Received: 13 November 2019 | Revised: 26 March 2020 | Accepted: 26 March 2020
DOI: 10.1002/acp.3664

RESEARCH ARTICLE

WILEY

Feeling time in nature: The influence of directed and undirected attention on time awareness

Sonja Ehret[1] | Sibylle Roth[2] | Salome U. Zimmermann[1] | Andy Selter[2] | Roland Thomaschke[1]

[1]Department of Psychology, Albert-Ludwigs-University of Freiburg, Freiburg, Germany

[2]Department of Forest and Environmental Policy, Albert-Ludwigs-University of Freiburg, Freiburg, Germany

Correspondence
Sonja Ehret, Cognition, Action, and Sustainability Unit, Department of Psychology, Albert-Ludwigs-University of Freiburg, Engelbergerstr. 41, 79085 Freiburg, Germany.
Email: sonja.ehret@psychologie.uni-freiburg.de

Funding information
German Research Foundation, Grant/Award Number: 197396619–SFB 1015

Summary

In the present study, we examined the impact of the interaction of environmental and task-induced attentional focus on time perception, specifically awareness of the time flow. We tested 48 participants in either a natural or urban setting over three 25- to 35-min sessions. We manipulated the within-subjects factor task by means of two tasks—one requiring directed attention on the task itself, the other undirected attention on the environment—alongside a control condition with no specific task. We measured time awareness, passage of time judgments, felt time judgments, and estimated time as dependent variables. For time awareness, we found an interaction between environment and task: in the natural environment, only a task requiring directed attention reduced time awareness; whereas, in the urban environment, both tasks reduced time awareness compared to the control condition. The results suggest that natural environments increase time awareness unless we focus our attention on a task.

KEYWORDS
directed attention, nature, restorative environments, time awareness, time perception

1 | INTRODUCTION

In "As You Like It" by William Shakespeare, the forest is described as a place where time is meaningless and artificial time barriers recede (Halio, 1962). The absence as well as the presence of the experience of time—often referred to as time awareness—has long been a prevalent subject of reflection in fictional literature (e.g., Miller, 2003), philosophy (e.g., Husserl, 1905), and cultural anthropology (especially in the context of doing nothing and waiting; e.g., Ehn & Löfgren, 2010). Experimental timing research, in contrast, usually focuses instead on absolute duration judgments or temporal expectancy in order to elucidate the mechanisms of timing. However, the estimation of a time duration does not necessarily relate to how aware one is of the passage of time and how this passage of time subjectively feels (Droit-Volet, Trahanias, & Maniadakis, 2017; Droit-Volet & Wearden, 2016; Wearden, 2015).

Very few studies in timing research have used a self-report measure of time awareness—in the sense of the subjective amount of attention paid to the passage of time—to systematically identify factors influencing time awareness (see, for example, Ehret, Schroeder, Bernet, Holzmüller, & Thomaschke, 2019). In contrast with time awareness, so-called passage of time judgments (PoTJ) concern the subjective impression that time "drags" or "flies," irrespective of the degree of time awareness. Some researchers have speculated that a slow passage of time might go along with or imply high time awareness (Droit-Volet et al., 2017). Yet, a relation between PoTJ and time awareness has, to our knowledge, not been directly tested. Consequently, despite focusing on time awareness we also recorded PoTJ in our study.

In the present paper, we aimed to investigate the focus of attention induced by task and environment as a potential influence on time awareness. A large body of evidence has shown that tasks that require directed attention can impair temporal resolution (for a recent review, see Matthews & Meck, 2016). In prospective timing tasks, high cognitive load due to, for example, directed (selective) attention, as opposed to low cognitive load, has been found to shorten duration judgments (Block, Hancock, & Zakay, 2010). In addition, estimates of time durations have been shown to be lengthened when the focus is only on the passage of time compared with when attention is additionally directed on a second, non-temporal, task (Macar, Grondin, & Casini, 1994). These findings on prospective timing are usually explained by the attentional-gate model (Block & Zakay, 1996). This model assumes an internal clock with a pacemaker that emits pulses. The number of accumulated pulses can be influenced by (bodily) arousal and attentional processes represented by an attentional gate. The more resources one can allocate to timing, the more pulses that pass the attentional gate. The more pulses that are accumulated, the longer the duration is judged to be.

However, this model does not explain how the mode of attention influences subjective time awareness. The relation between timing and attention to tasks has also been discussed in connection with PoTJ. Some have found a relation between concentrating on a task and acceleration in PoTJ (e.g., Conti, 2001; Larson & Von Eye, 2006), while others show no clear results (e.g., Droit-Volet et al., 2017; Droit-Volet & Wearden, 2015), which might be due to the considerable variability in the difficulty of the tasks performed (Droit-Volet et al., 2017).

