Time Perception: An Exploration of Time Perception and Possible Applications in Cognitive Archaeology

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Introduction to Time Perception in Archaeology

Since its beginnings, archaeology has been deeply concerned with the issue of time. One of the main concerns was the creation of chronology in order to achieve temporal control and perspective. A pioneer of temporal dimension in archaeology was Christian Thompson, who proved the basic tripartite chronology of northern European prehistory (Stone, Bronze, Iron)[69](Trigger 2007, p. 123). He was followed by many other now famous archaeologists such as Montelius and Kidder, who further refined Thompson's chronology[70]. However, archaeology was only concerned with the physical chronometric aspect of time and not with what is now known as time perception (Trigger, 2007).

The phenomenon time consists of two different frameworks, physical and perceived time. Physical time is the time that can be read from a chronometric device. In comparison to physical time, perceived time is rooted in our individual psychology. Physical time can be measured chronometrically, which means through devices such as a clock. Physical time can be explained by frameworks developed in physics. Although it was important to address these differences, the way that time is psychologically perceived by humans will remain the main focus (Gibson, 1979, p.12).

What is time perception? This question is difficult to completely answer because it entails a philosophical argument; but for the purposes of this topic, the assumption will be that time perception operates through the recognition of changes through human agent. We can relate here on Gibson's concept of events, which introduces a relational element to time perception since it can be argued that human observers perceive time in relation to events. The question of whether or not we can perceive an event itself is not as important for the discussion of time perception. It is evident that humans make order of their environment in terms of chronology anyway. This means humans used the movements of the sun and the moon to infer the time of the day and therefore which activities can or have to be performed (Le Poidevin, 2011). Another question arising from the study of time perception is the question of the reality of time as an object, which is a rather metaphysical question. McTaggart argues that time is not real in the sense of an objective reality, going as far as to declare time to be an artifact of human thought. However, even when time should only be part of human thinking, the influence it has on our interpretation of the environment is critical (Le Poidevin, 2011). The fact is: we perceive changes, such as the sun rising and sinking. Even when time itself is not real, we have to deal with the empirical reality of change (Gibson, 1979, p.12).

[69] This is important for relative chronology building which helps in identifying the age of an artifact.

[70] Montelius further developed relative chronology for the Northern German region, and Kidder further developed relative chronology for the four corners area in the US.

Time Perception and Phenomenology

However, time perception can be an important dimension for phenomenological[71] approaches to archaeology, but phenomenological inference does not include in its scope time perception. Phenomenological approaches focus on the visual aspect of human perceptual experience—including to a far lesser extent the olfactory and auditory components. Time perception is part of our embodied reality, which means humans are able to perceive time in a non-numerical unconscious manner. Since phenomenology is concerned with the embodied human experience, time perception should be included to make phenomenological analogies more holistic and therefore more convincing (Bruck, 2005; Tilley, 1994).

In order to give a concrete phenomenological example, let us turn to Tilley's embodied experiences at the Dorset Cursus[72]. He describes his visual experiences in detail, especially the intervisibility[73]of different mounds and how this might affect the access and experience of the site. It would have been easy for him to describe how the different features and mounds affected his individual perception of time; complex terminology is not necessary to talk about time perception, but it would have been in using the differences in perceive duration caused by for example different rotation patterns of geometrical shapes. This shortcoming of Tilley is due to his focus on visual perception, which narrows his phenomenology in such a way as to not include time perception (Tilley, 1994).

Time Perception and Evolution

An evolutionary framework could be utilized to explain differences in time perception. The ability of time perception on an intuitive level can be presumed to have an effect on the evolutionary fitness of human organisms. This means that time perception would improve the chance of humans to pass on their genes. For example, time perception may help organisms to time their escape from a predator. The systematic and scientific study of time perception has not been addressed in an extensive body of literature; therefore it is not surprising that many aspects of this interesting field remain under explored. For example, it would be revealing to see studies about time perception in non-human animals, especially when one wants to use an evolutionary framework when concerning time perception (Barkow, 1996; Segall, 1966).

Time Perception and Affordance

Time perception is also important in understanding the affordance of objects and environments. Affordance describes the opportunities an environment offers an organism in order to fulfill an organism's basic needs for survival. The direct ecological approach of Gibson focuses on the role of vision in the recognition of affordance; he especially argues that depth perception plays an important role. For example, an individual perceives a stone; depending on his tem-

[71]Phenomenology is a framework in which the world is experienced through the full bodily experience of individuals. This includes the senses such as vision or hearing, etc. Phenomenology as introduced by Tilley basically argues that the experiences of an environment by recent individuals will be similar to the experience past people had because of our shared body structure (Bruck, 2005; Tilley, 1994).

