Increased Frustration Predicts the Experience of Time Slowing-Down: Evidence from an Experience Sampling Study

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Abstract

Recent experience sampling research supports the idea that our experience of time speeds up when we are happy and slows down when we feel sad. However, this research had only examined a single negative mood state namely, sadness. Here, I extend this research by testing whether the experience of time speeding-up and slowing down is associated with other thoughts and negative mood states. Thirty-nine participants aged from 18 to 29 completed an experience sampling procedure that lasted for five consecutive days. The experience sampling procedure included measures of time experience (passage of time judgements), mood, levels of activity and time orientation. Increased frustration predicted the experience of time slowing down more than sadness and increased activity, thinking about the future and to a lesser extent happiness, predicted time moving more quickly. Implications of the findings are discussed in relation to laboratory-based studies of time perception.

Keywords: Time experience, time perception, emotion, Experience Sampling Methodology

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1. Introduction

Everyday sayings suggest an association with our experience of time and our feelings — time flies when we are having fun and drags when we are bored. One innovative line of research (Droit-Volet & Wearden, 2015, 2016) has directly examined these passage of time judgements in everyday life using experience sampling. Results showed that for mood states specifically, increased happiness was associated increased speed of time passing whereas sadness was associated with decrease in the speed of the passage of time. Here, I extend this research but testing for an association between passage of time judgements and additional negative mood states (anger, frustration and anxiety) as well as additional variables highlighted in other areas of research as linked to everyday conscious experience.

Although the key the aim of the study conducted by Droit-Volet and Wearden (2015) was to test for differences in passage of time judgements between older and younger participants, the researchers also took measures of mood throughout the day and therefore, were able to explicitly test the hypothesis that mood states are associated with experience of time-speeding up and slowing down. Specifically, participants were asked to respond on smartphones 8 times throughout the day to several questions: 1) their impression of the speed of the passage of time and 2) the degree to which they felt happy, sad, excited/sad and relaxed/calm. Further questions probed degree of arousal, relaxation, difficulty of activity at the time of the alert, and the extent to which the activity was judged to capture attention.

For mood specifically, the results showed that both the young and old participants rated time as passing more slowly when they felt sad and as passing more quickly when they felt happy (although the latter effect was smaller and non-significant

for the older participants). Also, for feeling states, time was rated as passing more quickly when participants reported high levels of stimulation and excitement and more slowly when they felt relaxed. Finally, for younger participants specifically, increased activity difficult was associated with time passing more quickly and, attentional capture for the reported activity was associated with the experience of time passing more quickly.

This basic pattern for mood states — time experience speeding-up with increased happiness and slowing-down with increased sadness — has been replicated in a number of experience sampling studies (Droit-Volet, 2016; Droit-Volet, Monceau, Berthon, Trahanias, & Maniadakis, 2018; Droit-Volet, Trahanias, & Maniadakis, 2017; Droit-Volet & Wearden, 2016, 2015). For example, a recent study (Droit-Volet, 2016) found that sadness remained a significant predictor of time slowing-down (in individuals aged over 75) even after statistically controlling for both depression scores and scores on a measure called past-negative perspective (a subscale of the Zimbardo Time Perspective Inventory; Zimbardo & Boyd, 1999).

Overall, the evidence (Droit-Volet, 2016; Droit-Volet & Wearden, 2015, 2016; Droit-Volet et al., 2017) indicates that time does seem to fly when people are happy — they experience a quickening of the passage of time — and, in agreement with clinical reports of depression (see, for example, Blewett, 1992), time drags when people feel sad. However, other measures of negative emotion were not taken and therefore, we do not know to what extent such findings are either specific to sadness or might be found for other negative emotions. It is even possible that the association for sadness reflects omitted variable bias whereby, the absence of key predictors — other negative emotions for example — leads to biased estimates.

Which other negative moods might predict the experience of time? Intuitively, feelings of frustration seem to be linked to the experience of time moving slowly — a few moments in a traffic jam can seem to last for ever when we have an important meeting to attend and similarly, waiting for a meal in a busy restaurant can seem to take a long time when we are very hungry. In support of such a link, diary research (Freedman et al., 2014) indicates that compared to other negative mood states feelings of frustration are most strongly association with the perceive duration of activities. Considering this, the first aim of the current study is to establish whether the relationship between sadness and time experience still holds when other negative emotions (including frustration), are considered along with sadness.

