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A Grounded Theory on the Relation of Time Awareness and Perceived Valence

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Abstract

The subjective experience of time has many different facets. The present study focused on time awareness and its antipode timelessness as an expression of the extent one focuses on the passage of time. In an exploratory mixed-methods study, we investigated different extents of this time awareness and their relation to perceived valence of the environment, different states of consciousness, and strategies to cope with doing nothing. Thirty-three participants were tested for one hour or more with sitting and exploring as the within-subjects factor. For each condition, they stayed in one of two libraries characterized by their contemplative architecture. Then, participants answered quantitative questionnaires on their time experience and perceived valence and participated in a semi-structured interview. By means of grounded theory, we extracted four different types of time awareness from the qualitative data, of which three corresponded to the results of a cluster analysis on the dimensions of time awareness and perceived valence of the environment. In line with previous literature, we found relations between unpleasant high time awareness and boredom and pleasant low time awareness and flow. Additionally, the data revealed a pattern of high time awareness and positively perceived valence that was mainly experienced while sitting. Possible connections to states of consciousness such as relaxation, idleness, and a mindful attitude are outlined. Real-life settings, long durations, and level of activation are discussed as possible fostering factors for finding this pattern.

Keywords

Time awareness, grounded theory, cluster analysis, experience of time, mixed-methods

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1. Introduction

Whether such a thing as time exists — and how time is structured — has been a longstanding issue in theoretical philosophy (Dolev & Roubach, 2016). "A human observer has the impression that physical time is a continuous flow that can be divided indefinitely into smaller units" (Grondin, 2010, p. 564). However, our inner experience of time is modulated by many factors, such as attention, arousal, and memory (Wittmann & van Wassenhove, 2009). In cognitive psychology, these factors are investigated by relating human estimates of time to clock time in order to make assumptions about our internal clock. By contrast, our everyday experience of time is expressed in a more qualitative form, evaluating how fast or slow the passage of time feels, for instance (Droit-Volet et al., 2017; Wearden et al., 2014). The experienced extent to which one focuses on the passage of time, also referred to as time awareness, can also differ on a continuum. The antipode of time awareness would be timelessness, expressed by people who report that they completely forgot about time. Timelessness is an often-described issue in literature (Halio, 1962) and philosophy (Husserl, 1905/1928). Time awareness, as it is referred to in our study, describes the self-reported extent of focus on the passage of time, which can range from experiences of complete timelessness up to a very strong focus on the passage of time. More precisely, the physically existent time flow can 'disappear' from our subjective experience in some situations and be strongly present in others. Examining these different extents of time awareness psychologically was the main subject of the present study. Here, we adopted a qualitative and quantitative exploratory approach in order to come to a more systematic view of the construct of time awareness.

In previous research on time perception, experienced time awareness has so far been more of a side issue. If addressed, conclusions are usually drawn indirectly from results of research on passage of time judgments (PoTJ), with a perceived faster passage of time indicating a lower time awareness, and vice versa (Droit-Volet et al., 2017; Wearden, 2005). PoTJ measure the subjective experience of time passing by fast ('flying') or slowly ('dragging'), whereas time awareness can be measured by asking how much one focused on the passage of time. A high time awareness can go along with a fast passage of time, for instance in examination situations, but it can also go along with a slow passage of time, for instance in boredom.

As becomes obvious from these examples, the experience of time and emotion are strongly intertwined. Numerous studies have found an overestimation of time for emotional content, especially for negative and highly arousing stimuli (Droit-Volet & Gil, 2009; Droit-Volet & Meck, 2007; Droit-Volet et al., 2011; Lambrechts et al., 2011). These results are usually explained by pacemaker–accumulator models (Treisman et al., 1990), such as the Attentional-Gate Model (Block & Zakay, 1996). These internal-clock models assume that a pacemaker emits pulses that are

accumulated and compared to a reference in order to make duration judgments. The pace of the pulses is modulated by arousal (with higher arousal increasing the internal-clock speed), and the widening and narrowing of an attentional gate determines how many pulses can be accumulated. Valence can modulate the attentional gate and therefore cause the described time distortions (Droit-Volet & Meck, 2007; Lui et al., 2011; Mella et al., 2011).

However, the integration of the subjective experience of passage of time into these models is still in progress (Droit-Volet, 2018). For PoTJs, it was found that they are strongly influenced by valence: the common finding is that positive valence hastens passage of time and negative valence slows down PoTJ (Wearden et al., 2014). Jokic et al. (2018) also showed that positive feelings are related to faster PoTJ and negative feelings to slower PoTJ in real-life waiting situations of several minutes. Although experimental studies have mostly focused on PoTJ, there are some studies examining time awareness and the influence of valence. Ehret et al. (in press) showed in one of their studies that a pleasant room atmosphere can decrease time awareness compared to an unpleasant room atmosphere. Conti (2001) found that participants experienced less positive affect when focusing on clock time compared to participants not thinking about time. High time awareness can even be experienced in a pleasant atmosphere when neither the environment nor the task requires selective attention (Ehret et al., 2020a). Apparently, both emotional as well as perceived valence of the environment can influence time awareness. Following Juslin and Laukka (2004), we differentiate between perception and induction of emotion. Valence of a face, music, or — in our experiment — a surrounding can be perceived and evaluated without necessarily feeling the according emotion. Therefore, perceived valence describes the degree of perceived overall pleasantness. Due to inconclusive results on the relation of time awareness and perceived valence in real-life settings, further research is needed. Therefore, our first research question focused on the relation of time awareness and perceived valence in real-life settings.

