Subjectively Experienced Time in Human-Computer Interaction: The Role of Passage of Time in User Experience

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Abstract. A study by Sackett et al. (2010) indicates that participants attribute more fun to an activity when they have the impression that time flies by. We investigate if this effect also occurs in human-computer interaction and impacts on User Experience (UX). We induced differences in the subjective passage of time by dividing the participants (n = 61) into three groups. Although all participants performed the same tasks for 10 min, the groups received different information about the duration of their activities (10, 20, or 5 min). This manipulation should invoke the impression that time passed normally, fast or slowly. Results showed that only a feeling of time passing by slowly could be induced. This temporal illusion led to a lower perceived usability and a lower overall UX while attractiveness and valence were not affected. We conclude that the investigation of subjectively experienced time improves the understanding of UX.

Keywords: User experience · Passage of time · CUE model · Time perception

1 Introduction

It is a common belief that 'time flies when you're having fun'. A study by Sackett and colleagues [1] indicates that participants also interpret this relation between fun and passage of time in the opposite direction. The authors showed an increase in hedonic ratings when time allegedly flew by for the enjoyment of a mundane task (underlining words), for the pleasantness of irritating noises, and for the liking of a good song. In the present paper, we investigate whether this effect also occurs during human-computer interaction. Is the interaction with a computer perceived as more enjoyable, easier or more attractive, when the user has the impression that time flies by? We adopt one of the paradigms used by [1, 2] to induce different experiences of time passing by during working at a task on a webpage and measure the user experience.

1.1 Time Flies When You're Having Fun, but Do You Have Fun When Time Flies?

In a series of seven experiments, Sackett and colleagues [1] showed that participants attributed more fun to an activity when they had the impression that time flew by

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during this activity. The authors induced this impression by providing false expectations and feedback about the duration of the activity. In one of their paradigms, they held the actual duration constant (10 min) while manipulating the alleged duration (5 min vs. 20 min). As their manipulation check showed, this led to differences in participants' passage of time judgments on a 7-point scale from 'time dragged' (1) to 'time flew' (7). While the 5 min-group on average rated time to have dragged, the 20 min-group indicated that time flew by. The authors [1] explained these findings as follows: In the 5 min-group, participants were told that 5 min had passed but experienced 10 min (time dragged.) For the 20 min-group, the illusion was reversed inducing a feeling of time flying by. In a similar paradigm [2], a control group was added with correct temporal information and feedback. This group showed intermediate passage of time judgments indicating that the illusion of time dragging and time flying by worked in opposite directions.

In their experiments, Sackett and colleagues [1] showed that the temporal illusion affected the hedonic quality of the activity. When comparing the two experimental groups, the time-flying-group rated the activity to be more enjoyable and was more willing to volunteer for a future study involving the same task. The authors explained this effect by a metacognitive process: people use their perception of time as an implicit cue for the enjoyment of an experience - "time flew, so the experience must have been fun" ([1] p. 111). Sackett and colleagues [1] further pointed out that the effect was moderated by two factors. First, the effect of higher enjoyment if time flew compared to time dragged was more pronounced among participants that strongly believed in the saying 'time flies when you're having fun'. Second, presenting an alternative explanation for the temporal illusion of time flying by or dragging also reduced the difference between the flying-by-condition and the dragging-condition to a nonsignificant level.

To summarize, the experience of time progression can influence the hedonic quality of a situation. When this experience is distorted, the hedonic evaluation changes accordingly, but only if one believes that 'time flies when you're having fun' and if there is no alternative explanation for the temporal distortion itself. In the present paper, we investigate whether spillover-effects of temporal experience on hedonic evaluations also occur during human-computer interactions. Therefore, we conduct a study using a similar manipulation of temporal experience as [1, 2] and examine the effect on user experience.

1.2 User Experience

According to the Components of User Experience - model (CUE model) [3, 4], user experience (UX) comprises three components: the perception of instrumental qualities, the perception of non-instrumental qualities and the emotional state of the user. Each component consists of specific sub-constructs. Perceived usability and utility, for example, are highly relevant to complete the task. They are part of the component 'perception of instrumental qualities'. Visual attractiveness, on the other hand, belongs to the non-instrumental qualities. Emotions are regarded as a central feature of UX. They are evoked by the perceived instrumental and non-instrumental qualities and may in return bias these perceptions depending on their valence. The three components

result from characteristics of the interaction which themselves are influenced by the user, the context, and the system. Finally, all three components contribute to the overall UX as an overall evaluation and to the intention to repeat the interaction.

