



# Temporal focus, temporal distance, and mind-wandering valence: Results from an experience sampling and an experimental study



Maitta Spronken <sup>a,\*</sup>, Rob W. Holland <sup>a</sup>, Bernd Figner <sup>a,b</sup>, Ap Dijksterhuis <sup>a</sup>

<sup>a</sup> Behavioural Science Institute, Radboud University, Postbus 9104, 6500 HE Nijmegen, The Netherlands

<sup>b</sup> Donders Institute for Brain, Cognition and Behaviour, Radboud University, The Netherlands

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## ABSTRACT

When mind-wandering, people may think about events that happened in the past, or events that may happen in the future. Using experience sampling, we first aimed to replicate the finding that future-oriented thoughts show a greater positivity bias than past-oriented thoughts. Furthermore, we investigated whether there is a relation between the temporal distance of past- and future-oriented thoughts and the frequency of positive thoughts, a factor that has received little attention in previous work. Second, we experimentally investigated the relation between temporal focus, temporal distance, and thought valence. Both studies showed that future-oriented thoughts were more positive compared to past-oriented thoughts. Regarding temporal distance, thoughts about the distant past and future were more positive than thoughts about the near past and future in the experiment. However, the experience sampling study did not provide clear insight into this relation. Potential theoretical and methodological explanations for these findings are discussed.

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## 1. Introduction

We tend to think about something else than the activity we are currently engaged in on a regular basis. Our mind may wander off to our plans for the weekend while reading a long method section, or thoughts about an incident at work may pop up into our mind while watching a movie. Schooler et al. (2014) define mind-wandering as “a common everyday experience in which attention becomes disengaged from the immediate external environment and focused on internal trains of thought” (p. 1). According to estimates based on experience sampling and lab studies, people spend 25–50 percent of their time mind-wandering (Schooler et al., 2014).

When people engage in mind-wandering, the temporal focus and temporal distance of their thoughts may vary: Thoughts may wander off to events that happened in the near or distant past, or to events that may happen in the near or distant future. Previous research showed that mind-wandering is more frequently directed toward the future than toward the past, and more frequently directed toward the near past and future than toward the distant past and future (Stawarczyk, Cassol, & D’Argembeau, 2013; Stawarczyk, Majerus, Maj, Van der Linden, & D’Argembeau, 2011). As such, it has been proposed that

\* Corresponding author.

E-mail addresses: [m.spronken@psych.ru.nl](mailto:m.spronken@psych.ru.nl) (M. Spronken), [r.holland@psych.ru.nl](mailto:r.holland@psych.ru.nl) (R.W. Holland), [b.figner@psych.ru.nl](mailto:b.figner@psych.ru.nl) (B. Figner), [a.dijksterhuis@psych.ru.nl](mailto:a.dijksterhuis@psych.ru.nl) (A. Dijksterhuis).

mind-wandering plays an important role in autobiographical planning and problem-solving (e.g. Baird, Smallwood, & Schooler, 2011; Mooneyham & Schooler, 2013; Ruby, Smallwood, Sackur, & Singer, 2013; Smallwood, Nind, & O'Connor, 2009). Furthermore, mind-wandering may entail negative, neutral, or positive thoughts. While people's minds wander more often to pleasant topics than to neutral or negative ones in general (e.g. Killingsworth & Gilbert, 2010), research in the mental time travel literature suggests that this positivity bias is greater for future-oriented thoughts than for past-oriented thoughts (e.g. Andrews-Hanna et al., 2013; Berntsen & Jacobsen, 2008; Finnbogadóttir & Berntsen, 2013; Newby-Clark & Ross, 2003).

Whereas previous studies have investigated the relation between temporal focus and thought valence, it is unclear whether temporal distance affects the valence of one's thoughts. Thoughts about the near past and future may be mostly concerned with relatively concrete daily hassles and joys (e.g. a flat tire or a dinner with friends), whereas thoughts about the distant past and future may largely be concerned with relatively abstract events (e.g. obtaining tenure or getting married). This difference in abstraction level may in turn influence the frequency of negative and positive thoughts.

In the next section, we review earlier studies on the relation between temporal focus and thought valence. While previous studies provide valuable insight into this relation, some methodological limitations of these studies were identified. Therefore, we propose a potentially more optimal method for investigating the relation between temporal focus and mind-wandering valence in people's daily lives: experience sampling. Following this, we discuss how temporal distance may influence the valence of one's thoughts. Temporal focus and temporal distance have not been investigated simultaneously in relation to the frequency of negative and positive thoughts before.

### 1.1. Temporal focus and mind-wandering valence

To the best of our knowledge, the relation between temporal focus and the valence of thoughts has received only limited attention in the mind-wandering literature. One lab study showed that thoughts with no particular future- or goal-oriented function, such as daydreaming or boosting positive emotions, were more positive than thoughts that did have a clear future- or goal-oriented function, such as problem solving or planning (both thought types could have a past or a future orientation; Stawarczyk et al., 2013). However, this study did not reveal a significant difference in affective valence between future-oriented mind-wandering and either non-future-oriented mind-wandering in general or past-oriented mind-wandering specifically (see footnote 1 in Stawarczyk et al., 2013). Furthermore, one experience sampling study examined characteristics of mind-wandering in Chinese daily lives and included measures of both temporal focus and emotional valence (Song & Wang, 2012). However, no results were reported regarding the relation between temporal focus and emotional valence.

Related to the present research, past-focused mind-wandering has been linked to prior sad mood (Poerio, Totterdell, & Miles, 2013; Smallwood & O'Connor, 2011; see also Stawarczyk, Majerus, & D'Argembeau, 2013). Past-other-oriented mind-wandering has also been related to subsequent negative mood, even when one's current thought was positive, while future-self-oriented mind-wandering has been related to subsequent positive mood, even when one's current thought was negative (Ruby, Smallwood, Engen, & Singer, 2013). Another study found a marginally significant relation between prior feelings of anxiety and future-oriented mind-wandering (Poerio et al., 2013). Taken together, these studies seem to suggest an association between mind-wandering about the past and negative affect, and an association between mind-wandering about the future and positive affect, as well as anxiety. However, these studies did not directly investigate the relation between temporal focus and mind-wandering valence, but investigated the relation between temporal focus and prior/subsequent mood. Importantly, mind-wandering valence and subsequent mood seemed to be partly independent, depending on the socio-temporal content of the wandering mind.

Several studies in the mental time travel literature have investigated the relation between temporal focus and thought valence specifically. Mental time travel involves reliving events in one's past and preliving possible events in one's future through autobiographical memories and future projections (Finnbogadóttir & Berntsen, 2013; Tulving, 2002). Although mind-wandering and mental time travel are not the same, especially the literature on involuntary (as opposed to voluntary) mental time travel may provide insight in the relation between temporal focus and mind-wandering valence. Namely, involuntary autobiographical memories and future projections may be seen as instances of the broader category of mind-wandering (Johannessen & Berntsen, 2010; Plimpton, Patel, & Kvavilashvili, 2015). In fact, the instructions used in mind-wandering research and involuntary mental time travel research are often rather similar. As such, Plimpton et al. (2015) have recently proposed to bridge these 'related but separate' (p. 261) areas of research.

In a diary study by Finnbogadóttir and Berntsen (2013) participants were asked to record the valence of involuntary autobiographical memories on a single day. On another day, participants did the same for autobiographical future projections. While the frequency of positive thoughts was higher than the frequency of negative thoughts for both memories and future projections, the positivity bias was greater for the future. Furthermore, Andrews-Hanna et al. (2013) asked participants to report 36 thoughts that had been on their minds recently, and to rate these thoughts on several dimensions, including valence. Future-oriented thoughts were on average more positive than past-oriented thoughts. In a diary study by Berntsen and Jacobsen (2008), participants were asked to reflect on two involuntary and two voluntary representations about past events on some days, and two involuntary and two voluntary representations about future events on other days. They found a positivity bias for the future for both voluntary and involuntary thoughts. Finally, in a lab experiment by Newby-Clark and Ross (2003), participants reported up to ten significant past as well as future events, and subsequently rated how they felt or would feel during these events. The average positive affect (which is likely to be related to thought

valence) was higher for future than for past events. As such, results of naturalistic and experimental studies, as well as results for voluntary and involuntary mental time travel, seem to converge.