Our second research question addresses how different extents of time awareness are experienced and described with regard to states of consciousness. When examining these states, the experience of the passage of time is often one among other distinguishing factors. Boredom can be described as a state with negative valence and consciously perceived passage of time (Eastwood et al., 2012). William James (1890/1981) even claimed an unpleasant bare feeling of time in boredom. Another example of a state of high time awareness, but one accompanied by positive feelings, could be idleness — as an unproductive, effortless, and free state of doing nothing (O'Connor, 2018). Meditative and substance-induced states of consciousness also have the potential to increase time awareness in some cases and decrease it in others (e.g., Griffiths et al., 2008; Wittmann & Schmitt, 2014; Wittmann et al., 2007). Flow, as the state of being absorbed in an intrinsically motivated task (Nakamura & Csikszentmihalyi, 2014), and immersion, a state of

"perceiving oneself enveloped by [...] an environment that provides a continuous stream of stimuli and experiences" (Witmer et al., 2005, p. 299), are described as states with low time awareness and a feeling of losing track of time (Jennett et al., 2008). Also mainly reflecting low self-awareness, yet in contrast to the task-related engagement of flow or immersion, are self-generated and perceptually decoupled thoughts in mind wandering (Smallwood & Schooler, 2015). Mind wandering can be helpful to endure in waiting situations, draws the focus away from time, and contracts time as well as declines temporal precision in time estimations (Smallwood et al., 2013; Terhune et al., 2017; Weiner et al., 2016; Wittmann, 2015). In conclusion, a high time awareness could be related to a very wide range of different states of consciousness. The neuroscientific approach suggesting the insula as one cortical structure that creates awareness of time considers a person's current state of consciousness in particular (Craig, 2009). The insula integrates all conditions of the human body. Accumulation of these global-emotional moments that combine bodily, environmental, and social contexts could create a subjective, emotional, and flexible experience of time (Craig, 2009; Wittmann, 2009; Wittmann et al., 2010). Therefore, awareness of affective states and entangled bodily states can change the experience of time (Meissner & Wittmann, 2011; Pollatos et al., 2014). By answering the second research question, we aim to give insights into possible connections of time awareness and states of consciousness.

An important role of the experience of these states of consciousness might lay in the contrast between doing nothing and being busy (Sweeny, 2018; Yang & Hsee, 2019). Especially during waiting, as a "situation in which one becomes conscious of oneself and time" (Jokic et al., 2018, p. 72), doing nothing can be perceived as highly aversive (Wilson et al., 2014; Yang & Hsee, 2019). Therefore, people use strategies to keep themselves busy — for example, choosing to walk a lengthier way under certain circumstances to avoid waiting times (Hsee et al., 2010), eating (Havermans et al., 2015), or even giving electroshocks to themselves (Wilson et al., 2014). On the other hand, doing nothing can be a highly pleasurable experience, like in idleness or leisure (O'Connor, 2018), that people seek to experience. These findings suggest that especially in situations of low cognitive demand, like waiting, people experience time awareness and the related state of consciousness very differently based on their needs. Thus, our third research question focuses on how different strategies to cope with doing nothing influence the extent of time awareness.

To summarize, the aim of our research was to identify systematic relations between the experience of different extents of time awareness and perceived valence, different states of consciousness, and strategies to cope with doing nothing. Although the studies reviewed above demonstrate substantial influences of perceived valence, states of consciousness, and dealing with doing nothing on time awareness, knowledge of their systematic relation to each other is scarce and

ambiguous. A theoretical framework systematically relating these factors to time awareness is still absent. Therefore, we chose to collect and analyze qualitative and, in a second step, quantitative data according to the principles of *Grounded Theory* (Glaser & Strauss, 1999). This qualitative approach aims to inductively discover new theory from systematically obtained data in order to suggest new hypotheses rather than testing a theory. The primary aim of our study was to display the diversity of different experiences of time awareness by categorizing the data and integrating these categories into a model that serves as a basis for developing hypotheses and empirical operationalization (Glaser & Strauss, 1999). We used a mixed-methods approach to compare the qualitatively developed model to structures in existing quantitative measures.

Two methodological issues arise when experimentally examining time awareness regarding experimental setting and duration: in laboratory settings, when participants are instructed to judge their time experience, stimulus durations are always consciously processed, whereas in everyday situations, durations do not constantly obtain the focus of consciousness (Droit-Volet et al., 2017). Consequently, as we aimed to investigate a variety of experiences of time awareness, we decided on testing very long durations of one hour or more in a real-life setting to avoid an artificially high time awareness due to the experiment. Secondly, we aimed to increase the inter-individual variety of perceived valence and experienced states of consciousness. Therefore, we conducted the present study in libraries with original and contemplative architecture that explicitly invited the experience of states like idleness or flow (for details, see Section 2).

2. General Methods

2.1. Participants

Thirty-three students ($M_{age} = 26.6$; $SD_{age} = 6.1$; 70% female, 30% male) participated in the study. The sample size was determined in accordance with a power analysis elsewhere (Ehret et al., 2020b), and no optional stopping was utilized. However, the targeted total of 48 participants could not be reached due to organizational and time limitations. Requirements for participation were student status, very good command of German, and no regular or frequent visits to one of the two libraries used as experimental sites during the past three years. All participants signed an informed consent form and received 36 Euros for participating.

2.2. Environments

The study was conducted in two libraries located in the city center of Berlin, Germany: the Jacob-und-Wilhelm-Grimm-Zentrum (Grimm-Zentrum), designed by architect Max Dudler and opened in 2009, and the Staatsbibliothek zu Berlin

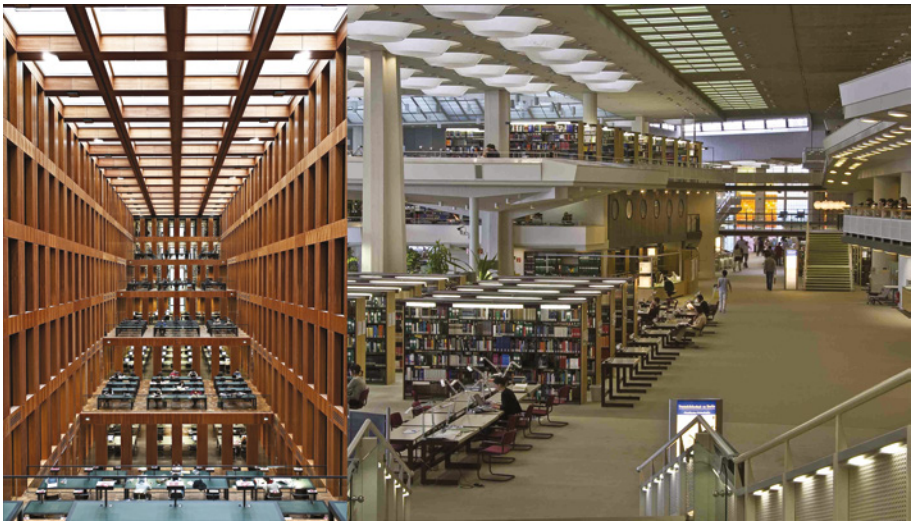

Figure 1. The Jacob-und-Wilhelm-Grimm-Zentrum (left) and the Staatsbibliothek zu Berlin Potsdamer Str. (right).