[72]The Cursus is a pathway formed of low and small mounds, surrounded by much bigger mounds of varying sizes and shape.

[73]This refers to the arrangement of monuments and how they can be seen from each other's positions by a researcher.

poral situation he may need different kinds of tools at different time intervals. Time perception in this sense is related to cultural change over time. Therefore, it can be argued that time perception and affordance are dependent on interval or time scale, which makes affordance relative in accordance with the used timeframe (Gibson, 1979, p.12).

Possible Uses of Time Perception In Archaeology

The study of time perception could be useful in adding to the importance of caves as ritual environments. Caves seem to have an effect on human visual perception and therefore it should be highly probable that caves are also affecting human time perception, because humans perceive time mainly as change. There are no studies that directly examine the connection between caves and human time perception, but there are other studies available (Calabria, 2011; Grondin, 2013; Hansen, 2013; Matthews, 2013; Smith, 2011), that highlight the influence of different visual stimuli on time perception; these can potentially be connected with the optical stimuli provided by a cave environment. This could be useful in understanding cave use for ritual activities (Moyes, 2013).

Time perception is culturally mitigated, which means in different cultures, time can be perceived differently. The cultural differences of time perception occur mostly in the religious and cosmological arena. There are basically two different schemes of how culture modifies time perception: the notion of a cyclical, always reoccurring time scheme, and the lineal following time. Both modes are rooted in the physical measurable time and not so much in time perception on the individual level. Therefore, the cultural influence on time is mainly focused on physical time and not on time perception of the individual. This enables one to conclude that time perception at its core could be universal, with relatively few variations (Gosden, 2012).

It is difficult to connect specific archaeological material and features with time perception since time perception as a cognitive function is not directly observable in artifacts and features, but has to be inferred through experimental knowledge acquired on groups of individuals in the present. Meaning is not physically inscribed into an artifact, but is created, rather, through human interactions with an artifact. Therefore, for time perception, archaeologists have to rely on analogy, rather than on direct evidence. The studies which will be used in this paper are all based on experiments on groups of individuals in the present and are mostly intangible in nature. Therefore, the study of time perception can mainly be used to refine phenomenological approaches and to add to affordance theory (Tilley, 1994; Moyes, 2013; Brady, 2005).

A way to possibly link human time perception to physical evidence would be over the identification of fractal patterns in building structures and in the composition of whole settlements. It is likely that the occurrence of fractals in architecture constitutes an unconscious choice, and therefore, it is possible that time perception is influencing the perpetuation of fractal patterns in man-made structures. Designs in art and architecture, such as the fractal structure of some African villages, could then be interpreted as subconscious projections of human time perception onto the material world. The resulting fractal designs may have a calming effect on individuals. A study conducted by Taylor can be useful to substantiate this. He used pendulum generated fractal images an introduced them to participants. Taylor measured the stress response of the participants by measuring the electrical resistance of the skin of the participants. He concluded, based on his measurements made on participants, that the stress response of the participants was reduced by certain fractals with a fractal dimension between 3 and 3.5 (Eglash, 1999; Taylor, 2006).

Olga Mitina, a Russian scientist, executed a study with 140 participants in two groups only differing in the time durations of the fractals that were presented. The participants were confronted with 20 fractal images generated by a computer algorithm with different time intervals between 5 and 20 seconds. The study concludes that the appreciation (based on questionnaire ratings) is based on fractal dimension rather than on time perception, which is correlated to the duration of the stimulus logarithmically (Mitina, 2003). The relatively limited number of participants and the limited availability of similar studies make it interesting to see further experiments directed toward the connection between human time perception and fractals. Mitina comes to compare results with Taylor in the sense of confirming the stress reducing quality of fractals. The difficulty of the concept is found in relating fractals and stress response with a distinct temporal dimension. Since only the one of Mitina seems to be cited here, which tries to approach the relation between fractals calming quality and time perception, her negative findings are simply not conclusive and need further experiments to provide conclusive results.

Different Explanations of Time Perception

So far, only visual stimuli were mentioned as influencing time perception, but different emotional states can also affect the perception of time. In fact, time perception is not bound to any sensory organ in particular; therefore, a clear localization of time perception in brain activation is difficult to achieve. There are some explanations, most of which are based on philosophical thought. The approach favored by cognitive science is known as the "pacemaker model" of time perception (Grondin 2001; Rupertm, 2012). In this view, the time perception apparatus in humans consists of an impulse generator and accumulator. The accumulator retains the generated pulses and a switch module which enables to prevent an impulse to reach the accumulator. The condition of this "switch" is affected by the mood of the individual and visual perception of stimuli. This model was also extended to include a circular impulse device which is presumed to deliver a stable reoccurring base pulse which could be the basic unit of reference to judge durations. Therefore, time perception seems to have a relational quality, which means time is not perceived directly, but rather, in relation to our other senses (Le Poidevin, 2013; Smith, 2011; Hansen, 2013; Grondin, 2001).