The positivity bias for future-oriented thoughts may be explained by the fact that thoughts about the past are constrained by reality, while thoughts about the future are less so. Despite people's general positivity bias, specific negative events that happened in one's past tend to be remembered well (Cacioppo & Gardner, 1999), and this may attenuate the positivity bias for the past. However, we cannot know what will happen in the future, and hence, this attenuation seems to be smaller or absent for thoughts about the future (Finnbogadóttir & Berntsen, 2013). Remembering negative events well may be functional as this enables people to prevent similar negative events in the future. Maintaining an optimistic view with regard to the future may be functional as this motivates one to explore the environment and set new goals (Cacioppo & Gardner, 1999).

### 1.2. Experience sampling

In the studies investigating the relation between temporal focus and thought valence in people's daily lives described above, participants were asked to report recent past- and future-oriented thoughts using a questionnaire approach (Andrews-Hanna et al., 2013), or were instructed to record autobiographical thoughts about either the past or the future themselves as they occurred using a diary approach (Berntsen & Jacobsen, 2008; Finnbogadóttir & Berntsen, 2013). However, various limitations of these methods make them less suitable for studying mind-wandering. Asking people to report thoughts in a questionnaire study may introduce memory biases (Scollon, Kim-Prieto, & Diener, 2003). For example, people may remember thoughts about one temporal focus better than thoughts about the other temporal focus. Furthermore, instructing participants to report every (or a number of) thoughts about the past or the future as one goes about one's daily life may be rather difficult for participants: After all, when people are mind-wandering, they are often not aware of this themselves (Smallwood & Schooler, 2015). Supporting this idea, Vannucci, Batool, Pelagatti, and Mazzoni (2014) showed that participants reported more involuntary memories during experimenter probing compared to self-caught probing. Furthermore, it may be difficult for participants to report past- or future-oriented thoughts in an unbiased fashion: Participants may be selective with regard to the thoughts they report (e.g. not mentioning highly negative thoughts), or may be more selective with regard to reporting either past- or future-oriented thoughts (e.g. not mentioning highly negative thoughts regarding the future). Finally, the instruction itself to record thoughts about either the past or the future may lead participants to think more, or in a different manner, about the currently instructed temporal focus. For example, Vannucci et al. (2014) showed that participants reported more involuntary memories when explicitly asked to report involuntary memories than when asked to report involuntary thoughts in general.

These limitations can be reduced by an experience sampling approach using random signaling. This method entails that participants carry a device (e.g. a smartphone) with them for an extended period of time, and they receive signals requiring them to fill out a questionnaire at random moments during the day. This allows researchers to sample a large number of representative moments in people's daily lives (Scollon et al., 2003). As such, the first aim of the present study was to investigate whether thoughts about the future also show a greater positivity bias for the broader category of mind-wandering with an experience sampling study using random signaling.<sup>1</sup>

### 1.3. Temporal distance and mind-wandering valence

As mentioned earlier, whereas a number of studies investigated the relation between temporal focus and thought valence, previous studies provide limited insight into the relation between temporal *distance* and the frequency of negative and positive past- and future-oriented thoughts.<sup>2</sup> Construal Level Theory states that temporal distance increases the abstractness of one's thoughts (Trope & Liberman, 2003). When thinking in an abstract manner, people tend to focus on the reasons for their actions (*why's*). However, when thinking in a concrete manner, people tend to focus on the actions that are required to achieve their goals (*how's*). As *why's* (e.g. losing weight) are typically more positive than *how's* (e.g. eating less; see Liberman & Trope, 1998), thoughts about the distant past or future may well be more positive compared to thoughts about the near past or future (see also Williams, Stein, & Galguera, 2014). Contemplating negative events in the recent past may be functional as it fosters learning and potentially behavior change. Considering potential negative events in the near future may be functional as this allows one to undertake action to avoid these negative events. However, thinking about things that may obstruct one's goal pursuit in the distant future might not be very practical, as one knows relatively little about the circumstances that may be relevant in the distant future.

<sup>1</sup> It should be noted that self-caught probing methods are generally found to be suitable for research on autobiographical memories and future projections. Namely, autobiographical memories and future projections are more specific and infrequent than mind-wandering in general, and may therefore be difficult to capture with random signaling methods (Rasmussen, Ramsgaard, & Berntsen, 2015). However, the above mentioned shortcomings of self-caught probing are likely to be applicable to involuntary mental time travel as well. This way, the present study may also be relevant for this area of research (see also Plimpton et al., 2015).

<sup>2</sup> It may be noted that D'Argembeau and Van der Linden (2004) included temporal distance in their study on the phenomenological characteristics of past and future projections. This study showed interesting results regarding the intensity of thoughts varying on temporal focus, temporal distance, and valence. However, this study could not answer any questions regarding the relation between temporal focus, temporal distance, and the frequency of negative and positive thoughts, or the average valence of thoughts.

Previous studies did not investigate the relation between temporal distance and the frequency of negative and positive thoughts for the past. For future-oriented mind-wandering, one lab study did not find a relation between temporal distance and affective valence (Stawarczyk et al., 2013). Another study did show a difference in valence between near and distant future-oriented thoughts. Participants were asked to imagine events that could happen to them on a bad or a good day in the near or distant future, and to rate these events on valence. While participants imagined good and bad days in the near future as relatively diverse in terms of negative and positive events (e.g. they also imagined some neutral or slightly negative events on a positive day), participants imagined the distant future as prototypically bad or good (Liberman, Sagristano, & Trope, 2002; also see Construal Level Theory; Trope & Liberman, 2003). Furthermore, another study showed that students were more optimistic about their performance in the distant (as opposed to the near) past and future (Gilovich, Kerr, & Medvec, 1993), suggesting that thoughts about the distant past and future are more positive. It seems that students considered daily hassles, situational details, and potential problems to a lesser extent for the distant past and future.

The study by Stawarczyk et al. (2013) did not show a relation between temporal distance and mind-wandering valence for future-oriented thoughts. The other two studies described above suggest that the frequency of positive thoughts may increase with temporal distance. However, the first study was only concerned with future events, and event valence was manipulated in this study (Liberman et al., 2002). The second study was concerned with a single, pre-determined event in either the past or the future, and did not directly measure thought valence (Gilovich et al., 1993). These studies did not directly investigate whether temporal distance increases the frequency of positive thoughts for both the past and the future, when event valence has not been manipulated, and did not investigate mind-wandering specifically. In our study, we aimed to fill in this gap.

#### 1.4. Present research

We aimed to go beyond previous research in three important ways. First, we aimed to replicate the finding that future-oriented thoughts show a greater positivity bias than past-oriented thoughts for the broader category of mind-wandering employing an experience sampling methodology. Second, we investigated whether there is a relation between the temporal distance of past- and future-oriented thoughts and thought valence. We expect that thoughts about the distant past and future are, overall, more frequently positive compared to thoughts about the near past and future. On the basis of the literature on temporal distance, we do not have reason to believe that temporal focus and temporal distance may interact. Third, in contrast to earlier research in this area that is mostly correlational, we investigated the relation between temporal focus, temporal distance, and the frequency of negative and positive thoughts in a lab experiment inducing a stream of (semi-) naturally occurring thoughts. As such, the experience sampling study (Study 1) provides ecologically valid insights into the relation between temporal focus, temporal distance, and thought valence, while the lab experiment provides insight into these relations under more controlled circumstances (Study 2).

