandiosity” (a07) “I felt the strength of the scale” (a15) “it was huge” (a17) “so large, so vertical, so grandiose” (a18) “such a grandiose structure, not our size” (a19)

	"I was surprised with the height, the distance, the building's dimension" (a27) "the grandiosity" (a31) "space…" (a35) "grandiosity" (a39) "grandiose" (a42) "I felt dazzled by the church's dimension" (a44) "the size. It was gigantic." (a45)
Tranquillity	"silence" (a02) "calm", "silent" (a03) "peace" (a07) "a certain calmness" (a08) "tranquil experience" (a08) "I felt calm" (a14) "calm – from beginning to end, that was always how I felt" (a14) "peace", "tranquility" (a21) "calm [along all the way]" (a23) "peace and tranquility and calmness" (a25) "I was in a state of contemplation and tranquility" (a26) "the light was peaceful" (a35)

Although there was an overwhelming unanimity in the recognition the main features of the space, there was some disparity in the stance before them. For instance, while some found the large scale to be intimidating, others felt welcomed (see Table B); while most expressed the appeal of the central nave's directionality, they still sometimes chose to divert to the side aisles (see Table C); the exceptional character of the ambulatory was also diversely interpreted (see Table D).

TABLE B. DUALITY IN THE REACTION TO THE CHURCH'S DIMENSION

Welcoming	Intimidating
"I felt small", "at the same time, welcomed" (a04) "I thought it was very large: I felt small (…) but small in a pleasant way, (…) I felt welcomed" (a29)	"we are very small comparing to this, comparing to the whole world", "people enter the church and think «ok, maybe there really is something bigger than us», and that is the whole intention, isn't it?" (a05) "it made me feel small" (a06) "it was very roomy" "[I felt] small" (a38) "I felt small. It was imposing" (a40)

TABLE C. DIVERTING TO THE SIDE AISLES

Shyness	Desire of exploring	Avoiding tourists
"[I chose the side aisle] because it was less exposed" (a01) "it is more sheltered" (a22) "it is intimidating to go ahead", "I felt it was disrespectful to go ahead as if I owned the place", "[the side aisle] has a different scale, is less intimidating", "one feels more sheltered in that path" (a26)	"because I wanted to try another perspective" (a05) "I went along the right aisle maybe to save the best for last" (a07) "[I thought about going through the central nave] when I first entered, but [I chose] to see this side first" (a21) "I wanted to see the view between the wall and the arches" (a45)	"I went to the side aisle because there were many tourists there" (a05) "[wearing the eye-tracker probably made me choose less exposed paths because] I didn't want to attract the attention [of other visitors]" (a24) "[I went along the side aisle because] there were tourists ahead" (a41)

TABLE D. DUALITY IN THE REACTION TO THE AMBULATORY

Coziness	Discomfort
"I remember feeling it was cozy", "then, looking at the [central nave's perspective], one can also perceive that grandiosity (…) knowing one is sheltered" (a07) "a sort of hideout" (a15) "an internal path, more hidden, a more personal area, not as exposed" (a34)	"it is uncomfortable because it is somewhat dark" (a04) "I felt like I shouldn't be there", "for me, it is a bit weird to be behind the altar" (a09)

The results of this survey were consistent with the other results of the empirical work.

Some ideas and impressions were recurrently expressed by the participants when talking about their experience in Alcobaça and its architectonical characteristics.

The clustering of these impressions around specific semantic concepts emerges as a cognitive pattern of the space. It is quite remarkable that the semantic concepts students evoke reflect the architectural precepts by which Cistercian architecture is usually described - in spite of the fact that first year students do not possess any knowledge of such precepts.

It is also worth noting that although people tend to ascribe the same qualities to the space - thus confirming the perceptive pattern of *gesture* - they feel them, relating to themselves, in a rather different way: for instance, some feel the grandeur of the space as threatening and some as cozy.

This survey, although not processed in same thorough way that others were, shows very promising results regarding the *gesture* theory. It reveals that the qualities of the space are understood in a somewhat objective manner (at the very least, we could say that the qualities of that work of architecture are intersubjective) in spite of a personal stance regarding them (like/doesn't like). These results, which step into the hermeneutics realm, support the usefulness of *gesture* as a relevant interpretative tool to access meaning in architecture.

3. Other works

3.1. Architectural 3D survey of the Church of the Monastery of Alcobaça with 3D laser scanning

With the objective of creating a three dimensional geometric basis on which the monastery church's visitors' flows could be charted, an architectural survey of it was conducted using 3D laser scanning.

The survey's methodology consisted of the following steps: i) *in situ* planning of the positioning of the laser scanning stations, ii) *in situ* planning of the positioning of auxiliary targets for the process of point cloud alignment, iii) point cloud acquisition, iv) point cloud alignment, and v) production of final elements.

The planning step involved choosing the more convenient positions for placing the laser scanning stations. This choice was aimed at achieving points of view that minimized the number of stations given the need for an extensive coverage. To this end 49 scans were made using a 3D laser scanner, colorless capture since only the church's geometry was sought-after to serve as a quality basis for the graphic documentation of the project.

The placement of targets was aimed at ensuring that a process of point cloud alignment as automated as possible was viable, thereby reducing processing times. For this end, 5 spherical targets whose position was altered during the course of the data collection process were used. The criterion for moving the targets was that of guaranteeing that, in consecutive scans, there were at least two or three spheres in common.

Point cloud alignment is a process by which these are oriented according to a common referential thereby defining a coherent three dimensional model. This three dimensional model may then be used for extracting other material such as ortho-imagery or another type of model, namely models of triangulated mesh.

As such, a 3D polygonal mesh model with about 4GB file size (220 million faces) was generated. That mesh allows for 3D printing and was, in this case, used for viewing. This 3D model also foresaw a 3D mapping of data, but that was not to be possible.

Along with the 3D model, several ortho-images that defined the church's sections and plans were extracted and used for various mappings.

3.2. 3D reconstruction from video frames

One of the types of data collected with the use of the eye-tracking device was video from the 50 experiment participants' visit. Therefore, a complementary approach that utilized frames extracted from those videos with the intent of rebuilding the visited space in 3D was introduced. For this purpose, a software that implements the 'Structure-from-Motion' (SfM) methodology was used.

" 'Structure-from-Motion' (SfM) operates under the same basic tenets as stereoscopic photogrammetry, namely that 3-D structure can be resolved from a series of overlapping, offset [photographic] images. However, it differs fundamentally from conventional photogrammetry, in that the geometry of the scene, camera positions and orientation is solved automatically without the need to specify a priori, a network of targets which have known 3-D positions. Instead, these are solved simultaneously using a highly redundant, iterative bundle adjustment procedure, based on a database of features automatically extracted from a set of multiple overlapping images (Snavely, 2008)." (Westoby et al., 2012, p. 301)

This approach followed the ensuing sequence: i) extraction of video frames, ii) selection of frames, iii) processing of frames using SfM methodology for the reconstruction of the position of the cameras in space, and iv) orientation of the cameras in the general 3D model of the church generated by 3D laser scanning.

The possibility of using the video captured by the eye-tracking device for 3D reconstruction was tested. Although these videos were of low quality and there were many parts in which the individual's head movements were too quick for any clear images to be obtained, there was still a great number of clear frames. There was a possibility that, even if a total reconstruction of the church was not achieved, a partial three dimensional reconstruction of some areas of the church could be accomplished. This reconstruction would provide knowledge about the 3D position of the extracted video frames and in that way, through these frames, identify the three dimensional path of the video camera.

More than 50000 frames were extracted and after clearing blurred images 22280 remained.

Processing of these photos was carried out using the VisualSFM software on a computer with extremely high RAM memory. This requirement results from the fact that it is necessary to correlate every frame (the use of at least 40GB of RAM was registered during the processing of the first half of the frames) and that, therefore, they are all loaded in memory simultaneously. In order to process all the frames, it is estimated that a few hundred hours in continuous processing are needed. Since the required equipment for this processing is not exclusively dedicated to the present project, there was not enough available processing time to finish this task before the project's official end date. It is, however, anticipated that this processing will continue being run and in the event of positive results they will be released.

References

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III. Results

In this section a summary of the results of the experiments performed will be presented (Statistical Analysis in Section II presents the results thoroughly). As introduced in Section I.3.c. the tests upon which Statistical Analysis was performed were three: gazing, stopping, and entry behavior. (There was also a computational processing of the trajectories – that will be presented further on.) Those tests were designed departing from a hypothesis – a conjecture – and also enabling a refutation proposition. Results will be presented accordingly.

Other results from data which it was not possible to process statistically will also be presented. These results concern the registered heart-rates and the interviews.

The inquiry allowed for population characterization, ascertaining in addition to that whether the participants had any difficulties with the procedures of the experiment. We will begin with that.

1. Inquiry

Statistical analysis of the inquiry about the experiment reveals no signs of dissatisfaction or difficulties. Even though redundant questions were posed to assess any concealed problems, the whole of the results evidences none. Therefore, we assume that the procedures of the experiments may be considered adequate and that those procedures did not affect the experiments' results.

2. Gaze

The hypothesis which presided over the gazing test was that the church of Alcobaça should have some areas that attract gaze more than others. Hence we pre-determined five "hot-spots" and three "cold-spots". Two of the chosen "hot-spots" show an overwhelming percentage, both in number of gazes and in time of gazing. This is consistent with the hypothesis, as much as these two areas are the ones we could assume, from an architectural point of view, to be the most privileged (the apse and the exit's interior façade including the main door and the rose window). Other areas we had presumed to be attractive (transept end walls and the Manueline door of the Sacristy) did not show results that differentiated them from some of the "cold-spots". This may be due to two main reasons: the small sample of individuals tested (more individuals would allow for more diffused results that could evince differences between these areas); or extra-architectural elements present in the "cold-areas" and not considered in the design of the experiment (objects, drapery…) that attract gaze as much as privileged architectural elements, thence making the results similar. Nevertheless, as much as there are two gazing areas that stand out clearly from other architectural parts, we ought to assume that the data from the gazing tests does not invalidate the *gesture* theory.

(There was another observation related to gaze, of which we took note while examining the eye-tracker videos, that deserves to be presented here: We noticed that, while visiting the Monastery of Alcobaça, participants made use of two distinct modes of looking at the environment around them: "ambient" mode and "focus" mode.

The "ambient" mode seemed to be the default way of navigation, with the large saccades sometimes complemented with wide head movements and very short fixations and usually a steady walking pace; the "focus" mode emerged whenever an interesting feature (such as a sculpture or a rose window) was being inspected. It was typically coupled with a slower pace, sometimes in the direction of the examined object, or even a complete stop.

Within the "focus" mode, we observed two somewhat distinct behaviors. One, which we designated as "reading" is an informative form of looking, but a voluntary one; it happens when, for instance, the participant notices and seems to study the small figures and signs on the sculptures; this pattern of looking usually consists of short saccades and longer fixations that progress according to a linear and constant trajectory, not going back and with no accelerations or slowdowns. The last and perhaps most interesting looking pattern, which we designated "contemplative", differs from reading in the fact that the eye repeatedly returns to the same feature (a window, for example) while in reading it usually fixates each region only once. A contemplative gaze is not extracting information anymore, but seems to be an end in itself – as if it was enjoyable. Another attribute of what we call contemplative gaze mode is that it seemed to fall on the same regions over and again; the subjects looked at them from different angles, at various points of their visit.)

3. Stops

The hypothesis that presided over the stopping test was that the architecture of the church of Alcobaça should have some privileged places for halting in order to contemplate the architecture, (near or correlated to the "hot-spots" gazing areas). The statistical analysis revealed the existence of privileged stopping places: mainly the locations just after the entrance, in the church's crossing, and facing the Manueline door of the Sacristy. We may consider these locations correlated to the gazing "hot-spots". These locations are also consistent with the hypothesis of a walking pattern of the church of Alcobaça – driven by the longitudinal axis and polarized between the entrance and the apse.

4. Entry behavior

The hypothesis that presided over the entry behavior test was that the architecture of the church of Alcobaça would determine a pattern of walking; and that this pattern, in the initial moment, when entering the church, would follow the longitudinal axis of the main nave. Then most of the visitors, after entering the main door, should follow straight ahead, not diverting into the aisles. The statistical analysis performed corroborates such a hypothesis in both the groups tested (random visitors and architectural students), although the percentage of students that chose the longitudinal axis trajectory is far less expressive than that of the random visitors. (Differences between these groups can be ascribed to shyness by the tested students, due to the awkwardness of wearing the eye-tracker apparatus). This test gave one of the most significant results regarding the *gesture* theory in Alcobaça.

5. Trajectory

Although trajectories have not yet been subjected to a thorough statistical analysis, a preliminary computational processing was conducted which produced some interesting results.

By using the Dynamic Time Warping Distance algorithm, it was possible to determine which of the 50 subjects completed the "most common path", i.e., the one with less dissimilarity when compared to the other 49 subjects. That participant started the visit by walking straight ahead, immediately upon entering, until she reached the crossing, then turning right to visit the pantheon, then proceeding to the ambulatory, the transept, and finally walking back to the exit, making some detours in order to see both side aisles.

This "most common path" is consistent with the *gesture* hypothesis – and with the "entry behaviour" experiment – since it shows that, although there were many possible individual paths, the most typical one approximately expresses the ideal exploration pattern suggested by the architecture – for instance, the initial appeal of the apse and the influence of the longitudinal axis in the overall trajectory.

6. Heart-rate

As was already mentioned above, it was not possible to thoroughly process the heart-rate data according to the scheme that was contrived (Section II, 2.1). The survey performed on heart-rate data (limited to determining the gaze that occurred immediately before the points of higher and lower hear-rate appeared) did not show any acknowledgeable pattern.

7. Interviews

The commonality of the data on the sensorimotor experience and the justifications presented on interviews let us conclude that a kinaesthetic impulse exists that focuses the *gesture* as a form of perception (see Section II, 2.2). This kinaesthetic impulse seems to be mainly associated with the architectural layout and not exactly the ornaments and other decorative elements that also are a part of environmental perception. Therefore, it is the architectonical information available to the perceiver that directly specifies the molar structure of environmental layout which induces the perception by *gesture*.

Interviews also indicate that the cognition of the main architectural characteristics of the Alcobaça environment tends to be trans-subjective, even if each individual assumes a personal stance in face of those characteristics.

While acknowledging that the interview as a method for understanding cognition associated with sensorimotor experience can be reductionist, especially due to the constructivist / cognitive biased information it conveys, the presence of *gesture* on interviews corroborates its molar character, allowing to link the sensorimotor experience and cognition.

8. Final Synthesis

It was not the purpose of this exploratory research to demonstrate the theory of *gesture*. Nevertheless, it is possible to state that none of the empirical results invalidate such a theory – strictly in what concerns the architecture of the church of Alcobaça. It is then open to further and more thorough experiments in the course of scientific research, as much in the same building as in other pieces of architecture.

IV. DISSEMINATION

1. Database and Website

1.1. Database

A database of both raw data that was collected during the main experiment and data that was subsequently treated and analysed was created. Due to the sensitive nature of the information that was a part of this database (it included personal information and contacts of the participants, for example) it was important that it should be nested on a secure platform. But it was also important that it should be accessible by all those in need, either during the course of the project, or afterwards for use in further scientific research.

For this purpose, all the material that was not already in a digital format was digitized for storage purposes and to allow access by multiple research team members simultaneously whenever necessary. Furthermore, all the information was made accessible on the cloud via *http://owncloud.org*, except for the footage acquired with the action cameras suspended from the church's ceiling, which, due to its great volume, exceeded the available storage capacity. Footage from the cameras was stored on external hard drives. *Owncloud* enables the access to the database, which is hosted on the Faculty of Architecture's servers, by anyone who either has access to this service and with whom particular files or documents can be shared, or by anyone with access to the project's own account (using the project's username and password). The database is either accessed on the internet (http://cloud.fa.ulisboa.pt) or by installing a client on a computer, which synchronizes data included in a folder (usually named owncloud) with the database on the servers.

Figure 1 shows the interface for access via the internet.

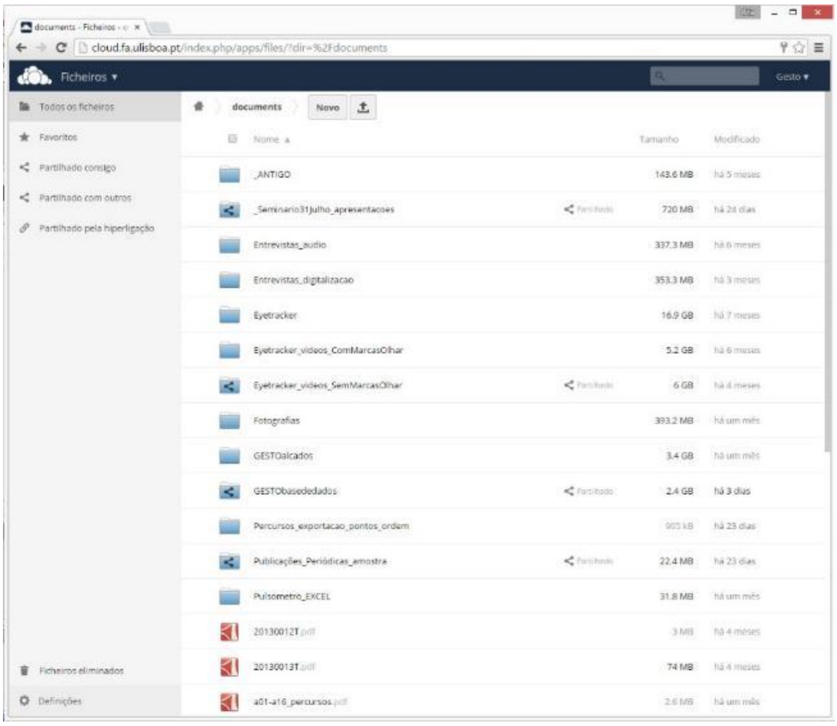

Fig. 1 – Accessible database on the *cloud*

1.2. Website

As a part of the project's dissemination strategy, a website for the Gesture Project was created. It is located in the Faculty of Architecture servers under the internet address:

- *http://home.fa.ulisboa.pt/~gesto.proj*
- *http://home.fa.ulisboa.pt/~gesto.proj/indexen.html* - For direct access to the English version.

It is a work in progress and will continue being updated with new material resulting from the continuation of the project, as a "public website with regular updates reporting the progress made in the research" (as stated in the project's program).

At the present time of the redaction of this report (November 2015), it presents a broad overview over the project and participants, and serves as a platform for divulging the project's main contact (the email *gesto.proj@fa.ulisboa.pt*) and mailing address. A very simple design was used and, in order to disseminate the website to a broader public, both a Portuguese and English version exist.

In the near future, the website will be updated by including contributions of research team members in their fields, resulting from both the project's closing seminar and the present report.

The website was written in html5 with a CSS stylesheet using Notepad++, versions 6.7.8.2 (Release date 2015-05-23) through

6.8 (Release date 2015-07-21) (Figure 2). It was tested on Internet Explorer, Google Chrome and Firefox on Windows 7, 8.1 and 10, Safari and Google Chrome on Mac OS X, Google Chrome on Android OS, and Safari on iOS.

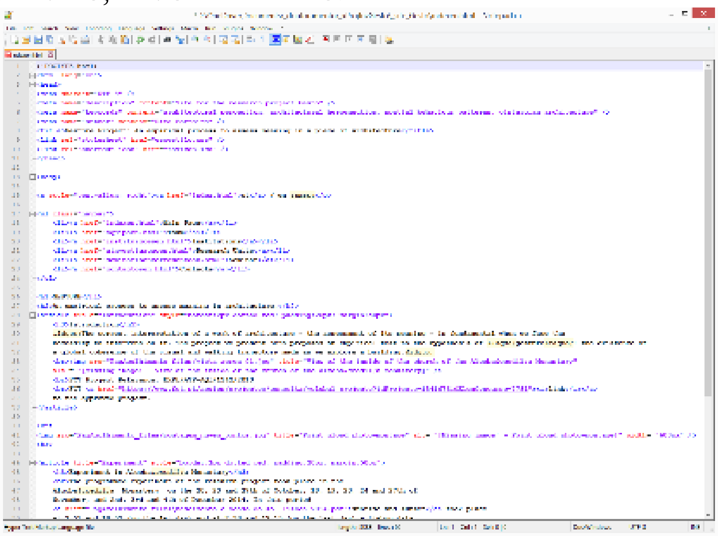

Fig. 2 – Example of html5 (Notepad++)

Although the preferred method for exploring the project's website should be a visit to *http://home.fa.ulisboa.pt/~gesto.proj/*, a series of screenshots for a summary presentation of the website have been added to the report as a record of its current state. All screenshots illustrate the website's English version.

Figure 3 illustrates the website´s **Main Page**. It includes a short introduction of the project with a link to FCT's project page. It also shows a photomontage of the interior of the church of the Monastery of Alcobaça resulting from the laser scanner survey, as well as a brief introduction of the experiment that occurred in the same church.

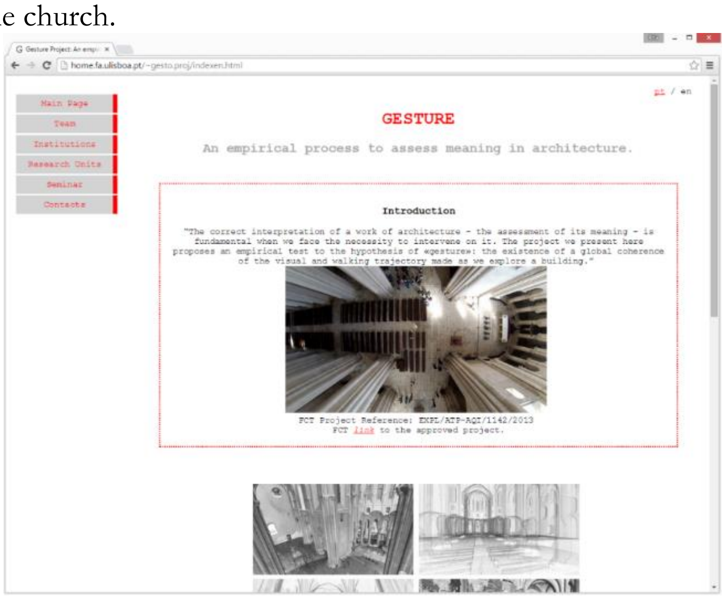

Fig. 3 – GESTO site – Main Page (Google Chrome)

The **Research Team** has its own page. In it, all research team members are listed and links are shown for each team member who has a personal or institutional website (Figure 4).

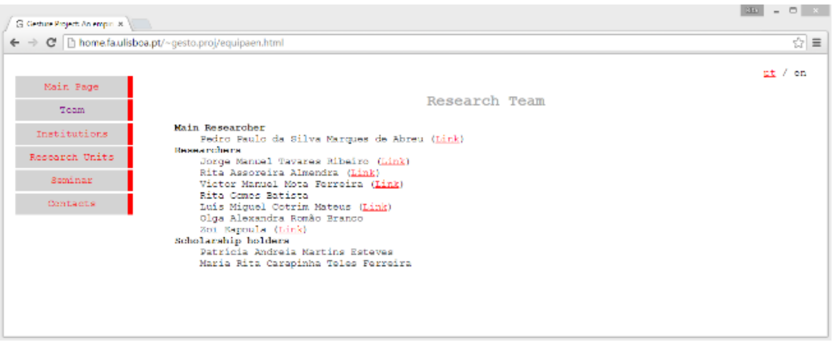

Fig. 4 – GESTO site – Team (Google Chrome)

In the **Institutions**' page, links are available for the Principal Contractor's, Participating Institutions' and Host Institution's websites (Figure 5). The same method was used in presenting the **Research Units** on their page (Figure 6).

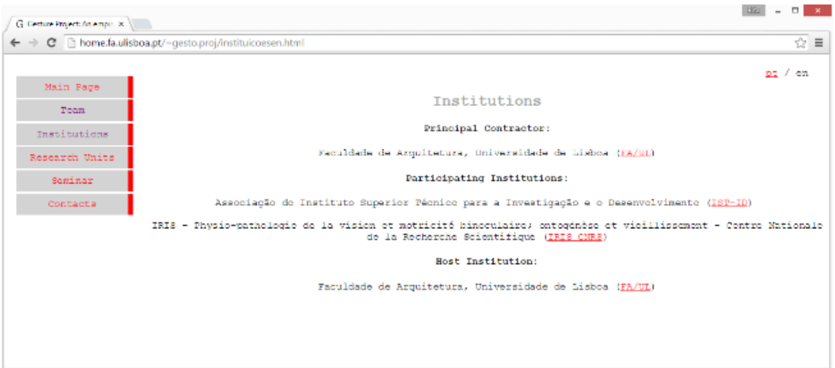

Fig. 5 – GESTO site – Institutions (Google Chrome)

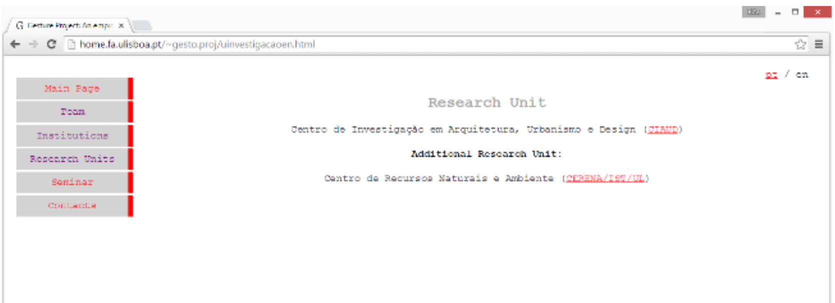

Fig. 6 – GESTO site – Research Units (Google Chrome)

The page for the **Closing Seminar** has a poster of the event that took place on July 31st. This page will be updated with the results from the closing seminar, as well as with the divulgation of a future Seminar that will take place in the Monastery of Alcobaça (Figure 7).

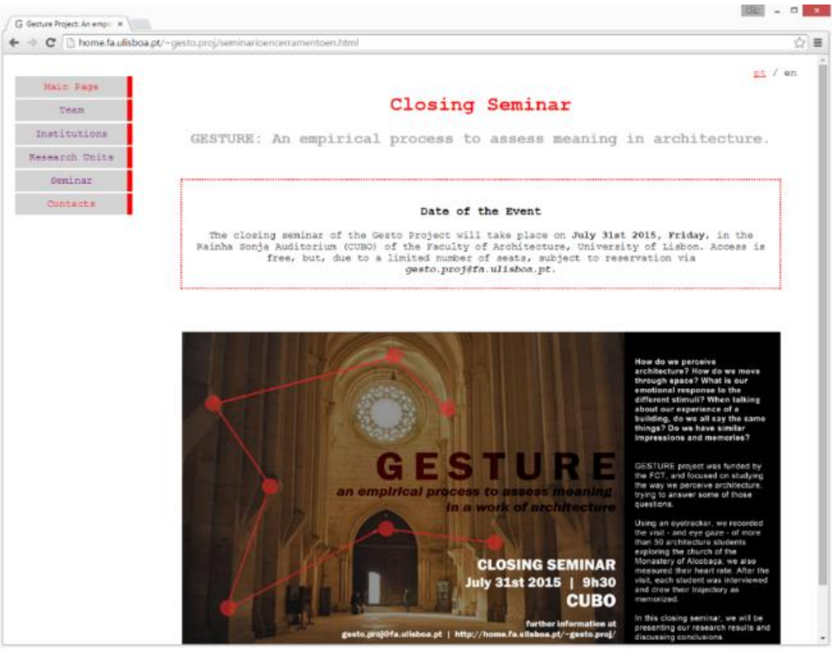

Fig. 7 – GESTO site – Seminar (Google Chrome)

Finally, a page for easy access to the **Contacts** was created (Figure 8).

Fig. 8 – GESTO site – Contacts (Google Chrome)

All pages are accessible by clicking the links on the vertical navigation bar from every other page. Language can be shifted from English to Portuguese (and vice-versa) from the active link on the top right corner in every page.

2. Conferences

2.1. Closing Seminar – Lisbon, July 31st 2015

The closing seminar for the GESTO project was held in the Faculty of Architecture, University of Lisbon on Friday July 31st 2015. It took place in the faculty's *Rainha Dona Sonja Auditorium* (CUBO), and was partially recorded on video. At the time of the writing of the present report (November), the video has not yet been made available by the faculty's multimedia centre.

The promotion of this event was executed by hanging posters on various public and high visibility places in the faculty's buildings. A request for the divulgation of the seminar on the faculty's site, which was granted, was also submitted to the faculty's Editorial and Communications Department (Figure 1). As was already mentioned in the website's chapter, a page for the seminar was also created:

http://home.fa.ulisboa.pt/~gesto.proj/seminarioencerramentoen.html

In addition to these, invitation emails were sent using the faculty's teacher, student and employee mailing lists. Alongside with these invitations, personal invitations were sent to the Faculty's President and Vice-President; to the President of the Faculty's Research Centre (CIAUD); to the President of the School Council; to the President of the Scientific Council; to the President of the Pedagogic Council; to the heads of the Departments of Architecture Project; of Urban Planning Project; of Design Project; of Technologies of Architecture, Urban Planning and Design; of Social and Territory Sciences; of Design, Geometry and Computation; and of History and Theory of Architecture, Urban Planning and Design. People who served as consultants to the project at any given moment were also personally invited, such as Prof. José Pinto Duarte (FA-UL and MIT-DL), Dr. Sara Eloy (ISCTE-IUL and ISTAR-IUL) and Dr. Miguel Sales Dias (ISCTE-IUL and Microsoft). A special invitation was also sent to all experiment participants, so that they could learn what they were a part of.

Fig. 1 – Promoting the seminar on the faculty's institutional website.

The closing seminar was intended to be a presentation of the project. At a stage when results from the different areas of investigation and analysis had already been obtained, it was planned as the exposure of the project, an overview over all the different aspects that were involved. Besides being a presentation it was also intended to be a platform for discussion. In fact, besides foreseeing a discussion moment at the end of the session, any questions or criticism that could enrich the project even further was welcomed and promptly addressed. For this reason, the closing seminar somewhat surpassed the initially planned schedule.

The contents of the present report, being a mirror of the closing seminar, summarize perfectly all the contributions that were made by the presenters. The closing seminar's program (with references to the chapters in the present report that correspond to the presentations that were delivered) was as follows:

9:30 Opening and welcoming speech

9:45 Theoretical grounding (Section I. Theoretical Work) – *Pedro Abreu*

10:05 Experiments and data processing (Section II. Empirical Work; Main Experiment) – *Jorge Ribeiro, Rita Ferreira, Patrícia Esteves*

- Population characterization;
- The gaze experiment;
- The stop experiment;
- Inquiry;
- Entry behaviour.

10:35 Other processed experiments (Section II. Empirical Work; Other Experiments) – *Rita Batista, Patrícia Esteves*

- Heart-rate monitor;
- Interviews and drawings;
- Analysis hypothesis.

10:50 Website of Gesto (Section IV. Dissemination; Website and Database) – *Rita Ferreira*

11:00 3D architectural survey of the church (Section II. Empirical Work; Other Works) – *Luís Mateus*

Processing of frames from the eye-tracker (Section II. Empirical Work; Other Works) – *Victor Ferreira*

11:15 Coffee break (15 minutes)

11:30 Computational analysis of path similarity (Appendix H) – *Fernando Abreu*

11:45 Qualitative Analysis (Section II. Empirical Work; Other Experiments & Appendix G) – *Olga Romão*

12:05 Management, logistics and accounts (Cancelled) – *Rita Almendra*

12:15 Results and synthesis (Section III. Results) – *Pedro Abreu*

12:35 Discussion

13:00 Closing speech

Finally, a special acknowledgment of Fernando Brito e Abreu's (ISCTE-IUL and ISTAR-IUL) presentation is due. Although he was not one of the research team members, he made an extraordinary contribution to the project that was presented during the closing seminar. The full paper that was written and is fully reproduced in Appendix H.

2.2. Dissemination Colloquium – Alcobaça, October 31st 2015

We presented the project and its results in Alcobaça, the place where the main experiment took place. The event program was similar to that of the Closing Seminar, suffering only minor adaptations to better suit the interests of the audience – which included Monastery personnel, such as historian Dr. Isabel Costeira, and DGPC (Direcção Geral do Património Cultural) representatives, such as architect João Seabra. (The Monastery's director could not attend the colloquium due to personal reasons.)

The presentations also reflected some of the research progress made since July 31st. Further trajectory analysis (conducted by Fernando Brito e Abreu, who was not a member of the official research team, but whose effort was invaluable) obtained the typical trajectory of our sample, among other important data; and further data treatment of the interviews revealed a strong unanimity in the immediate sensorial experience of the church.

Presenting the research at the Monastery of Alcobaça was very fruitful, since it allowed us to clarify and better understand our results with the help of those who best know the building and its history. For instance, it was pointed out that the space qualities perceived and expressed in the interviews (such as verticality, simplicity, tranquillity) formed the building doctrine of the Cistercian order, and how interesting it was that they were so aptly conveyed.

2.3. Presentation in the SUWMIAC (3rd Summer Workshop Microsoft ISCTE-IUL on Applied

Computing) – Microsoft Portugal, Lisbon October 30th 2015

We were invited to present our research in the 3rd SUWMIAC, a workshop for the exchange of information and ideas between Microsoft researchers and the Portuguese and international academic community – especially in the architecture and computing fields.

In this workshop, we had the possibility of hearing about other research projects using similar methods and instruments as ours and to learn from their experience – both with their successes and their challenges. It also offered a valuable opportunity to discuss technologies which could be useful to future research, namely Plux biosignal apparatus, ISTAR's pocket cave technology and different models of eye-trackers.

Our presentation was well received and contacts were made with ISTAR investigators to explore other research possibilities and join efforts in future projects.

2.3. Presentation in CIAUD's (Centro de Investigação em Arquitectura, Urbanismo e Design) 3rd Research Seminar – FA-UL, 4-6th November 2015

Although this seminar was held shortly after the project's official closure date, we believe that it is worth mentioning.

The project was presented in the seminar as part of the Faculty's research center, and subject to the evaluation of a panel of external consultants – particularly Henri Achten, of the Faculty of Architecture of the Czech Technical University in Prague and Luiz Amorim of the Federal University of Pernambuco.

The evaluation made by the panel did not express any negative criticism, and stated that "the research project brought together in the span of just one year a very rich series of measurement technologies to verify the behavioral patterns of people [while visiting the church of the Monastery of Alcobaça]. It was very impressive to see how the wide range of technologies (eye tracking, movement recording, interviews and so on) was applied in the building."

The declaration of participation, as well as the general public remarks are attached in Annex A.

3. Presented papers

3.1. AEAULP

Our first communication was presented at the 3rd International Seminar of the AEAULP (Associação de Escolas de Arquitectura e Urbanismo de Língua Portuguesa – Association of Lusophone Schools of Architecture and Urbanism) which took place in Lisbon from the 13th to the 15th of October.

"Gesto: um processo experimental para determinar o sentido de uma obra de arquitectura" (Appendix I) was written while the Data Collection task was taking place, and as such it does not yet include any results. Because the attendants of this seminar were mainly academics of the architecture field, our paper essentially addressed the theoretical context of our hypothesis, although we did briefly describe the Alcobaça experiment.

In our spoken presentation, further details were given about the methods and proceedings of out empirical study, and we played a video of the pilot experiment as an illustration.

The article was published in Arquiteturas do Mar, da Terra e do Ar – Arquitetura e Urbanismo na Geografia e na Cultura – Vol. I. Ed. Academia de Escolas de Arquitectura e Urbanismo de Língua Portuguesa, 2014.

3.2. REHAB

The second communication was presented at the 2nd International Conference on Preservation, Maintenance and Rehabilitation of Historical Buildings and Structures (organized by the Green Lines Institute for Sustainable Development), which was held in Oporto, from July 22 to 24.

"How to make rehabilitation intersubjective: the "Gesture tool" (Appendix J) was written half way through the Statistical Evaluation task, so it was possible to include some of our results in the paper.

The group of attendants of this congress was quite heterogeneous, including architects, engineers, historians and teachers from every continent. In our spoken presentation, we briefly explained our theoretical background, presented our empirical work and its results, and discussed how *Gesture* could be used to help one to make better decisions in rehabilitation projects.

The article was published in the Proceedings of the 2nd International Conference on Preservation, Maintenance and Rehabilitation of Historical Buildings and Structures. 22-24 July 2015, Porto, Portugal. (ed. AMOÊDA, Rogério; LIRA, Sérgio; PINHEIRO, Cristina)

4. Proposed papers

A further step in the dissemination of the project was coming into contact with publications in which articles could be published.

In a first phase, considering mostly the area of Arts and Architecture, but also the field of Psychology (in particular Environmental Psychology), a research for related publications was initiated. The following list of publications resulted from this research:

- Journal of Architectural Education;
- Journal of Aesthetics and Phenomenology;
- Empirical Studies of the Arts;
- Frontiers of Architectural Research;
- Journal of Architecture;
- Arquitetura Revista;
- Leonardo;
- Journal of Architectural and Planning Research;
- Architectural Science Review;
- PLoS One;
- Frontiers in Psychology;
- Journal of Environmental Psychology.

In a second phase, a first contact with a few of these publications was initiated. This phase was important because, given the exploratory nature of the project, it was considered necessary to select the appropriate medium for disseminating any results, but also to probe the publications for their interest in publishing a paper that would be a result of the present research project. In that regard, three publications in the fields of the Arts and Architecture were carefully chosen as the aim for this contact, namely *Leonardo,* the *Journal of Architectural Education*, and the *Journal of Aesthetics and Phenomenology*.

At this time the project was in a phase when the results from the analyses that were conducted were not yet determined. So, for the purpose of introducing the project and its intentions, the following abstract was produced and sent to the editorial teams of the aforementioned publications:

"It is widely acknowledged that architecture differs from current building, as a higher level, because it conveys a deeper meaning, something beyond plain function. The meaning of a work of architecture – something of existential value – is what makes it unique and irreplaceable. Understanding it is necessary so that we can better benefit from its content, but also so that architects can uphold it when working on pre-existing architecture. But how can we acquire this meaning, and acquire it in an intersubjective manner, so that we can hope to agree on it? We suggest the concept of gesture as an interpretative basis. "Gesture" is the chain of movements (walking, looking around) and also

emotional shifts of someone experiencing an architectural space. "Gesture", inasmuch as it is determined by the environment, would be essentially similar for every person. These movements we make – an unconscious dance – are induced by space itself and convey its meaning to us. Our hypothesis is that we can use gesture to reach meaning. Its value as an analytical tool lies on the fact that it a) derives directly from the work itself rather than, for instance, the architect's intentions; b) focuses on the more tangible, observable parts of the subjective experience; c) is typically shared by everyone: a common ground for discussion of meaning. We performed an experiment based on this theory in which we recorded the motion of a group of architecture students freely exploring the church of the Monastery of Alcobaça, in Portugal, registering their walking trajectory as well as their gaze trajectory (using an eye tracking device). Our preliminary observations seemed to indicate the existence of a shared response to that architectural form. To test these observations, a statistical analysis focusing on gaze, trajectory stops and on entry behavior was performed. This analysis identifies an exploratory pattern that confirmed the existence of the shared response and will constitute a basis to further pursue our theory."

As a result from this first contact the following answers were received:

- The co-editor in chief of the *Journal of Aesthetics and Phenomenology* gracefully accused the reception of the email, but has not yet given a response as to the publication's interest in the presented subject;
- The editor of the *Journal of Architectural Education* replied that only full papers were accepted for review;
- After being acknowledged by the editorial team of *Leonardo*, the final answer from the executive editor was that the topic is within the scope of the publication and the applied methodology, since it is *"an evidence based project which we encourage"*, is suiting to their approach.

So, in this line of procedure, the following step was to finalize a paper for submission to Leonardo (Appendix L). The final paper was professionally reviewed by a native English speaker and sent to Leonardo.

The paper is now awaiting review (unfortunately, due to the unavailability of some of the magazine's prospective reviewers, the process is taking longer than usual).

We are also pursuing further contacts with other publications belonging to the fields of Art and Architecture. Another article, more closely describing the mathematical aspect of the stops analysis, especially the application of the kriging method in the architectural context, was written and has been submitted to the

Journal of Architecture, Building Research and Information and the International Journal of Architecture Heritage. It can be found in appendix K.

Another course to be explored is that of the field of Psychology. In that regard, the paper produced by Dr. Olga Romão for the present report (Appendix G) will be further developed and prepared for submission to related publications in the area of environmental psychology such as the *Journal of Environmetal Psychology* and *Environment and Behaviour*.

This paper is a contextualization of the Gesture concept with the theoretical body of perception and environmental psychology, as well as a content analysis of the material collected in the interviews.

The first part is a literature review of classic perception theories – such as Piaget's cognitivism and Gibson's ecological approach – and places *Gesture* among them, as a response to some of the latent issues.

In the second part there is a description of our interview method and structure, followed by a thorough content analysis of the collected data.

At the end of the present project, during the closing seminar, another contribution was brought forth that opened new possibilities for the dissemination of the project in the field of Computation. A full paper entitled "Analyzing the commonality among walking routes: the GESTO experience" was written by Prof. Fernando Brito e Abreu (Appendix H) in the sequence of his presentation and has become a new prospect of dissemination that was added to the initial strategy.

This article is a technical report on the analysis of the walking paths of the experimental subjects during their visit to the church of the Monastery of Alcobaça.

It includes an overview of existing route distance algorithms and carefully describes the new approach created in order to answer the mathematical problem of finding commonality between trajectories.

In order to devise a virtual "most common route", as well as a heat map of the most visited regions, a tool was developed from scratch. The article describes the software components that were produced and presents the results of this experiment.

5. ***Gesture* book**

As an additional means for the dissemination of our research, a *Gesture* book is now being prepared, in order to be freely distributed throughout the scientific community. It will be issued in English, so that it will serve a broader public.

It will comprise all the results of the present study, including trajectory analysis, visual exploration, preferred stopping points, entry behavior and the two studies based on the interviews. Since past trials and errors are so often useful to scientific advance, it will also mention the less well succeeded studies, such as the hear-rate data analysis and the frame-based 3D reconstruction.

About 100 pages long, the book is a joint effort of the whole research team – Pedro Abreu in the theoretical field, Jorge Ribeiro in mathematics and statistics, Zöi Kapoula and Patrícia Esteves in the eye-tracking and experimental fields, Luís Mateus, Victor Ferreira and Rita Ferreira in computation and 3D modelling, Olga Romão in environmental psychology, and also include the important trajectory study of Fernando Brito e Abreu.

V. FUTURE RESEARCH

This project was an *exploratory* empirical research of the Gesture theory. It was meant as a preliminary step for a future more thorough research.

In the future it would be necessary, firstly, to perform analogous experiments in several architectonical spaces, including more complex ones – perhaps including gardens and urban tissues, as well.

Secondly, in order to further pursue our theory, there should be an attempt to examine the role of as many perceptive systems as possible. Although the visual system is vital in the understanding of attention allocation, other systems (such as the hearing and the haptic system, including proprioceptive elements) participate in architecture experience as well – be it in its aesthetical fruition, by supporting plain navigation, etc. A strategy should be discovered that allowed us to collect data on how these other perceptive systems respond to the surrounding stimuli and contribute to its perception as a whole, in the full experience of dwelling.

Thirdly, a larger subject sample would be required, in order to reinforce statistical validation.

Furthermore, due to the innovative character of this project, we faced several challenges which demand new strategies and tools. The problem of how to automatically superimpose trajectories onto virtual models, for instance, is yet to be solved. The mathematical problem of how to find commonality between multiple paths had to be solved by developing new software from scratch: it has already produced some notable results (see appendix H).

The pioneering nature of this project will inevitably create new challenges and demand new solutions – be in the field of architecture theory (considering new empirically testable conjectures), environmental psychology (generating experimental conditions as near as possible to real-world navigation, creating an integrated study of several perceptive systems), and mathematical and computational sciences (generating new software compounds to calculate trajectories commonality).

Some of the key challenges ahead lie in the environmental psychology field. Both the interviews and the drawings collected need a more effective method of information withdrawal, since their rich content has not yet been sufficiently acknowledged.

Another important element of our experiment that would need improving has to do with emotional assessment. We have already examined a large number of biosignal apparatus; unfortunately, though, we learned that more sophisticated apparatuses do not yet allow for complete freedom of movement. We expect that a new generation of devices should be developed in the near future, allowing for emotional responses to be reliably measured outside the laboratory.

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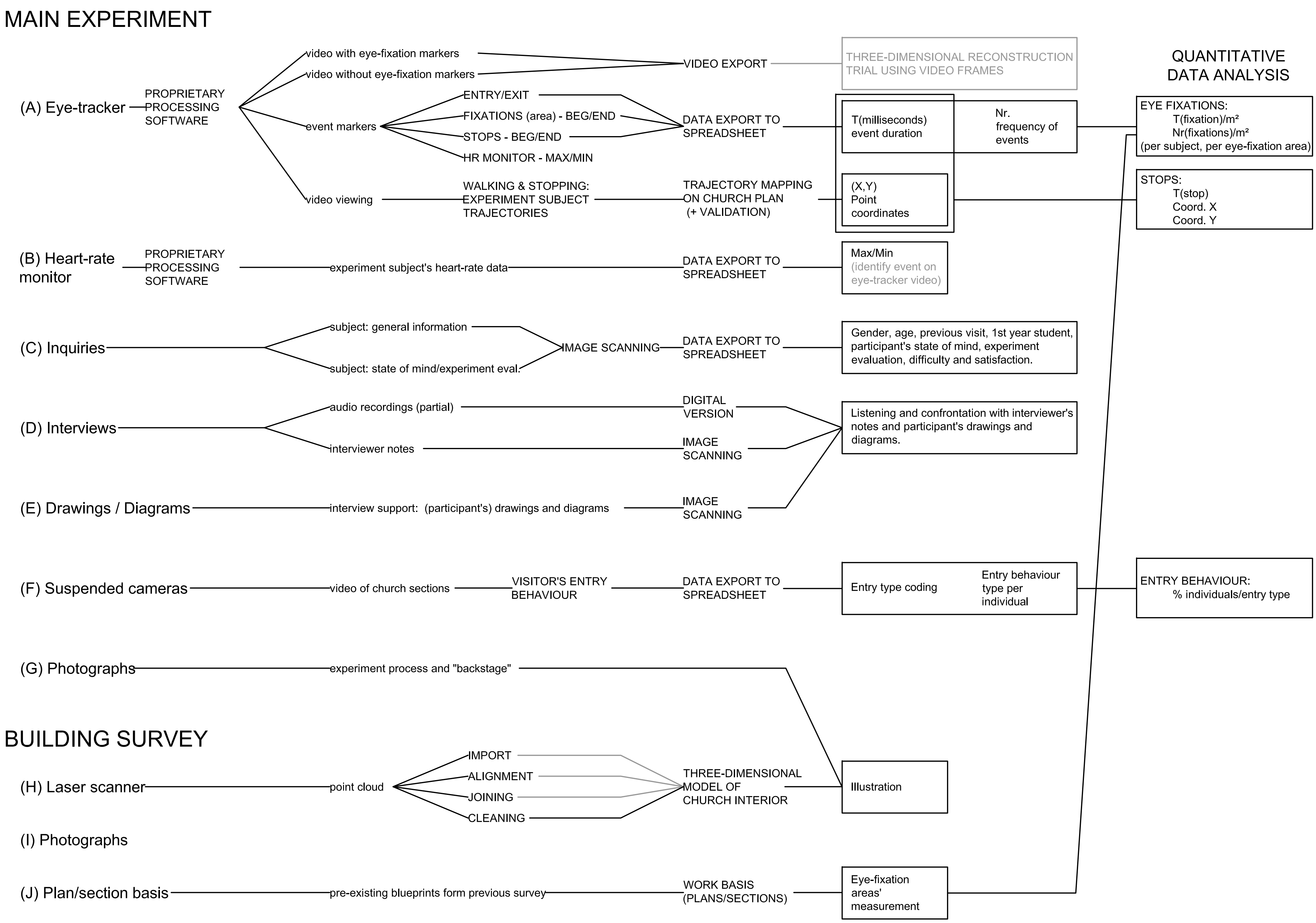
VII. Appendices

1. Appendix A – Data Diagram


MAIN EXPERIMENT
(A) Eye-tracker
PROPRIETARY PROCESSING SOFTWARE
video with eye-fixation markers
video without eye-fixation markers
VIDEO EXPORT
THREE-DIMENSIONAL RECONSTRUCTION TRIAL USING VIDEO FRAMES
event markers
ENTRY/EXIT
FIXATIONS (area) - BEG/END
STOPS - BEG/END
HR MONITOR - MAX/MIN
DATA EXPORT TO SPREADSHEET
T(milliseconds) event duration
Nr. frequency of events
video viewing
WALKING & STOPPING: EXPERIMENT SUBJECT TRAJECTORIES
TRAJECTORY MAPPING ON CHURCH PLAN (+ VALIDATION)
(X,Y) Point coordinates
QUANTITATIVE DATA ANALYSIS
EYE FIXATIONS: T(fixation)/m² Nr(fixations)/m² (per subject, per eye-fixation area)
STOPS: T(stop) Coord. X Coord. Y
(B) Heart-rate monitor
PROPRIETARY PROCESSING SOFTWARE
experiment subject's heart-rate data
DATA EXPORT TO SPREADSHEET
Max/Min (identify event on eye-tracker video)
(C) Inquiries
subject: general information
subject: state of mind/experiment eval.
IMAGE SCANNING
DATA EXPORT TO SPREADSHEET
Gender, age, previous visit, 1st year student, participant's state of mind, experiment evaluation, difficulty and satisfaction.
(D) Interviews
audio recordings (partial)
interviewer notes
DIGITAL VERSION
IMAGE SCANNING
Listening and confrontation with interviewer's notes and participant's drawings and diagrams.
(E) Drawings / Diagrams
interview support: (participant's) drawings and diagrams
IMAGE SCANNING
(F) Suspended cameras
video of church sections
VISITOR'S ENTRY BEHAVIOUR
DATA EXPORT TO SPREADSHEET
Entry type coding
Entry behaviour type per individual
ENTRY BEHAVIOUR: % individuals/entry type
(G) Photographs
experiment process and "backstage"
BUILDING SURVEY
(H) Laser scanner
point cloud
IMPORT
ALIGNMENT
JOINING
CLEANING
THREE-DIMENSIONAL MODEL OF CHURCH INTERIOR
Illustration
(I) Photographs
(J) Plan/section basis
pre-existing blueprints form previous survey
WORK BASIS (PLANS/SECTIONS)
Eye-fixation areas' measurement

2. Appendix B – Eye Fixations

Análise do olhar dos visitantes em diferentes áreas da Igreja de Alcobaça

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1. INTRODUÇÃO

Esta análise incide sobre uma amostra de 50 indivíduos que visitaram a Igreja de Alcobaça no período entre 20/out./2014 e 04/dez./2014 e que se voluntariaram para a realização da experiência. O procedimento experimental consistiu em dividir os 50 indivíduos em dois grupos – alunos do 1º ano dos Mestrados Integrados em Arquitetura (MiARQ) e em Arquitetura de Interiores e Reabilitação do Edificado (MiAIRE) da Faculdade de Arquitetura da Universidade de Lisboa (39 indivíduos) e alunos do 5º ano do MiARQ e alunos graduados (AGMiARQ) que concluíram recentemente o mesmo mestrado (11 indivíduos). Para cada um dos grupos de indivíduos e para cada uma das 12 áreas distintas assinaladas na figura 1, designadas por A, AA, B, BB, C, CC, D, DD, E, X, Y e Z, registaram-se o número de fixações do olhar por unidade de área (variável NF); bem como a duração dessas mesmas fixações por unidade de área (variável Time, medida em milisegundos). Ambas as variáveis são quantitativas e contínuas.

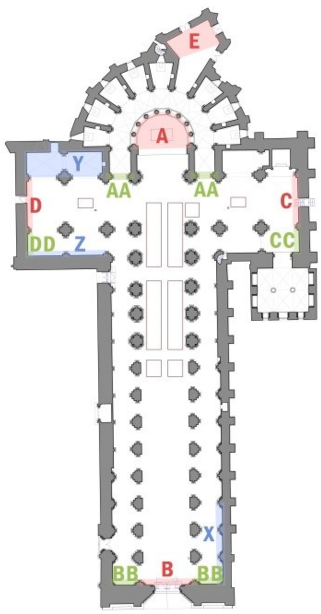


Fig. 1 – Identificação das áreas observadas na Igreja.

2. METODOLOGIA DE ANÁLISE

Em termos metodológicos procedeu-se sequencialmente à análise univariada, bivariada (Murteira *et al*. 2010) e multivariada (Benzécri 1981; Cibois 1984; Escofier & Pagès 1998; Gomez & Castellanos 2004) de cada um dos conjuntos de dados, correspondentes a cada um dos grupos de indivíduos. Foi igualmente submetido à mesma sequência de análise o conjunto de dados correspondente à totalidade dos indivíduos. Todas as análises foram efetuadas usando como recurso computacional o programa AnDad (CVRM/CERENA/IST 1989, 2002, 2012).

3. Alunos do 1º ano do MiARQ e do MiAIRE

3.1. Análise Univariada

As figuras 2 e 3 mostram inequivocamente que as áreas A e B são as preferidas pelos visitantes deste grupo de indivíduos, quer em tempo de observação que lhes dedicam (cerca de 3750 ms/m^2 – *vd*. figura 2), quer em número de vezes que as observam (cerca de 1.2 fixações/m^2 – *vd*. figura 3).

Em termos do tempo de fixação das áreas, seguem-se as áreas E, D, BB, C, AA e Y (entre 900 e 1600 ms/m^2 – *vd*. figura 2). Este grupo de indivíduos dedica menos tempo à observação das áreas Z, CC, X e DD (menos de 550 ms/m^2 – *vd*. figura 2).

No que diz respeito ao número de fixações das áreas, às anteriormente mencionadas seguem-se as áreas D, C, AA e BB (entre 0.5 e 0.6 fixações/m^2 – *vd*. figura 3). As áreas menos fixadas por este grupo de indivíduos são: E, CC, Y, DD, Z e X (com menos de 0.3 fixações/m^2 – *vd*. figura 3).

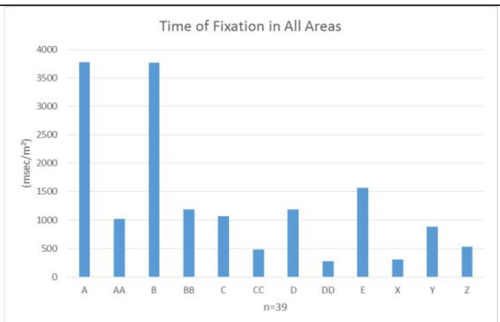


Fig. 2 – Tempo de fixação das áreas da Igreja

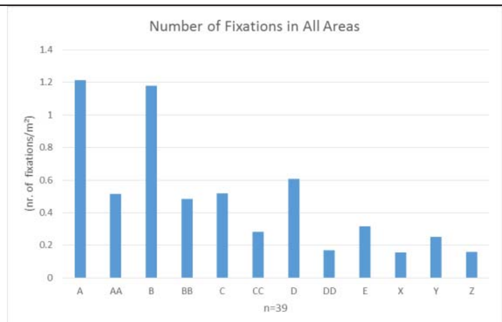


Fig. 3 – Número de fixações das áreas da Igreja

Na figura 4 apresentam-se os estatísticos básicos calculados para ambas as variáveis em cada uma das 12 áreas da Igreja.

		Identificador	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Padrão	Coef. Variação	Amplitude	Int. Interquartil	Coef. Assimetria	S'
Area A	Fixation time/m²	At	39	96.971	N/A	73.2881	8.7056	32.6553	137.6452	432.6148	8449.4622	91.921	0.9479	423.9093	104.9899	1.9916	0.2256
	Nr. Fixations/m²	Anr	39	0.0311	N/A	0.0289	0.0058	0.0144	0.0433	0.0982	0.0004	0.0199	0.6403	0.0925	0.0289	1.4167	0.0769
Area AA	Fixation time/m²	AAt	39	26.179	N/A	18.706	0	6.1892	36.2169	116.0348	674.6585	25.9742	0.9922	116.0348	30.0277	1.7143	0.2489
	Nr. Fixations/m²	AAnr	39	0.0132	N/A	0.0119	0	0.004	0.0198	0.0317	0.0001	0.0094	0.713	0.0317	0.0158	0.3489	0.0833
Area B	Fixation time/m²	Bt	39	96.586	N/A	83.0998	4.1419	38.9229	135.6874	281.3222	4902.1082	70.0151	0.7249	277.1804	96.7645	0.8441	0.1394
	Nr. Fixations/m²	Bnr	39	0.0302	N/A	0.0263	0.0044	0.0175	0.0394	0.0701	0.0003	0.017	0.5643	0.0657	0.0219	0.4993	0.1795
Area BB	Fixation time/m²	BBt	39	30.506	N/A	24.2659	0	8.0055	50.4201	103.0702	686.8437	26.2077	0.8591	103.0702	42.4146	0.7754	0.1471
	Nr. Fixations/m²	BBnr	39	0.0124	N/A	0.0092	0	0.0046	0.0185	0.0323	0.0001	0.0082	0.6609	0.0323	0.0138	0.4934	0.2308
Area C	Fixation time/m²	Ct	39	27.431	N/A	19.383	0	10.2468	34.8717	82.5321	547.8183	23.4055	0.8533	82.5321	24.6249	0.9866	0.3268
	Nr. Fixations/m²	Cnr	39	0.0133	N/A	0.0099	0	0.0049	0.0197	0.0444	0.0001	0.0103	0.777	0.0444	0.0148	1.1775	0.2308
Area CC	Fixation time/m²	CCt	39	12.358	N/A	0	0	0	22.4232	62.7326	275.9026	16.6103	1.3441	62.7326	22.4232	1.2704	0.5511
	Nr. Fixations/m²	CCnr	39	0.0072	N/A	0	0	0	0.0105	0.0418	0.0001	0.0096	1.3319	0.0418	0.0105	1.52	0.6923
Area D	Fixation time/m²	Dt	39	30.458	N/A	24.0622	0	10.1431	45.6811	114.8322	756.085	27.497	0.9028	114.8322	35.538	1.3196	0.18
	Nr. Fixations/m²	Dnr	39	0.0156	N/A	0.0148	0	0.0099	0.0197	0.0642	0.0001	0.012	0.7682	0.0642	0.0099	2.1275	0.0769
Area DD	Fixation time/m²	DDt	39	7.0774	N/A	0	0	0	6.5022	56.314	226.3626	15.0454	2.1258	56.314	6.5022	2.2419	1.0885
	Nr. Fixations/m²	DDnr	39	0.0043	N/A	0	0	0	0.0105	0.0314	0.0001	0.0079	1.8307	0.0314	0.0105	1.8936	0.4102
Area E	Fixation time/m²	Et	39	40.29	N/A	31.3782	0	9.369	67.0818	139.5766	1192.2646	34.5292	0.857	139.5766	57.7127	0.8425	0.1544
	Nr. Fixations/m²	Enr	39	0.0081	N/A	0.0083	0	0.0042	0.0125	0.0374	0	0.0065	0.798	0.0374	0.0083	2.4351	-0.026
Area X	Fixation time/m²	Xt	39	7.9486	N/A	3.4338	0	0	15.4567	56.2496	136.8277	11.6973	1.4716	56.2496	15.4567	2.3544	0.2921
	Nr. Fixations/m²	Xnr	39	0.0039	N/A	0.003	0	0	0.006	0.0211	0	0.0045	1.1524	0.0211	0.006	1.6303	0.1538
Area Y	Fixation time/m²	Yt	39	22.761	N/A	19.5672	0	8.5966	33.09	64.6673	254.3933	15.9497	0.7007	64.6673	24.4934	0.659	0.1304
	Nr. Fixations/m²	Ynr	39	0.0064	N/A	0.0061	0	0.004	0.0081	0.0162	0	0.0035	0.5489	0.0162	0.004	0.618	0.0896
Area Z	Fixation time/m²	Zt	39	13.744	N/A	5.5217	0	0	12.3537	151.69	992.6473	31.5063	2.2923	151.69	12.3537	3.8586	0.6656
	Nr. Fixations/m²	Znr	39	0.004	N/A	0.0034	0	0	0.0068	0.0171	0	0.0039	0.9701	0.0171	0.0068	1.2964	0.0898

Fig. 4 – Estatísticos básicos de cada área da Igreja

No caso da variável Time, verifica-se que algumas áreas apresentam os principais estatísticos básicos da mesma ordem de grandeza, nomeadamente os casos das áreas A e B (*vd*. figura 5); as áreas AA, BB, C, D, E e Y (*vd*. figura 6); e as áreas X e Z (*vd*. figura 7). As áreas CC e DD apresentam estatísticos básicos diferentes entre si e diferentes dos anteriormente mencionados (*vd*. figura 8).