The pacemaker model of time perception is currently conceptualized to be fragmented, which means that different time spans and different forms of inferred change (based on visual or audio input) make use of different pacemaker systems. Thus, there is not only one internal timing device, but a whole array of such units. This circularity in the impulse described, as an addition to the pacemaker model, could connect human time perception to the use of fractal patterns in architecture and village structuring. It is possible that the subconscious use of fractal patterning is the projection of the reoccurring rhythmic of our internal pacemaker systems into the environment (Grondin, 2001).

Experiments on Time Perception in Cognitive Psychology

One study which elucidates human time perception was based on the response of participants to rotating stimuli; the shapes were either accelerating, decelerating in motion, or in constant rotation. The participants were asked to watch the stimuli and then judge the duration of the stimulus on a scale from 1 (short) to 9 (long). The experiment concluded that a constant rotating shape is considered to have lower stimulus duration then both the accelerated and decelerated stimuli; the duration in which the stimuli were presented was kept constant.

Therefore, the motion of different visually perceived objects can alter the way an individual perceives time, independent from measured physical time. This could possibly apply to whole environments as stimuli, such as in caves. This idea can be supported through the concept of isovists[74], which argues that human visual perception is fragmental in nature. Humans perceive only a part of an environment as part of an equation, connecting the pane of the environment we see with the parameter's position in space and time. This means that we actually divide the environment we visually perceive into smaller stimuli, which may affect our perception of time in the way covered by the experiment (Matthews, 2011; Benedikt, 1979; Moyes, 2013; Brady, 2005).

An experiment at the University of Winnipeg suggests a connection between the mood of the participant and the judgment of duration. In order to test the connection between the emotional state of the participant and duration judgment, the experimenters employed pictures from the international affective picture system (IAPS), a database containing pictures rated for their emotional impact. Two blocks of durations were compiled and the participants had to determine the relative duration of the different images. The results of the sort block indicate that images with a strong negative emotional impact were estimated to be shorter in duration. The data analysis for the long blocks indicates that images with a moderate negative emotional impact were underestimated in their duration (Smith et. al., 2011).

This shows that emotions have an impact on time perception, which is related with the critique that phenomenology is too fixated on vision. The resulting bias could be counterweighted by including studies on human time perception and the effect of emotional state into phenomenological practice (Smith, 2011).

The impact of emotions onto time perception is also a possible concern in cave environments since it is likely that the perceptual appearance of a cave could result in a changed emotional state of the cave visitor—especially when connected with ritual practices. Therefore, it would be interesting to rate cave environments for their emotional impact and generate a rated picture repository similar to the IAPS use by Smith. This would enable archaeologists and cognitive psychologists to prepare and execute experiments to improve the body of actual data available to test the impact of the emotional effect of cave environments on human time perception (Smith, 2011; Moyes, 2013; Brady, 2005).

The impact of the mental state on time perception was explored in a different experiment executed by Jochim Hansen and Yaakov Trope. The mindset of the participants was determined using a questionnaire. The two mindsets probed for were either concrete or abstract and determined by the answers the participants gave; the participants were asked to stop a timer after 30 seconds passed. Finally, this experiment concluded that participants in the abstract mind state fell short in their duration judgment in comparison to the participants in a concrete mind state. This result further clarifies the influence cognitive processes such as the state of mind have on time perception (Hansen, 2013).

This experiment adds a further di-

[74]The shape of the field of view, which can be described in geometric terms.

mension to time perception; not only do emotions have a measurable effect of how humans perceive time, but they also have a measurable effect on their state of mind—or when a person is inclined to see the abstract ramifications of time, or the strict connection between time and concrete action. This could be important in cave rituals because ritual activity should set the participant's mind to abstract interpretation. However, rituals involve abstract symbolism, such as in, for example, Mayan rituals. The Maya used caves as locations for ritual activities; one of those caves is known as Actun Tunichil Muknal. Archaeological evidence from this site suggests that the cave ritual corresponded symbolically to the world and the heavens (Hansen 2013; Moyes, 2013).