2 Method

2.1 Participants

We conducted a study with $n = 61$ participants (30 female, 31 male). On average, they were $M = 24.3$ years of age ($SD = 4.6$). The sample consisted mostly of students of the Technische Universität Berlin (92%). They received course credits for their participation. Most participants had no prior experience with the webpage that was used for the experiment (89%). All of them gave their informed consent in accordance with the declaration of Helsikni.

2.2 Experimental Design and Operationalization

To test whether an interaction with a computer induces a more positive user experience when the user is under the impression that time flies by, we used the paradigm by [1] and added a control group (similar to [2]). Participants were divided into three groups which performed a sequence of typical tasks with an online-tool to configure a closet on a webpage (PAX planner on ikea.de). For each group, the length of the interaction was identical, i.e., it lasted 10 min. However, the groups received different information about the duration of their activities. Only one group was told the actual time (control group, $n = 21$). The other two groups (experimental groups) were either informed that the interaction lasted 20 min (time-flying-group, $n = 20$) or 5 min (time-dragging-group, $n = 20$). According to [2], the manipulation for the experimental groups should invoke the impression that time passed fast or slowly. After working 10 min on the tasks, all participants were told that their given time (10, 20, or 5 min.) was over and were asked to judge their user experience as well as the passage of time. The study was based on a one-factorial between-subject design with three groups.

Based on the CUE model for UX, we measured *perceived usability* as an instrumental quality, *perceived attractiveness* as a non-instrumental quality, and *valence* as part of the emotion-component. Additionally, we assessed the *overall UX* with the corresponding item from the validated German questionnaire meCUE [5]. This was a single item based on a semantic differential ranging from ‘bad’ (1) to ‘good’ (11) asking the participants to rate the website. We used similar scales for perceived usability (2 items: ‘not usable’ to ‘usable’ and ‘hard to use’ to ‘easy to use’) and for perceived attractiveness (2 items: ‘not attractive’ to ‘attractive’ and ‘ugly’ to ‘pretty’). The valence was rated with the Affect Grid [6]. Passage of time judgments served as manipulation check and were assessed with two items based on [1, 7, 8]: ‘time dragged on’ (1) to ‘time flew by’ (11) and ‘the duration seemed to be longer’ (1) to ‘the duration seemed to be shorter’ (11). As an additional manipulation check, we asked participants

how much they agreed with the saying ‘Time flies, when you’re having fun’ (do not agree (1) to agree (11)). All questions were presented in German.

2.3 Procedure

Participants were welcomed and received an instruction for the experiment. They gave their informed consent, and answered a short questionnaire regarding gender, age, occupation, as well as experience with the PAX planer and usability evaluations. This questionnaire also contained six further items, including the participants’ agreement to the saying ‘Time flies, when you’re having fun’. The other five items served as a cover and were not analyzed.

The experimental phase consisted of three parts: a presentation of a picture of the PAX planer for 10 s, a free exploration of the PAX planer for 2 min, and an interaction with the PAX planer lasting 10 min. During this interaction, the participants received a list of tasks to be completed with the PAX planer. After each part, the participants filled out a short questionnaire to rate their overall UX, perceived usability, perceived attractiveness, and the experienced emotional valence. This procedure was exactly the same for all three experimental groups (control group, time-flying-group, time-dragging-group). The only difference was the temporal expectation and feedback during the third part. While the control group received correct information about the duration of the third part (10 min) before and after the interaction, the time-flying-group and the time-dragging-group received incorrect information (20 resp. 5 min). This procedure was chosen in order to make the temporal information more credible, since it was correct for the first two parts. The experiment ended with the two ratings of the passage of time. In the experimental groups, participants were informed about the false temporal feedback during debriefing. Overall, the study lasted approximately 30 min per subject.