In addition to these main aims, the present study also had one explorative goal concerning the link between mind-wandering and happiness. If mind-wandering about the future is on average more positive compared to mind-wandering about the past, are people on average happier while mind-wandering about the future than while mind-wandering about the past? Berntsen and Jacobsen (2008) included a mood measure in their diary study, but did not find a relation between temporal focus and mood. However, no study investigated the relation between temporal focus, temporal distance, and happiness in people's daily lives with an experience sampling study.

## 2. Study 1: Experience sampling

### 2.1. Method

#### 2.1.1. Participants

In total, 207 participants took part in this study. Some participants ( $n = 46$ , 22.2%) failed to fill out demographics information. As such, the reported demographics are based on the participants who did fill out this information. The study included 100 women (62.1%) and 61 men (37.9%), and the age of participants ranged from 18 to 72, with an average age of 39.6 years ( $SD = 14.1$ ). Regarding ethnic background, 154 participants (95.7%) indicated having a Dutch background and seven participants (4.3%) indicated having a non-Dutch background. Five participants (3.1%) completed pre-vocational education, 17 participants (10.6%) lower vocational education, 47 participants (29.2%) higher vocational education, 27 participants (16.8%) higher general and pre-university education, and 65 participants (40.4%) university.

Participants were recruited in the city center of Nijmegen (a city in the East of the Netherlands;  $n = 113$ ), via a local soccer club ( $n = 35$ ), and via a local hockey club ( $n = 19$ ). Moreover, a group of meditators ( $n = 40$ ), recruited via the organization zen.nl, took part in this study. People in possession of an iPhone or Android smartphone were asked to participate in a one-week smartphone study investigating happiness. Participants who were recruited in the city center or via zen.nl received EUR 10 for their participation. If a participant was recruited via the hockey or soccer club, EUR 10 were transferred to the bank account of his/her sports club (none of the reported results interacted with either recruitment group or phone type).

### 2.1.2. Procedure and materials

**2.1.2.1. Application.** In order to collect a large number of data from participants during their daily lives, an application for iPhones as well as an application for Android smartphones was developed (the application looked the same on both phone types). The application contained a short questionnaire inquiring into participants' momentary happiness, thoughts, and activities (see Section 2.1.2.3.). After downloading and activating the application, participants received six signals per day for the duration of one week, in which they were asked to fill out the questionnaire. Signals were sent at (semi-) random times within six equally long time windows between 08.00 am and 10.00 pm. Participants with iPhones received text messages signaling that they were required to fill out a questionnaire, participants with Android smartphones received signals from the app itself. Answers were recorded on a server of the Radboud University.

**2.1.2.2. Instructions.** One week before the start of the experience sampling study, participants received a manual via e-mail, explaining how they could install our application on their phone. Furthermore, the manual explained that the study consisted of three parts: (1) experience sampling week, (2) keeping a sports and meditation journal during the experience sampling week (not further relevant here), (3) internet questionnaire after the experience sampling week (not further relevant here). The manual contained specific instructions for each part of the study. During the study, instructions were repeated in e-mails multiple times.

With regard to the experience sampling week, participants were instructed to fill out the short questionnaires for the moment directly preceding the signal. Furthermore, the importance of filling out the questionnaire immediately after receiving a signal was stressed. If responding to a signal immediately was not possible (for example because the participant was driving or attending an important meeting), participants were asked to remember their answers and fill them out later.

**2.1.2.3. Experience sampling questionnaire.** During the experience sampling week, participants were asked six times a day how happy they felt at that moment ('How happy do you feel at the moment?', scale from 0 = *not happy at all* to 100 = *very happy*) and whether they were mind-wandering ('Were you thinking about something else than what you are currently doing?', yes or no). If the mind-wandering question was answered affirmatively, a number of questions inquiring into the participant's thoughts followed, including questions related to temporal focus ('Were you thinking about the past, the future, or neither?'), temporal distance ('How far back/forward were you thinking into the past/future?'; 24 h, 1 week, 1 month, 3 months, 6 months, 1 year, 1–5 years, more than 5 years), and thought valence ('Was your thought negative, neutral, or positive?', scale from -5 = *very negative* to +5 = *very positive*). Furthermore, a number of questions were asked regarding the nature of the activity the participant was engaged in, which are not further relevant here. Filling out the questionnaire took approximately one minute each time (see [Appendix A](#) for complete questionnaire).

### 2.1.3. Data cleaning and analysis

In total, the dataset consisted of 5940 experience sampling questionnaires. On a small number of occasions, the happiness and mind-wandering valence questions were answered with a number that fell outside the range of the scale. Namely, these questions could be answered by pulling a slider. However, the slider might not have worked optimally on some phones, leading people to type a number in an answer box accompanying the slider, showing the participant's response. On one occasion, a participant indicated accidentally having pressed the next button before filling out the intended happiness rating. These responses (three happiness ratings and seven mind-wandering valence ratings) were excluded and coded as missing values. Finally, participants who filled out less than half of the questionnaires (that is, less than 21) were excluded from the analyses (if exclusion of these participants led to different results compared to including these participants, this will be reported in [online supplementary materials](#)). After exclusion of these participants, the dataset consisted of 162 participants (5436 experience sampling questionnaires).

In view of the nested structure of the data (repeated measurement occasions within participants), data were analyzed with a (generalized) linear mixed-effects model approach. This approach is an extension of linear regression, and entails the estimation of both fixed effects (i.e. the relation between the predictor of interest and the dependent variable) and random (participant) effects. More traditional statistical approaches (such as repeated measures Analysis of Variance) require aggregating observations for each participant, resulting in a loss of information. In contrast, a linear mixed-effects model approach allows one to retain all observations from participants, resulting in less unexplained variance and more statistical power. Additional advantages of a linear mixed-effects model approach include that it handles unbalanced and missing data better than more conventional statistical methods, and gives more weight to participants with more data ([Baayen, Davidson, & Bates, 2008](#); [Barr, Levy, Scheepers, & Tily, 2013](#); [Gelman & Hill, 2006](#)).

We used the (g)lmer function of the lme4 package (version 1.1-7; [Bates, Maechler, Bolker, & Walker, 2014](#)) in R, a language and environment for statistical computing ([R Core Team, 2013](#)). Following the advice of [Barr et al. \(2013\)](#), a maximal random-effects structure was used for models where possible: a per-participant random adjustment to the fixed intercept as well as per-participant random adjustments to the slopes of predictors varying within-subject. All possible random correlation terms among the random effects were included (if a maximal random-effects structure was not possible, this will be reported). Treatment contrasts (and accordingly Type II Sums of Squares) were used for models with categorical predictors with more than two levels, as these contrasts allow a direct comparison between the different levels of a predictor. Sum contrasts (and accordingly Type III Sums of Squares) were used for models involving interactions (see [Barr et al., 2013](#)). Thoughts



about the future and thoughts about the near (as opposed to the medium term and distant) past and future were used as reference categories for temporal focus and temporal distance respectively.

For linear mixed-effects models, *p*-values of overall effects were determined using conditional F tests with Kenward–Roger correction of degrees-of-freedom, as implemented in the Anova function from the package car (version 2.0-21; Fox & Weisberg, 2011; this function calls the KRmodcomp function from the package pbkrtest: Halekoh & Højsgaard, 2014). For generalized linear mixed-effects models, *p*-values of overall effects were determined using Likelihood Ratio Tests, as implemented in the anova function from the package stats4 (version 3.0.1; R Core Team, 2013). *P*-values for differences between levels of categorical predictors were determined using parametric bootstrapping as implemented in lme4's bootMer function, with 1000 simulations and deriving confidence intervals using the function boot.ci of the package boot (version 1.3-11; Canty & Ripley, 2014; Davison & Hinkley, 1997). Confidence intervals that do not include zero indicate a significant difference. For significant results, we reported the most extreme confidence interval (95% or 99%) that was significant. For non-significant results, we reported the 95% confidence interval. Confidence intervals, together with the point estimates from a model, provide information about the precision and magnitude of the effects (narrower confidence intervals suggest more precision, larger point estimates suggest larger effects). However, we additionally calculated pseudo  $R^2$  values using the r.squaredGLMM function of the package MuMIn (version 1.15.1; Barton, 2014). This function provides a value for marginal  $R^2$  (variance explained by fixed effects) and a value for conditional  $R^2$  (variance explained by both fixed and random effects). Pseudo  $R^2$  is generally seen as the best approximation of  $R^2$  for linear mixed-effects models (although this is subject to debate).