Para o caso da variável NF as áreas que revelam estatísticos básicos da mesma ordem de grandeza são as seguintes: áreas A e B (*vd*. figura 9); áreas AA, BB, C e D (*vd*. figura 10); áreas E, X, Y e Z (*vd*. figura 11); e áreas CC e DD (*vd*. figuras 12).

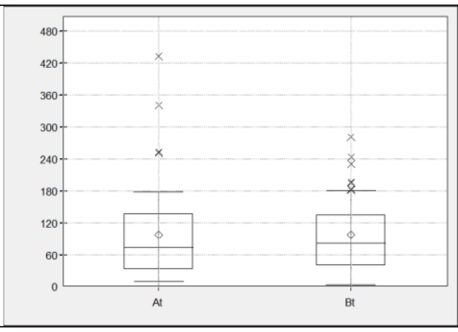


Fig. 5 – Box-Plots do tempo de fixação das áreas A e B

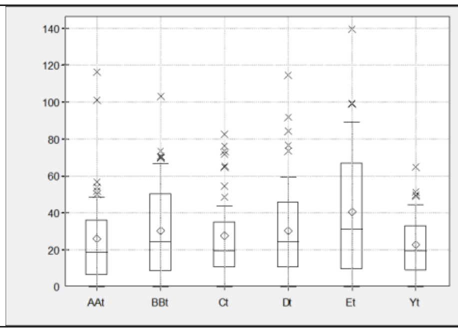


Fig. 6 – Box-Plots do tempo de fixação das áreas AA, BB, C, D, E e Y

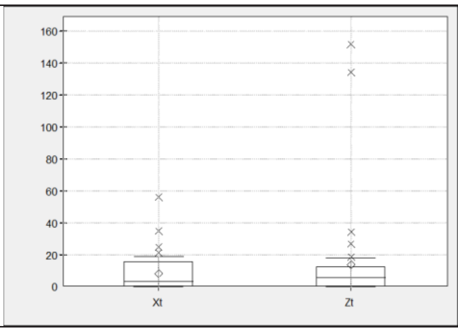


Fig. 7 – Box-Plots do tempo de fixação das áreas X e Z

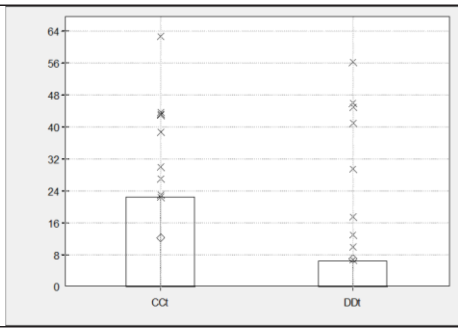


Fig. 8 – Box-Plots do tempo de fixação das áreas CC e DD

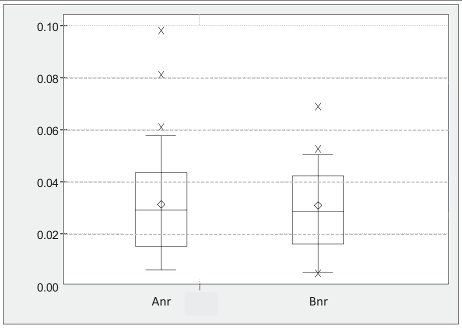


Fig. 9 – Box-Plots do número de fixações das áreas A e B

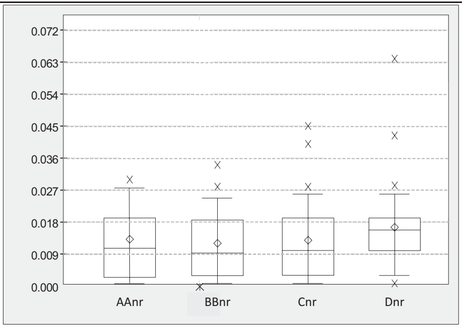


Fig. 10 – Box-Plots do número de fixações das áreas AA, BB, C e D

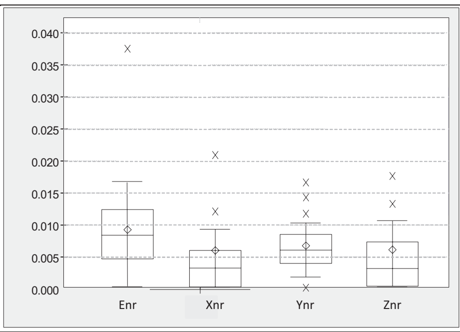


Fig. 11 – Box-Plots do número de fixações das áreas E, X, Y e Z

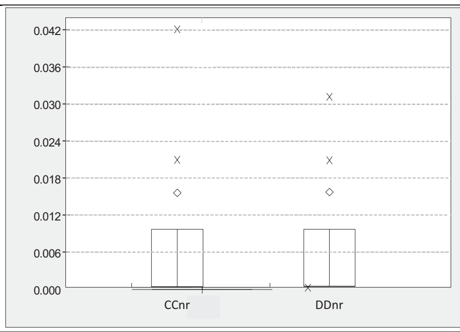


Fig. 12 – Box-Plots do número de fixações das áreas CC e DD

Nota-se também que, em todas as áreas, a dispersão da variável Time é bastante superior à dispersão da variável NF, podendo afirmar-se que esta última variável revela maior homogeneidade do que a primeira. As variáveis apresentam assimetria positiva em todas as áreas. É também evidente que para a variável Time existem mais valores anómalos em cada uma das áreas observadas do que no caso da variável NF, ou seja a diferenciação de postura dos indivíduos perante as diferentes áreas é mais acentuada em termos da duração das fixações do que em termos do número de fixações.

A distribuição dos valores de cada uma das variáveis, para cada uma das áreas de observação da Igreja é apresentada nas figuras 13 a 36.

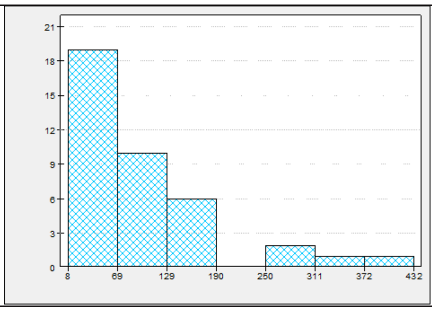


Fig. 13 – Distribuição do tempo de fixação na área A

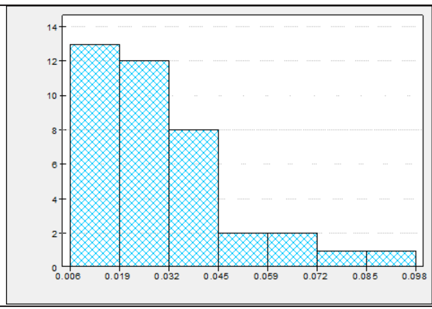


Fig. 14 – Distribuição do número de fixações na área A

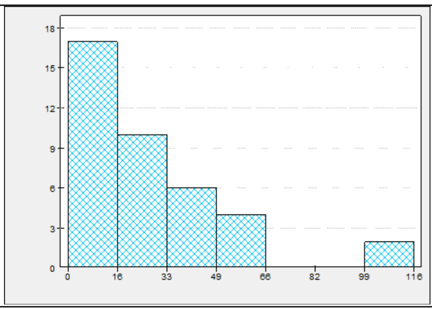


Fig. 15 – Distribuição do tempo de fixação na área AA

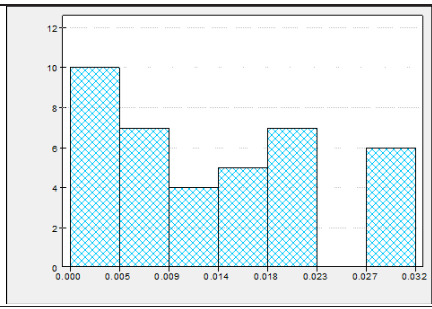


Fig. 16 – Distribuição do número de fixações na área AA

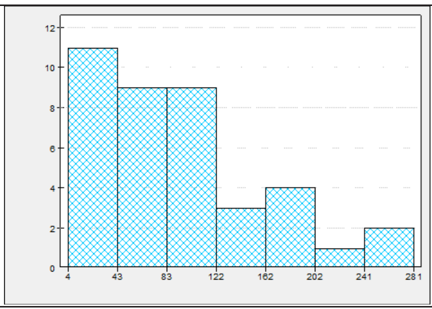


Fig. 17 – Distribuição do tempo de fixação na área B

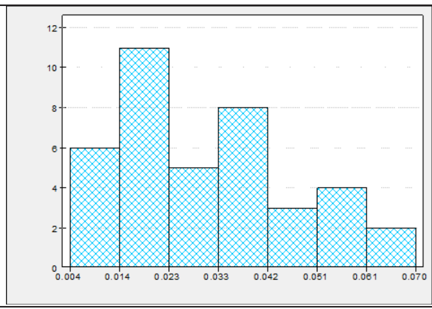


Fig. 18 – Distribuição do número de fixações na área B

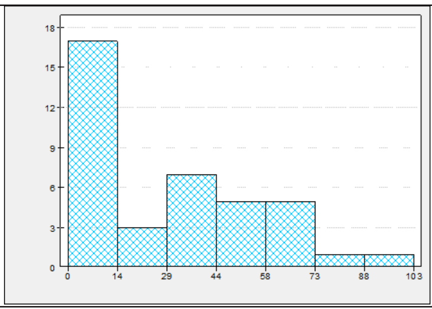


Fig. 19 – Distribuição do tempo de fixação na área BB

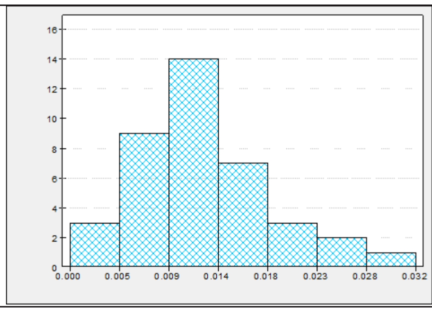


Fig. 20 – Distribuição do número de fixações na área BB

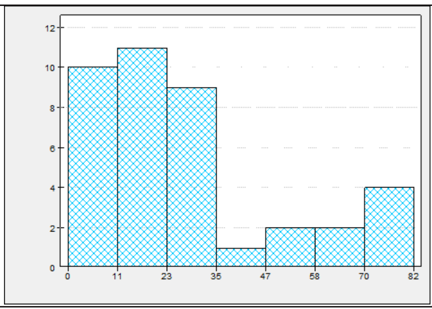


Fig. 21 – Distribuição do tempo de fixação na área C

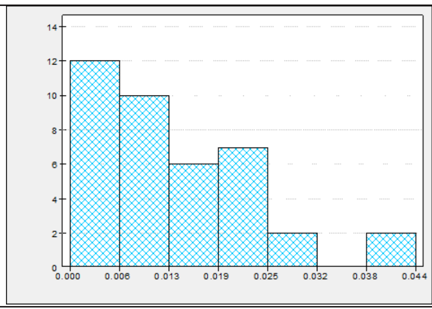


Fig. 22 – Distribuição do número de fixações na área C

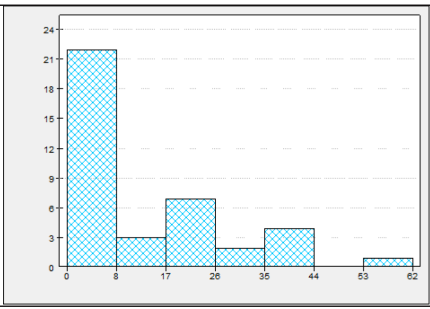


Fig. 23 – Distribuição do tempo de fixação na área CC

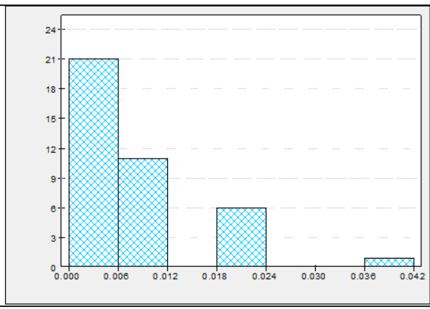


Fig. 24 – Distribuição do número de fixações na área CC

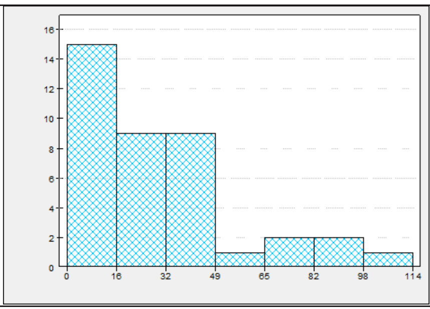


Fig. 25 – Distribuição do tempo de fixação na área D

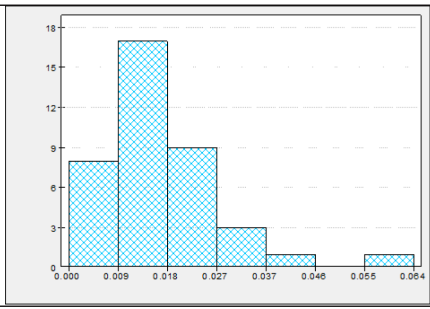


Fig. 26 – Distribuição do número de fixações na área D

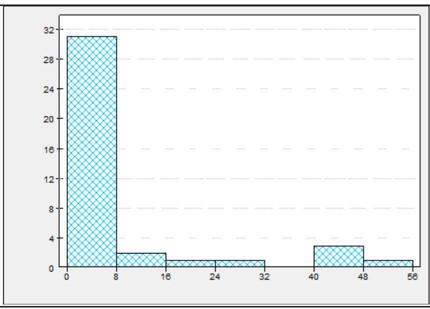


Fig. 27 – Distribuição do tempo de fixação na área DD

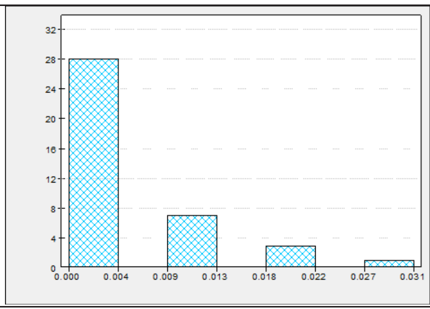


Fig. 28 – Distribuição do número de fixações na área DD

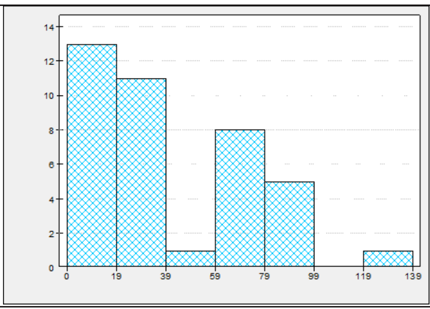


Fig. 29 – Distribuição do tempo de fixação na área E

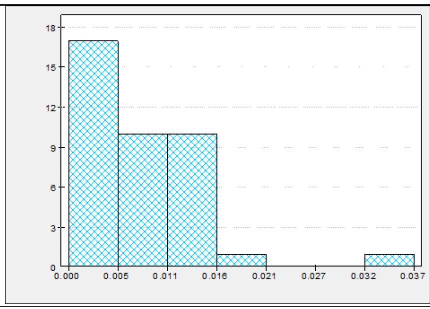


Fig. 30 – Distribuição do número de fixações na área E

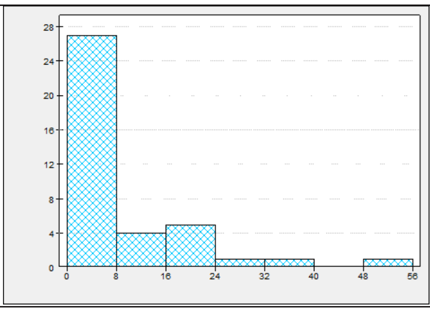


Fig. 31 – Distribuição do tempo de fixação na área X

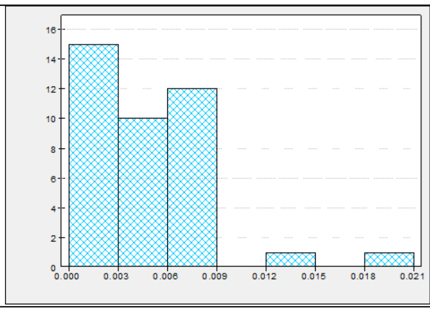


Fig. 32 – Distribuição do número de fixações na área X

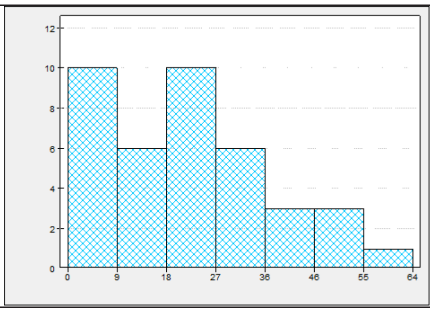


Fig. 33 – Distribuição do tempo de fixação na área Y

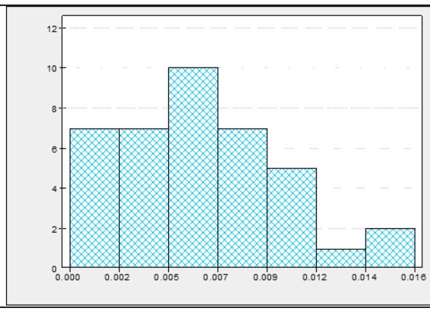


Fig. 34 – Distribuição do número de fixações na área Y

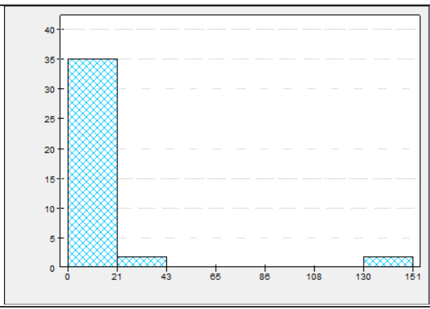


Fig. 35 – Distribuição do tempo de fixação na área Z

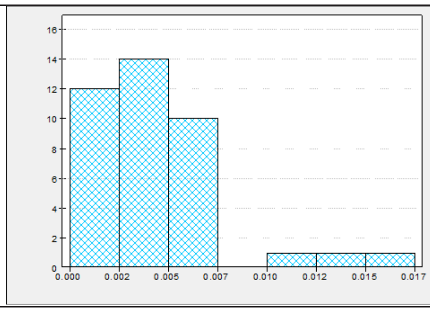


Fig. 36 – Distribuição do número de fixações na área Z

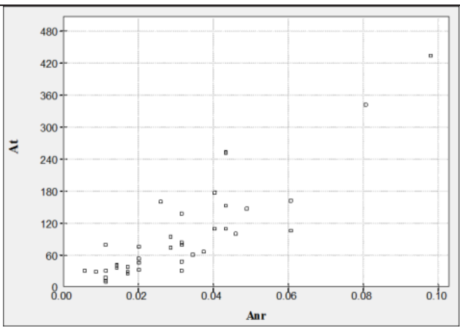
No que diz respeito ao tempo de fixação, nas áreas A, AA, BB, CC, D, DD, X e Y grande parte dos indivíduos fixa o olhar pouco tempo em cada área, havendo poucos indivíduos que dedicam tempos elevados à fixação do olhar em cada área. Nas áreas B, C, E e Y os indivíduos distribuem o tempo de fixação do olhar em cada área de forma mais equitativa.

A variável NF apresenta comportamentos mais diferenciados do que a variável Time. Nas áreas A, CC, DD, E, X e Z grande parte dos indivíduos apresenta baixo número de fixações por unidade de área, havendo poucos indivíduos com maior número de fixações por unidade de área. Por outro lado, nas áreas AA, B, C e Y os indivíduos distribuem-se de modo mais equitativo por todas as classes do número de fixações em cada área. As áreas BB e D mostram maiores concentrações de indivíduos nos valores intermédios do número de fixações e menos indivíduos nos valores extremos da variável.

Em termos conclusivos pode dizer-se que as áreas A e B são as mais atrativas para os indivíduos, quer em número de fixações, quer em tempo de fixação. Porém, enquanto na área A há muitos indivíduos com baixo número de fixações e baixos tempos de fixação e poucos indivíduos com elevados valores em ambas as variáveis; na área B os indivíduos distribuem-se de forma mais equitativa pelas diferentes classes em ambas as variáveis. No outro extremo, as áreas CC, DD, X e Z são as menos atrativas para os visitantes em ambas as variáveis, distribuindo-se de forma similar à da área A, também em ambas as variáveis. As áreas E e Y embora sejam pouco atrativas para os indivíduos (embora na área E a distribuição seja similar à área A e na área Y essa distribuição seja similar à área B), quando são fixadas, por vezes, os indivíduos dedicam-lhes algum tempo de observação, distribuídos de forma equitativa. As áreas AA, BB, C e D apresentam valores intermédios do número e da duração das fixações por unidade de área. Nestas últimas áreas, os valores de ambas as variáveis distribuem-se de diferentes formas.

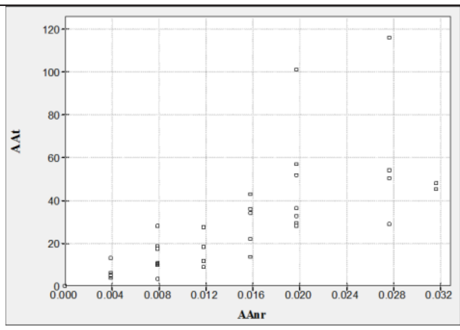
3.2. Análise Bivariada

A análise bivariada efetuada teve por base os diagramas de dispersão das duas variáveis e o cálculo do coeficiente de correlação de Pearson (*vd*. figuras 37 a 48).



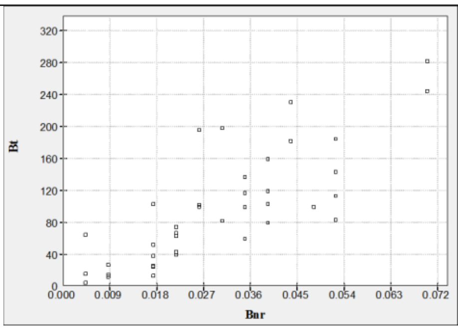
r = 0.86

Fig. 37 – Diagrama de dispersão – área A



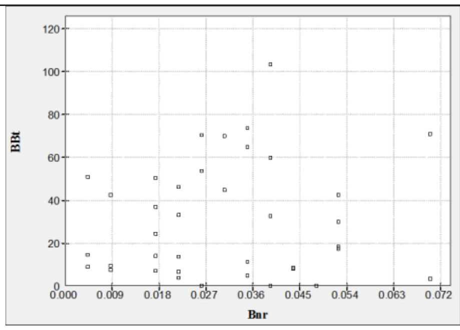
r = 0.8

Fig. 38 – Diagrama de dispersão – área AA



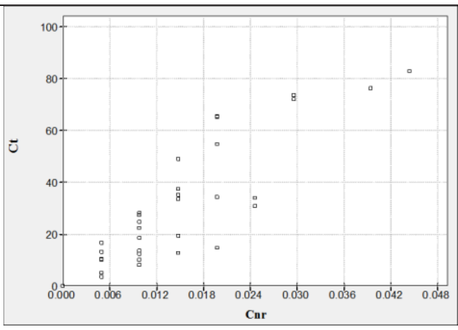
r = 0.79

Fig. 39 – Diagrama de dispersão – área B



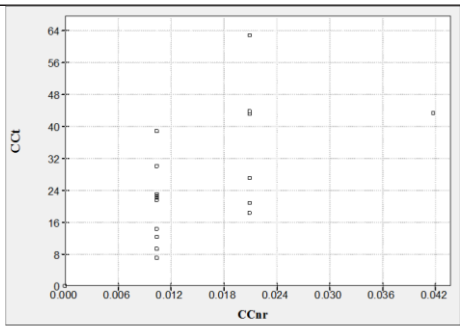
r = 0.60

Fig. 40 – Diagrama de dispersão – área BB



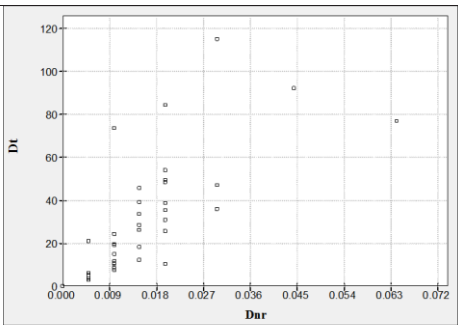
r = 0.88

Fig. 41 – Diagrama de dispersão – área C



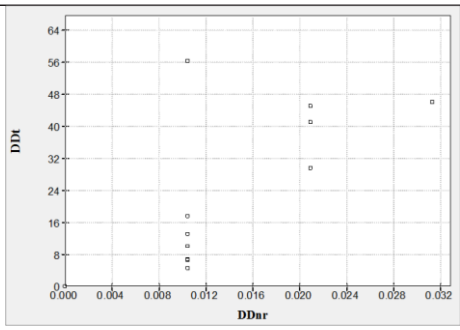
r = 0.85

Fig. 42 – Diagrama de dispersão – área CC



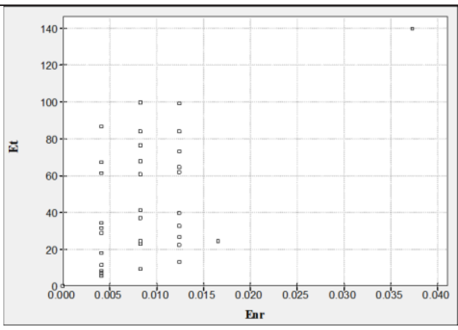
r = 0.72

Fig. 43 – Diagrama de dispersão – área D



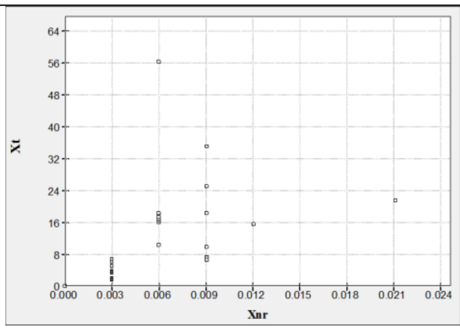
r = 0.86

Fig. 44 – Diagrama de dispersão – área DD



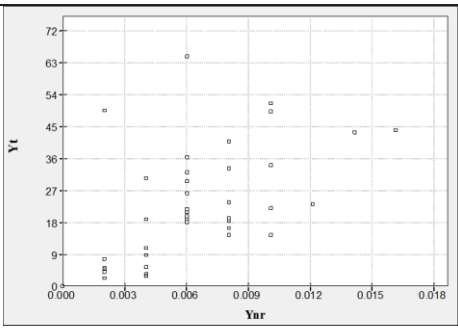
r = 0.61

Fig. 45 – Diagrama de dispersão – área E



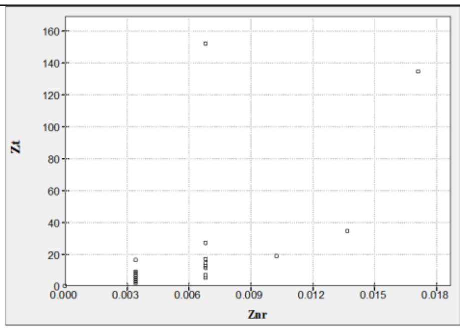
r = 0.62

Fig. 46 – Diagrama de dispersão – área X



r = 0.55

Fig. 47 – Diagrama de dispersão – área Y

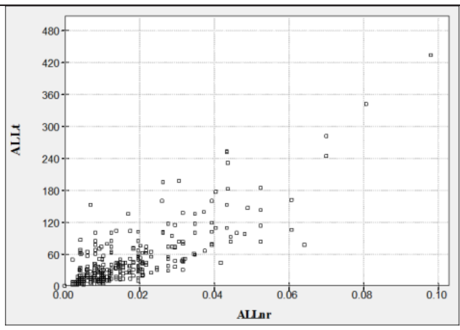


r = 0.62

Fig. 48 – Diagrama de dispersão – área Z

As áreas A, B e C revelam a existência de forte correlação direta entre as variáveis Time e NF, ou seja à medida que o número de fixações aumenta o tempo de observação também aumenta. Por outro lado, nas restantes áreas AA, BB, CC, D, DD, E, X, Y e Z a correlação entre as variáveis Time e NF é fraca, denotando a inexistência de um comportamento padronizado dos indivíduos.

Observa-se ainda uma forte correlação direta entre as duas variáveis estudadas quando se consideram todas as áreas em conjunto (*vd*. Figura 49). Tal facto deve-se provavelmente ao peso relativo das áreas A, e B.



r = 0.83

Fig. 49 – Diagrama de dispersão – todas as áreas

3.3. Análise Multivariada

Os dados deste grupo de indivíduos foi submetido a um algoritmo de Análise em Componentes Principais, tendo-se considerado ambas as variáveis das áreas A, B, C, D, E, X, Y e Z como ativas (16 colunas ativas) e as restantes como suplementares (8 colunas). As figuras 50 e 51 mostram a inércia do conjunto de dados em cada eixo fatorial.

	Valor Prop	% Exp	% Acum
1	3.628846	22.68029	22.68029
2	2.824486	17.65304	40.333328
3	2.2531	14.08188	54.415199
4	1.355243	8.47027	62.885479
5	1.344403	8.402517	71.287987
6	1.175533	7.347083	78.635078
7	1.052042	6.57526	85.210342
8	0.554541	3.465878	88.676224
9	0.499351	3.120943	91.797157
10	0.327441	2.046506	93.843674

Fig. 50 – Valores próprios e inércia dos eixos fatoriais

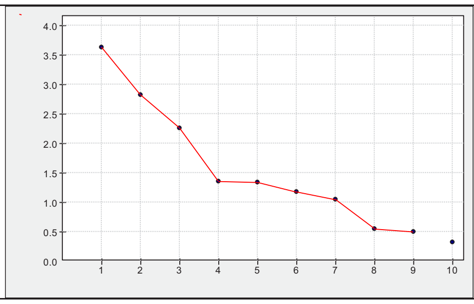


Fig. 51 – Screeplot

Os quatro primeiros eixos fatoriais explicam mais de 60% da inércia total da nuvem de dados. Constata-se que o número de fixações e a duração dessas mesmas fixações estão associadas em cada uma das áreas da Igreja. No primeiro plano factorial (eixos 1 e 2 com cerca de 40% da inércia total), o eixo 1 explica a importância das áreas A, B e C, em termos de tempo de fixação e de número de fixações e o segundo eixo traduz uma oposição entre a área C e as áreas A e B (*vd*. figura 52). Este segundo eixo, por outro lado, destaca a área D. As áreas E, X, Y e Z não são explicadas neste plano factorial (*vd*. figura 52). As variáveis suplementares projectam-se no centro do plano factorial, não evidenciando nenhuma associação com as outras variáveis (*vd*. figura 53).

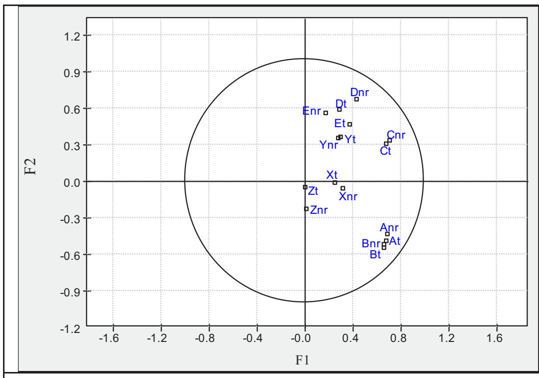


Fig. 52 – Projeção das variáveis ativas no 1º plano fatorial

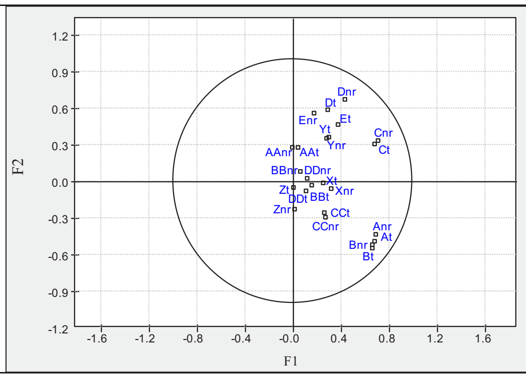


Fig. 53 – Projeção das variáveis ativas e suplementares no 1º plano fatorial

Na figura 54 pode ver-se que a grande maioria dos indivíduos deste grupo não têm nenhuma associação às áreas da Igreja, havendo apenas alguns casos pontuais como sejam os indivíduos a18 e a47 associados às áreas A e B e os indivíduos a35, a51, a49 e a53 associados à área C. O indivíduo a52 divide a sua preferência pelas áreas A, B e C (*vd*. figura 54).

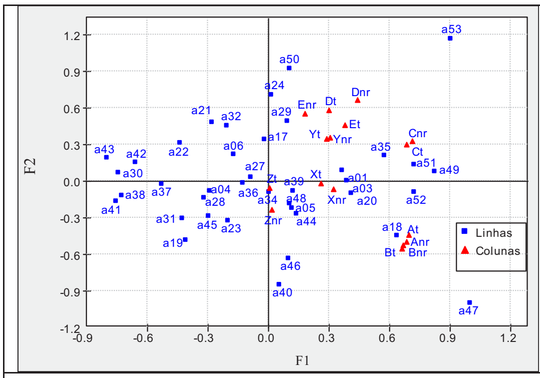


Fig. 54 – Projeção das variáveis ativas e indivíduos no 1º plano fatorial

O terceiro eixo fatorial evidencia uma associação entre as áreas X e Z em ambas as variáveis (*vd*. figura 55). As áreas da Igreja submetidas em suplementar projectam-se também no centro deste plano factorial, não estando associadas a nenhuma das outras áreas da Igreja (*vd*. figura 56).

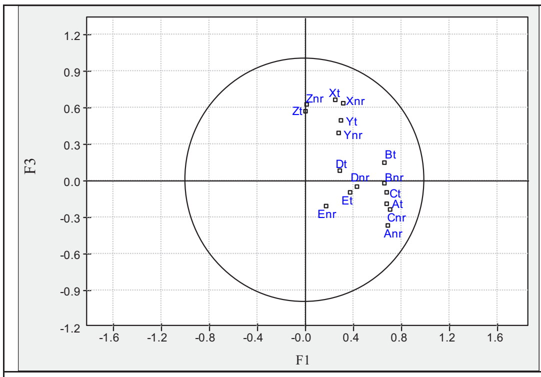


Fig. 55 – Projeção das variáveis ativas no 2º plano fatorial

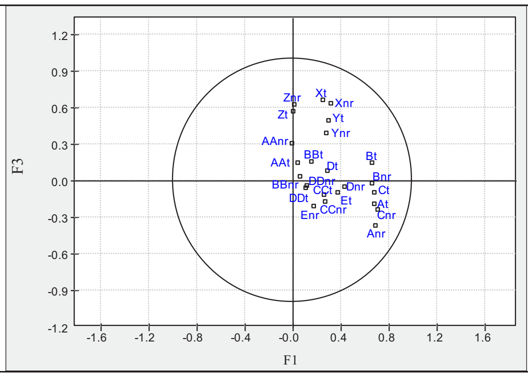


Fig. 56 – Projeção das variáveis ativas e suplementares no 2º plano fatorial

Na figura 56 pode observar-se a associação dos indivíduos a01 e a35 à área X e do indivíduo a06 à área Z. Os indivíduos a05 e a46 partilham a associação por estas duas áreas (*vd*. figura 57).

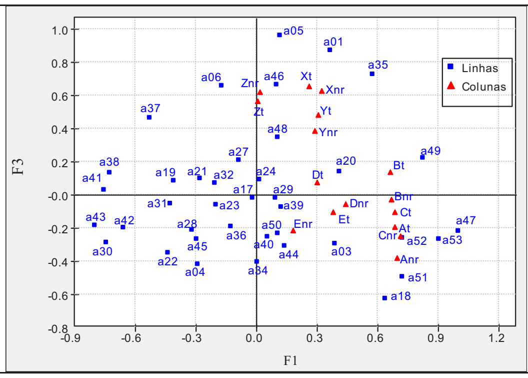


Fig. 57 – Projeção das variáveis ativas e indivíduos no 2º plano fatorial

O quarto eixo fatorial destaca a área E das restantes (*vd*. figura 58). As áreas da Igreja submetidas em suplementar projectam-se também no centro deste plano factorial, não estando associadas a nenhuma das outras áreas da Igreja (*vd*. figura 59).

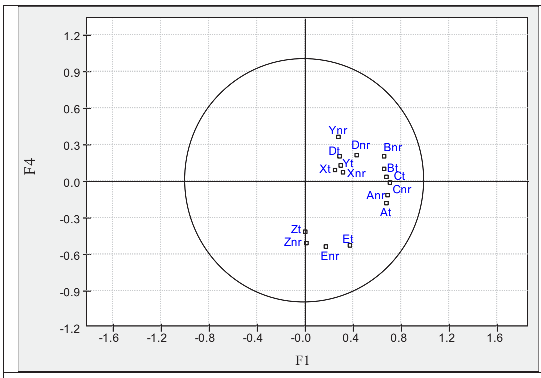


Fig. 58 – Projeção das variáveis ativas no 3º plano fatorial

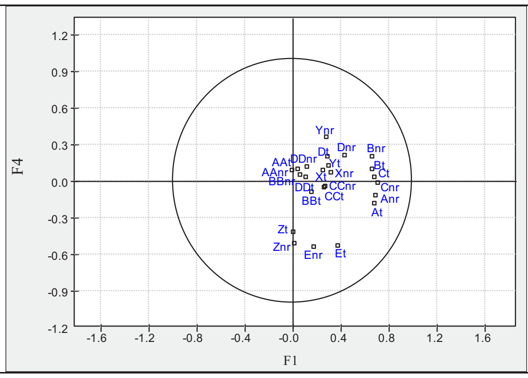


Fig. 59 – Projeção das variáveis ativas e suplementares no 3º plano fatorial

Na figura 60 pode observar-se a associação dos indivíduos a05, a18, a44 e a50 à área E da Igreja.

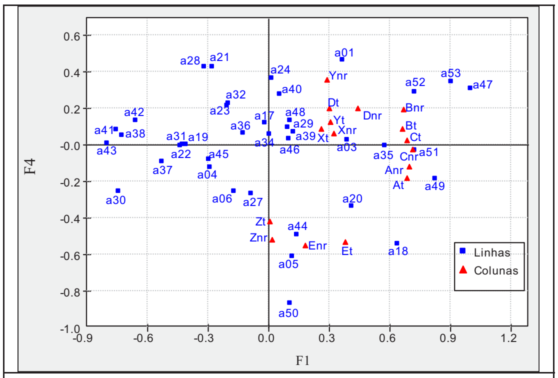


Fig. 60 – Projeção das variáveis ativas e indivíduos no 3º plano fatorial

Na figura 61 apresenta-se uma síntese das principais conclusões deste grupo de indivíduos.

Grupos	Áreas	Indivíduos
I	A, B	a18, a47, a52
II	C	a35, a51, a49, a53, a52
III	X, Z	a01, a35, a06, a05, a46
IV	E	a05, a18, a44, a50

Fig. 61 – Síntese da análise fatorial

4. Alunos do 5º ano do MiARQ e AGMiARQ

4.1. Análise Univariada

Em tudo o que diz respeito a este grupo de indivíduos, é importante sublinhar que se trata de um grupo reduzido de elementos (apenas 11 indivíduos), tornando quaisquer considerações pouco representativas.

De qualquer modo, as figuras 62 e 63 mostram inequivocamente que as áreas A e B são as preferidas pelos visitantes deste grupo de indivíduos, quer em tempo de observação que lhes dedicam (entre 1500 e 2400 ms/m^2 – *vd*. figura 62), quer em número de vezes que as observam (entre 0.57 e 0.69 fixações/m^2 – *vd*. figura 63).

Em termos do tempo de fixação das áreas, seguem-se as áreas D, BB, E, C e Y (entre 450 e 750 ms/m^2 – *vd*. figura 62). Este grupo de indivíduos dedica menos tempo à observação das áreas CC, AA, DD, X e Z (menos de 250 ms/m^2 – *vd*. figura 62).

No que diz respeito ao número de fixações das áreas, às anteriormente mencionadas seguem-se as áreas D, C, BB e CC (entre 0.17 e 0.27 fixações/m^2 – *vd*. figura 63). As áreas menos fixadas por este grupo de indivíduos são: AA, DD, Y, E, Z e X (com menos de 0.12 fixações/m^2 – *vd*. figura 63).

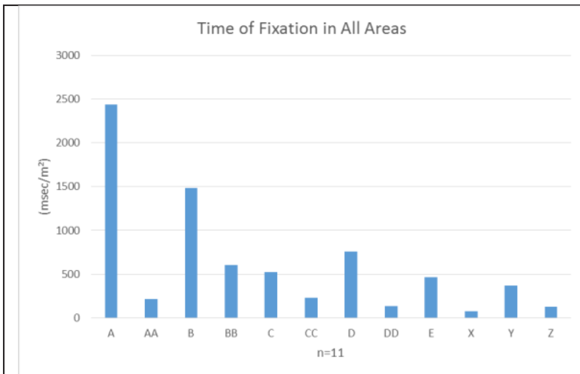


Fig. 62 – Tempo de fixação das áreas da Igreja

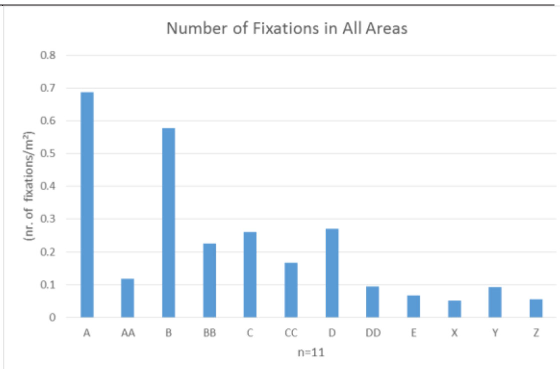


Fig. 63 – Número de fixações das áreas da Igreja

Na figura 64 apresentam-se os estatísticos básicos calculados para ambas as variáveis em cada uma das 12 áreas da Igreja.

		Identificador	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Padrão	Coef. Variação	Amplitude	Int. Interquartil	Coef. Assimetria	S'
Area A	Fixation time/m²	At	11	221.43	N/A	223.4672	31.5631	142.6986	265.9838	480.2254	13993.671	118.2948	0.5342	448.6622	123.2852	0.6822	-0.017
	Nr. Fixations/m²	Anr	11	0.0625	N/A	0.0636	0.026	0.0491	0.078	0.0838	0.0003	0.0176	0.2813	0.0578	0.0289	-0.82	-0.036
Area AA	Fixation time/m²	AAt	11	23.722	N/A	5.833	0	3.8504	30.9379	73.5061	517.7689	22.7545	0.9592	73.5061	27.0875	0.7569	0.6604
	Nr. Fixations/m²	AAnr	11	0.0132	N/A	0.004	0	0.004	0.0237	0.0277	0.0001	0.0105	0.7937	0.0277	0.0198	-0.0489	0.4667
Area B	Fixation time/m²	Bt	11	134.8	N/A	141.6506	55.9107	100.9764	163.5595	208.7697	1838.2618	42.875	0.3181	152.859	62.5832	-0.2662	-0.11
	Nr. Fixations/m²	Bnr	11	0.0525	N/A	0.0525	0.0263	0.0438	0.0657	0.0788	0.0002	0.0148	0.2814	0.0525	0.0219	-0.0572	0
Area BB	Fixation time/m²	BBt	11	54.767	N/A	50.6002	9.2798	26.9344	71.2927	112.2669	1128.4891	33.593	0.6134	102.9871	44.3583	0.7063	0.0939
	Nr. Fixations/m²	BBnr	11	0.0206	N/A	0.0231	0.0046	0.0092	0.0323	0.0416	0.0001	0.0116	0.5622	0.0369	0.0231	0.3923	-0.109
Area C	Fixation time/m²	Ct	11	47.564	N/A	30.5528	11.4709	23.5982	57.6209	134.3978	1206.5311	34.7352	0.7303	122.9269	34.0227	1.7056	0.5
	Nr. Fixations/m²	Cnr	11	0.0238	N/A	0.0247	0.0049	0.0099	0.0346	0.0444	0.0002	0.0123	0.5153	0.0395	0.0247	-0.0345	-0.036
Area CC	Fixation time/m²	CCt	11	23.166	N/A	12.3458	0	4.5578	38.1455	71.9841	493.3292	22.211	0.9588	71.9841	33.5877	1.1003	0.3222
	Nr. Fixations/m²	CCnr	11	0.0167	N/A	0.0105	0	0.0105	0.0209	0.0418	0.0001	0.0112	0.6719	0.0418	0.0105	1.0847	0.6
Area D	Fixation time/m²	Dt	11	69.179	N/A	60.7256	7.5962	18.2922	125.696	154.4324	2681.6987	51.7851	0.7486	146.8361	107.4037	0.4885	0.0787
	Nr. Fixations/m²	Dnr	11	0.0247	N/A	0.0197	0.0099	0.0148	0.0395	0.0494	0.0002	0.0141	0.5727	0.0395	0.0247	0.7183	0.2
Area DD	Fixation time/m²	DDt	11	27.552	N/A	0	0	0	24.9216	39.3895	66.9384	8.1816	0.297	39.3895	24.9216	-27.7748	1.1055
	Nr. Fixations/m²	DDnr	11	0.0188	N/A	0	0	0	0.0209	0.0209	0	0.0047	0.2485	0.0209	0.0209	-48.472	0.9
Area E	Fixation time/m²	Et	11	41.908	N/A	40.2159	1.8306	15.4628	70.7846	84.3047	770.4315	27.7566	0.6623	82.4741	55.3217	0.2131	0.0306
	Nr. Fixations/m²	Enr	11	0.006	N/A	0.0042	0.0042	0.0042	0.0083	0.0125	0	0.0029	0.4727	0.0083	0.0042	1.3239	0.4545
Area X	Fixation time/m²	Xt	11	12.407	N/A	4.088	0	0	14.278	19.9819	44.8987	6.7007	0.5401	19.9819	14.278	-3.8917	0.5826
	Nr. Fixations/m²	Xnr	11	0.0085	N/A	0.003	0	0	0.009	0.0151	0	0.0044	0.5195	0.0151	0.009	-4.1881	0.6111
Area Y	Fixation time/m²	Yt	11	33.454	N/A	38.8453	2.8817	9.274	53.088	69.911	543.2855	23.3085	0.6967	67.0293	43.814	0.1313	-0.123
	Nr. Fixations/m²	Ynr	11	0.0085	N/A	0.0101	0.002	0.004	0.0101	0.0182	0	0.0044	0.5219	0.0162	0.0061	0.7047	-0.273
Area Z	Fixation time/m²	Zt	11	17.709	N/A	4.3175	0	0	7.7078	85.5696	908.5105	30.1415	1.702	85.5696	7.7078	1.2463	1.7374
	Nr. Fixations/m²	Znr	11	0.0078	N/A	0.0034	0	0	0.0068	0.0239	0.0001	0.0076	0.9689	0.0239	0.0068	0.5496	0.6429

Fig. 64 – Estatísticos básicos de cada área da Igreja

No caso da variável Time, verifica-se que algumas áreas apresentam os principais estatísticos básicos da mesma ordem de grandeza, nomeadamente os casos das áreas BB, C, D, E e Y (*vd*. figura 65); as áreas AA e CC (*vd*. figura 66); as áreas X e Z (*vd*. figura 67). As restantes áreas (A, B, e DD) têm estatísticos básicos diferentes entre si e diferentes dos casos anteriormente mencionados (*vd*. figura 68). Para o caso da variável NF as áreas que revelam estatísticos básicos da mesma ordem de grandeza são as seguintes: áreas A e B (*vd*. figura 69); áreas BB, C, CC e D (*vd*. figura 70); áreas E, X, Y e Z (*vd*. figura 71) e as áreas AA e DD (*vd*. figura 72).

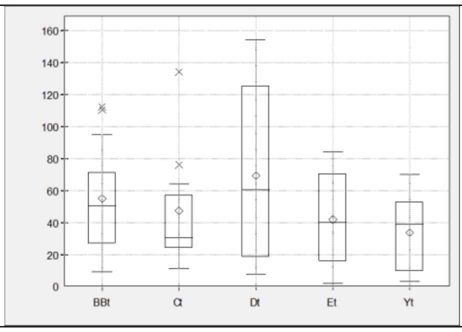


Fig. 65 – Box-Plots do tempo de fixação das áreas BB, C, D, E e Y

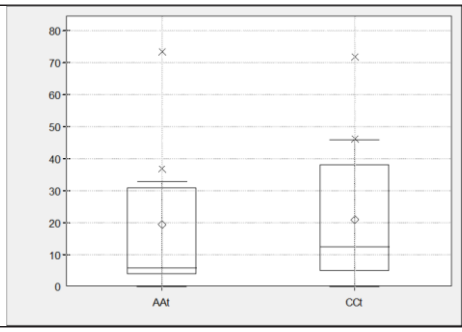


Fig. 66 – Box-Plots do tempo de fixação das áreas AA e CC

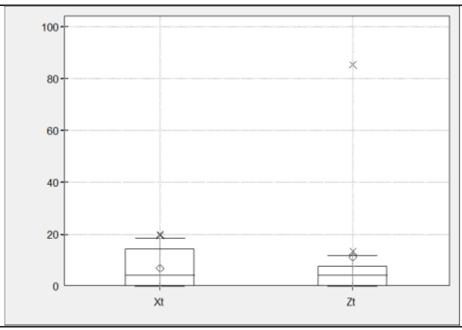


Fig. 67 – Box-Plots do tempo de fixação das áreas X e Z

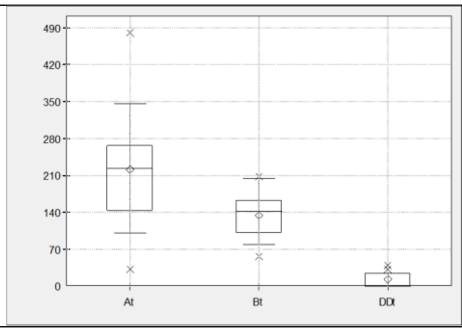


Fig. 68 – Box-Plots do tempo de fixação da área A, B e DD

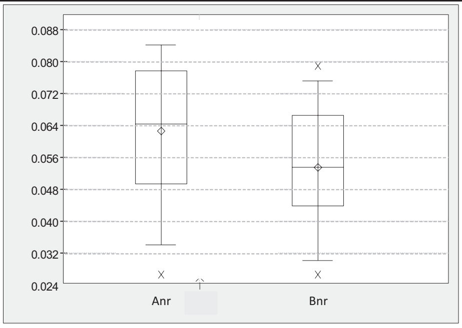


Fig. 69 – Box-Plots do numero de fixações das áreas A e B

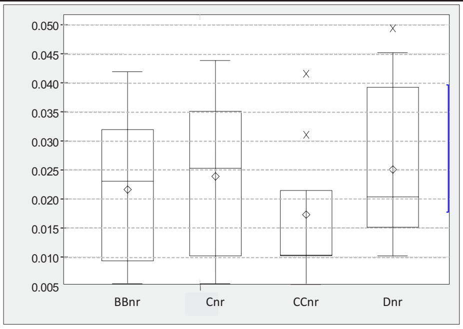


Fig. 70 – Box-Plots do número de fixações das áreas BB, C, CC e D

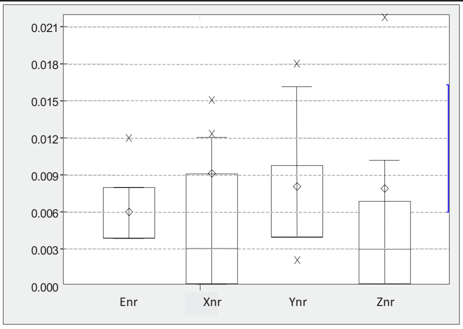


Fig. 71 – Box-Plots do numero de fixações das áreas E, X, Y e Z

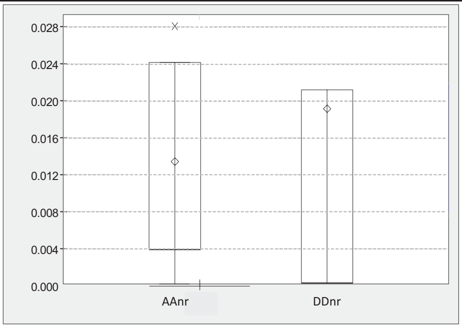


Fig. 72 – Box-Plots do número de fixações das áreas AA e DD

Nota-se também que, em todas as áreas, a dispersão da variável Time é bastante superior à dispersão da variável NF, pelo que esta última variável revela maior homogeneidade do que a primeira. Em quase todas as áreas, as variáveis apresentam pouca assimetria, exceto no caso da área DD que revela assimetria negativa acentuada em ambas as variáveis. É também evidente que para este grupo de indivíduos se registam poucos valores anómalas em ambas as variáveis, uma vez que se trata de um reduzido grupo de indivíduos.

A distribuição dos valores de cada uma das variáveis, para cada uma das áreas de observação da Igreja é apresentada nas figuras 73 a 96.