In addition to tasks that evoke directed and undirected attentional foci, we systematically manipulated the experimental environment as a second factor. Restorative environments have been found to help us recover our directed-attention abilities from the mental fatigue of directing attention in our daily lives, as described by attention restoration theory (ART; Kaplan & Kaplan, 1989). Findings have shown that they do this by facilitating undirected attention (Berman, Jonides, & Kaplan, 2008). Typical restorative environments include natural settings such as forests and parks. Additionally, natural environments in particular are known to reduce negative emotions (Hartig, Mang, & Evans, 1991; McMahan & Estes, 2015). Only a few studies have investigated the direct influence of natural environments on the perception of time. For example, time was found to be estimated as longer and there was a tendency to feel that the passage of time was slower when individuals were exposed to a natural compared with an urban environment (Berry et al., 2015; Davydenko & Peetz, 2017). In terms of time awareness, it was generally found for room atmosphere, that spending time in a negative atmosphere evoked by music or room could increase it compared to a positive atmosphere (Ehret et al., 2019). In the present study, we compared an environment that is traditionally seen as highly restorative (i.e., forest) with an environment typically seen as having low restorative qualities (i.e., city).

The present study expanded upon previous research by using a direct self-report measure of time awareness and investigating the influence of directed and undirected attention induced by task (directed, undirected, control) and environment (urban, natural). We expected both environment and task to influence the experience of time substantially. We hypothesized that a task that enhanced undirected attention on the environment, as opposed to directed attentional focus on a task, would lead to higher time awareness as it would allow participants to focus on the passage of time. According to ART, natural environments in particular should support this undirected focus and therefore increase the effect on time awareness. Conversely, when a task requires directed attention this should decrease time awareness. Furthermore, directed attention should be enhanced by an urban environment and therefore should inhibit time awareness.

So far, it has been suggested by previous literature that time awareness is mainly accompanied by negative affect (Conti, 2001). If high time awareness is confined to unpleasant circumstances, a comparatively more pleasant environment or more enjoyable task should reduce time awareness. To control for this possibility, we included ratings of the affective qualities of the environment, mood, and emotion as dependent variables. We hypothesized that compared with an urban environment, a natural environment would be perceived more positively and have a positive effect on mood and emotion.

In order to be able to relate the results of the present study to the studies described above, we also investigated duration judgments and PoTJ. In line with previous findings, we expected a natural environment and a task requiring undirected attention to lengthen duration judgments and slow down PoTJ, compared with an urban environment and a task requiring directed attentional focus. We also conducted qualitative interviews to obtain a more detailed understanding of participants' conceptualization of their surroundings.

2 | METHOD

2.1 | Participants

Forty-eight participants (M_{age} = 26.36, SD_{age} = 3.5; 73% female, 27% male) were recruited via a participant database of the University of Freiburg and personal approach. All participants were German native speakers, 73% were students (11 psychology students). They all signed an informed consent form and received 24 euros for participation. Twenty-eight of these participants additionally took part in an optional qualitative interview: 16 of them in the natural setting and 12 in the urban setting. Participation in the interview was recompensed with 2 euros.

2.2 | Materials

2.2.1 | Manipulation of attentional focus through task

In order to create three different modes of attentional focus—directed, undirected, and control—participants had to perform three different tasks. For directed attention, the idea was to draw

FIGURE 1 Picture of the piece of forest used as the natural setting (left) and the urban public square as the urban setting (right)

attentional focus explicitly away from the environment and towards an exercise that required concentration but was easy enough to remain focused on. To this end, we used a join-the-dots task with over 500 numbers to be connected in order to create a picture. In the event that this task was completed too quickly within the time, we provided a second, similar join-the-dots task.

For the task requiring undirected attention, the aim was to widen attentional focus on the environment as a whole and thereby increase awareness of it. We used a method called soundscape, which originates in experiential and adventure education, and specifically adjusted it for adults (Metz, 2010; also referred to as a "sound map," e.g., Cornell, 2015). Participants were instructed to create a soundscape by drawing a map of sounds and/or their sources that could be discerned in the environment around them. They were given a blank sheet of paper and a pencil, and began by marking their own position on it with an "X." All the sounds they detected were to be depicted according to their distance and intensity. The exact spatial layout was left to the participants.

In the control condition, participants received the instruction to do nothing specific and just let the environment affect them. This instruction was intended to induce a focus that was neither particularly directed nor particularly undirected.

The two tasks were chosen to be as similar as possible, barring the attentional focus element. Both were moderately demanding, visual, and figurative paper-and-pencil tasks. Nevertheless, we expected the task of creating a soundscape to be novel for the participants, and the join-the-dots task to be slightly more tiring given that it required constant focus over a long period of time. In all three conditions participants remained seated in one spot, in order to control for the influence of physical arousal.

2.2.2 | Manipulation of attentional focus through environment

For the natural restorative environment, we selected our natural experimental site in a forest adjacent to a residential area. An urban public square in the city center was selected as the complementary urban space (Figure 1).

The forest could be assumed not to be very crowded—with only a ropes course situated inside it and a forest kindergarten around it—while the urban public square was usually very crowded all day, having several tram lines passing through it. In each setting, participants could use a seat cushion to sit on and no timing devices were visible to them.

2.2.3 | Time variables

Measurement of the perception of time was operationalized in four ways: *time awareness*, *PoTJ*, *felt time judgments*, and *estimated time*. To measure time awareness, we asked participants to indicate on a visual analog scale (VAS) how much attention they paid to the flow of time (from 0 = no attention at all to 100 = maximum amount of attention). We also measured how the passage of time was experienced in two different ways, in accordance with Wearden (2015): first, using PoTJ, where participants indicated on a VAS how fast or slow time passed (from 0 = maximum slow to 100 = maximum fast); and second, using felt time ("feel judgments"; Wearden, 2015, p.167), where participants assessed how long the testing period of time subjectively felt (in minutes) compared with their objective duration estimate of how much time had actually passed. Finally, we measured this estimated time by asking participants to estimate the duration of the task between a start and an end signal given by a whistle. We considered this measure to be prospective because our participants had explicit knowledge of this timing task. However, due to the length of the time interval, the prospective nature of the task could be questioned (Thönes & Wittmann, 2016).