## 2.2. Results

### 2.2.1. General information sample

The average happiness level of the sample was 73.26 on a scale from 0 to 100. Mind-wandering was reported on 26.9% of all measurement occasions (1459 mind-wandering samples across 158 participants). An overview of the number and percentage of thoughts per thought category (categorized according to thought valence, temporal focus, and temporal distance) can be found in Table 1. In line with previous studies, more thoughts were positive than negative or neutral, more thoughts were future-oriented than past-oriented or oriented toward neither the past nor the future, and more thoughts were directed toward the near past and future (24 h, 1 week) than toward the medium term (1 month, 3 months, 6 months) and distant past and future (1 year, 1–5 years, more than 5 years).

### 2.2.2. Temporal focus

**2.2.2.1. Thought valence.** A linear mixed-effects model with temporal focus (past, future, neither) as predictor and thought valence as the dependent variable showed a significant overall effect,  $F(2, 94.89) = 4.39, p = .015, \text{marginal } R^2 = .01, \text{conditional } R^2 = .22$ . In line with our hypothesis, thoughts about the future ( $M = 1.30$ ) were significantly more positive compared to thoughts about the past ( $M = 0.64$ ),  $\text{Estimate} = -0.66(0.25), 99\% \text{ CI } [-1.30, -0.01]$ . Thoughts about the future were also more positive than thoughts about neither the past nor the future ( $M = 0.98$ ),  $\text{Estimate} = -0.35(0.15), 95\% \text{ CI } [-0.64, -0.04]$ . In order to test whether thoughts about the past and thoughts about neither differed significantly, a second model was run using thoughts about the past as the reference category instead of thoughts about the future. There was no significant difference between thoughts about the past and thoughts about neither,  $\text{Estimate} = 0.31(0.24), 95\% \text{ CI } [-0.17, 0.83]$  (see Fig. 1; see online supplementary materials for complete models).

**2.2.2.2. Proportion of negative, neutral, and positive thoughts.** In order to test whether the proportion of negative (mind-wandering valence from  $-5$  to  $-1$ ), neutral (mind-wandering valence equals 0), and positive thoughts (mind-wandering valence from 1 to 5) significantly differed for thoughts about the past, future, and neither, three mixed-effects binomial regression models were carried out with temporal focus as a predictor and the proportion of negative, neutral, or positive thoughts as the dependent variable. For these analyses, only a random intercept was used. Adding random slopes was not possible as there were more random effects than observations.

A significant overall effect of temporal focus on the proportion of negative thoughts was found,  $\text{Chisq}(2) = 18.60, p < .001, \text{marginal } R^2 = .03, \text{conditional } R^2 = .15$ . The proportion of negative thoughts was lower for thoughts about the future compared to thoughts about the past,  $\text{Estimate} = 0.88(0.20), 99\% \text{ CI } [0.36, 1.40]$ . No significant difference was found between thoughts about the future and thoughts about neither,  $\text{Estimate} = 0.09(0.16), 95\% \text{ CI } [-0.23, 0.40]$ . Thoughts about the past had a higher proportion of negative thoughts compared to thoughts about neither,  $\text{Estimate} = -0.80(0.22), 99\% \text{ CI } [-1.36, -0.23]$ .

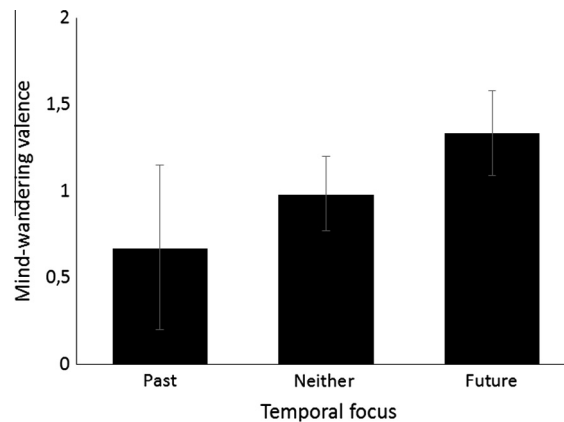
Furthermore, there was a significant overall effect of temporal focus on the proportion of neutral thoughts,  $\text{Chisq}(2) = 13.19, p = .001, \text{marginal } R^2 = .03, \text{conditional } R^2 = .23$ . The proportion of neutral thoughts was higher for thoughts about the future than for thoughts about the past,  $\text{Estimate} = -0.77(0.30), 95\% \text{ CI } [-1.36, -0.15]$ . Thoughts about the future and thoughts about neither did not significantly differ,  $\text{Estimate} = 0.27(0.17), 95\% \text{ CI } [-0.06, 0.61]$ . For thoughts about the past the proportion of neutral thoughts was lower than for thoughts about neither,  $\text{Estimate} = 1.04(0.31), 99\% \text{ CI } [0.22, 1.81]$ .

Finally, a marginally significant overall effect of temporal focus on the proportion of positive thoughts was found,  $\text{Chisq}(2) = 5.26, p = .07, \text{marginal } R^2 = .007, \text{conditional } R^2 = .097$ . Compared to thoughts about the future, the proportion of positive thoughts was marginally significantly lower for both thoughts about the past,  $\text{Estimate} = -0.36(0.19), 90\% \text{ CI } [-0.66, -0.07]$ ,

**Table 1**

Percentage and number of thoughts per thought category.

	Mind-wandering past			Mind-wandering future			Mind-wandering neither
	Near	Medium	Distant	Near	Medium	Distant	
Negative % (n)	2.95(43)	0.48(7)	1.03(15)	7.20(105)	2.33(34)	1.64(24)	6.92(101)
Neutral % (n)	1.03(15)	0.0(0)	0.14(2)	8.43(123)	0.96(14)	0.34(5)	6.92(101)
Positive % (n)	4.25(62)	0.89(13)	1.44(21)	26.05(380)	6.44(94)	1.78(26)	18.78(274)

**Fig. 1.** Temporal focus and mind-wandering valence. Average mind-wandering valence for thoughts about the past, thoughts about the future, and thoughts about neither the past nor the future (based on model).

and thoughts about neither,  $Estimate = -0.24(0.14)$ , 90% CI  $[-0.47, -0.02]$ . Thoughts about the past and thoughts about neither did not significantly differ,  $Estimate = 0.12(0.20)$ , 95% CI  $[-0.28, 0.53]$ .

Thus, in short we found that thoughts about the future were on average more positive compared to thoughts about the past. Future-oriented thoughts were less frequently negative, more frequently neutral, and somewhat more frequently positive than past-oriented thoughts.

### 2.2.3. Temporal distance

**2.2.3.1. Thought valence.** A linear mixed-effects model with temporal distance (near, medium, distant) as predictor and thought valence as the dependent variable did not show a significant overall effect,  $F < 1$ .

**2.2.3.2. Proportion of negative, neutral, and positive thoughts.** In order to test whether the proportion of negative, neutral, and positive thoughts was significantly different for thoughts about the near, medium term and distant past/future, three mixed-effects binomial regression models were carried out with temporal distance as a predictor and the proportion of negative, neutral, or positive thoughts as the dependent variable. For these analyses, only a random intercept was used. Adding random slopes was not possible as there were more random effects than observations.