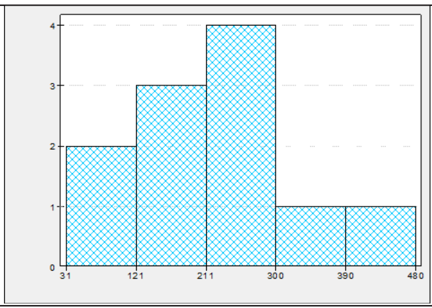


Fig. 73 – Distribuição do tempo de fixação na área A

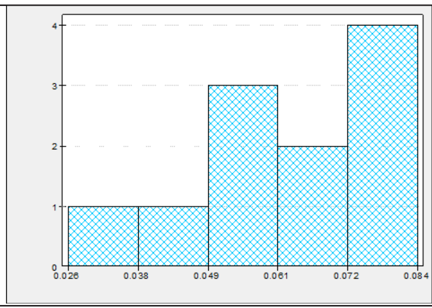


Fig. 74 – Distribuição do número de fixações na área A

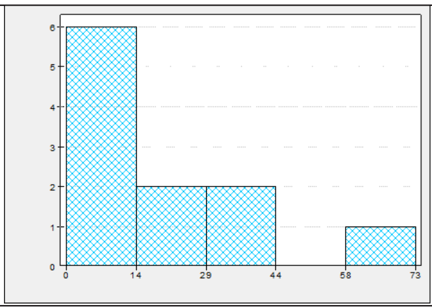


Fig. 75 – Distribuição do tempo de fixação na área AA

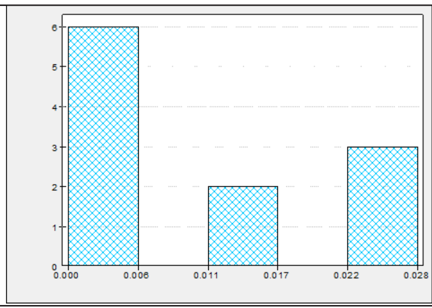


Fig. 76 – Distribuição do número de fixações na área AA

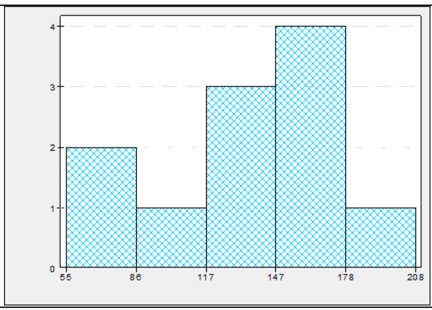


Fig. 77 – Distribuição do tempo de fixação na área B

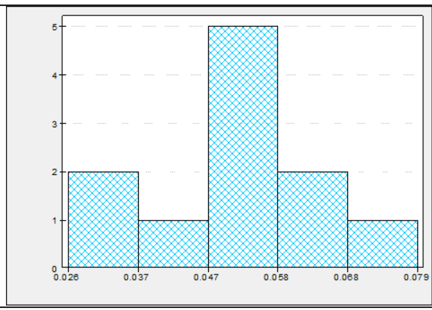


Fig. 78 – Distribuição do número de fixações na área B

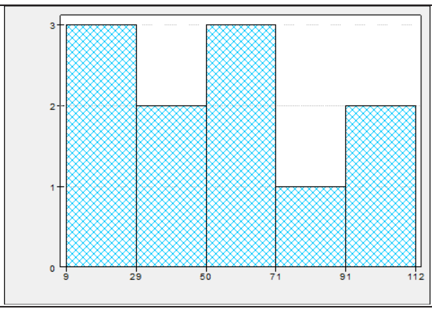


Fig. 79 – Distribuição do tempo de fixação na área BB

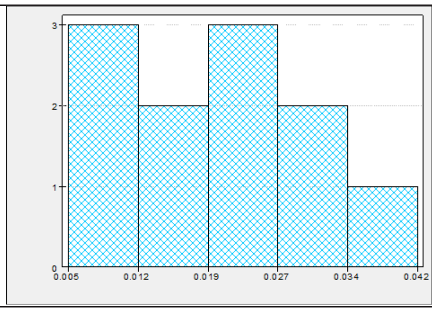


Fig. 80 – Distribuição do número de fixações na área BB

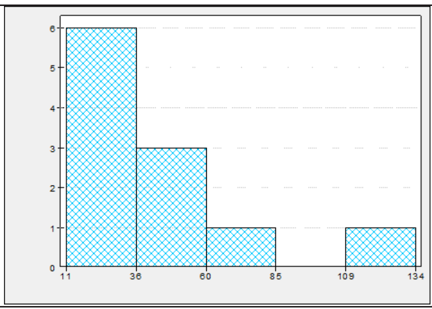


Fig. 81 – Distribuição do tempo de fixação na área C

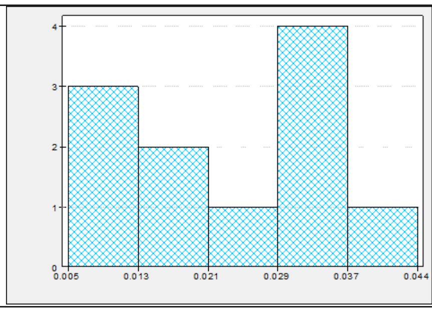


Fig. 82 – Distribuição do número de fixações na área C

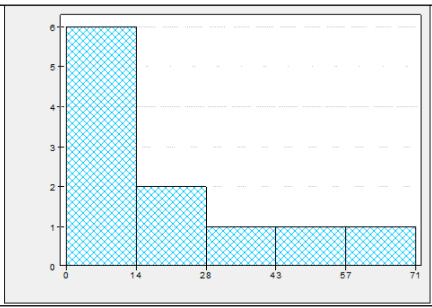


Fig. 83 – Distribuição do tempo de fixação na área CC

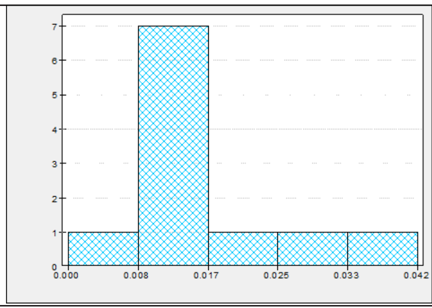


Fig. 84 – Distribuição do número de fixações na área CC

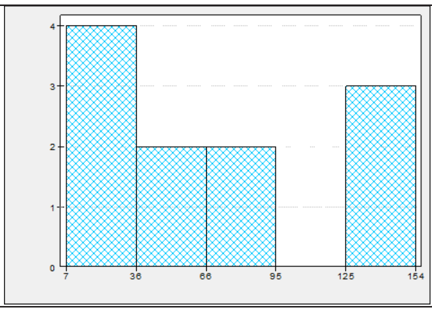


Fig. 85 – Distribuição do tempo de fixação na área D

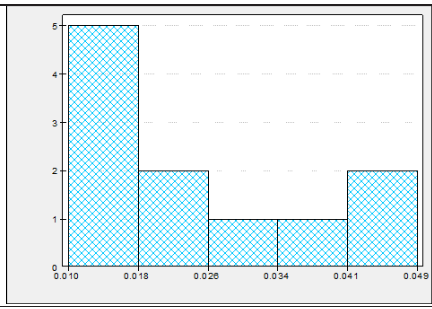


Fig. 86 – Distribuição do número de fixações na área D

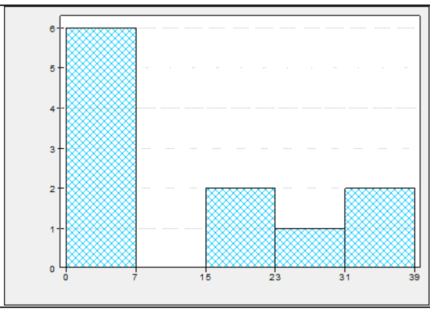


Fig. 87 – Distribuição do tempo de fixação na área DD

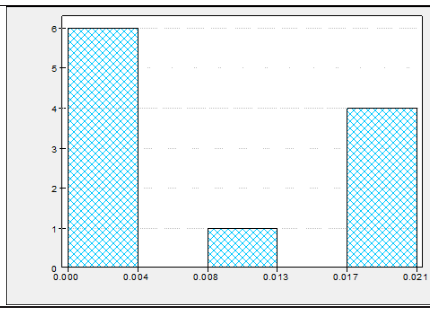


Fig. 88 – Distribuição do número de fixações na área DD

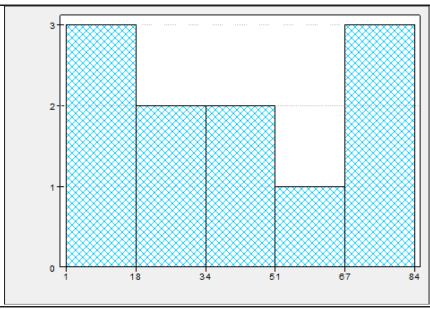


Fig. 89 – Distribuição do tempo de fixação na área E

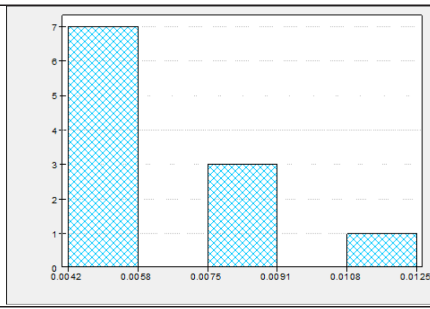


Fig. 90 – Distribuição do número de fixações na área E

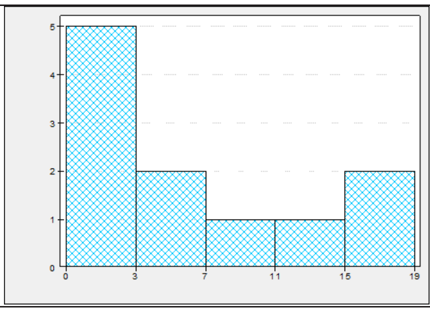


Fig. 91 – Distribuição do tempo de fixação na área X

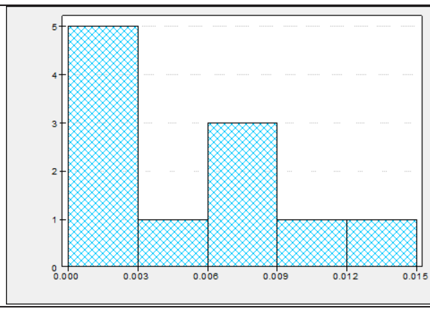


Fig. 92 – Distribuição do número de fixações na área X

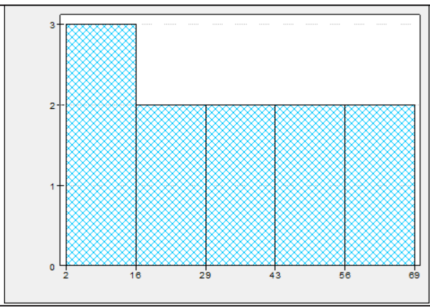


Fig. 93 – Distribuição do tempo de fixação na área Y

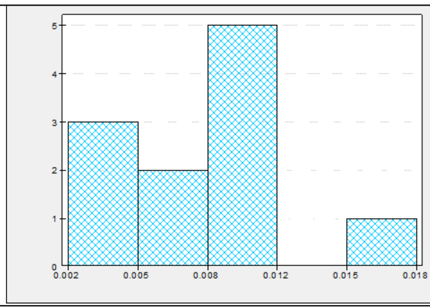


Fig. 94 – Distribuição do número de fixações na área Y

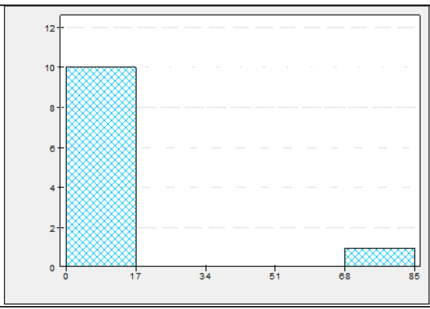


Fig. 95 – Distribuição do tempo de fixação na área Z

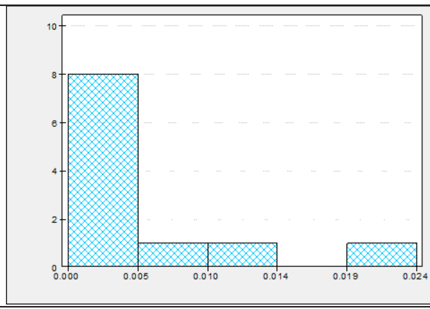


Fig. 96 – Distribuição do número de fixações na área Z

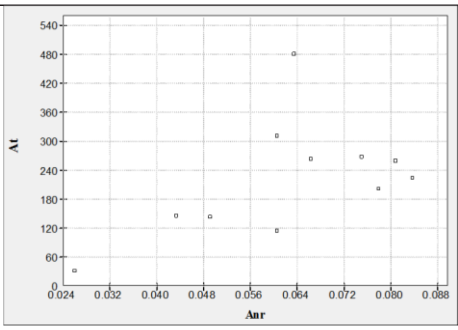
No que diz respeito ao tempo de fixação, nas áreas AA, C, CC, DD, X e Z grande parte dos indivíduos fixa o olhar pouco tempo, havendo poucos indivíduos que fixam o olhar por tempo elevado. Nas áreas BB, D, E e Y os indivíduos distribuem o tempo de fixação do olhar por unidade de área de forma mais equitativa. Nas áreas A e B o tempo de fixação do olhar por unidade de área distribui-se de modo aproximadamente simétrico.

A variável NF apresenta maior diferenciação de comportamento do que a variável Time. Nas áreas E, X e Z grande parte dos indivíduos apresenta reduzido número de fixações, havendo poucos indivíduos com elevado número de fixações. Por outro lado, nas áreas C, CC e BB os indivíduos distribuem-se de modo mais equitativo por todas as classes do número de fixações. As áreas A, B e Y mostram maiores concentrações de indivíduos nos valores intermédios do número de fixações e menos indivíduos nos valores extremos da variável, embora na área A haja uma assimetria negativa mais acentuada. As áreas AA, D e DD, por outro lado, apresentam poucos indivíduos com número intermédio de fixações e bastantes indivíduos nos valores extremos.

Em termos conclusivos pode dizer-se que as áreas A e B são as mais atrativas para estes indivíduos, quer em número de fixações por unidade de área, quer em tempo de fixação por unidade de área. Dada a pequena representatividade deste grupo de indivíduos, considera-se pouco oportuno reforçar algumas das considerações feitas anteriormente.

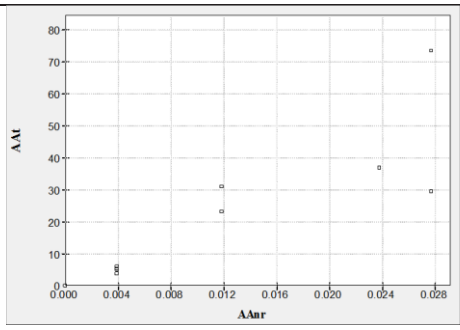
4.2. Análise Bivariada

A análise bivariada efetuada teve por base os diagramas de dispersão das duas variáveis e o cálculo do coeficiente de correlação de Pearson (*vd*. figuras 97 a 108).



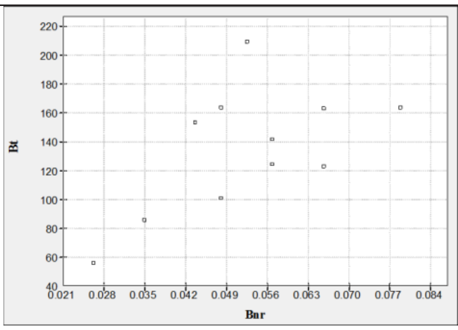
***r* = 0.52**

Fig. 97 – Diagrama de dispersão – área A



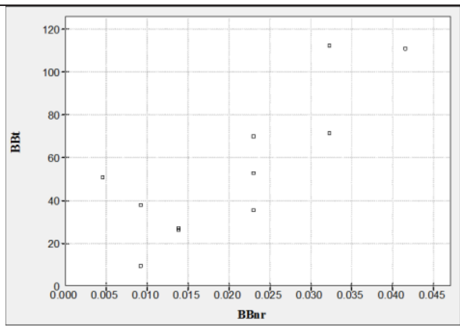
***r* = 0.88**

Fig. 98 – Diagrama de dispersão – área AA



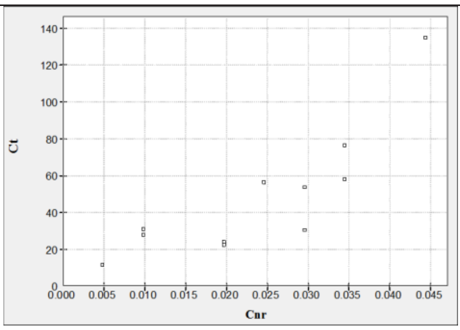
***r* = 0.59**

Fig. 99 – Diagrama de dispersão – área B



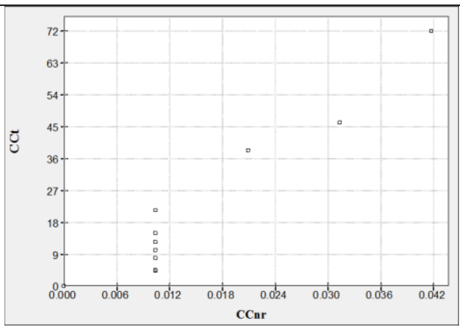
***r* = 0.82**

Fig. 100 – Diagrama de dispersão – área BB



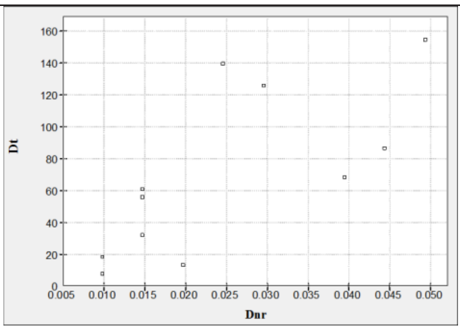
***r* = 0.83**

Fig. 101 – Diagrama de dispersão – área C



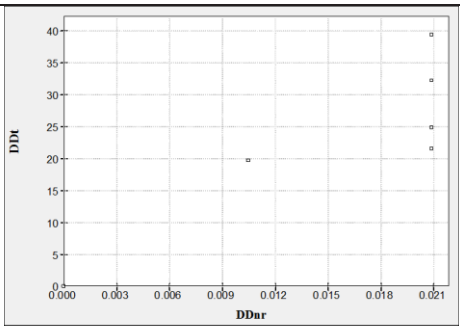
***r* = 0.96**

Fig. 102 – Diagrama de dispersão – área CC



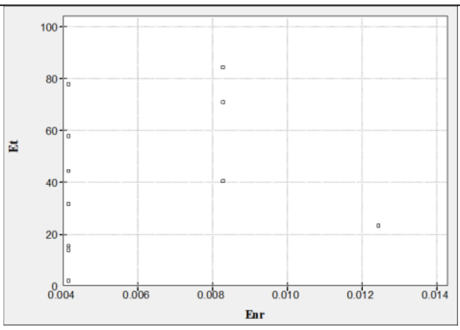
***r* = 0.71**

Fig. 103 – Diagrama de dispersão – área D



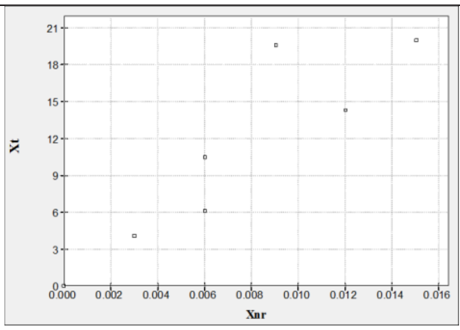
***r* = 0.95**

Fig. 104 – Diagrama de dispersão – área DD



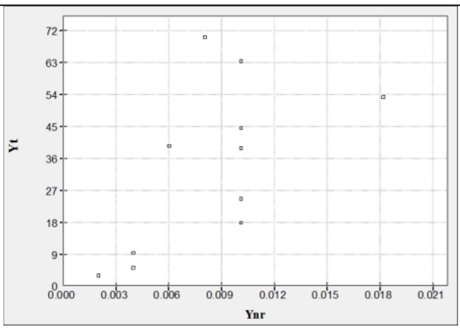
***r* = 0.17**

Fig. 105 – Diagrama de dispersão – área E



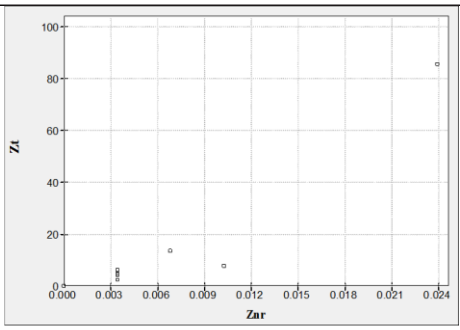
***r* = 0.95**

Fig. 106 – Diagrama de dispersão – área X



***r* = 0.61**

Fig. 107 – Diagrama de dispersão – área Y

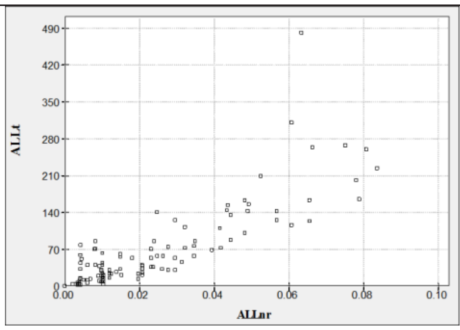


***r* = 0.94**

Fig. 108 – Diagrama de dispersão – área Z

As áreas C e X revelam a existência de correlação direta entre as variáveis Time e NF, ou seja à medida que o número de fixações aumenta o tempo de observação também aumenta. Por outro lado, nas restantes áreas A, AA, B, BB, CC, D, DD, E, Y e Z não há correlação entre as variáveis Time e NF, provavelmente devido ao reduzido número de indivíduos que constitui este grupo.

Observa-se ainda a existência de correlação direta entre as duas variáveis estudadas quando se consideram todas as áreas em conjunto (*vd*. figura 109).



r = 0.85

Fig. 109 – Diagrama de dispersão – todas as áreas

4.3. Análise Multivariada

Os dados deste grupo de indivíduos foi submetido a um algoritmo de Análise em Componentes Principais, tendo-se considerado ambas as variáveis das áreas A, B, C, D, E, X, Y e Z como ativas (16 colunas ativas) e as restantes como suplementares (8 colunas). As figuras 110 e 111 mostram a inércia do conjunto de dados em cada eixo fatorial.

	Valor Pro	% Exp	% Acum
1	6.040381	37.75238	37.75238
2	2.978634	18.616461	56.368851
3	1.994987	12.46867	68.837509
4	1.820948	11.38093	80.218437
5	1.283523	8.022017	88.240463
6	0.9638	6.02375	94.264214
7	0.495881	3.099257	97.363457
8	0.290243	1.814016	99.177483
9	0.09789	0.61181	99.789291
10	0.033714	0.210712	100

Fig. 110 – Valores próprios e inércia dos eixos fatoriais

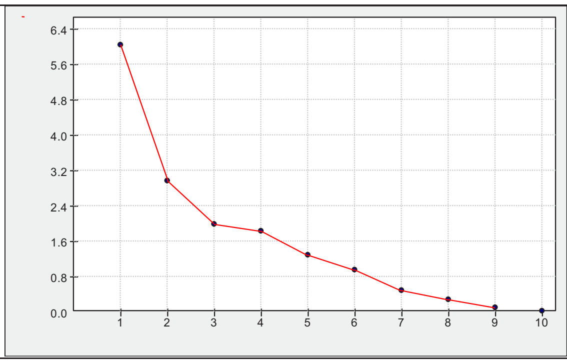


Fig. 111 – Screeplot

Os quatro primeiros eixos fatoriais explicam mais de 80% da inércia total da nuvem de dados. Embora com algumas exceções, observa-se a relativa associação entre o número de fixações e a duração dessas mesmas fixações em cada uma das áreas da Igreja. No primeiro plano factorial (eixos 1 e 2 com cerca de 56% da inércia total), o eixo 1 explica a importância das áreas B, D, X e Z, em termos de tempo de fixação e de número de fixações e o número de fixações na área Y. O segundo eixo traduz uma oposição entre a área Z e a área C e a duração das fixações na área E (*vd*. figura 112). As restantes áreas não são explicadas neste plano factorial (*vd*. figura 112). A área CC, projectada em suplementar, associa-se claramente à área C (*vd*. figura 113).

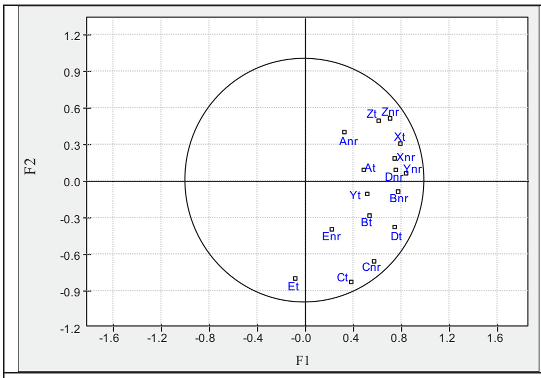


Fig. 112 – Projeção das variáveis ativas no 1º plano fatorial

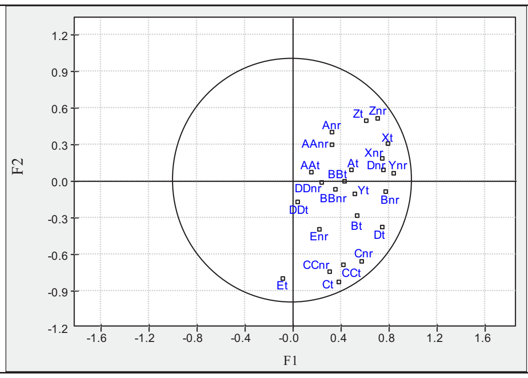


Fig. 113 – Projeção das variáveis ativas e suplementares no 1º plano fatorial

Na figura 114 pode ver-se que cerca de metade dos indivíduos deste grupo não está associado a nenhuma área da Igreja. O indivíduo a11 associa-se às áreas X e Z, o indivíduo a08 aparece associado ao número de fixações nas áreas D, Y e X e o indivíduo a26 à duração das fixações da área E (*vd*. figura 114).

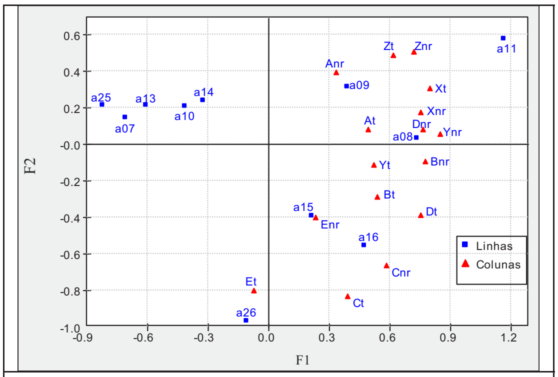


Fig. 114 – Projeção das variáveis ativas e indivíduos no 1º plano fatorial

O terceiro eixo fatorial evidencia uma associação entre a duração das fixações nas áreas A e Y, as quais se opõem ao número de fixações da área E (*vd*. figura 115). A área DD, projectada em suplementar associa-se ao número de fixações da área E (*vd*. figura 116).

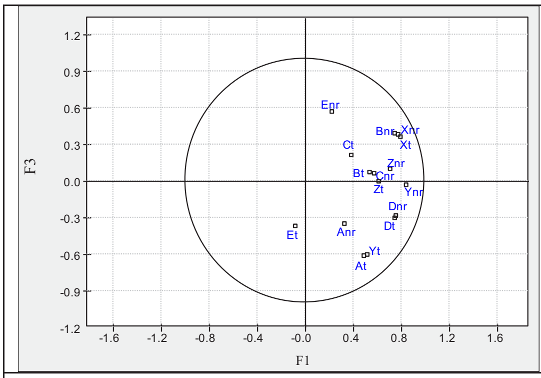


Fig. 115 – Projeção das variáveis ativas no 2º plano fatorial

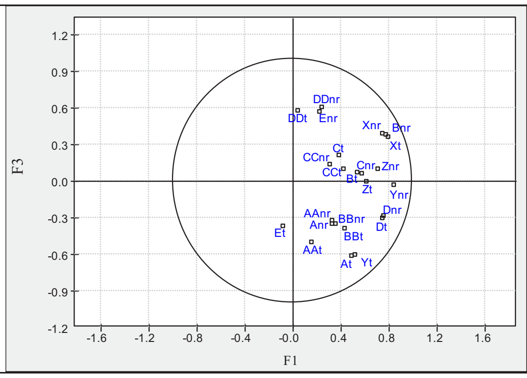


Fig. 116 – Projeção das variáveis ativas e suplementares no 2º plano fatorial

Na figura 117 pode observar-se que o indivíduo a08 surge associado à área X e ao número de fixações da área B, enquanto o indivíduo a11 se associa ao número de fixações da área Y (*vd*. figura 117).

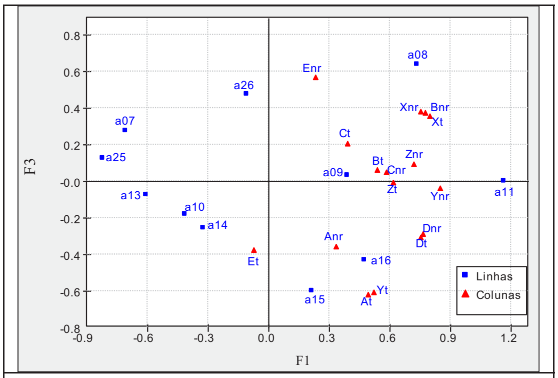


Fig. 117 – Projeção das variáveis ativas e indivíduos no 2º plano fatorial

O quarto eixo fatorial evidencia moderadamente o número de fixações da área A (*vd*. figura 118). As áreas da Igreja submetidas em suplementar projectam-se no centro deste plano factorial, não estando associadas a nenhuma das outras áreas da Igreja (*vd*. figura 119).

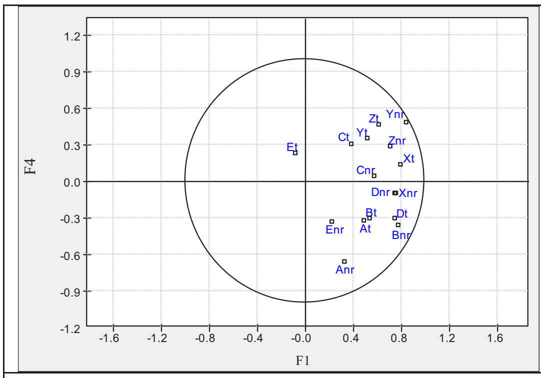


Fig. 118 – Projeção das variáveis ativas no 3º plano fatorial

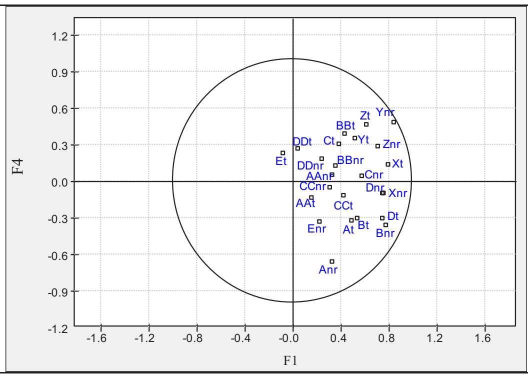


Fig. 119 – Projeção das variáveis ativas e suplementares no 3º plano fatorial

Na figura 120 pode observar-se que nenhum indivíduo se associa a nenhuma variável e ou área da Igreja.

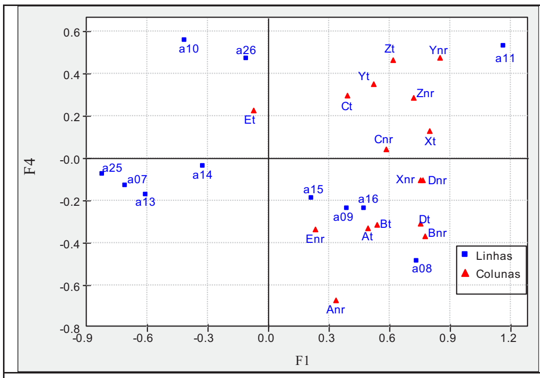


Fig. 120 – Projeção das variáveis ativas e indivíduos no 3º plano fatorial

Na figura 121 apresenta-se uma síntese das principais conclusões deste grupo de indivíduos.

Grupos	Áreas	Indivíduos
I	B, D, X, Z e Ynr	a11, a08
II	C, Et, CC	A26
III	At, Yt	
IV	Enr, DD	
V	Anr	

Fig. 121 – Síntese da análise fatorial

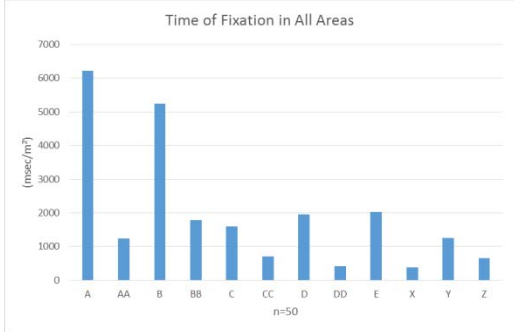
5. Total de indivíduos

5.1. Análise Univariada

As figuras 122 e 123 mostram inequivocamente que as áreas A e B são as preferidas pelos visitantes, quer em tempo de observação que lhes dedicam (entre 5100 e 6100 ms/m^2 – *vd*. figura 122), quer em número de vezes que as observam (entre 1.75 e 1.9 fixações/m^2 – *vd*. figura 123).

Em termos do tempo de fixação das áreas, seguem-se as áreas E, D, BB, C, AA e Y (entre 1200 e 2000 ms/m^2 – *vd*. figura 122). Os visitantes da igreja dedicam menos tempo à observação das áreas CC, Z, DD, e X (menos de 750 ms/m^2 – *vd*. figura 122).

No que diz respeito ao número de fixações das áreas, às anteriormente mencionadas seguem-se as áreas D, C, BB, e AA (entre 0.61 e 0.85 fixações/m^2 – *vd*. figura 123). As áreas menos fixadas pelos visitantes são: CC, E, Y, DD, X e Z (com menos de 0.42 fixações/m^2 – *vd*. figura 123).



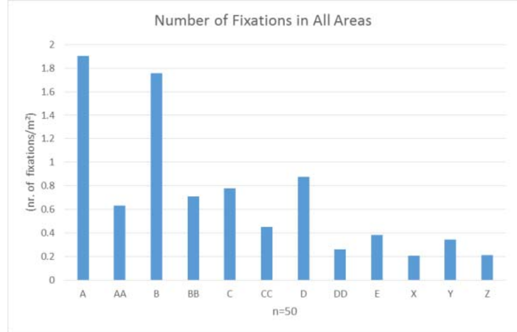


Fig. 122 – Tempo de fixação das áreas da Igreja

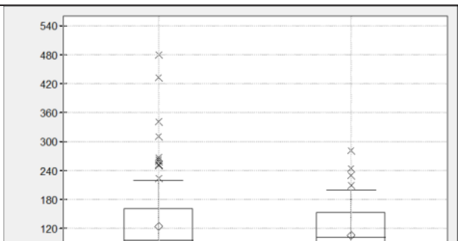
Fig. 123 – Número de fixações das áreas da Igreja

Na figura 124 apresentam-se os estatísticos básicos calculados para ambas as variáveis em cada uma das 12 áreas da Igreja.

		Identificador	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Padrão	Coef. Variação	Amplitude	Int. Interquartil	Coef. Assimetria	S'
Area A	Fixation time/m²	At	50	124.3512	N/A	94.4265	8.7056	37.5123	161.41	480.2254	12120.6236	110.0937	0.8853	471.5198	123.8977	1.4122	0.2415
	Nr. Fixations/m²	Anr	50	0.038	N/A	0.0318	0.0058	0.0173	0.0491	0.0982	0.0005	0.0233	0.6132	0.0925	0.0318	0.7227	0.1964
Area AA	Fixation time/m²	AAt	50	24.6898	N/A	18.706	0	5.2711	35.6035	116.0348	634.557	25.1904	1.0203	116.0348	30.3324	1.6693	0.1973
	Nr. Fixations/m²	AAnr	50	0.0127	N/A	0.0119	0	0.004	0.0198	0.0317	0.0001	0.0097	0.7629	0.0317	0.0158	0.4068	0.05
Area B	Fixation time/m²	Bt	50	104.9919	N/A	100.9764	4.1419	55.9107	152.8765	281.3222	4432.4496	66.5766	0.6341	277.1804	96.9658	0.5393	0.0414
	Nr. Fixations/m²	Bnr	50	0.0351	N/A	0.035	0.0044	0.0219	0.0482	0.0788	0.0004	0.0189	0.5382	0.0744	0.0263	0.2919	0.0033
Area BB	Fixation time/m²	BBt	50	35.8434	N/A	32.964	0	9.0905	52.7008	112.2669	866.0235	29.4283	0.821	112.2669	43.6103	0.8455	0.066
	Nr. Fixations/m²	BBnr	50	0.0142	N/A	0.0138	0	0.0046	0.0185	0.0416	0.0001	0.0096	0.6716	0.0416	0.0138	0.7101	0.0267
Area C	Fixation time/m²	Ct	50	31.8599	N/A	27.384	0	12.5962	48.8598	134.3978	742.0475	27.2405	0.855	134.3978	36.2636	1.4428	0.1234
	Nr. Fixations/m²	Cnr	50	0.0156	N/A	0.0148	0	0.0049	0.0197	0.0444	0.0001	0.0115	0.7383	0.0444	0.0148	0.8433	0.0533
Area CC	Fixation time/m²	CCt	50	14.2722	N/A	7.9239	0	0	22.4232	71.9841	327.7957	18.1051	1.2686	71.9841	22.4232	1.3722	0.2831
	Nr. Fixations/m²	CCnr	50	0.009	N/A	0.0105	0	0	0.0105	0.0418	0.0001	0.0106	1.1748	0.0418	0.0105	1.4046	-0.14
Area D	Fixation time/m²	Dt	50	38.9764	N/A	28.3662	0	10.6071	53.9339	154.4324	1396.1793	37.3655	0.9587	154.4324	43.3268	1.4338	0.2449
	Nr. Fixations/m²	Dnr	50	0.0176	N/A	0.0148	0	0.0099	0.0197	0.0642	0.0002	0.0129	0.7337	0.0642	0.0099	1.6003	0.28
Area DD	Fixation time/m²	DDt	50	8.2756	N/A	0	0	0	9.9833	56.314	228.4548	15.1147	1.8264	56.314	9.9833	1.8051	0.8289
	Nr. Fixations/m²	DDnr	50	0.0052	N/A	0	0	0	0.0105	0.0314	0.0001	0.0085	1.6288	0.0314	0.0105	1.4168	0.5
Area E	Fixation time/m²	Et	50	40.6457	N/A	32.5612	0	12.7397	67.0818	139.5766	1082.3026	32.8984	0.8094	139.5766	54.3421	0.7573	0.1488
	Nr. Fixations/m²	Enr	50	0.0076	N/A	0.0083	0	0.0042	0.0125	0.0374	0	0.0059	0.7714	0.0374	0.0083	2.6584	-0.08
Area X	Fixation time/m²	Xt	50	7.6887	N/A	3.5182	0	0	14.278	56.2496	119.5045	10.9318	1.4218	56.2496	14.278	2.3011	0.2921
	Nr. Fixations/m²	Xnr	50	0.0041	N/A	0.003	0	0	0.006	0.0211	0	0.0047	1.1483	0.0211	0.006	1.376	0.18
Area Y	Fixation time/m²	Yt	50	25.1134	N/A	21.6704	0	9.274	38.8453	69.911	328.1787	18.1157	0.7214	69.911	29.5713	0.6565	0.1164
	Nr. Fixations/m²	Ynr	50	0.0069	N/A	0.0061	0	0.004	0.0101	0.0182	0	0.0038	0.5511	0.0182	0.0061	0.7059	0.1333
Area Z	Fixation time/m²	Zt	50	13.1998	N/A	4.7178	0	0	11.0058	151.69	898.4185	29.9736	2.2708	151.69	11.0058	3.7726	0.7707
	Nr. Fixations/m²	Znr	50	0.0042	N/A	0.0034	0	0	0.0068	0.0239	0	0.0047	1.1118	0.0239	0.0068	2.0309	0.12

Fig. 124 – Estatísticos básicos de cada área da Igreja

No caso da variável Time, verifica-se que algumas áreas apresentam os principais estatísticos básicos da mesma ordem de grandeza, nomeadamente os casos das áreas A e B (*vd*. figura 125); as áreas AA, BB, C, D, E e Y (*vd*. figura 126) e as áreas CC, DD, X e Z (*vd*. figura 127). Para o caso da variável NF as áreas que revelam estatísticos básicos da mesma ordem de grandeza são as seguintes: áreas A e B (*vd*. figura 128); áreas AA, BB, C e D (*vd*. figura 129); áreas DD, X, Y e Z (*vd*. figura 130) e as áreas CC e E (*vd*. figura 131).



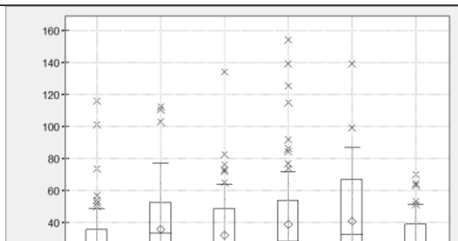


Fig. 125 – Box-Plots do tempo de fixação das áreas A e B

Fig. 126 – Box-Plots do tempo de fixação das áreas AA, BB, C, D, E e Y

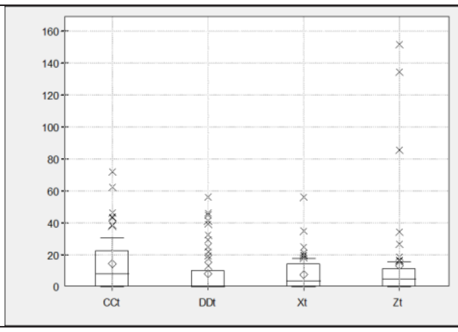


Fig. 127 – Box-Plots do tempo de fixação das áreas CC, DD, X e Z

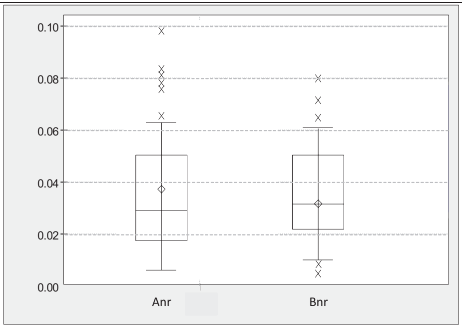


Fig. 128 – Box-Plots do número de fixações das áreas A e B

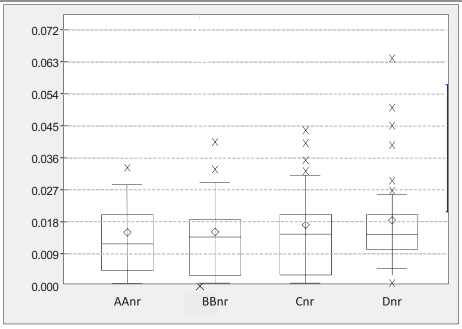


Fig. 129 – Box-Plots do número de fixações das áreas AA, BB, C e D

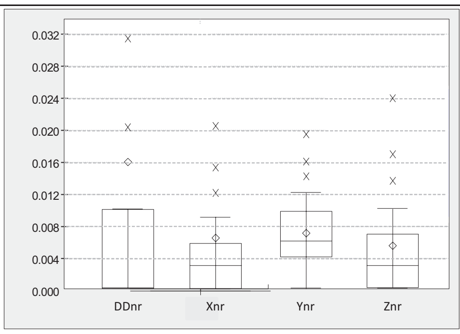


Fig. 130 – Box-Plots do número de fixações das áreas DD, X, Y e Z

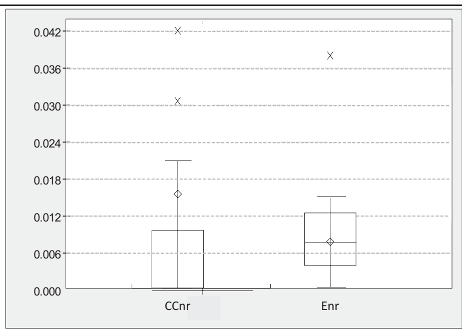


Fig. 131 – Box-Plots do número de fixações das áreas AA, BB, C e D

Nota-se também que, em todas as áreas, a dispersão da variável Time é bastante superior à dispersão da variável NF, pelo que esta última variável revela maior homogeneidade do que a primeira. Em todas as áreas, as variáveis apresentam reduzida assimetria. A existência de bastantes valores anómalos em ambas as variáveis, denota uma diversidade de comportamento dos visitantes.

A distribuição dos valores de cada uma das variáveis, para cada uma das áreas de observação da Igreja é apresentada nas figuras 132 a 155.

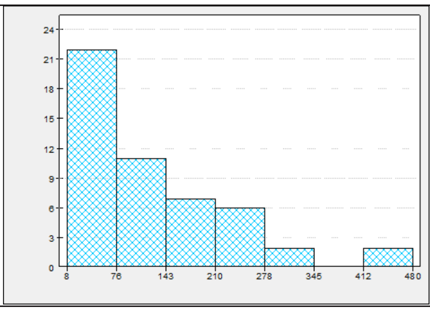


Fig. 132 – Distribuição do tempo de fixação na área A

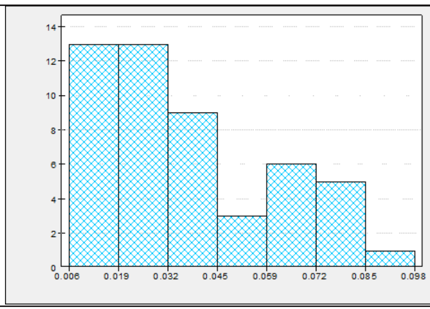


Fig. 133 – Distribuição do número de fixações na área A

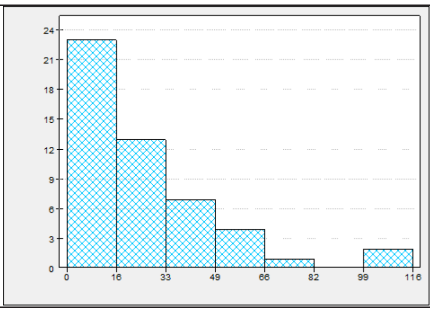


Fig. 134 – Distribuição do tempo de fixação na área AA

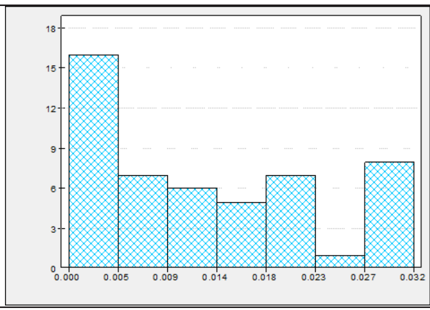


Fig. 135 – Distribuição do número de fixações na área AA

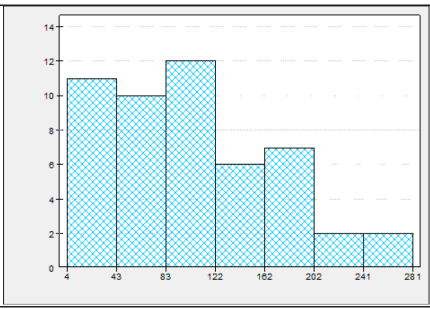


Fig. 136 – Distribuição do tempo de fixação na área B

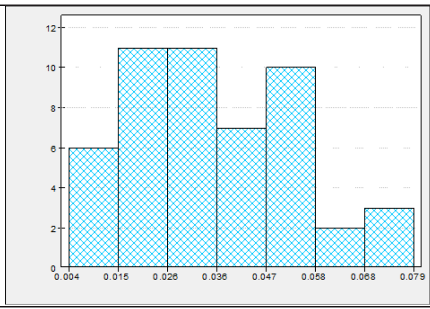


Fig. 137 – Distribuição do número de fixações na área B

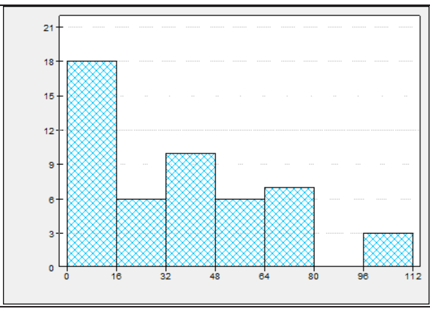


Fig. 138 – Distribuição do tempo de fixação na área BB

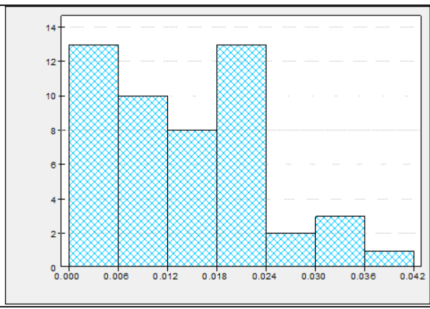


Fig. 139 – Distribuição do número de fixações na área BB

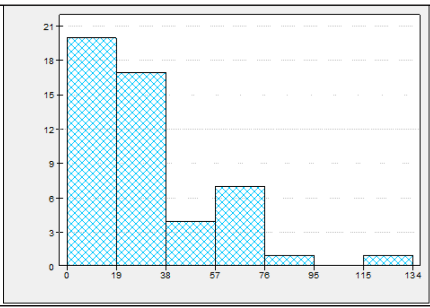


Fig. 140 – Distribuição do tempo de fixação na área C

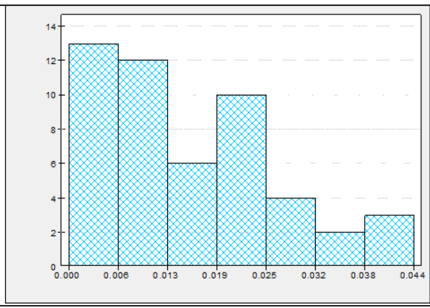


Fig. 141 – Distribuição do número de fixações na área C

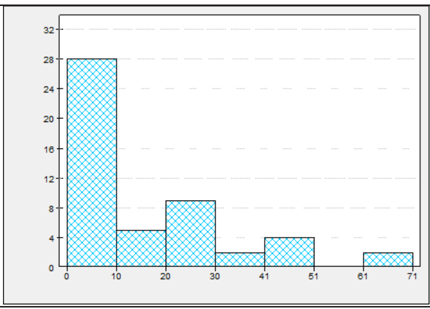


Fig. 142 – Distribuição do tempo de fixação na área CC

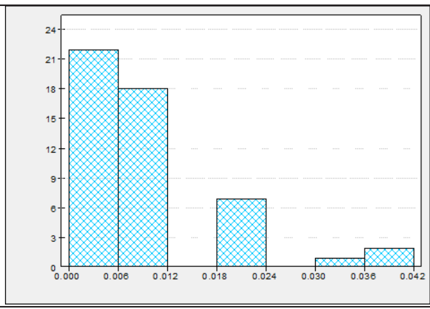


Fig. 143 – Distribuição do número de fixações na área CC

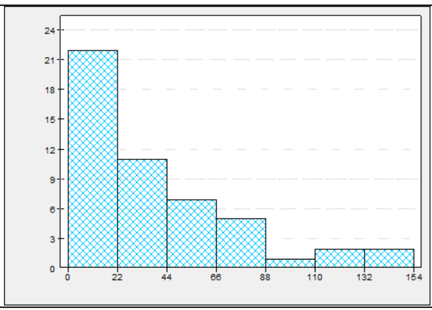


Fig. 144 – Distribuição do tempo de fixação na área D

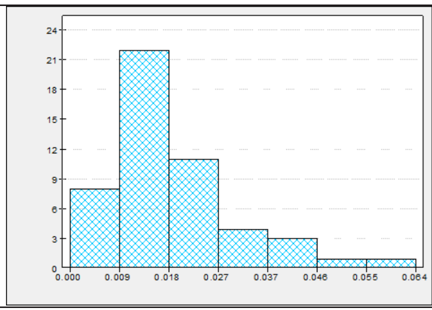


Fig. 145 – Distribuição do número de fixações na área D

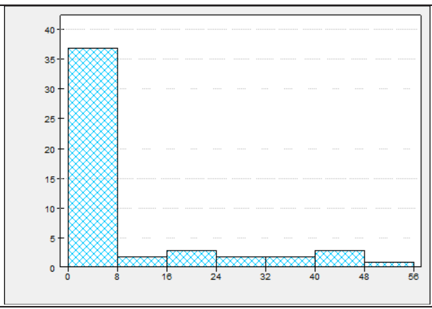


Fig. 146 – Distribuição do tempo de fixação na área DD

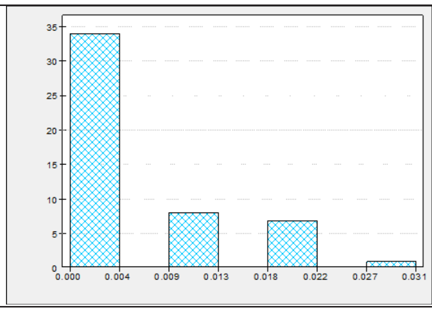


Fig. 147 – Distribuição do número de fixações na área DD

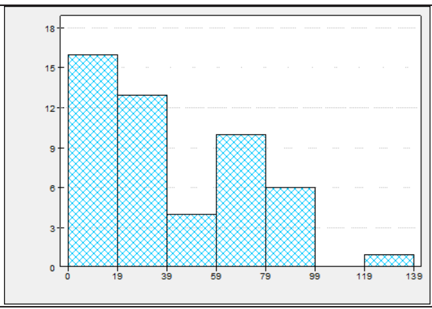


Fig. 148 – Distribuição do tempo de fixação na área E

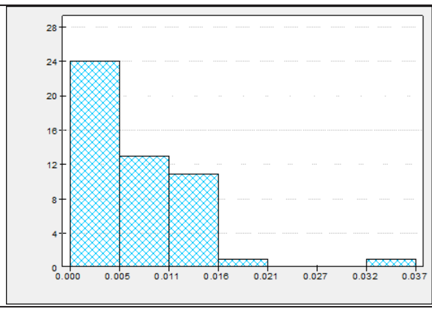


Fig. 149 – Distribuição do número de fixações na área E

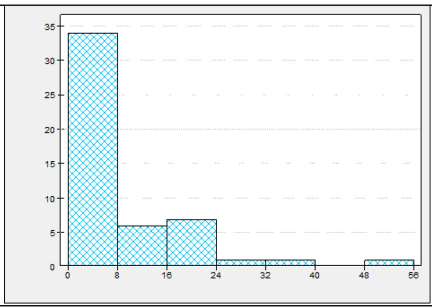


Fig. 150 – Distribuição do tempo de fixação na área X

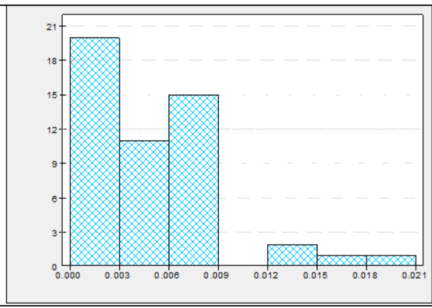


Fig. 151 – Distribuição do número de fixações na área X

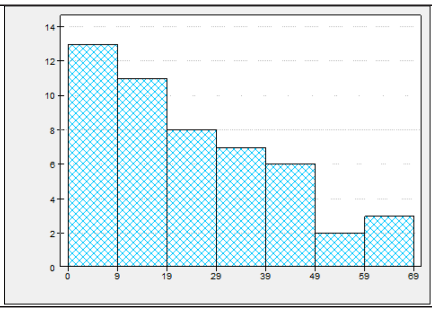


Fig. 152 – Distribuição do tempo de fixação na área Y

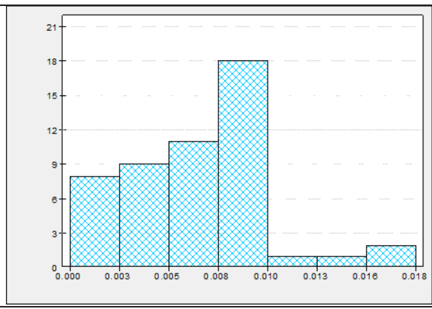


Fig. 153 – Distribuição do número de fixações na área Y

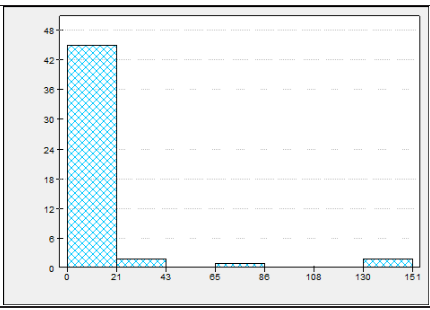


Fig. 154 – Distribuição do tempo de fixação na área Z

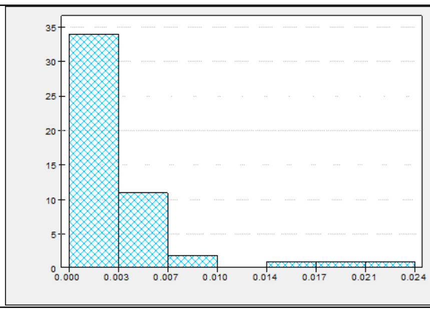


Fig. 155 – Distribuição do número de fixações na área Z

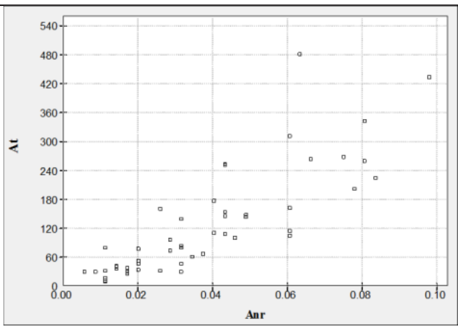
No que diz respeito ao tempo de fixação, nas áreas A, AA, BB, C, CC, D, DD, X e Z grande parte dos indivíduos fixa o olhar pouco tempo, havendo poucos indivíduos que o que fazem mais demoradamente. Nas áreas B, E e Y os indivíduos distribuem o tempo de fixação do olhar de forma mais equitativa.

A variável NF apresenta mais diferenciação de comportamento do que a variável Time. Nas áreas A, CC, DD, E, X e Z grande parte dos indivíduos apresenta baixo número de fixações, havendo poucos indivíduos com um número de fixações mais elevado. Por outro lado, nas áreas AA, B, BB e C os indivíduos distribuem-se de modo mais equitativo por todas as classes do número de fixações por unidade de área. As áreas D e Y mostram maiores concentrações de indivíduos nos valores intermédios do número de fixações e menos indivíduos nos valores extremos da variável.

Em termos conclusivos pode dizer-se que as áreas A e B são as mais atrativas para os indivíduos, quer em número de fixações, quer em tempo de fixação. Porém, enquanto na área A há muitos indivíduos com baixo número de fixações e baixos tempos de fixação e poucos indivíduos com elevados valores em ambas as variáveis; na área B os indivíduos distribuem-se de forma mais equitativa pelas diferentes classes em ambas as variáveis. No outro extremo, as áreas CC, DD, X e Z são as menos atrativas para os visitantes em ambas as variáveis, distribuindo-se de forma similar à da área A, também em ambas as variáveis. As áreas E e Y embora sejam pouco atrativas para os indivíduos, quando são fixadas, por vezes, os indivíduos dedicam-lhes algum tempo de observação, distribuídos de forma equitativa. As áreas AA, BB, C e D apresentam valores intermédios do número e da duração das fixações por unidade de área. Nestas últimas áreas, os valores de ambas as variáveis distribuem-se de diferentes formas.

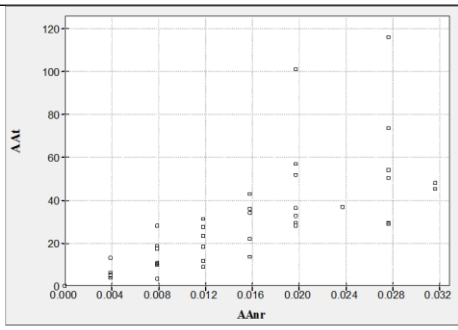
5.2. Análise Bivariada

A análise bivariada efetuada teve por base os diagramas de dispersão das duas variáveis e o cálculo do coeficiente de correlação de Pearson (*vd*. figuras 156 a 167).



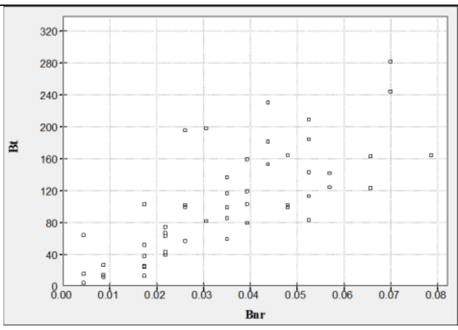
***r* = 0.83**

Fig. 156 – Diagrama de dispersão – área A



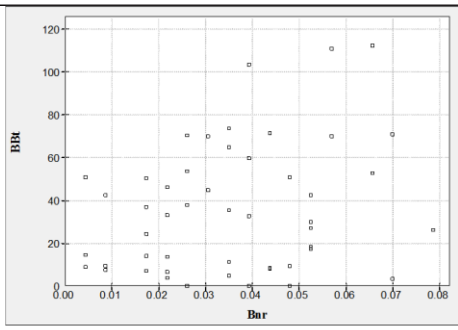
***r* = 0.8**

Fig. 157 – Diagrama de dispersão – área AA



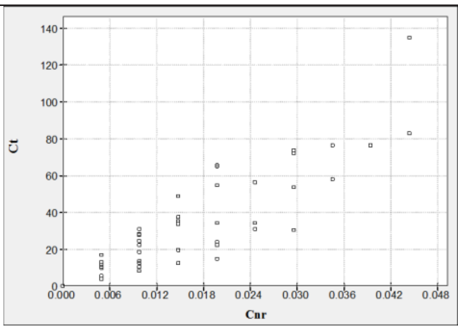
r = 0.76

Fig. 158 – Diagrama de dispersão – área B



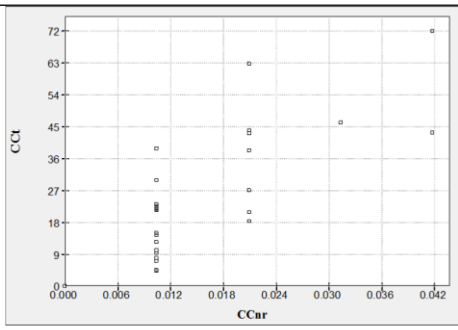
r = 0.71

Fig. 159 – Diagrama de dispersão – área BB



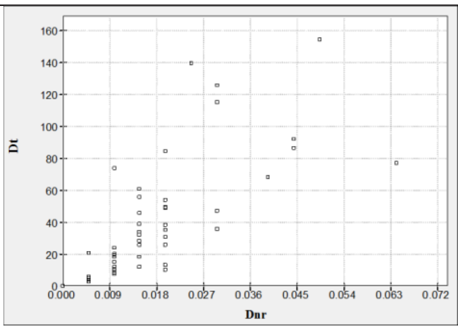
r = 0.87

Fig. 160 – Diagrama de dispersão – área C



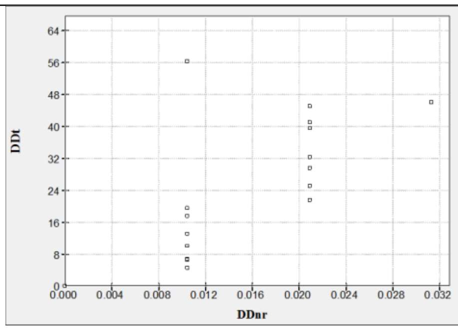
r = 0.88

Fig. 161 – Diagrama de dispersão – área CC



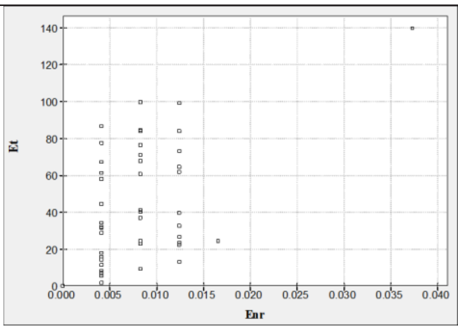
r = 0.73

Fig. 162 – Diagrama de dispersão – área D



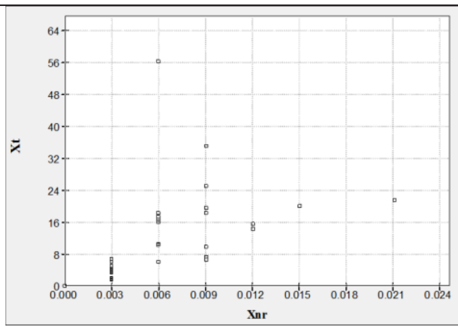
r = 0.88

Fig. 163 – Diagrama de dispersão – área DD



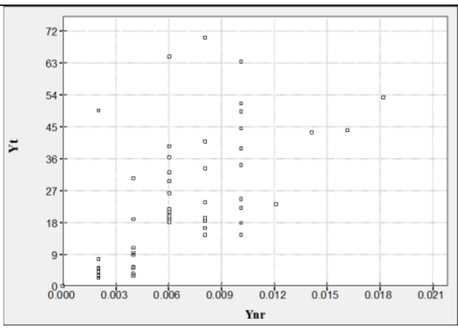
r = 0.56

Fig. 164 – Diagrama de dispersão – área E



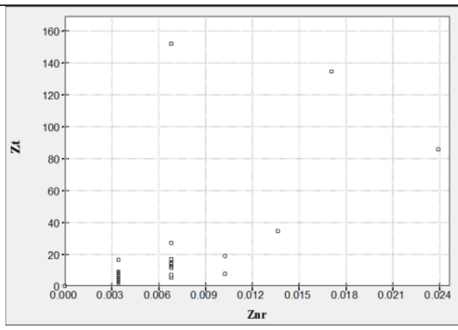
r = 0.66

Fig. 165 – Diagrama de dispersão – área X



r = 0.59

Fig. 166 – Diagrama de dispersão – área Y

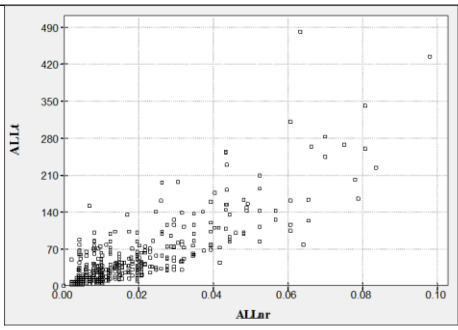


r = 0.66

Fig. 167 – Diagrama de dispersão – área Z

As áreas A, B e C revelam a existência de forte correlação direta entre as variáveis Time e NF, ou seja à medida que o número de fixações aumenta o tempo de observação também aumenta. Por outro lado, nas restantes áreas AA, BB, CC, D, DD, E, X, Y e Z a correlação entre as variáveis Time e NF é fraca, denotando a inexistência de um comportamento padronizado dos indivíduos.