Feelings such as frustration can be understood in the context of dimensional approaches to understanding emotion (Carver & Scheier 1990, 1998; Lang et al., 1997; Russell, 2009). For example, in the motivational model proposed by Carver and Scheier (1990), increased feelings of sadness, frustration and anger all provide feedback to the individual that they are failing to make progress (over time) toward an incentive. If feelings are sufficiently strong they may make a person re-consider their course of action. For example, with increasing frustration at being held up in traffic we might consider taking a different route or aborting our trip altogether. Feelings of frustration, sadness and anger can be distinguished from feelings of anxiety and worry. Increased anxiety and worry indicates that progress has not been made avoiding an aversive event (e.g., you are unable to postpone an anxiety-inducing talk). Positive emotions (e.g., happiness, excitement and elation) indicate success in approaching an incentive — we are excited when we know that we are about to receive a present. The appeal of this model is that it specifies a role for representations of time — we make progress toward our goals with respect to time passing.

In addition to testing for an association between frustration (and other negative emotions) and the experience of time passing, a further aim was to establish whether our experience of time might co-vary with other thoughts and feelings. Existing experience sampling research (Larson & von Eye, 2006) indicates that engagement in an activity is associated with the experience of time as passing more relative to both clock time and a more general impression of the speed of passage of time. To account for this relationship, in the current research I asked participants at each prompt to rate the extent to which they felt active. Further variables were included because research evidence indicates that they are important predictors of everyday conscious experience. These predictors include thought processes and content related to conscious emotional experience namely, rumination and worry (Hartley et al., 2014), mind wandering (Killingsworth & Gilbert, 2010) attention to emotion (Thompson et al., 2011) and time orientation (Kircanski et al., 2015). Although I did not have a strong hypothesis about how they might relate to time experience, these variables are typically associated with focus on specific mental content (e.g., rumination about past failure) and therefore, may draw attention away from the passage of time (Block et al., 1980) leading to an experience of time moving more quickly.

In summary, the goal was to clarify the relationship between sadness and the passage of time by including wider range of self-reported negative feelings and thoughts.

2. Method

2.1. Participants

Thirty-nine undergraduate students (26 female; age range 18 to 29) were recruited. All participants provided consent and the research was approved by the Ethical Review

Committee at the University of Hull. Participants did not receive an incentive for taking part.

2.2. *Materials and Procedure*

After giving consent participants registered their mobiles phones with the experience sampling software and completed the following self-report questionnaires: 1) the Beck Depression Inventory–II (Beck et al., 1996), 2) a brief, five-item version of both the Penn State Worry Questionnaire (bPSWQ; Topper et al., 2014), and 3) a brief, five-item version of the Ruminative Response Scale (bRRS; Topper et al., 2014).

The experience sampling procedure began on the day after completion of the self-report questionnaires and lasted for five consecutive days. Participants received prompts via a text message to their smart phone to answer questions at random times within five 96-min windows per day (between 10:00 a.m. and 6 p.m.). A reminder was sent to each participant if they failed to respond to the text message within 15 minutes. If a participant failed to respond within one hour the signal timed out. A minimum of 45 minutes separated each signal. At each mobile phone prompt participants were asked to report their perception of time in response to the question “Would you say time was moving slowly, quickly or neither slowly or quickly?” using a seven-point scale (where 1 = Very Slowly, 4 = neither slowly or quickly, 7 = Very quickly). Also, at each prompt participants were asked to report the intensity with which they were currently feeling each of four negative emotions (sad, anxious, angry, frustrated) and each of four positive emotions (happy, excited, alert, and active) using a five-point scale (1=very slightly or not at all, 2 = a little, 3 = moderately, 4 = quite a bit, 5 = extremely). Further questions were included worry ("In the last hour I have been worrying"; 1 = Not at all, 4 = Moderately, 7 = A lot), rumination ("In the last hour I have been going over my problems in my mind"; 1 = Not at all, 4 = Moderately, 7 = A lot), attention to emotion ("I

am paying a lot of attention to how I feel right now" (1 = Not at all, 7 = a great deal), mind wandering ("Are you thinking about anything other than what you are doing?"). These items have been validated in previous research (Killingsworth & Gilbert, 2010; Kircanski et al., 2015; Moberly & Watkins, 2008; Thompson et al., 2011). Participants responded to an average 64% prompts (SD = 7.8)[1].

3. Results

Table 1.

Participant scores for the intake measures of depression (Beck Depression Inventory–II), rumination (brief Ruminative Response Scale) and worry (brief Penn State Worry Questionnaire).

