Draft version 2023-11-20 submitted for peer review

Time in suspense: Investigating boredom and related states in a virtual waiting room

Corinna S. Martarelli[1], David Weibel[2], Deian Popic[1], & Wanja Wolff[3,4]

[1] Faculty of Psychology, UniDistance Suisse, Switzerland

[2] Department of Psychology, University of Bern, Switzerland

[3] Department of Sport Science, University of Konstanz, Germany

[4] Department of Educational Psychology, University of Bern, Switzerland

Correspondence concerning this article should be addressed to Corinna Martarelli

Acknowledgments

We would like to thank Melanie Meister and Lia Langenegger for their help in the project, including data collection.

Abstract

We studied the role of time in the experience of boredom and its relationship with various psychological states using virtual reality. Sixty-six participants visited nine virtual waiting rooms and evaluated their perception of time and psychological experiences, including boredom, exhaustion, restlessness, amotivation, frustration, anger, unhappiness, spontaneous and deliberate mind-wandering, fantasy, and absorption. Results confirmed the relationship between boredom and time perception, showing that the higher the levels of boredom, the slower time seems to pass. However, manipulating time-related information via a slower/faster ticking clock did not affect boredom. We also found that boredom increased as participants progressed through the nine virtual rooms, and its affective characterization over time remained stable, while its cognitive characterization fluctuated. While boredom was consistently associated with exhaustion, restlessness, amotivation, and frustration, its relationship with fantasy, absorption, spontaneous mind-wandering and deliberate mind-wandering, evolved dynamically over time. These findings provide novel insights into the intricate and differentiated cognitive and affective consequences of being bored.

Time in suspense: Investigating boredom and related states in a virtual waiting room

Boredom has long fascinated researchers and individuals alike due to its impact on human cognition, emotion, and behavior. It distinguishes itself from other psychological states through its unique properties and by evading clear-cut categorization as an emotion or cognition (Wolff et al., 2022). One well-established property of boredom is its association with time: Imagine being in a room with nothing to do. Your experience will vary based on the length of the waiting time, your current schedule, and your psychological state. Can you enjoy the time doing nothing, such as letting your mind wander deliberately? Or does boredom kick in, leading you to repeatedly check your watch as time seemingly slows down the longer you wait? Notably, a robust connection between the experience of boredom and the subjective perception of time was found (Witowska et al., 2020). In their study, Witowska et al., had 99 participants placed alone in an empty room for 7.5 minutes. Afterward, they reported their estimation of the waiting duration ("How much time did you spend in the room?"), their thoughts about time ("How often did you think about time?"), and the subjective passage of time ("How fast did time pass for you?") among other aspects. The findings revealed that boredom was associated with more frequent thoughts about time and the feeling of time passing more slowly (interestingly, boredom was not significantly associated with how many minutes participants thought they had waited). This link between boredom and the perception of time, with ratings indicating that time passes slower when bored, has been replicated in other studies (e.g., Igarzábal et al., 2021).

If time perception and boredom are tightly coupled, it becomes intriguing to investigate whether manipulating time information can alter the experience of boredom. Indeed, early attempts suggest manipulations of time information can have an effect on boredom, such as when participants were told that an activity would be shorter than it actually was (London & Monello, 1974). More recently, Fahlman et al. (2013) combined the manipulation of time information with other factors (i.e., the interestingness of the task and freedom of choice) to create a validated manipulation of boredom (see also Mercer-Lynn et al., 2014). In the boredom condition the participants had to watch an uninteresting video clip, they were explicitly told that they had no choice which video they watched due to technical difficulties, and were misled to believe that time was passing more slowly than it actually was. They were informed that the video had a duration of 20 minutes, although its true duration was 25 minutes. Participants in the non-boredom condition watched an interesting scene from a movie and were led to believe that they were free in their choice of video to watch. In addition, they were informed that the video had a duration of 30 minutes, although its actual duration was 25 minutes. Thus, participants were misled to believe that time was passing more quickly. Consistent with expectations, participants in the experimental condition reported higher levels of boredom than in the non-boredom condition. However, it is unclear which specific factor – time manipulation, interestingness of the video, or freedom of choice – is driving the observed effect. In addition, the time manipulations that have been used so far have not directly manipulated the speed of the visual passage of time (e.g., via a slowed down clock) but have created expectations about how long a given task would take. This raises the question of whether humans are sensitive to the speed of the passage of time (e.g., does a slower ticking clock distort time perception?), or whether they integrate this information into their experience of boredom (e.g., does a slower ticking clock increase boredom?).

Given the centrality of the time dimension in the experience of boredom (Danckert & Elpidorou, 2023), we aim to test the influence of manipulating time-related information on the experience of boredom. This approach will allow us to test the causal link between time and boredom, providing a controlled, experimental means to study this challenging psychological state. Furthermore, we aim to replicate the well-known relationship between the experience of boredom and the subjective perception of time (Witowska et al., 2020). In addition, boredom is also linked to increased negative affect and changes in cognitive states, such as mind-wandering, which have been suggested to be a cognitive response to boredom when no other change in behavior is possible (Martarelli & Baillifard, 2022). By assessing these variables – exhaustion, restlessness, amotivation, frustration, anger, unhappiness, spontaneous and deliberate mind-wandering, fantasy, and absorption – which are potential correlates or consequences of boredom (Wolff et al., 2022), our study seeks to explore the temporal dynamics of boredom and its relationship with these other psychological states.

Defining boredom

Boredom is understood to serve as a signal that one is currently not adequately utilizing one's capacities (Wolff et al., 2022). While boredom can occur in many situations, it is prototypically associated with situations of high monotony (Bieleke et al., 2021), situations where one's agency is limited (Gorelik & Eastwood, 2023), and activities that hold low personal value (van Tilburg & Igou, 2012). When boredom occurs, it is understood to act as a push to action, prompting a search for more rewarding behavioral alternatives in order to alleviate boredom (Elpidorou, 2018). If no outward behavioral responses to alleviate boredom are available to the person (e.g., taking out one's phone to browse social media to end the boredom one might experience while sitting in a room waiting), one might turn to inward mental responses instead. For example, research shows that boredom is associated with changes in deliberate and spontaneous mind-wandering (Martarelli, Bertrams, et al., 2021).

In addition to such inward mental responses to boredom, boredom is also robustly linked to increases in various negative affective states, such as frustration, anger, or restlessness (Dahlen et al., 2004; Danckert et al., 2018; van Hooft & van Hooff, 2018). Despite its association with negative affect (Vodanovich et al., 1991), boredom is clearly distinct from other negative emotions. For instance, van Tilburg and Igou (2017) examined whether boredom differed from negative emotions like sadness, anger, frustration, fear, disgust, feeling depressed, guilt, shame, regret, and disappointment. Using a multidimensional scaling approach, they found that boredom was situated farthest away from the other emotions on the obtained spatial maps. As an example, boredom and frustration are not interchangeable; in a study, Westgate and Wilson (2018) found that frustration increased linearly with task difficulty, whereas boredom followed a quadratic pattern, being high when task difficulty was either too low or too high. These findings indicate that boredom, although it might beget a host of negative emotions – is a signaling sensation that is not just another emotion.