A significant overall effect of temporal distance on the proportion of negative thoughts was found,  $Chisq(2) = 13.67$ ,  $p = .001$ ,  $marginal R^2 = .03$ ,  $conditional R^2 = .13$ . Compared to thoughts about the near past/future, thoughts about the medium term past/future had a marginally significantly higher proportion of negative thoughts,  $Estimate = 0.46(0.24)$ , 90% CI  $[0.07, 0.85]$ , and thoughts about the distant past/future a significantly higher proportion of negative thoughts,  $Estimate = 0.94(0.27)$ , 99% CI  $[0.24, 1.66]$ . Thoughts about the medium term and distant past/future did not significantly differ,  $Estimate = -0.48(0.33)$ , 95% CI  $[-1.11, 0.16]$ .

Furthermore, a significant overall effect of temporal distance on the proportion of neutral thoughts was found,  $Chisq(2) = 22.17$ ,  $p < .001$ ,  $marginal R^2 = .07$ ,  $conditional R^2 = .24$ . Compared to thoughts about the near past/future, the proportion of neutral thoughts was significantly lower for thoughts about the medium term past/future,  $Estimate = -1.07(0.32)$ , 99% CI  $[-1.93, -0.16]$ , and significantly lower for thoughts about the distant past/future,  $Estimate = -1.34(0.44)$ , 95% CI  $[-2.31, -0.17]$ . There was no significant difference between thoughts about the medium term and distant past/future,  $Estimate = 0.27(0.52)$ , 95% CI  $[-0.97, 1.44]$ .

Finally, there was no significant overall effect of temporal distance on the proportion of positive thoughts,  $Chisq(2) = 1.19$ ,  $p = .55$ .

In summary, we did not find a relation between temporal distance and average thought valence. However, thoughts about the medium term and distant past/future were somewhat more frequently negative and less frequently neutral than thoughts about the near past/future.

### 2.2.4. Interaction temporal focus and temporal distance

A linear mixed-effects model with temporal focus (past, future), temporal distance (near, medium, distant), and their interaction as predictors and thought valence as the dependent variable did not show a significant interaction,  $F < 1$ . However, as there were very few data for some combinations of temporal focus and temporal distance (see Table 1), this analysis may have lacked power. Results were reported separately for temporal focus and temporal distance because this allowed us to include all answer categories for temporal focus (past, future, neither) in the analyses.

### 2.2.5. Happiness

A linear mixed-effects model with temporal focus as a predictor and momentary happiness as the dependent variable did not reveal a significant overall effect,  $F < 1$ . Neither did a linear mixed-effects model with temporal distance as a predictor and momentary happiness as the dependent variable show a significant overall effect,  $F < 1$ . In order to test whether mind-wandering valence was related to momentary happiness, a linear mixed-effects model with mind-wandering valence as a predictor and momentary happiness as the dependent variable was carried out. A significant positive relation between mind-wandering valence and momentary happiness was found,  $Estimate = 3.14(0.20)$ , 99% CI [2.61, 3.67].

## 2.3. Discussion

Future-oriented thoughts were on average more positive than past-oriented thoughts. Thoughts about the future were less frequently negative, more frequently neutral, and somewhat more frequently positive than past-oriented thoughts. These findings are in line with earlier research investigating the relation between temporal focus and thought valence in the mental time travel literature. Interestingly, people indicated rather often that they were thinking about neither the past nor the future ( $n = 476$ , 32.6%). Participants may indeed often have thoughts that cannot be classified as pertaining to the past or the future (e.g. political views, philosophical musings, or a logical problem), but it is also possible that classifying thoughts as past- or future-oriented was difficult for participants (e.g. when reflecting on how a problem one encountered in the past can be prevented in the future). As such, it is uncertain what thoughts in the neither category were about. However, adding this category ensured that thoughts classified as past- or future-oriented were really about the past or the future, and were not classified as past- or future-oriented as a result of a forced choice.

Regarding temporal distance, thoughts about the medium term and distant past/future were somewhat more frequently negative and less frequently neutral than thoughts about the near past/future. However, no relation between temporal distance and average thought valence was found. As such, the results of the experience sampling study are not in line with our hypothesis that thoughts about the distant past and future may be more positive compared to thoughts about the near past and future. If anything, the frequency findings suggest an opposite effect. Furthermore, although we found a positive relation between mind-wandering valence and momentary happiness, temporal focus and temporal distance did not moderate this relationship.

As will be elaborated on in Section 4, there may be several methodological and theoretical explanations for the findings regarding temporal distance and thought valence. One possibility is that the experience sampling study suffered from a lack of power with regard to temporal distance. As people tend to think more about the near past and future than about the medium term and distant past and future, there were rather few data for the latter categories: In total, there were 728 mind-wandering samples for the near past/future, 162 mind-wandering samples for the medium term past/future, and 93 mind-wandering samples for the distant past/future across 149 participants. Only 28 participants had data for all three temporal distance categories. For the linear mixed-effects model with temporal distance (near, medium, distant) as predictor and thought valence as the dependent variable, the confidence intervals for the near past/future versus the medium term past/future,  $Estimate = 0.13(0.26)$ , 95% CI [-0.39, 0.64], and for the near past/future versus the distant past/future,  $Estimate = -0.15(0.37)$ , 95% CI [-0.87, 0.56], were relatively broad (the boundaries of the confidence intervals were four to five times higher/lower than the estimates). This suggests that this analysis may indeed have lacked power.

In order to test our hypothesis regarding temporal distance with more statistical power, we conducted a lab study in which we induced a stream of semi-naturally occurring thoughts about the near past, distant past, near future, and distant future for a duration of five minutes per condition (Study 2). It may be noted that mind-wandering paradigms in previous studies generally lasted from 30 to 40 min (e.g. Baird et al., 2011). However, these were generally non-experimental paradigms in which people did a task (e.g. a simple choice reaction time task) that was interrupted by probes inquiring into people's mind-wandering. In such paradigms, it may take some time before people's minds wander away from the primary task. Mind-wandering in our study may be comparable to mind-wandering when one is doing nothing in particular (e.g. sitting in a train or lying on the beach). As there was no primary task participants' minds had to wander away from, it stands to reason to use a much shorter period in our experiment. We considered a period of five minutes per condition reasonable. After all, introspection suggests that when one is doing nothing – again, sitting in a train or car can serve as an example – one's mind tends to wander off almost immediately. Although our approach has disadvantages (as will be elaborated on in Section 4), this approach allowed us to investigate people's train of thought about a specific temporal focus and temporal distance experimentally.

As we will show in the next section, the results of Study 2 did confirm our hypotheses, suggesting that a lack of power may indeed be a valid explanation for the unclear results regarding temporal distance and thought valence in Study 1.



### 3. Study 2: Lab experiment

#### 3.1. Method

##### 3.1.1. Participants and design

In total, 79 participants (55 females; average age: 21.97 years,  $SD = 3.42$ ) took part in this study. Participants were recruited via the Radboud Research Participation System and received EUR 7.5 or course credits for their participation. Forty-three participants were Psychology or Educational Science students, and 36 participants indicated that they were enrolled in another study program. Fifty-nine participants were Dutch, 18 participants were German, and 2 participants indicated that they had another nationality. For this study, a within-subjects design was used with temporal focus (past vs. future) and temporal distance (near vs. distant) as within-subjects factors and thought valence (average thought valence and the frequency of negative, neutral, and positive thoughts) as the dependent variables.