(Potsdamer Straße), opened in 1978 and designed by the architect Hans Scharoun. Both are characterized by their unique, though very different contemplative architecture (Fig. 1). The architecture of the Grimm-Zentrum is characterized by a rational grid system, where symmetric axes result in an overall system. The central, four-storied, terraced reading room is completely surrounded by books – however, it is separated from the bookshelves by tall quadrangular glass windows and a dark wooden wall façade. Thus, even and unpretentious cuboids characterize the aesthetics of the library. While Dudler's architecture can be allocated to rationalism, Scharoun is a representative of organic architecture. Neither an overall system nor a grid can be found in the Staatsbibliothek zu Berlin. The library is characterized by asymmetries and freely placed concrete platforms within one central room. Here, readers have the possibility to see the cityscape through a tall panorama window. We chose these libraries as experiential sites to create an atmosphere that increases the chance of experiencing different states of time awareness. The architecture is an invitation for awe and exploration; however, for students, libraries can also be perceived as stressful places of exam preparation. In both libraries, clocks were not directly visible (yet, could be found, e.g., on computers), and the temperature was held constant due to air-conditioning. We used two different libraries in order to avoid repetition effects. The libraries were visited in a randomized order.

2.3. Procedure

All participants were tested in two sessions with two different waiting conditions (sitting/exploring) as a within-subjects factor. Each session took place in one of the two libraries and over two different days. In the sitting condition, participants were seated at a particular spot and instructed to stay there for the whole waiting time. In the exploring condition, participants were told to explore the library and get to know all the details of the premises as well as possible. While exploring, they had the liberty to organize the waiting time themselves without any further specification.

We used a different library for each condition to avoid repetition effects due to boredom, for instance. It was not intended to compare the two libraries directly to each other. The order of the waiting conditions and the libraries was randomized. Of 19 participants sitting in the first session, 11 were in the Staatsbibliothek and eight in the Grimm-Zentrum. Of 14 participants exploring in the first session, eight came to the Staatsbibliothek and six to the Grimm-Zentrum for the first session. For the second session, participants changed condition and library.

At the beginning of each session, participants handed over all personal belongings and timers (watches, smartphones, etc.) to the experimenter and filled in a pretest on mood and emotion. They were instructed to stay inside the library between 60 and 100 minutes and were picked up by the experimenter within this time ($M_{\text{time}} = 83$; $\text{SD}_{\text{time}} = 6$) at the end of the session. They were told to avoid looking on the clock if they found one and to indicate honestly at the end if they spotted a clock or clock time. After being picked up by the experimenter, the participants filled in a quantitative questionnaire (see Section 2.5.1) and were then interviewed for about 10–15 minutes (see Note 1).

2.4. Qualitative Method and Data Analysis

2.4.1. Structure and Transcription of the Guideline-Based Interview

We developed a semi-structured interview guide that included four parts: time experience, dealing with doing nothing, room atmosphere, and (only in the second session) comparison of the two sessions. The interview began by informing the participant that there were no right or wrong answers and answers should only be given if he or she feels comfortable with the question. The first question was always a general question about their time experience: "Tell me how you experienced your time in the library." Similarly, each of the parts started with a general question on the topic, and then — depending on the answer — more detailed questions on specific subareas were asked. The suggested sequential order of these parts in the guideline could be changed by the experimenter in order to follow the interview flow. For all interview questions, see the Supplementary Text S1. All interviews were recorded with a dictaphone and literally transcribed with the freeware *Express Scribe* (NCH Software, 2018). The transcripts only included

spoken word, and dialect was translated to written German language. A total of 66 transcripts (two per participant, one for each waiting condition) were identified by participant ID, session (1/2), and condition (sitting/exploring).

2.4.2. Theoretical Sampling

Following the *theoretical sampling method* by Glaser and Strauss (1999), 38 interviews were selected from these 66 transcripts by their relevance to the content. Therefore, we started the selection and analysis process by choosing the interviews that differed the most in their descriptions of the experience of time in order to maximize the contrasts between the codes of our categories. In the present study, this meant maximizing the variety by developing as many diverse properties of time experience as possible. Then, to minimize contrasts, we selected interviews that resembled the ones chosen, so that we could further differentiate the codes of our categories and, with it, the described states of experienced time. Theoretical saturation could be reached after 19 participants. Saturation implies when the diversity of a category is stretched as far as possible and no further properties can be found, so that the researcher cannot add new information to it (Glaser & Strauss, 1999).Thus, 38 transcripts were included in the analysis ($M_{age} = 27.52$; $SD_{age} = 6.84$; 68% female, 32% male) and were the basis of the developed model.

2.4.3. Generation of Coding System

The data were analyzed with the software *MAXQDA* (VERBI Software, 2016). To develop a grounded theory from the data, Glaser and Strauss (1999) suggest three steps of coding: open, axial, and selective. In the first step, data were coded openly by applying codes directly to the raw data. This included the generation of *in-vivo* codes and subsuming codes under umbrella terms. These codes were then aggregated to categories in the axial coding step by finding empirical relations between codes. The categories were used to find relations and contradictions in the data and to define more special and more general cases within the sample. In this first step, the preliminary guiding principle for theoretical sampling also evolved: to condense different ways of experiencing time and maximize the variety of experiences from high time awareness to timelessness. A structure of four main categories evolved from the analysis process. During the selective coding, the main categories and the guiding principle were integrated into a model. The basis of this model was a typology for time awareness developed by relating the four main categories to each other and finding patterns. All 38 interviews were then re-examined according to this model. A new structure of the category system was developed that represented the dimensions of experiencing time and the main criteria that could differentiate between them. All steps of coding were accompanied by discussions in interpretation groups. Parts of the data were double-coded in order to check for inter-coder consistency and to define categories and codes more precisely.