Measure	Mean	SD
BDI-II[1]	11.99	9.43
Rumination[2]	9.67	3.16
Worry[3]	14.79	6.40

[1] Beck et al., 1996.

[2] Topper et al., 2014.

[3] Topper et al., 2014.

Table 1 shows the participant scores for the intake measures of depression (1, Beck Depression Inventory–II; Beck et al., 1996), rumination (2, brief Ruminative Response Scale; Topper et al., 2014) and worry (3, brief Penn State Worry Questionnaire; Topper et al., 2014).

[1] The completion rate may have been low in part because of the lack of financial compensation.

The mean BDI-II score was 11.99 (SD = 9.43) with 23 individuals reporting minimal, 9 mild, 3 moderate, and 4 severe symptoms. This is somewhat higher than previous research (Droit-Volet & Wearden, 2015) although the group mean indicates normal to mild mood disturbance. Means and standard deviations of all the questionnaire scores are displayed in Table 1.

3.1. Multilevel Modelling

The data had a multilevel structure — prompts to the ratings were nested within individuals. Put differently, a repeated measures design was used — individual participants made repeated ratings across time. To account for this dependency, the ratings at each prompt were modelled in a Multilevel Bayesian Linear Regression using the brms package (Bürkner, 2017) as an interface between RStan (Stan Development Team, 2017) and R (R Core Team, 2018). All models included varying intercepts for individuals and, varying intercepts for prompts nested within individuals. In experience sampling, successive prompts are likely correlated (feeling happy at time 1 will relate to happiness at time 2) and therefore, the model included a first-order autoregressive covariance structure to account for the autocorrelations between successive occasions (or beeps).

The Bayesian modelling approach used here uses Markov Chain Monte Carlo (MCMC) sampling to estimate a range of probable values for model parameters. MCMC requires checks for chain convergence. For brevity, regression diagnostics (e.g., multicollinearity), chain convergence diagnostics and further model quality checks can be found in the online supplement. All models converged, the residuals were normally distributed and there was little evidence for multicollinearity. Weakly informative priors were used for all coefficients. For example, the prior distribution for beta coefficients for the predictor variables were centred on zero and allowed to take on a

range of plausible positive and negative values. Leave-k-out cross-validation was used an index of relative model adequacy (for a review see; Arlot asnd Celisse 2010) – a lower k-fold value indicates a relatively better model fit – the model has greater predictive accuracy. Finally, effects were deemed significant if the interval containing the 95% most credible estimates for the effects excluded zero.

Measure	Male		Female	
	M	SD	M	SD
Time experience	4.10	1.43	3.62	1.30
Worry	2.56	1.67	2.51	1.37
Rumination	2.56	1.63	2.49	1.35
Sad	1.58	0.95	1.77	1.14
Anxious	1.83	1.05	2.09	1.18
Angry	1.32	0.74	1.46	0.90
Frustrated	1.67	1.02	1.98	1.11
Happy	2.83	1.19	2.84	1.14
Alert	2.61	1.22	2.86	1.20
Active	2.31	1.09	2.81	1.24
Attention to feelings	2.60	1.40	2.45	1.55
Time orientation	4.18	1.11	3.96	1.13

Table 2. Means and standard deviations of variables recorded during experience sampling for male (N = 13) and female (N = 26) participants, separately[2]. Time experience, Attention to feelings, Worry and Rumination and Time orientation were all rated on a 7-point scale. Sad, Anxious, Angry, Frustrated, Happy, Alert and Active were rated on 5-point scales.

The mean and standard deviations for each of the rated experience sampling measures are shown in Table 2. For Model 1, I regressed time experience onto the happiness and sadness ratings. The pattern of results supports those reported in previous research namely, increases in self-reported happiness were associated with the experience of time moving more quickly β = 0.18, CrI 95% (0.07,0.29) whereas, sadness was associated with a relative slowing down of the experience of time, β = -0.13, CrI 95% (-0.27,0.0002). For Model 2, I included the remaining predictors. Model fit

[2] None of the participant sex differences in the average experience sampling ratings were significant using two-tailed independent samples t-tests (anger, $t(37) = -0.87$, $p = 0.38$; frustration, $t(37) = -1.1731$, $p = 0.248$; alert, $t(37) = -0.72$, $p = 0.47$; active, $t(37) = -1.82$, $p = 0.07$; attention to feelings, $t(37) = 1.11$, $p = 0.27$; time orientation, $t(37) = 1.55$, $p = 0.12$; anxious, $t(37) = -0.72$, $p = 0.47$; sad, $t(37) = -0.72$, $p = 0.47$; happy, $t(37) = 0.26$, $p = 0.78$; rumination, $t(37) = 0.15$, $p = 0.87$; worry, $t(37) = -0.02$, $p = 0.98$).

improved with the addition of the new predictors (Model 1 K-fold = 2030, Model 2 K-fold = 2004).