2.2.4 | Other scales

In addition to the time variables, we measured other variables in order to control for several potential sources of changes in time perception. Analysis of these measures was explorative. By assessing the perceived atmosphere, we intended to test whether the tasks performed in the different environments also changed how the environments' atmosphere was perceived. To do this, we modified a questionnaire on the affective quality of environments (Russell & Pratt, 1980) by forward–backward translating only the endpoints of the four bipolar scales into German and using them as endpoints on VAS: *unpleasant* (0) to *pleasant* (100), *sleepy* (0) to *arousing* (100), *gloomy* (0) to *exciting* (100), and *relaxing* (0) to *distressing* (100).

Emotion was rated on the bipolar dimensions *valence* (unhappy/happy), *arousal* (calm/excited), and *dominance* (controlled/in control) using the 9-point Self-Assessment Manikin Scale (Bradley & Lang, 1994). We also measured mood according to the German Multidimensional Mood State Questionnaire (Steyer, Schwenkmezger, Notz, & Eid, 1997) using the dimensions of *good/bad*, *awake/tired*, and *calm/restless* on a 5-point scale from "not at all" to "very."

Participants answered additional questions on how they perceived their task (e.g., pleasant, challenging, interesting), how they liked their particular surroundings during the experiment as well as how they liked the type of surroundings—forest or urban public squares—in general, and how prototypical they would judge their particular surroundings to be, using a 6-point scale as a manipulation check. We also recorded the temperature and weather (e.g., sunny, cloudy) as potential influences.

In order to gain a more differentiated picture of participants' qualitative perceptions and conceptualizations of the chosen surroundings, after completing the experimental procedure they had the option of taking part in a qualitative interview on the categories of environment and social frame. Concerning the environment, we asked participants about particular elements in their surroundings that had caught their attention. We also asked them what they thought a perfect forest/urban square would look like and how they would design their own forest/urban square. With regards to framing, we asked participants what role forests/urban squares played now and during their childhood, why they visit forests/urban squares, and what rules typically apply to forest/urban square visits for them. For a list of all interview questions, please see Appendix A.

2.3 | Procedure

All testing took place in August, during the daytime, and in group settings of a maximum of four people. If it was raining, the testing was canceled. Half of the participants were randomly assigned to the forest setting, the other half to the urban public space. All participants were tested in three 1-hr sessions over three different days, with one of the three attentional focus tasks randomly assigned to each day. The experiment was announced to the participants as a study on environmental perception. Each session started with their informed consent and a pre-test on emotion and mood. Then, participants were asked to hand over any timing devices (e.g., watch, smartphone) and given a general instruction together with specific task instructions (join-the-dots, soundscape, no task) according to the condition to which they had been allocated. The general instruction was to look for a place to make themselves comfortable and which, if possible, meant that they could not see any of the other participants. As soon as they heard the start signal, given by a whistle, they were supposed to start their task. The time until the end signal given by the whistle varied between 25 and 35 min, according to the throw of a dice.

After the session, participants completed the questionnaires on time perception, atmosphere, emotion, mood, and general questions about the task. The general questions about the setting were only given after the last session. The qualitative interviews were conducted on location straight after the questionnaires, at the end of the session.

2.4 | Design

A 3 x 2 mixed-model design was used to manipulate attentional focus with the within-subjects factor *Task* (directed/undirected/control, represented, respectively, by the task conditions of join-the-dots, soundscape, and no explicit task), and with the between-subjects factor *Environment* (natural/urban). Time awareness, PoTJ, felt time judgments, and estimated time were measured as dependent time variables. Additionally, we assessed the variables of atmosphere, emotion, mood, temperature, weather, and general ratings of tasks and settings for explorative reasons.

3 | RESULTS

3.1 | Manipulation check

In order to ensure that the chosen tasks were perceived by the participants as intended, we conducted a manipulation check. We calculated one-factorial repeated measures ANOVAs comparing the metacognitive ratings of the three task conditions that were supposed to evoke different modes of attentional focus. The ratings of participants did not significantly differ in terms of their enjoyment and interest for any of the three task conditions. They did differ for challenge, $F(2, 94) = 25.44$, $p < .001$, $\eta_p^2 = .351$; distraction, $F(2, 94) = 155.94$, $p < .001$, $\eta_p^2 = .768$; effort, $F(2, 94) = 10.37$, $p < .001$, $\eta_p^2 = .181$; novelty, $F(2, 94) = 25.66$, $p < .001$, $\eta_p^2 = .353$; and relaxation, $F(2, 94) = 5.37$, $p = .006$, $\eta_p^2 = .102$. Bonferroni-corrected post-hoc tests showed that the two actual tasks—join-the-dots ($M_{Diff} = 1.44$), $p < .001$, 95% CI [0.83, 2.04] and soundscape ($M_{Diff} = 1.06$), $p < .001$, 95% CI [0.62, 1.51]—were perceived as more challenging than having no task. The join-the-dots task was perceived to be more distracting from the environment than either the soundscape task ($M_{Diff} = 3.15$), $p < .001$, 95% CI [2.61, 3.68] or no task ($M_{Diff} = 3.23$), $p < .001$, 95% CI [2.70, 3.76], and also more tiring than the soundscape task ($M_{Diff} = 0.71$), $p = .015$, 95% CI [0.11, 1.30] and no task ($M_{Diff} = 1.02$), $p < .001$, 95% CI [0.45, 1.59]. The soundscape task was more likely than the join-the-dots task ($M_{Diff} = 1.90$), $p < .001$, 95% CI [1.09, 2.71] and no task ($M_{Diff} = 1.83$), $p < .001$, 95% CI [1.11, 2.56] to be new to participants. Having no task was perceived as more relaxing than the join-the-dots task (M_{Diff} = 0.79), p = .010, 95% CI [0.16, 1.43]. In sum, the metacognitive evaluation of the tasks was as expected.