2.5. Quantitative Method and Data Analysis

In the next step, we aimed to contrast the model developed from qualitative data and related patterns within the quantitative data regarding time awareness and perceived valence by means of a cluster analysis.

2.5.1. Dependent Variables

Time awareness was operationalized by asking participants to indicate on a visual analog scale (VAS) how much attention they paid to the passage of time (from 0 = no attention at all to 100 = maximum amount of attention).

As the perceived valence of the environment influenced time awareness, we measured the perceived affective quality using a German translation of the *Scales of the Affective Quality Attributed to Places* by Russell and Pratt (1980; Ehret et al., in press). The underlying dimensions of the questionnaire are valence and arousal. For perceived valence, 10 items on the bipolar scale *pleasant–unpleasant* (Cronbach's $\alpha = 0.93$) were rated on an eight-point scale (1 = extremely inaccurate, 8 = extremely accurate). Participants' statements subsumed under perceived valence described the *perception* of a certain affective atmosphere in contrast to an *induction* of the corresponding emotional reaction (Ehret et al., in press; Juslin & Laukka, 2004). In terms of external validity, Russell and Pratt (1980) showed high correlations of the pleasant–unpleasant scale with felt pleasure.

Various additional variables were collected and analyzed in the aforementioned study (Ehret et al., 2020b). As additional time variables, we assessed estimated time, feel judgments, PoTJ, and temporal dynamics of time awareness and PoTJ. We also conducted questionnaires on mood and emotion, a manipulation check for the negative expectation, detected clocks, general attitude toward libraries, and recorded step counts and weather. However, we based our quantitative analysis on the two main categories of the qualitative results (see Section 3). The additional variables are analyzed and discussed elsewhere (Ehret et al., 2020b).

2.5.2. Data Analysis

Based on the qualitative analysis of the categories of time awareness and perceived valence of the stay, we decided to include the quantitative variables of time awareness and perceived valence on the pleasant–unpleasant scale in a cluster analysis. For this analysis, we included all values of the 33 participants. Cluster analyses are also an exploratory procedure to suggest hypotheses (Jain, 2010), so we aimed to further specify our qualitative assumptions. The cluster analysis was conducted with the freeware R (R Core Team, 2017). For calculating distances between data points, we used the Euclidean distance. As our qualitative analysis provided a theoretical assumption for the number of clusters, we used the *K*-means method, with the sum of squared Euclidean distances from the aggregated mean as a criterion. As no single clustering algorithm has been shown to dominate other algorithms (Jain, 2010), we additionally conducted a latent profile analysis (LPA)

using the R package tidyLPA (Rosenberg et al., 2018) to validate our results. For parameter estimation, we used a model with varying variances and covariances fixed to zero for the clusters, as this showed the best model fit according to the lowest Akaike information criterion (AIC) and Bayesian information criterion (BIC). For detailed results, please see Supplementary Text S2.

3. Qualitative Results

3.1. Coding System

The analysis revealed a category system with four main categories: *Person*, *Time experience*, *Strategies*, and *Setting*. Within these main categories, 22 codes, divided into 98 subcodes, were defined. In Table 1, an overview of the categories, all codes, and the most relevant subcodes are summarized. A table with all subcodes and anchor quotations can be found in Supplementary Table S1.

3.2. Typology

By finding relations among the presented categories across all participants, a structure of four different types of time experience evolved. The main discriminating criteria were the perceived valence of the stay, which was perceived from very negative to very positive, and the extent of time awareness. People described experiences of very high time awareness, low time awareness, and also moments of complete timelessness. To create a comprehensive typology, the other codes on time experience were related to time awareness. The typology classified experiences of time within one experimental condition (sitting or exploring) and its relations to other factors. Therefore, all 38 transcripts — not every participant — were assigned to the most similar type of time experience. It is also important to note that the typology refers to one kind of experience of time under the circumstances of one certain session. This means that one person theoretically can experience every type of time awareness depending on the accompanying context. We found that eight of the participants were assigned to the same type, while 11 participants experienced different types of time awareness depending on the condition. As described above, in the following typology, only the most prevalent patterns are included.

3.2.1. Type A: Aversive Waiting for the End

This time experience was mainly characterized by an experience of high time awareness. Passage of time was described as being present over the whole duration, and moments of timelessness were not experienced: “Time felt like an eternity. In the end, I was afraid that you [the experimenter] were not coming back” (P34-2-E (Note 2)). The time flow was also described as a mere waiting time: slow and unpleasant.

Table 1.
Category system.

Main category	Codes	Subcodes
Person	Perceived valence of stay	– Sitting – Exploring – Interest/curiosity
	Thoughts	– Library – Personal life – Condition or psychological stress test – Experimental setting
	States	– Mental – Physical – Emotional – Complex (e.g. boredom, freedom, loss of control)
	Evaluation of doing nothing	
	General perception of libraries	
	Personal benefit	
	Expectations	
Time experience	Time awareness	– aware – timeless – changes in times awareness – desire for a soon end
	Speed of passage of time	– fast/slow – acceleration/deceleration
	Temporal orientation	– no temporal orientation – desire for temporal orientation – no desire to know (clock) time
Strategy	Implicit strategies	– be aware of oneself – accepting the situation/ letting go
	Explicit strategies	– watching people – counting – pondering – practicing mindfulness – not thinking about time

Table 1.
Category system. (*cont.*)

Main category	Codes	Subcodes
	Seeking out activity	
	Strategy not successful	
	No strategy	
Setting	Influence of other people	– atmosphere created by others
		– social pressure/tension
	Time of the day	
	Familiarity	
	Digital devices	
	Interior	– room elements
		– room atmosphere
		– lighting
		– noises
		– temperature
	Others	

Only subcodes relevant for the resulting typology are mentioned.