##### 3.1.2. Materials and procedure

The experiment was run in four (partly adjacent) weeks in March and April 2013. In order to diminish potential weekend effects on thought valence (i.e., participants might think more positively about the past week when participating on Monday and more positively about the coming week when participating on Friday), the experiment was only run on Tuesdays, Wednesdays and Thursdays. Eight participants were run in the first week, 25 participants in the second week, 16 participants in the third week, and 30 participants in the fourth week. Furthermore, fourteen participants took part on a Tuesday, 43 participants on a Wednesday, and 22 on a Thursday.

Participants were asked to sit down in front of a computer in a cubicle. First, they answered some demographical questions (sex, age, nationality, field of study) and indicated their current mood (slider from 0 = *very bad* to 100 = *very good*). Next, four blocks followed in which participants were asked to think about the past week, future week, past year, and future year consecutively (without breaks), and were asked to rate the valence of their thoughts. Both temporal focus and temporal distance were counterbalanced across participants.

At the start of each block, participants read the following instructions:

*You will be asked to think about the [PAST 7 DAYS/COMING 7 DAYS/PAST 12 MONTHS/COMING 12 MONTHS] for a duration of 5 min, and type out all thoughts that come to your mind. For this study, it is most important that you really type out all thoughts and do not make a selection. These thoughts could be about small, unimportant things, or big, important things. Your answers will be processed anonymously.*

Furthermore, it was explained that a screen with text boxes would appear in which they could type the content of all their thoughts. Participants were asked to type each thought in a separate text box (40 thoughts could be entered). At the end of each block, all thoughts that were reported during that block were presented on the computer screen sequentially, and participants were asked to rate each thought on a scale from  $-5 = \textit{very negative}$  to  $+5 = \textit{very positive}$ . The amount of time that participants needed to write down a substantial number of thoughts, the required number of text boxes, and the clarity of the instructions were pilot tested beforehand.

After completing all four blocks, a number of control questions followed. Participants were asked to indicate to what extent the past week and past year represented an average/normal week or year (not average/normal at all, not entirely average/normal, quite average/normal, very average/normal), and to what extent they expected the coming week and year to be average/normal. Furthermore, participants were asked whether they had enough time to write down their thoughts (yes, no), whether they thought it was difficult to generate thoughts (yes, no), whether they consciously tried to think of positive things (yes, no), and whether they consciously tried to think of both negative and positive things (yes, no).

Finally, participants completed a Dutch translation of the Subjective Happiness Scale (Lyubomirsky & Lepper, 1999), as well as a number of questionnaires and a task that were included for explorative reasons, but are not further relevant here (Short version of the Big Five Inventory: Benet-Martínez & John, 1998; Rosenberg Self-esteem Scale: Rosenberg, 1965; General Regulatory Focus Measure: Lockwood, Jordan, & Kunda, 2002; Revised Life Orientation Test: Scheier, Carver, & Bridges, 1994; single target happiness IAT: Derks, Gloude-mans, & Dijksterhuis, unpublished data).

##### 3.1.3. Data preparation and analysis

After taking part in the experiment, two participants indicated that they had not read the instructions properly and wrote about the same time period in the different blocks. Data from these participants were excluded from the analyses.

For each participant, mean thought valence was calculated for the past week, past year, future week, and future year. One participant had a mean thought valence that deviated more than 4 standard deviations from the mean in the future year condition. Data from this participant were excluded (excluding this participant did not substantially change the reported results). All other means were within 3 standard deviations from the mean.

As in Study 1, data were analyzed with a (generalized) linear mixed-effects model approach, using the (g)lmer function of the lme4 package (version 1.1-7; Bates et al., 2014) in R (R Core Team, 2013).

### 3.2. Results

#### 3.2.1. Frequency of thoughts

In order to test whether the number of reported thoughts differed depending on temporal focus and temporal distance, we used a Poisson generalized linear mixed-effects model with temporal focus (past vs. future), temporal distance (near vs. distant), and their interaction as predictors and number of thoughts as the dependent variable. No effect was found of temporal focus, *Estimate* =  $-0.003(0.02)$ , 95% *CI* [ $-0.03, 0.03$ ]. For the near past/future conditions ( $M = 17.09$ ) fewer thoughts were reported than for the distant past/future conditions ( $M = 18.11$ ), *Estimate* =  $-0.02(0.02)$ , 95% *CI* [ $-0.07, -0.004$ ]. The interaction between temporal focus and temporal distance was not significant, *Estimate* =  $-0.004(0.01)$ , 95% *CI* [ $-0.04, 0.02$ ]. On average, participants reported approximately 17 thoughts per thought condition (see Table 2 for an overview of the number and percentage of negative, neutral, and positive thoughts per condition).

#### 3.2.2. Thought valence

A linear mixed-effects model with temporal focus (past vs. future), temporal distance (near vs. distant), and their interaction as predictors and thought valence as the dependent variable was performed. In line with our hypothesis, thoughts about the future ( $M = 1.48$ ) were significantly more positive compared to thoughts about the past ( $M = 0.95$ ), *Estimate* =  $0.27(0.06)$ , 99% *CI* [ $0.10, 0.43$ ], and thoughts about the distant past/future ( $M = 1.43$ ) were more positive compared to thoughts about the near past/future ( $M = 1.00$ ), *Estimate* =  $-0.22(0.05)$ , 99% *CI* [ $-0.35, -0.09$ ]. No significant interaction between temporal focus and temporal distance was found, *Estimate* =  $0.005(0.05)$ , 95% *CI* [ $-0.09, 0.11$ ] (*marginal*  $R^2 = .01$ , *conditional*  $R^2 = .11$ ; see Fig. 2; see [online supplementary materials for additional analyses](#)).

#### 3.2.3. Proportion of negative, neutral, and positive thoughts

In order to test whether the proportion of negative (mind-wandering valence from  $-5$  to  $-1$ ), neutral (mind-wandering valence equals 0), and positive thoughts (mind-wandering valence from 1 to 5) significantly differed for thoughts varying on temporal focus and temporal distance, three mixed-effects binomial regression models were carried out with temporal focus, temporal distance, and their interaction as predictors and the proportion of negative, neutral, or positive thoughts as the dependent variable. For the analyses on the proportion of negative thoughts and for the analyses on the proportion of positive thoughts, no random slope for the interaction was added, as these models did not converge when adding a random slope for the interaction.

The proportion of negative thoughts was significantly higher in the past conditions compared to the future conditions, *Estimate* =  $-0.24(0.05)$ , 99% *CI* [ $-0.36, -0.12$ ], and marginally significantly higher in the near past/future conditions compared to the distant past/future conditions, *Estimate* =  $0.08(0.04)$ , 90% *CI* [ $0.008, 0.15$ ]. The interaction was not significant, *Estimate* =  $-0.004(0.03)$ , 95% *CI* [ $-0.07, 0.06$ ] (*marginal*  $R^2 = .02$ , *conditional*  $R^2 = .07$ ).

The proportion of neutral thoughts was significantly higher in the future conditions compared to the past conditions, *Estimate* =  $0.13(0.06)$ , 95% *CI* [ $0.0008, 0.26$ ], and significantly higher for the near past/future conditions compared to the distant past/future conditions, *Estimate* =  $0.17(0.07)$ , 95% *CI* [ $0.03, 0.31$ ]. The interaction was not significant, *Estimate* =  $0.04(0.07)$ , 95% *CI* [ $-0.09, 0.18$ ] (*marginal*  $R^2 = .01$ , *conditional*  $R^2 = .21$ ).

Finally, the proportion of positive thoughts was higher for the future conditions, *Estimate* =  $0.16(0.04)$ , 99% *CI* [ $0.06, 0.27$ ], and the distant past/future conditions, *Estimate* =  $-0.16(0.04)$ , 99% *CI* [ $-0.25, -0.06$ ]. No significant interaction was found, *Estimate* =  $0.008(0.03)$ , 95% *CI* [ $-0.05, 0.07$ ] (*marginal*  $R^2 = .01$ , *conditional*  $R^2 = .098$ ).