Ratings of participants' liking of the environment showed that they generally preferred natural environments (M = 5.54, SD = 0.72) to urban ones (M = 4.21, SD = 1.18), $t(46)$ = 4.73, p < .001, d = 1.37. However, there was no difference in liking between the two specific locations used in the experiment.

3.2 | Time variables

For all time variables, we calculated a 3 × 2 repeated measures ANOVA with the within-subjects factor task (directed/undirected/control) and the between-subjects factor environment (natural/urban).

Time awareness values were calculated by dividing the length of the VAS from zero to the marking of the participant, by the total length of the VAS (14 cm), then multiplying by 100. There was a main effect for task, $F(2, 92)$ = 5.48, p = .006, η_p^2 = .106. Bonferroni-corrected post-hoc tests showed that participants reported being significantly less aware of the passage of time with task-induced directed attention than in the control condition, p = .005, 95% CI [3.85, 26.59]. The main effect of the environment did not reach significance. We did, however, find a significant interaction between task and environment, $F(2, 92)$ = 4.02, p = .021, η_p^2 = .080 (Figure 2). Further analysis showed that the only significant difference between the natural and urban environments was for the task requiring undirected attention, $t(46)$ = 2.30, p = .026, d = 0.66, with perceived higher time awareness in the natural than in the urban environment. A one-way ANOVA with the within-factor task, separately calculated for the urban environment, revealed a main effect for task, $F(2, 46)$ = 3.89, p = .027, η_p^2 = .145. Bonferroni-corrected post-hoc tests showed that in the urban environment, participants reported being more aware of time in the control condition than in the task requiring undirected attention, p = .037, 95% CI [0.89, 34.11]. In a similar one-way ANOVA conducted separately for the natural environment, there was also a main effect for task, $F(2, 46)$ = 5.58, p = .007, η_p^2 = .195. Here, Bonferroni-corrected post-hoc tests suggested that in the natural environment, participants performing the directed attention task reported being less aware of time than did those performing the undirected attention task, p = .008, 95% CI [5.52, 33.94], and also less aware of time compared with those in the control condition, p = .038, 95% CI [0.84, 35.47].

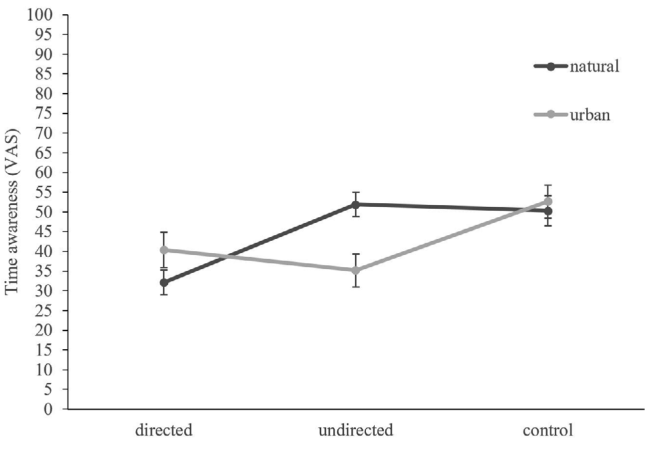

FIGURE 2 Interaction of task and environment. The figure shows mean ratings of *time awareness* (0 = no attention to time at all, 100 = maximum amount of attention to time). Error bars represent 1 standard error of the mean

For the PoTJ values, we calculated scores in the same way as that for time awareness. We again found a main effect for task, $F(2, 92)$ = 26.23, p < .001, η_p^2 = .363 (Figure 3). Bonferroni-corrected post-hoc tests showed that time was perceived to pass significantly faster in the condition with the directed attention task compared with both the undirected attention task, p < .001, 95% CI [13.49, 36.54] and the control condition, p < .001, 95% CI [17.38, 37.89]. There was also a main effect for environment, $F(1, 45)$ = 11.60, p = .001, η_p^2 = .201, with time being perceived to pass faster in an urban environment than in a natural environment. The interaction between the two factors was not significant.