The valence of the stay was perceived as negative and was accompanied by descriptions of boredom. Participants were very aware of being in an experiment and felt a lack of freedom within the experimental setting, which resulted in loss of control, coercion, and a "must-feeling" (P23-1-E) in extreme cases. These feelings were experienced due to the constraint of sitting, and were also described due to the felt pressure of being expected to explore: "I have to walk around here. I have to look at something to get this finished" (P23-1-E). Doing nothing while sitting was perceived negatively, and therefore, seeking out an activity and the desire for a temporal orientation became very strong. When sitting, doing nothing was, retrospectively, revaluated as something positive by some. Explicit strategies to deal with time, like counting things in the library or observing people, for instance, were used, but led only to a short distraction from focusing on the time. The negative feelings toward doing nothing increased when participants became aware that others studied eagerly and they were the only ones without a task. They felt a social pressure that led to "a really, really terrible experience to go to a place that is characterized by industriousness, by diligence, and to sit there as the only one without having anything close by. And just look straight ahead" (P9-1-S). When participants talked about the room atmosphere, they described it negatively as hectic, restless, and loud, and thereby mainly influenced by other people.

3.2.2. Type B: Seeking Activities

In contrast to Type A, moments of timelessness could be experienced for Type B. These moments were very dependent on the extent of engaging in an activity, as well as on the novelty of the situation. Therefore, doing nothing was perceived negatively, and participants were constantly seeking activities while exploring and also while sitting: "It was unusual not to have any devices or nothing at all. I don't know, you just try to keep yourself busy, to observe other people or I don't know ... to think about something" (P27-1-S). As soon as there was a lack of activity, participants became aware of time, the desire for temporal orientation developed, and the search for new explicit strategies to deal with time began: "But when I had seen everything, it nearly became a little boring, because I didn't know what else to do" (P16-1-E). Even before the testing started, participants had negative expectations about: "sitting there for a minimum of an hour and as it started, I wasn't very much in the mood for it and had the expectation that time will probably drag very slowly and, yes, didn't find it very cool" (P21-2-S). Although some of the strategies to deal with time worked for a while, the overall perception of the stay was primarily negative. Also, the atmosphere was mainly described as unpleasant. Reported thoughts dealt with their personal life or daily life, and, to a lesser extent, with the experimental setting, as well.

3.2.3. Type C: Relaxing

The main difference between Types B and C was that the stay in the library was mainly perceived as positive. Also doing nothing was perceived positively. In particular, the reduction of possibilities and of sensory irritations led to enjoyment and relaxation: "I mean, I get money to sit down somewhere and do nothing — how awesome is that? That means this is like a short vacation, a moment for me, as I know the next weeks will be very exhausting" (P8-1-S). This experience of relaxing was described twice as much while sitting than exploring. Instead of reporting about time spent seeking activities, either explicit strategies were competently used in order to engage in activities, or satisfying actions were taken implicitly: "So in the beginning, it was kind of like when you start to meditate or something. That you still have so many thousands of thoughts in the beginning and then you think like, okay, I can also stop with that now, and then you stop it" (P8-1-S). Additionally, while exploring, there was a feeling that time passes "without having to exert myself that it passes faster" (P21-2-E). There was no expressed desire to know the time, but in some cases, it was particularly reflected that being in an experimental setting could conflict with timelessness: "Because this [the experiment] is about time and understanding time. That's why it was always, yes, I think about it and I asked myself how I perceive time. So walking around completely timeless, I didn't have that" (P21-1-E). As this and the following example show, Type C also included the experience of a slower passage of time and a high time awareness that were regarded as positive: "Yes, I had this feeling of adapting to this relaxed boredom (laughing) and I sat there like, I think, without body tension, I'd say. Relaxed and

didn't have anything to do. And therefore, in such a serene … a little bit bored, but being bored can sometimes be good, too […] And then, um, you're in a little bit of meditative and in a time-space-free space somehow" (P32-1-S).

3.2.4. Type D: Forgetting Time

Forgetting time and not or only rarely being aware of time for most of the time in the library was the main criterion for Type D: "First I thought, what was I supposed to do here for one hour? But then, within a few minutes, I didn't think about time anymore at all, it was secondary" (P23-2-S). When one was aware of time, it was perceived as passing quickly: "The time passed very quickly. I don't know why, I was just sitting and doing nothing but thinking, imagining things, thinking things over and that's why it was over very quickly for me, I think" (P23-2-S). There was no expressed need for temporal orientation. When asked for their time experience, some participants did not mention time at all, but only described what they experienced and engaged in — such as a detailed report on their exploration route, for instance. In both conditions, participants rarely reported explicit strategies or seeking out any activities, but instead did what spontaneously came across their minds: "I simply started walking and immediately had a positive feeling […] and that's why I did not think about time at all" (P4-2-E). In the exploring condition, thoughts were only rarely mentioned: "Thoughts? Well, I didn't really think much, but rather just read or looked at something" (P39-1-E). Experiencing a reduction of action alternatives within the experiment was perceived as relieving in both conditions: "You have your peace and you had time for yourself, so to speak, whatever you wanted to do" (P39-1-E). Thus, the stay in the library was perceived positively, and the atmosphere of the library was also perceived as pleasant.

The four types were included in a model, suggesting a dimensional structure of time awareness and perceived valence (Fig. 2). The typology suggests that each time experience is composed of how aware people were of the time and whether their experience of time was positive or negative. If they were aware of time, the experience could be further differentiated according to the speed of the passage of time. Perceived valence summarizes all positive and negative expressions of the affective perception of the stay.

4. Quantitative Results

On the basis of the qualitative typology, we conducted a *K*-means cluster analysis with four predefined clusters, including the variables of time awareness and perceived valence. The correlation of the two variables was $r = -0.13$, $p = .28$. The cluster analysis for four clusters did not show stable results. When comparing the within sum of squares (SS) of solutions between two and six clusters, Fig. 3 shows that three, as well as four clusters, can decrease the total within-cluster variance, as two points of inflection can be detected in this plot (Everitt et al., 2011).