Boredom has been shown to correlate with psychological states beyond affect (Wolff et al., 2022), such as absorption (Ulrich et al., 2016), mind-wandering (Blondé et al., 2022), and fantasy (Weibel et al., 2018). While absorption, often described as a state of flow, has been considered at times as the opposite of boredom (Csikszentmihalyi, 1975), correlational evidence suggests that the two states are not exact mirror states, leaving room for several other non-boring states (Harris, 2000; Wolff et al., 2022). When it comes to mind-wandering and fantasy, it is particularly in constrained situations that internal escapes from boredom may occur (Tam et al., 2021). It is plausible that the relationships between these states, which we refer to as more cognitive states here[1], and boredom are dynamic and evolve over time. By unraveling these connections, we can gain deeper insights into the nuanced dynamics of boredom and its implications for human cognition, emotion, and behavior.

Boredom and time

As evident from its name in German, “Langeweile” literally means "long while", suggesting the feeling of being trapped in a prolonged period without engaging activities. When experiencing boredom, time seems to stretch out, amplifying the perception of its passage (Craig, 2009; Droit-Volet & Meck, 2007). This can be explained by pacemaker-accumulator models (Treisman, 2013), in which an internal pacemaker generates a sequence of pulses, that are

[1] Here, we follow the prominent distinction between affective/emotional and cognitive states. However, it has to be acknowledged that this distinction is probably less clear cut as previously assumed (Pessoa, 2008). This is also indicated by boredom, as a sensation that evades straightforward classification.

subsequently matched against stored patterns, enabling us to assess durations and generate estimations of time (Gibbon, 1977; see also Ivry & Schlerf, 2008 for a review). A classical pacemaker-model is the attentional-gate model (Zakay & Block, 1995) which proposes that paying attention to the passage of time, which is particularly true in waiting situations, leads to a perception of time slowing down.

The relationship between boredom and the perception of time appears to be bidirectional. It is unclear whether boredom intensifies the attention to time and/or if a heightened focus on time leads to increased boredom (Zakay & Block, 1997). Boredom is an unpleasant state (Martarelli, Wolff, et al., 2021) that signals the need to search for more rewarding activities and serves as a signal for action (Wolff & Martarelli, 2020). This signal for action may lead to impatience and the feeling that time is dragging on (Zakay, 2014). It has been suggested that subjective time perception, similar to pain, plays a role in alerting us that a change is needed (Zakay, 2014). On the contrary, when our attention is fully engaged in a task, we lose track of time, and experience it as passing faster (Nakamura & Csikszentmihalyi, 2002).

A good way to investigate time perception is through virtual reality (VR) (e.g., Weber et al., 2020). As an example, Igarzábal et al. (2021) replicated the previously mentioned study by Witowska et al. (2020) using VR. They recreated the waiting room in VR and again assessed different variables, including boredom and time perception. Once again, they found the relationship between boredom and the passage of time slowing down. Contrary to their expectations, they found that participants in the virtual room experienced more boredom compared to those waiting in the real room. This is surprising, because previous research investigating time perception in VR rather suggests that VR generally speeds up the perception of time (Mullen & Davidenko, 2021). One possible explanation is that VR is usually expected to be entertaining and associated with engaging activities. Therefore, when individuals are waiting in a virtual room with no activities or engagement, which is atypical for a VR scenario, it might lead to heightened levels of boredom (Igarzábal et al., 2021).

Other researchers have investigated the link between trait boredom, specifically boredom proneness, and time perception. For example, individuals who are prone to boredom reported that time drags on during tedious tasks, in contrast to individuals with a lower propensity for boredom (Watt, 1991; see also Wittmann & Paulus, 2008). Danckert and Allman (2005) found that boredom prone individuals exhibited higher error rates in time estimation. These results collectively suggest that subjective perception of time may be a crucial component in the experience of boredom.

Present study

Despite various models explaining time perception, they all share the assumption that the brain constructs our perception of time, making it easily manipulable (Eagleman, 2008). In this study, our primary aim was to investigate whether manipulating time information with a slower/faster ticking clock alters the perception of time, experienced boredom, and choices. Additionally, we aimed to replicate the established association between the perception of time and the experience of boredom. Furthermore, we aimed to explore the dynamic interactions between boredom and other psychological states over time. To achieve this, we employed a VR environment with a clock operating at different speeds in order to manipulate time perception. Within the VR setting, participants were presented with three waiting rooms, each featuring a manipulated clock with a different pace (real-time, faster, and slower). In each waiting period, the actual time duration was four minutes. In the real-time manipulation, it remained at 1000ms per second, however, in the slow manipulation, one second was stretched to 1200ms, and in the fast manipulation, one second was compressed to 800ms. Across a series of nine waiting rooms, participants could choose one of three doors, which determined the waiting room they entered. After each four-minute waiting period, participants provided ratings of their perception of time, and reported their psychological experiences, including boredom, exhaustion, restlessness, amotivation, frustration, anger, unhappiness, spontaneous and deliberate mind-wandering, fantasy, and absorption. Our study aimed to investigate the relationship between time perception and boredom, as well as explore the dynamic interactions between boredom and other psychological states over time.

Specifically, our research questions were as follows: 1) Does a change in time information alter time perception and boredom? 2) Does time perception relate to the experience of boredom? and 3) taking an exploratory approach, how do boredom and other psychological states interact dynamically over time? In terms of hypotheses, we expect 1) to be able to manipulate time perception to induce boredom (Mercer-Lynn et al., 2014) and 2) anticipate finding a significant relationship between the subjective experience of time dragging on and the levels of experienced boredom (Witowska et al., 2020). Furthermore, we hypothesize that the duration of the task, which involves visiting the 9 waiting rooms, will have a significant impact on levels of boredom, particularly in relation to the interaction with other variables (3). Of particular interest are the potential differential dynamics between boredom and affective states (exhaustion, restlessness, amotivation, frustration, anger, unhappiness) and cognitive states (absorption, spontaneous and deliberate mind-wandering, fantasy).

Methods

Participants

Based on G*Power (Faul et al., 2009), we determined a sample size of 66 participants [repeated measures ANOVA with an alpha error of 5%, a power of 95%, a small to medium effect size (f = 0.2), one group, three measurements (manipulation of time information)]. 67 participants took part to the study, however one participant who discovered our hypothesis was excluded from data analysis. Out of the remaining 66 participants, 35 (53%) were male. The average age was 34.3 years (*SD* = 10.6), with the youngest participant being 18 years old and the oldest participant being 59 years old. The participants were recruited from the acquaintances of the experimenters and did not receive any compensation for their participation. The local ethics committee approved the study,

Material

VR headset and manipulation of time information

The three waiting rooms in VR were presented using an Oculus Quest 1 VR headset and programmed in the game engine Unreal Engine 4. The waiting rooms differed only in terms of manipulation of time information. In each waiting period, the actual time was four minutes. In the virtual room, there was a clock on the wall where we manipulated the speed. Thus, the clock's minute hand was moving at different speeds. Specifically, in the slow manipulation, one second was extended to 1200ms increasing the duration by 20%, in the real-time manipulation, it remained at 1000ms per second, and in the fast manipulation, one second was shortened to 800ms, thus decreasing the duration by 20%.