For felt time judgments, we calculated participants' perceptions of passage of time in relation to their estimations of physical (clock) time, using the ratio of $\frac{\text{felt time} - \text{estimated time}}{\text{estimated time}}$. There was a significant main effect for task, $F(2, 92)$ = 4.65, p = .012, η_p^2 = .092 (Figure 4). Bonferroni-corrected post-hoc tests showed that the task requiring directed attentional focus made time feel significantly shorter than did the task requiring undirected attentional focus, p = .016, 95% CI [0.04, 0.51]. The main effect of environment was also significant, $F(1,46)$ = 7.29, p = .010, η_p^2 = .137. Time in the natural environment felt significantly longer than it did in the urban environment. The interaction of the two factors did not reach significance.

For the estimated time, we calculated the accuracy of estimation (relative error) for each participant using the ratio of $\frac{\text{estimated time} - \text{physical time}}{\text{physical time}}$. We found a significant main effect for task, $F(2, 92)$ = 5.95, p = .004, η_p^2 = .115 (Figure 5). Bonferroni-corrected post-hoc tests suggested that time duration was estimated to be significantly shorter in the undirected attention task than in the control condition, p = .001, 95% CI [0.07, 0.31]. We found neither a main effect for environment nor an interaction between the two factors.

3.3 | Atmosphere, emotion, and mood scales

For all atmosphere, emotion, and mood scales, we conducted exactly analogous ANOVAs (see Table 1) to test whether the crucial interaction between task and environment in time awareness could be explained by atmospheric or mood factors. For mood and emotion, we calculated differential values of the pre and post ratings. Because of missing values for one participant on the atmosphere scale gloomy–exciting, we excluded this participant from the respective analysis.

We found two significant interactions: one for the atmosphere scale gloomy–exciting and one for the mood scale calm–restless.

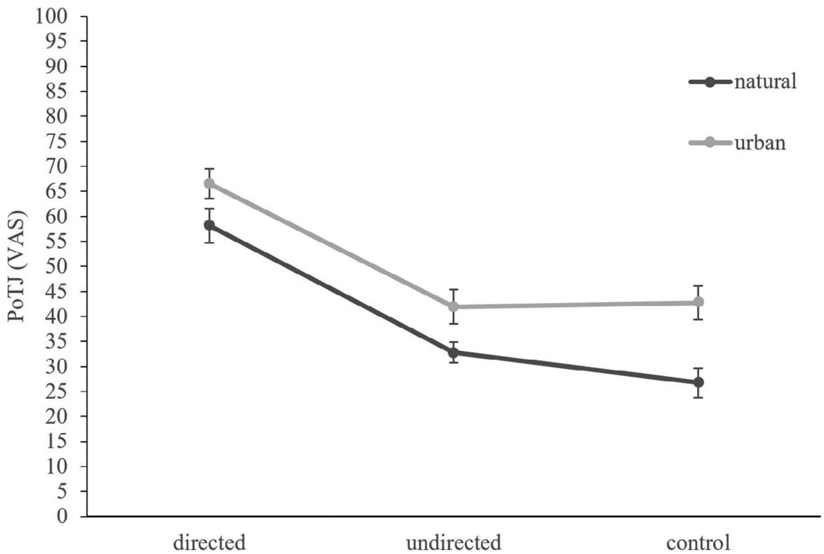

FIGURE 3 Interaction of task and environment. The figure shows mean ratings of *PoTJ* (0 = maximum slow, 100 = maximum fast). Error bars represent 1 standard error of the mean

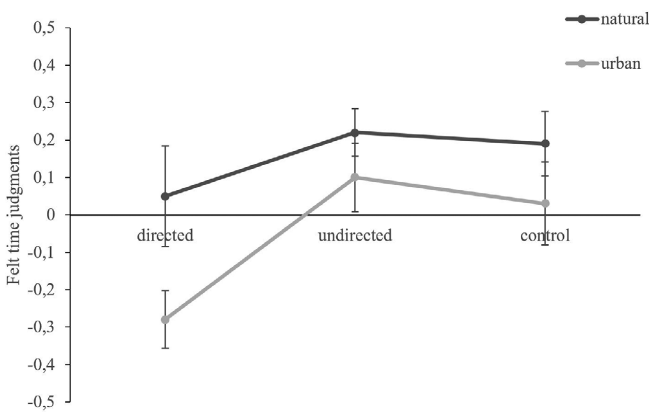

FIGURE 4 Interaction of task and environment. The figure shows felt time judgments calculated using the ratio of *(felt time–estimated time)/estimated time*. Values above zero indicate a perceived lengthening of time, below zero a perceived shortening of time. Error bars represent 1 standard error of the mean

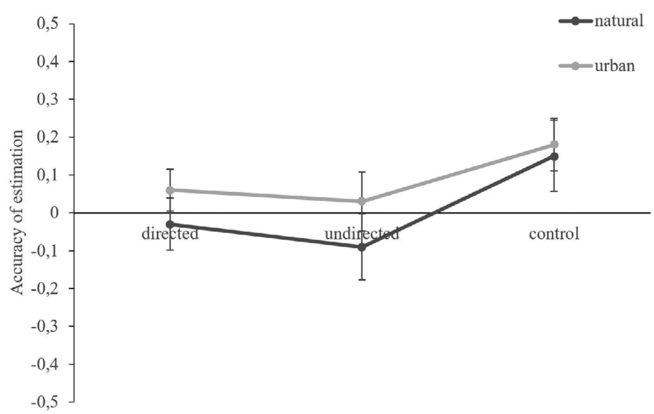

FIGURE 5 Interaction of task and environment. The figure shows the relative accuracy of estimations calculated by the ratio of *(estimated time–physical time)/physical time in minutes*. Values above zero indicate an overestimation, below zero an underestimation. Error bars represent 1 standard error of the mean

However, post-hoc tests revealed that neither interactions followed the same pattern as that for time awareness.