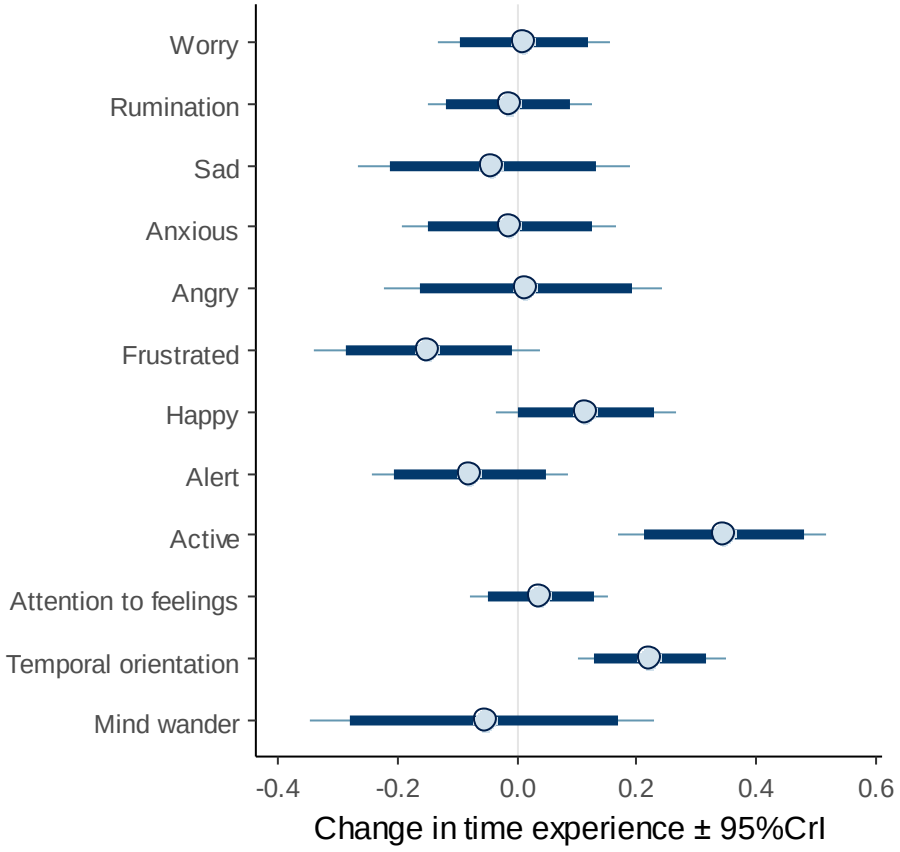

Figure 1. Posterior Estimates of change (Beta coefficients) in passage of time judgements ("Would you say time was moving slowly, quickly or neither slowly or quickly?") for each of the variables separately. The shaded portion of the error bars indicate the 95% most credible values for the effect centred on the mean, most likely value (circle).

For Model 2, the posterior probability estimates for the change in time experience associated with each of the self-reported measures is shown in Figure 1. The shaded portion of the error bars indicate the 95% most likely range of true values of the parameter (given the prior and the data). As can be seen in Figure 1, increases in frustration were associated with time slowing down whereas increases in both self-reported activity and time orientation (to the future) were associated with the

experience of time moving more quickly. Slope estimates for happiness and sadness were reduced in magnitude relative to Model 1; from -0.13 to -0.04 for sadness and from 0.18 to 0.12 for happiness. The 95% most probable estimates for the remaining beta coefficients all included zero and therefore, were considered not significant (Worry; β = -56 95% CrI [-93 , -19]; Rumination; β = -0.01; 95% CrI [-0.11 , 0.08]; Anxious; β = -0.01; 95% CrI [-0.14 , 0.12]; Angry; β = 0.01;95% CrI [-0.16 , 0.19]; Alert; β = -56 95% CrI [-93 , -19]; Attention to feelings; β = 0.03; 95% CrI [-0.04 , 0.12]; Mind wandering; β = -0.05; 95% CrI [-0.27, 0.16]).