2.4 Hypothesis and Analysis Strategy

As manipulation check, we examined whether the participants agreed with the saying ‘time flies, when you’re having fun’ and whether the manipulation in the three groups led to the desired temporal illusion (passage of time). Regarding the UX variables, we analyzed the data after the manipulation (part 3) to answer the research question. We expected a less positive UX in the time-dragging-group than in the control group as well as a less positive UX in the control group than in the time-flying-group. To test these hypotheses, we fitted a linear model for each dependent variable with a sliding-difference contrast [9] for the group factor. This contrast coding makes it possible to interpret the estimates as the group differences.

3 Results

Overall, the participants agreed with the saying ‘time flies, when you’re having fun’ (median = 10, see Fig. 1). The analysis of the passage of time showed that the manipulation of the temporal illusion was partly successful. The time-dragging-group

reported a significantly slower passage of time than the control group, *estimate* = 1.34, *SE* = 0.62, *t* = 2.26, *p* = .027. There was, however, no significant difference between the control and the time-flying-group, *estimate* = 0.31, *SE* = 0.62, *t* = 0.49, *p* = .623.

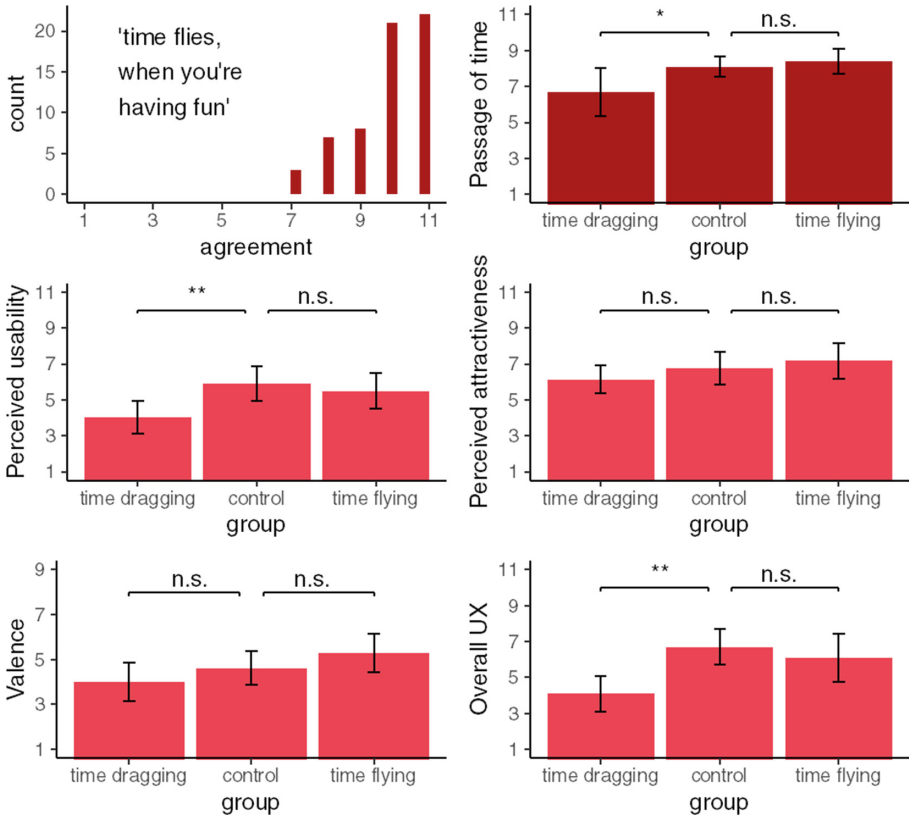

Fig. 1. Manipulation check (*darker shade*) and hypothesis testing (*lighter shade*). Histogram of the agreement to the saying 'time flies, when you're having fun' on a scale from 1 to 11 (*upper left)* and mean values of passage of time (*upper right),* perceived usability (*middle left)*, perceived attractiveness (*middle right)*, valence (*lower left)*, and overall UX (*lower right)*. *Error bars* indicate 95% CI standard errors. *** for $p < .001$, ** for $p < .01$, * for $p < .5$, *n.s.* for not significant.