Observa-se ainda uma forte correlação direta entre as duas variáveis estudadas quando se consideram todas as áreas em conjunto (*vd*. Figura 168). Tal facto deve-se provavelmente ao peso relativo das áreas A e B.



r = 0.84

Fig. 168 – Diagrama de dispersão – todas as áreas

5.3. Análise Multivariada

Os dados da totalidade dos indivíduos, à semelhança dos grupos anteriores, foi também submetido a um algoritmo de Análise em Componentes Principais, tendo-se considerado ambas as variáveis das áreas A, B, C, D, E, X, Y e Z como ativas (16 colunas ativas) e as restantes como suplementares (8 colunas). As figuras 169 e 170 mostram a inércia do conjunto de dados em cada eixo fatorial.

	Valor Proprio	% Exp	% Acum
1	4.667309	29.170679	29.170679
2	2.345259	14.65787	43.828548
3	2.23336	13.9585	57.78706
4	1.256499	7.853116	65.640167
5	1.141785	7.136157	72.776329
6	0.998909	6.243181	79.019508
7	0.84677	5.292312	84.311821
8	0.587945	3.674657	87.986481
9	0.460183	2.876142	90.862633
10	0.380305	2.376907	93.239532

Fig. 169 – Valores próprios e inércia dos eixos fatoriais

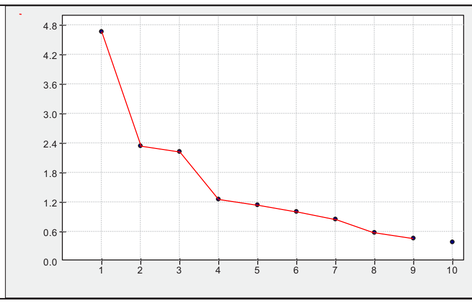


Fig. 170 – Screeplot

Os quatro primeiros eixos fatoriais explicam mais de 60% da inércia total da nuvem de dados. Constata-se que o número de fixações e a duração dessas mesmas fixações estão associadas em cada uma das áreas da Igreja. No primeiro plano factorial (eixos 1 e 2 com cerca de 44% da inércia total), o eixo 1 explica a importância das áreas A, B, C e D em termos de tempo de fixação e de número de fixações e o segundo eixo traduz uma oposição moderada entre a área Z e E (*vd*. figura 171). As áreas X e Y não são explicadas neste plano factorial (*vd*. figura 171). As variáveis suplementares projectam-se no centro do plano factorial, não evidenciando nenhuma associação com as outras variáveis (*vd*. figura 172).

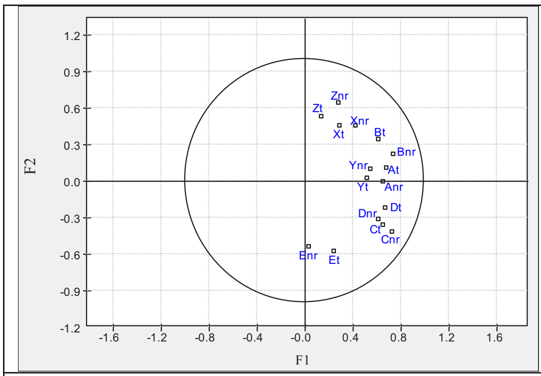


Fig. 171 – Projeção das variáveis ativas no 1º plano fatorial

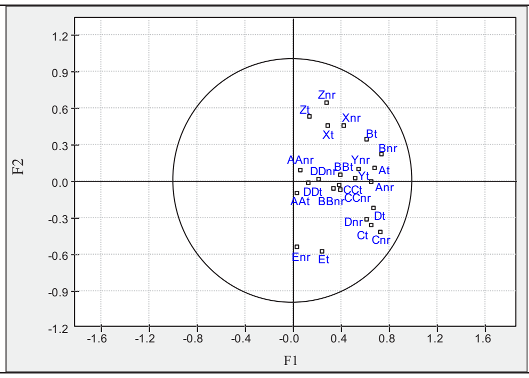


Fig. 172 – Projeção das variáveis ativas e suplementares no 1º plano fatorial

Na figura 173 pode ver-se que a grande maioria dos indivíduos não tem nenhuma associação às áreas da Igreja, havendo apenas alguns casos pontuais como sejam os indivíduos a08, a09, a11 e a47 associados às áreas A e B; os indivíduos a15 e a16 associados às áreas C e D; os indivíduos a26, a50, a51 e a53 associados à área E e os indivíduos a01, a05 e a46 associados à área Z (*vd*. figura 173).

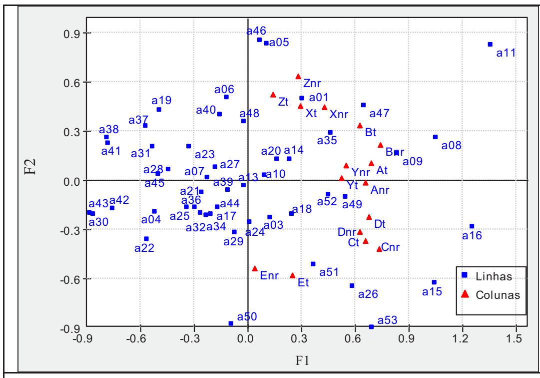


Fig. 173 – Projeção das variáveis ativas e indivíduos no 1º plano fatorial

O terceiro eixo fatorial apenas evidencia uma oposição moderada entre as áreas A e B e as áreas X e Y (*vd*. figura 174). As áreas da Igreja submetidas em suplementar projectam-se também no centro deste plano factorial, não estando associadas a nenhuma das outras áreas da Igreja (*vd*. figura 175).

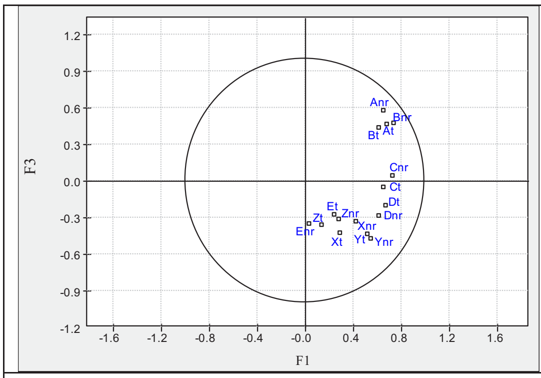


Fig. 174 – Projeção das variáveis ativas no 2º plano fatorial

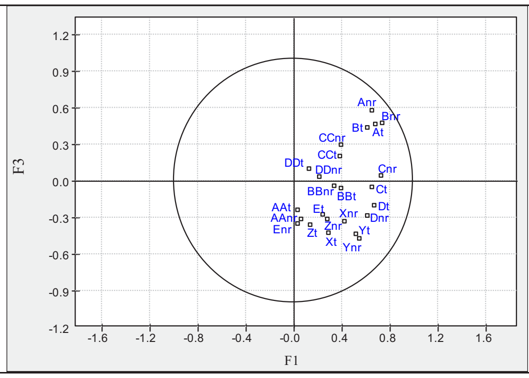


Fig. 175 – Projeção das variáveis ativas e suplementares no 2º plano fatorial

Na figura 176 pode observar-se a associação dos indivíduos a08, a09, a15 e a16 à área C; do indivíduo a47 às áreas A e B e dos indivíduos a11, a35 e a53 à área Y (*vd*. figura 176).

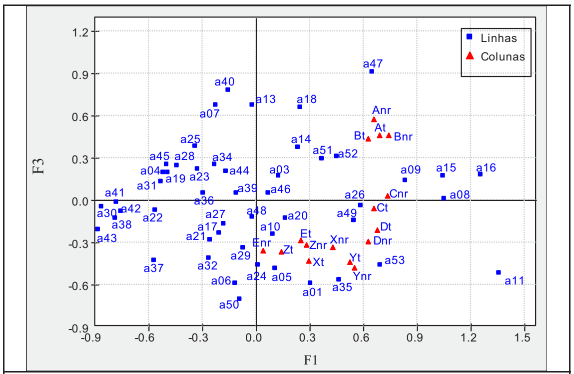


Fig. 176 – Projeção das variáveis ativas e indivíduos no 2º plano fatorial

O quarto eixo fatorial evidencia moderadamente a área X (*vd*. figura 177). As áreas da Igreja submetidas em suplementar projectam-se no centro deste plano factorial, não estando associadas a nenhuma das outras áreas da Igreja (*vd*. figura 178).

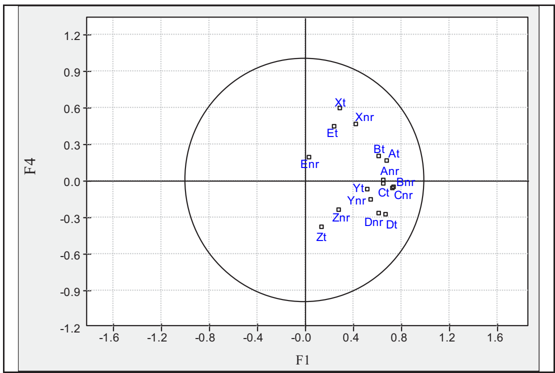


Fig. 177 – Projeção das variáveis ativas no 3º plano fatorial

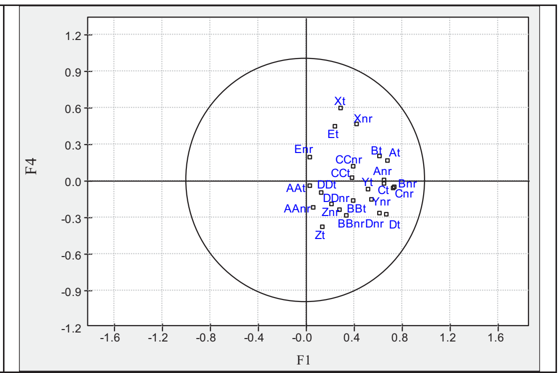


Fig. 178 – Projeção das variáveis ativas e suplementares no 3º plano fatorial

Na figura 179 pode observar-se a associação dos indivíduos a01, a20 e a35 à área X da Igreja; os indivíduos a08, a09 e a16 às áreas A, B e C e os indivíduos a11, a15 e a53 à área D.

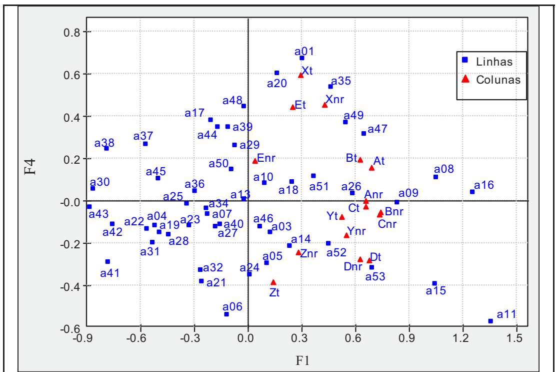


Fig. 179 – Projeção das variáveis ativas e indivíduos no 3º plano fatorial

Na figura 180 apresenta-se uma síntese das principais conclusões deste grupo de indivíduos.

Grupos	Áreas	Indivíduos
I	A, B, C, D	a08, a09, a11, a47, a15, a16, a11, a53
II	Z	a01, a05, a46
III	E	a26, a50, a51, a53
IV	X, Y	a11, a35, a53, a01, a20

Fig. 61 – Síntese da análise fatorial

6. Conclusões

A análise exploratória efetuada permitiu identificar as áreas da igreja preferidas de cada grupo de visitantes, em termos de número de fixações e duração das mesmas. Foi ainda possível identificar associações entre as diferentes áreas em cada grupo de indivíduos. Estas associações permitiram tipificar as diferentes zonas da igreja pela criação de grupos de áreas/indivíduos. É ainda de referir que os resultados obtidos para o grupo de indivíduos do 1º ano do MiARQ e do MiAIRE são muito idênticos aos da totalidade dos indivíduos, dado que representam cerca de 80% do total. Na mesma linha de raciocínio é importante salientar que os resultados obtidos para o grupo de alunos do 5º ano do MiARQ e AGMiARQ são pouco significativos pois resultam de um número de elementos bastante reduzido.

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3. Appendix C – Stops

Estimação por krigagem dos tempos de paragem de visitantes da Igreja de Alcobaça

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[3]Universidade de Lisboa, CIAUD

1. INTRODUÇÃO

Esta análise incide sobre uma amostra de 50 indivíduos que visitaram a Igreja de Alcobaça no período entre 20/out./2014 e 04/dez./2014 e que se voluntariaram para a realização da experiência. O procedimento experimental consistiu em dividir os 50 indivíduos em dois grupos – alunos do 1º ano dos Mestrados Integrados em Arquitetura (MiARQ) e em Arquitetura de Interiores e Reabilitação do Edificado (MiAIRE) da Faculdade de Arquitetura da Universidade de Lisboa (39 indivíduos) e alunos do 5º ano do MiARQ e alunos graduados (AGMiARQ) que concluíram recentemente o mesmo mestrado (11 indivíduos). Para cada um dos grupos registaram-se os tempos de paragem no interior da igreja, bem como a localização geográfica dessas paragens. Deste modo, obtiveram-se dois ficheiros com o formato da Tabela 1.

Tabela 1 – Formato dos ficheiros de entrada

Indivíduo_paragem	Coordenada X	Coordenada Y	Time (ms)
a1_01	-27.5	0.8	3456
a1_02	-25.6	2.4	43582
. . .	. . .	. . .	. . .
a39_23	0.75	94.3	2349

Procedeu-se inicialmente ao estudo de cada um dos grupos de indivíduos e, posteriormente, a um estudo da totalidade dos indivíduos.
De forma simplificada, o estudo consistiu em fazer a estimação espacial dos tempos de paragem dos indivíduos, por intermédio de um estimador linear de krigagem simples (Krige 1951; Journel 1989; Soares 2000), representando também a sua distribuição pelas diversas zonas da igreja, cuja identificação se ilustra na figura 1.

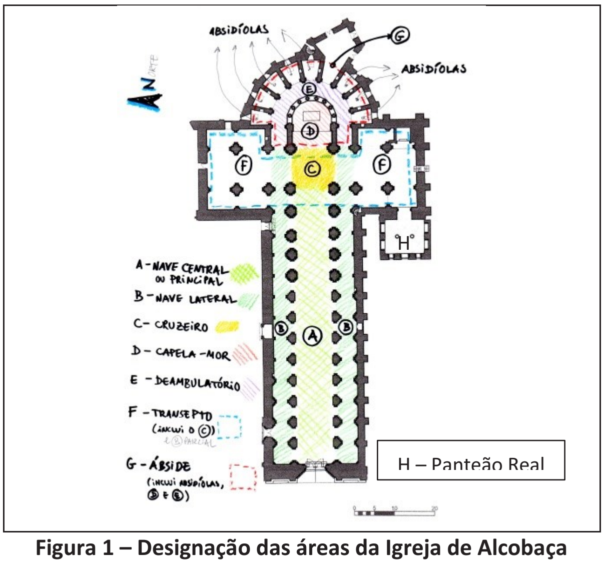

Figura 1 – Designação das áreas da Igreja de Alcobaça

A variável estudada – tempo de paragem (Time) – é uma variável distribuída espacialmente pela igreja que pode ser entendida como uma variável regionalizada (Matheron 1965), *i.e.* com um duplo carácter. Trata-se por um lado de uma variável aleatória desconhecendo-se de ponto para ponto o valor do

tempo de paragem, e simultaneamente, uma variável estruturada pois haverá uma relação entre os tempos de paragem de ponto para ponto.
Todos os cálculos que se apresentam em seguida foram efectuados com recurso ao programa *GeoMS – Geostatistical Modelling Software* (CMRP 2000).

2. Alunos do 1º ano do MiARQ e do MiAIRE

Este estudo contempla os 1117 registos correspondentes às paragens dos 39 indivíduos que constituem este grupo.
Na figura 2 apresentam-se os resultados da análise univariada da variável Time (tempo de paragem).

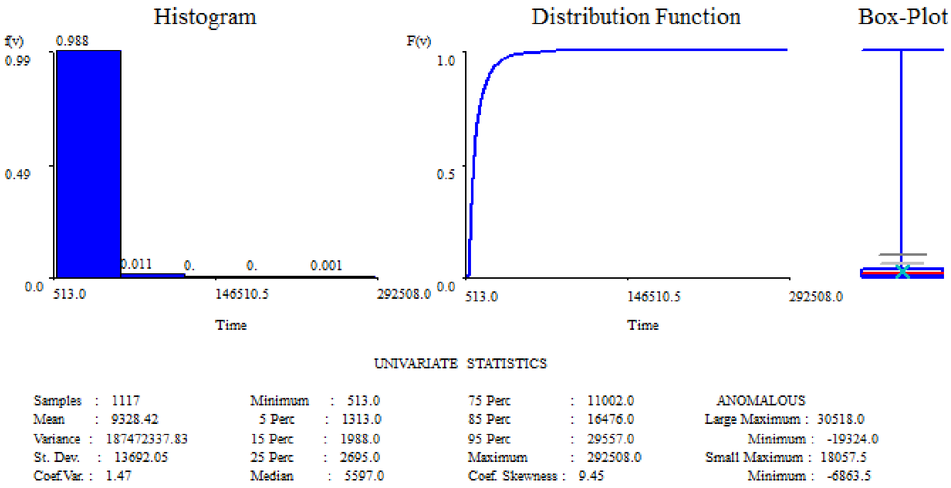

Figura 2 – Análise univariada dos tempos de paragem dos indivíduos do 1º ano do MiARQ e do MiAIRE

Verifica-se que os diversos indivíduos param pouco tempo em cada ponto (85% das paragens são inferiores a cerca de 16.5 s). A média aritmética é muito superior à mediana devido à existência de cerca de 15% de *outliers* (cerca de 10% de *outliers* severos e 5% de *outliers* moderados). Embora a amplitude total dos dados seja muito elevada (cerca de 292 s), a amplitude dos 90% de valores centrais é de apenas cerca de 29 s e a amplitude interquartis de 8.5 s. De facto, apesar do elevado desvio padrão, os valores centrais revelam alguma homogeneidade.
Os dados estão representados espacialmente na figura 3, observando-se que os tempos de paragem mais elevados se concentram em três zonas da igreja – entrada, zona leste da nave central A, zona sul do transepto F e zona do cruzeiro (C).

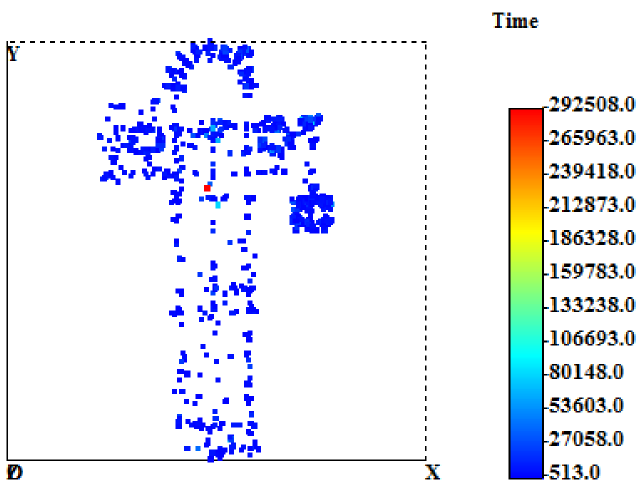

Figura 3 – Distribuição espacial dos tempos de paragem dos indivíduos do 1º ano do MiARQ e MiAIRE

A variabilidade espacial da variável Time foi modelada por um modelo teórico de variograma omnidireccional do tipo esférico, com "efeito de pepita", com os seguintes parâmetros: c_0 = 0.738; c_1 = 0.261; a = 1.99 (*vd*. figura 4).

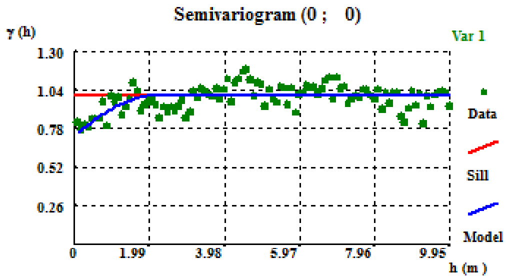

Figura 4 – Variograma experimental e modelo teórico dos tempos de paragem dos indivíduos do 1º ano do MiARQ e MiAIRE

É evidente a reduzida continuidade espacial dos dados pelo elevado "efeito de pepita" e pela reduzida amplitude do modelo teórico ajustado ao variograma experimental.

Seguidamente procedeu-se à estimação espacial da variável, cujos resultados se apresentam nas figuras 5 e 6.

Em qualquer das representações é clara a existência de algumas zonas da igreja onde os indivíduos apresentam maiores tempos de paragem, nomeadamente na zona da entrada, na zona leste da nave central A, na zona do cruzeiro (C), na zona sul do transepto F. Com menor expressão, os indivíduos também param na zona do Panteão Real (H), na absidíola G, na zona norte do transepto F e a meio da nave central A. Os menores tempos de paragem registam-se a meio da nave lateral sul B e na zona leste da nave lateral norte B.

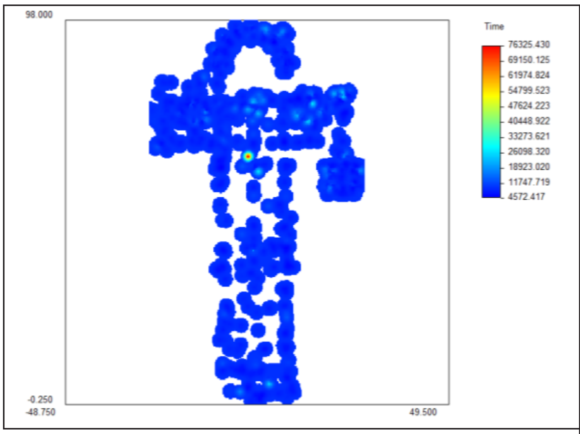

Figura 5 – Estimação dos tempos de paragem dos indivíduos do 1º ano do MiARQ e MiAIRE – escala linear

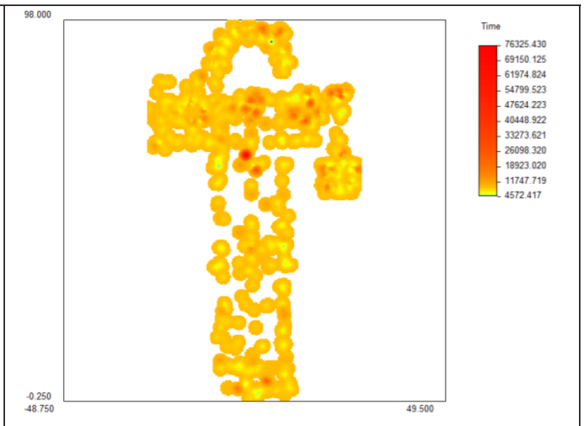

Figura 6 – Estimação dos tempos de paragem dos indivíduos do 1º ano do MiARQ e MiAIRE – escala logarítmica

Na figura 7 apresenta-se a análise univariada dos valores estimados, notando-se um comportamento similar aos dados originais.

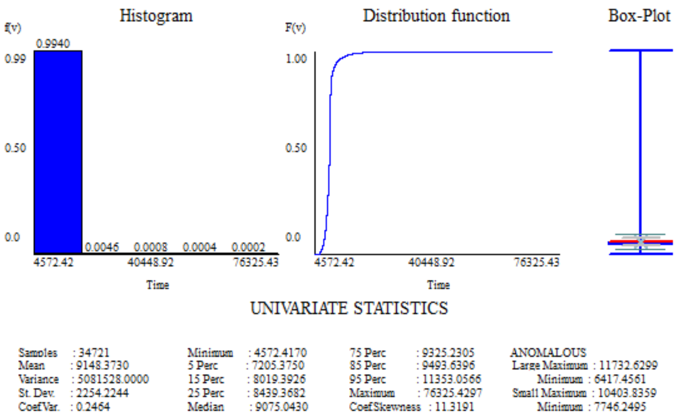

Figura 7 – Análise univariada dos tempos de paragem estimados dos indivíduos do 1º ano do MiARQ e MiAIRE

3. Alunos do 5º ano do MiARQ e AGMiARQ

Este estudo contempla os 279 registos correspondentes às paragens dos 11 indivíduos que constituem este grupo.
Na figura 8 apresentam-se os resultados da análise univariada da variável Time (tempo de paragem).

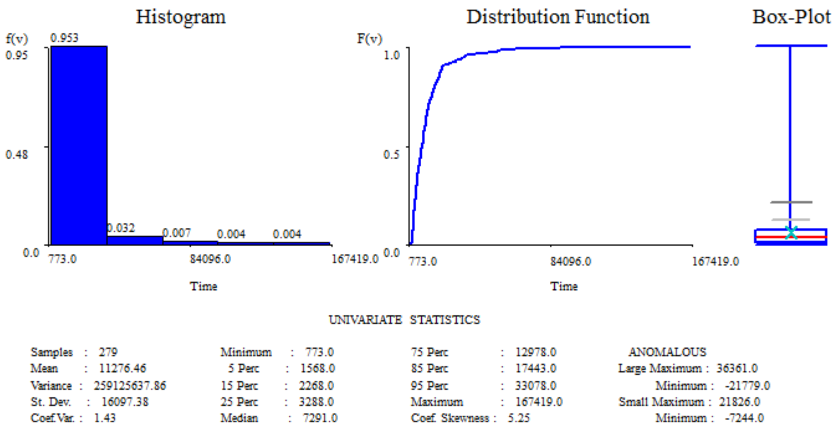

Figura 8 – Análise univariada dos tempos de paragem dos indivíduos do 5º ano do MiARQ e AGMiARQ

Verifica-se que os diversos indivíduos param pouco tempo em cada ponto (85% das paragens são inferiores a cerca de 17.4 s). A média aritmética é bastante superior à mediana devido à existência de cerca de 20% de *outliers* (cerca de 18% de *outliers* moderados e apenas cerca de 2% de *outliers* severos). Embora a amplitude total dos dados seja muito elevada (cerca de 166.5 s), a amplitude dos 90% de valores centrais é de apenas cerca de 31.5 s e a amplitude interquartis de 9.7 s. É evidente que, mesmo nos valores centrais, há uma maior dispersão dos dados no grupo de indivíduos do 5º ano do MiARQ e AGMiARQ do que no caso dos indivíduos do 1º ano do MiARQ e do MiAIRE.
Os dados estão representados espacialmente na figura 9, observando-se que os tempos de paragem mais elevados se concentram em oito zonas da igreja – entrada, no centro da nave central A, na zona leste da nave central A, na zona do cruzeiro (C), zona do transepto sul F, zona leste do transepto norte F, absidíolas norte (E) e zona oeste do Panteão Real H.

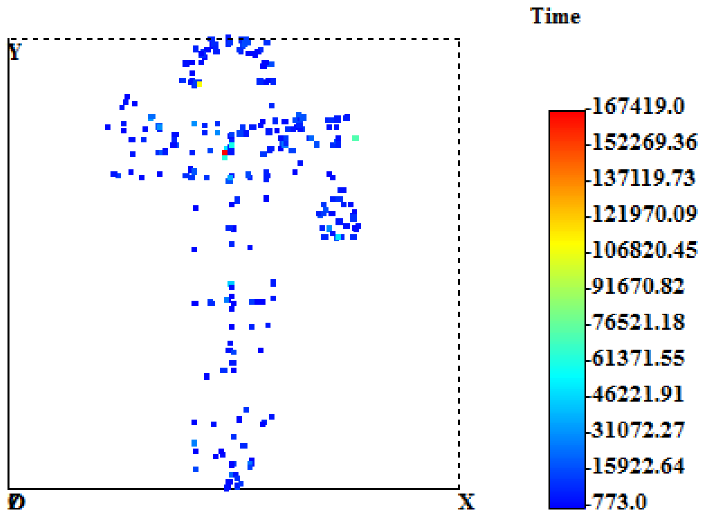

Figura 9 – Distribuição espacial dos tempos de paragem dos indivíduos do 5º ano do MiARQ e AGMiARQ

A variabilidade espacial da variável Time foi modelada por um modelo teórico de variograma omnidireccional do tipo esférico, com "efeito de pepita", com os seguintes parâmetros: c_0 = 0.851; c_1 = 0.149; a = 4.509 (*vd*. figura 10).

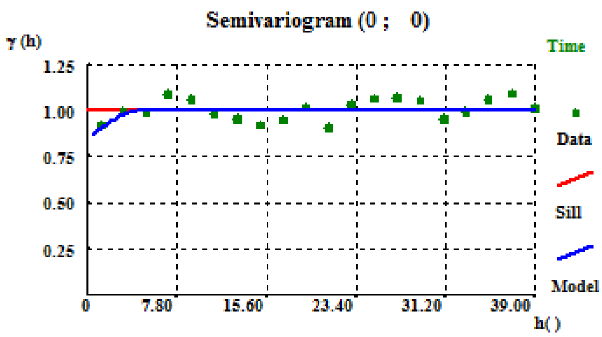

Figura 10 – Variograma experimental e modelo teórico dos tempos de paragem dos indivíduos do 5º ano do MiARQ e AGMiARQ

Nota-se neste caso que o modelo teórico do variograma revela uma maior continuidade espacial do que no caso anterior, embora também seja evidente o elevado "efeito de pepita" do modelo teórico ajustado ao variograma experimental.

Seguidamente procedeu-se também à estimação espacial da variável, cujos resultados se apresentam nas figuras 11 e 12.

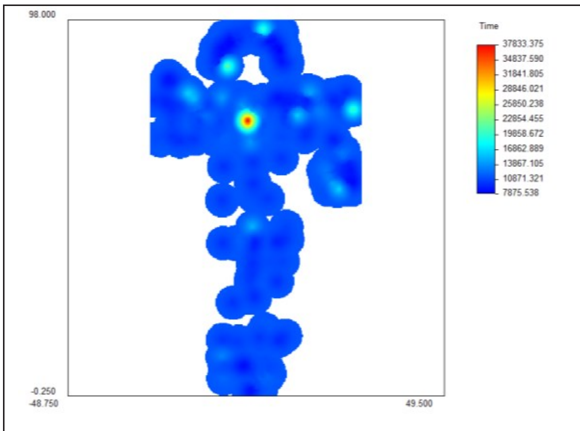

Figura 11 – Estimação dos tempos de paragem dos indivíduos do 5º ano do MiARQ e AGMiARQ – escala linear

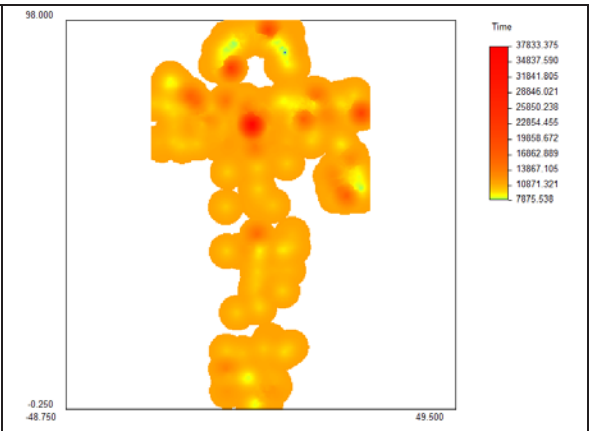

Figura 12 – Estimação dos tempos de paragem dos indivíduos do 5º ano do MiARQ e AGMiARQ – escala logarítmica

Em qualquer das representações é clara a existência de algumas zonas da igreja onde os indivíduos apresentam maiores tempos de paragem, nomeadamente na zona da entrada, no centro da nave central A, na zona do cruzeiro (C), no transepto sul F, na zona das absidíolas norte E, na absidíola G e na zona leste do transepto norte F. Com menor expressão, os indivíduos também param na zona oeste do Panteão Real H. Os menores tempos de paragem registam-se na zona sul do Panteão Real H e nas zonas nordeste e sudeste das absidíolas E.
Na figura 13 apresenta-se a análise univariada dos valores estimados, notando-se um comportamento similar aos dados originais.

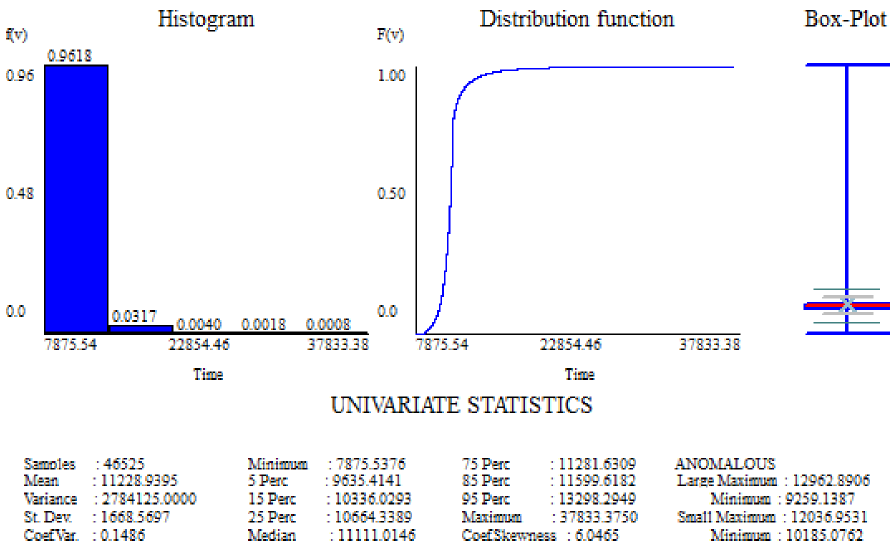

Figura 13 – Análise univariada dos tempos de paragem estimados dos indivíduos do 1º ano do MiARQ

4. Todos os indivíduos

Este estudo contempla os 1396 registos correspondentes às paragens da totalidade dos 50 indivíduos. É de salientar que a larga maioria destes registos correspondem aos alunos do 1º ano do MiARQ e do MiAIRE, pelo que as conclusões obtidas serão manifestamente semelhantes às que se obtiveram para este grupo de indivíduos.
Na figura 14 apresentam-se os resultados da análise univariada da variável Time (tempo de paragem).

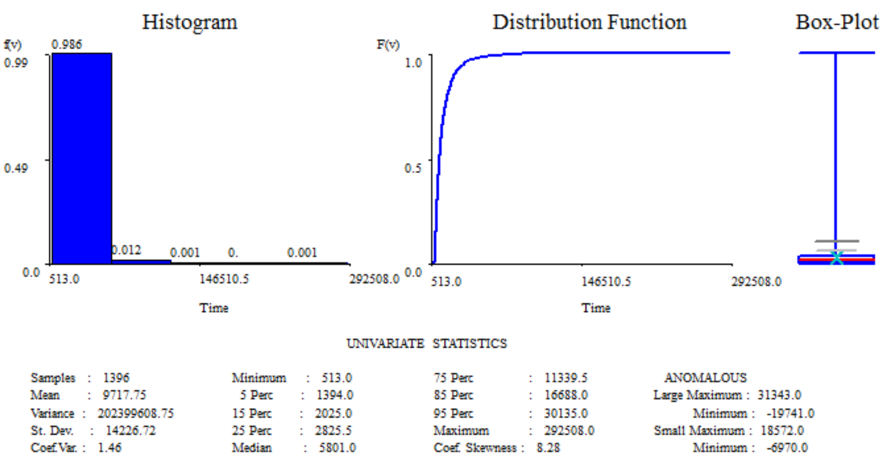

Figura 14 – Análise univariada dos tempos de paragem dos 50 indivíduos

Verifica-se que os diversos indivíduos param pouco tempo em cada ponto (85% das paragens são inferiores a cerca de 16.7 s). A média aritmética é bastante superior à mediana devido à existência de cerca de 20% de *outliers* (cerca de 6% de *outliers* severos e 14% de *outliers* moderados). Embora a

amplitude total dos dados seja muito elevada (cerca de 292 s), a amplitude dos 90% de valores centrais é de apenas cerca de 29 s e a amplitude interquartis de 8.5 s. De facto, apesar do elevado desvio padrão, os valores centrais revelam alguma homogeneidade.
Os dados estão representados espacialmente na figura 15, observando-se que os tempos de paragem mais elevados se concentram em três zonas da igreja – entrada, zona leste da nave central A, na zona sul do transepto F e na zona do cruzeiro (C).

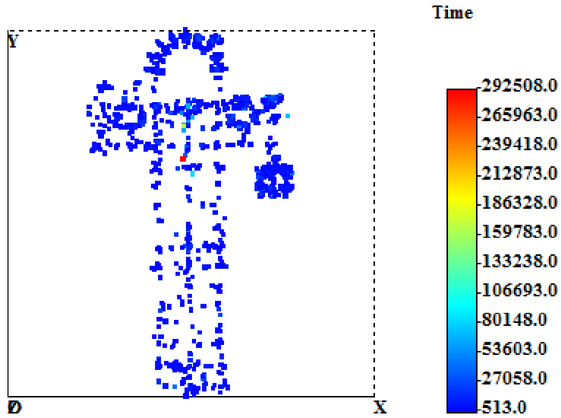

Figura 15 – Distribuição espacial dos tempos de paragem dos 50 indivíduos

A variabilidade espacial da variável Time foi modelada por um modelo teórico de variograma omnidireccional do tipo esférico, com "efeito de pepita", com os seguintes parâmetros: $c_0 = 0.731$; $c_1 = 0.269$; a = 1.424 (*vd*. figura 16).

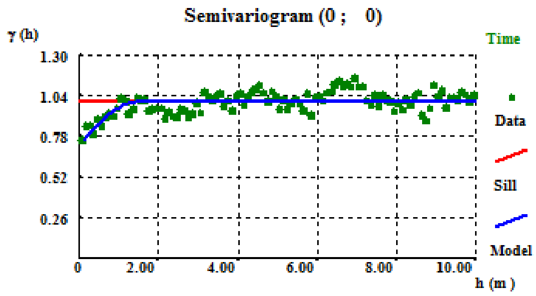

Figura 16 – Variograma experimental e modelo teórico dos tempos de paragem dos 50 indivíduos

É evidente a reduzida continuidade espacial dos dados pelo elevado "efeito de pepita" e pela reduzida amplitude do modelo teórico ajustado ao variograma experimental.
Seguidamente procedeu-se à estimação espacial da variável, cujos resultados se apresentam nas figuras 17 e 18.

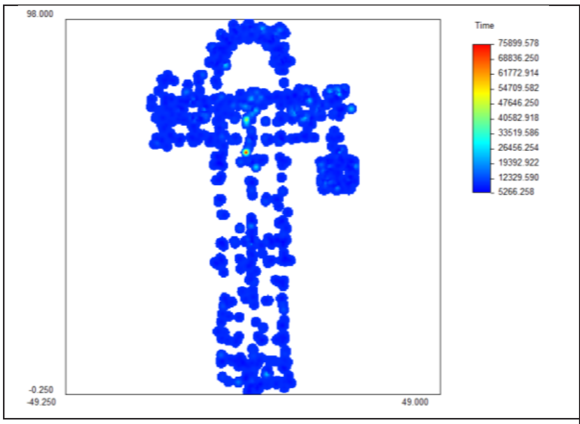

Figura 17 – Estimação dos tempos de paragem dos 50 indivíduos – escala linear

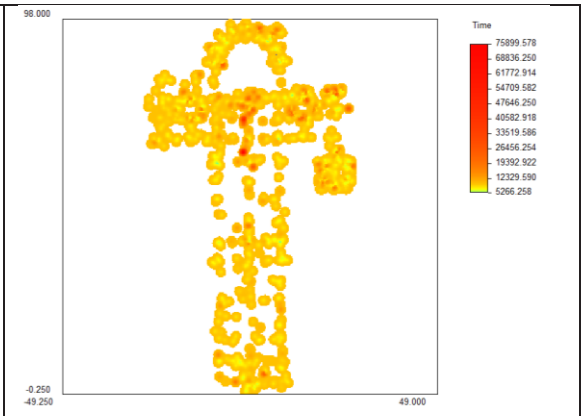

Figura 18 – Estimação dos tempos de paragem dos 50 indivíduos – escala logarítmica

Em qualquer das representações é clara a existência de algumas zonas da igreja onde os indivíduos apresentam maiores tempos de paragem, nomeadamente na zona da entrada, no centro da nave central A, na zona leste da nave central A, na zona do cruzeiro (C), no transepto sul F. Com menor expressão, os indivíduos também param na zona do Panteão Real H, na absidíola G e no transepto norte. Os menores tempos de paragem registam-se a meio da nave lateral sul B e na zona leste da nave lateral norte B.
Na figura 19 apresenta-se a análise univariada dos valores estimados, notando-se um comportamento similar aos dados originais.

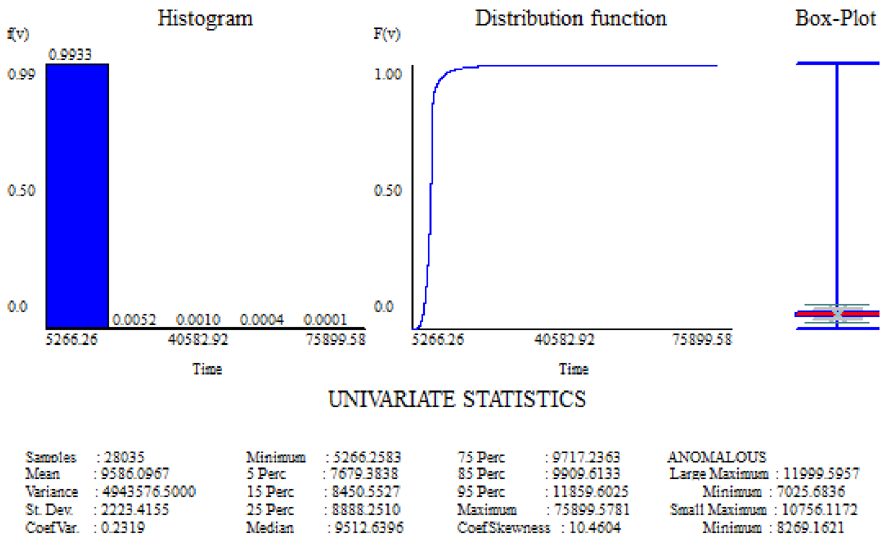

Figura 19 – Análise univariada dos tempos de paragem estimados dos 50 indivíduos

5. Conclusões

Os dados relativos aos alunos do 5º ano do MiARQ e AGMiARQ revelam uma maior continuidade espacial e, consequentemente são mais estruturados do que os dados relativos aos alunos do 1º ano do MiARQ e do MiAIRE, permitindo a estimação de maior área da igreja. Apesar dos registos dos alunos do 5º ano do MiARQ e AGMiARQ corresponderem a poucos indivíduos, é inequívoco que há diferenças entre os dois grupos de indivíduos no que se refere às zonas da igreja onde dedicam maiores e menores tempos de paragem.

6. Agradecimentos

Os autores agradecem a todos os participantes que se voluntariaram para a realização da experiência e à FCT no âmbito do projeto de investigação GESTO (Refª: EXPL/ATP-AQI/1142/2013).

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4. Appendix D – Inquiries

Análise do inquérito aos visitantes da Igreja de Alcobaça

Jorge Tavares Ribeiro[1]; Pedro Marques Abreu[2]; Rita Ferreira[3]; Patrícia Esteves[3]
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[3]Universidade de Lisboa, CIAUD

1. INTRODUÇÃO

Esta análise incide sobre uma amostra de 50 indivíduos que visitaram a Igreja de Alcobaça no período entre 20/out./2014 e 04/dez./2014 e que se voluntariaram para a realização da experiência. O procedimento experimental consistiu em dividir os 50 indivíduos em dois grupos – alunos do 1º ano dos Mestrados Integrados em Arquitetura (MiARQ) e em Arquitetura de Interiores e Reabilitação do Edificado (MiAIRE) da Faculdade de Arquitetura da Universidade de Lisboa (39 indivíduos) e alunos do 5º ano do MiARQ e alunos graduados (AGMiARQ) que concluíram recentemente o mesmo mestrado (11 indivíduos). Para todos os indivíduos efectuou-se um inquérito (*vd*. anexo A) e uma entrevista após a visita à Igreja de Alcobaça. O inquérito, cujos resultados são apresentados neste texto, está dividido em quatro categorias de questões: caracterização do indivíduo, emoção/estado de espírito sentido durante a visita, qualidade da experiência realizada, dificuldades e satisfação com a experiência. As variáveis em estudo são qualitativas, excepto a idade dos visitantes que é quantitativa e contínua.

2. METODOLOGIA DE ANÁLISE

Em termos metodológicos procedeu-se sequencialmente à análise univariada (Murteira *et al*. 2010) e multivariada (Benzécri 1981; Cibois 1984; Escofier & Pagès 1998; Gomez & Castellanos 2004) de cada um dos conjuntos de dados, correspondentes a cada um dos grupos de indivíduos. Foi igualmente submetido à mesma sequência de análise o conjunto de dados correspondente à totalidade dos indivíduos. Para proceder à análise multivariada de todas as variáveis (qualitativas e quantitativa) houve necessidade de as codificar (*vd*. figuras 1 e 2) em disjuntiva completa (Nakache 1973), tornando-as todas qualitativas, cujo formato matricial se apresenta na Tabela 1. Estas matrizes são então submetidas a um algoritmo de Análise Factorial de Correspondências (Pereira *et al*. 2015). Todas os calculos foram efetuados usando como recurso computacional o programa AnDad (CVRM/CERENA/IST 1989, 2002, 2012).

GENERAL DATA	Age	17-18	1718
		19-21	1921
		>21	22+
	Visited Before	Yes	VISy
		No	VISn
	1st Year Student	Yes	1STy
		No	1STn
	Gender	Female	Gfem
		Male	Gmal

Fig. 1 – Codificação das variáveis – caracterização dos indivíduos

STATE OF MIND OF THE PARTICIPANT	Happiness	Happy	HAPy
		Neutral	HAPx
		Unhappy	HAPn
	Relaxation	Relaxed	RELy
		Neutral	RELx
		Tense	RELn
	Accomplishment	Accomplished	ACCy
		Neutral	ACCx
		Frustrated	ACCn
	Self-confidence	Self-confident	SCOy
		Neutral	SCOx
		Diminished	SCOn
	Comfort	Comfortable	COMy
		Neutral	COMx
		Uncomfortable	COMn
	Reward	Rewarded	REWy
		Neutral	REWx
		Frustrated	REWn
	Curiosity	Curious	CURy
		Neutral	CURx
		Wearied	CURn
EXPERIMENT EVALUATION	Interesting	No	INTn
		Neutral	INTx
		Yes	INTy
	Challenging	No	CHAn
		Neutral	CHAx
		Yes	CHAy
	Difficult to accomplish	No	DIAn
		Neutral	DIAx
		Yes	DIAy
	Difficult to understand	No	DIUn
		Neutral	DIUx
		Yes	DIUy
	Frustrating	No	FRUn
		Neutral	FRUx
		Yes	FRUy
	Satisfactory	No	SATn
		Neutral	SATx
		Yes	SATy
EXPERIMENT DIFFICULTY & SATISFACTION	Easy to concentrate	No	ECOn
		Neutral	ECOx
		Yes	ECOy
	Managed to concentrate	No	MCOn
		Neutral	MCOx
		Yes	MCOy
	Fear of unaccomplishment	No	FUNn
		Neutral	FUNx
		Yes	FUNy
	Doubt of own ability to accomplish	No	DOAn
		Neutral	DOAx
		Yes	DOAy
	Enjoyed participating	No	EPAn
		Neutral	EPAx
		Yes	EPAy
	Urge a friend to participate	No	UFPn
		Neutral	UFPx
		Yes	UFPy
	Regrets participating	No	RPAn
		Neutral	RPAx
		Yes	RPAy

Fig. 2 – Codificação das variáveis – questões relacionadas com a visita

Tabela 1 – Formato matricial dos ficheiros de entrada

Indivíduo	1718	1921	22+	VISy	VISn	…	INTn	INTx	INTy	…	UFPn	UFPx	UFPy
a1	1	0	0	1	0	…	0	0	1	…	0	0	1
a2	0	1	0	0	1	…	0	1	0	…	1	0	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
a53	0	1	0	1	0	…	0	0	1	…	0	0	1

3. Alunos do 1º ano do MiARQ e do MiAIRE

3.1. Análise Univariada

Este grupo de indivíduos é constituído por jovens com idades entre os 17 e os 22 anos. A grande maioria tem idades compreendidas entre 17 e 19 anos (*vd*. figura 3), havendo apenas 3 alunos com idade superior (*vd*. figura 3). São jovens maioritariamente do género feminino (*vd*. figura 4), e que na sua maioria também nunca tinham visitado a Igreja de Alcobaça (*vd*. figura 5). Nas figuras 6 a 12 apresentam-se os diagramas de barras que mostram as respostas destes alunos às questões do inquérito relacionadas com as emoções/estado de espírito sentido na experiência. Verifica-se que a grande maioria dos indivíduos expressa um sentimento favorável e positivo perante a experiência realizada, registando-se apenas em algumas questões a existência de uma atitude de indiferença/neutralidade.

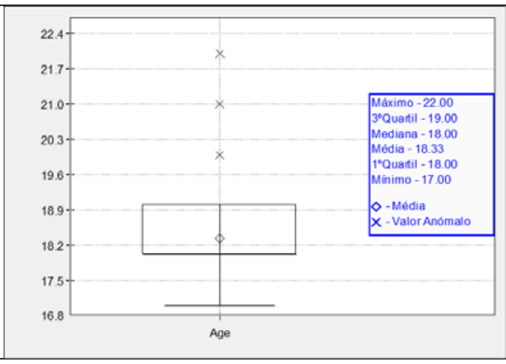

Fig. 3 – Box-plot da idade dos alunos

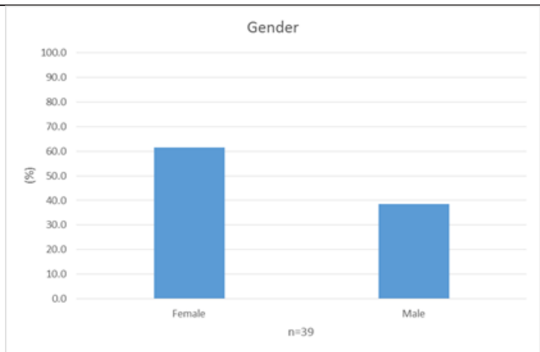

Fig. 4 – Género

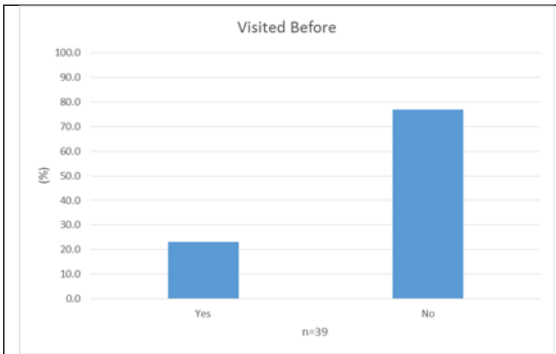

Fig. 5 – Visita anterior

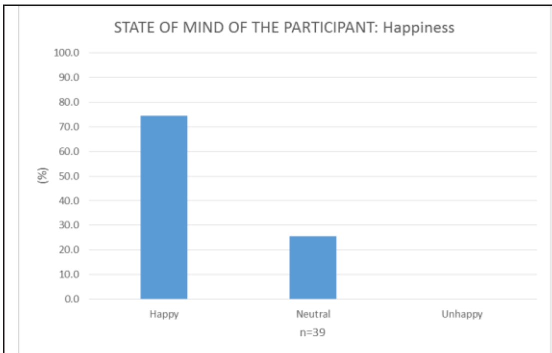

Fig. 6 – Estado de espírito: Felicidade

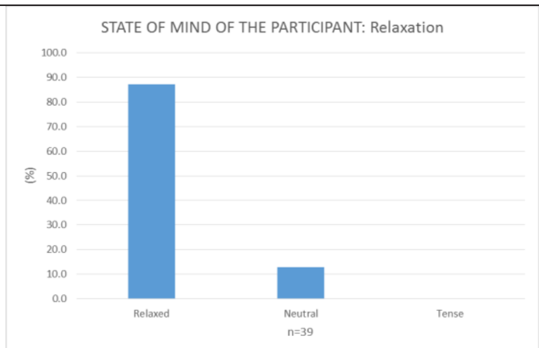

Fig. 7 – Estado de espírito: Relaxação

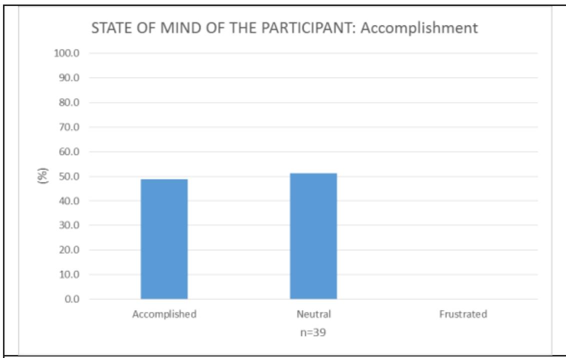

Fig. 8 – Estado de espírito: Realização

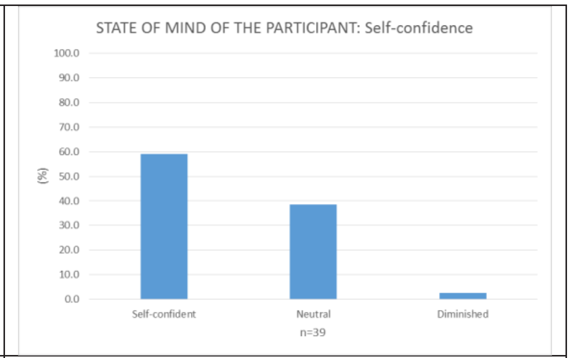

Fig. 9 – Estado de espírito: Auto-confiança

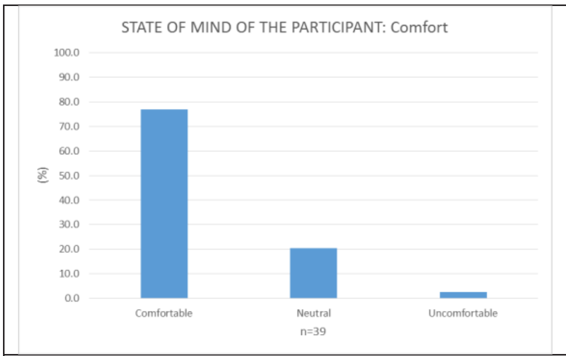

Fig. 10 – Estado de espírito: Conforto

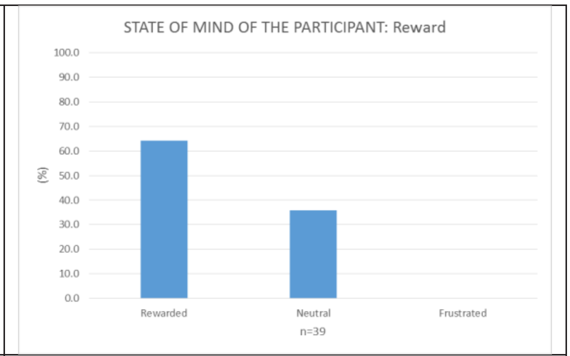

Fig. 11 – Estado de espírito: Recompensação

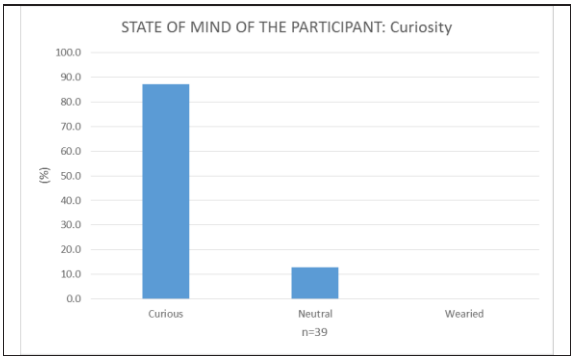

Fig. 12 – Estado de espírito: Curiosidade

No que diz respeito à qualidade da experiência realizada, nas figuras 13 a 18 encontram-se os resultados obtidos. A maioria das respostas revela elevado grau de satisfação com a qualidade da experiência realizada.