An exploration of time perception would not be complete when only covering the "average" participant. It is highly possible that in the past some individuals could have suffered cognitive disorders which could have affected their time perception abilities. This is especially relevant when time perception should be treated under an evolutionary paradigm. The evolutionary paradigm can be regarded as the backdrop, which enables us to explain the high order questions such as, "Why and how did time perception develop as it did?" The anomalies can be potentially useful in showing us possible detrimental effects on evolutionary fitness when time perception is deficient (Calabria, 2011).

In order to gain a greater understanding of the importance of time perception, individuals suffering from spatial neglect will be addressed. Spatial neglect occurs in patients who do not perceive parts of their sensory field. The study utilized test sound signals, which the participants had to determine as being shorter or longer to a standardized base tone. The study consisted of patients with spatial neglect and a control group (individuals with normal visual fields). The results of the study conclude that participants with spatial neglect are significantly inhibited in judging the duration of the test sounds correctly (Calabria, 2011). Therefore, acoustic signals can be assumed to have played an important role in determining the evolutionary fitness of an individual (Barkow, 1996).

Cultural Influence on Time Perception

Therefore, it seems that cultural factors influence visual perception (Denise, 2010; Segall, 1966). This is important for the concept of time perception, since visual recognition affects time perception; this idea can be referenced in the study concerning rotating shapes and the judgment of duration. However, the evidence in that particular study focuses on optical illusions. Those optical illusions seem to hint to a possible influence of culture on visual perception. It is important to include evidence for cultural influence on visual perception, because that could mean that time perception may also be influenced by culture. Furthermore, visual recognition of change or the material consequences of change, such as moved objects, could influence the human sense of time as well. The review cited here contains studies from the early 20th century, which were additionally biased by the concept of "race" and colonialism. Therefore, it is necessary to produce more current experimentation since they would provide the necessary database. Ultimately, this will allow for a clearer picture about the degree of cultural influence changing time perception on the very basic level, or on the level of direct phenomenon based visual perception. This would provide the necessary basis for exploring the full extent of culture on time perception through visual perception. Visual perception is important, because through the visual recognition of change, time perception is established. However, this would not be enough, because we have seen here that time perception is far more complicated encompassing human capacities such as emotions and mental states.

There seems to be neurological evidence for a different processing of visual perceptive data between East Asians and Western Europeans concerning faces and building facades. This could be relevant to time perception, because visual perception is important for humans to recognize change, which in turn is important for a sense of time. If further experiments could further substantiate the differences in processing visual stimuli in Asians and Europeans then this could be used to understand why fractal architecture seems to be confined to Africa. Furthermore, the importance of cultural influence on time perception would be clarified (Matthews, 2011; Segall, 1966; Denise, 2010).

Discussion and Conclusion

Finally, perception is crucial for humans in creating place. There is a difference between "space" and "place." "Space" is simply a physical measure without meanings for humans. "Place," in contrast, is physical space endowed with meaning through human interactions, such as through human symbolic appropriation of a space in a certain time. Therefore, the ability to perceive time is a necessary condition for creating place (through human interactions in that space), because if humans were not aware of time on a subconscious level, places would not have been created until the development of measured time. This, in turn, can be linked to Affordance Theory (Affordance Theory argues that objects such as a chair afford certain possibilities; for example, sitting in a chair), in which the space that is manipulated by humans contains affordance of place (Chadwick, 2004).

Furthermore, perception of time is an interesting field which is quite underexplored. Therefore, it remains mostly a concept to think about in terms of theoretical archaeology, but it could help define new ways of interpreting existing data through enhancing the study of visual perception. However, it would be interesting to further explore the possible impact of time perception on the experience of environments by humans. As demonstrated, time perception is one of our most basic senses, but it is also elusive, since there is no single sensory organ involved in time perception. The importance of the study of time perception for archaeology lies in the possible enhancement of our understanding of the past human experience. Therefore, time perception can also be seen as the core of cognitive archaeology. This means that time perception is fundamental in understanding the thought patterns of past humans, inferred through their material remains.

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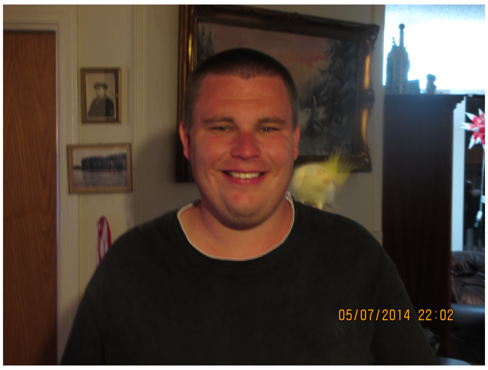

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