State variables assessed after each waiting room

Participants completed a state questionnaire after each waiting situation. The questionnaire was programmed using the open-source software Limesurvey (www.limesurvey.org). To minimize order effects, the items were presented to participants in randomized order after each waiting period. It took participants approximately three minutes to complete the questionnaire. The questionnaire assessed various psychological states using the scales described below.

Boredom. The experience of boredom was measured using four items to be answered on 5-point Likert scales ranging from 1 = strongly disagree to 5 = strongly agree. Participants indicated whether they found the waiting situation boring ("I found waiting to be boring"), tedious ("I found waiting to be tedious"), and effortful ("I found waiting to be effortful"), and whether they would prefer to do something else rather than be in this room ("I would prefer to do something else than being in this room"). The items were developed based on current definitions of boredom (see, e.g., Wolff & Martarelli, 2020). McDonald's ω was .871, and, thus, internal consistency was good.

Time perception. To assess time perception for each experienced waiting period, participants were presented with three items used in previous research (see, e.g., Weibel et al., 2018). The first item was: "Time passed quickly during the wait" and was reverse-coded. The second item was: "I felt the waiting time was very long" to be answered on 5-point Likert scales ranging from 1 = strongly disagree to 5 = strongly agree. These two items were averaged. McDonald's ω was .817, showing good internal consistency. The third item was "I think I waited for (...) minutes," where participants could enter the subjectively perceived elapsed time in minutes in a free-text field.

Mind wandering. Spontaneous and deliberate mind wandering was measured using two single items, drawing from current distinctions between these types of mind-wandering (Seli et al., 2016). Participants were asked to rate "I noticed my thoughts wandering spontaneously" and "I intentionally let my mind wander" on 5-point Likert scales ranging from 1 = strongly disagree to 5 = strongly agree.

Fantasy. Fantasy was assessed using a self-generated single item: "I immersed myself in imagined worlds" to be answered on a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree.

Absorption. Absorption during the waiting periods was measured using three items adapted from the Flow Short Scale (Rheinberg et al., 2003, 2016). These items were "I did not notice how time goes by" "I was completely absorbed in myself," and "Thoughts and inner images came naturally" to be answered on 5-point Likert scales ranging from 1 = strongly disagree to 5 = strongly agree. McDonald's ω was .755, and, thus, internal consistency was good.

Affect. Affect during the respective waiting situations was captured using six single items, adopting a procedure similar to the PANAS scales (Watson et al., 1988). Participants were asked to rate on 5-point Likert scales ranging from 1 = strongly disagree to 5 = strongly agree the extent to which they felt exhausted, restless, amotivated, frustrated, angry, and unhappy.

Participants interpretations of experiment hypotheses. In order to exclude participants who may have realized the hypotheses being tested in our experiment, the following two questions were asked after completion of the entire experiment: "Do you have any suspicions about the hypotheses being investigated in this experiment?" and "During the experiment, I was influenced by my assumptions in the following way...". Both questions could be answered in a free-text field. We had to exclude one participant who noticed our time manipulation.

Procedure

Participants received an invitation via email to participate in the experiment. The invitation included a cover story, so the participants were unaware of the research questions and hypotheses being investigated. The experiment lasted approximately one hour and consisted of nine waiting periods. After each waiting period, participants completed a questionnaire about their experience during the preceding waiting period. One week after the experiment, participants received another email with a link to a follow-up questionnaire. In this questionnaire, participants reported socio-demographic information, and completed trait questionnaires that are not further considered in this publication. After completing the second questionnaire, a debriefing session took place either in person or via email, where participants were informed about the research questions and hypotheses tested in the experiment. Figure 1 illustrates the experimental design.

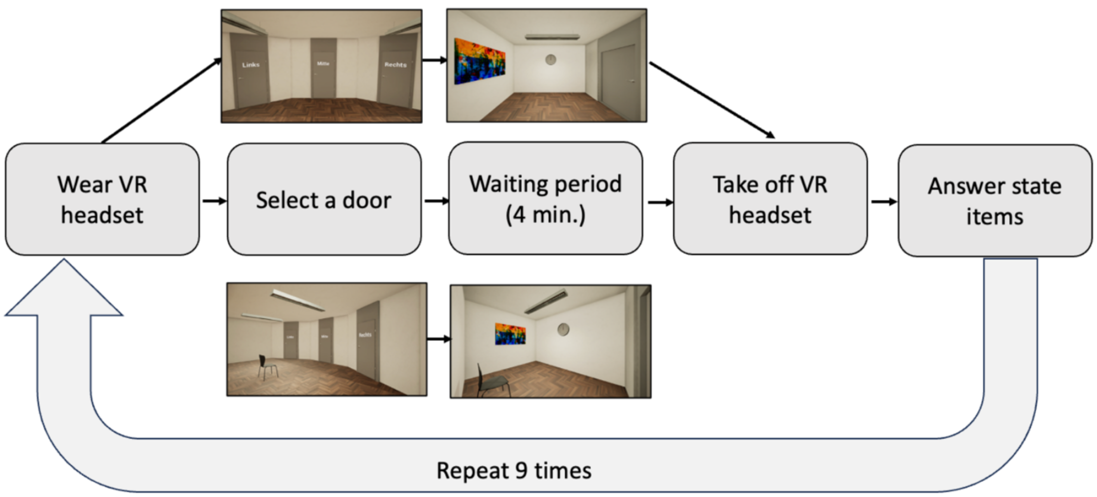

Figure 1. Graphical representation of the experimental design, including views of the virtual rooms.

Waiting periods

Participants were instructed to take a seat and wear the VR headset (see Figure 1). To ensure familiarity with the VR environment, a brief practice round was conducted. During the experiment, participants were presented with three gray doors labeled "Left," "Middle," and "Right" in front of them. Each door led to a different waiting room, corresponding to the three manipulations of time information (slow, real-time, fast). The waiting rooms themselves were identical, except for the manipulation of time-related information, which was randomly assigned to the individual rooms for each participant. Using a controller, participants could select one of the doors. We gave the participants the choice to choose the room in order to analyze whether the manipulation of time information had an impact on behavior (choices). Once a choice was made, participants were automatically seated in the corresponding waiting room with no further tasks assigned except to wait. They were not allowed to stand up. After a waiting period ended, participants were automatically returned to the virtual room with the initial door selection. They then took off the headset and proceeded to answer the state questionnaire. Once the questionnaire was completed, participants were instructed to put on the VR headset again. They would once more encounter the three doors (see Figure 1) and use the controller to select a waiting room. In total, there were nine waiting periods.

Analytical approach

We report the analyses according to our three research hypotheses, starting from the impact of the manipulation of time information on the choice of the room, time perception, and boredom (analyses of variance), followed by the test of the relationship between boredom and the subjective experience of time (correlations), and finally we explore the dynamic relationships between boredom and other psychological states (mixed model analyses). The analyses were computed with jamovi version 2.3.21.0 (jamovi project, 2022), R (2021) with the functionalities of the GAMLj toolbox (Gallucci, 2019). The dataset is available on OSF https://osf.io/87vp2/.