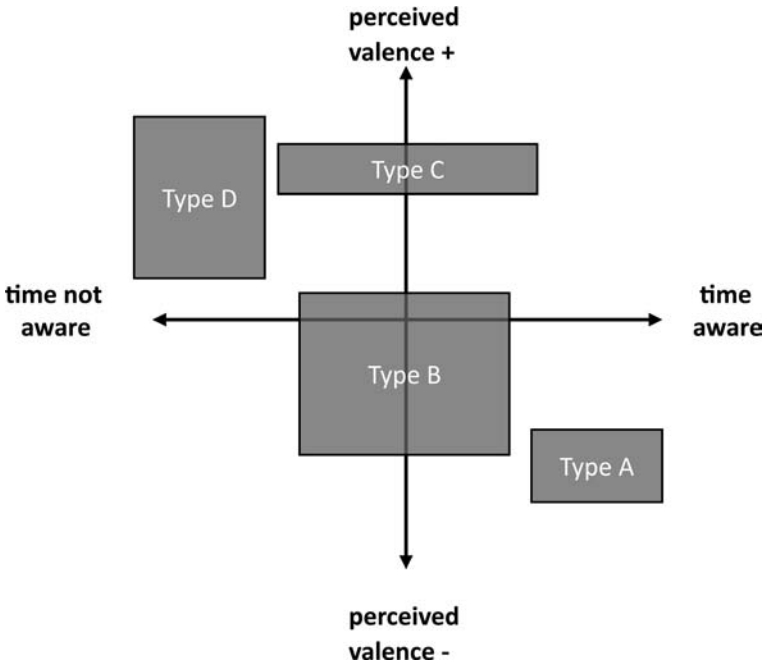

Figure 2. Model of the relation of time awareness and perceived valence including qualitative types of time experience.

Therefore, we decided to continue the analysis with a stable, three-cluster solution and excluded two values that could not be clearly assigned to one of the clusters. The *K*-means cluster analysis with three predefined clusters could explain 67.4% of the variance (between SS/total SS).

In Table 2 a summary of the cluster means for three clusters is shown. The first cluster includes the highest number of observations. Within this group, a positive perceived valence with low time awareness was experienced. By contrast, cluster 2 connects observations with a negatively perceived valence and high time awareness. The observations of the last cluster represent a very positively perceived valence combined with a high time awareness (Fig. 4).

Figure 4 also includes the visualization of inter- and intra-individual differences in the cluster assignment. The descriptive comparison of cluster membership between the experimental manipulations of exploring and sitting showed that the pattern of membership frequency differed between exploring and sitting (Fig. 4). The experience of high time awareness and positively perceived valence (cluster 3) in particular was more frequent when sitting ($n = 12$) compared to exploring ($n = 7$). On the intra-individual level, the majority of participants (61%) was assigned to a different cluster for each condition as they showed varying experiences of time awareness for sitting and exploring. As Ehret et al. (2020b) found

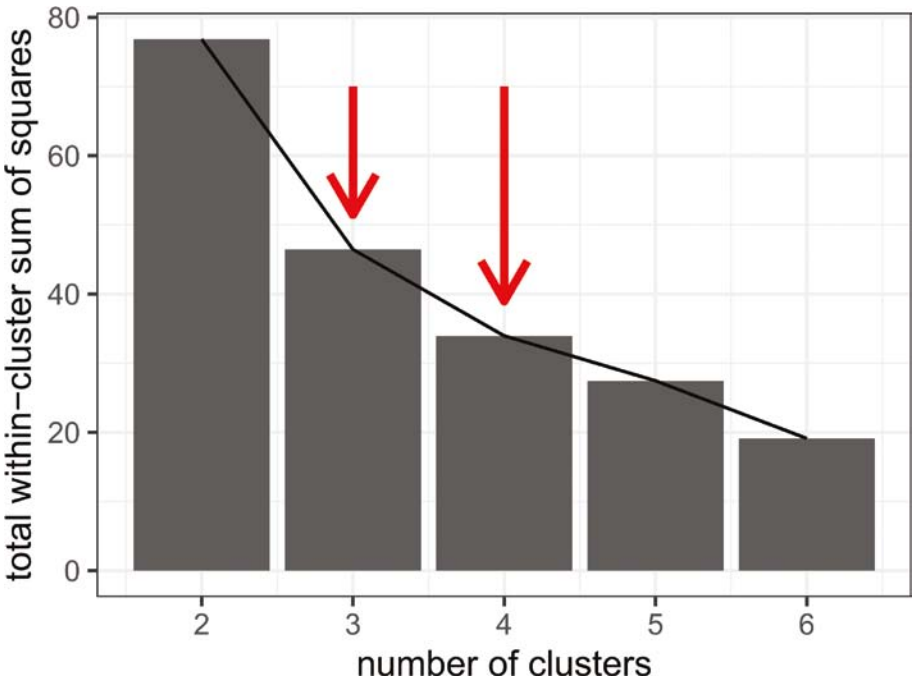

Figure 3. Comparison of total within-cluster sum of squares for 2–6 clusters. The arrows indicate the two inception points.

Table 2.
Summary of standardized cluster means for time awareness and perceived valence and within-cluster SSfor *K*-means analysis with three clusters.

Cluster	Time Awareness	Perceived valence	Within SS
1 ($n = 26$)	−0.97	0.26	14.90
2 ($n = 19$)	0.67	−1.22	16.35
3 ($n = 19$)	0.66	0.85	9.78

n refers to the number of observations, not to the number of participants.

an influence of expectation on temporal experience, we additionally descriptively analyzed the clusters according to the expectation manipulation. For no expectation, the cases were equally distributed (cluster 1 = 11, cluster 2 = 11, cluster 3 = 12) whereas for the induced negative expectation, cluster 2, with high time awareness and negatively perceived valence, contained the highest number of cases (cluster 1 = 8, cluster 2 = 15, cluster 3 = 7).