For gloomy–exciting, post-hoc t-tests revealed that a difference of the natural environment being less exciting than the urban environment only appeared for the directed attention task, M_{Diff} = 11.88, $t(46)$ = 2.81, p = .007, d = 0.81 and the undirected attention task, M_{Diff} = 12.37, $t(46)$ = 2.23, p = .031, d = 0.65, not for the control condition. Two one-way ANOVAs with the within-factor task calculated separately for urban and natural environments showed no main effect for task in either environment.

Comparing the natural and urban environments on the calm–restless scale with the different tasks, we found that only in the control condition were participants affected by the environment. They became more restless in the urban environment than in the natural environment, M_{Diff} = 0.50, $t(46)$ = –2.42, p = .019, d = 0.70. One-way ANOVAs with the within-subjects factor task conducted separately for the two environment conditions showed a significant main effect of task only for the natural environment, $F(2, 46)$ = 5.27, p = .009, η_p^2 = .187. Bonferroni-corrected post-hoc tests showed that in the natural environment, there was a higher increase in restlessness in the control condition than in the directed attention task, M_{Diff} = 0.51, p = .010, 95% CI [0.11, 0.91].

3.4 | Results from the qualitative interviews

The interview data comprised 28 transcribed interviews: 16 conducted in the forest setting, 12 in the urban setting. The data were subjected to qualitative content analysis in accordance with Mayring (2000, 2014). We identified relevant text segments, paraphrased them, and inductively developed a code system with the main categories of *relevance of the environment*, *atmosphere*, and *time* (see Appendix B for detailed descriptions of the time-related codes employed).

TABLE 1 Two-factorial within-subjects ANOVAs for atmosphere, emotion, and mood

Variable	*df*	MS	*F*	*p*	η_p^2	*df*	MS	*F*	*p*	η_p^2	*df*	MS	*F*	*p*	η_p^2	*df*	MS	*F*	*p*	η_p^2
Atmosphere	Pleasant–unpleasant					Sleepy–arousing					Relaxing–distressing					Gloomy–exciting				
Task (T)	2	199.10	0.68	.511	.014	2	946.35	4.31	.016*	.086	2	695.86	3.35	.039*	.068	2	158.77	0.89	.414	.019
Environment (E)	1	10,011.91	11.38	.002**	.198	1	7,124.64	11.84	.001***	.205	1	12,723.30	16.70	<.001***	.266	1	2,541.42	5.86	.020*	.115
T x E	2	591.60	2.00	.140	.042	2	84.00	0.38	.683	.008	2	171.67	0.83	.441	.018	2	640.52	3.60	.031*	.074
Error (T/E)	92/46	294.82/879.85				92/46	219.62/601.56				92/46	207.81/761.91				90/45	178.19/434.00			
Emotion	Valence					Arousal					Dominance									
Task (T)	2	4.30	2.51	.087	.052	2	1.17	0.60	.550	.013	2	0.34	0.15	.857	.003					
Environment (E)	1	6.25	3.83	.056	.077	1	1.00	0.32	.574	.007	1	0.34	0.13	.930	.003					
T x E	2	0.02	0.01	.988	<.001	2	5.02	2.57	.082	.053	2	0.44	0.17	.684	.004					
Error (T/E)	92/46	1.71/1.63				92/46	1.95/3.12				92/45	2.21/2.70								
Mood	Good/bad					Awake/tired					Calm/restless									
Task (T)	2	0.47	0.54	.221	.032	2	1.89	2.96	.057	.060	2	0.48	1.57	.213	.033					
Environment (E)	1	0.83	2.50	.121	.051	1	0.27	0.31	.578	.007	1	1.13	1.83	.182	.038					
T x E	2	0.30	0.97	.381	.021	2	0.43	0.67	.513	.014	2	1.21	4.00	.022*	.080					
Error (T/E)	92/46	0.31/0.33				92/46	0.66/0.86				92/46	0.30/0.62								

Note: *$p \le .05$, *$p \le .01$, ***$p \le .001$.

In the following summary, the focus is on the main category of time: *time constraints* and its related codes *time-related resources* and *personal experience of qualitative time* are concerning particularly the connection between experience of time and a specific environment. As participants' experience of time was not explicitly asked about in the interview, any such statements were derived from unprompted references to time made by them. Participants did not reflect differences in their experience due to the different experimental tasks. All the statements were translated from German to English.

The interviews revealed that time constraints were understood differently in the city and in the forest. Participants in the urban environment tended to report rather transient cycle times like the weather, “appealing opening times” (5-u-di), “different working hours” (5-u-di), “something like quietness erm after a certain time of day” (8-u-ud), and even the “monotonous noise [of the tram] that you can hear every 2-3 minutes” (3-u-ud) that structured their experience. In the natural setting, participants focused more on the rhythm of seasons such as the “the cool just now in summer” (33-f-ud), “a season when leaves are on the trees” (32-f-di) or in winter when you need “a certain awareness” (25-f-di) for animals in hibernation. One person also reflected that “these trees have always been standing there or very long and somehow endure a lot” (36-f-ud).