Results

Time manipulation to induce boredom

To test our first hypothesis, we carried out four analyses of variance with the within-subjects factor of manipulation of time information (slow, real-time, fast manipulation) and the four dependent variables choice of the room, subjective perception of time (average of two items, as described in the methods section), estimated waiting time in minutes, and boredom (average of four items, as described in the methods section) respectively. None of these analyses yielded significant results. We report *F*-values, *p*-values, and effect sizes (eta-squared) in Table 1. We report descriptive statistics in Appendix A (see Table A1).

Table 1. Results of the four analyses of variance.

Dependent variable	df	F	p	η^2
Choice	2, 130	0.385	0.681	0.006
Time estimation	2, 130	2.284	0.106	0.034
Time perception	2, 130	1.568	0.212	0.024
Boredom	2, 130	1.580	0.210	0.024

Thus, altering information on the passage of time by 20% did not change boredom levels, participants' estimation of time, their perception of time, nor their preferred choice of waiting room.

Relationship between boredom and perception of time

To examine the association between boredom and perception of time, we computed two correlations. The correlation between boredom and the subjective perception of time slowing down (average of two items) was large and significant (r = .828, 95% CI [.732, .891], p < .001), indicating a strong relationship between the experience of boredom and the perception of time dragging on. The correlation between boredom and the estimated waiting time in minutes was moderate and significant (r = .338, 95% CI [.105, .537], p = .005), indicating that the more bored participants felt, the longer they estimated to have spent time in the room.

Temporal dynamics of boredom and associated states

To examine our last exploratory hypothesis, we computed a linear mixed effects model with random intercepts for participants, and fixed effects for timepoint (9 waiting rooms), exhaustion, restlessness, amotivation, frustration, anger, unhappiness, spontaneous and deliberate mind-wandering, fantasy, and absorption. In addition to the main effects, we included all two-way interactions between timepoint and the 10 psychological states assessed in this study. The dependent variable was boredom, which was calculated as the average of four items (as described in the methods section). We obtained the degrees of freedom by using a Satterthwaite approximation implemented in jamovi and employed the default restricted maximum likelihood method. Before reporting these results, we present the correlations between the variables investigated in Table 2. In addition, we report the descriptive statistics in Appendix A (see Table A2). It is important to note that in these tables, timepoint is not considered and the responses were averaged across timepoints (N = 66).

Table 2. Correlation matrix

	Boredom	Exhaustion	Restlessness	Amotivation	Frustration	Anger	Unhappiness	Spontaneous mind-wandering	Deliberate mind-wandering	Fantasy	Absorption
Boredom	—										
Exhaustion	0.591 ***	—									
Restlessness	0.525 ***	0.510 ***	—								
Amotivation	0.577 ***	0.565 ***	0.504 ***	—							
Frustration	0.599 ***	0.524 ***	0.700 ***	0.722 ***	—						
Anger	0.595 ***	0.441 ***	0.560 ***	0.553 ***	0.859 ***	—					
Unhappiness	0.633 ***	0.552 ***	0.614 ***	0.765 ***	0.939 ***	0.849 ***	—				
Spontaneous mind-wandering	-0.156	-0.014	-0.027	-0.147	-0.181	-0.266 *	-0.253 *	—			
Deliberate mind-wandering	0.036	0.190	0.204	0.087	0.109	-0.016	0.012	0.442 ***	—		
Fantasy	-0.165	-0.092	-0.060	-0.236	-0.128	-0.138	-0.208	0.601 ***	0.559 ***	—	
Absorption	-0.371 **	-0.054	-0.102	-0.256 *	-0.295 *	-0.315 *	-0.388 **	0.759 ***	0.347 **	0.647 ***	—

Note. N = 66. * p < .05, ** p < .01, *** p < .001

In the first column of Table 2 we see the correlations between boredom and the other psychological states. The correlational analysis revealed strong positive correlations (larger than .5, see Table 2) between boredom and exhaustion, restlessness, amotivation, frustration, anger, and unhappiness. The analysis also revealed a moderate negative association between boredom and absorption (r = -.370, 95% CI [-.140, -.562], p = .002).

The mixed model analysis revealed a significant effect of timepoint (*b* = .111, *SE* = .033, 95% CI [.046, .176], *p* < .001) as well as significant effects of exhaustion (*b* = .192, *SE* = .050, 95% CI [.094, .291], *p* < .001), restlessness (*b* = .132, *SE* = .046, 95% CI [.042, .222], *p* = .004), amotivation (*b* = .141, *SE* = .054, 95% CI [.035, .248], *p* = .010), frustration (*b* = .172, *SE* = .084, 95% CI [.006, .338], *p* = .042), and deliberate mind-wandering (*b* = .130, *SE* = .041, 95% CI [.050, .209], *p* = .002). Furthermore, the interactions between timepoint and absorption (*b* = -.041, *SE* = .011, 95% CI [-.063, -.019], *p* < .001), timepoint and spontaneous mind-wandering (*b* = .026, *SE* = .008, 95% CI [.010, .042], *p* = .001), timepoint and deliberate mind-wandering (*b* = -.022, *SE* = .0007, 95% CI [-.036, -.009], *p* = .001), and timepoint and fantasy (*b* = .019, *SE* = .008, 95% CI [.003, .035], *p* = .017) also yielded significant results. We report all estimates in Table 3.

Table 3. Fixed effects parameter estimates

			95% Confidence Interval				
Names	**Estimate**	**SE**	**Lower**	**Upper**	**df**	**t**	**p**
(Intercept)	1.679	0.224	1.241	2.117	552.495	7.510	< .001
Timepoint	**0.111**	**0.033**	**0.046**	**0.176**	**518.726**	**3.326**	**< .001**
Exhaustion	**0.192**	**0.050**	**0.094**	**0.291**	**547.616**	**3.836**	**< .001**
Restlessness	**0.132**	**0.046**	**0.042**	**0.222**	**550.071**	**2.882**	**0.004**
Amotivation	**0.141**	**0.054**	**0.035**	**0.248**	**532.722**	**2.603**	**0.010**
Frustration	**0.172**	**0.084**	**0.006**	**0.338**	**526.761**	**2.037**	**0.042**
Anger	0.115	0.088	-0.057	0.288	538.690	1.312	0.190
Unhappiness	-0.044	0.063	-0.168	0.080	515.506	-0.697	0.486
Spontaneous mind-wandering	-0.074	0.046	-0.164	0.016	521.426	-1.622	0.106
Deliberate mind-wandering	**0.130**	**0.041**	**0.050**	**0.209**	**535.751**	**3.183**	**0.002**
Fantasy	-0.055	0.043	-0.139	0.030	527.746	-1.263	0.207
Absorption	-0.054	0.066	-0.184	0.075	539.724	-0.820	0.412
Timepoint ✻ Exhaustion	-0.006	0.007	-0.020	0.009	519.878	-0.778	0.437
Timepoint ✻ Restlessness	0.004	0.008	-0.012	0.020	535.944	0.488	0.626
Timepoint ✻ Amotivation	-0.004	0.010	-0.023	0.015	519.164	-0.398	0.691
Timepoint ✻ Frustration	-0.022	0.017	-0.055	0.011	520.196	-1.296	0.195
Timepoint ✻ Anger	-0.022	0.016	-0.052	0.009	518.461	-1.373	0.170
Timepoint ✻ Unhappiness	0.016	0.013	-0.009	0.042	518.606	1.241	0.215
Timepoint ✻ Spontaneous mind-wandering	**0.026**	**0.008**	**0.010**	**0.042**	**518.865**	**3.259**	**0.001**
Timepoint ✻ Deliberate mind-wandering	**-0.022**	**0.007**	**-0.036**	**-0.009**	**520.047**	**-3.294**	**0.001**
Timepoint ✻ Fantasy	**0.019**	**0.008**	**0.003**	**0.035**	**525.942**	**2.390**	**0.017**
Timepoint ✻ Absorption	**-0.041**	**0.011**	**-0.063**	**-0.019**	**519.812**	**-3.701**	**< .001**