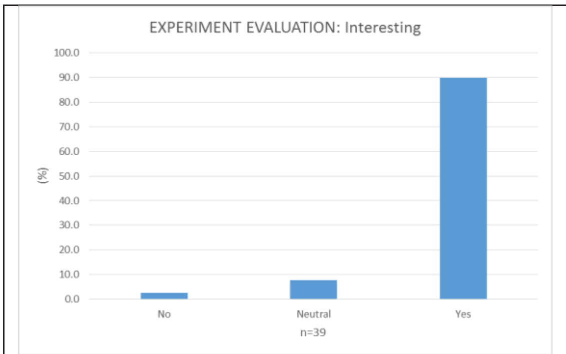

Fig. 13 – Qualidade da experiência: Interesse

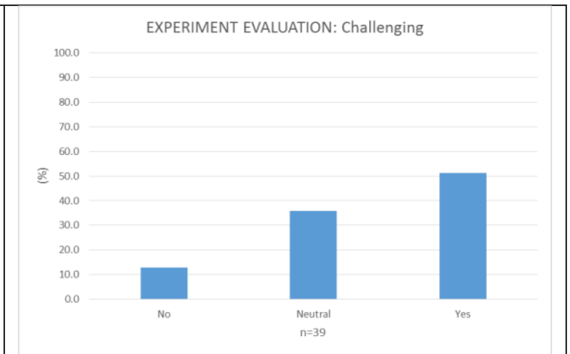

Fig. 14 – Qualidade da experiência: Desafio

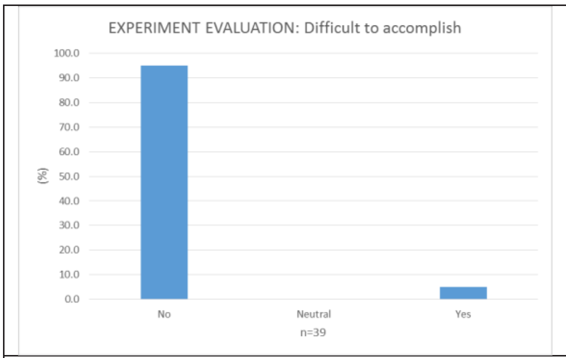

Fig. 15 – Qualidade da experiência: Realização

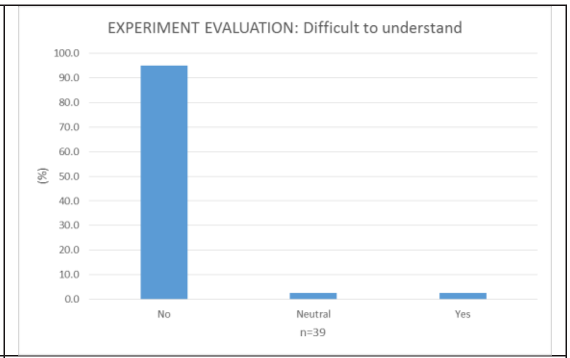

Fig. 16 – Qualidade da experiência: Compreensão

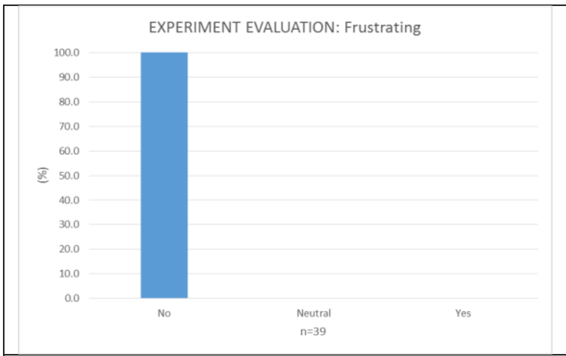

Fig. 17 – Qualidade da experiência: Frustração

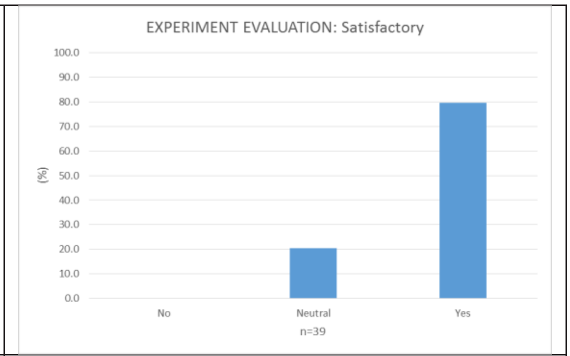

Fig. 18 – Qualidade da experiência: Satisfação

Em termos da dificuldade e satisfação com a experiência, os diagramas de barras obtidos (*vd*. figuras 19 a 25) mostram claramente que a experiência é fácil e agradável de realizar para a larga maioria dos participantes.

Fig. 19 – Dificuldade e satisfação com a experiência: Facilidade de concentração

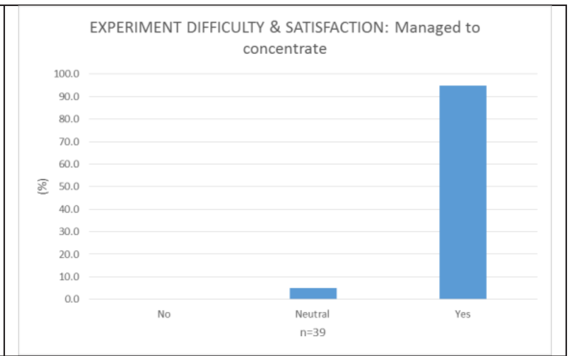

Fig. 20 – Dificuldade e satisfação com a experiência: Manutenção da concentração

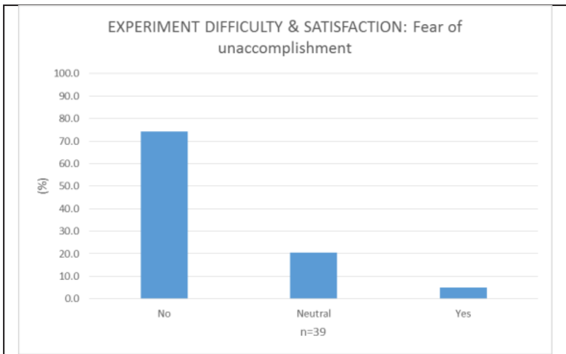

Fig. 21 – Dificuldade e satisfação com a experiência: Receio da experiência

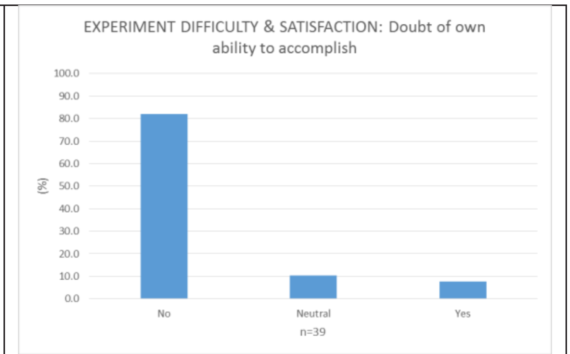

Fig. 22 – Dificuldade e satisfação com a experiência: Dúvidas da capacidade de realizar a experiência

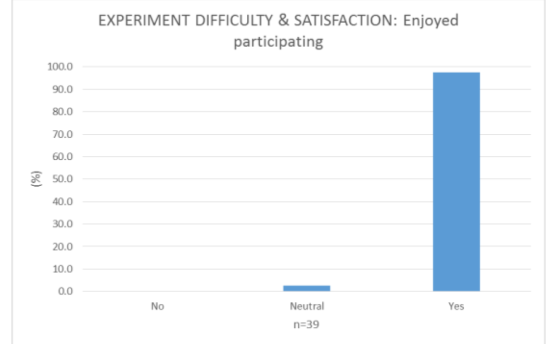

Fig. 23 – Dificuldade e satisfação com a experiência: Satisfação com a participação

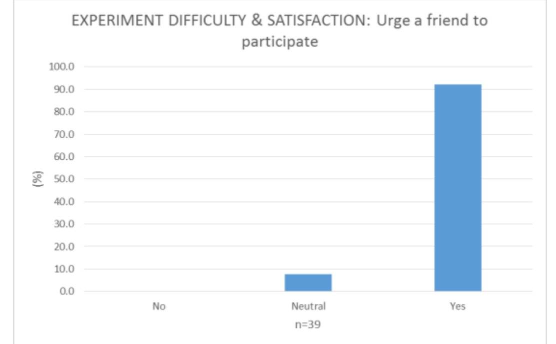

Fig. 24 – Dificuldade e satisfação com a experiência: Convite à participação

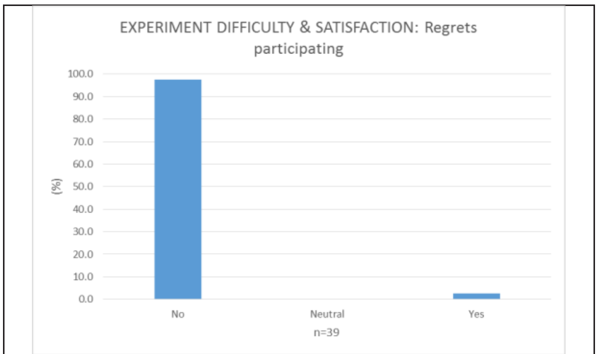

Fig. 25 – Dificuldade e satisfação com a experiência: Arrependimento da participação

Em termos conclusivos pode dizer-se que os indivíduos deste grupo não teve dificuldades em participar na experiência e que esta constituiu uma atividade que os satisfez e na qual se sentiram confortáveis e agradados. É ainda de sublinhar que em termos do estado de espírito não há indivíduos infelizes, nem tensos, nem frustrados, nem desinteressados. Em termos da qualidade da experiência, há indivíduos com ou sem dificuldade na realização da experiência, todos se sentem não frustrados e não há indivíduos insatisfeitos. Já no que diz respeito à satisfação com a experiência, não há indivíduos com dificuldade em manter a concentração, não há indivíduos que não tenham gostado da experiência e não há indivíduos que não recomendem a experiência a outrem.

3.2. Análise Multivariada

Para este grupo de indivíduos foram excluídas algumas variáveis ou algumas das suas categorias pelas seguintes razões:

- Excluiu-se a variável 1st *Year Student* por todos os alunos serem do 1º Ano do MiARQ e do MiAIRE;
- Excluiu-se a variável *Frustrating* por todos os alunos terem respondido *No*;
- Excluiram-se as categorias HAPn, RELn, ACCn, REWn, CURn, DIAx, SATn, MCOn, EPAn, UFPn por nenhum aluno ter escolhido estas categorias.
- Excluiu-se a variável *Regrets participating* por haver erros no ficheiro de *input* que não foram corrigidos em tempo útil.

Nas figuras 26 e 27 pode observar-se a percentagem da inércia da nuvem de dados retida em cada um dos eixos factoriais, bem como a representação gráfica dos valores próprios resultantes da diagonalização da matriz disjuntiva completa.

	Valor Proprio	% Exp	% Acum
1	0.224763	15.73341	15.73341
2	0.152608	10.68258	26.41599
3	0.135715	9.500028	35.91602
4	0.100395	7.027642	42.94366
5	0.094297	6.600786	49.54444
6	0.081409	5.698609	55.24305
7	0.077694	5.438591	60.68164
8	0.07377	5.16392	65.84556
9	0.067993	4.759506	70.60506
10	0.057658	4.036083	74.64114

Fig. 25 – Valores próprios e inércia dos eixos fatoriais

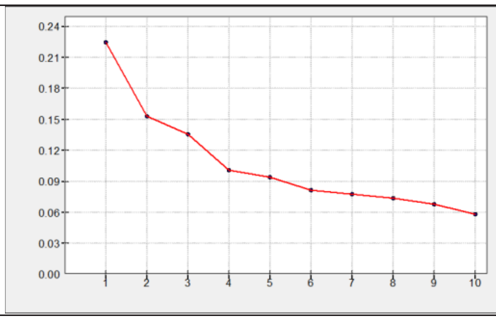

Fig. 26 – Screeplot

Os quatro primeiros eixos fatoriais explicam cerca de 43% da inércia total da nuvem de dados, havendo algumas categorias de variáveis e ou indivíduos explicados pelos eixos de ordem superior. As contribuições absolutas calculadas permitiram identificar as categorias de variáveis e os indivíduos que mais contribuíram para a formação de cada um dos eixos factoriais, que depois de projectados nos planos factoriais permitiram identificar alguns grupos de categorias de variáveis associadas e de indivíduos que se identificam com esses grupos. Na figura 28 estão projectadas as variáveis que mais contribuíram para os dois primeiros eixos factoriais, bem como a identificação dos respectivos grupos. Na figura 29 estão representados simultaneamente os indivíduos que se associam a cada um dos grupos definidos.

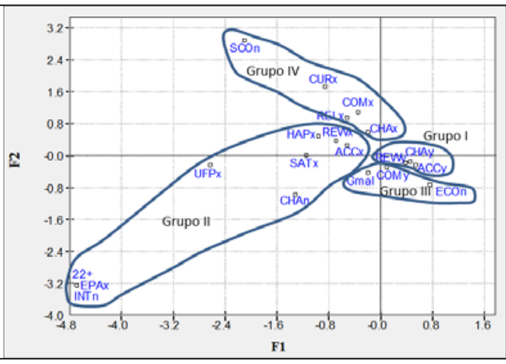

Fig. 28 – Projeção das variáveis com maiores contribuições para o 1º plano fatorial

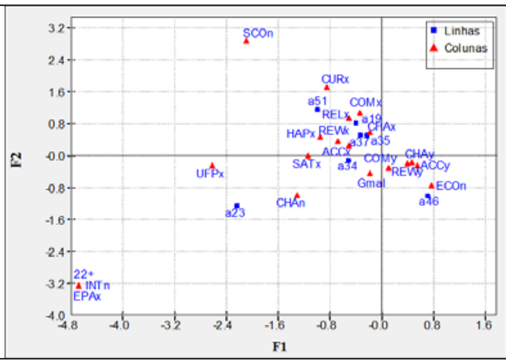

Fig. 29 – Projeção das variáveis e indivíduos com maiores contribuições para o 1º plano fatorial

Nas figuras 30 a 33 apresentam-se as mesmas representações para o 3º e 4º eixo factorial, respetivamente.

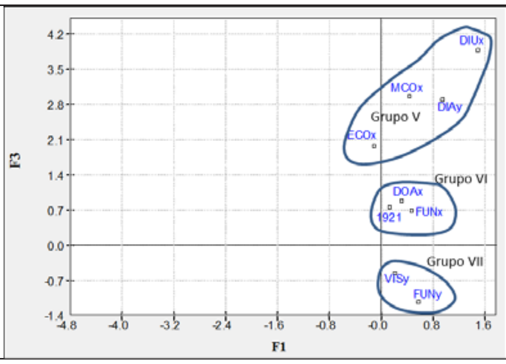

Fig. 30 – Projeção das variáveis com maiores contribuições para o 3º eixo fatorial

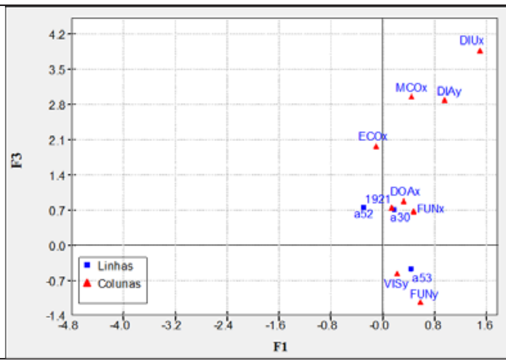

Fig. 31 – Projeção das variáveis e indivíduos com maiores contribuições para o 3º eixo fatorial

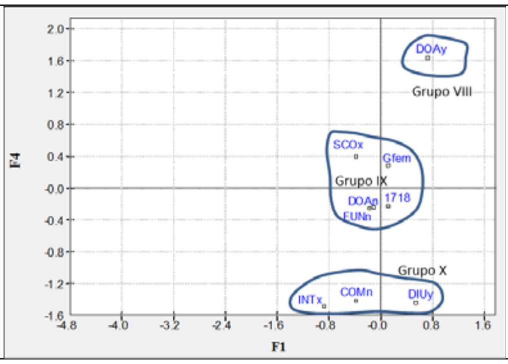

Fig. 32 – Projeção das variáveis com maiores contribuições para o 4º eixo fatorial

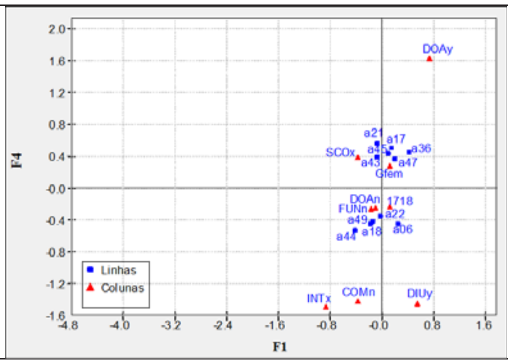

Fig. 33 – Projeção das variáveis e indivíduos com maiores contribuições para o 4º eixo fatorial

Na figura 34 apresenta-se uma síntese das principais conclusões deste grupo de indivíduos.

Grupos	Categorias	Indivíduos
I	ACCy, REWy, CHAy	
II	22+, HAPx, ACCx, REWx, INTn, CHAn, SATx, EPAx, UFPx	a23, a34
III	Gmal, COMy, ECOn	a46
IV	RELx, SCOn, COMx, CURx, CHAx	a19, a35, a37, a51
V	DIAy, DIUx, ECOx, MCOx	
VI	1921, FUNx, DOAx	a52, a30
VII	VISy, FUNy	a53
VIII	DOAy	
IX	1718, Gfem, SCOx, FUNn, DOAn	a06, a17, a18, a21, a22, a36, a43, a44, a45, a47, a49
X	COMn, INTx, DIUy	

Fig. 34 – Síntese da análise fatorial

4. Alunos do 5º ano do MiARQ e AGMiARQ

4.1. Análise Univariada

Em tudo o que diz respeito a este grupo de indivíduos, é importante sublinhar que se trata de um grupo reduzido de elementos (apenas 11 indivíduos), tornando quaisquer considerações pouco representativas.

Este grupo de indivíduos é constituído por adultos com idades entre os 22 e os 47 anos. A grande maioria tem idades compreendidas entre 23 e 30 anos (*vd*. figura 35), havendo apenas um indivíduo com idade superior (*vd*. figura 35). São adultos distribuídos igualmente pelos dois géneros (*vd*. figura 36), e que na sua maioria também nunca tinham visitado a Igreja de Alcobaça (*vd*. figura 37). Nas figuras 38 a 44 apresentam-se os diagramas de barras que mostram as respostas destes indivíduos às questões do inquérito relacionadas com as emoções/estado de espírito sentido na experiência. Verifica-se que a grande maioria dos indivíduos expressa um sentimento favorável e positivo perante a experiência realizada, registando-se em algumas questões uma percentagem significativa de indivíduos com uma atitude de indiferença/neutralidade. Tal facto poderá dever-se a maior maturidade deste grupo de indivíduos, manifestando mais facilmente a sua postura crítica.

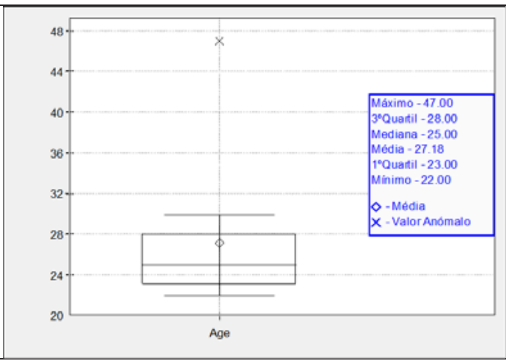

Fig. 35 – Box-plot da idade dos indivíduos

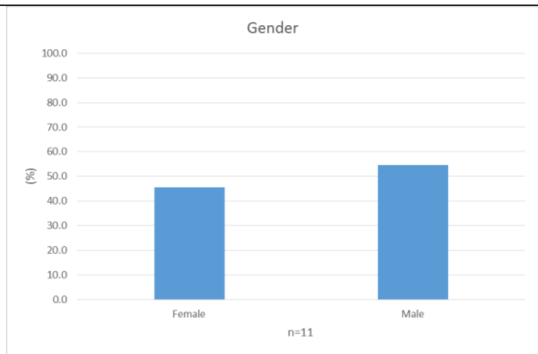

Fig. 36 – Género

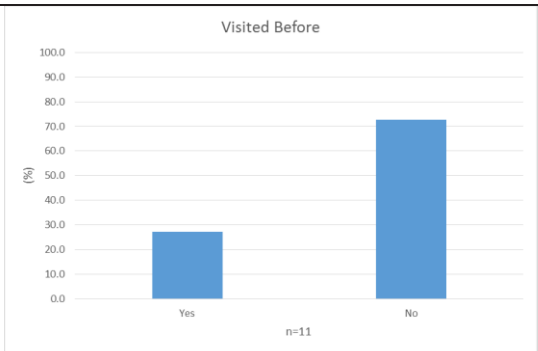

Fig. 37 – Visita anterior

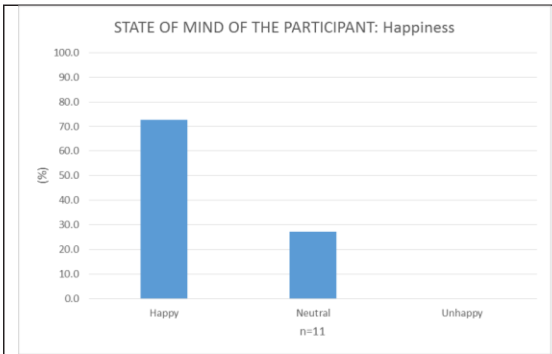

Fig. 38 – Estado de espírito: Felicidade

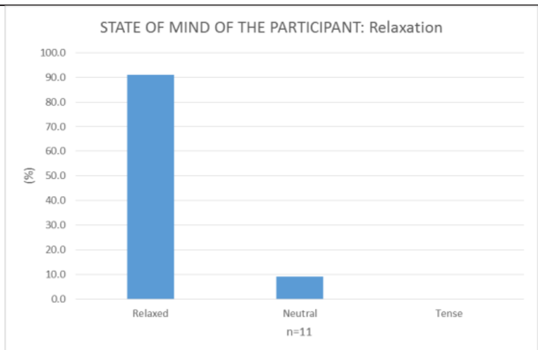

Fig. 39 – Estado de espírito: Relaxação

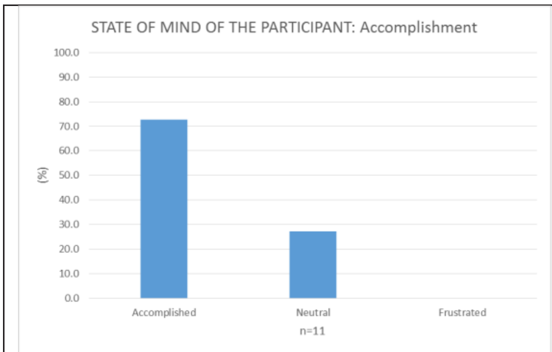

Fig. 40 – Estado de espírito: Realização

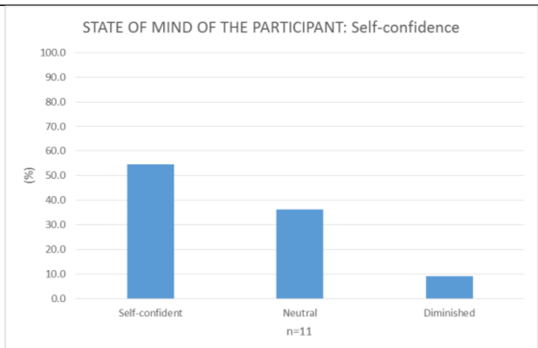

Fig. 41 – Estado de espírito: Auto-confiança

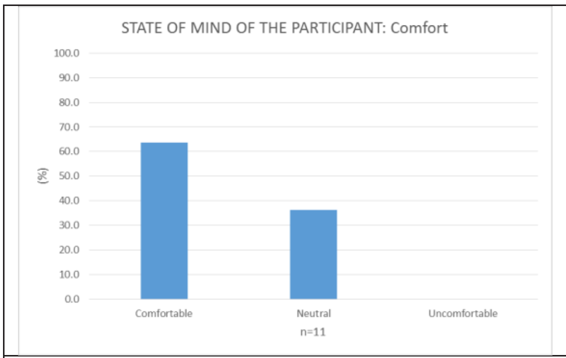

Fig. 42 – Estado de espírito: Conforto

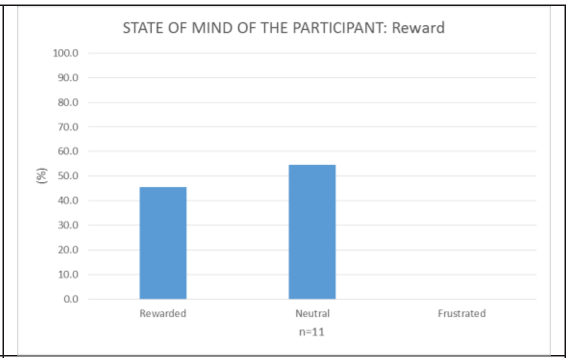

Fig. 43 – Estado de espírito: Recompensação

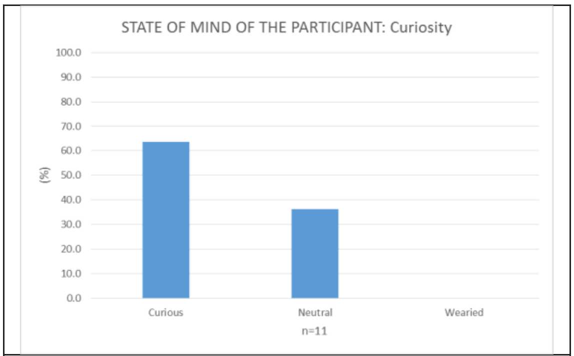

Fig. 44 – Estado de espírito: Curiosidade

No que diz respeito à qualidade da experiência realizada, nas figuras 45 a 50 encontram-se os resultados obtidos. A maioria das respostas revela elevado grau de satisfação com a qualidade da experiência realizada, evidenciando apenas alguma neutralidade quanto ao facto da experiência constituir ou não um desafio.

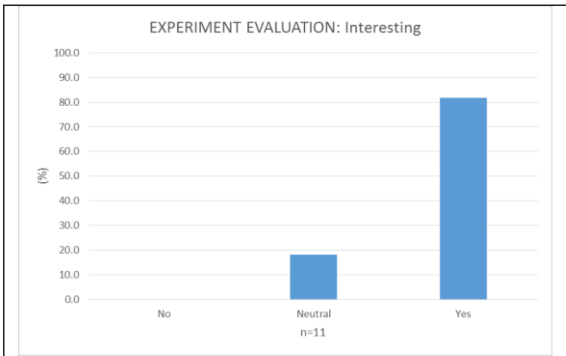

Fig. 45 – Qualidade da experiência: Interesse

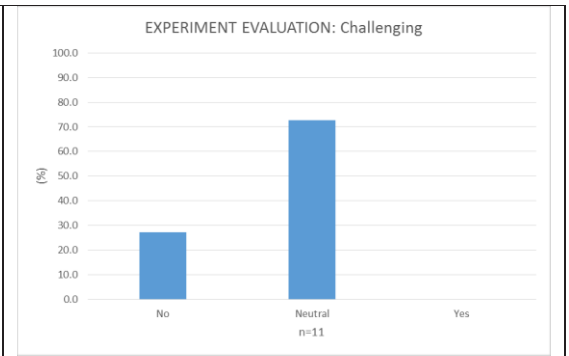

Fig. 46 – Qualidade da experiência: Desafio

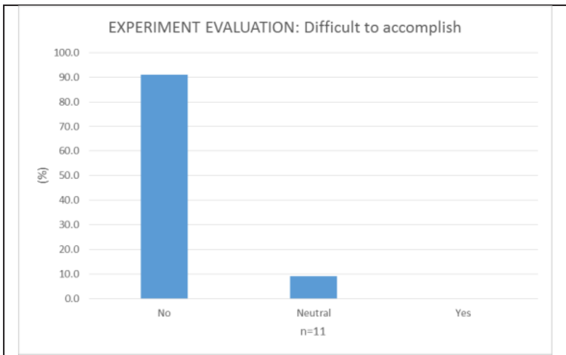

Fig. 47 – Qualidade da experiência: Realização

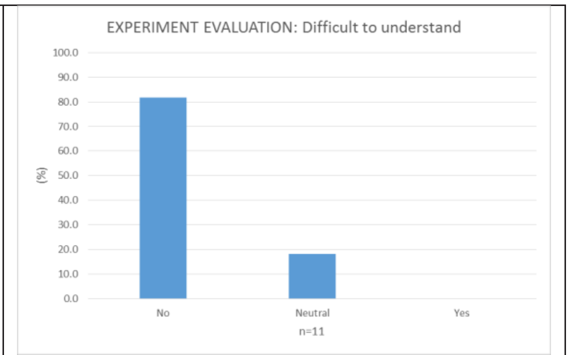

Fig. 48 – Qualidade da experiência: Compreensão

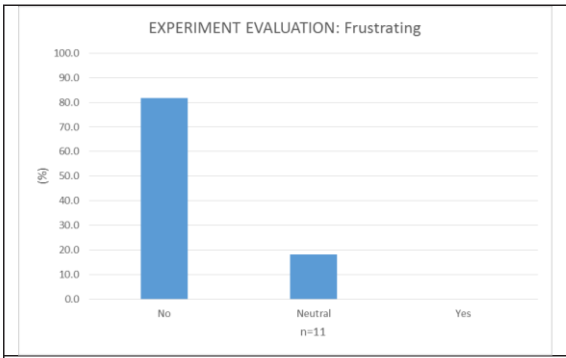

Fig. 49 – Qualidade da experiência: Frustração

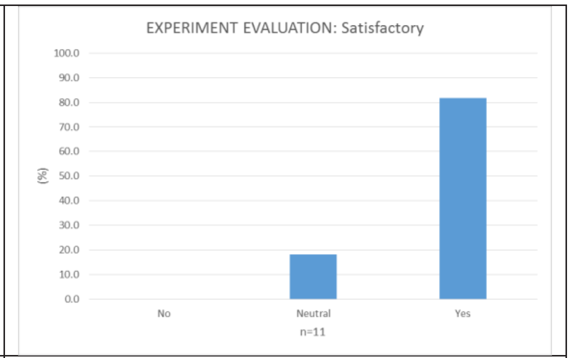

Fig. 50 – Qualidade da experiência: Satisfação

Em termos da dificuldade e satisfação com a experiência, os diagramas de barras obtidos (*vd*. figuras 51 a 57) mostram claramente que a experiência é fácil e agradável de realizar para a larga maioria dos participantes.

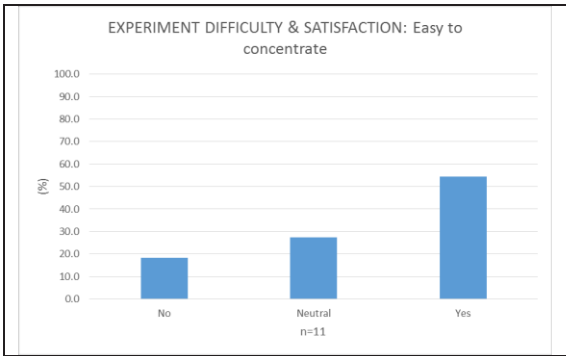

Fig. 51 – Dificuldade e satisfação com a experiência: Facilidade de concentração

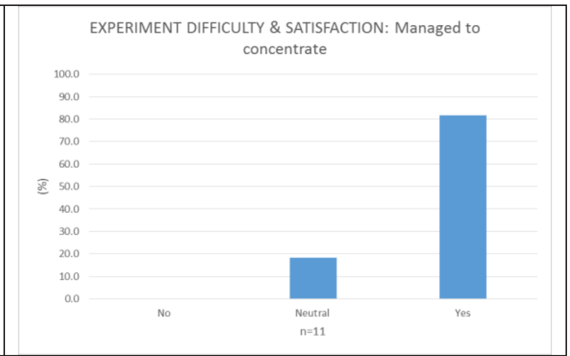

Fig. 52 – Dificuldade e satisfação com a experiência: Manutenção da concentração

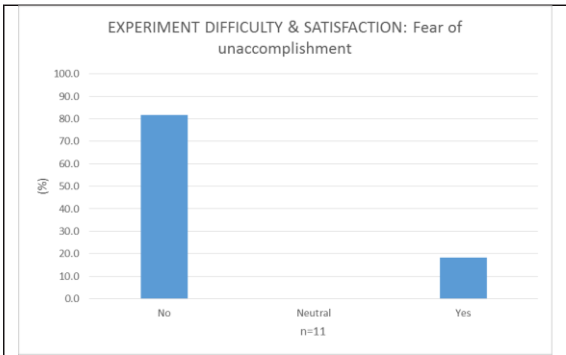

Fig. 53 – Dificuldade e satisfação com a experiência: Receio da experiência

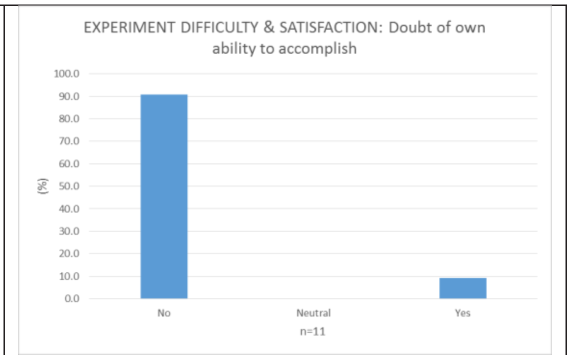

Fig. 54 – Dificuldade e satisfação com a experiência: Dúvidas da capacidade de realizar a experiência

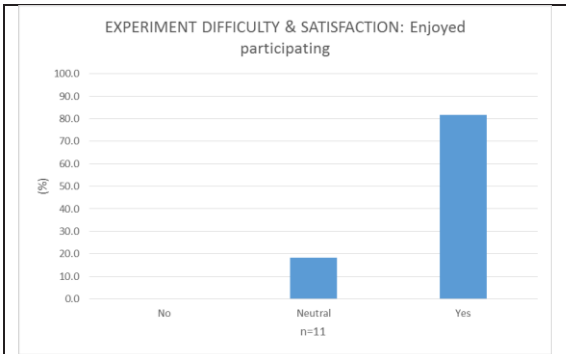

Fig. 55 – Dificuldade e satisfação com a experiência: Satisfação com a participação

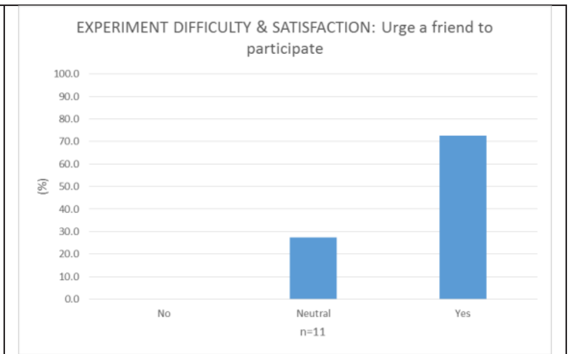

Fig. 56 – Dificuldade e satisfação com a experiência: Convite à participação

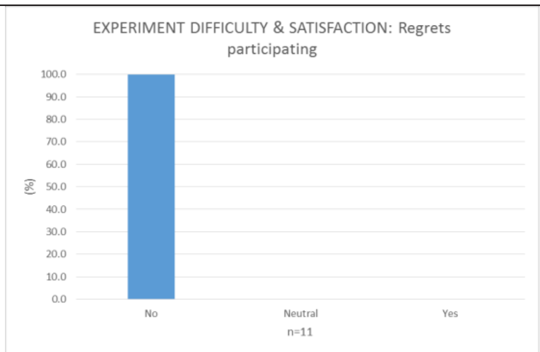

Fig. 57 – Dificuldade e satisfação com a experiência: Arrependimento da participação

Em termos conclusivos pode dizer-se que os indivíduos deste grupo não teve dificuldades em participar na experiência e que esta constituiu uma atividade que os satisfez, mostrando contudo alguma indiferença emocional com a experiência, mas onde se sentiram confortáveis e agradados. Deve também ser sublinhado que em termos do estado de espírito não há indivíduos infelizes, nem tensos, nem frustrados, nem desconfortáveis, nem frustrados, nem desinteressados. Em termos da qualidade da experiência, há indivíduos desinteressados, nem sentiram a actividade desafiante, nem com dificuldade na realização da experiência, nem frustrados e não há indivíduos insatisfeitos. Já no que diz respeito à satisfação com a experiência, não há indivíduos com dificuldade em manter a concentração, há indivíduos que sentiram ou não receio na realização da experiência, há indivíduos com ou sem dúvidas na realização da experiência, não há indivíduos que não tenham gostado da experiência, não há indivíduos que não recomendem a experiência a outrem e nenhum indivíduo se sentiu arrependido por realizar a experiência.

4.2. Análise Multivariada

Para este grupo de indivíduos foram excluídas algumas variáveis ou algumas das suas categorias pelas seguintes razões:

- Excluiu-se a variável *Age* por todos os alunos terem idade superior a 22 anos;
- Excluiu-se a variável 1^{st} *Year Student* por todos os alunos serem do 5º Ano do MiARQ e AGMiARQ;
- Excluiram-se as categorias HAPn, RELn, ACCn, COMn, REWn, CURn, INTn, CHAy, DIAy, DIUy, FRUy, SATn, MCOn, FUNx, DOAx, EPAn, UFPn por nenhum aluno ter escolhido estas categorias.
- Excluiu-se a variável *Regrets participating* por todos os indivíduos terem respondido *No*.

Nas figuras 58 e 59 pode observar-se a percentagem da inércia da nuvem de dados retida em cada um dos eixos factoriais, bem como a representação gráfica dos valores próprios resultantes da diagonalização da matriz disjuntiva completa.

	Valor Proprio	% Exp	% Acum
1	0.300417	27.42937	27.42937
2	0.192944	17.61662	45.04598
3	0.156885	14.32425	59.37024
4	0.119401	10.9018	70.27204
5	0.098624	9.004779	79.27682
6	0.081853	7.473555	86.75037
7	0.054792	5.002723	91.7531
8	0.034305	3.132191	94.88528
9	0.031356	2.862916	97.7482
10	0.024663	2.251796	99.99999

Fig. 58 – Valores próprios e inércia dos eixos fatoriais

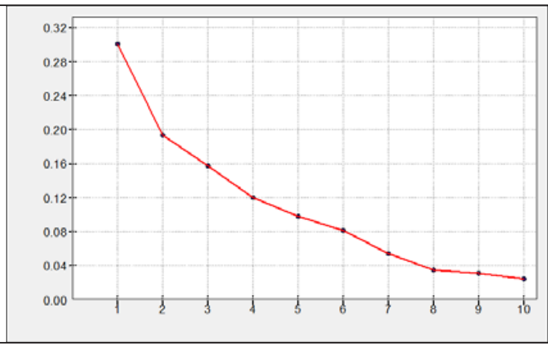

Fig. 59 – Screeplot

Os quatro primeiros eixos fatoriais explicam mais de 70% da inércia total da nuvem de dados, não havendo categorias de variáveis e ou indivíduos explicados pelos eixos de ordem superior. As contribuições absolutas calculadas permitiram identificar as categorias de variáveis e os indivíduos que mais contribuíram para a formação de cada um dos eixos factoriais, que depois de projectados nos planos factoriais permitiram identificar alguns grupos de categorias de variáveis associadas e de indivíduos que se identificam com esses grupos. Na figura 60 estão projectadas as variáveis que mais contribuíram para os dois primeiros eixos factoriais, bem como a identificação dos respectivos grupos. Na figura 61 estão representados simultaneamente os indivíduos que se associam a cada um dos grupos definidos.

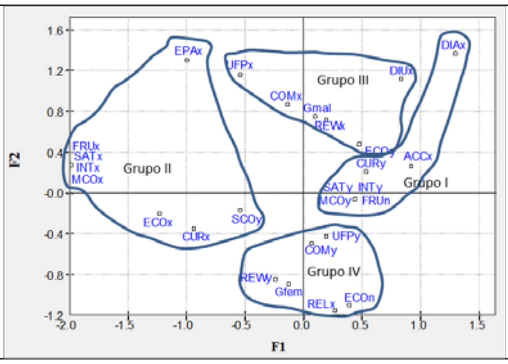

Fig. 60 – Projeção das variáveis com maiores contribuições para o 1º plano fatorial

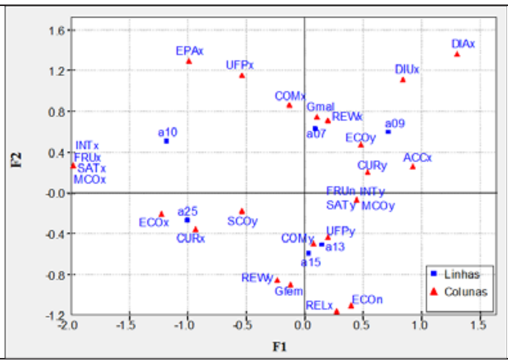

Fig. 61 – Projeção das variáveis e indivíduos com maiores contribuições para o 1º plano fatorial

Nas figuras 62 a 65 apresentam-se as mesmas representações para o 3º e 4º eixo factorial, respetivamente.

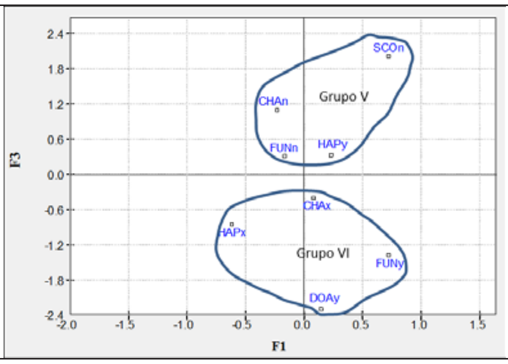

Fig. 62 – Projeção das variáveis com maiores contribuições para o 3º eixo fatorial

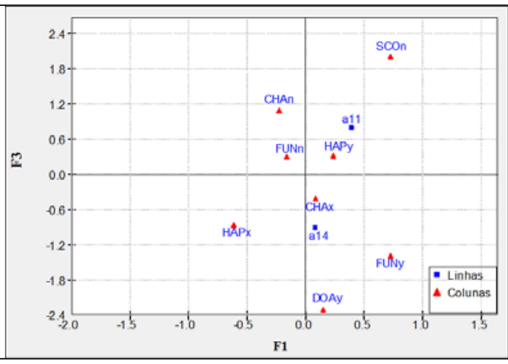

Fig. 63 – Projeção das variáveis e indivíduos com maiores contribuições para o 3º eixo fatorial

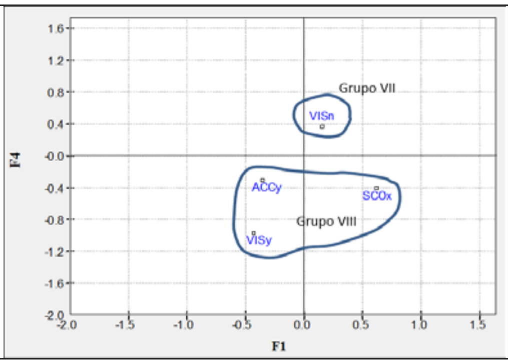

Fig. 64 – Projeção das variáveis com maiores contribuições para o 4º eixo fatorial

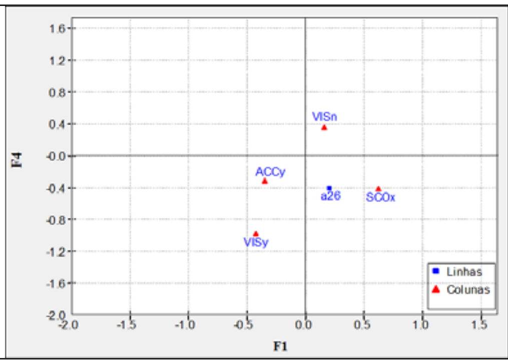

Fig. 65 – Projeção das variáveis e indivíduos com maiores contribuições para o 4º eixo fatorial

Na figura 66 apresenta-se uma síntese das principais conclusões deste grupo de indivíduos.

Grupos	Categorias	Indivíduos
I	ACCx, CURy, INTy, DIAx, FRUn, SATy, MCOy	a09
II	SCOy, CURx, INTx, FRUx, SATx, ECOx, MCOx, EPAx	a10, a25
III	Gmal, COMx, REWx, DIUx, ECOy, UFPx	a07
IV	Gfem, RELx, COMy, REWy, ECOn, UFPy	a13, a15
V	HAPy, SCOn, CHAn, FUNn	a11
VI	HAPx, CHAx, FUNy, DOAy	a14
VII	VISn	
VIII	VISy, ACCy, SCOx	a26

Fig. 66 – Síntese da análise fatorial

5. Total de indivíduos

5.1. Análise Univariada

Este grupo de indivíduos é constituído por jovens com idades entre os 17 e os 47 anos. A grande maioria tem idades compreendidas entre 17 e 21 anos (*vd*. figura 67), havendo 9 indivíduos com idade superior (*vd*. figura 67). Trata-se de indivíduos maioritariamente do género feminino (*vd*. figura 68), e que na sua maioria nunca tinham visitado a Igreja de Alcobaça (*vd*. figura 69). Nas figuras 70 a 76 apresentam-se os diagramas de barras que mostram as respostas destes indivíduos às questões do inquérito relacionadas com as emoções/estado de espírito sentido na experiência. Verifica-se que a grande maioria dos indivíduos expressa um sentimento favorável e positivo perante a experiência realizada, registando-se apenas em algumas questões a existência de uma atitude de indiferença/neutralidade.

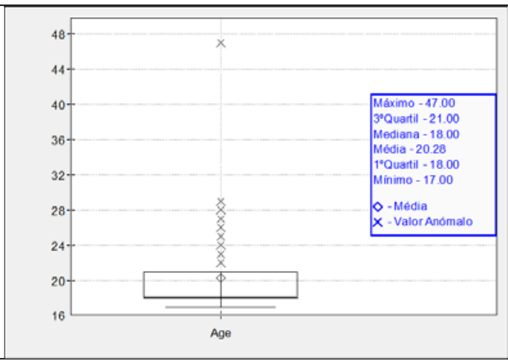

Fig. 67 – Box-plot da idade de todos os indivíduos

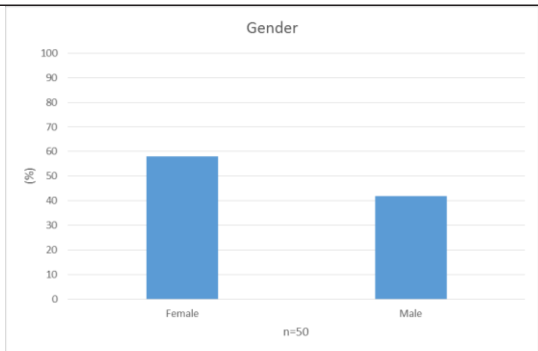

Fig. 68 – Género

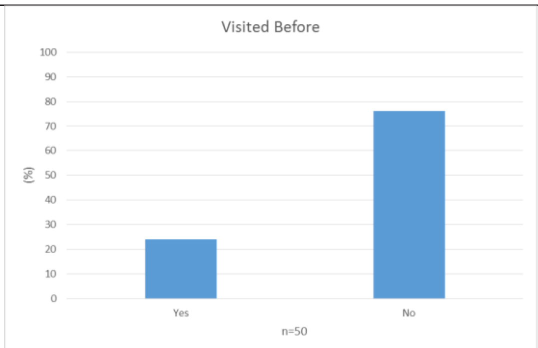

Fig. 69 – Visita anterior

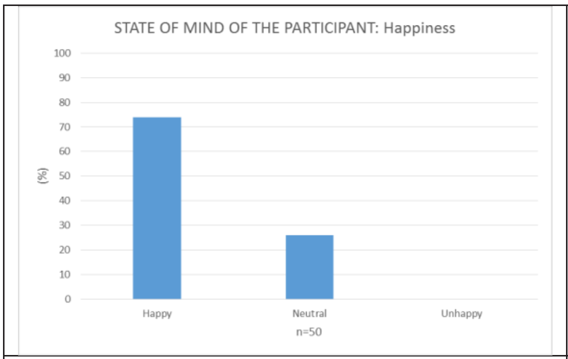

Fig. 70 – Estado de espírito: Felicidade

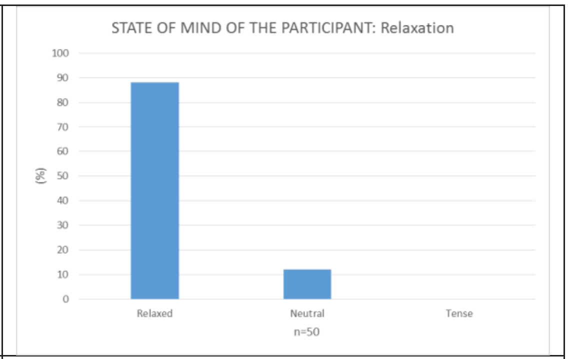

Fig. 71 – Estado de espírito: Relaxação

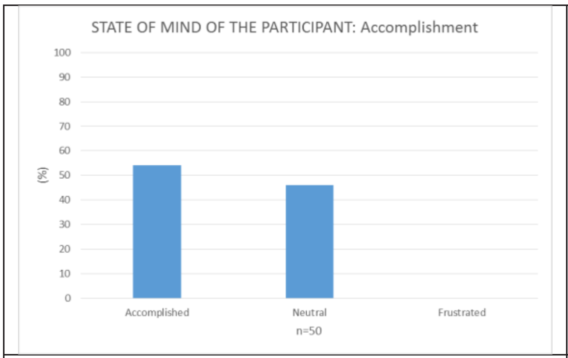

Fig. 72 – Estado de espírito: Realização

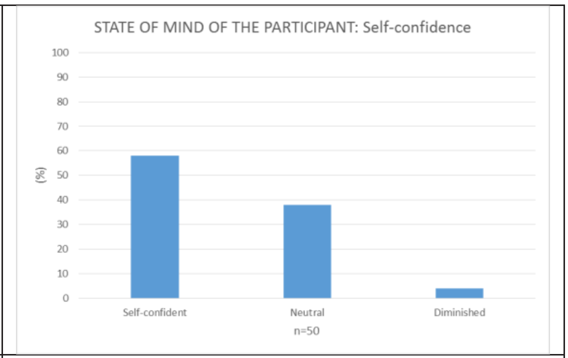

Fig. 73 – Estado de espírito: Auto-confiança

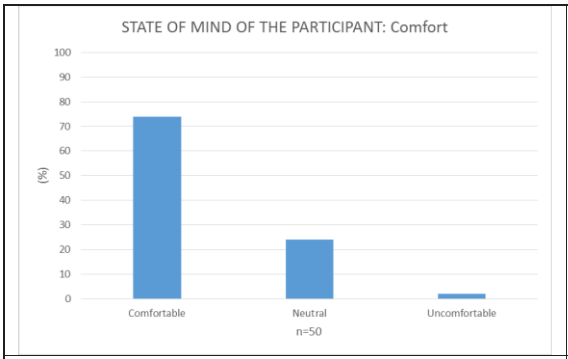

Fig. 74 – Estado de espírito: Conforto

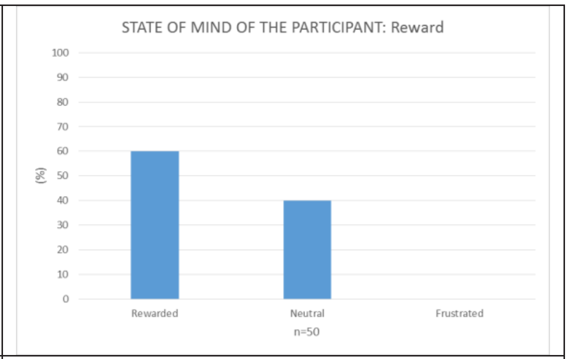

Fig. 75 – Estado de espírito: Recompensação

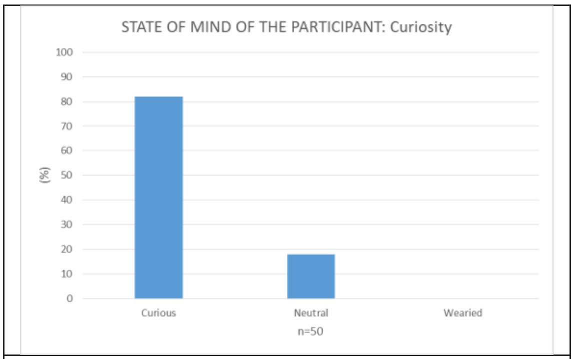

Fig. 76 – Estado de espírito: Curiosidade

No que diz respeito à qualidade da experiência realizada, nas figuras 77 a 82 encontram-se os resultados obtidos. A maioria das respostas revela elevado grau de satisfação com a qualidade da experiência realizada, exceto no que se refere a considerá-la como uma atividade desafiante.

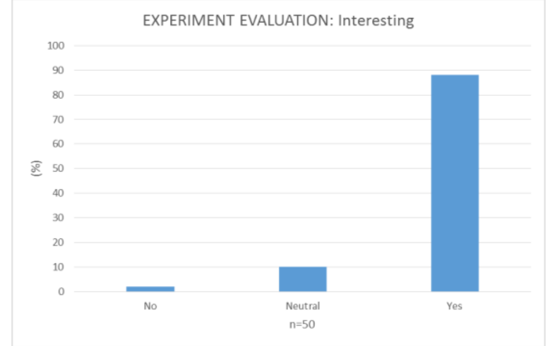

Fig. 77 – Qualidade da experiência: Interesse

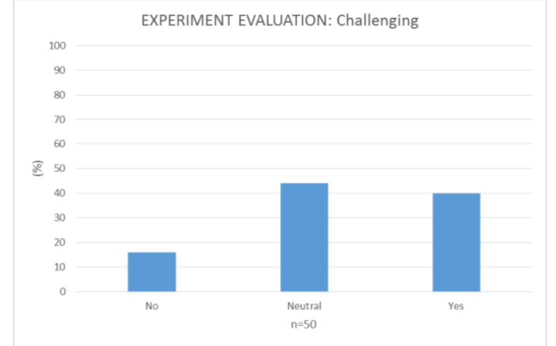

Fig. 78 – Qualidade da experiência: Desafio

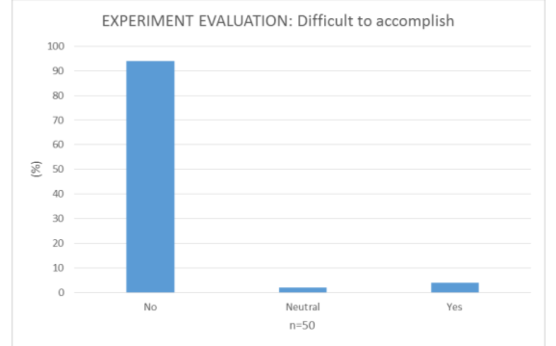

Fig. 79 – Qualidade da experiência: Realização

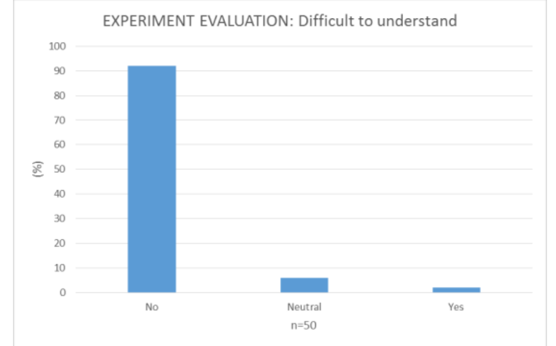

Fig. 80 – Qualidade da experiência: Compreensão

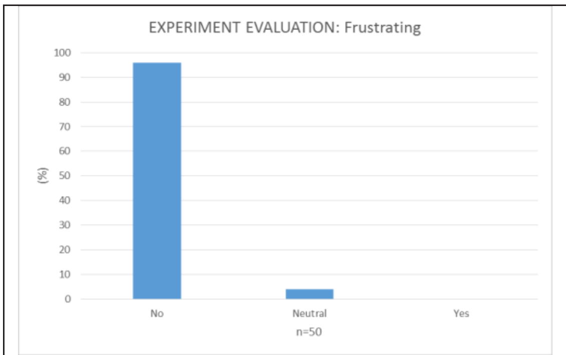

Fig. 81 – Qualidade da experiência: Frustração

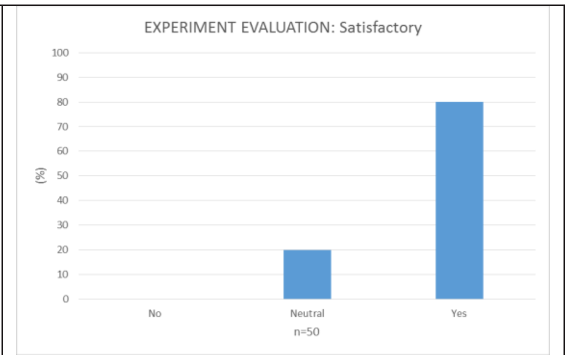

Fig. 82 – Qualidade da experiência: Satisfação

Em termos da dificuldade e satisfação com a experiência, os diagramas de barras obtidos (*vd*. figuras 83 a 89) mostram claramente que a experiência é fácil e agradável de realizar para a larga maioria dos participantes.

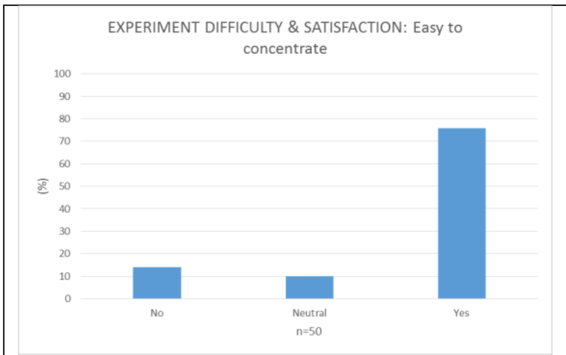

Fig. 83 – Dificuldade e satisfação com a experiência: Facilidade de concentração

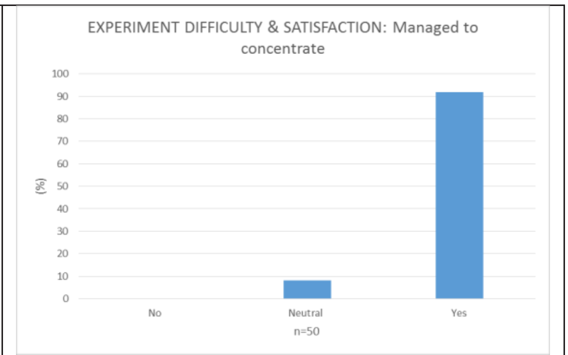

Fig. 84 – Dificuldade e satisfação com a experiência: Manutenção da concentração

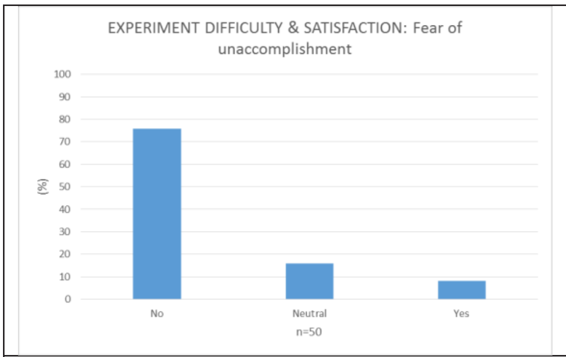

Fig. 85 – Dificuldade e satisfação com a experiência: Receio da experiência

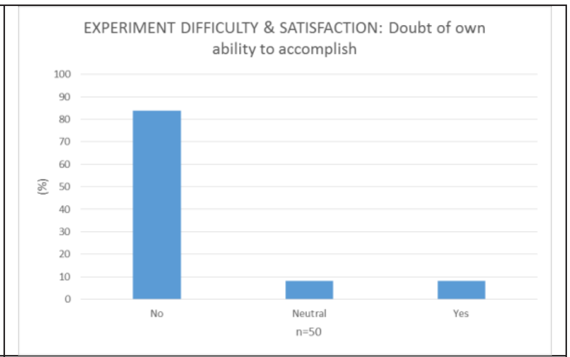

Fig. 86 – Dificuldade e satisfação com a experiência: Dúvidas da capacidade de realizar a experiência

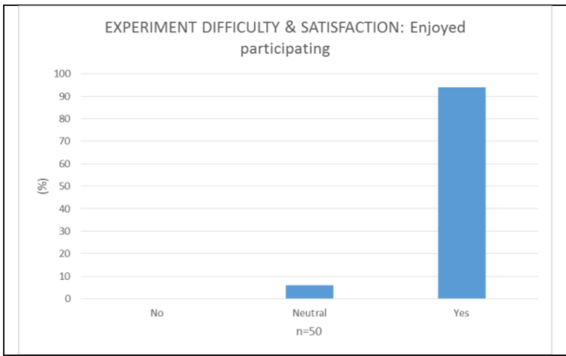

Fig. 87 – Dificuldade e satisfação com a experiência: Satisfação com a participação

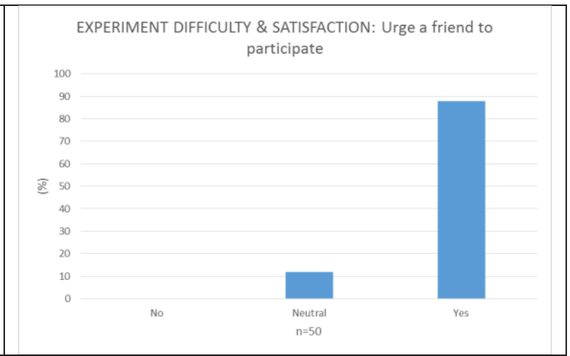

Fig. 88 – Dificuldade e satisfação com a experiência: Convite à participação

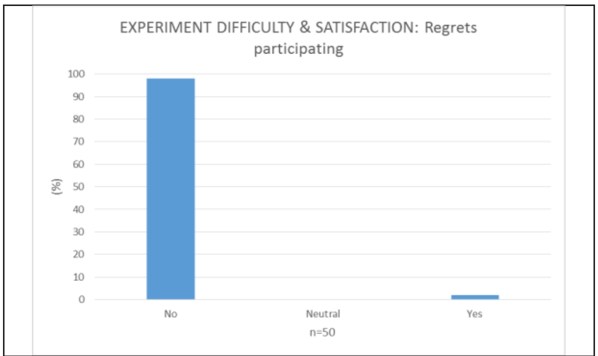

Fig. 89 – Dificuldade e satisfação com a experiência: Arrependimento da participação

Em termos conclusivos pode dizer-se que os indivíduos que realizaram a experiência não sentiram dificuldades na sua participação, tendo esta constituído uma atividade que os satisfez e na qual se sentiram confortáveis e agradados. É ainda de sublinhar que em termos do estado de espírito não há indivíduos infelizes, nem tensos, nem frustrados, nem desinteressados. Em termos da qualidade da experiência, todos se sentem não frustrados e não há indivíduos insatisfeitos. Já no que diz respeito à satisfação com a experiência, não há indivíduos com dificuldade em manter a concentração, não há indivíduos que não tenham gostado da experiência e não há indivíduos que não recomendem a experiência a outrem.