Statements about time-related resources mainly focused on the perceived availability or scarcity of time. Participants reported that spending time in an urban environment is “always somehow very tiring” (7-u-ud), “hectic” (3-u-ud) and waiting times are non-productive as “you have to waste time to wait for someone” (10-u-co). In contrast, in the natural setting, time slots are particularly scheduled for visiting the forest: “I take the time to do that [go into the forest] more times less” (10-f-ud). Here, it is perceived as pleasant to “just be in nature for a few minutes and be detached a little from everything and be for yourself” (27-f-di).

Along with the forest being perceived as a resource to detach from daily life, participants described personal experiences of a qualitatively valuable time in the forest. The forest was, for example, seen as a place where its visitors can think and gather their thoughts, and which enables peace of mind: “time for me, time to ponder, time to come down, […] mainly a place of tranquility and where I somehow for me erm can untangle stuff” (10-f-ud), a place “where I can be at peace. Where you are able to shed the burdens of the world” (11-f-di) and where you can “enjoy the fresh air” (28-f-ud).

4 | DISCUSSION

In the current study, we aimed to investigate how attentional focus induced by task and environment influences the experience of time, particularly awareness of time. To this end, we tested 48 participants in either a natural or urban setting (between-subjects factor environment). We manipulated the within-subjects factor task using two tasks: one requiring directed attention on the task; the other requiring undirected attention on the environment. We also included a control condition with no specific task. Time awareness, PoTJ, felt time judgments, and estimated time were measured as dependent variables.

With regard to the effect of attentional focus on time awareness, we found an interaction between task and environment. The environment moderated the effect of task. In the urban environment, focusing attention on a task and focusing attention on the environment had similar inhibiting effects on time awareness; whereas, in a natural environment, task-induced undirected attention on the environment increased time awareness compared with focusing on a task that required directed attention.

This finding is in accordance with our expectations. Resources of directed attention required by urban environments apparently also affect time awareness. In contrast, natural environments have the potential to increase time awareness, if one is not distracted by a task requiring directed attention. Especially remarkable is the fact that this high time awareness was observed under circumstances that did not induce a negative mood as the forest was perceived to be more pleasant than the urban setting and all tasks were equally enjoyable. Thus, the alternative hypothesis—that high time awareness is confined to unpleasant circumstances—could not be supported. Previous studies mainly focused on the connection of negative valence and high time awareness (Conti, 2001; Ehret et al., 2019). Therefore, the determination of conditions that evoke an experience of pleasant time awareness could be the subject of further research. Regarding ART, restorative environments might give the opportunity to focus on the passage of time due to the low demand of directed attention. To determine the effect of restoration, an important question for future research is whether restorative but man-built environments, like museums (Kaplan, Bardwell, & Slakter, 1993; Packer & Bond, 2010), can also increase time awareness. Additionally, Davydenko and Peetz (2017) found that natural environments can induce a higher general awareness of the environment. Thus, another explanation for the results of the present study might be that an increased awareness of the environment also increases time awareness. Future studies should examine this issue further. As we only investigated the impact of directed and undirected attentional focus, further research might also usefully focus on how other attentional processes and natural environments interact in the perception of time.

5 | CONCLUSION

A focus on natural environments can evoke high time awareness if one is not focused on a task that requires directed attention. We conclude that high time awareness is not confined to negative affective states or circumstances. It is not clear yet whether the experience of high time awareness and slow passage of time is limited to natural environments or results from the quality of restorative environments in general.

ACKNOWLEDGMENTS

This work was supported by the German Research Foundation (grant number 197396619–SFB 1015).

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

ORCID

Sonja Ehret https://orcid.org/0000-0002-6698-9945

ENDNOTE

[1]Abbreviations for participant and condition: Participant ID-Environment (f = forest, u = urban)-Task (di = directed, ud = undirected, co = control).

DATA AVAILABILITY STATEMENT

Raw data are available in OSF at https://osf.io/67y5w/.

ORCID

Sonja Ehret https://orcid.org/0000-0002-6698-9945

REFERENCES

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science*, *19*(12), 1207–1212. https://doi.org/10.1111/j.1467-9280.2008.02225.x

Berry, M. S., Repke, M. A., Nickerson, N. P., Conway, L. G., III, Odum, A. L., & Jordan, K. E. (2015). Making time for nature: Visual exposure to natural environments lengthens subjective time perception and reduces impulsivity. *PLoS One*, *10*(11), e0141030. https://doi.org/10.1371/journal.pone.0141030

Block, R. A., Hancock, P. A., & Zakay, D. (2010). How cognitive load affects duration judgments: A meta-analytic review. *Acta Psychologica*, *134*, 330–343. https://doi.org/10.1016/j.actpsy.2010.03.006

Block, R. A., & Zakay, D. (1996). Models of psychological time revisited. In H. Helfrich (Ed.), *Time and mind* (pp. 171–195). Kirkland, WA: Hogrefe & Huber.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, *25*, 49–59. https://doi.org/10.1016/0005-7916(94)90063-9

Conti, R. (2001). Time flies: Investigating the connection between intrinsic motivation and the experience of time. *Journal of Personality*, *69*, 1–26. https://doi.org/10.1111/1467-6494.00134

Cornell, J. B. (2015). *Sharing nature: Nature awareness activities for all ages*. Nevada City, CA: Crystal Clarity Publishers.