Note. *N* = 66. Significant effects are written in bold.

Unpacking the significant interactions, simple slope analyses revealed that the conditional effect of timepoint on the experience of boredom was significantly different from zero at one standard deviation below the mean of absorption (*b* = .057, *SE* = .014, 95% CIs [.030, .085], *p* < .001). However, at the mean of absorption, the effect was not significant (*b* = .016, *SE* = .008, 95% CIs [-.001, .032], *p* = .063), and one standard deviation above the mean of absorption also showed a non-significant effect (*b* = -.026, *SE* = .014, 95% CIs [-.053, .002], *p* = .065). These results suggest that the duration of the task was associated with higher levels of boredom for individuals low in absorption, but not for those at the mean or higher levels of absorption. Figure 2A illustrates the interaction.

Further simple slope analyses reveal a similar pattern for the interaction between timepoint and deliberate mind-wandering, as illustrated in Figure 2B. The conditional effect of timepoint on the experience of boredom was significantly different from zero at one standard deviation below the mean of deliberate mind-wandering (*b* = .012, *SE* = .014, 95% CIs [.022, .070], *p* < .001). However, at the mean (*b* = .016, *SE* = .008, 95% CIs [-.001, .032], *p* = .063) and one standard deviation above the mean of deliberate mind-wandering (*b* = -.014, *SE* = .013, 95% CIs [-.040, .011], *p* = .257), there was no significant effect. These results suggest that the duration of the task was associated with higher levels of boredom for individuals low in deliberate mind-wandering, but not for those at the mean or higher levels of deliberate mind-wandering.

With respect to the interaction between timepoint and spontaneous mind-wandering, the analyses revealed that the conditional effect of timepoint on the experience of boredom was significantly different from zero at one standard deviation above the mean of spontaneous mind-wandering (*b* = .049, *SE* = .013, 95% CIs [.023, .075], *p* < .001), but not at the mean (*b* = .016, *SE* = .008, 95% CIs [-.001, .032], *p* = .063), nor one standard deviation below the mean of spontaneous mind-wandering (*b* = -.018, *SE* = .013, 95% CIs [-.044, .008], *p* = .179). These results suggest that the duration of the task was associated with higher levels of boredom for individuals high in spontaneous mind-wandering, but not for those at the mean or lower levels of spontaneous mind-wandering. Figure 2C illustrates the interaction.

Further simple slope analyses revealed a similar pattern for the interaction between timepoint and fantasy, illustrated in Figure 2D. The conditional effect of timepoint on the experience of boredom was significantly different from zero at one standard deviation above the mean of fantasy (*b* = .041, *SE* = .014, 95% CIs [.014, .068], *p* = .003), but not at the mean (*b* = .016, *SE* = .008, 95% CIs [-.001, .032], *p* = .063), nor one standard deviation below the mean of fantasy (*b* = -.010, *SE* = .013, 95% CIs [-.036, .016], *p* = .461). These results suggest that the duration of the task was associated with higher levels of boredom for individuals high in fantasy, but not for those at the mean or lower levels of fantasy.

A) B)

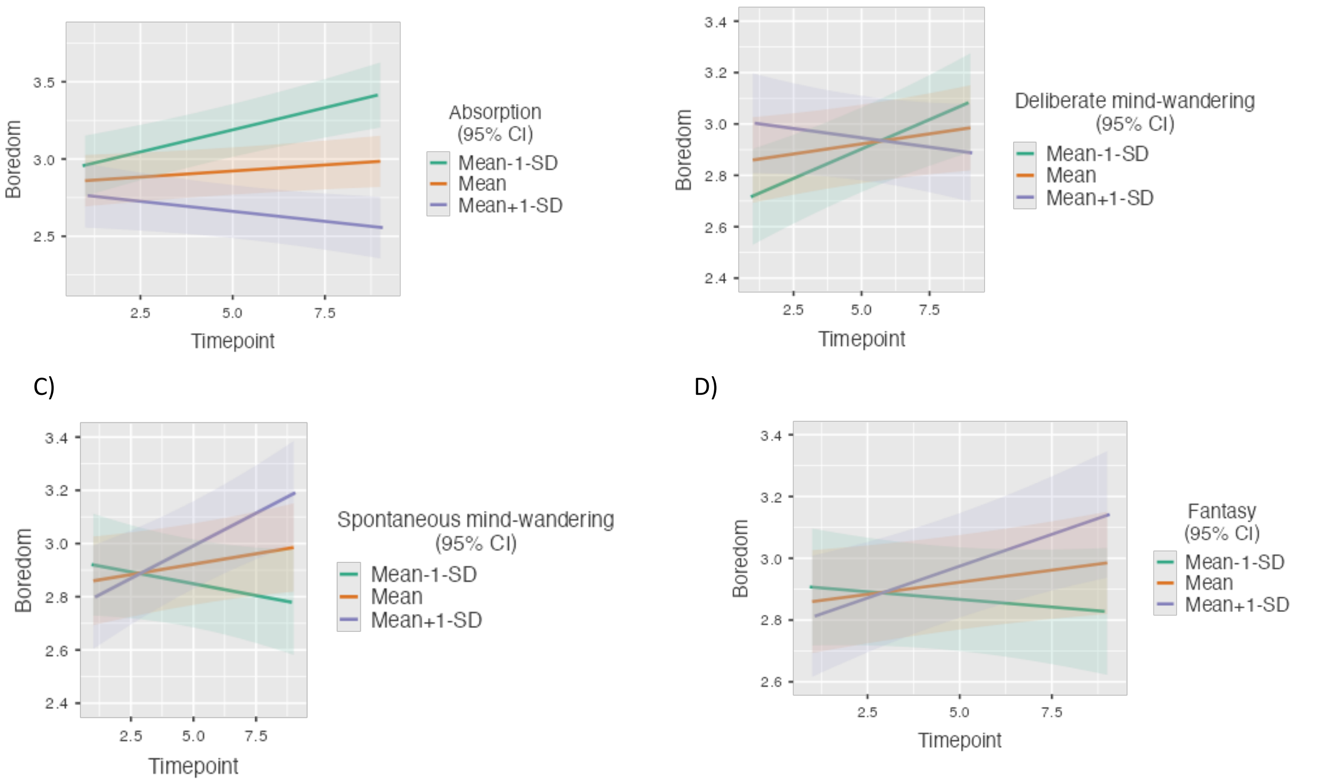

Figure 2. *N* = 66. A visual depiction of the interactions between timepoint and absorption (A), timepoint and deliberate mind-wandering (B), timepoint and spontaneous mind-wandering (C), and timepoint and fantasy (D). 95% confidence intervals of the simple effects are depicted (colored shades around the lines).