In short, these results show that thoughts about the future were on average more positive than thoughts about the past. Future-oriented thoughts were less frequently negative, more frequently neutral, and more frequently positive. Furthermore, thoughts about the distant past and future were on average more positive than thoughts about the near past and future. Thoughts oriented toward the near past and future were somewhat more frequently negative, more frequently neutral, and less frequently positive.

#### 3.2.4. Thought valence and trait happiness

In the present study, momentary happiness was not measured after each condition. Therefore, it was not possible to relate temporal focus and temporal distance to momentary happiness. However, in order to explore whether the valence of thoughts was related to trait happiness, the Subjective Happiness Scale (Lyubomirsky & Lepper, 1999) was correlated with the average thought valence across all conditions, and with the average thought valence for each condition separately. Average thought valence across all conditions showed a moderate to large positive correlation with the Subjective Happiness Scale,  $r(76) = .45$ ,  $p < .001$ . There was no significant correlation between the Subjective Happiness Scale and average thought valence within the past week condition,  $r(76) = .15$ ,  $p = .20$ , a moderate positive correlation within the past year condition,  $r(76) = .35$ ,  $p = .002$ , a moderate to large positive correlation within the future week condition,  $r(76) = .40$ ,  $p < .001$ , and a moderate positive correlation within the future year condition,  $r(76) = .33$ ,  $p = .003$ .

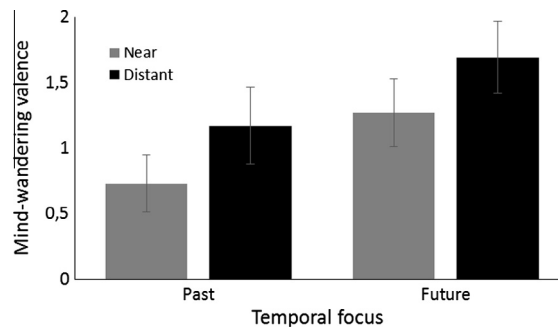
### 3.3. Discussion

Replicating the results of Study 1 and earlier research, thoughts about the future were on average more positive than thoughts about the past. In line with this, future-oriented thoughts were less frequently negative, more frequently neutral,

**Table 2**

Percentage and number of negative, neutral, and positive thoughts per condition.

	Past		Future	
	Near	Distant	Near	Distant
% negative ( <i>n</i> )	36.36(480)	32.74(456)	27.56(352)	24.49(333)
% neutral ( <i>n</i> )	10.45(138)	6.96(97)	12.37(158)	9.41(128)
% positive ( <i>n</i> )	53.18(702)	60.30(840)	60.06(767)	66.10(899)
% total ( <i>n</i> )	100(1320)	100(1393)	100(1277)	100(1360)

**Fig. 2.** Temporal focus, temporal distance, and mind-wandering valence. Average mind-wandering valence for thoughts about the near and distant past, and thoughts about the near and distant future (based on model).

and more frequently positive. Regarding temporal distance, thoughts about the distant past and future were on average more positive than thoughts about the near past and future. Thoughts oriented toward the near past and future were somewhat more frequently negative, more frequently neutral, and less frequently positive. As such, the results of Study 2 provided support for our hypothesis regarding temporal distance. Although there were several differences between Study 1 and Study 2 (as will be elaborated on in Section 4), these results suggested that a lack of power may indeed be one possible explanation for the unclear (somewhat contradicting) temporal distance findings of Study 1. No interaction between temporal focus and temporal distance was found.

## 4. General discussion and conclusion

### 4.1. Temporal focus and mind-wandering valence

With regard to temporal focus, the experience sampling as well as the lab study showed that thoughts about the future are on average more positive than thoughts about the past. In the experience sampling study, thoughts about the future were less frequently negative, more frequently neutral, and marginally significantly more often positive compared to thoughts about the past. As such, this was the first experience sampling study showing that the positivity bias is greater for future-oriented than for past-oriented mind-wandering. By using an experience sampling study with random signaling, limitations of methods used in previous studies, such as potential memory and reporting biases, were reduced. In the lab experiment, thoughts about the future were less frequently negative, more frequently neutral, and more frequently positive compared to thoughts about the past. These results are in line with previous findings obtained in lab studies, in questionnaire research, and in diary studies on involuntary autobiographical memories and future projections (Andrews-Hanna et al., 2013; Berntsen & Jacobsen, 2008; Finnbogadóttir & Berntsen, 2013; Newby-Clark & Ross, 2003).

### 4.2. Temporal distance and mind-wandering valence

We hypothesized that the frequency of positive thoughts is higher for the distant past and future than for the near past and future. However, the experience sampling study did not show a difference in average valence between thoughts about the near, medium term, and distant past/future. The frequency of negative thoughts was somewhat lower for thoughts about the near past/future than for thoughts about the medium term and distant past/future. As the frequency findings were statistically relatively weak, and as no differences on average thought valence were found, these results did not provide clear insights in the relation between temporal distance and thought valence. If anything, these results suggested that increasing temporal distance is associated with more negative thoughts.

The results of the lab study were consistent with our expectations, and showed that thoughts about the distant past/future were on average more positive than thoughts about the near past/future. Thoughts oriented toward the near past/future were somewhat more frequently negative, more frequently neutral, and less frequently positive compared to

thoughts oriented toward the distant past/future. In sum, the results of the lab experiment provided support for our hypothesis regarding temporal distance, while the results of the experience sampling study, if anything, pointed toward an opposite effect.

As we will speculate below, it is possible that different processes play a role in mind-wandering in daily life versus during induced mind-wandering in the lab. However, as we discuss subsequently, we may have captured different types of mind-wandering (intentional and unintentional) in the different studies. In addition, the experience sampling study may have suffered from insufficient statistical power with regard to the temporal distance analyses.

#### 4.2.1. *Measuring versus inducing mind-wandering*

A potential explanation for the diverging findings on temporal distance in our studies may stem from the difference between measuring mind-wandering in people's daily lives and inducing mind-wandering in a lab setting. When asked to report one's stream of thoughts about the near past/future in a lab experiment, concrete negative and positive events that actually happened or are expected to happen may readily come to people's minds. When asked to think about the distant past/future, most people may automatically adopt a more abstract mindset (focus on *why*'s), leading to a higher frequency of positive thoughts. However, one may speculate that in daily life, mind-wandering about the distant past and future tends to occur more when people experience regrets, traumas, or worries with regard to the distant past and future, and to occur less when people do not experience such worries, traumas, or regrets (see literature on rumination; e.g. [Martin & Tesser, 1996](#); [Smith & Alloy, 2009](#)). If this is the case, we may have sampled a disproportionate number of thoughts from a particular group of people with negative thoughts about the distant past and future. This may have resulted in a somewhat higher frequency of negative thoughts for the distant past and future than for the near past and future.

#### 4.2.2. *Intentional versus unintentional mind-wandering*

However, in the experience sampling study we may also have, inadvertently, captured various different types of mind-wandering. In order to measure mind-wandering, participants were asked whether they were thinking about something else than the activity they were currently engaged in. While this question makes a clear distinction between thinking about one's primary task versus thinking about something else, this question does not distinguish between intentional versus unintentional thought about something else than one's current task. For example, participants may have answered the mind-wandering question affirmatively when intentionally thinking about their grocery list while actually attending a boring presentation. A lab study by [Seli, Cheyne, Xu, Purdon, and Smilek \(2015\)](#) showed that a substantial percentage of off-task thought (41%) is reported to be intentional by participants.