Davydenko, M., & Peetz, J. (2017). Time grows on trees: The effect of nature settings on time perception. *Journal of Environmental Psychology*, *54*, 20–26. https://doi.org/10.1016/j.jenvp.2017.09.003

Droit-Volet, S., Trahanias, P., & Maniadakis, M. (2017). Passage of time judgments in everyday life are not related to duration judgments except for long durations of several minutes. *Acta Psychologica*, *173*, 116–121. https://doi.org/10.1016/j.actpsy.2016.12.010

Droit-Volet, S., & Wearden, J. (2016). Passage of time judgments are not duration judgments: Evidence from a study using experience sampling methodology. *Frontiers in Psychology*, *7*, 176. https://doi.org/10.3389/fpsyg.2016.00176

Droit-Volet, S., & Wearden, J. H. (2015). Experience sampling methodology reveals similarities in the experience of passage of time in young and elderly adults. *Acta Psychologica*, *156*, 77–82.

Ehn, B., & Löfgren, O. (2010). *The secret world of doing nothing*. Los Angeles, CA: University of California Press.

Ehret, S., Schroeder, C., Bernet, J., Holzmüller, A., & Thomaschke, R. (2019). All or nothing: The interaction of musical and spatial atmosphere. *Psychology of Music*, 030573561988028. https://doi.org/10.1177/0305735619880288

Halio, J. L. (1962). "No clock in the forest": Time in as you like it. *Studies in English Literature, 1500–1900*, *2*(2), 197–207. https://doi.org/10.2307/449499

Hartig, T., Mang, M., & Evans, G. W. (1991). Restorative effects of natural environment experiences. *Environment and Behavior*, *23*(1), 3–26. https://doi.org/10.1177/0013916591231001

Husserl, E. (1905). Erster Teil. Die Vorlesungen über das innere Zeitbewußtsein aus dem Jahre 1905. In M. Heidegger (Ed.), *Edmund Husserls Vorlesungen zur Phänomenologie des inneren Zeitbewußtseins [Edmund Husserl's lectures on the phenomenology of the inner time consciousness]* (pp. 369–449). Germany: Max Niemeyer Verlag. Halle a.d.S.

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge, England: Cambridge University Press.

Kaplan, S., Bardwell, L. V., & Slakter, D. B. (1993). The museum as a restorative environment. *Environment and Behavior*, *35*(6), 725–742. https://doi.org/10.1177/0013916593256004

Larson, E., & von Eye, A. (2006). Predicting the perceived flow of time from qualities of activity and depth of engagement. *Ecological Psychology*, *18*, 113–130.

Macar, F., Grondin, S., & Casini, L. (1994). Controlled attention sharing influences time estimation. *Memory & Cognition*, *22*(6), 673–686.

Matthews, W. J., & Meck, W. H. (2016). Temporal cognition: Connecting subjective time to perception, attention, and memory. *Psychological Bulletin*, *142*(8), 865–907. https://doi.org/10.1037/bul0000045

Mayring, P. (2000). Qualitative content analysis. *Forum: Qualitative Social Research*, *1*(2), 1–10.

Mayring, P. (2014). Qualitative content analysis: Theoretical foundation, basic procedures and software solution [monograph]. Klagenfurt. Retrieved from https://nbn-resolving.org/urn:nbn:de:0168-ssoar-395173

McMahan, E. A., & Estes, D. (2015). The effect of contact with natural environments on positive and negative affect: A meta-analysis. *The Journal of Positive Psychology*, *10*(6), 507–519. https://doi.org/10.1080/17439760.2014.994224

Metz, A. (2010). *Outdoor-kids: Praxishandbuch für Kindergruppen [outdoor-kids: Practical manual for children's groups]*. Kassel, Germany: Deutsche Wanderjugend.

Miller, J. (2003). Time in literature. *Daedalus*, *132*(2), 86–97.

Packer, J., & Bond, N. (2010). Museums as restorative environments. *Curator: The Museum Journal*, *53*(4), 421–456. https://doi.org/10.1111/j.2151-6952.2010.00044.x

Russell, J. A., & Pratt, G. (1980). A description of the affective quality attributed to environments. *Journal of Personality and Social Psychology*, *38*(2), 311–322.

Steyer, R., Schwenkmezger, P., Notz, P., & Eid, M. (1997). *Der Mehrdimensionale Befindlichkeitsfragebogen (MDBF) [the multidimensional affect rating scale (MDBF)]*. Göttingen, Germany: Hogrefe.

Thönes, S., & Wittmann, M. (2016). Time perception in yogic mindfulness meditation - effects on retrospective duration judgments and time passage. *Psychology of Consciousness: Theory, Research, and Practice*, *3*(4), 316–325. https://doi.org/10.1037/cns0000088

Wearden, J. H. (2015). Passage of time judgements. *Consciousness and Cognition*, *38*, 165–171. https://doi.org/10.1016/j.concog.2015.06.005

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Ehret S, Roth S, Zimmermann SU, Selter A, Thomaschke R. Feeling time in nature: The influence of directed and undirected attention on time awareness. *Appl Cognit Psychol*. 2020;34:737–746. https://doi.org/10.1002/acp.3664