5.2. Análise Multivariada

Para este grupo de indivíduos foram excluídas algumas variáveis ou algumas das suas categorias pelas seguintes razões:

- Excluiram-se as categorias HAPn, RELn, ACCn, REWn, CURn, FRUy, SATn, MCOn, EPAn, UFPn por nenhum aluno ter escolhido estas categorias.

- Excluiu-se a variável *Regrets participating* por haver erros no ficheiro de *input* que não foram corrigidos em tempo útil.

Nas figuras 90 e 91 pode observar-se a percentagem da inércia da nuvem de dados retida em cada um dos eixos factoriais, bem como a representação gráfica dos valores próprios resultantes da diagonalização da matriz disjuntiva completa.

	Valor Proprio	% Exp	% Acum
1	0.207334	14.45053	14.45053
2	0.119881	8.355335	22.80586
3	0.115464	8.047499	30.85336
4	0.094743	6.603294	37.45666
5	0.090565	6.312083	43.76874
6	0.082424	5.744733	49.51347
7	0.074041	5.160405	54.67388
8	0.071725	4.998998	59.67287
9	0.064612	4.503238	64.17611
10	0.058418	4.071569	68.24768

Fig. 90 – Valores próprios e inércia dos eixos fatoriais

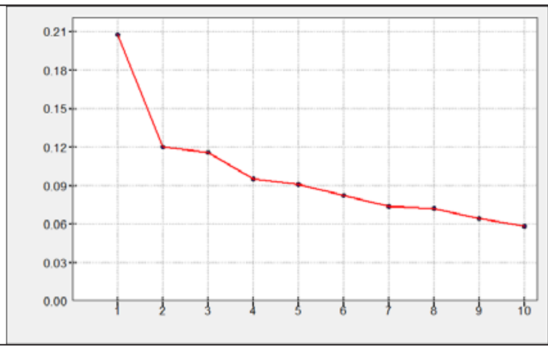

Fig. 91 – Screeplot

Os quatro primeiros eixos fatoriais explicam cerca de 37% da inércia total da nuvem de dados, havendo algumas categorias de variáveis e ou indivíduos explicados pelos eixos de ordem superior. As contribuições absolutas calculadas permitiram identificar as categorias de variáveis e os indivíduos que mais contribuíram para a formação de cada um dos eixos factoriais, que depois de projectados nos planos factoriais permitiram identificar alguns grupos de categorias de variáveis associadas e de indivíduos que se identificam com esses grupos. Na figura 92 estão projectadas as variáveis que mais contribuíram para os dois primeiros eixos factoriais, bem como a identificação dos respectivos grupos. Na figura 93 estão representados simultaneamente os indivíduos que se associam a cada um dos grupos definidos.

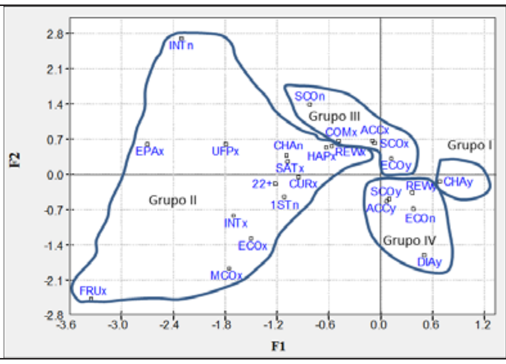

Fig. 92 – Projeção das variáveis com maiores contribuições para o 1º plano fatorial

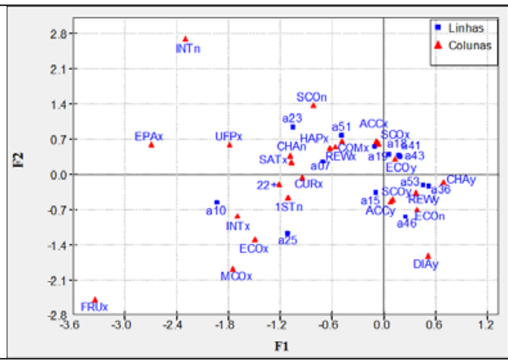

Fig. 93 – Projeção das variáveis e indivíduos com maiores contribuições para o 1º plano fatorial

Nas figuras 94 a 97 apresentam-se as mesmas representações para o 3º e 4º eixo factorial, respetivamente.

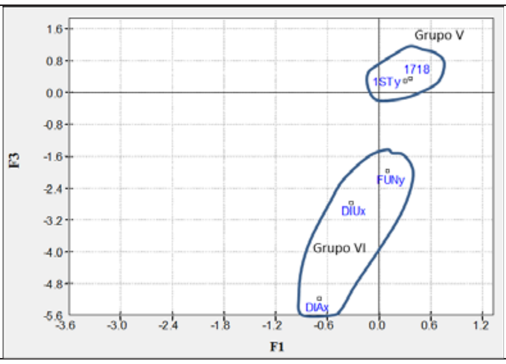

Fig. 94 – Projeção das variáveis com maiores contribuições para o 3º eixo fatorial

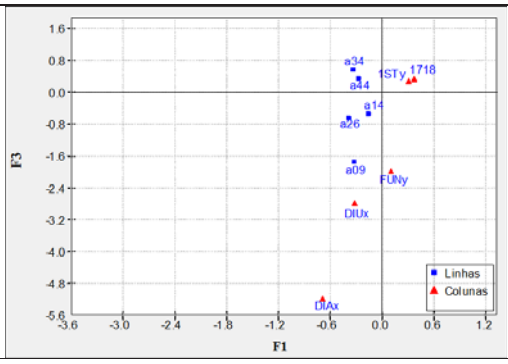

Fig. 95 – Projeção das variáveis e indivíduos com maiores contribuições para o 3º eixo fatorial

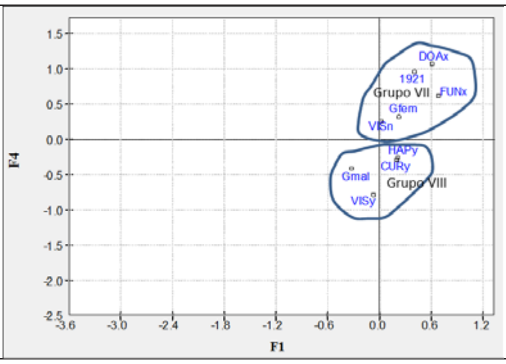

Fig. 96 – Projeção das variáveis com maiores contribuições para o 4º eixo fatorial

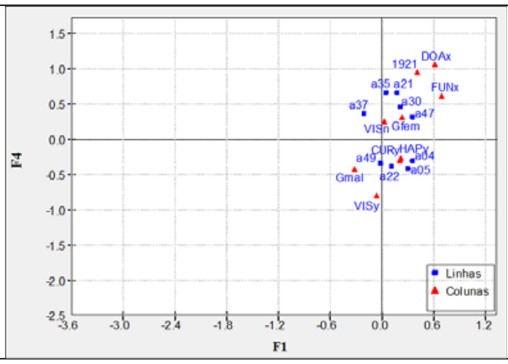

Fig. 97 – Projeção das variáveis e indivíduos com maiores contribuições para o 4º eixo fatorial

Na figura 98 apresenta-se uma síntese das principais conclusões sobre todos os indivíduos.

Grupos	Categorias	Indivíduos
I	CHAy	
II	22+, 1STn, HAPx, REWx, CURx, INTn, INTx, CHAn, FRUx, SATx, ECOx, MCOx, EPAx, UFPx	a07, a10, a25
III	ACCx, SCOx, SCOn, COMx, ECOy	a18, a19, a23, a41, a43, a51
IV	ACCy, SCOy, REWy, DIAy, ECOn	a15, a46
V	1718, 1STy	a34, a44
VI	DIAx, DIUx, FUNy	a09, a14, a26
VII	1921, VISn, Gfem, FUNx, DOAx	a21, a30, a35, a37, a47
VIII	VISy, Gmal, HAPy, CURy	a04, a05, a22, a49

Fig. 98 – Síntese da análise fatorial

6. Conclusões

A análise exploratória efetuada permitiu caracterizar os indivíduos participantes na experiência, bem como a sua atitude e sentimento perante a atividade. As respostas dadas ao inquérito revelam haver semelhança entre os dois grupos de indivíduos, notando-se uma ligeira indiferença perante a experiência no grupo de alunos do 5º ano do MiARQ e AGMiARQ. É ainda de referir que os resultados obtidos para o grupo de indivíduos do 1º ano do MiARQ e do MiAIRE são muito idênticos aos da totalidade dos indivíduos, dado que representam cerca de 80% do total. Na mesma linha de raciocínio é importante salientar que os resultados obtidos para o grupo de alunos do 5º ano do MiARQ e AGMiARQ são pouco significativos pois resultam de um número de elementos bastante reduzido. A análise multivariada permitiu sintetizar os três conjuntos de dados, estabelecendo grupos de categorias das variáveis que se associam mutuamente e com os quais os indivíduos se identificam.

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5. Appendix E – Entry Behavior

Análise do comportamento da entrada dos visitantes da Igreja de Alcobaça

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1. INTRODUÇÃO

Esta análise incide sobre uma amostra de 517 indivíduos que visitaram a Igreja de Alcobaça no período entre 20/out./2014 e 04/dez./2014 e que consentiram ser filmados durante o seu percurso de entrada na Igreja. O procedimento experimental consistiu em dividir os 517 indivíduos em dois grupos – alunos do 1º ano dos Mestrados Integrados em Arquitetura (MiARQ) e em Arquitetura de Interiores e Reabilitação do Edificado (MiAIRE), alunos do 5º ano do MiARQ e alunos graduados (AGMiARQ) que concluíram recentemente o mesmo mestrado da Faculdade de Arquitetura da Universidade de Lisboa (50 indivíduos), aqui designados por indivíduos da experiência e, outro grupo constituído por visitantes anónimos (467 indivíduos), daqui em diante designados por indivíduos anónimos. As variáveis em estudo são quantitativas discretas e dão conta da direção que os indivíduos tomaram ao entrar na Igreja.

2. METODOLOGIA DE ANÁLISE

Em termos metodológicos procedeu-se à elaboração de gráficos (Murteira *et al*. 2010) para cada um dos conjuntos de dados, correspondentes a cada um dos grupos de indivíduos, bem como para a totalidade dos indivíduos. Todos os gráficos e cálculos foram efetuados usando como recurso computacional o Microsoft Excel versão 14.0.7153.5000 (Microsoft Office Profissional Plus 2010).

3. Indivíduos da experiência

Na figura 1 verifica-se que a maioria dos indivíduos deste grupo opta pelas direcções F e 1S-3S ao entrar na Igreja. Seguem-se como direções preferenciais a F+ES, 1N-3N e 7N-9N. Nenhum indivíduo opta pelas direções 4N-6N e BS+Sit.

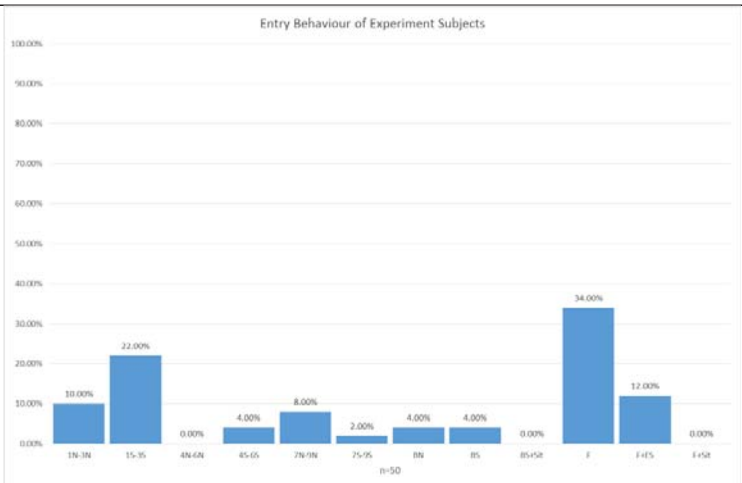

Fig. 1 – Comportamento à entrada na Igreja dos indivíduos da experiência

4. Indivíduos anónimos

Na figura 2 é claro que a maioria dos indivíduos deste grupo opta pela direção F ao entrar na Igreja. A enorme distância, segue-se como direção preferencial a BS. Todas as outras direções constituem opção para um reduzido número de indivíduos.

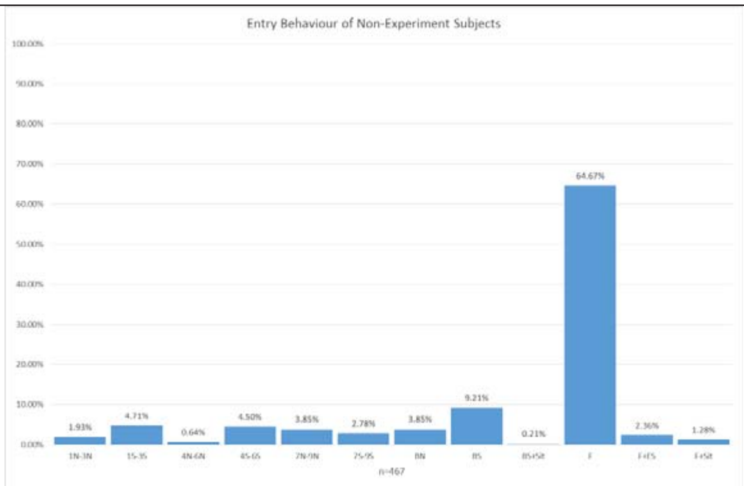

Fig. 2 – Comportamento à entrada na Igreja dos indivíduos anónimos

5. Todos os indivíduos

Na figura 3 é também claro que a maioria dos indivíduos deste grupo opta pela direção F ao entrar na Igreja. A enorme distância, seguem-se como direções preferenciais as BS e 1S-3S. Todas as outras direções constituem opção para um reduzido número de indivíduos.

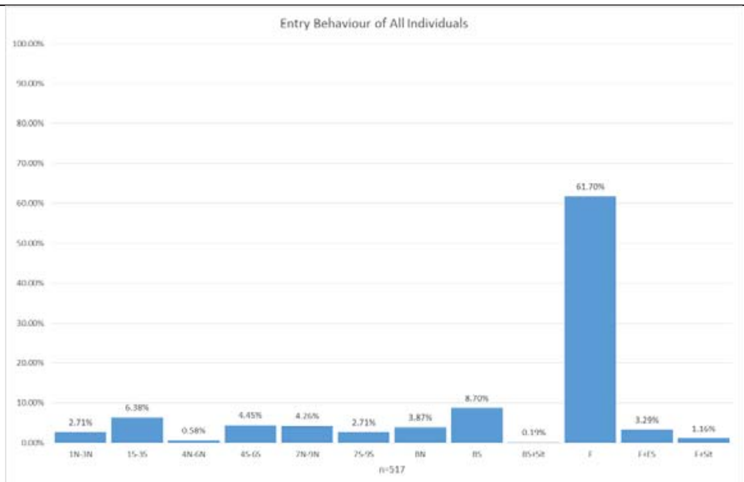

Fig. 3 – Comportamento à entrada na Igreja de todos os indivíduos

6. Comparações entre grupos de indivíduos

Na figura 4 apresenta-se a comparação entre os dois grupos de indivíduos.

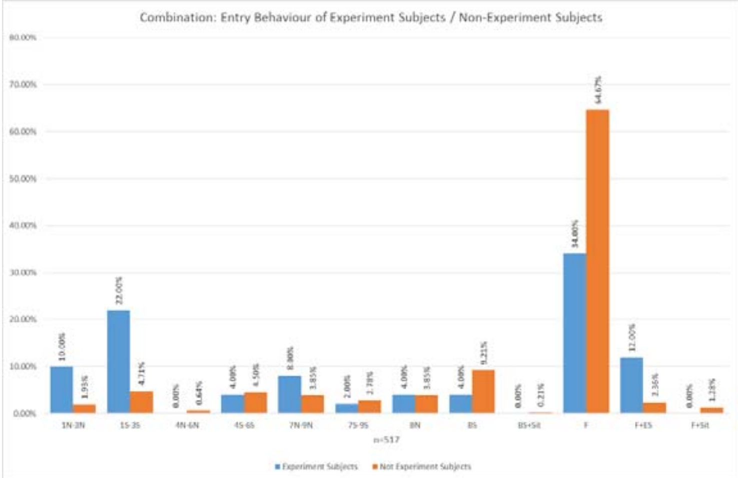

Fig. 4 – Comparação do comportamento à entrada na Igreja dos indivíduos da experiência com os indivíduos anónimos

Considerando os valores obtidos para os indivíduos anónimos como valores esperados e os valores obtidos para os indivíduos da experiência, fez-se um teste de hipóteses para verificar se são ou não dois conjuntos independentes. Obteve-se Q_{obs} = 160.95 > 19.675 para α = 0.05 com 11 graus de liberdade. Portanto, com 95% de confiança pode afirmar-se que os dois grupos de indivíduos são independentes, ou seja os comportamentos destes dois grupos de indivíduos à entrada da Igreja são diferentes um do outro.

7. Conclusões

A análise exploratória efetuada permitiu estudar individualmente os dois grupos de indivíduos em termos do seu comportamento na entrada da Igreja e verificar que o grupo de indivíduos da experiência tem um comportamento diferente dos indivíduos anónimos.

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6. Appendix F – Temporary Eye Fixations (Without Areas)

ANÁLISE UNIVARIADA E BIVARIADA

1. INTRODUÇÃO

Esta análise incide sobre uma amostra de 50 indivíduos que visitaram a Igreja de Alcobaça no período entre 20/out./2014 e 04/dez./2014, que se voluntariaram para a realização da experiência. O procedimento experimental consistiu no registo do número de fixações do olhar (variável NF) em 8 áreas distintas da Igreja, identificadas pelas letras A, B, C, D, E, X, Y e Z na figura 1, bem como a duração (variável Time, medida em segundos) dessas mesmas fixações. Embora ambas as variáveis sejam quantitativas, a variável NF é discreta, enquanto a variável Time é contínua.

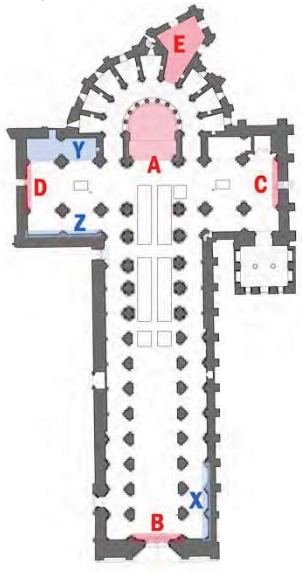


Fig. 1 – Identificação das áreas observadas na Igreja.

2. ANÁLISE UNIVARIADA

As figuras 2 e 3 mostram inequivocamente que a área A é a preferida pelos visitantes, quer em tempo de observação que lhe dedicam, quer em número de vezes que é observada. A área B é a segunda área preferida pelos indivíduos, porém estes dedicam-lhe cerca de metade do tempo e metade do número de observações que dedicam à área A. A grande distância das anteriores, a área Y é a terceira área a ser observada durante mais tempo. Todas as outras áreas registam, para a totalidade dos indivíduos, tempos de observação inferiores a 500 s (*vd*. Figura 2). As áreas X e Z são aquelas a que os indivíduos dedicam menor tempo de observação (*vd*. Figura 2). Por outro lado, as áreas D, Y e C seguem as áreas A e B, a grande distância, em número de fixações. As áreas X, Z e E são as áreas menos fixadas, registando para a totalidade dos indivíduos, menos de 100 fixações.

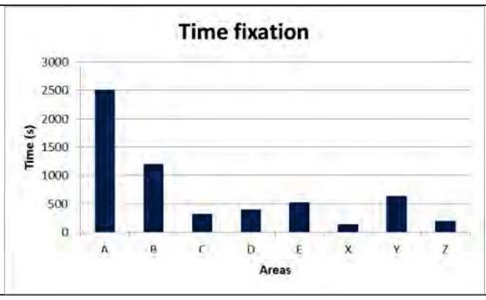


Fig. 2 – Tempo de fixação das áreas

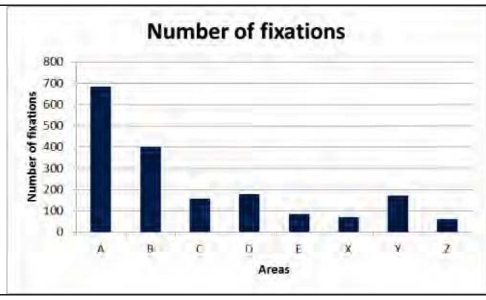


Fig. 3 – Número de fixações das áreas

Na figura 4 apresentam-se os estatísticos básicos calculados para ambas as variáveis na totalidade das áreas e em cada uma das áreas individualmente.

	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
All areas	Time	400.0	16666.05	N/A	6896	0	2061	18478	171414	5.3E+08	23011.59	1.3807	171414	16417	2.8262	0.5951
	NF	400.0	5.1073	N/A	3	0	1	5	36	31.2632	5.5914	1.0948	36	4	2.1673	0.5268
	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
Area A	Time	50.0	50163.88	N/A	40690	4076	14267	74762	171414	1.69E+09	41126.84	0.8198	167338	60495	1.1069	0.1566
	NF	50.0	13.68	N/A	13	2	6	17	36	75.569	8.693	0.6355	34	11	0.8415	0.0618
	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
Area B	Time	50.0	23952.32	N/A	23063	946	12770	34917	64254	2.36E+08	15357.17	0.6412	63308	22147	0.5997	0.0402
	NF	50.0	7.98	N/A	8	1	5	11	18	18.5914	4.3118	0.5403	17	6	0.3356	-0.0033
	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
Area C	Time	50.0	6454.82	N/A	5548	0	2552	9899	27229	30458647	5518.935	0.855	27229	7347	1.4428	0.1234
	NF	50.0	3.16	N/A	3	0	1	4	9	5.4433	2.3331	0.7383	9	3	0.8433	0.0533
	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
Area D	Time	50.0	8225.646	N/A	5747	0	2149	10927	31288	56983270	7548.726	0.9177	31288	8778	1.309	0.2824
	NF	50.0	3.7083	N/A	3	0	2	4	13	6.5514	2.5596	0.6902	13	2	1.5119	0.3542
	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
Area E	Time	50.0	11207.89	N/A	7844	0	3069	16275	39766	71860642	8477.066	0.7563	39766	13206	0.7506	0.2547
	NF	50.0	1.8696	N/A	1	0	1	2	8	1.4937	1.2222	0.6537	8	1	2.3786	0.8696
	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
Area X	Time	50.0	4338.613	N/A	1245	0	0	5127	18658	14466489	3803.484	0.8767	18658	5127	0.5855	0.6034
	NF	50.0	2.2581	N/A	1	0	0	2	7	2.1312	1.4599	0.6465	7	2	-0.593	0.629
	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
Area Y	Time	50.0	12927.02	N/A	10716	0	4586	19230	36943	85081971	9223.989	0.7135	36943	14644	0.6927	0.151
	NF	50.0	3.4898	N/A	3	0	2	5	9	3.4218	1.8498	0.5301	9	3	0.6193	0.1633
	Identifica	n	Média	Moda	Mediana	Mínimo	1º Quartil	3º Quartil	Máximo	Variância	Desvio Pa	Coef. Vari	Amplitude	Int. Interq	Coef. Assi	S'
Area Z	Time	50.0	3858.3	N/A	1379	0	0	3217	44339	76760238	8761.292	2.2708	44339	3217	3.7726	0.7707
	NF	50.0	1.24	N/A	1	0	0	2	7	1.9004	1.3786	1.1117	7	2	2.0308	0.12

Fig. 4 – Estatísticos básicos da totalidade das áreas e de cada área.

Nota-se que ambas as variáveis se distribuem de forma assimétrica, quer para a totalidade das áreas, quer quando cada área é analisada individualmente. O mesmo acontece em ambas as situações de análise, registando-se elevada dispersão para as duas variáveis. Conclui-se assim que o comportamento dos indivíduos é bastante diversificado perante cada uma das áreas da Igreja. Esta conclusão é igualmente comprovada pelos respectivos box-plots das figuras 5 a 22. É também evidente que para a variável Time existem bastantes valores anómalos em cada uma das áreas observadas, bem como no caso da totalidade das áreas. A variável NF regista globalmente e em cada uma das áreas observadas, um reduzido número de valores anómalos, ou seja a diversidade de postura dos indivíduos perante as diferentes áreas é mais acentuada em termos da duração das fixações do que em termos do número de fixações.

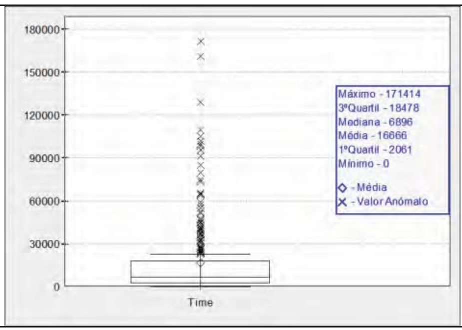


Fig. 5 – Box-Plot do tempo de fixação de todas as áreas

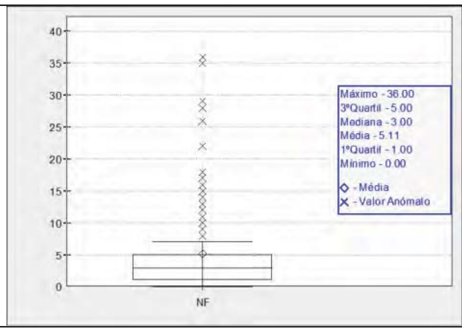


Fig. 6 – Box-Plot do número de fixações de todas as áreas

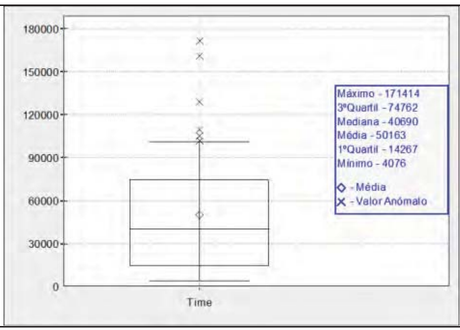


Fig. 7 – Box-Plot do tempo de fixação da área A

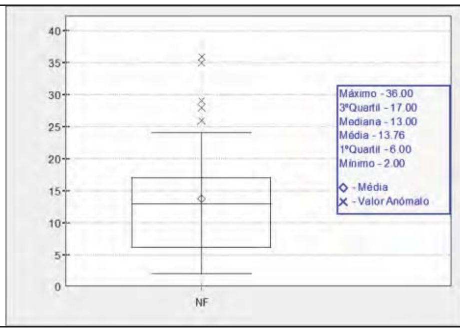


Fig. 8 – Box-Plot do número de fixações da área A

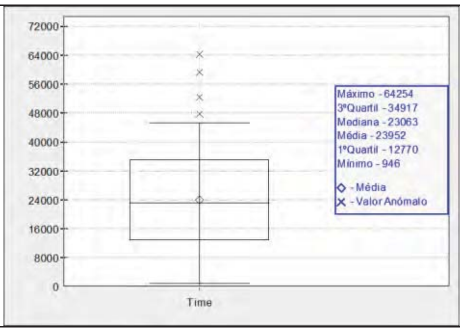


Fig. 9 – Box-Plot do tempo de fixação da área B

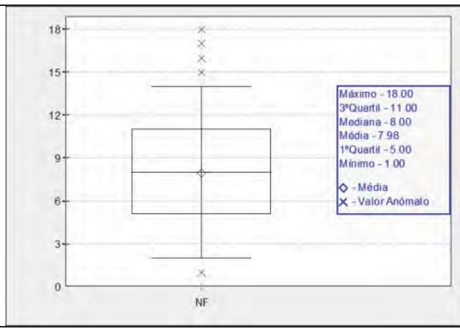


Fig. 10 – Box-Plot do número de fixações da área B

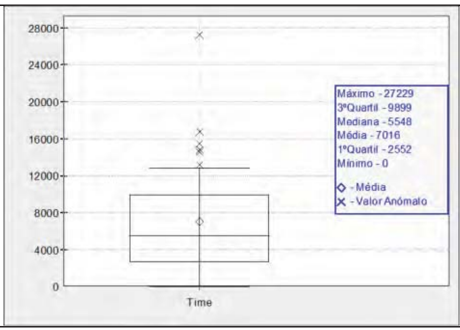


Fig. 11 – Box-Plot do tempo de fixação da área C

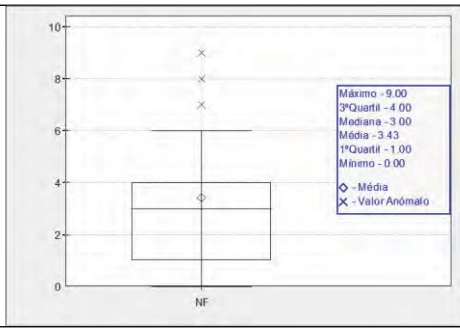


Fig. 12 – Box-Plot do número de fixações da área C

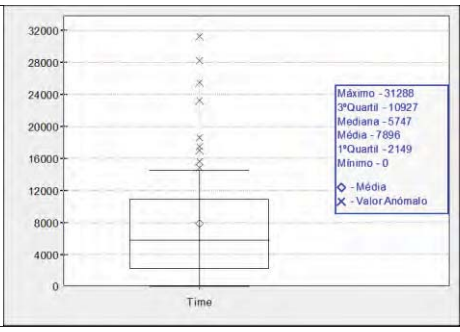


Fig. 13 – Box-Plot do tempo de fixação da área D

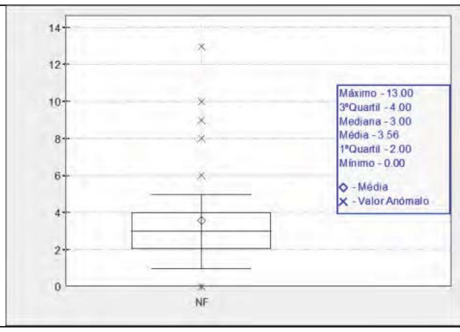


Fig. 14 – Box-Plot do número de fixações da área D

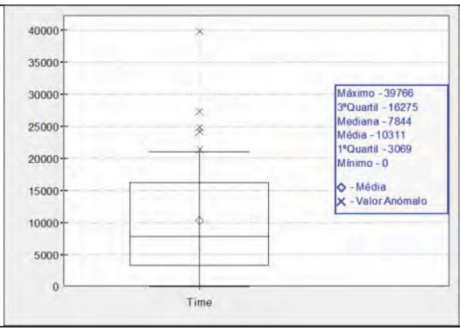


Fig. 15 – Box-Plot do tempo de fixação da área E

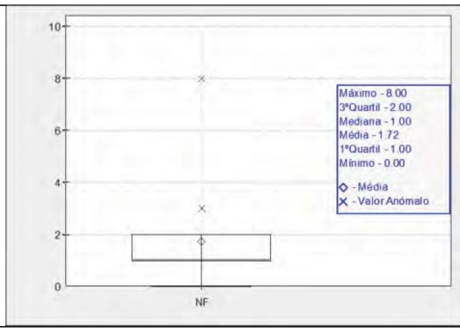


Fig. 16 – Box-Plot do número de fixações da área E

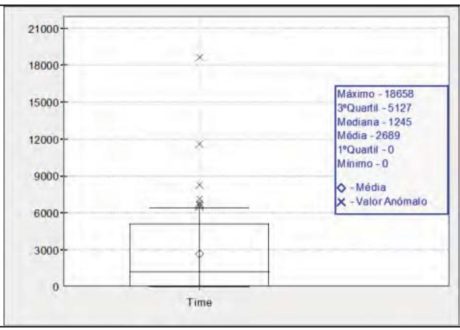


Fig. 17 – Box-Plot do tempo de fixação da área X

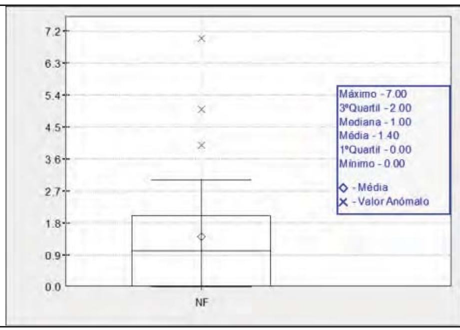


Fig. 18 – Box-Plot do número de fixações da área X

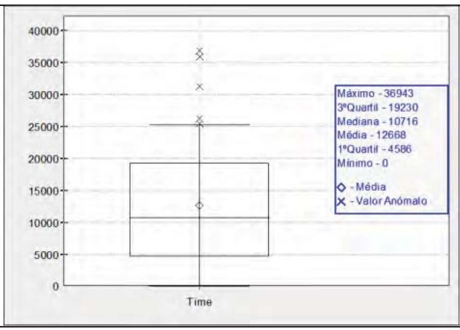


Fig. 19 – Box-Plot do tempo de fixação da área Y

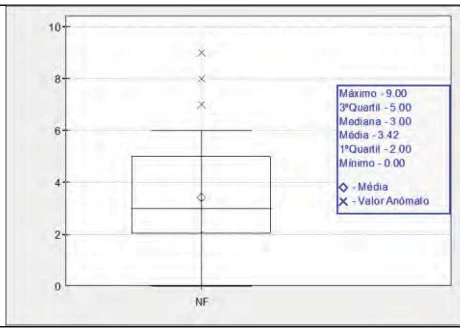


Fig. 20 – Box-Plot do número de fixações da área Y

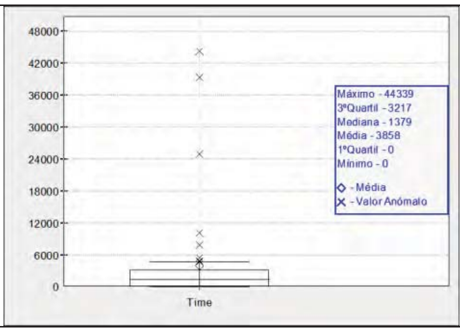


Fig. 21 – Box-Plot do tempo de fixação da área Z

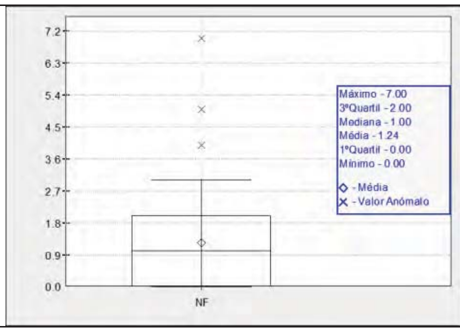


Fig. 22 – Box-Plot do número de fixações da área Z

A distribuição dos valores de cada uma das variáveis, para cada uma das áreas de observação da Igreja é apresentada nas figuras 23 a 38.

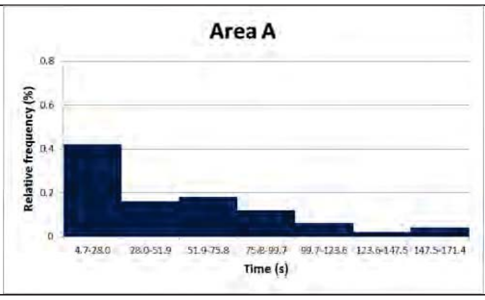


Fig. 23 – Distribuição do tempo de fixação na área A

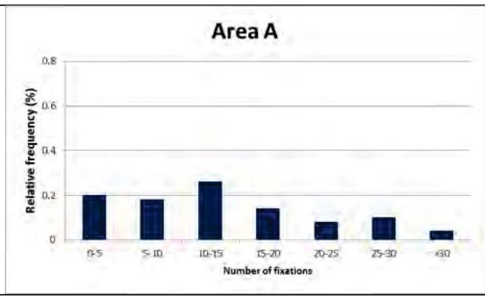


Fig. 24 – Distribuição do número de fixações na área A

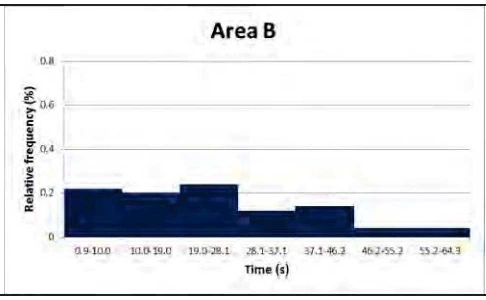


Fig. 25 – Distribuição do tempo de fixação na área B

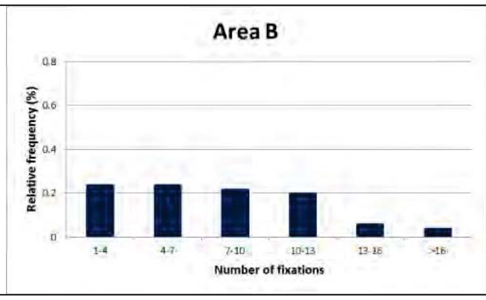


Fig. 26 – Distribuição do número de fixações na área B

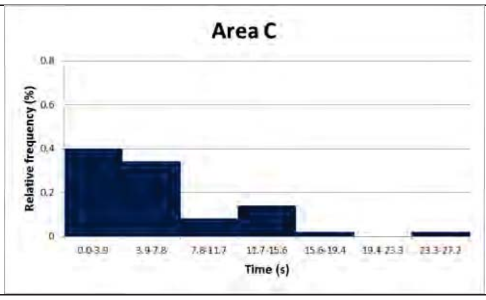


Fig. 27 – Distribuição do tempo de fixação na área C

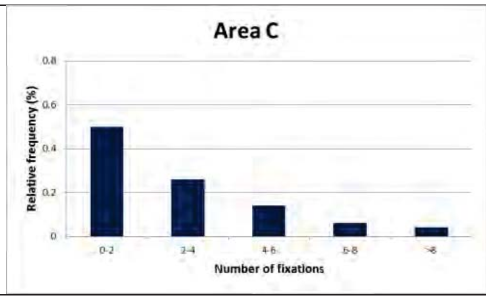


Fig. 28 – Distribuição do número de fixações na área C

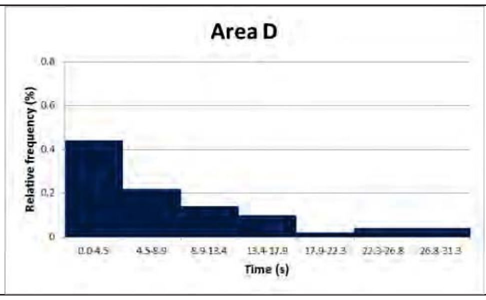


Fig. 29 – Distribuição do tempo de fixação na área D

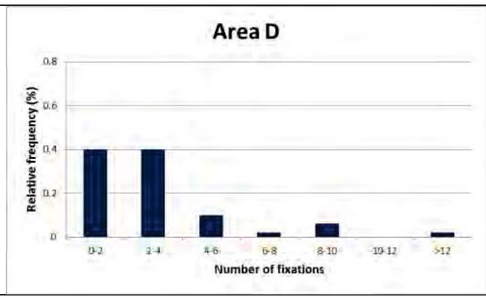


Fig. 30 – Distribuição do número de fixações na área D

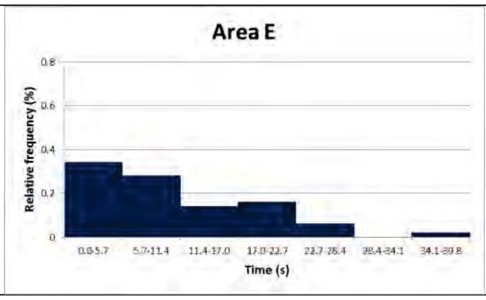


Fig. 31 – Distribuição do tempo de fixação na área E

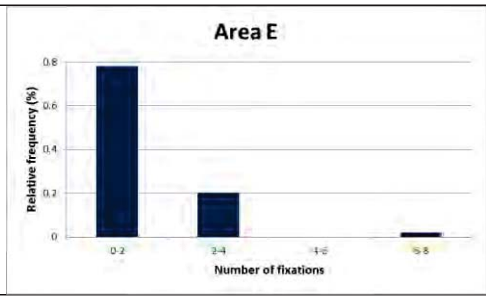


Fig. 32 – Distribuição do número de fixações na área E

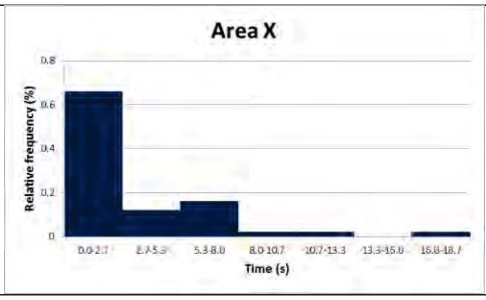


Fig. 33 – Distribuição do tempo de fixação na área X

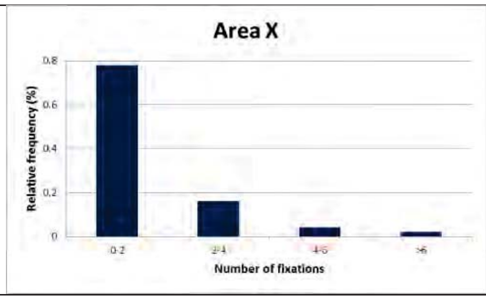


Fig. 34 – Distribuição do número de fixações na área X

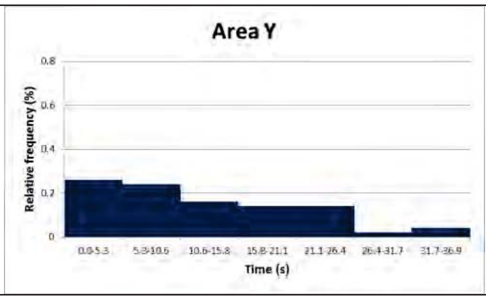
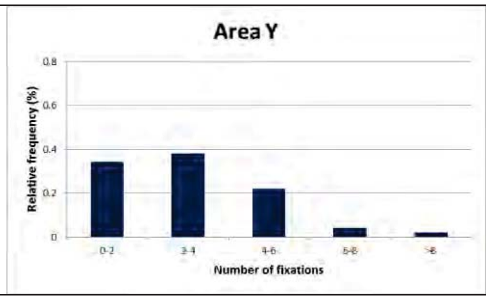
	

Fig. 35 – Distribuição do tempo de fixação na área Y	**Fig. 36 – Distribuição do número de fixações na área Y**

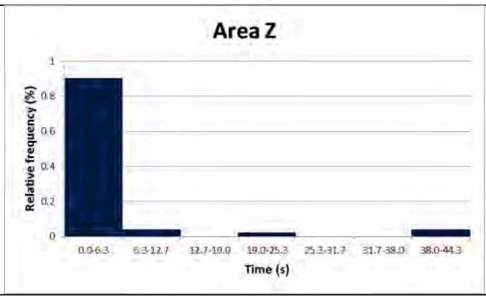
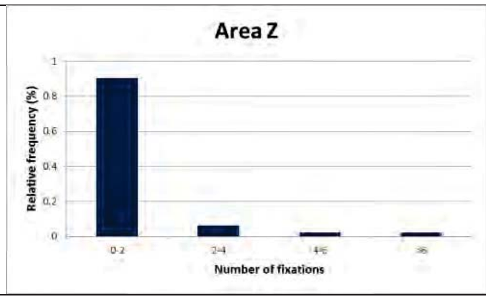
	

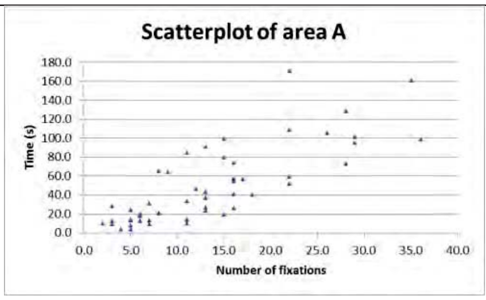
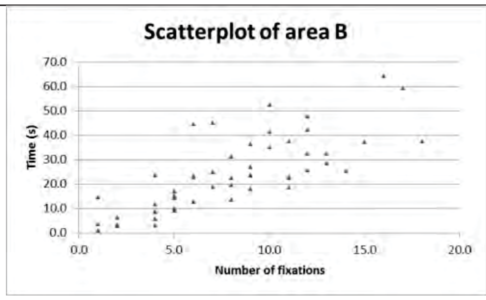
Fig. 37 – Distribuição do tempo de fixação na área Z	**Fig. 38 – Distribuição do número de fixações na área Z**

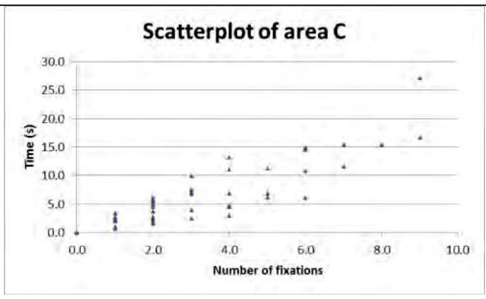
No que diz respeito ao tempo de fixação, verifica-se que os indivíduos se distribuem por todas as classes de tempo de forma relativamente equilibrada nas áreas A, B, C, D, E e Y. Por outro lado, existem elevadas percentagens de indivíduos que dedicam pouco tempo à observação das áreas X e Z. Em termos do número de fixações, verifica-se que os indivíduos se distribuem de modo relativamente equitativo por todas as classes nas áreas A, B e Y; enquanto a larga maioria dos indivíduos observa poucas vezes as áreas C, D, E, X e Z.

Em termos conclusivos pode dizer-se que as áreas A e B são as mais atractivas para os indivíduos, quer em número de fixações, quer em tempo de fixação. As áreas C, D e E são pouco atractivas para os indivíduos, mas quando são fixadas, por vezes, os indivíduos dedicam-lhes algum tempo de observação. Apesar da área Y ser pouco atractiva para os indivíduos, estes dedicam-lhe tempos elevados de observação quando a fixam. Finalmente as áreas X e Z atraem pouca atenção dos indivíduos, quer em termos de tempo de fixação, quer em termos de número de fixações.

3. ANÁLISE BIVARIADA

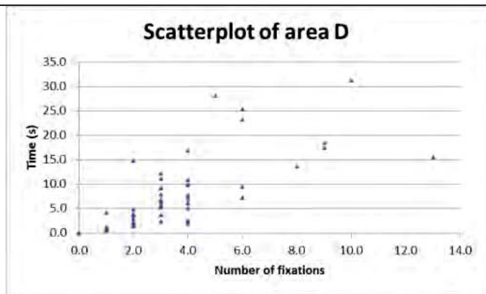
A análise bivariada efectuada teve por base os diagramas de dispersão das duas variáveis e o cálculo do coeficiente de correlação de Pearson (*vd*. Figuras 39 a 46).

	
***r* = 0.792628**	***r* = 0.76913**
Fig. 39 – Diagrama de dispersão – área A	**Fig. 40 – Diagrama de dispersão – área B**



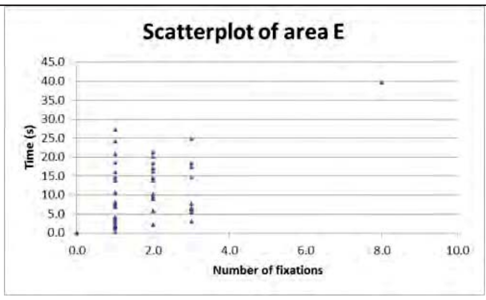
r = 0.873308

Fig. 41 – Diagrama de dispersão – área C



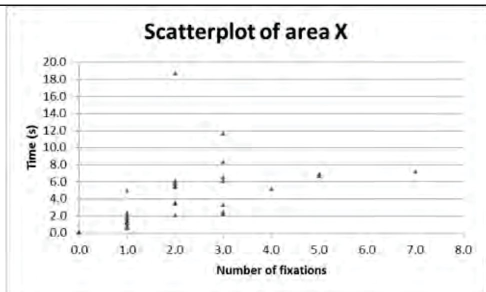
r = 0.730141

Fig. 42 – Diagrama de dispersão – área D



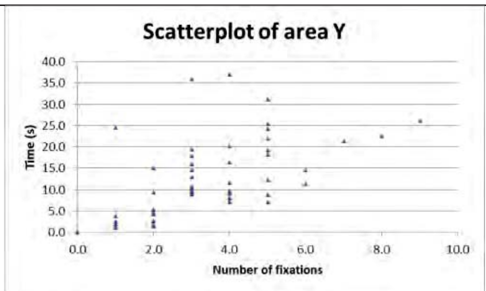
r = 0.542323

Fig. 43 – Diagrama de dispersão – área E



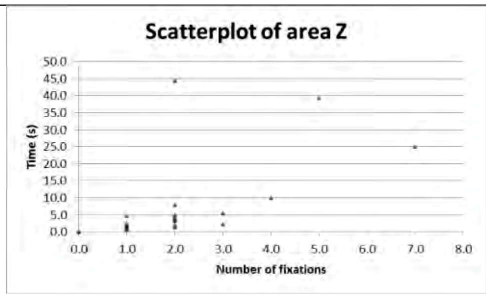
r = 0.66206

Fig. 44 – Diagrama de dispersão – área X



r = 0.579844

Fig. 45 – Diagrama de dispersão – área Y

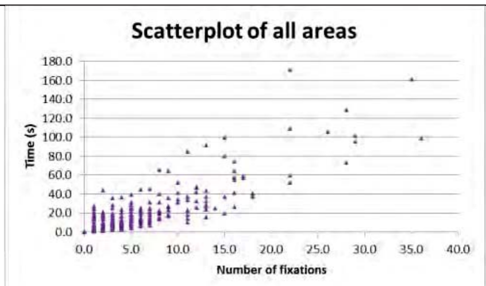


r = 0.65595

Fig. 46 – Diagrama de dispersão – área Z

As áreas A, B e C revelam a existência de forte correlação direta entre as variáveis Time e NF, ou seja à medida que o número de fixações aumenta o tempo de observação também aumenta. Por outro lado, nas áreas D, E, X, Y e Z há uma fraca correlação entre as variáveis Time e NF, denotando a inexistência de um comportamento padronizado dos indivíduos.

Observa-se ainda uma forte correlação direta entre as duas variáveis estudadas quando se consideram todas as áreas em conjunto (*vd*. Figura 47). Tal facto deve-se provavelmente à importância das áreas A, e B.



r = 0.860122

Fig. 47 – Diagrama de dispersão – todas as áreas

7. Appendix G – Manuscript Draft (Olga Romão)

CONTRIBUTIONS TO A GESTURE THEORY AS A THEORY OF ENVIRONMENTAL PERCEPTION: A QUALITATIVE EXPLORATORY ANALYSIS

OLGA ROMÃO

1 Introduction

Environmental psychology deals with environmental perception in daily life as one of its themes of excellence. Early in its history, Ittelson (1976) argued that traditional experimental psychology had exclusively investigated object perception, rather than environmental perception. He wrote that "*One does not, indeed cannot, observe the environment: one explores it*" (p.149). In other words, he emphasized the daily situation in which people perceive the surrounding environment, while actively moving in it. This emphasis still persists today in environmental psychology. For example, a major textbook (Gifford,2002) begins its chapter on environmental perception with: "*We know a great deal about the perception of a one-eyed man with his head in a clamp watching glowing lights in a dark room, but surprisingly little about his perceptual abilities in a real-life situation*" (Ross,1974,p.9).

The inability of environmental psychology to construct perceptual theories is attributed to two methodological problems. One is that the experimental conditions are designed without taking into consideration the dynamic nature of environmental perception. Most experiments have presented environments by using static displays (e.g. photographs), which provide experiences that are different from daily perception.

The other methodological problem is that most of the experiments only deal with subjective assessments, emphasizing the constructive nature of perception, which leads to neglect the environmental physical characteristics of the perceptive process (see Heft,1983). Most of the empirical support for constructivist theories have been gathered under controlled conditions. It should not be surprising that one would find evidence for perceptual inferences and constructions when information is presented in an equivocal manner and when opportunities for information pick up are limited. In light of the possible artificial nature of the supportive data, the validity of constructivism as a theory of perception comes into question (Turvey, 1977).

Note that the GESTO project perception is analyzed in a real context (Alcobaça monastery) where the analysis is not only based on the mental representation of the environment, but also in physical variables, through sensorimotor experience. Therefore, in this project we will use the distal and proximal dimension of perception (as Brunswik's theory of probabilistic functionalism).

Our sensorimotor experiences results demonstrated that there is a uniform standard (commonality of the eye track and footed route) in environmental perception. In the qualitative study presented herein we aim at understanding if the subjective construction allows to explain some of the sensorimotor experience characteristics. The purpose of this qualitative analysis is merely exploratory.

Before proceeding to the main results of this qualitative analysis, we present a brief summary of the most significant classical theories of perception, while taking into account their degree of proximity to environmental psychology fundamentals. This summary is important because it scopes the framework used in the subsequent classification of the justifications given by the sensorimotor experience participants.

2 Classical Theories of Perception

2.1 Information Processing Approaches

The major assumption of an information processing approach is that perception is not an immediate outcome of stimulation, but is the result of processing over time. Neither the perceiver's visual experience, nor his straight response are immediate results of stimulation. They are consequences of processes corresponding to a series of transformations of the information contained in internal representations of the stimulus. (Haber & Hershenson, 1980, pp. 293-294) claim that perception is not immediate, but instead involves a series of stages which serve to transform sensorial input, clearly marks information processing as a constructivist theory. Another distinctive feature of this approach is the view that there are limits on the amount of information that can be processed at any given time. Information processing channels are considered to have relatively fixed capacities for storing and handling input, and these limitations result in processing selectivity. The notion of a limited processing capacity has been employed by some psychologists (e.g., Milgram, 1970) in applying the information processing model to the environmental stress area. The latter has suggested that many characteristics of urban life are a direct consequence of information overload. The individual is overwhelmed by the stimulation springing from social sources in the city and, since cognitive processes have limited capacities for handling input, the individual adopts strategies for coping with these conditions. Cohen (1978) has offered a more detailed description of the nature of information overload and its effects. In both studies, the analysis of environmental stress emphasizes characteristics of cognitive processes, and the consequences of stress are tied directly to limitations in information processing capabilities. The central role of cognitive variables as determinants of environmental stress has received further attention in Cohen (1980). Drawing on a variety of studies in this area, he concludes that stress is typically a result of interpreting a stimulus situation as being threatening, undesirable, or uncontrollable. It is Cohen's contention that "*the meaning of a stimulus configuration is generally more important than its physical properties in producing stress effects*".

A distinguishing feature of the aforementioned analyses is their focus on intra-organismic processes, while neglecting the objective environment. This cognitive orientation is a direct consequence of adopting an information processing approach. Applying this approach to an analysis of environmental stress leads to a focus on characteristics of cognitive functioning, while the environmental basis for stress is rarely examined, a peculiar omission for environmental psychology. In addition, the use of cognitive constructs as environmental descriptors draws investigators further away from an examination of objective, environmental conditions. In short, approaching this problem area from a constructivist perspective results in an emphasis on cognitive processes and, in turn, little attention is paid to environmental aspects.

2.2 Piaget's Cognitive Theory and Environmental Cognition

In Piaget's framework, knowledge is represented through cognitive structures, schemes, which are derived from the child's operations on the environment. These operations are initially motoric but, with subsequent development, they become symbolic. Schemes are viewed as the basis for all knowledge. Consequently, perception is seen as involving the assimilation of sensory data to existing schemes, (cf. Piaget, 1969, pp. 359-360). From this perspective, an analysis of environmental perception would need to take into account the individual's concept of space, especially since spatial knowledge appears to undergo age-related changes (for reviews, cf. Hart & Moore, 1973; Siegel, et al., 1978; Moore, 1979).

According to Piaget, the young child encodes spatial location in relation to himself (an egocentric system) rather than in terms of its relation to other objects in the spatial array (an objective frame of reference). The child progresses from a coding system based on the relationship of landmarks to his own body and own perspective, to a system in which landmarks become central features for a partial coordination of space (a fixed frame, topological in nature), and finally to a coding system based on abstract axes, thereby facilitating full coordination in space (i.e., to a coordinate frame of reference that is Euclidean in nature) (Siegel et al., 1978, pp. 236-237). Piaget's theory is positioned in the constructivist camp. As we saw with the information processing approach, sensory input is considered to be modified and enriched by cognitive processes. From a Piagetian approach, the patterns of sensory stimulation are transformed through their assimilation to cognitive structures. In contrast, information processing models maintain a distinction between input and mental functions; input is enriched due to the cognitive operations performed on the former, rather than their being modified through assimilation to operations (schemes). However, because of their commonly held assumption about the indirect nature of environmental perception and, more particularly, about the role of cognitive processes in perception, both approaches can be seen as alternatives within the constructivist metatheory.

As we saw in our previous discussion on the information processing approach, the adoption of a constructivist framework focuses on cognitive processes, rather than on the environment.

2.3 Gibson’s ecological approach

Gibson (1966; 1979) rejects the assumption that several environment characteristics are not represented in the proximal stimulus and provides grounds for a theory of direct perception of the environment.

In contrast to constructivist theorists, who usually begin their analysis of perception by examining characteristics of the perceiver and, in particular, the two-dimensional qualities of the retinal surface, Gibson considers environment properties on the perception process, namely in visual perception. He notes that there are two different types of light: radiant light, which is light originating from an energy source, such as the sun, and ambient light, which is light reflected by environment objects’ surfaces. Since those surfaces may differ in their orientation to the light source, as well as in shape, texture, pigmentation, and motion, ambient light will be structured in a manner corresponding to these characteristics. As a result, information specific to the layout of the environment will be carried in ambient light. In other words, structure in the environment is preserved in the ambient light and, consequently, information specifying the features of the environment is present in the medium. He points out that if there is information available in the medium which unequivocally specifies the structure of the environment, an animal with sensitivity to that structure could pick this information up directly. Constructive processes which supplement sensory inputs would be superfluous. Adopting an evolutionary perspective, Gibson argues that this is indeed the case. The evolution of species' perceptual systems is seen as a process of adaptation to that subset of information in the medium.