For the perceived usability, we found similar results. The time-dragging-group rated the usability of the PAX planer to be lower as the control group, *estimate* = 1.88, *SE* = 0.64, *t* = 2.92, *p* = .005. There was no difference between the control group and the time-flying-group, *estimate* = −0.41, *SE* = 0.64, *t* = −0.63, *p* = .531. Regarding perceived attractiveness, we found no differences between the groups, *estimate* = 0.61, *SE* = 0.60, *t* = 1.02, *p* = .314, and *estimate* = 0.41, *SE* = 0.60, *t* = 0.69, *p* = .495, indicating no differences in perceived attractiveness of the PAX planer between the groups. Also, no significant differences were found for valence, *estimate* = 0.62,

SE = 0.55, *t* = 1.12, *p* = .267, and *estimate* = 0.68, *SE* = 0.55, *t* = 1.23, *p* = .222. The result regarding the overall rating showed a similar pattern as the perceived usability: Overall UX was rated significantly lower in the time-dragging-group than in the control group, *estimate* = 2.61, *SE* = 0.76, *t* = 3.45, *p* = .001, but there was no difference between the control group and the time-flying-group, *estimate* = −0.61, *SE* = 0.76, *t* = −0.81, *p* = .421. All means for the UX scales are shown in Fig. 1. All significant effects occurred in the expected direction indicating that the UX was lower in the time-dragging-group than in the control group. There were, however, no significant differences between the control group and the time-flying-group.

4 Discussion

The perception of time passing by is closely linked to the hedonic value of a situation: Time passes slowly when one is bored [10] or fast when one is focused on an enjoyable and demanding task [11]. Sackett and colleagues [1] showed that participants use their perception of time as an implicit cue to infer the pleasantness of an activity. In the present paper, we asked whether this also applies to human-computer interactions. Is the interaction with a computer perceived to be more enjoyable, easier or more attractive, when the user is under the impression that time flew by? We addressed this question by creating a temporal illusion of time dragging and time flying based on [1, 2] and analyzed whether this illusion impacted the participants' UX ratings.

The results showed that a temporal illusion was only partially created. While the 'time-dragging'-group reported a slower passage of time than the control group, we found no difference between the control group and the time-flying-group. This indicates that only the impression of time dragging was elicited. This pattern was mirrored in some of the UX ratings. Both perceived usability (instrumental quality) and overall UX were lower when time was dragging but not more positive when time was flying by. Hence, the data supports the notion that users rely on their perception of time passing by to assess the instrumental qualities of the interaction and their overall experience. Based on the partially unsuccessful illusion, however, this notion is so far only supported for a negative experience of time dragging. Contrary to perceived usability and overall UX, the temporal illusion did not affect perceived attractiveness (non-instrumental quality) or valence. We conclude that the interaction with a computer is perceived to be harder and overall worse, when the user is under the impression that time was dragging.

Based on the results, two questions arise: First, why was the temporal illusion only partly successful? Second, why did the illusion of time dragging affect only one of the components of UX and the overall UX? Regarding the first question, we used the same experimental paradigm with the same durations as [1]. However, [1] did not have a control group, so we cannot be sure whether they were successful in creating the illusion in both directions or whether their reported effects were also based on a negative illusion only. In contrast, [2] also included a control group in their experimental design and were successful to create both a negative (time dragging) and a positive (time flying) illusion. But, [2] used a different range of durations (3 to 7 min). Hence, shorter durations with smaller differences between the groups might be more

believable than the durations we used in our experiment. Future studies are needed to test whether shorter durations allow to create a positive temporal illusion during human-computer interaction and whether this illusion affects UX ratings positively.

Regarding the second question, the temporal illusion of time dragging only significantly affected the perception of instrumental qualities. [12] reported correlations between passage of time and UX components. In line with our results, she found strong correlations between passage of time and perceived usability but not with perceived attractiveness. In accordance with other authors [e.g., 7], however, she also reported strong correlations between emotions and passage of time. Here, future research is needed to address why emotions seem to be related to passage of time but may not be affected by manipulations of the passage of time.

In summary, our study indicates that the interaction with a computer induces a less positive user experience when the user is under the impression that time was dragging during the interaction. This relation between time perception and UX should be taken into account when designing interactions. The user's time perception is affected by many different factors (e.g., cognitive demands, distraction, and emotions [e.g., 13]). Changes in time perception can induce changes in UX, and especially the perception of instrumental qualities and the overall evaluation can get affected.

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