Discussion

The current VR study had three aims. Firstly, to investigate the feasibility of manipulating time information to induce boredom; secondly, to examine the correlation between the experience of boredom and the subjective time perception; and finally, to explore the temporal dynamics of boredom in relation to other psychological states. In the following, we discuss the results pertaining to these three aims.

Our manipulation of time information did not yield the expected results. In the context of our study, it appears that boredom cannot be induced by manipulating the speed of passing time by 20%, irrespective of the direction of manipulation (i.e., acceleration or deceleration). This is in contrast to prior studies that found an impact of time information on the experience of boredom. However, it is worth noting that previous studies used tasks with longer durations and *verbally* informed the participants about upcoming tasks duration, thereby creating expectations about task duration (e.g., watching a 25-minutes movie and being informed that it lasts 20 or respectively 30 minutes, as in Mercer-Lynn et al., 2014). In our study, participants entered virtual waiting rooms that contained clocks which ran at different speeds, thereby creating an alteration of *visually* presented time information. This experimental manipulation of the visual passage of time did not alter participants' perception and estimation of time, their choices regarding which room they preferred to visit, and their experience of boredom. This indicates that time perception is robust against ±20% alterations of external time information and that estimations about the passage of time might rely more on internal sensations. Thus, while time perception is strongly linked to boredom, the perception of time is surprisingly independent of external information about time.

We found a very strong relationship between experienced boredom and subjective time perception (r = .83), which is consistent with previous research, showing that time seems to pass more slowly when individuals are bored (Witowska et al., 2020; Igarzábal et al., 2021). The relationship between experienced boredom and estimated time in minutes was moderately positive (r = .34). The difference in magnitude between the two correlations is interesting: It seems that the experience of boredom is closely linked to a qualitative interpretation of passing time (e.g., "I felt the waiting time was very long"), but less so to quantitative assessment of elapsed time in minutes. This finding aligns with the earlier discussed absence of an effect from time information manipulation. It seems that more objective aspects, such as manipulating the actual duration of seconds on a clock or asking participants to estimate time in minutes, are less related to the subjective experience of boredom. One speculative interpretation of this link between boredom and time follows from current definitions of boredom arguing that boredom indicates that one's resources are not adequately utilized (Wolff et al., 2022). Through this lens, it is possible that boredom signals the underutilization of resources within each unit of time, essentially conveying that one has been engaged in unproductive activities for a certain period. The correlation between boredom and time perception would therefore reflect the accumulation of "wasted units of time". In other words, the link between boredom and time is likely dependent on how much of a given timeframe *feels* wasted. Consequently, boredom is not necessarily linked to how long a task actually took[2], but more to the perception about how much time one's resources were not adequately utilized. Clearly, further research is needed to untangle the specifics of how the subjective utility of how time has been spent is associated with boredom.

It has to be highlighted that we found a moderate positive correlation between boredom and estimation of time, whereas previous research found non-significant relationships between these two variables (e.g., r = .18, in Witowska et al., 2020, r = .12 in Igarzábal et al., 2021). A potential explanation for the divergent findings may lie in the experimental design. While Witowska et al. (2020) and Igarzábal et al. (2021) had participants wait in a room for 7.5

[2] Although longer tasks structurally allow for more units of time to feel wasted. Therefore, one would expect to see boredom rise over the course of a prolonged waiting session, which is the case in our study.

minutes, we extended the waiting time to 4 minutes multiplied by 9, totaling 36 minutes. This discrepancy in design could account for the differences in results, which are not contradictory but different in size. Overall, the results suggest that the perception of time passage and boredom are tightly coupled. Building on previous theorizing (Zakay, 2014), we propose that boredom, via the subjective slowing of time, provides crucial information for regulating actions. It serves as a prompt for exploring other activities or investing additional effort to re-engage with the task at hand, thus counteract boredom and restore optimal functioning.

We investigated boredom-related states to uncover the subjective experiences that share the most variance with the experience of boredom. To account for the influence of time, we employed mixed models and integrated interaction terms between timepoints and the various psychological states in the analysis. Firstly, our findings revealed the influence of task duration (timepoints involving the nine waiting rooms) on the experience of boredom. This outcome underscores the significant role that the objective duration of a given activity plays in shaping the experience of boredom. Moreover, this suggests a broader implication that inducing waiting times can trigger boredom, and the longer the wait, the more pronounced the sensation of boredom becomes.

Furthermore, we observed substantial correlations between boredom and states that are typically categorized as affective or cognitive, in line with our expectations. Boredom, as a sensation, has the potential to elicit a range of responses (Wolff et al., 2022). Our analysis revealed robust associations between boredom and feelings of exhaustion, restlessness, amotivation, and frustration, which remained stable across different time points. Boredom also showed correlations with anger (r = .60) and unhappiness (r = .64), although these effects did not maintain significance in the context of the mixed model analyses. These results capture the lasting negative affective undertone that often accompanies boredom. Regarding more cognitive variables, boredom displayed dynamic relationships with variables such as absorption (sometimes considered an antidote to boredom, Csikszentmihalyi, 1990), mind-wandering, and fantasy. The interactions observed with different timepoints suggest dynamic changes in the relationships between these variables and boredom over time. It appears that individuals who exhibit low levels of absorption, lack deliberate engagement in mind-wandering but instead naturally let their minds wander, and demonstrate a propensity for fantasizing, tend to experience an increased sense of boredom over time.

Limitations

Some limitations of this study should be acknowledged, as they can serve as basis for identifying directions for future research. A first limitation is the use of VR. We opted for VR as we believed it to be an optimal methodology to manipulate time information and to test participants in controlled settings. As an example, VR headsets allowed us to test participants at different locations, while keeping the virtual room constant, including specific aspects as luminance, that could potentially influence time estimations. At the beginning of this project, we were unaware of the studies conducted by Witowska et al. (2020) testing participants in a real-world stetting, as well as Igarzábal et al. (2021) who compared real and VR conditions. These studies revealed differences in time estimation and its relationship to the subjective perception of time between real-world and VR conditions. Thus, we would be cautious to generalize the results presented here to a real-world setting. Future research is needed to compare these distinct settings. A second limitation pertains our first hypothesis about the manipulation of time information. Changing time information by 20% did not factor into participants' choices regarding which room they preferred to visit, their perception and estimation of time, as well as their experience of boredom. It is possible that our manipulation was too weak. It should be noted however that we carefully piloted the manipulation, and selected a manipulation that was as strong as possible while remaining undetectable. Although null results should be interpreted with caution, we tentatively suggest that manipulating time in a setting such as ours may prove challenging. A third limitation pertains our last hypothesis. Here we want to remind, that this part of the study was explorative, and the interaction effects were relatively small. Future research is needed to replicate and better understand these interactions.