For the lowest AIC, LPA suggested a four-cluster solution. As one of the clusters only contained three observations, we did not further interpret it. The other three clusters corresponded in their content with the *K*-means cluster. The lowest BIC

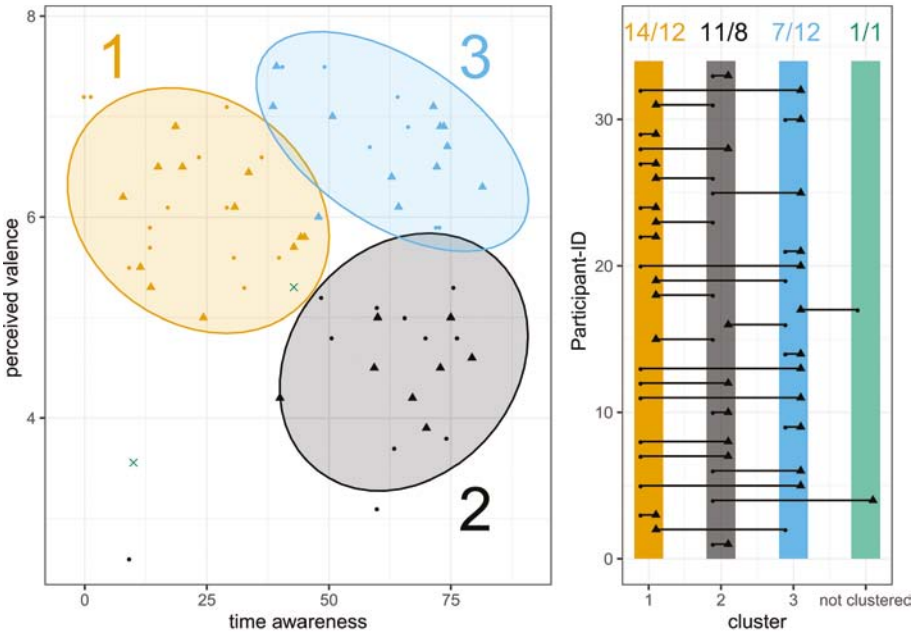

Figure 4. Left: Scatterplot of observations grouped by clusters on the variables of time awareness and perceived valence. Circles represent the exploring condition, and triangles represent the sitting condition. The green Xs identify the two values that could not be clearly assigned to one of the clusters. Right: On the upper right, the numbers refer to the comparison of cluster membership between conditions (exploring/sitting). Each number refers to the frequency of observations (two per participant) per condition. Color and number identify the corresponding cluster on the left, and the non-clustered observations are marked in green. On the lower right, for each of the 33 participants, cluster membership is compared intra-individually. Again, circles represent the exploring condition, and triangles represent the sitting condition.

suggested a two-cluster solution. This solution differentiated only a high and low time awareness cluster that could not make any further suggestions on the relation with perceived valence. Please see Supplementary Text S2 for detailed results and figures of the LPA.

5. Discussion

In the present study, we developed a grounded theory on time awareness by qualitatively and quantitatively examining different extents of time awareness and their relation to perceived valence, states of consciousness, and dealing with doing nothing. To this end, we tested 33 participants in two 60–100 minute sessions, with sitting and exploring as a within-subjects factor, on two different days. To avoid repetition effects, we used one of two different libraries for each condition in a randomized order. These were characterized by their special contemplative

architecture to elicit various states of consciousness. We conducted a semi-structured interview on the topics of time experience, dealing with doing nothing, room atmosphere, and comparison of the two sessions. As dependent quantitative variables, we analyzed time awareness and perceived valence.

Analysis of the qualitative interviews according to the principles of the grounded theory framework resulted in a model combining the experience of time awareness with the perceived valence of the stay within a dimensional structure. The pattern of four different experiences of time awareness could be located in this model. The cluster analysis on the variables of time awareness and perceived valence suggested a pattern of three clusters. These three clusters also overlapped in content with three clusters of the LPA. One type of time experience from the qualitative analysis could not be shown in the cluster analysis. As in this type, time awareness was dependent on the activity, it apparently integrated different states of time awareness and perceived valence instead of differentiating them from each other, and therefore had to be excluded from the model due to its low explanatory power.

In both analyses, we found the connection between high time awareness and negatively perceived valence. The qualitative analysis revealed that this type of time experience was mainly accompanied by a negative evaluation of doing nothing while sitting and a perceived lack of freedom due to the experimental constraints while sitting and exploring. In order to avoid this negative perception, explicit strategies were tried, but they failed in their implementation. Consequently, people experiencing a high time awareness and perceived a negative valence reported high levels of boredom. Boredom can be defined as an "aversive state of wanting, but being unable, to engage in satisfying activity" (Eastwood et al., 2012, p. 483). Apparently, for our participants, this inability resulted from either an external constraint of possibilities while sitting or an internal, felt constraint due to the experimental setting in both conditions. Interestingly, this experience was also more frequent in the group that received the induction of a negative expectation in the quantitative data.

Another pattern that was found in both analyses was the experience of low time awareness and positively perceived valence. Instead of reporting their experience of time, participants focused on activities that structured their time. Some even experienced moments of complete timelessness. This state could be achieved while sitting and exploring. Interestingly, reflections on time and experimental constraints occurred only very rarely during the waiting time. The limitation of possibilities, especially while sitting, as well as the liberty to move while exploring, were perceived as relieving. The descriptions of low time awareness and positively perceived valence resemble states of flow (Nakamura & Csikszentmihalyi, 2014), as participants interpreted our experimental instructions in their own ways, engaged successfully in intrinsically motivated tasks that fit their current needs, and tended to stop reflecting on the self and time as they became absorbed by their activities.

The two patterns just described have been previously demonstrated (Wearden et al., 2014). However, we found another type of time experience in the qualitative and quantitative data mostly for people in the sitting condition: the experience of a high time awareness and positively perceived valence. The qualitative data revealed that this 'relaxed boredom' — as one of our participants described it — occurred when people enjoyed doing nothing or experienced the experiment as a 'holiday' from their daily life. The role as a participant in the experiment was actively reflected and accepted. Regarding states of consciousness, this time experience is more difficult to allocate. As relaxation and reflection were key, idleness might be one converging concept. O'Connor (2018) describes idle experiences as unproductive and effortless, yet enjoyable in themselves. Idleness can be seen as the freedom to do nothing. In addition, the attitude of acceptance toward the limitations of their current situation shows similarities to a mindful attitude. The acceptance component of mindfulness: "involves approaching one's experiences with an orientation of curiosity, openness, and acceptance, regardless of their valence and desirability" (Hölzel et al., 2011, p. 538). This acceptance seemed to be important for the participants to ultimately evaluate the situation as pleasant.