The mind-wandering literature is somewhat unclear regarding the issue of intentionality. Although mind-wandering has often been described as unintentional thought about something else than one's current activity (e.g. [Smallwood & Schooler, 2006](#)), instances of intentional mind-wandering about something else (e.g. during a boring task) have also been mentioned in previous work (e.g. [Mooneyham & Schooler, 2013](#); [Smallwood & Schooler, 2015](#)). While both types of mind-wandering may be considered an interesting topic of investigation, it is relevant to make a distinction between them (see also [Seli et al., 2015](#)). Namely, although it is uncertain how the intentionality of mind-wandering is related to the valence of one's thoughts, it seems likely that intentional mind-wandering is more positive compared to unintentional mind-wandering. For example, rumination (which is typically defined as unintentional) tends to be negative ([Martin & Tesser, 1996](#)), while fanciful daydreaming (which is often described as more deliberate; [Klinger, 2009](#)), is inherently positive. If thoughts about the near and distant past/future differed regarding their proportion of intentional and unintentional mind-wandering in the experience sampling study, this may in turn have had consequences for the valence of thoughts varying with regard to their temporal distance.

In relation to this issue of intentionality, it should be noted that it is difficult to unobtrusively manipulate mind-wandering about a specific temporal focus and temporal distance. One may argue that once participants are instructed to let their minds wander, as was done in our lab experiment, it is not really mind-wandering anymore. The instruction to report thoughts about a particular temporal focus and distance may increase participants' control over their thoughts, and prime the retrieval of relatively accessible, rehearsed thoughts (see [Vannucci et al., 2014](#)). However, it should be noted that this seems to be a limitation inherent to mind-wandering research aimed at investigating specific mind-wandering contents experimentally. Furthermore, in research on mind-wandering and unintentional mental time travel, participants are always aware – to some extent at least – that they will be asked to report their thoughts (in general or about a specific topic), which may in turn influence the number of thoughts they have, as well as the characteristics of their thoughts.

Methodologically, there may be several ways to deal with the challenges associated with investigating mind-wandering content experimentally. Unobtrusively cueing participants with a particular temporal focus (e.g. by cueing achieved versus unachieved goals) may increase the number of thoughts about a particular temporal focus. However, people are likely to have a wide variety of other thoughts (possibly about the non-cued temporal focus) as well. Furthermore, it is questionable to what extent it is possible to manipulate both temporal focus and temporal distance simultaneously by cueing participants. Recently, [Cole, Staugaard, and Berntsen \(2015\)](#) developed a laboratory paradigm in which participants carried out a monotonous task that included cues to elicit involuntary mental time travel. Participants were instructed to report either past- or future-oriented involuntary representations during the task. This paradigm is a methodological advancement as it allows the simulation of involuntary past- and future-oriented thoughts in a controlled setting. However, this method also has some of the limitations mentioned previously, such as potential unawareness of involuntary thoughts, reporting biases, frequent occurrence of other thought types than the manipulated thought type, and potential difficulties in manipulating both temporal focus and distance.

Although participants may initially have had relatively intentional thoughts in our experiment, their thoughts may have become more associative and unintentional, more like ‘real’ mind-wandering, over time. This process may actually be quite similar to mind-wandering in daily life. Namely, previous research suggests that “mind-wandering is stimulus independent only once the task unrelated thoughts are set in motion, but that it is stimulus dependent in terms of identifiable cues that trigger these thoughts in the first place” (Plimpton et al., 2015, p. 273). In other words, also in daily life, mind-wandering may initially be triggered by external cues. However, as it is uncertain whether the five minutes per block in our experiment were sufficient to lead people to move from intentional to unintentional thought, we can only speculate about this. To the best of our knowledge, this was the first study to manipulate a semi-natural stream of thoughts about a specific temporal focus and distance. As suggested before, this may be similar to mind-wandering when one is doing nothing.

#### 4.2.3. Statistical power

Finally, the somewhat unclear findings with regard to temporal distance in the experience sampling study may be attributable to a lack of statistical power. As was discussed earlier in this article, there were rather few data for the medium term and distant past/future. Replicating this study with a bigger sample may shed light on the robustness of the present findings. While experience sampling has many advantages, the lack of control over the types of thoughts that are sampled may be considered a disadvantage of carrying out an experience sampling study using random signaling.

#### 4.3. Temporal focus, temporal distance, and happiness

The present study had one explorative aim, namely investigating the relation between temporal focus, temporal distance, and happiness. While thought valence was indeed related to momentary happiness in the experience sampling study, temporal focus and distance did not moderate this relation. Happiness was not measured after each condition in the lab study, but the valence of people’s thoughts was related to trait happiness.

#### 4.4. Directions for future research and conclusions

This was the first study to investigate the relation between temporal focus and mind-wandering valence with experience sampling, as well as the first to investigate the role of temporal distance for both past and future-oriented mind-wandering. By combining the experience sampling study with an experimental study, we benefited from the strengths of both methods. Using both a field and a lab study seems especially relevant as some types of thoughts (e.g. about the distant past and future) might only occur for some people (with particular characteristics) in daily life. As described above, there are several challenges associated with investigating mind-wandering content experimentally. The further exploration and development of paradigms that are suitable for this end may be a worthwhile endeavor for future work.

Future research may also shed more light on the relation between temporal distance and thought valence. It may be interesting to investigate this relation in people’s daily lives with a bigger sample. Furthermore, it seems relevant to investigate potential differences in the relation between temporal distance and happiness depending on whether mind-wandering is measured or induced (both could be done in the lab). Finally, for the present research as well as for mind-wandering research in general, it is highly important to distinguish between intentional and unintentional mind-wandering. Knowledge of the relation between temporal focus, temporal distance, and mind-wandering valence in people’s daily lives and in an experimental context may not only be relevant from a theoretical perspective, but may also be relevant for interventions aimed at boosting happiness by increasing the valence of people’s thoughts.

### Appendix A. Experience sampling questionnaire

- (1) **How happy do you feel at the moment?** (slider from 0 = *not happy at all* to 100 = *very happy*)
- (2) **Were you thinking about something else than what you are currently doing?** (yes, no)
  - (a) **Were you thinking about the past, the future, or neither?** (past, future, neither)
    - (i) **How far were you thinking back/forward into the past/future?** (24 h, a week, a month, three months, six months, a year, one to five years, more than five years).
  - (b) **Were you thinking about yourself or something else?** (myself, something else)
    - (i) **Were you thinking about your private self or yourself in relation to others?** (private self, public self, neither)
  - (c) **Was your thought negative, neutral, or positive?** (slider from –5 = *very negative* to 5 = *very positive*)
- (3) **What are you currently doing?** (personal care, commuting/traveling, groceries, shopping, household, preparing food, eating, studying, working, taking care of my children, praying, meditating, resting/sleeping, relaxing/nothing special, reading leisure, watching television, sports, computer leisure, listening to the radio, walking, listening to music, playing, talking/conversation, making love, cinema/concert/theatre, playing instrument, ‘Other, namely ...’)
  - (a) **How much do you like this activity at the moment?** (slider from –5 = *not at all* to 5 = *very much*)



- (b) **To what extent are you mentally active?** (Likert scale from 1 = *not at all* to 7 = *very much*)  
 (c) **To what extent are you physically active?** (Likert scale from 1 = *not at all* to 7 = *very much*)  
 (d) **To what extent is this activity meaningful for you?** (Likert scale from 1 = *not at all* to 7 = *very much*)  
 (e) **To what extent are you doing this activity voluntarily?** (Likert scale from 1 = *not at all* to 7 = *very much*)
- (4) **Are you communicating with other people at the moment?** (yes, no)  
 (a) **Whom are you communicating with?** (partner, children, family, friends, colleagues, boss, clients/patients/students, 'Other, namely...')
- (5) **Where are you at the moment?** (home, work, school/university, 'Other, namely...')
- (6) **Did you fill out the questionnaire immediately after receiving the text message?** (yes, no)  
 (a) **How much time passed between receiving the text message and filling out the questionnaire?** (1 min, 5 min, 15 min, 30 min, more than 30 min).

## Appendix B. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.concog.2016.02.004>.

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