4. Discussion

The aim was to clarify the relationship between mood states and the experience of time in everyday life. Previous reports (Droit-Volet & Wearden, 2015, 2016) suggested an association between increased sadness and the experience of time slowing down and increased happiness and time speeding up. Here, I replicated the relationship between time experience and both happiness and sadness. However, the statistical effect sizes for both happiness and sadness were reduced in magnitude when other important predictors of time experience were added to the regression equation. Specifically, a second model showed that increased feelings of frustration were associated with the experience of time passing more slowly. Conversely, people reported time passing more quickly when they were more active and focused on the future. In short, the results give a more nuanced picture of how passage of mood judgements relate to our feelings and thoughts.

The finding that time seemed to slow when people felt frustration is consistent with a daily diary study (Freedman et al., 2014) in which people estimated the duration of activities. Specifically, across a 24-hour period, 394 older aged couples (for each couple one person was over 60 years old) were asked to recall what they did the day

before, how long it took, who they with and, after being asked to re-imagine the activity they were asked to recall how it felt during the activity. There was a positive association between reported activity length and an aggregate of all negative emotions (frustrated, worried, sad, tired, and pain). Activities were rated as lasting longer when participants were in a negative mood. However, and in agreement with the current results, regression of all emotions separately onto duration estimates showed that only feelings of frustration were a significant predictor of activity lasting longer after controlling for covariates. In short, diary research corroborates the finding reported here namely, increased feelings of frustration and the experience of time slowing down.

In the current study, feelings of frustration, happiness and to lesser extent sadness predicted changes in time estimates whereas feelings of anxiety and worry did not. One way to interpret such relationship is in the context of the motivational model proposed by Carver and Scheier (1990). According to Carver and Scheier, feelings of frustration, anger, happiness and sadness are associated with differing degrees of success in progress towards incentives (approach motivation) whereas anxiety and worry are associated with lack of progress at avoiding aversive stimuli (avoidance motivation). Viewed in the context of this model, the current results suggest that passage of time judgements are more strongly associated with approach motivation both in terms of making progress towards incentives (happiness) and failure to make progress towards incentives (sadness and frustration). Testing this approach hypothesis was not an aim of the current study and therefore, it would be beneficial to establish whether this hypothesis finds support in future experience sampling studies of passage of time judgements.

Increased feelings of activity were associated with reports of time passing more quickly. This effect agrees with previous occupational therapy research (Larson & von

Eye, 2006) that recorded an association between participation in activities and the perception of time passing in relation to clock time. The premise of the latter research was that our experience of time passing during an activity may be a useful index of the degree of challenge afforded by the activity. Specifically, when we are highly engaged in an activity that is sufficiently challenging (but not to the extent that we feel frustrated) then we lose our sense of time and we may even experience a sense of "flow" (Csikszentmihalyi, 2008). Put differently, the relationship may reflect the fact that when people are highly active they pay less attention to time and consequently report time passing more quickly. In the current study, a reduced attention to the passage of time due to increased activity may be the reason why people experienced time speeding-up. This is the reverse of the 'watched pot' phenomenon (Block et al., 1980) where people report a lengthening of time when they increasingly attend to time as they wait for an event to occur (a pot to boil). In short, attention to the passage of time may be the critical variable underlying all effects association with retrospective passage of time judgements.

4.1. Relationship with Other Duration Judgments

Measures of time experience and interval estimation tasks differ in a myriad of ways and therefore, it seems appropriate to caution against assuming a simple relationship between these different measures. Many laboratory-based measures are prospective — participants are informed that they should time a forthcoming interval whereas experience-sampling measures are retrospective — they ask participants to judge a recent experience. This distinction seems critical as highlighted in a recent experience sampling study (Droit-Volet & Wearden, 2016) that compared the two types of temporal judgment. Specifically, participants were prompted on mobile phones to make both retrospective passage of time judgements and prospective judgment of durations.

There was no relationship between the measures and therefore, it seems likely that the different measures tap different processes. As noted elsewhere (Wearden, 2015), this not to say that experience sampling measures of temporal judgements are a different phenomenon altogether from the effects reported in laboratory research. Indeed, laboratory studies of retrospective timing have similarly reported an association between feelings and retrospective time judgments (Wearden et al., 2014). In short, the key distinction in studies of timing seems to be that between prospective timing — when people are informed they should time an event — and retrospective timing — when people are prompted to report the passage of time after the event has elapsed (or expired).

In summary, the results extend recent research by showing that feelings of frustration were associated with the experience of time slowing down and increased activity, thinking about the future and to a lesser extent happiness were associated with the experience of time moving more quickly. Although time flies when you are having fun it more typically slows down when you feel frustrated.

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