Apparently, participants perceived a high time awareness when they did not engage in various activities during their time in the library, but rather perceived that they had nothing (productive and meaningful) to do. Considering a connection between the awareness of affective and bodily states and the experience of time (Craig, 2009; Wittmann, 2009), self-reported high time awareness might be related to interoceptive awareness in situations of low cognitive and attentional demand. However, during meditation — an activity that increases self-awareness and is attention-demanding — experienced meditators reported experiences of timelessness (Droit-Volet & Dambrun, 2019). Thus, further research is needed on what modulates the relation of self- and time-awareness. However, our results suggest that whether more unpleasant states of consciousness, such as boredom, or more pleasant states, such as idleness, are experienced in a situation of low cognitive demand depends on the respective attitude of the individual and are a consequence of the evaluation of the time experience.

Several characteristics of the current study could have caused the observation of high time awareness and positively perceived valence compared to previous studies, which have shown a correlation between higher time awareness and negative valence (Conti, 2001; Ehret et al., in press). Droit-Volet et al. (2017) found that PoTJ and time estimations correlate for longer durations (2–8 min in their study). Thus, the extremely long waiting time of about 1.5 hours may have increased the chances of experiencing a subjectively high time awareness, while perceived valence was not influenced to this extent. Another distinctive feature of the present study was created by the contemplative architecture of the libraries. They are both constructed to spend long pleasant hours — especially sitting — within the space. Ehret et al. (2020a) also found a high time awareness accompanied by positively

perceived valence in a real-life forest setting when no selective attention on a task was required. Therefore, environments that can detach from daily life might be predestined to elicit states of consciousness such as idleness, which are rarely observed in laboratory or everyday settings. As high time awareness and positively perceived valence mainly occurred while sitting, another factor might be simply the level of activation. Previous studies found that higher arousal can accelerate PoTJ, while relaxation decelerates PoTJ. Additionally, the amount of attention captured by an activity can hasten passage of time (Droit-Volet & Wearden, 2016; Droit-Volet et al., 2017). Jokic et al. (2018) found that arousal, but not relaxation, correlated positively with how often people thought about time. As PoTJ can differ from time awareness, it remains unclear from these results whether time awareness decreases with arousal and increases with relaxation. This issue therefore needs further investigation.

Impulsivity and meta-cognitive knowledge of time could be additional factors that may have facilitated an experience of high time awareness and positively perceived valence, but were not specific to the present study. Jokic et al. (2018) showed that more impulsive people perceive the passage of time more slowly and intensely in real-life waiting situations. This indicates that some personality traits might make an individual more capable of certain time experiences than others. In the present study, participants also reported explicitly that they used strategies to cope with the time. Lamotte et al. (2012) showed that meta-cognitive knowledge of time distortions could influence accuracy of time judgments. As a use of strategy might reflect meta-cognitive knowledge of time distortions, it would be interesting to assess how this meta-cognitive knowledge can influence the subjective experience of the passage of time.

With regard to limitations, the present study followed an exploratory approach, and therefore, all suggested relations between time awareness and perceived valence, states of consciousness, and dealing with doing nothing need to be subject to further hypothesis-driven and controlled studies. The following points should be mentioned concerning the reliability and validity of our results.

Whereas for the qualitative analysis we could integrate a sufficient number of interviews, the relatively low number of observations included for a cluster analysis led to unstable results and differences between *K*-means cluster analysis and LPA. We tried to approach the clusters with caution by excluding two observations from the *K*-means cluster analysis that could not ultimately be assigned to one of the clusters and by not interpreting the fourth cluster of the LPA that only contained three observations. However, larger data sets are needed to find more stable and more clearly distinguishable clusters. For the qualitative analysis according to grounded theory, it is important to note that theoretical sampling could only be implied in data selection, but not in data collection, as this would have confounded the collection of quantitative data.

A further limitation of our ecologically valid situations with real-life settings and participant instructions that allowed for different states of consciousness was

the issue of uncontrollable influences that might confound the results. Additionally, the conditions were randomized but could not fully be counterbalanced due to organizational limitations. Therefore, on the one hand, laboratory studies are needed to identify the impact of the described factors on time awareness more precisely. On the other hand, further studies in real-life settings are needed to generalize the effects on other contemplative environments.

Another future implication might be the inclusion of physiological measures to draw conclusions not only for perceived valence, but also for actually felt affective states. This would also be interesting regarding the interoceptive awareness of these states and their relation to the experience of the passage of time.

To conclude, in the present study, the evaluation of perceived valence was positive when participants either successfully engaged in intrinsically motivated tasks — which was associated with a low time awareness — or when they accepted the constraints of their current situation and relaxed, which was associated with a high time awareness. When engaging in activities failed or the experimental situation was perceived as a lack of freedom, an unpleasant high time awareness was experienced along with descriptions of boredom. In literature on the subjective experience of time, positively perceived valence is typically associated with low time awareness and fast passage of time, and negatively perceived valence with high time awareness and slow passage of time (e.g., Wearden et al., 2014). The present study suggests that a high time awareness does not necessarily appear to be unpleasant, but rather, it seems to depend on an evaluation according to the respective attitude and handling of a situation by the individual.

6. Conclusion

The present exploratory study found three different types of experiencing time awareness corresponding in qualitative and quantitative data. In addition to previously shown relations of high time awareness and negatively perceived valence associated with boredom, and low time awareness and positively perceived valence associated with flow, we found a pattern of high time awareness and positively perceived valence. Very long testing durations, contemplative environments, and level of activation might be eliciting factors of this time experience to be tested in future confirmative empirical studies.

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Supplementary Material

Supplementary material is available online at:
https://doi.org/10.6084/m9.figshare.12363032

Notes

1. Combined with the present study was another hypothesis-driven one targeting the expectation during sitting and exploring. Therefore, for 15 of the participants, a negative expectation was induced by telling them that they would have to conduct a psychological stress test in the end. This manipulation was done between-subjects and was orthogonal to the active–passive manipulation. The quantitative effects of the manipulations on time experience have been analyzed as part of another paper. Raw data, analyses, and manuscript available at osf.io/kpt3h (Ehret et al., 2020b). In the manipulation check, participants reported that they were not affected negatively by the announcement of a stress test during their waiting time and the stress test was also not the focus of reflection during the interview. We found an interaction between expectation and waiting condition on the dynamical measure of time awareness. The effect of waiting condition was stronger without than with a negative expectation. Hence, we also describe the influence of expectation in Section 5.
2. P34-2-E: P = Participant-Nr; 1/2 = first/second session; E/S = Exploring/Sitting.

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