Conclusions and further directions

To summarize, our study did not find an impact of manipulating time information via a clock on participants' room preference, time perception, time estimation, or boredom experience. But we found a strong relationship between boredom and the perception of time, highlighting the phenomenon of time dragging as a hallmark of boredom. This finding suggests that time perception might not merely be an incidental byproduct of boredom, but rather a pivotal aspect that might trigger exploratory behaviors. This proposition warrants further investigation. Furthermore, we found interactions between time and psychological associations to boredom when no other behavioral response is possible. This result highlights the importance of integrating temporal information into statistical analyses within boredom research, due to the substantial role it seems to play. Notably, the temporal relationship with these responses differed between more affective and more cognitive dimensions. While heightened boredom appeared to be consistently linked to an affective tone in our waiting room scenario, the interaction with cognitive states displayed a more dynamic pattern. This dynamism even revealed instances where boredom might not increase over time, particularly when certain parameters, such as being fully absorbed and deliberately mind-wandering, are present.

Engaging in purposeful mind-wandering could serve as a conscious strategy during waiting periods. As our study delves into these aspects, it sheds light on the intricate interplay between time, cognitive and affective processes, and individual differences in shaping the multifaceted experience of boredom. Further studies are needed to unravel these complexities and expand our understanding of how we navigate moments of monotony.

References

Bieleke, M., Barton, L., & Wolff, W. (2021). Trajectories of boredom in self-control demanding tasks. *Cognition & Emotion*, *35*(5), 1018–1028. https://doi.org/10.1080/02699931.2021.1901656

Blondé, P., Sperduti, M., Makowski, D., & Piolino, P. (2022). Bored, distracted, and forgetful: The impact of mind wandering and boredom on memory encoding. *Quarterly Journal of Experimental Psychology*, *75*(1), 53–69. https://doi.org/10.1177/17470218211026301

Craig, A. D. (Bud). (2009). Emotional moments across time: A possible neural basis for time perception in the anterior insula. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1525), 1933–1942. https://doi.org/10.1098/rstb.2009.0008

Csikszentmihalyi, M. (1975). *Beyond Boredom and Anxiety*. Jossey-Bass.

Dahlen, E. R., Martin, R. C., Ragan, K., & Kuhlman, M. M. (2004). Boredom proneness in anger and aggression: Effects of impulsiveness and sensation seeking. *Personality and Individual Differences*, *37*(8), 1615–1627. https://doi.org/10.1016/j.paid.2004.02.016

Danckert, J. A., & Allman, A.-A. A. (2005). Time flies when you're having fun: Temporal estimation and the experience of boredom. *Brain and Cognition*, *59*(3), 236–245. https://doi.org/10.1016/j.bandc.2005.07.002

Danckert, J., & Elpidorou, A. (2023). In search of boredom: Beyond a functional account. *Trends in Cognitive Sciences*, *27*(5), 494–507. https://doi.org/10.1016/j.tics.2023.02.002

Danckert, J., Hammerschmidt, T., Marty-Dugas, J., & Smilek, D. (2018). Boredom: Under-aroused and restless. *Consciousness and Cognition*, *61*, 24–37. https://doi.org/10.1016/j.concog.2018.03.014

Droit-Volet, S., & Meck, W. H. (2007). How emotions colour our perception of time. *Trends in Cognitive Sciences*, *11*(12), 504–513. https://doi.org/10.1016/j.tics.2007.09.008

Elpidorou, A. (2018). The bored mind is a guiding mind: Toward a regulatory theory of boredom. *Phenomenology and the Cognitive Sciences*, *17*(3), 455–484. https://doi.org/10.1007/s11097-017-9515-1

Fahlman, S. A., Mercer-Lynn, K. B., Flora, D. B., & Eastwood, J. D. (2013). Development and validation of the multidimensional state boredom scale. *Assessment*, *20*, 68–85. https://doi.org/10.1177/1073191111421303

Gibbon, J. (1977). Scalar expectancy theory and Weber's law in animal timing. *Psychological Review*, *84*(3), 279–325. https://doi.org/10.1037/0033-295X.84.3.279

Gorelik, D., & Eastwood, J. D. (2023). Trait boredom as a lack of agency: A theoretical model and a new assessment tool. *Assessment*. https://doi.org/10.1177/10731911231161780

Harris, M. B. (2000). Correlates and characteristics of boredom proneness and boredom. *Journal of Applied Social Psychology*, *30*(3), 576–598. https://doi.org/10.1111/j.1559-1816.2000.tb02497.x

Igarzábal, A. F., Hruby, H., Witowska, J., Khoshnoud, S., & Wittmann, M. (2021). What happens while waiting in virtual reality? A comparison between a virtual and a real waiting situation concerning boredom, self-regulation, and the experience of time. *Technology, Mind, and Behavior*, *2*(2). https://doi.org/10.1037/tmb0000038

Ivry, R. B., & Schlerf, J. E. (2008). Dedicated and intrinsic models of time perception. *Trends in Cognitive Sciences*, *12*(7), 273–280. https://doi.org/10.1016/j.tics.2008.04.002

London, H., & Monello, L. (1974). Cognitive manipulation of boredom. In H. London & R. E. Nisbett (Eds.), *Thought and Feeling: Cognitive Alteration of Feeling States*.

Martarelli, C. S., & Baillifard, A. (2022). *Mind-wandering as an exploratory response to boredom.* https://doi.org/10.31234/osf.io/a9538

Martarelli, C. S., Bertrams, A., & Wolff, W. (2021). A Personality trait-based network of boredom, spontaneous and deliberate mind-wandering. *Assessment*, *28*(8), 1915–1931. https://doi.org/10.1177/1073191120936336

Martarelli, C. S., Wolff, W., & Bieleke, M. (2021). Bored by bothering? A cost-value approach to pandemic boredom. *Humanities and Social Sciences Communications*, *8*(1), 218. https://doi.org/10.1057/s41599-021-00894-8

Mercer-Lynn, K. B., Bar, R. J., & Eastwood, J. D. (2014). Causes of boredom: The person, the situation, or both? *Personality and Individual Differences*, *56*, 122–126. https://doi.org/10.1016/j.paid.2013.08.034

Mullen, G., & Davidenko, N. (2021). Time Compression in Virtual Reality. *Timing & Time Perception*, *9*(4), 377–392. https://doi.org/10.1163/22134468-bja10034

Nakamura, J., & Csikszentmihalyi, M. (2002). The concept of flow. In *Handbook of Positive Psychology* (pp. 89–105).