It is important to underscore that Gibson is interested in an analysis of perception as it occurs in a natural setting – the animal's ecological niche. This setting raises two additional issues.

First, natural settings are rich in available information. By contrast, perceptual investigations traditionally conducted their experiments in darkened rooms, where the available information is markedly reduced, or under conditions where the environmental information is deliberately obfuscated.

Second, subjects (animals) are mobile in their ecological niche. Gibson (1979) suggested that species' perceptual systems have evolved to enable animals to perceive functionally significant conditions in the environment. Those aspects of the environment, which have functional consequences for the animal, are called "affordances", and affordances are specified in the informational structure of ambient light.

The concept of affordance offers an alternative approach to the problem of meaning in perception. As we have seen, sensory stimulation is usually viewed as carrying physical or geometrical data, with meaning considered a quality added to this input by the perceiver. From the affordance perspective, the animal is seen to exist in an environment containing meaningful features, rather than in the meaning-free universe of physics and geometry.

Although this design is interesting, Gibson evolutionary trend was challenged. In fact, for animals and (pre-historical) men, perception is (was) a matter of affordance, corresponding to the fulfillment of their own, survival, needs. However, for a civilized man, the recognition and interpretation of space goes far beyond the survival needs.

3 GESTO Case Study

3.1 Type of Study

The present case study is of a data driven type, starting from data to the construction of theory. It is explained elsewhere (…) why the Alcobaça monastery serves theorizing.

As previously stated, it is not because there are no theories of perception that it is justified to carry out this case study. The fact is that previous theories are not sufficiently enlightening, especially in the context of environmental psychology.

3.2 Method

The data used while attempting to explore how the sensorimotor experience and cognitions influence each other, giving rise to environmental perception, came from interviews. Each interview was based on the sketch of foot routes performed by the participants. That sketch was drawn by the participants themselves right after they concluded their visit to the monastery. The interview was performed immediately after the sketching task. The main consigne contained in the interview protocol was as follows: based on the layout you have just drawn, can you say what have you thought and felt that might have influenced the choices on the chosen route.

Since this was an exploratory interview, other questions arose following the responses, in order to understand the perceptive dynamics. The tasks difficulty (sketch and recall of route decisions) was also assessed.

We had a total of 50 participants. Around 20 hours of speech were recorded during the interviews and part of its contents has been transcribed verbatim.

3.3 Data Analysis

Data analysis was performed using a methodology that assumes multiple perspectives in the analysis and interpretation of information (Gioia, Corley and Hamilton, 2013). As noted by Gioia et al. (2013), the relevance of such multiple classification is justified by the increased accuracy granted by the conjunction of two perspectives: "*the tandem reporting of both voices – informant and researcher – allowed not only a qualitatively rigorous demonstration of the link between the data and the induction of this new concept, sensegiving, but also allowed for the kind of insight that is the defining hallmark of high-quality qualitative research*" (p.18).p.18).

In the analysis according to the perspective of informants or participants, the experimenter merely identifies the main reasons given by the participants themselves, classifying the former according to their similarity, by means of a classical content analysis, avoiding any kind of interpretation of theoretical nature. In the analysis by the experimenter's perspective, data is analyzed based on pre-existing theoretical explanations and other explanations emerging from data.
The internal validity of this analysis if provided through inter-rater agreements (among experimenters), the triangulation of theories to interpret data and the use of Gioia's methodology.

3.4 Results

Figure 1 depicts what Gioia et al. (2013) described as "data structure". It shows how the second-order themes (in this case the justifications regarding perception) originated from first order concepts (justification for walking route options).

Figure 1: Data structure for content analysis: from the justification for walking route options (participants' perspective) to the justification regarding perception (researchers' perspective)

First order concepts: Content analysis results (participants' perspective)			Second order themes: Content analysis results (researchers' perspective)
Thoughts categorization	**Emotions categorizations**		**Categorization based on existing and emergent theories**
(1) find a protected position or protect himself from physical stimuli and emotional meanings; (2) Explore the whole and explore details; (3) meet historical and symbolic elements (4) evaluate from the aesthetic point of view; (5) get snatched and taken by the symbolic appeal of space; (6) a quasi-unconscious physical experience / no justification / cannot recall.	melancholy ache curiosity dazzle admiration relaxation amazement satisfaction fear relief amazement sadness rapture (the love story) inferiority		**Control the information** **Assimilation of perceptive content to pre-existing mental scripts** **Determinism of space by recognizing their intrinsic meaning** **Call on GESTO**

The results from content analysis in the participants' perspective are the follows: (1) find a protected position or protect himself from physical stimuli and emotional meanings; (2) Explore the whole and explore details; (3) meet historical and symbolic elements (4) evaluate from the aesthetic point of view; (5) get snatched and taken by the symbolic appeal of space; (6) a quasi-unconscious physical experience / no justification / cannot recall. These categories represent the main explanations of walking routes given by participants.

A content analysis of feelings / emotions evoked by the participants was also performed. These feelings / emotions were classified into 15 categories and revealed both a positive and a negative connotation.

The analysis performed on the researchers' perspective classified the justifications of the walking routes based on the theories of perception. One of the major results is the emerging of the GESTO Theory as a need to justify the interaction between sensory-motor experience and cognition.

The following table presents arguments to justify that walking routes are associated with explanations from the main perceptual theories.

Table 1: Theories and their main postulates that explain options for routes

Categorization	Theoretical perspective	Main postulates
Control the information (1) find a protected position or protect himself from physical stimuli and emotional meanings; (2) Explore the whole and explore details	**Information Processing Approaches** (Haber & Hershenson, 1980; Schmidt & Keating, 1980)	Perception is not a direct result from environmental stimulation but from information cognitive processing capacity
Assimilation of perceptive content to pre-existing mental scripts (3) meet historical and symbolic elements (4) evaluate from the aesthetic point of view	**Piaget's Cognitive Theory** (Piaget, 1969) **and Environmental Cognition** (Lynch, 1960)	It is the cognitive modeling of the environment that determines the interpretation of the real environment and therefore the behavior The perception results from the assimilation of sensory stimuli to cognitive structures
Determinism of space by recognizing their intrinsic meaning Determinism of the space by the recognition of their intrinsic meaning (5) get snatched and taken by the symbolic appeal of space	Affordance theory by Gibson (1979);	The perception results from the recognition of the value and the intrinsic meaning of the physical environment
Call to GESTO (6) a quasi-unconscious physical experience / no justification / cannot recall.	The GESTO Theory (Abreu, 2010)	The perception results from the look and walk prior to recognizing the space meaning or attribution of meaning to the space It is the suggestion of certain gestures, certain "e-motions" that architecture begins by entering into a relationship with us, manifest in his being-for-me.

The following tables exemplifies, with participants' speech excerpts, the aforementioned classifications.

Table 2: Examples of representative speeches of perception as control of information processing

Categorization	**Examples of participants speeches**
Control the information to process Tries to control the information reaching him to control over its processing; protect themselves, want to find out, want to try (touch, feel) analyzed	A21: Went to the church aisle because it is a larger shelter experience, being closer, despite the equal height A18 [went to the pantheon because] "I felt more welcome here than in the transepts, being a smaller space, more suitable to human proportion" A17: [did not go beside the altar] "It would take to moments of contemplation and reflection and at that moment I was not much turned to that side" A05: I approached to feel more present to the story of Pedro and Inês A06: I wanted to see the pictures of the graves, watching all those details A23: I was curious about the door, but got frustrated because I could not exploit it A43: In the ambulatory my attention was caught to the decor and I wanted to jump the barrier to be able to see more

As shown in Table 2, environmental perception results from the information processing capability. Indeed, efforts are presented by some participants to restrict or enlarge the perceptive window in order to be able to process the information. In entrance, for example, is particularly noticeable the tentative to restrict the information to be processed. This need justifies why some participants choose to move to the aisle. Elsewhere, such as for example next to the tombs, door, columns and sword, are made contrary efforts, namely to broaden the information to be processed.

Table 3: Examples of representative speeches of perception while assimilating the perceptive content to pre-existing mental scripts (cognitive theory)

Categorization	**Examples of participants speeches**
Assimilation of perceptive content to pre-existing mental scripts Try to understand the symbolism and unravel the meaning Hypothesis testing about space	43: I went to see the tombs attracted by history and mystery A21: I confirmed the symmetry A21: I made a noise to realize the acoustics of the church A21: The Tomb of Inês reminded me to Queen Beatrix of the Netherlands and my past (my colleagues from 3 years) A21: I rang the bells to feel the density A21: I looked at the spine and stood beside the pillar to measure the height of the church; around 18m. A24: I went to see the graves to see who the people were A26: [such] as I would address a person's home, I could not get inside, I preferred to take refuge on the side A26: of course I kept the route not to turn my back to the householder A29: Wow sculpture work. Looking for a sense. A29: the door of sacristy remind me nature and the entrance to a garden A30: I looked down the aisle and I thought about my church in Funchal in Christmas festivities

Another justification for the waking routes that may also warrant the perception was the attempt to understand the symbolism and unravel the meaning of space based on the evocation of pre-existing cognitive structures

As we can see in table 3, participants report that they have posed hypotheses about place and later they test them. They explain that ware the hypothesis they pose the main condition to the chosen walking routes.

On this sense, perception does not depend only on the information processing capability (as supported by information processing theories) but also depends on the capability of associating information to previously cognitive structures. In both theories environment has a minor impact on perception; actually perception is a constructivist process. Note that this type of perception arises from church ornaments and not from the architecture itself.

Table 4: Examples of representative speeches of perception as affordance

Categorization	Examples of participants speeches
Determinisms of space The architectural features and recognition of their intrinsic meaning determine the options Ravishness before the space	S10: I felt slow down when I got to the transept area A18: do not pull up as the ship's space because the arches cut a bit upright (...) I became to feel the certain scale A08: a desire to quickly go there to the bottom, to go direct because everything is up front is that it attracts, here there is nothing behind A13: I follow the side but felt the need to return to the center A26: the steady pace of the columns gave me the direction

Corroborating affordance theory, we can observe that sometimes perception comes from the recognition of certain attributes of the space itself, which allow satisfying subject needs. For example, when one of the participants stated that he had "a desire to quickly go ahead because everything there attracted him, while behind there is nothing", he is clearly recognizing the sacred significance associated with the altar and the will to reach it.

Table 5: Examples of representative speeches of perception as gesture

Categorization	Examples of participants speeches
Call to GESTO before they could assign / project any meaning or recognize the significance of space, individuals are driven to act, that is, explore the space with the eyes and walk	A16: [on entrance] I felt like dancing A1: It is not so much the emotions felt and the thoughts I had that made me hold the space but the fact of going there to see I felt a circulation boost to see all A12: I have a hard time remembering, did the route he had to do ... I feel like walking and going to see and went A14: it was more contemplative than striking (...) but when I looked at her I felt the need to go in that direction A18: I was always following the main nave almost as if I could not deviate myself from that predetermined route through the building, it seems that leaves not divert our sense

Although gesture is "almost automatic", and therefore hardly accessible from the interviews, there are participants who refer an "impetus to circulation", emphasizing that they were conducted by the look and not exactly by some sort of decision making rationale about the adopted trajectory, therefore being something spontaneous.

Although the interview was performed shortly after the walking route took place, participants found it difficult to reconstruct it (by means of a sketch) and recall the corresponding decision-making processes. In our view this is a clear evidence of the quasi-automatic gesture feature.

4 Conclusion/Discussion

The commonality of the data on the sensorimotor experience and the justifications presented on interviews let us conclude that a kinesthetic impulse exists that focuses the gesture as a form of perception. This kinesthetic impulse seems to be mainly associated with the architectural layout and not exactly the ornaments and other decorative elements that also make part of environmental perception.

Therefore, is the architectonical information available to the perceiver that directly specifies the molar structure of environmental layout which induces the perception by gesture.

This finding raises the possibility, if not the likelihood, that perception of environmental layout is direct. If such is the case, it would suggest that mental representations of the environment are utilized only under certain circumstances – such as when an individual is thinking about a place or a route, or drawing a map of an area – but they are not required for the perception of environmental / architectonical layout.

Some of the issues that can be immediately derived from these conclusions are: how do we recognize the architectural layout and why does gesture assists architectural perception? We hope to come to an answer to these questions in future projects.

Applying classical theories of perception to the explanations given for route choices was an interesting exercise that contributed to sketching an initial outline of the gesture theory. Our main suggestion for future work is the reinterpretation of these same results in the light of other reworks of classical theories of perception, particularly those that have emerged in the field of embodied cognition.

While acknowledging that the interview as a method for understanding cognition associated with sensorimotor experience can be reductionist, especially due to the constructivist / cognitive biased information it conveys, the presence of gesture on interviews corroborates its molar character, allowing to link the sensorimotor experience and cognition.

8. Appendix H – Manuscript Draft (Fernando Brito e Abreu)

Analyzing the commonality among walking routes: the GESTO experience

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ABSTRACT

This technical report presents a preliminary analysis on the commonality among a set of walking routes within a monastery. These routes were captured for 50 subjects in the scope of the GESTO project experience and their study is expected to provide some insights on how individuals explore an architectural space. Several instruments were used for analyzing the collected data, namely trajectory distance algorithms, hierarchical cluster analysis and a heat gradient plotting technique.

Keywords: routes distance; DTW algorithm; routes commonality; cluster analysis; heat maps.

1 INTRODUCTION

This technical report was produced in the scope of the GESTO project[1]. The latter aims at testing the hypothesis of "gesture": the existence of a global coherence of the visual and walking trajectory made as we explore a building. Several questions arise regarding that exploration, namely when the building is an architectural masterwork. How do we perceive it? How do we move through space? Do we do it quasi-automatically (spontaneously) or is it the result of a deliberate decision-making process?

The aim of this document is supporting the answer to one of the aforementioned questions – how do we walk through an architectural space – based on the evidence recorded during a data collection experiment carried out at the Alcobaça Monastery, a mediaeval Roman Catholic monastery located in the town of Alcobaça, in Portugal. This monastery is particularly interesting since it was founded by the first Portuguese king, Afonso Henriques, in 1153, and maintained a close association with the kings of Portugal throughout its history[2].

This technical report is organized as follows: section 2 provides an introduction to the GESTO experiment and the direct data collected during it that was used as input for the analysis presented herein; section 3 reviews some approaches to compute the distance between two routes and

2 THE GESTO EXPERIENCE

2.1 Brief overview of the experimental design

The collection instruments and procedures adopted in this experiment are described in detail elsewhere […], so we only include a brief description here. Each of 53 experimental subjects was invited to perform a free walking route, like a visiting tourist, within the Alcobaça monastery. Walking routes are functions from a time domain and their reconstruction requires sampling. Each route was recorded non-intrusively, with hidden cameras in the monastery

[1] http://home.fa.ulisboa.pt/~gesto.proj
[2] https://en.wikipedia.org/wiki/Alcoba%C3%A7a_Monastery

ceiling (see Figure 1) and other places, as a sequence of (x, y) points, corresponding to inflection points in the trajectory. Within two consecutive points the subject approximately followed a straight line.

Figure 1: Image taken from a hidden camera on Alcobaça monastery nave rooftop

Each walking route was given a label, ranging from “a1” to “a53”. Three of these 53 walking routes (a02, a12 and a33) had recording problems and were discarded, so the final sample kept 50 routes. An example of the input data for each route is provided in Annex A.

2.2 Plotting routes

The 2D computational representation of a walking route is a polyline whose vertices are the aforementioned points. We considered that the actual area covered (space occupied) by a single person in a given instant, can be roughly represented by a circle with a 1 meter diameter, as represented in Figure 2.

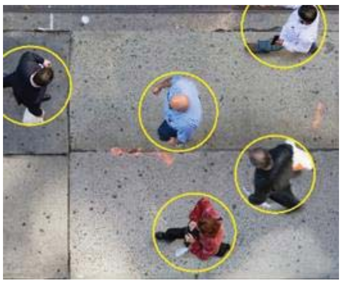

Figure 2: Instantaneous individual occupation area

A segment of the polyline that describes a concrete walking route can be plotted as a straight line whose thickness corresponds to that diameter, with rounded edges, as plotted in Figure 3.

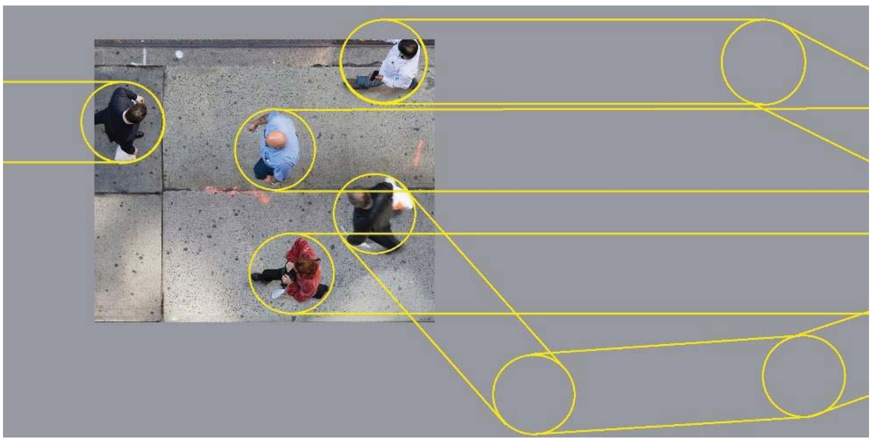

Figure 3: Walking route segments

The captured walking routes were initially plotted using an *Autodesk*[3] tool. However, since we need to apply several algorithms to analyze the commonality among walking routes, we had to develop a domain specific application, that we dubbed *GESTOOL*. We have chosen to do so using the *Java* programming language on the *Eclipse* software development platform[4], since that language has sophisticated software libraries to manipulate 2D images.

The first software component produced, reads a text input file containing the route points for all subjects and allows plotting each one separately, as represented in Figure 4. Note that a walking route is represented as a polyline where segments are straight lines with rounded ends as aforementioned. An arrow was added every 5 segments, to represent motion direction. The number of points in each walking route is displayed in the table of Annex A.

The validity of these plots was confirmed, since they all match perfectly with the original ones, produced with the *Autodesk* tool.

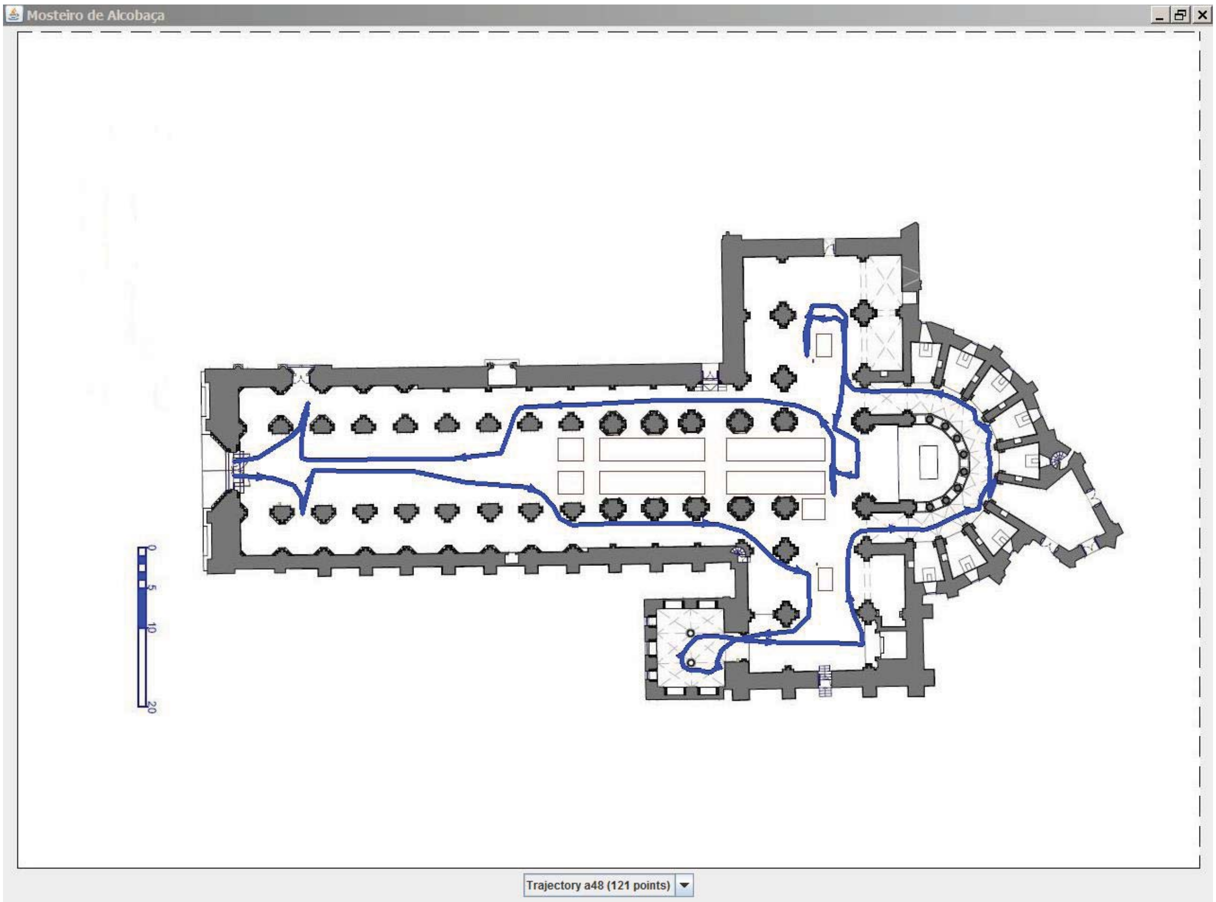

Figure 4: GESTOOL walking route plotting component

3 ROUTE DISTANCE ALGORITHMS

This technical report is about the problem of analyzing the commonality among walking routes. Individual walking routes can have complex shapes, and even small nuances lead to big differences in their understanding. A central problem in analyzing route data is to measure the similarity between a pair of routes and to identify portions that are common. Besides being

[3] http://www.autodesk.com/

[4] http://www.eclipse.org

interesting in its own right, this problem often lies at the core of classifying, clustering, and computing mean routes (aka trajectories) [1].

Several approaches were proposed to provide a score or measure indicating the degree of similarity (or inversely, distance) between two routes. Such a score allows ranking multiple pairs of routes according to similarity, e.g. in clustering applications. In the following subsections we will review some of these approaches.

3.1 The topologists approach

Two of the most commonly used methods for measuring similarity are Hausdorff[5] distance [2] and earth-movers distance [3], and their variants. These methods are, however, not suitable for measuring the similarity between two routes because they only focus on the location of the points and not their ordering along the routes. A better choice is the so-called Fréchet[6] distance [4]. Informally, consider a person and a dog connected by a leash, each walking along a curve from its starting point to its end point. Both are allowed to control their speed, but they cannot backtrack. The Fréchet distance between the two curves is the minimal length of a leash that is sufficient for traversing both curves in this manner.

3.2 The telecom engineers approach

Although the Fréchet distance is often used as a measure of curve matching, in its traditional definition, it may produce inadequate results in situations such as the following: consider two routes that are very close to each other, except for a small segment, yielding a biased Fréchet distance, since it is based on the distance between the two farthest points in the coupling. Thus, in order to identify a good correspondence between two trajectories, we must resort to the average Fréchet distance, more commonly known as dynamic time warping (DTW) distance, where the goal is to minimize the "average length" of the leash instead of its maximum length. DTW distance was originally proposed for matching speech signals in speech recognition [5], but has been used in many other areas such as optical character recognition (OCR) [6], handwriting recognition [7], signature recognition [8] or generic shape matching [9].

Due to the successful and widespread use of DTW algorithms (there are many small variants), we have decided to adopt this algorithm for the first version of the *GESTOOL*.

4 ROUTE DISTANCE ALGORITHMS

4.1 Routes clustering

To analyze the commonality of our set of routes, we will start by performing a cluster analysis exercise. Clustering is the task of grouping a set of objects (routes, in our case) in such a way that objects in the same group, called a "cluster", are more similar (closer, in our case) to each other than to those in other groups (clusters). Cluster analysis is a main task of exploratory data mining, and a common technique for statistical data analysis, used in fields such as machine learning, pattern recognition, image analysis, information retrieval, and bioinformatics.

To perform any kind of clustering operation we need a distance (aka dissimilarity) matrix. The latter is a square matrix, where each position corresponds to the distance between the object in the row and the object in the column. Since the objects in rows and columns are the same and the distance function is commutative, the matrix is symmetric and has zeros in the main

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[5] Felix Hausdorff (1868–1942) was a German mathematician who is considered to be one of the founders of modern topology.

[6] Maurice Fréchet (1878–1973) was a French mathematician that made major contributions to the topology of point sets and introduced the entire concept of metric spaces.

diagonal. We have generated the values in our route distance matrix based upon the DTW distance algorithm. The *GESTOOL* allows exporting the distance matrix in a tab delimited or CSV (comma separated values) format, to allow inputting it in a statistical tool such as the R Project[7] or SPSS[8] to perform clustering analysis.

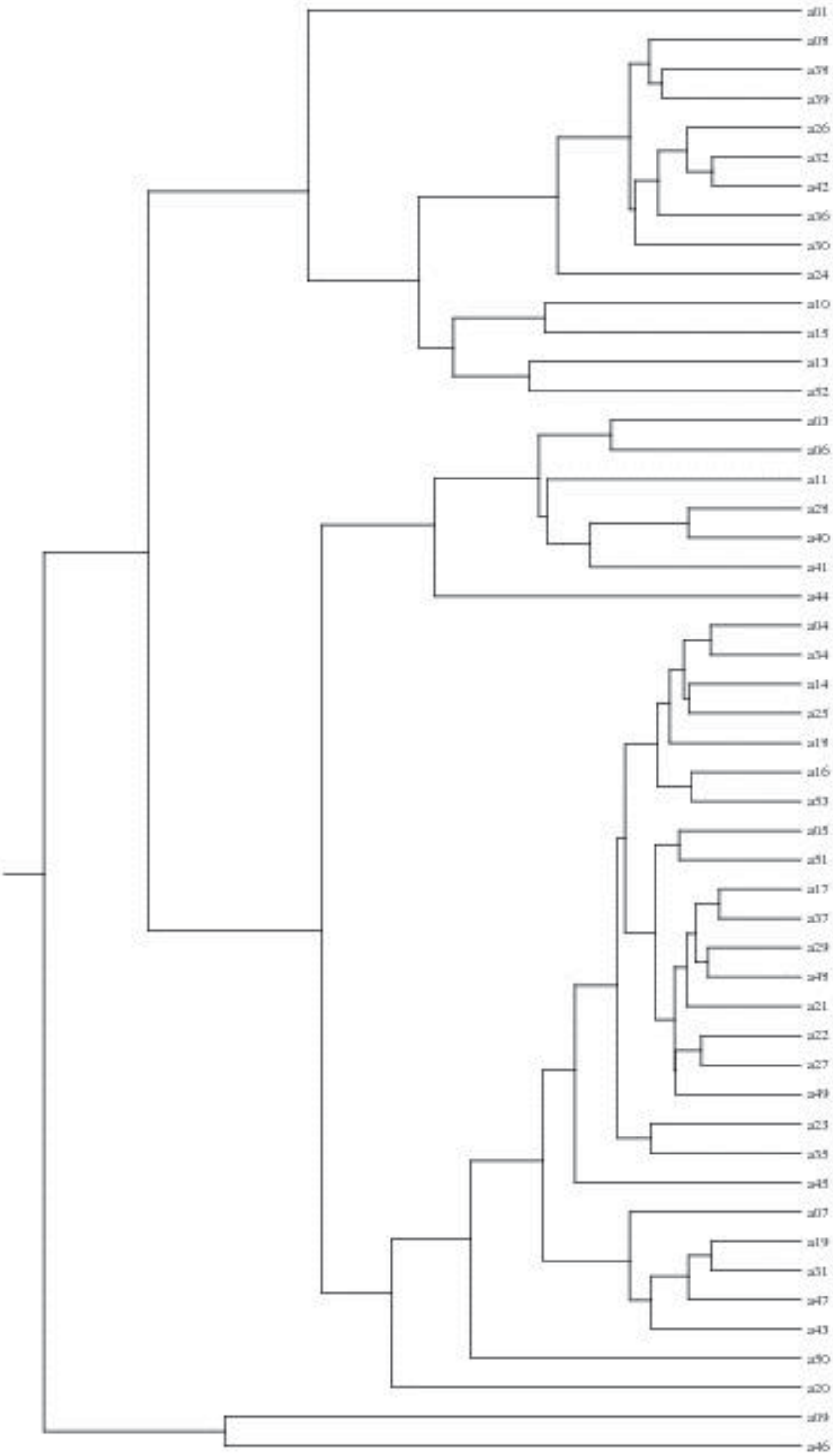

Figure 5: Dendrogram of the routes clustering process

[7] https://www.r-project.org/
[8] http://www-01.ibm.com/software/analytics/spss/

We have used a hierarchical clustering algorithm. The clustering process itself can provide interesting insights for complementing the qualitative analysis based on subjects' responses regarding the reasons (or unconscious impulse) why they have followed a given route. For instance, a content analysis based clustering can be compared with this distance-based clustering. To support such an analysis we have plotted the dendrogram corresponding to our distance matrix (Figure 5).

Dendrograms provide a very intuitive perspective of the clustering process. A dendrogram (from Greek *dendro* "tree" and *gramma* "drawing") is a tree diagram, frequently used to illustrate the arrangement of the clusters produced by hierarchical clustering. The root nodes represent individual observations (our routes from a01 to a53 in our case), and the remaining nodes represent the clusters to which the data belong. The length of the connectors is proportional to the value of the intergroup dissimilarity between its two daughters (the root nodes representing individual observations are all plotted at zero "height").

4.2 Most common route

Based upon the distance matrix used for clustering purposes, we developed a straightforward algorithm of the most common route, as being the one that minimizes the average distance to all other routes. The average distance of each walking route to all the other walking routes is displayed in the table of Annex B. Therefore, the candidate for the most common route is the "a25" one that is plotted in Figure 6.

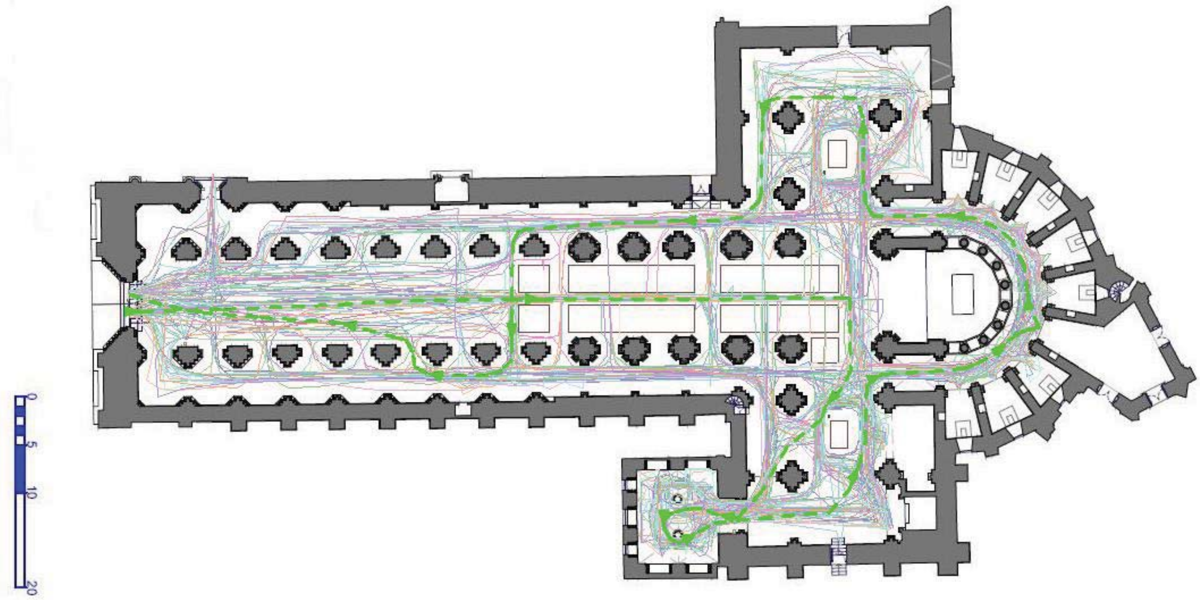

Figure 6: Most common route

4.3 Most dissimilar route

Based upon the distance matrix used for clustering purposes, we also developed a straightforward algorithm of the most uncommon or dissimilar route, as being the one that maximizes the average distance to all other routes. Based on the table in Annex B, the most dissimilar route is therefore "a09", which is plotted in Figure 7. This is indeed a somehow awkward route that deserves further attention, namely a deeper analysis on the rationale of that route, as asked to the corresponding subject, right after he concluded his walk. The same applies to a few other routes that lie on the bottom of the aforementioned table.

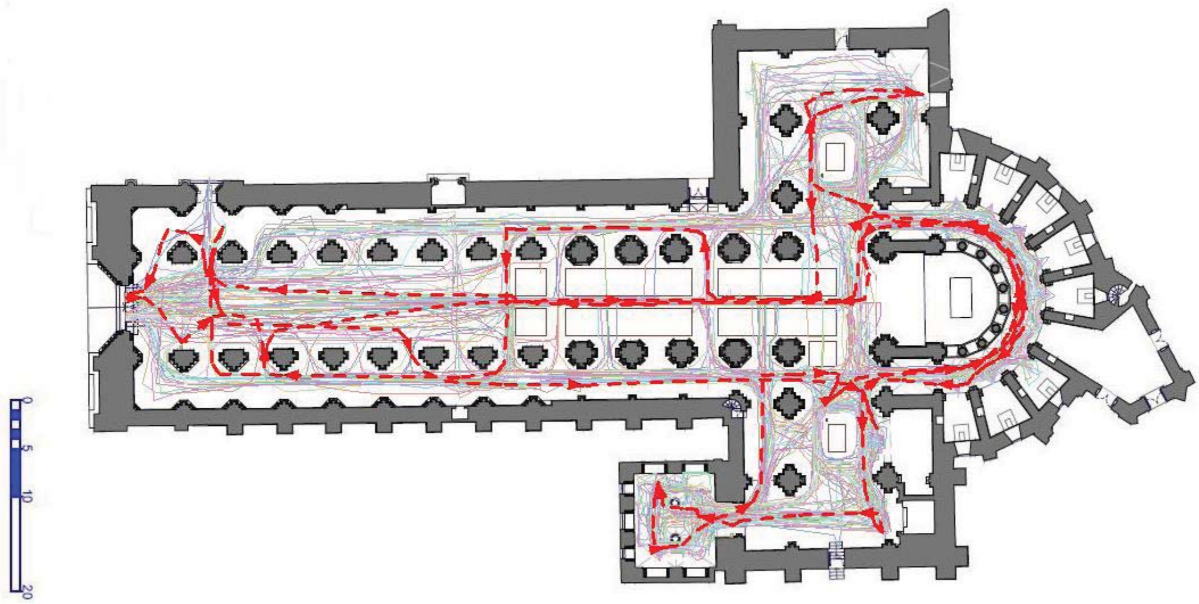

Figure 7: Most dissimilar route

Cognition researchers have found out that humans are very effective and efficient in detecting differences among images [10]. Therefore, we performed a simple qualitative validation experiment of the route distance algorithm. The experimental setup was as follows: we picked the 50 individual route plots produced with Autodesk (each one like Figure 3) and placed them side by side in random order on top of a large table in a 5x10 matrix-like position. We then asked 10 subjects (one at a time) to pick the 5 most dissimilar routes. Each time we scrambled the position of the route plots. Figure 8 shows the resulting frequency analysis, which allows to confirm that the empirical perception of distance matches well the computed solution.

Figure 8: Frequency analysis of subjective assessment on dissimilar routes

<<This simple experiment will hopefully be concluded in the next meeting of the GESTO team>>

4.4 Plotting route commonality

A heat map is a two-dimensional representation of data in which values of a given characteristic are represented through a color gradient, ranging from cold (blueish) colors to hot (reddish). Heat maps provide an immediate visual summary of information and they have been used for representing distinct characteristics other than temperature itself, such as: sea surface salinity[9], property values[10], social networks activity[11], sights popularity[12], genomics info[13] or brain activity[14].

In this technical report we propose the usage of heat maps for representing “space usage”. The monastery areas that were walked through more frequently are considered to be “hotter”, while the ones that were less traversed are considered “colder”. The full color gradient, adapted from [11], is presented in Annex B.

Each point in a walking plot has only a dichotomous information: either it was traversed or not. The thermal map computation uses an integration algorithm that scans each of the 50 walking route plots (such as the one in Figure 3). A mapping function produces a color value for each visited point. Unvisited points keep their neutral, white, color.

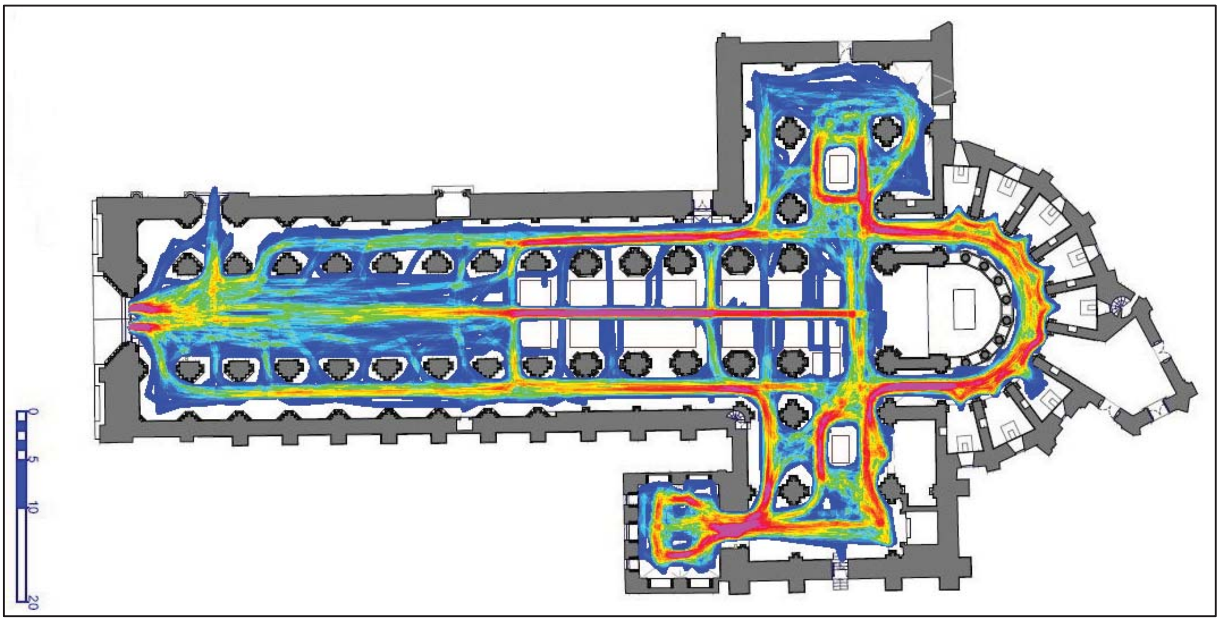

Figure 9: Walking routes heat map

5 CONCLUSIONS AND FUTURE WORK

5.1 Conclusions

The objective of this work was answering to the question of how we walk through an architectural space, based upon on data collected during an experiment carried out at the Alcobaça Monastery. To do so, we have developed, from scratch, a tool that enables the visualization of walking routes, the determination of the most common and the most dissimilar among them, as well as a visualization facility based on the heat maps metaphor, that allows a cumulative perspective of how the monastery space was walked through. The tool allows to output a distance matrix that can (and was) used for performing cluster analysis among routes. This tool also allows generating an animated view of walking route, based on timing data. Based on the same data we can generate another heat map that takes time into consideration. The

[9] http://aquarius.nasa.gov/
[10] http://www.zoopla.co.uk/heatmaps/
[11] http://onemilliontweetmap.com/
[12] http://sightsmap.com/
[13] https://genome-cancer.ucsc.edu/proj/site/help/
[14] https://neurobollocks.wordpress.com/2014/06/21/the-power-of-a-well-chosen-image-eeg-measures-of-brain-activity-and-exercise/

current map in Figure 9 is "time-agnostic", that is, only considers space traversal. In other words, the time spent in each church spot is not accounted for, but simply if a subject was there at some point in time or not.

We expect that the obtained results, which were presented in this report, will act as some sort of scaffolding for answering the other research questions of the GESTO project, namely those regarding how we perceive and explore architectural spaces, either in a spontaneous, gesture-guided fashion, or resulting from a conscious decision-making process.

5.2 Future work

We have provisions to continue this work in several directions. First, we want to compare the results of applying other route distance algorithms. As aforementioned, we have implemented in the *GESTOOL* a DTW distance algorithm. Some authors have pointed out that if the trajectories contain significant dissimilar portions, DTW algorithms (there are several variants) may not behave so well [1], so it is worth paying attention to another research field where new "route" algorithms are being proposed.

In our case a route is a sequence of points defined on a Euclidean space, but we can generalize the problem to a sequence of other objects with properties other than (x, y) coordinates. That is the case of computational biology / genomics engineering, where researchers want to identify (align) similar portions between two protein sequences. Given two sequences A and B, their alignment is expressed by writing them in two rows respectively, such that at each position in the first (resp. second) row, there is either a character in A (resp. B) or a blank character (termed as a gap character). Their goal is to compute an alignment which optimizes a similarity scoring function which assigns a score for aligning two characters and a penalty for gaps. The score for an alignment of two characters is an incentive if they are deemed similar and is a penalty if not.

In computational biology, the algorithms for sequence alignments have been extended to aligning two polygonal curves such as protein structures [12]. This model can be adapted to the alignment of trajectories with the choice of an appropriate scoring function.

We also plan to explore if other clustering algorithms will produce different results and then discuss why. We have used a hierarchical agglomerative connectivity-based algorithm, but many other alternatives exist, such as centroid-based algorithms (e.g. K-means), distribution-based clustering, and density-based clustering, among others.

Last, but not the least, we plan to develop another algorithm to find the best surrogate for the route commonality, based on a heat efficiency metaphor. Our cornerstone idea is that the surrogate route will be the one that maximizes the ratio between the captured distinct heat to the route length. By "captured heat", we mean the integral of the values of the heat function (as represented in the heat map) calculated along the whole route trajectory. By "distinct", we mean that points that are swept repeatedly will not be considered, therefore avoiding that recurring route segments (e.g. going in circles around a tomb of a famous king) will bias the result.

ACKNOWLEDGMENT

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ANNEX A – SAMPLE INPUT DATA FOR A WALKING ROUTE

Order	Subject	X (m)	Y (m)
1	a01	8,1472	1,5494
2	a01	9,3008	4,6577
3	a01	8,9983	8,1966
4	a01	9,7197	34,811
5	a01	7,7219	45,2522
6	a01	13,7519	71,9613
7	a01	16,5253	73,2383
8	a01	16,8038	75,507
9	a01	20,7009	79,3243
10	a01	14,0138	78,9175
11	a01	8,967	77,4259
12	a01	6,9359	86,4814
13	a01	6,6403	89,8048
14	a01	5,4165	92,4231
15	a01	2,5849	95,1449
16	a01	-1,2111	96,4899
17	a01	-4,6037	95,0415
18	a01	-7,5102	93,169
19	a01	-10,6326	90,4316
20	a01	-11,306	86,7155
21	a01	-15,8108	76,0819
22	a01	-16,7856	72,0204
23	a01	-19,3059	72,7159
24	a01	-15,7795	76,925
25	a01	-0,4221	78,0571
26	a01	23,4144	60,9115
27	a01	26,9312	55,7023
28	a01	25,0967	53,3863
29	a01	23,292	53,438
30	a01	21,3542	53,4504
31	a01	18,3154	53,389
32	a01	17,721	55,2558
33	a01	18,3777	56,9888
34	a01	18,7676	58,3697
35	a01	17,9443	59,7615
36	a01	17,5747	60,5845
37	a01	24,7905	60,8893
38	a01	26,3607	60,8351
39	a01	22,4765	72,5462
40	a01	6,4411	71,1583
41	a01	3,2606	71,1681
42	a01	-0,4871	66,5021
43	a01	-11,526	65,7889
44	a01	-23,7315	65,4938
45	a01	-25,8845	65,3214
46	a01	-13,3009	83,3242

ANNEX B – AVERAGE ROUTE DISTANCE TO OTHER ROUTES

Route	Distance	Points
a25	1129,67	86
a45	1174,36	113
a34	1196,42	104
a19	1199,01	68
a04	1204,51	89
a14	1214,21	115
a47	1222,90	95
a40	1241,16	59
a18	1261,01	128
a48	1262,96	121
a53	1265,08	117
a17	1283,93	102
a37	1322,21	117
a31	1329,35	102
a29	1360,99	142
a22	1365,80	110
a16	1380,01	145
a07	1390,69	46
a21	1402,73	134
a43	1406,55	101
a28	1408,77	94
a23	1422,93	148
a51	1435,30	152
a49	1457,32	139
a05	1570,73	166
a41	1623,50	132
a27	1635,16	171
a35	1680,14	197
a06	1691,15	156
a38	1715,70	97
a10	1728,53	126
a03	1757,49	140
a50	1769,11	193
a11	1792,27	149
a08	1799,34	118
a26	1806,92	66
a13	1886,43	148
a24	1898,06	120
a52	1948,67	108
a44	1983,21	212
a20	2093,75	251
a42	2217,84	127
a36	2228,02	136
a46	2230,61	137
a01	2309,27	185
a15	2383,39	206
a39	2388,70	160
a32	2426,17	124
a30	2503,40	159
a09	3059,11	213

ANNEX C – COLOR TEMPERATURE GRADIENT

Color: RGB | Hexadecimal

255,14,240 | FF0EF0
255,13,240 | FF0DF0
255,12,240 | FF0CF0
255,11,240 | FF0BF0
255,10,240 | FF0AF0
255,9,240 | FF09F0
255,8,240 | FF08F0
255,7,240 | FF07F0
255,6,240 | FF06F0
255,5,240 | FF05F0
255,4,240 | FF04F0
255,3,240 | FF03F0
255,2,240 | FF02F0
255,1,240 | FF01F0
255,0,240 | FF00F0
255,0,224 | FF00E0
255,0,208 | FF00D0
255,0,192 | FF00C0
255,0,176 | FF00B0
255,0,160 | FF00A0
255,0,144 | FF0090
255,0,128 | FF0080
255,0,112 | FF0070
255,0,96 | FF0060
255,0,80 | FF0050
255,0,64 | FF0040
255,0,48 | FF0030
255,0,32 | FF0020
255,0,16 | FF0010
255,0,0 | FF0000
255,10,0 | FF0a00
255,20,0 | FF1400
255,30,0 | FF1e00
255,40,0 | FF2800
255,50,0 | FF3200
255,60,0 | FF3c00
255,70,0 | FF4600
255,80,0 | FF5000
255,90,0 | FF5a00
255,100,0 | FF6400
255,110,0 | FF6e00
255,120,0 | FF7800
255,130,0 | FF8200
255,140,0 | FF8c00
255,150,0 | FF9600

255,160,0 | FFa000
255,170,0 | FFaa00
255,180,0 | FFb400
255,190,0 | FFbe00
255,200,0 | FFc800
255,210,0 | FFd200
255,220,0 | FFdc00
255,230,0 | FFe600
255,240,0 | FFf000
255,250,0 | FFfa00
253,255,0 | fdff00
215,255,0 | d7ff00
176,255,0 | b0ff00
138,255,0 | 8aff00
101,255,0 | 65ff00
62,255,0 | 3eff00
23,255,0 | 17ff00
0,255,16 | 00ff10
0,255,54 | 00ff36
0,255,92 | 00ff5c
0,255,131 | 00ff83
0,255,168 | 00ffa8
0,255,208 | 00ffd0
0,255,244 | 00fff4
0,228,255 | 00e4ff
0,212,255 | 00d4ff
0,196,255 | 00c4ff
0,180,255 | 00b4ff
0,164,255 | 00a4ff
0,148,255 | 0094ff
0,132,255 | 0084ff
0,116,255 | 0074ff
0,100,255 | 0064ff
0,84,255 | 0054ff
0,68,255 | 0044ff
0,50,255 | 0032ff
0,34,255 | 0022ff
0,18,255 | 0012ff
0,2,255 | 0002ff
0,0,255 | 0000ff
1,0,255 | 0100ff
2,0,255 | 0200ff
3,0,255 | 0300ff
4,0,255 | 0400ff
5,0,255 | 0500ff

9. Appendix I – Presented Paper AEAULP

Gesto: um processo experimental para determinar o sentido de uma obra de arquitectura

Pedro Marques de Abreu*

Patrícia Esteves**

Resumo

É amplamente aceite que a Arquitectura se distingue da construção corrente – elevando-se acima desta – por comunicar um sentido, algo além da sua função. O sentido, um valor existencial que ela nos revela, é aquilo que a torna única, insubstituível. É necessário compreendê-lo para que possamos beneficiar do seu conteúdo, mas também para que asseguremos a sua preservação quando trabalhamos sobre pré-existências.

Como descobrir este significado, e de modo a que seja intersubjectivo? Sugerimos o conceito de *gesto* como base para uma interpretação da arquitectura. *Gesto* é a sequência de movimentos – o andar, o olhar, mas também variações emocionais – que fazemos quando experienciamos o espaço arquitectónico e que forma um padrão essencialmente comum a todos. Estes movimentos são induzidos pelo próprio espaço e correspondem à sua maneira de nos comunicar o sentido. A nossa hipótese é a de que podemos usar o *gesto* como maneira de chegar ao sentido.

Estamos actualmente a trabalhar num estudo empírico baseado nesta teoria. Serão registados os percursos pedonais e visuais, bem como o pulso, de 30 estudantes explorando livremente a igreja de Alcobaça. Se a análise estatística dos resultados revelar um padrão explotatório, teremos uma base para aprofundar a nossa teoria e testá-la noutros edifícios.

Palavras-Chave: Percepção; Teoria da Arquitectura; Padrões comportamentais no espaço; Arquitectura cisterciense

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Sentido

Paul Valery, tratando da arquitectura, reconhece que há edifícios mudos, outros que falam e outros ainda, mais raros, que cantam[1]. Consideramos que o canto não exprime aqui apenas um grau superior numa escala de arquitecturalidade; julgamos tratar-se de um atributo identificativo. No mesmo texto, o autor aproxima a Arquitectura da Música, na medida em que ambas as artes são capazes de criar um ambiente. É pois nessa capacidade de produzir uma envolvência que reside a identidade individual de cada obra; é a ambiência que cria que torna única essa obra.

A identidade de uma obra de arquitectura – de qualquer obra de arte – não é directamente assimilável ao ser humano. Ela participa em nós enquanto sentido, enquanto conteúdo pertinente para o Eu – um conteúdo poético, existencial, não apenas funcional. A descoberta do sentido numa obra de arte – aqui também se inclui a Arquitectura – contribui para a nossa humanidade, para a nossa vida[2].

Enquanto arquitectos, esse sentido é a essência que devemos preservar quando trabalhamos sobre uma obra já existente – e, quando for possível, não apenas preservar mas revelar, pôr em evidência. O sentido deve ser o guia das decisões de projecto: se uma parede pode ser demolida, se podemos iluminar um espaço de certa maneira, se podemos abrir um vão em certo sítio – sem descaracterizar a pré-existência. Quando agimos sobre uma obra não lhe conhecendo o sentido, de pouco serve o conhecimento que temos da história do edifício, a compreensão que temos dos materiais ou dos procedimentos construtivos – porque não os sabemos orientar. Vale a pena notar que, de certo modo, quase toda a arquitectura é feita sobre pré-existências, isto é, é feita no contexto de uma paisagem humanizada, com identidade e valores específicos.

Tom, ritmo, melodia

Como podemos então descobrir o sentido de uma obra? Regressando a Valery, tentemos compreender como é que experienciamos uma arquitectura e ela nos revela a sua identidade.

A arquitectura começa por ter – como outras obras de arte – a capacidade para gerar um silêncio interior, para suspender o ruído dos nossos pensamentos; gera uma circunstância na qual ficamos receptivos aos primeiros estímulos que a arquitectura produz. Esses estímulos traduzem-se para nós naquilo a que chamamos *tom* e *ritmo*.

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[1] "Dis-moi (puisque tu es si sensible aux effets de l'architecture), n'as-tu pas observé, en te promenant dans cette ville, que d'entre les édifices dont elle est peuplée. Les uns sont muets, les autres parlent, et d'autres enfin, qui sont les plus rares, chantent? – Ce n'est pas leur destination, ni même leur figure générale, qui les animent à ce point, ou qui les réduisent au silence." (Valery, 1996, p. 29).

[2] A afirmação de que a Arquitectura se assemelha a outras formas de arte na medida em que, como elas, é portadora de sentido e (como proporemos adiante) depende da nossa percepção para comunicar esse sentido, não significa que não reconheçamos a suas especificidades ontológicas. A Arquitectura é em primeiro lugar, evidentemente, a morada do Homem, o lugar onde pode viver uma vida integralmente humana, onde a sua existência não é reduzida nem instrumentalizada – um espaço onde o Eu pode existir.

Por *tom* queremos designar a nota afectiva de um ambiente, aquilo que faz com que um ambiente seja dito “frio” ou “quente”, “vibrante” ou “sereno”, “jovial” ou “solene” e que influencia de maneira estável a percepção que dele fazemos. O *tom* vai determinar a velocidade dos nossos movimentos em deslocação naquele espaço. O *ritmo* ditará as acelerações.

O *ritmo* depende da intensidade e frequência de estímulos e vai criar um certo tipo, um certo padrão de movimento pedonal e visual naquele que experiencia aquela arquitectura. O *ritmo* de um espaço pode resultar da alternância de zonas de luz e sombra ou de contrastes de elementos com o fundo e vai articular diferentes atmosferas, organizando e orientando a trajectória de quem percorre aquele espaço.

Então, o encadeamento no espaço do *tom* e do *ritmo* – ou *tons* e *ritmos*, se falarmos de uma obra com vários espaços – dá origem a uma sequência perceptiva comparável a uma melodia, para levar mais longe a metáfora musical. Esta “melodia” é pois uma sequência de estímulos que age sobre a pessoa e a conduz física e emocionalmente[3]. Não faz apenas uma impressão directa na pessoa, como o *tom* (que estabeleceu a coloração afectiva do espaço) ou o *ritmo* (que fez flutuar essa coloração), mas, induzindo um primeiro estado de ânimo que depois modela e conduz, tem já relevância existencial, comunica já um percurso, ilumina já uma faceta da vida, de uma cultura, da humanidade.

Gesto

O *gesto* é, se partirmos da ideia de melodia, a dança inconsciente suscitada pela arquitectura. É o encadeamento ordenado dos movimentos – do andar e do olhar – e dos sentimentos – segundo o qual acontece a nossa percepção de uma obra de arquitectura e que é o modo segundo o qual essa obra, mediante a sua forma, se imprime em nós[4].

Consideramos então que a obra de arquitectura produz uma “melodia” que é portadora de sentido – um sentido que vem directamente daquilo que é próprio daquela arquitectura: não de quem teve a iniciativa de a construir, não da intenção do arquitecto ou do contexto histórico e geográfico – mas da matéria, da forma. E o *gesto*, sendo a repercussão imediata da obra no sujeito é o meio privilegiado para aceder ao sentido. Ao tomarmos consciência do *gesto*, começa o trabalho de descoberta do sentido.

Essa leitura, a ser feita sobretudo por arquitectos, mas também por críticos e historiadores de arquitectura, e que tem como fim encontrar o sentido de uma obra – um sentido que é intersubjectivo, que é partilhado por todos –

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[3] Edmund Husserl tinha já compreendido a importância da cinestesia, da sensação de movimento. A maneira como o corpo se sente quando está num lugar e como nele se move constitui a experiência que deles fazemos e determina a leitura da sua identidade. Husserl escreve: “*The place is realized through kinesthesia, in which the character* (das Was) *of the place is optimally experienced.*” (Casey, 1998, p. 219)

[4] Maurice Merleau-Ponty (2006) diz-nos que é o modo como o nosso corpo reage ao ambiente que nos faz dar conta desse ambiente. Ele recusa a causalidade linear tradicional que toma as reacções do corpo aos estímulos exteriores como uma relação simples de causa (ambiente)/efeito (reacção reflexo). Defende antes que os nossos movimentos são causados pelos estímulos ambientais, mas que por sua vez esses estímulos foram recebidos devido aos movimentos por nós feitos previamente. A causalidade não é portanto linear, mas circular.

tem como instrumento privilegiado o *gesto*, por três razões. Em primeiro lugar, como vimos, porque o *gesto* advém directamente da obra, da sua existência física; em segundo lugar, por ser um fenómeno observável e mensurável; em terceiro, por ser, na sua essência, partilhado pela generalidade das pessoas[5] e poder constituir, por isso, um ponto de partida comum para a discussão do sentido – e, em última análise para uma intersubjectivação da intervenção arquitectónica sobre pré-existências.

Estudos empíricos

Esta teoria do *gesto* ainda não foi testada empiricamente, devido às dificuldades técnicas implicadas no registo da experiência arquitectónica e que só agora começa a ser possível ultrapassar. É interessante, porém, olhar para os estudos que se têm focado na percepção da Pintura, e que podem ajudar a antecipar aquilo que passará quanto à Arquitectura.

Nas décadas de 1950 e 1960, Alfred L. Yarbus desenvolveu uma investigação acerca da maneira como as pessoas olhavam para pinturas. Usando um sistema de *eyetracking*, registou os movimentos oculares de diferentes pessoas e concluiu que, ao observar as imagens, esses movimentos formavam um padrão bastante consistente e que se repetia, com variações, em diferentes sujeitos. Ao invés de explorar toda a imagem, os olhos fixavam-se insistentemente nos mesmos elementos. A percepção acontecia por ciclos e cada pintura gerava espontaneamente o seu próprio padrão visual.

A investigação divulgada por Yarbus foi continuada nas décadas seguintes e até aos nossos dias, com o surgimento de aparelhos de *eyetracking* progressivamente menos invasivos e mais precisos. Assim, várias equipas – por exemplo, Noton e Stark (1971), Brandt e Stark (1997), Kapoula, Yang, Vernet e Bucci (2008), Illes (2008) – secundaram a observação destes ciclos visuais, também designados *scanpaths*, gerados pela imagem e reconhecíveis de pessoa para pessoa.

Voltando à nossa teoria, julgamos ser possível fazer uma analogia entre o padrão exploratório do espaço arquitectónico – o *gesto* – e o padrão exploratório do espaço pictórico – o *scanpath*. O primeiro seria como que uma versão tridimensional do segundo.

Supomos então que, se fossem registadas as trajectórias de um certo número de pessoas – um universo suficientemente grande para ser estatisticamente significativo – seria possível identificar uma cadeia de movimentos comum, um padrão exploratório típico. Para uma validação da teoria do *gesto* seria necessário um conjunto de estudos alargado em que fosse demonstrado que a existência deste padrão se verifica em arquitecturas diversas – em edifícios, jardins, praças e na generalidade dos

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[5] A propósito da intersubjectividade da experiência do ambiente, Mark Johnson (2007) põe em evidência o sistema sensório-motor enquanto base do nosso diálogo com o mundo. Este sistema, constituído por todos os receptores periféricos (que captam características exteriores como a temperatura, a luz, a cor, a inclinação do terreno, o cheiro) e as respectivas relações com o córtex sensorial, engloba também a resposta motora integrada no processamento dos estímulos. O sistema sensório-motor é comum a todos os seres humanos, o que significa que tendemos a ler as situações de maneira semelhante. Há uma maneira especificamente humana de se ser enquanto corpo, de encarnar – uma maneira "táctil e cinestésica"; essa maneira molda a nossa percepção do mundo e é responsável por trazer à tona um *sentido* eminentemente *humano*.

espaços habitáveis com reconhecidas qualidades e que tivessem portanto potencial parar gerar uma resposta intersubjeciva.

Estamos neste momento a preparar um estudo empírico preparatório que registará o movimento pedonal e visual de 30 estudantes da licenciatura em Arquitectura em visita livre à igreja do Mosteiro de Alcobaça. O percurso pedonal será registado por um conjunto de câmaras de vídeo fixas ao longo do tecto da igreja. O percurso visual será captado recorrendo a um aparelho de *eyetracking* (Tobii Glasses Eye Tracker Smart IR, perfeitamente portátil, semelhante a um par de óculos ligado a um aparelho do tamanho de um smartphone). Os participantes usarão também um relógio com medidor do pulso. O objectivo deste pulsómetro é apurar, mesmo que de um modo ainda algo primário, se há uma correlação entre os biossinais e a experiência espacial – isto é, se há uma variações deste indicador emocional (o pulso) ao longo da visita.

Embora contemos fazer uma comparação das 30 trajectórias – para averiguar se, estatisticamente, existe ou não um padrão comum – este estudo não pretende ainda servir de demonstração da nossa teoria. Por um lado porque, sendo a primeira vez que se executa um projecto deste género, há uma incerteza quanto à eficácia do método e do protocolo que só se poderá apurar com a prática. Por outro lado, a quantidade e complexidade de dados que serão gerados pelo *eyetracker* estabelecerá um desafio quanto à sua análise não facilmente resolúvel, tanto mais que não está disponível *software* suficientemente desenvolvido que torne o tratamento de dados automático. Por fim, um universo de 30 participantes não constitui ainda uma amostra representativa.

Ainda que, para nós, este estudo tenha um valor mais exploratório que final, acreditamos que a base de dados gerada pelo nosso projecto, pela sua riqueza e pelo seu carácter original, terá interesse num âmbito mais alargado que o da nossa teoria. A sua análise noutros contextos e por outros investigadores poderá iluminar o entendimento da experiência da arquitectura e aprofundar a sua compreensão.

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10. Appendix J – Presented Paper REHAB

How to make rehabilitation intersubjective: the “Gesture” tool

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ABSTRACT: It is widely acknowledged that architecture differs from current building, as a higher level, because it conveys a deeper meaning, something beyond plain function. The meaning of a work of architecture – something of existential value – is what makes it unique and irreplaceable. Understanding it is necessary so that we can better benefit from its content, but also so that architects can uphold it when working on pre-existing architecture. But how can we acquire this meaning, and acquire it in an intersubjective manner, so that we can hope to agree on it? We suggest the concept of *gesture* as an interpretative basis. “Gesture” is the chain of movements (walking, looking around) and also emotional shifts of someone experiencing an architectural space. “Gesture”, inasmuch as it is determined by the environment, would be essentially similar for every person. These movements we make – an unconscious dance – are induced by space itself and convey its meaning to us. Our hypothesis is that we can use *gesture* to reach meaning. Its value as an analytical tool lies on the fact that it a) derives directly from the work itself rather than, for instance, the architect’s intentions; b) focuses on the more tangible, observable parts of the subjective experience; c) is typically shared by everyone: a common ground for discussion of meaning. We performed an experiment based on this theory in which we recorded the motion of a group of architecture students freely exploring the church of the Monastery of Alcobaça, registering their walking trajectory as well as their gaze trajectory (using an eye tracking device). Our preliminary observations seem to indicate the existence of a shared response to that architectural form. If the statistical analysis of the data (not yet completed) does identify an exploratory pattern, we will have a basis to further pursue our theory, refine it and attempt it in other buildings.

1 MEANING

Reflecting on architecture, Paul Valery (1926) recognizes that some buildings are *silent*, others *speak*, and yet others *sing*. We believe that “singing” is not a mere superlative degree of a hierarchical scale of *architecturality*; we consider that it is an identity attribute. *Architecture* can indeed be associated with *music*, as the only two forms of art capable of producing an ambiance, an atmosphere (Abreu 2007a).

We believe that it is in this capacity for creating an environment that lies the fundamental principle of the architecture’s specificity.

This *singing* that works of architecture are capable of doing offer a *meaning* – some kind of poetical, existential, not merely functional content. Something significant to us, to the way we should live our lives, some truth about human condition.

That meaning is the essence we should preserve, as architects, when working on pre-existing pieces of architecture – and, whenever possible, not only preserve but emphasize it. Meaning should work as a guide in every project decision: to discern whether we can demolish a wall, use artificial lighting in a certain way or add a window to a certain room – without distorting the identity of the pre-existing work beyond recognition. When we act upon a piece of architecture not knowing its meaning, even our knowledge of its history, our comprehension of materials and building techniques become useless, because we do not know how to apply them. It is important to notice that, in a way, all architecture work is done on something pre-existing, since it usually happens in the context of some kind of humanized landscape, with its own character and values.

Meaning is the message conveyed by a piece of architecture. It allows the dweller – anyone who experiences the building – to understand it, to fully relate to it, to grab and assimilate its identity and its cultural value.

2 TONE, RHYTHM, MELODY

How can we, then, understand the meaning of a piece of architecture? We will use as a starting point the vision of Valery mentioned above to allegorically describe the endogenous process of communication of architecture with the Self and in this way describe its identity.

It is quite straightforward, within a first glance, to grasp the tone of a building. *Tone* corresponds to the general affective hue of an environment, which steadily and significantly affects our perception. *Tone* is the first element of the feeling conveyed to us by architecture. This is why we sometimes refer to an atmosphere as being 'warm' or 'cool', 'formal' or 'casual'.

Rhythm derives from the intensity and frequency of stimuli and is materialized in the type of walking and visual movement that it causes in the subject who perceives the piece of architecture. *Rhythm* may exist inside a room – in its shades and contrasts with the background color – but its most remarkable function is the separation of various atmospheres, organizing and directing the subject's trajectory.

The way in which *tone* and *rhythm* are arranged (or tones and rhythms, if the work has several different spaces), that is, how stimuli are distributed spatially and also, through the sequence perceived, temporally, induces variations in the behavior and feelings of the reader and creates the "melody" (to take our musical metaphor further); it is the musical "theme" of that work of architecture.

This organized sequence of stimuli (with different shades) that we designate as "melody" guides the reader's feelings. Through its "melody", the piece of work no longer simply makes a direct impression on the subject, as it does through *tone* and *rhythm*: the repercussion of the "melody" is more personal. It starts by inducing a particular mood, modelling and guiding it afterwards – as in a waltz – subsequently offering a path of life, the shades of a state of mind, a trail of existential understanding of the Self, of culture, of mankind. "Melody" tells a story, which conveys an existential meaning.

(It should be noted that this terminology is allegorical: the words we use are imperfect, but they are meant to translate what typically happens when we experience a work of architecture. The actual experience is of course more complex than these notions are able to say.)

3 GESTURE

The idea of "melody" helps us to explain our concept of *gesture*.

What we designate as *gesture* is the inner and outer motion (in space and time) of the subject – both movement and feeling – induced by architecture, through the layout of *tone* and *rhythm* set in a kind of "musical phrase". "Gesture" is the organized chain of movements – walking and looking – and feelings – caused directly by architectural form. It is through *gesture* that a piece of architecture communicates itself to the subject who perceives it. Edmund Husserl had already understood the value of kinesthesia, the sensation of movement. The way our body feels like in a certain place and how it moves through space truly determines our experience of that place and our understanding of its identity. Husserl writes: "*The place is realized through kinesthesia, in which the character* (das Was) *of the place is optimally experienced.*" (Casey 1998). Maurice Merleau-Ponty (2006) also claims that it is the way our body reacts to the environment that makes us realize that environment. He rejects a traditional linear causality of cause (environment)/effect (reflex reaction) and remarks that although our body motion was caused by the stimuli around us, those stimuli were first received because of our previous movements.

If we consider that a work of architecture is capable of producing a "melody" and has the ability to cause a "gesture" – an arranged sequence of movements and feelings of the subject perceiving the environment – then it is easy to admit that this sequence conveys a message, a meaning (order is always meaningful). Hence, the understanding of the meaning of the piece of architecture comes directly from the work itself and what strictly belongs to it, i. e., its form: not from the artist's intention or any other external matters. "Gesture" corresponds thus to the immediate repercussion of the piece of architecture on the subject – because nothing stands between the piece of work and the subject (other than himself). Therefore, the awareness of *gesture* is the crucial tool to realize the meaning of a work of architecture; once aware of the gesture, the work towards the understanding of meaning begins.

As we said earlier, only works of architecture are capable of producing a "melody" and causing a "gesture": every building produces a kind of noise – inasmuch as they offer the subject a collection of stimuli – but some "orchestration" is needed in order to generate this *dance*. The artistic quality of the environment, the existence of *architecture,* is fundamental for the concept of "gesture".

Discovering the meaning of a piece of architecture would be useful to architects, but also to architecture critics and historians. We should note that it is not a personal, private meaning we speak of (in the sense of "what does this building mean *to me*?"), but an intersubjective one – one that is shared by everyone. That is why "gesture" is such an invaluable tool. As we have seen, it comes directly from the work itself, from its physical existence; it is an observable, measurable phenomenon; finally, it is fundamentally shared by most people[1], which allows it to be the common ground for a discussion about meaning – and, ultimately, the basis for a responsible intervention on valuable pre-existing architecture.

4 TWO EXAMPLES

In order to illustrate how gesture leads to meaning, and how meaning advises rehabilitation, we will provide the example of two buildings in Lisbon: Basílica da Estrela, and Torre de Belém[2]. We will shortly exemplify how to discover meaning through gesture and how knowing the meaning affects project decisions.

Basílica da Estrela is a church built in the late eighteenth century in Lisbon.

Because its dome can be seen from any high point of Lisbon, its presence is felt throughout the town; even when there are other domes in the landscape, this one stands out due to its size and its details; it has a distinctive long, vertical lantern that differentiates it from the rest. Due to its decoration, it has a kind of black and white intense texture which casts a vibrant brilliance, like a sun. The sight of it is somehow magnetic – it arouses our curiosity, it attracts us.

If we accept that tacit invitation, we will find that reaching the dome is not easy: we need to cross some of Lisbon's labyrinthine neighborhoods, sometimes losing sight of the dome and discovering it again, from a new angle, further ahead in the way. When we finally reach it, however, we find out that its façade works like a barrier: it is flat, with somewhat small doors, always shaded (because, awkwardly, faces north) and not very inviting overall – but the sunlit dome, above it, still attracts us; so we dive swiftly through this façade to get to the inside dome.

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[1] About the intersubjectiveness of the environment's experience, Mark Johnson (2007) proposes the sensory-motor system as the basis for our dialogue with the world. This system, composed by all peripheral receptors (which capture external features such as temperature, light, color, ground inclination, smell) and their connections with the sensory cortex in the brain, also encompasses the motor response which is part of the stimuli processing. It generates an understanding of the environment that is, on a primary level, very much alike for every human being. There is a specifically human way of being embodied: a "tactile-kinesthetic" way; it shapes our perception of the world and creates a *human* type of *meaning*.

[2] Both examples are more extensively analyzed in Abreu (2007b).

We find a quiet, warm, welcoming space – we have to stop, the architecture makes us stop. We sit down in one of the benches and rest. The interior of the church is full of recesses with altars in which we rest our eyes for a moment, but which visually block us the way, preventing us from walking.

All around, there is a yellow-orange ambient hue caused by the light from the superior windows reflecting multiple times on the yellow and red stone panels. Somehow, this experience is vaguely evocative of being inside a living body, like a fetus inside its mother's womb.

But then, against the warm atmosphere, we notice the fresh, brilliant light coming from the dome that we now see from the inside. We are now immersed in a soothing environment, free of the gravitational forces previously compelling us to move; our body is resting, but our head looks up, our eyes are attracted to the lit up windows in the dome. They fixate the light coming from *outside*, from *above*, from the *sky*, from where absolute meaning comes from. We feel protected, embraced, but also keen on the drive to act, resolute.

There are therefore two types of "gesture" in the way we relate to this building – the first one, centered around the dome, is centripetal; it happens outside the Basílica and encourages us to pursue it and enter it. We could say the dome works as a star that guides us on our way (in fact, "Estrela" means "Star"). The second type of gesture happens once we are inside; while the warm atmosphere and overall layout of the church is inviting us to rest, our attention is still captured by the dome, which throws it outside, upwards, now in a centrifugal motion.

The nature of the Basílica da Estrela is both the one of a Star and of a Heart. Like a star, it is a reference, a guide, both spiritually and geographically. And also, like a heart, it draws us in and sends us back again to the exterior, but in a very extraordinary, meaningful way. The heart metaphor is especially significant, since the Basílica is devoted to the Sacred Heart of Jesus.

Having found – through the "gesture" – the meaning of the Basílica, we are better equipped to think over its revitalization.

In the interior, the atmosphere depends mostly on the color-charged light that comes from the reflection of sunlight on the wall stones. These surfaces have deteriorated, lost their luster, and it would be advisable to restore them in order to achieve the original intensity of reflection. Other contributors to the experience of the interior are the painted retables by Battoni – also important for the thematic understanding of the building, and which need cleaning as well.

As for the exterior, the most important thing for the existential reading of the building is the Star analogy, which is conveyed primarily through the white glow of the stone; in that sense, periodic cleaning should help to keep its surface free from chemical and biological black spots. But, as we mentioned, this cleaning has to be mindful. The most recent one may have been too rough: it removed the oxidation of the stone surface; that natural reaction, which happens over time, generates a pulverized layer which polarizes light and contributes to the building's splendor.

Torre de Belém is a fortified tower built in the Manueline style in the beginning of the sixteenth century, also in Lisbon.

When approaching it, two features strike us most about this monument: the fact that it is built over the water; and its dense and variegated decoration.

The vertical element of the tower denotes ownership and humanization of the place in which it stands: as if someone was taking possession of a new territory, marking it, grabbing it out of Chaos and into Cosmos – like the Portuguese discoverers did when they left a "padrão" on newly found land. The boat-shape of the building indicates that is the *surface* that is being appropriated: i. e., the seas. This, in fact, more or less summarizes the enterprise of Portuguese Discoveries period (we may say that the Portuguese most important cultural task was precisely showing that the seas were a vehicle, not a barrier).

This meaning is corroborated by decoration, that, if we look carefully, we will see that it tells a story: the story of a sea voyage: with the elements that talk about the vessel (ropes, shields on the side of the ship, the rail section, the seemingly galleon profile, with a tower on its stern, when seen from along the river, etc.), elements that talk about exotic landscapes (ribbed domes, strange animals like the rhino, the mythical sea beasts) and elements that talk about home (the saints and angels, the tower itself, the seemingly Romanic church profile, when seen from north). (Several other aspects of the interior space experience, which we do not have the time to address right now, also support this interpretation.)

To any architect who has to work in or around the Torre de Belém, this reading should be a guide as to what could potentially help the building express its meaning and what could destroy its ability to do so.

About the site, for instance, an important understanding arises from the fact that the Torre's identity is that of a *tower built in the waters*: that the coastal line increasing closeness to the monument, as well as its loss of altimetric dominance by the construction of higher buildings nearby compromise its very nature; it reads less and less as being in the water and as being a tower.

Further considerations can be made, as for instance about the decision made in the 1998 cleaning, not to reproduce the rhino image – the ornaments are a fundamental part of the identity of the building; also about the erasing of several projectile marks in the east and north façades. This speaks to the fact that every intervention on a work of architecture, even a cleaning operation, supposedly neutral, has to take into account the identity of the building – so as not to wipe it away unknowingly.

These analyses exemplify the potentiality of our approach, but they could also render the unprepared reader somewhat uncomfortable and unsatisfied with its subjectivity. We can assert the experience of architecture as being subjective, as it always depends on the experience of a human subject (we will never be able to program a computer to tell the difference between building and architecture). Validity, in this case, comes from *intersubjectivity*. That is why we designed an experiment meant to investigate the existence of a common way of reading and reacting to a piece of architecture.

5 EXPERIMENT

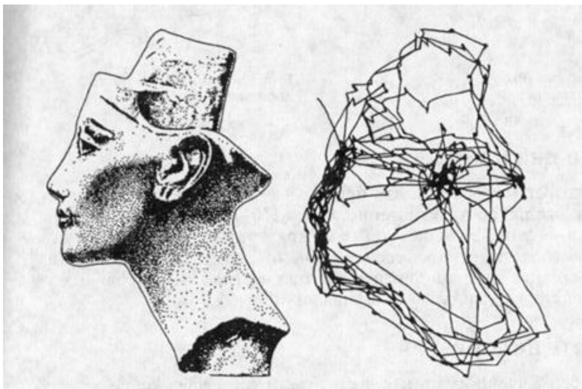


Figure 1 – Scanpath of the bust of Nefertiti, as acquired by Yarbus eyetracking experiments.

Our empirical study is the first to attempt to test the "gesture" theory. The technical difficulties in doing so are great and only recently did the means to reliably register eye movement in free movement conditions became available.

In other fields, however, such as Painting, there is already a large number of empirical studies regarding perception, which help anticipate what is to be expected in Architecture. Alfred L. Yarbus found out that, when looking at pictures, our eye movements form a consistent pattern (Yarbus 1967). Instead of exploring the whole image, the eye repeatedly returns to the same few elements: each picture spontaneously generates its own visual pattern. He observed that this pattern is repeated, with small deviation, by different subjects. Later investigators[3] named this pattern "scanpath".

We believe there is a possible analogy between the exploratory pattern of architectural space – *gesture* – and the exploratory pattern of pictorial space – the *scanpath*. The former would be a

[3] Noton and Stark (1971) analyzed the sequential nature of eye motion and, like Yarbus, saw those perceptual cycles, which they named "scanpaths". Each image suggests its own sequence, which is recognizable from subject to subject, with variations. Brant and Stark (1997), and later Kapoula, Yang, Vernet and Bucci (2008), observed that these eye movements are also reproduced by our eyes when we imagine the image previously seen. This findings support the supposition according to which scanpaths reveal inner mechanisms of object comprehension and memorization.

three-dimensional version of the later. Consequently, if we recorded the motion of different subjects freely exploring an architectural space, it would be possible to make out a common pattern, revealing in which way our body reads the whole group of stimuli presented by the building and responds to it. Surely the sequence would not be equal for every subject, but nonetheless there should be a certain consistency of results.

For a complete validation of the *gesture* theory, a vast series of empirical studies would be in order. We would have to find a common exploratory pattern in different sites – buildings, gardens, squares and every living space with enough architectural quality to generate an intersubjective response.

Figure 2 - Calibration of the Tobii Glasses Eyetracker Smart IR.

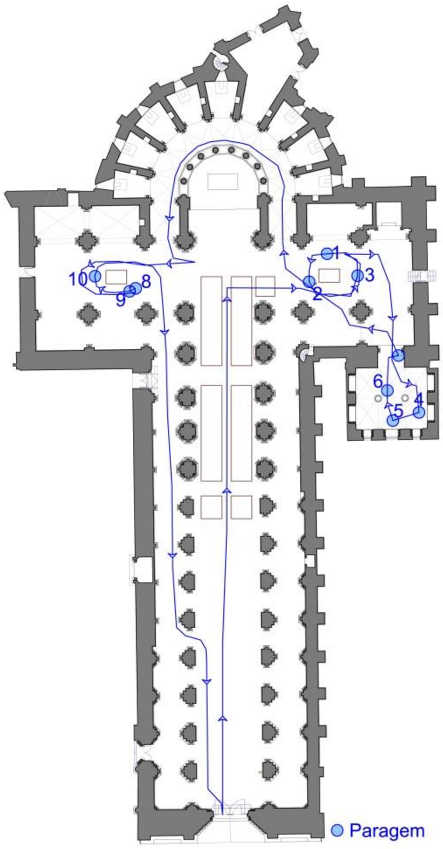
We performed a preliminary empirical study in which the walking trajectory as well as the visual exploration of 50 subjects (39 first-year architecture students plus 11 older architecture students and just-graduated architects) were recorded while they freely explored the church of the Monastery of Alcobaça.

We used an eye tracker– Tobii Glasses Eye Tracker Smart IR (figure 2), perfectly portable, similar to a pair of glasses wired to a light pocket-sized device – which recorded a movie of the subject's point of view through the visit, while also registering the motion of their right eye pupil. The output was a video recording of each visit with a moving cursor indicating where the subject was focusing their vision throughout the visit (figure 3).

Unfortunately, the existing data treatment software is not yet adapted to real life eye tracking the way it is to 2D image viewing and thus there are few automated analysis tools. The ideal output would be a heat map juxtaposed to a 3D model of the church, showing the most fixated sites. Because that technology does not exist yet, we manually coded every recording (figure 4) and are, at this stage, still processing our statistical results.

Figure 3 – Video frame of one of the eye tracking recordings. The red dots represent a series of fixation locations.

Additionally, we asked participants, immediately after the visit was made, to draw their perceived trajectory (fig. 5) and also to make a drawing that represented the most meaningful experience of the church itself (fig. 6). We also interviewed each subject about their experience, using their drawings as a starting point.



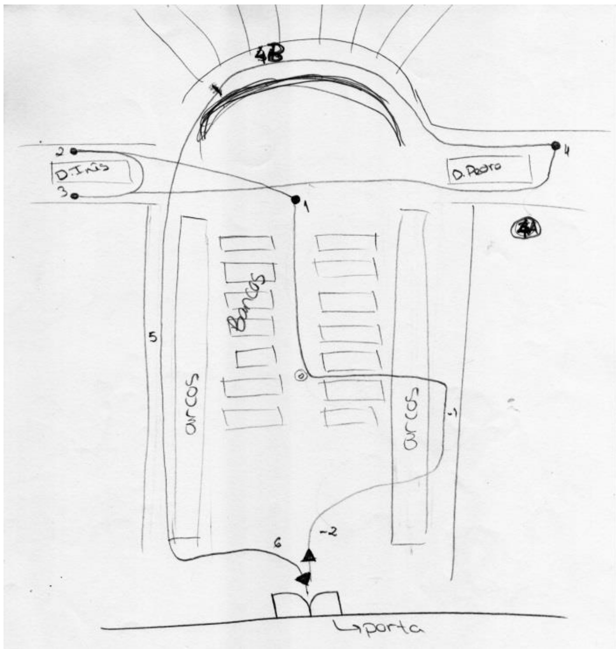


Figure 4 (left) – Walking path of one of the first-year participants, manually extrapolated by watching their eye tracking recording.

Figure 5 (above) – Drawing of perceived path by one of the first-year participants.

Figure 6 – Drawing of the architectonical experience by one of the first-year participants.

While statistical results are still being processed, a few observations can be made, relying only on our attentive viewing of the recordings. When exploring a place like the church of the Monastery of Alcobaça, participants seem to make use of three kinds of looking strategy. They are: navigation, reading and contemplation. The first seems to allow them to navigate the space; it is composed of quick, long saccades (eye movements) and short fixations; the eye jumps from element to element, from nearby objects to people entering the visual field, in a reactive, involuntary manner. *Reading* is also an informative form of looking, but a voluntary one; it happens when, for instance, the participant notices and seems to study the small figures and signs on the tombs; this pattern of looking usually consists of short saccades and longer fixations that progress according to a linear and constant trajectory, not going back and with no accelerations or disaccelerations. The last and to us most interesting looking pattern, which we designated *contemplative*, differs from reading in the fact that the eye repetitively returns to the same feature (a window, for example) while in reading it usually fixates each region only once. A contemplative gaze is not extracting information anymore, but seems to be an end in itself – as if it was enjoyable.

Let us note that the existence of two distinct ways of visual processing has already been established for image (static scene) and also video (dynamic scene) viewing. This duality has been referred to as *focal-ambient* (Trevarthen 1968) or *foveal-ambient* (Stone, Dreher & Leventhal 1979). Although parameters can vary, fixations with a duration of 90 to about 260 milliseconds, along with saccades that go beyond the parafoveal part of the retina, thus aiming at blurred targets, are associated with ambient mode. Fixations longer than 260 milliseconds and smaller saccades tend to indicate focal processing (Velichkovsky, Joos, Helmert & Pannasch 2005). Although our equipment did not measure fixation duration, and thus we cannot compare our data with that from 2D eye tracking, it seems very likely that the distinction in visual processing found in those conditions also exists in real-world navigation. What we call *reading* and *contemplative* ways of looking are both part of the foveal processing, while ambient processing would be the more navigation-oriented type of looking described above.

Even though it is not easy to make an integrated analysis of walking and looking behavior, we observed that contemplative gaze is often paired with two walking patterns: the first is simply being still, for instance stopping just as the eye engages a certain feature; some of the subjects sit down on the benches to examine the apse more extensively. The second is slowly walking towards, or around, the element one is looking at. This behavior is possibly site-specific: the church in which the experience took place has a nave more than 100 meters long which ends in a well-lit apse; walking along the length of the nave while fixating the apse seemed to be a common response to that architectural form, i. e., the typical “gesture” induced by this piece of architecture. Another observation about this contemplative gaze mode is that it seemed to fall on the same regions (for example, the apse in one end of the nave or the rose window in the other) over and again; the subjects looked at them from different angles at various points of their visit.

Although they are also not yet formally processed, something can be said about the interviews: the same words were repeated by different subjects. “Silence”, “solemnity” and “height” seemed often to be first impressions, which shows how the *tone* of the building is promptly and easily picked up. Older participants described the “magnetism” of the apse and how its light was inviting. Many acknowledged that appeal, but said they were too shy of the grandiosity of the central nave to pursue it immediately or directly.

As for the “experience drawings”, the most recurring theme was perhaps the height and repetition of the naves (something like the example on figure 6) – which again reveals a commonness in how stimuli were processed. It should be noted that each visit and subsequent drawings and interview were made individually and separately, so that each participant was not influenced by the experience of the next.

6 CONCLUSION

More substantial conclusions will arise when statistical processing is completed. This is of course still an incomplete account of the results of our experiment. This article aims mostly at its theoretical justification, still lacking the statistical evidence it pursues.

However, the preliminary observations seem to indicate that the building’s form generates a pattern of exploration; for example, the long, repetitive nave with sunlit extremities creates an axial walking movement where the eyes are constantly being drawn to the light ahead.

That observation could already tell us something about how to improve the church of the Monastery of Alcobaça; it already could help us make decisions about simple interventions, by helping us ask the right questions: “which illumination best suits the solemn, repetitive rhythm of the nave?”, “How dim does the artificial lighting need to be so as not to take the focus away from the apse?”, “Where should signage be located so that it doesn’t disturb axial movement?”, “Is it adequate that the tombs of D. Pedro and D. Inês should be where they are?”, etc.

This empirical way of finding meaning could guide the architect’s knowledge and creativity in order to enhance the architectural experience of the building. If the statistical analysis of the collected data should verify the pertinence of the gesture theory, other experiments, in other locations, would still have to be made. As for now, it seems to be a valuable research path that could lead to a better understanding of buildings and, in the future, provide useful guidance for decision-making in architectural projects.

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11. Appendix K – Submitted manuscript: The Journal of Architecture

Estimation by kriging the time of stop points from visitors of the Alcobaça Church, Portugal

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Abstract (123 words)

This paper is dedicated to the experimental study of the behaviour of two groups of individuals while carrying out a visit to the church of the Monastery of Alcobaça, located in the middle-west of Portugal. During the course of the visit of the church interior, individuals occasionally interrupted their movement to contemplate the architecture of the building or other decorative motifs of interest. The experimental procedure consisted in recording the duration of each stop of the individuals from both groups in order to identify, through the simple kriging estimation, the areas preferred by individuals for observation inside the church. This study is part of the research project GESTURE: an empirical process to assess meaning in a piece of architecture, financed by FCT, Portugal.

Keywords

Architecture observation, Kriging estimation, Church of the Monastery of Alcobaça

1. Introduction

The main purpose of this paper is assessing the behaviour of some visitors towards an architecture object.

This paper focuses on a sample of 50 individuals who visited the church of the Monastery of Alcobaça in the period between 20/Oct./2014 and 04/Dec./2014 and who volunteered to carry out the experience. The 50 subjects were divided into two groups – students of the 1st year of the Integrated Masters in Architecture (MiARQ) and in Interior Architecture and Rehabilitation of the Built (MiAIRE), both from the Faculty of Architecture of the University of Lisbon (39 individuals) – Group A; and students of the 5th year of MiARQ and graduates (GMiARQ) which recently concluded the same master course (11 individuals) – Group B. For each group the length and geographical location of each stop inside the church was recorded. Thus were obtained two files (for groups A and B) with the format of Table 1.

Each group of individuals (Group A and Group B) was individually analysed.

The study consisted in the spatial estimation of time of stop points from individuals, through a linear estimator of simple kriging (Krige 1951, Journel 1989; Soares 2000), also representing its distribution among different areas of the church, whose identification is illustrated in Figure 1.

The study variable – duration of stops (Time) – is a variable distributed spatially by the church that can be seen as a regionalized variable (Matheron 1965), *i.e.* with a dual character. It presents on the one hand a random behaviour, that individuals stop for a while in various parts of space; and at the same time a structured behaviour revealed by a relation between the duration of stops and several places. The geostatistical linear estimator, $[Z(x_0)]^* = \sum_{\alpha=1}^{N} \lambda_\alpha \, Z(x_\alpha)$, called kriging is a linear combination of the set of N neighbouring variables of $x_0 - Z(x_\alpha),\ \alpha = 1, \dots N$, which meets the two criteria with respect to the estimation error $\varepsilon(x_0) = [Z(x_0)]^* - Z(x_0)$: unbiasedness $E\{\varepsilon(x_0)\} = 0$ and minimum estimation variance $min\{var[\varepsilon(x_0)]\}$, and it was applied to spatial estimate the regionalized variable – duration of stops.

All calculations and graphics presented below were made using the GeoMS software – Geostatistical Modelling Software (CMRP 2000).

2. Students of the 1st year of MiARQ and MiAIRE – Group A

This study covers the 1117 records corresponding to the duration of stops for the 39 individuals who constitute this group. Figure 2 shows the results of univariate analysis of the time variable for stops (Time).

It is noted that many individuals stop little time in each point (85% of stops are less than about 16.5 s). The arithmetic mean is much greater than the median owing to about 15% of outliers (about 10% of severe outliers and 5% moderate outliers). Although the total amplitude of the data is very high (about 292 s), the amplitude of 90% of core values is only about 29 s and the interquartile range of 8.5 s. In fact, despite the high standard deviation, the core values reveal some homogeneity.

The data are spatially represented in Figure 3, noting that the lengthier stops are concentrated in four areas of the church – entrance, eastern side of the nave (A), near the tomb of D. Pedro I in southern side of the Transept (F) and the Crossing area (C).

The spatial variability of stop length was modelled by a spherical type of theoretical model of an omnidirectional variogram, with the following parameters: $c_0 = 0.738$; $c_1 = 0.261$; $a = 1.99$ (Figure 4).

It is evident the reduced spatial continuity of data due to high nugget effect and the reduced range of the theoretical model fitted to the experimental variogram.

The results of the spatial variable estimation are shown in Figure 5. It is clear that there are some areas of the church where individuals stop for longer, particularly in the entrance area, on the east side of the nave (A), in the Crossing area (C) and near the D. Pedro I tomb in the southern side of Transept (F). To a lesser extent, individuals also stop in the area of the Royal Pantheon (H), in the passageway to the new sacristy (G) and near the tomb of Inês de Castro[1] in the north side of the Transept (F). Shorter stops were recorded in the middle of the south side-aisle (B) and on the east side of the north side-aisle (B).

3. Students of the 5th year of MiARQ and GMiARQ – Group B

This study includes 279 records corresponding to the duration of stops for the 11 individuals who constitute this group.

The Figure 6 shows the results of univariate analysis of the time variable for stops (Time).

It is noted that many individuals stop little time in each point (85% of stops are less than about 17.4 s long). The arithmetic mean is considerably higher than the median owing to about 20%

[1] The love of Pedro for Inês is one of the most fascinating legends in the history of Portugal. D. Pedro I (1320-1367) married in 1336, in second nuptials, with D. Constança Manuel (1318-1345), a Spanish princess. Due to several wars between Portugal and Castile, D. Constança only arrived in Portugal in 1339. In his entourage, she brought the maid Inês de Castro (1320-1355), who came from an ancient and powerful Galician noble family. D. Pedro I fell in love with her. In 1345, D. Constança died fourteen days after the birth of his surviving son. D. Pedro I went to live publicly with Inês, born of these relationship three children. D. Afonso IV, the father of D. Pedro I, never accepted the loving relationship of your child with Inês de Castro, and condemned her to death for high treason. After ascending the throne, D. Pedro I avenged the death of his beloved (claiming to have married her secretly in the year 1354) and decreed that honour D. Inês de Castro as queen of Portugal.

of outliers (about 18% moderate outliers and only about 2% of severe outliers). Although the total range of the data is very high (about 166.5 s), the range of 90% of core values is only of about 31.5 s and the interquartile range of 9.7 s. Clearly, even in core values, there is a greater dispersion of data in the Group B of individuals than in the case of individuals of the Group A.

Data are represented spatially in Figure 7, observing that the longer stops are focused on eight areas of the church – the entrance, the middle of the nave (A), the east side of the nave (A), the Crossing (C), near the tombs of D. Pedro I and Inês de Castro, respectively in the south of the Transept (F) and in the northeast of the Transept (F), the north of the ambulatory (E) and the west of the Royal Pantheon (H).

The spatial variability of duration of stops was modelled by a spherical type theoretical model from an omnidirectional variogram, with the following parameters: $c_0 = 0.851$; $c_1 = 0.149$; $a = 4.509$ (Figure 8).

Note in this case that the theoretical model of variogram shows greater spatial continuity than in the previous case, although the high nugget effect of the theoretical model fitted to the experimental variogram is also evident.

Then also it held up estimation of the spatial variable, whose results are shown in Figure 9.

It is clear that there are some areas of the church where individuals stop for longer, particularly in the middle of the nave (A), in the Crossing area (C), near the tomb of D. Pedro I in the south area of the Transept (F), in the northern area of the ambulatory (E), in the passageway to the new sacristy (G) and near the tomb of Inês de Castro in the northeast of the Transept (F). To a lesser extent, individuals also stop in the entrance and in the western area of the Royal Pantheon (H). Shorter stops were recorded in the southern area of the Royal Pantheon (H) and in the northeast and southeast areas of ambulatory (E).

4. Conclusions

The data for the Group B individuals showed greater spatial continuity and are hence more structured than the data of individuals of Group A, allowing estimation for most of the area of the church. Although records of the individuals in Group B correspond to fewer individuals, it is clear that there are differences between the two groups of individuals regarding the areas of the church that were dedicated longer and shorter stop times.

5. Acknowledgments

The authors thank all the participants who volunteered to carry out the experience and the FCT agency which supported the GESTURE research project (Ref: EXPL/ATP-AQI/1142/2013).

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12. Appendix L – Submitted manuscript: Leonardo

THE *GESTURE* HYPOTHESIS OF SPACE PERCEPTION: AN EMPIRICAL STUDY

Pedro Marques Abreu; Jorge Tavares Ribeiro; Patrícia Esteves; Rita Ferreira

ABSTRACT

The research presented here is based on the hypothesis that each work of architecture induces a particular behavioral response in those who experience it, that response being a series of walking and looking movements, with an associated emotional repercussion. We have called that perceptive sequence – an unconscious slow dance – *gesture*. *Gesture*, inasmuch as it is determined by the environment, would be fundamentally similar for every individual. This intersubjective quality would make *gesture* a reliable guide in interpreting pre-existing architectural structures, providing architects with a common basis for more adequate interventions. We performed a preliminary experiment based on this theory in which we recorded the motion of 50 subjects freely exploring the church of the Monastery of Alcobaça, in Portugal, registering their walking trajectory as well as their gaze trajectory using an eye-tracking device. Our observations seemed to indicate the existence of a shared response to that architectural form. Gaze analysis shows that there is a consistency regarding the areas which are more visually attractive, with two regions clearly standing out. Stopping analysis – looking at where and how long participants stopped during their visit – resulted in less coherent data, while still remaining consistent with our hypothesis. Finally, the analysis of entry behavior – looking at what path people took immediately upon entering – revealed an overwhelming consistency of behavior not only for the initial 50 subjects but for a larger sample of 467 visitors. Therefore the empirical results for the Church of the Monastery of Alcobaça do not disprove the *gesture* hypothesis.

INTRODUCTION

Gesture

The hypothesis that prompted this research project states that a piece of architecture must elicit, in those who experience it, a particular *gesture*, i.e. a series of walking and looking movements and, correspondingly, a given set of emotions [1]. This chain of walking and looking movements would be the direct perceptive response to the stimulus of the architectural form. The perceptive flow is composed of visual, acoustic, tactile, and olfactory, but also proprioceptive, stimuli. Since it is mainly determined by the architectural form, *gesture* would be common to all those who experience one piece of architecture [2] [3] [4].

Let us imagine one is visiting a large nave; all of the walls, ceiling and floor are even and homogeneous; there are no peculiar light effects; but somewhere there is a niche with ornamentation. After a very brief general inspection of the space, one's gaze will be drawn to that niche; if it has any sort of complexity or meaning, one would most likely cross the nave in order to examine the niche in further detail.

Many architects design space as if to be seen during a walk, almost as if in a movie (one may recall the Corbusian concept of "*promenade architecturale*"), playing with the light, the color, and the ornamentation as a means to attract and guide the visitor's attention. They also often work with space in order to produce certain emotional effects: surprise, relaxation, exaltation, experiences of coziness, of formality, etc.

A truly architectural work conveys an existential meaning which makes it valuable beyond its practical function, in such a way that it imprints itself on the consciousness and memory of the visitor as something irreplaceable in its existential content. This imprint is possible because all of these design strategies are orchestrated in order to induce something similar to a *slow dance*, from which results a sequence of perceptual data and feelings through which a message is conveyed – not unlike what happens in music. In fact, as with music, it is possible to say that an environment has a certain tone (e.g. cozy, formal, amusing, strict) and a certain rhythm as well (suggested for instance by the size of the steps, a set of pilasters in a gallery, a sequence of bays in a wall). As with music, tone and rhythm come together to create a melody – and a melody conveys a message. This message touches and informs the innermost part of the human subject. It is through the meaning that pervades *gesture* that architecture achieves its value and its place, at an anthropological level.

If this anthropological claim is true, then the *gesture* hypothesis implies that each architecturally valuable building possesses a perceptive pattern and this pattern is intersubjective.

The premises of this theory are not new. Husserl presumes the theory when he says that place is understood by the kinesthesia that is proper to itself: "The place is realized through kinesthesia, in which the character (*das Was*) of the place is optimally experienced." [5]. Wittgenstein, furthermore, states that one is compelled to answer to architecture with a *gesture*: "Remember the impression made by good architecture, that it expresses a thought. One would like to respond to it too with a *gesture*" [6].

Investigation into eye movement, which has been intensely studied for the past five decades, provides evidence which appears to support the *gesture* theory.

Firstly, gaze is highly selective. It does not scan every area of a scene; instead, it picks a few locations and focuses on them repeatedly, while others are seldom examined [7] [8]. Noton & Stark [9] and Brant & Stark [10] analyzed the sequential nature of eye motion and observed perceptual patterns, which they named "scanpaths". Each image suggests its own sequence, which is recognizable from subject to subject, despite minor variations. Furthermore, this eye movement seems to be connected to the inner mechanisms of object comprehension and memorization [11] [12]. The "scanpaths" or scan patterns the eye makes when looking at realistic pictures offers an insight into how people explore three-dimensional space as well. *Gesture* would be a more complex, whole-bodied, tridimensional version of the two-dimensional scan pattern.

Secondly, the preferred areas of "scanpaths" seem to be those with either greater semantic value or, if the subject is completing a task, those that will be useful in that context. Cristino & Baddeley [13] state that "people rarely look at the sky. Unless judging the weather or searching for airplanes, the sky rarely contains behaviorally important information". This further reinforces the notion that there could be an underlying logic that governs perception. Moreover, our brain seems to be able to predict very accurately where in the environment to find the most interesting information [14] [15].

Thirdly, there is a similarity in gaze behavior across different individuals. The same viewing strategies are followed when completing a task, and, when freely viewing complex scenes, individuals are attracted by the same features. The use of similar looking strategies was detected by multiple researchers and emerged in almost every experimental setting.

These observations are all consistent with the *gesture* hypothesis.

When analyzing the gaze and posture of subjects looking at paintings with strong depth cues, Kapoula et al. [16] observed the convergence of the eyes as well as the sway of the body in the direction of the perceived depth. This experiment prompted the question of what the subjects' response would be if there really was a tridimensional space in front of them – something which we explore in this experiment.

There is also evidence [17] [18] [19] supporting the idea that works of art are particularly capable of guiding our senses and create an intense, coherent response in which meaning is conveyed in an especially compelling way.

To explore the *gesture* theory and further understand the perception of architecture, we performed an empirical study in which the walking trajectory as well as the visual exploration of 39 subjects (plus an additional group of 11) was recorded while they freely explored the church of a Cistercian Monastery in Alcobaça. Afterwards, the participants were asked to draw their perceived trajectories as well as something that illustrated their general impression and were interviewed on their reactions to the space.

The aim of this study was to explore the physical response caused by a work of architecture and to verify whether there was any consistency in that response. We questioned whether subjects were visually attracted to the same architectural regions and features; had similar walking trajectories; and, when interviewed, expressed a similar experience of that space.

In this paper, we present the first results of that experiment: gaze analysis (what are the most visually attractive regions of the church), partial trajectory analysis (what is the preferred trajectory immediately upon entering), and an analysis of stops (where in the church and for how long did subjects stop).

Further processing of the collected data is still under way, especially concerning trajectory analysis. A complete analysis of the trajectories of the 50 subjects, interviews, and drawings are also still being examined.

EXPERIMENT 1 – GAZE ANALYSIS [var. = t(fixation)/m2; nr(fixations)/m2]

Hypothesis

In the first experiment we looked into what church regions were visually explored. From an architectonical point of view, we considered that the apse behind the presbytery should be the main focal point (we named it "hot-spot A"), the west façade, with the entrance and the rose window, the second-most looked at region (named "hot-spot B"), the south façade the third ("hot-spot C"), the north façade the fourth ("hot-spot D"), and the passage to the Manueline sacristy the fifth ("hot-spot E"). We also designated three of what we expected to be less visually attractive features ("cold-spots X, Y and Z"). Our hypothesis was that people would fixate "hot-spots" more frequently and longer.

Participants

Our main sample was composed of participants who were recruited from first-year architecture classes in the Faculty of Architecture, University of Lisbon. There was also an additional group of fifth-year and graduate architecture students.

Although 54 participants completed the visit, four of the records were later disregarded due to technical or recording issues. The results that were obtained are thus based on the remaining 50 students – 39 first-year students and 11 fifth-year students and recent graduates. First-year students were favored because they are more likely to have a special sensitivity regarding architecture, and yet they have not developed preconceptions. Participation was voluntary; no course credits or remunerations were given; round-trip transportation was made available to all participants.

Procedure

Upon their arrival at the Monastery of Alcobaça, participants were escorted directly to the support station of the experiment, preventing them from entering the church. In the support station, the eye-tracker was equipped, adjusted, and calibrated. Afterwards, each participant was accompanied to the main door of the church by a research team member. The participants then proceeded to freely visit the church on their own. There was no time limitation; participants were instructed to explore the church as they would in normal, "touristic" circumstances.

Materials

Monocular (right) eye position was recorded using Tobii Glasses Eye Tracker Smart IR, a portable device similar to a pair of glasses wired to a light pocket-sized recording assistant. This eye-tracker allows for an unhindered freedom of movement both of body and head.

Tobii Glasses Eye Tracker uses the pupil-centered corneal reflection technique: a vector between pupil center and corneal reflection created by IR light is used to calculate gaze direction. Data rate is 30 Hz and the recording angles are 56° horizontal and 40° vertical. It creates a video recording of the visit from the point of view of the participant with an overlap of a moving cursor indicating what point in the scene is being fixated at each moment.

During the visit, subjects were told to keep the recording assistant – a small device wired to the glasses – in their pockets or attached to their belts so as not to interfere with their movement.

Data Treatment

Existing software does not offer many tools for the examination of the data generated by this type of experiment, in contrast to its proficiency in the analysis of 2D-image viewing.

In order to overcome the lack of automated analysis tools, a manual analysis of fixation incidence on certain architectural regions was performed. Eight study areas were initially defined (Figure 1): areas of expected gaze and eye fixation attractiveness, designated as hot-spots (A-E), and, in opposition to these, areas that were expected to be less visually attractive, designated as cold-spots (X-Z). Data for surfaces adjacent to some hot-spots was also collected (AA-DD).

We then proceeded to ascertain, for each individual, how often, in number of fixations, and for how long, in milliseconds, their gaze focused on the hot- and cold-spots.

Due to the lack of automatic analysis in this process, data collection implied viewing the eye-tracker video of each individual while taking note of when their gaze was directed at one of the study areas. Whenever a subject directed their gaze at area A, for instance, an "A-start" marker would be set to signal the start of that event; and an "A-end" marker would signal the end of that same event – and so on for each time a subject would look at one of the study areas (see Figure 2a-c). The insertion of markers was performed using Tobii Studio and data sets were afterwards exported into a spreadsheet format (Figure 3).

Given the need to compare areas of different sizes, the area of the study regions was measured in m2 and, for the data acquired in the first phase, the time of fixation/m2 and number of fixations/m2 was calculated.

Statistical analysis

Exploratory analysis made it possible to identify which church regions were preferred by the subjects, in terms of number and duration of fixations.

Univariate analysis

Areas A and B were the most attractive for the 39 individuals, both in length of fixation (about 3750 ms/m2 – see Figure 4) and in frequency (about 1.2 fixations/m2 – see Figure 5). In contrast to this, areas CC, DD, X, and Z were less attractive for visitors in both variables. Areas E and Y were faintly attractive, and attracted a limited number of long fixations[1].

The group of 11 older students and graduates obtained similar results: regions A and B were the most visually attractive, both in how long they were looked at (between 1500 and 2400 ms/m2 – see Figure 6) and in how frequently they were looked at (about 0.57 and 0.69 fixations/m2 – see Figure 7).

Bivariate analysis

Areas A, B and C show the existence of a strong direct correlation between the variables of time and number of fixations, meaning that, as the number of fixations rises,

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[1] Our technical means did not allow us to measure fixation times and saccade amplitude in the precise, automatic way that they are usually measured by in 2D eye-tracking. But it was still possible to make a few observations based in objective, although not immediately measurable. parameters. We detected the existence of three "modes" of looking: navigation, reading and contemplation. The first seems to allow subjects to navigate the space; it is composed of short fixations and quick, ample saccades, sometimes accompanied by wide head movement, the eye jumping from element to element in a reactive, involuntary manner. Reading is also an informative form of looking, but a voluntary one; it happens when, for instance, one examines an inscription or a complex sculpture; this pattern of looking usually consists of short saccades and longer fixations that progress according to a linear and constant trajectory, irreversible and with neither accelerations nor decelerations. The last and to us most interesting looking pattern, which we designated contemplative, is also composed of short saccades and long fixations, although it differs from reading in the fact that the eye repetitively returns to the same feature (a window, for example) while in reading it usually fixates each region only once. [20].

so does the time of fixation. This means that these areas were not only fixated more frequently, but also that, statistically, they were also looked at for longer each time.

On the other hand, there is a weak correlation between the variables of time and number of fixations in the remaining areas (AA, BB, CC, D, DD, E, X, Y and Z), denoting the inexistence of a patterned behavior amongst the individuals for these areas.

Results

The hypothesis which presided over the gazing test was that the church of Alcobaça should have some areas that are more visually attractive than others. It follows that we pre-determined "hot-spots" and "cold-spots". Two of the chosen "hot-spots" carry an overwhelming percentage, both in the number of fixations and fixation time. This is consistent with the original hypothesis, since these two areas are the ones we would assume, from an architectural point of view, to be the most favored (the apse as well as the exit's interior façade including the main door and rose window). Other areas we had presumed to be attractive (transept end walls and the Manueline door of the sacristy) did not show results that clearly differentiated them from some of the "cold-spots". This may be due to two main reasons: the small sample of individuals tested (more individuals would allow for more diffused results that could reveal differences between these areas); or extra-architectural elements present in the "cold-spots" and not considered in the design of the experiment (objects, drapery...) that attract gaze as much as privileged architectural elements, hence making the results similar. Nevertheless, while there are two gazing areas that clearly stand out from other architectural areas, we ought to assume that the data from the gazing tests at least does not invalidate the *gesture* theory.

EXPERIMENT 2 – Stops [var. = t(stop); coord(X); coord(Y)]

Hypothesis

In the second experiment we analyzed where and for how long subjects stopped during their visit. From an architectural point of view, the church's crossing would be an important spot, since it is situated at the end of the central nave, the endpoint of the initial impulse towards the apse. It is also the interception of the two main axes (the nave and the transept), and connects to almost every other church space, not to mention that it is a privileged viewpoint for the understanding of the church's whole structure. Near the entrance would be another predictable place to pause, since people sometimes stop when entering to take in the first impression and choose a path, and then again before leaving, to take a last look at the space.

Procedure, Participants & Materials

This experiment drew from the same data source as the first one.

Data Treatment

Initial data treatment for stops in each participant's trajectory was partially similar to that of eye fixations: the perspective of each individual's visit was also recorded in the Tobii Studio software using the data from the eye-tracker video. So, the process repeats itself, at least in the method of inserting markers for events and data extraction and of calculating the duration of each stop using a spreadsheet. In this case, however, the noteworthy events were the beginning and end of a halt in their walking movement.

Along with the variable of time, each stop was also associated with a location in the church's plan: an X and a Y coordinate were attributed to each stopping point. The process of acquiring these coordinates involved, once more, viewing the eye-tracker video of each of the participants and mapping their trajectory. Each trajectory was registered on a plan of the church using computer-aided drafting software (Figure 8); trajectory mapping was accomplished by viewing the eye-tracker videos while gradually registering the trajectories. It involved inferring the location of the participant inside the church given the spatial and physical cues from the available media. Since this was a manual process, it was deemed necessary to verify its reliability. This was done by having a second investigator mapping a few trajectories using the same method and comparing the results with those of the first investigator; the degree of reliability of the technique was considered satisfactory: there were very few disparities, all quantitative rather than qualitative – for instance, one mapping might have the trajectory line further to the left or right, but both lines were always on the same side of a column. Furthermore, this method was approved by the eye-tracker manufacturer, who confirmed that it had been successfully used before by other researchers.

In this format, it was possible to extract coordinates of the walking points in each trajectory, as well as of the stops (which were signaled by circles). The data of the coordinates were extracted from the draft and imported into the spreadsheet where the association of stop coordinates to stop duration was attained.

From this data collection and initial treatment resulted stop coordinates (X,Y) and their associated duration (in milliseconds). This data was subsequently used in the statistical analysis of stops.

Statistical Analysis

Regarding the stops of experimental individuals we performed a univariate analysis and complemented the study with a spatial modelling and ordinary kriging estimation of stopping times for the whole church.

Results

Figure 9 shows the results for the univariate analysis of the Time variable (the length of the stop) for the 39-subject group. Individuals did not stop for too long in each spot – 85% of the stops were shorter than 16.5 s long. The mathematical mean was considerably higher, due to the existence of about 15% of outliers: 10% of extreme outliers and 5% of mild outliers. Extreme outliers, that is, occurrences of longer stops, were linked to people sitting in the benches and/or extensively examining a particular region of the church.

The same trend was followed by the group of older students (see Figure 10).

Data is spatially represented in Figures 11 and 12, where we can observe that stops of a longer duration occurred in three regions of the church – the entrance, the south end of the transept and the crossing. The shorter stopping durations happened in the lateral naves.

These results are consistent with our hypothesis, although the stops are widely spread across space. It must be noted that some of the unpredicted but nonetheless preferred stopping points (such as the one in the Southeast end of the transept) were linked to sculptures and statuary – extra-architectonical elements.

EXPERIMENT 3 – Entry Behavior

Hypothesis

This third study was a preliminary study of the trajectory of the visitors. We analyzed the first part of the subjects' path inside the church (a more comprehensive analysis of the subjects' trajectory is still being developed) as well as the path of a much larger pool of subjects: the anonymous visitors of the monastery.

Our hypothesis, based on the architectonical characteristics of the church, was that subjects were going to walk straight ahead, through the central nave, attracted by the apse.

Along with finding out what would be the most typical initial part of the trajectory, this study also provided, through the large pool of random, varied visitors – a control group to counterpoint our 39 first-year architecture students (plus 11 older students).

Procedure & Materials

An action camera (GoPro) was suspended from the ceiling of the church's nave, near the entrance. It captured about 2/3 of the length of the central nave.

Participants

A new group of participants was introduced for this study. They were the church's anonymous visitors who completed their visit during the recording period. Cameras were recording while the eye-tracker sessions took place. These subjects were largely unaware of their movement being recorded[2], and as such were completely spontaneous.

Big groups were not included in this study, since they were likely to be guided visits, in which the freedom of movement of the visitants is greatly affected, as they tend to follow one guide. We also omitted the visitors who, after entering the church, proceeded to visit the rest of monastery immediately, without exploring the church's space. The participants of the eye-tracking experiment, the monastery's employees and the experimenters whose movements were recorded were likewise disregarded for the purpose of this study.

Of the total number of anonymous church visitors, 467 were considered.

The group of 39 first-year architecture students and 11 fifth-year architecture students and graduates was considered separately.

Data treatment

We monitored the footage from the suspended camera, and took note of the trajectory of every individual that entered the church, as far as they were visible. Afterwards, these trajectories were classified according to different types – see Figure 13.

For the group of 50 students, we used their existing trajectory mappings to code entry behavior.

This data was used in the following statistical analysis.

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[2] There was a notice in the church's information board informing visitors that they might be being filmed.

Statistical Evaluation

The entry behavior of the experimental subjects as well as of the 467 anonymous individuals was analyzed.

Univariate analysis, experiment participants (group of 39 subjects)

The majority of individuals in this group went straight ahead along the central nave (direction F); see Figure 14. The second most popular trajectory was turning right shortly after entering the church and going ahead along the south nave (direction 1S-3S).

The second- and third-most popular trajectories were, respectively, moving forward along the central nave after having advanced in the south aisle for a few meters (F+ES) and turning left shortly after entering the church and going ahead along the north nave (1N-3N).

Univariate analysis, anonymous participants (group of 467 subjects)

The majority of individuals in this group also went straight ahead along the central nave (direction F) upon entering the church; see Figure 15. Diverting to the south aisle immediately before the benches (entry behavior type BS) was also common but much less popular. All other directions were taken only by a very small amount of individuals.

Comparison of the two groups

In both groups, going straight ahead through the central nave (direction F) was the preferred trajectory. In that respect, the groups were convergent, although this tendency was more accentuated in the large pool of anonymous visitors. It is also worth noting that the direction 1S-3S, which implied diverting to the south aisle soon after entering the church, which was the second most frequent trajectory carried out by the 39 experimental subjects, was not once observed in the group of 467 subjects.

Results

The hypothesis that presided over the entry behavior test was that the architecture of the church of Alcobaça would determine a pattern of walking; and that this pattern would, in the initial moment, follow the longitudinal axis of the main nave. We expected that most of the visitors, after entering the main door, would walk straight ahead, not diverting into the aisles. The statistical analysis performed supports that hypothesis in both of the groups tested (random visitors and architectural students), although the percentage of students that chose the longitudinal axis trajectory is far less accentuated than that of the random visitors.

Differences between these groups can be ascribed to shyness by the tested students, due to the awkwardness of wearing an eye-tracker, their young age or the fact that they were alone, whereas most of the other visitors were in pairs or trios; in any case, it raises the question of the smaller group's degree of spontaneity.

Nevertheless, this test provided one of the most significant results regarding the *gesture* theory in Alcobaça.

CONCLUSION

It was not the purpose of this exploratory research to statistically validate the theory of *gesture*. However, it is possible to state that *it was not invalidated* by any of the empirical results – although, of course, they are circumscribed by the church of the Monastery of Alcobaça. More expansive and thorough experiments are still necessary.

The preliminary observations seem to indicate that this building's form generates a pattern of exploration. The long, repetitive nave with sunlit extremities creates an axial walking movement where the eyes are constantly being drawn to the light ahead. All three exploratory experiments converge to reveal that *gesture*. Experiment 1 shows that fixations are concentrated in the extremities of the central nave (the apse with the presbytery in one end and the rose window and door in the other); experiment 2 shows that the entrance area at the beginning of the central nave as well as the crossing at the end of it are two of the places where participants stopped for longest. Finally, experiment 3, which encompasses a much larger subject sample, shows that the central nave is the preferred path ahead, and that walking this path is the visitor's first impulse.

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VIII. Annexes

1. Annex A – Declaration of Participation: 3rd Research Seminar, CIAUD

DECLARAÇÃO

Para os devidos efeitos, o Centro de Investigação em Arquitectura, Urbanismo e Design, com sede na Faculdade de Arquitectura da Universidade de Lisboa, Rua Sá Nogueira, Pólo Universitário da Ajuda, Alto da Ajuda, Lisboa, declara que o Professor Doutor Pedro Marques Abreu, Investigador efetivo do núcleo de arquitectura, apresentou o seu projecto de investigação com o título "*GESTO: Um processo experimental para determinar o sentido de uma obra de arquitectura*", no 3º Seminário de Investigação do CIAUD, que se realizou nos dias 4, 5 e 6 de Novembro de 2015.

Por ser verdade e nos ter sido solicitado se passa esta declaração que vai ser assinada pelo Presidente do CIAUD

Lisboa, 30 de Novembro de 2015

O Presidente do CIAUD

Fernando Moreira da Silva
Professor Catedrático

Anexo – Relatório Público do 3º Seminário de Investigação do CIAUD

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ANEXO

Report 3rd CIAUD

Henri Achten, Luiz Amorím's report

GENERAL (PUBLIC) REMARKS

The overall quality of the projects and the presentations was high. With respect to previous edition of the CIAUD Research Seminar, the proportion of English language presentations was higher. It seems that the mixture of additional or external researchers from different groups, schools, and eve countries is increasing. This is a good sign, because it puts the research work in a wider context, and takes advantage of a wider framework of reference for the research work.

During the presentations only the presenters of that particular block were present in the audience. This is a missed opportunity, because a lot can be learned from the presentations of other researchers and the discourse with the panel after the presentation. We hope that general participation in the future will be of a higher level.

The section of presentation in the first day contained a lot of qualitative research, with not much quantitative research presented. Explorative, interpretative research is valuable and can give a lot o context to research work, but it is also very difficult evaluate in a more structured way. Projects of this kind need a strong theoretical framework and good reflection so that they stay on track and do not wander off into too many directions. Providing such contexts needs to be fostered more. The second day was very strong in quantitative research and well-structured qualitative research.

We notice a promising development in that an increasing amount of research is embedded in education. This promotes research-based education, which is a good goal for an academic institutior Although the research work suffers a bit in terms of scope, consistency, and depth of inquiry, a lot is also gained through student awareness, testing through doing, and increasing the general level of education.