Pessoa, L. (2008). On the relationship between emotion and cognition. *Nature Reviews Neuroscience*, *9*(2), 148–158. https://doi.org/10.1038/nrn2317

Rheinberg, F., Vollmeyer, R., & Engeser, S. (2003). *Die Erfassung des Flow-Erlebens*. https://doi.org/10.23668/PSYCHARCHIVES.8590

Rheinberg, F., Vollmeyer, R., & Engeser, S. (2016). *Flow Short Scale* [dataset]. https://doi.org/10.1037/t47787-000

Seli, P., Risko, E. F., Smilek, D., & Schacter, D. L. (2016). Mind-wandering with and without intention. *Trends in Cognitive Sciences*, *20*(8), 605–617. https://doi.org/10.1016/j.tics.2016.05.010.

Tam, K. Y. Y., Tilburg, W. A. P. van, Chan, C. S., Igou, E. R., & Lau, H. (2021). Attention drifting in and out: The boredom feedback model. *Personality and Social Psychology Review*, *25*(3), 251–272. https://doi.org/10.1177/10888683211010297

Treisman, M. (2013). The information-processing model of timing (Treisman, 1963): Its sources and further development. *Timing & Time Perception*, *1*(2), 131–158. https://doi.org/10.1163/22134468-00002017

Ulrich, M., Keller, J., & Grön, G. (2016). Neural signatures of experimentally induced flow experiences identified in a typical fMRI block design with

BOLD imaging. *Social Cognitive and Affective Neuroscience*, *11*(3), 496–507. https://doi.org/10.1093/scan/nsv133
van Hooft, E. A. J., & van Hooff, M. L. M. (2018). The state of boredom: Frustrating or depressing? *Motivation and Emotion*, *42*(6), 931–946. https://doi.org/10.1007/s11031-018-9710-6
van Tilburg, W. A. P., & Igou, E. R. (2012). On boredom: Lack of challenge and meaning as distinct boredom experiences. *Motivation and Emotion*, *36*, 181–194. https://doi.org/10.1007/s11031-011-9234-9
van Tilburg, W. A. P., & Igou, E. R. (2017). Boredom begs to differ: Differentiation from other negative emotions. *Emotion*, *17*(2), 309–322. https://doi.org/10.1037/emo0000233
Vodanovich, S. J., Verner, K. M., & Gilbride, T. V. (1991). Boredom proneness: Its relationship to positive and negative affect. *Psychological Reports*, *69*(3 Pt 2), 1139–1146. https://doi.org/10.2466/pr0.1991.69.3f.1139
Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070.
Watt, J. D. (1991). Effect of boredom proneness on time perception. *Psychological Reports*, *69*(1), 323–327. https://doi.org/10.2466/pr0.1991.69.1.323
Weber, S., Weibel, D., & Mast, F. W. (2020). How Self-Motion in Virtual Reality Affects the Subjective Perception of Time. *Timing & Time Perception*, *8*(2), 119–136. https://doi.org/10.1163/22134468-20191152
Weibel, D., Martarelli, C. S., Häberli, D., & Mast, F. W. (2018). The fantasy questionnaire: A measure to assess imaginative and creative fantasy. *Journal of Personality Assessment*, *100*(4), 431–443. https://doi.org/10.1080/00223891.2017.1331913
Westgate, E. C., & Wilson, T. D. (2018). Boring thoughts and bored minds: The MAC model of boredom and cognitive engagement. *Psychological Review*, *125*(5), 689–713. https://doi.org/10.1037/rev0000097
Witowska, J., Schmidt, S., & Wittmann, M. (2020). What happens while waiting? How self-regulation affects boredom and subjective time during a real waiting situation. *Acta Psychologica*, *205*. https://doi.org/10.1016/j.actpsy.2020.103061
Wittmann, M., & Paulus, M. P. (2008). Decision making, impulsivity and time perception. *Trends in Cognitive Sciences*, *12*(1), 7–12. https://doi.org/10.1016/j.tics.2007.10.004
Wolff, W., & Martarelli, C. S. (2020). Bored into depletion? Towards a tentative integration of perceived self-control exertion and boredom as guiding signals for goal-directed behavior. *Perspectives on Psychological Science*, *15*(5), 1272–1283. https://doi.org/10.1177/1745691620921394
Wolff, W., Radtke, V. C., & Martarelli, C. (2022). *Same same but different – What is boredom actually?* https://doi.org/10.31234/osf.io/jze5k
Zakay, D. (2014). Psychological time as information: The case of boredom. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg
Zakay, D., & Block, R. A. (1995). An attentional-gate model of prospective time estimation. In M. Richelle, V. D. Keyser, G. D. Ydeualle, & A. Vandierendonck (Eds.), *Time and the Dynamic Control of Behavior* (pp. 167–178). University of Liege Press.
Zakay, D., & Block, R. A. (1997). Temporal cognition. *Current Directions in Psychological Science*, *6*(1), 12–16. https://doi.org/10.1111/1467-8721

Appendix A

Table A1. N = 66. Descriptive statistics (mean, standard deviation (SD), skewness, and kurtosis) for participants' choices regarding which room they preferred to visit, their time estimation (in minutes), time perception (assessed on Likert scales from 1 to 5), and boredom (assessed on Likert scales from 1 to 5), separated by manipulation of time information (slow, real-time, and fast).

	Choice *slow*	Choice *real-time*	Choice *fast*	Time estimation *slow*	Time estimation *real-time*	Time estimation *fast*	Time perception *slow*	Time perception *real-time*	Time perception *fast*	Boredom *slow*	Boredom *real-time*	Boredom *fast*
Mean	3.045	3.076	2.879	4.397	4.525	4.651	2.611	2.507	2.497	2.911	2.900	2.821
SD	1.169	1.057	1.170	1.523	1.400	1.592	0.840	0.785	0.889	0.933	0.923	0.907
Skewness	1.100	1.377	0.361	1.942	2.484	2.045	0.162	0.151	0.598	-0.208	0.016	0.206
Kurtosis	2.018	3.067	0.129	5.384	9.565	8.219	-0.360	-0.742	0.211	-0.446	-0.757	-0.385

Table A2. N = 66. Descriptive statistics (mean, standard deviation (SD), skewness, and kurtosis) for boredom, exhaustion, restlessness, amotivation, frustration, anger, unhappiness, spontaneous mind-wandering, deliberate mind-wandering, fantasy, and absorption averaged across the 9 waiting situations. All items were answered on 5-point Likert scales.

	Boredom	Exhaustion	Restlessness	Amotivation	Frustration	Anger	Unhappiness	Spontaneous mind-wandering	Deliberate mind-wandering	Fantasy	Absorption
Mean	2.906	2.273	1.949	1.904	1.498	1.406	1.638	3.114	2.916	2.650	2.735
SD	0.882	1.075	0.997	0.987	0.750	0.715	0.770	0.937	1.033	1.063	0.823
Skewness	-0.037	0.613	1.046	0.959	1.675	2.189	1.259	-0.139	0.195	0.298	0.074
Kurtosis	-0.513	-0.598	0.274	-0.284	2.127	4.910	0.612	-0.543	-0.780	-0.965	-0.830