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The relation between thinking and mood in daily life: The effects of content and context of thought

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ABSTRACT

The association between thought content and mood in daily life is far from established. The aim of the present investigation was to examine the role of content and context of thought in daily life mood (i) concurrent and across time, and (ii) as simple effects and as interactions between them. Participants were 50 university students (82% female), who completed experience sampling assessments for a week. Linear mixed-effects models showed that time and object aspects of thought were significantly associated with concurrent mood. In addition, interaction effects between object of thought and thought context (activity) significantly predicted concurrent, but not future, mood, sometimes showing a switch from a positive to a negative association in certain contexts. It is concluded that associations between thought content and mood in daily life (i) are depending on the activity context, and (ii) seem to be relatively short-lived in most cases.

1. Introduction

The association between thinking and mood remains largely obscure to date. A notable exception is the area of (perseverative) negative thinking, including rumination and worry, which has shown its role in negative mood (Miranda & Nolen-Hoeksema, 2007; Nolen-Hoeksema, 2000). Most research has been devoted to the study of mind-wandering, or spontaneous off-task thought. This is a widely occurring phenomenon, with estimates showing that about half of our waking time is spent thinking about things other than the activity of the present moment (Killingsworth & Gilbert, 2010). Attempts have been made to examine its association with emotional well-being.

1.1. Experimental studies

Several controlled laboratory studies have shown an association between mind-wandering and negative mood. In such studies, the focus has been mainly on the induction of negative affect, which generally leads to more mind-wandering during various tasks after the mood induction (Jonkman et al., 2017; Smallwood et al., 2009; Stawarczyk et al., 2013). In addition, mind-wandering in negative mood seems to be mainly oriented towards thoughts about the past, compared to thoughts situated in another time frame (Smallwood & O’Connor, 2011).

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Studies experimentally manipulating mind-wandering are much more scarce, partially probably because of the difficulty of having a valid control condition (Mason et al., 2013). In one study, mind-wandering as a predictor of affect was induced by a continuous response task, but indeed without a control condition, not permitting conclusions regarding causality. The authors showed that more mind-wandering was associated with later increased accessibility of negative thoughts in somewhat depressed young adults, but not with concurrent thought valence or later mood (Marchetti et al., 2012). In a recent elegant laboratory investigation, differential associations were obtained between habitual positive mind-wandering during a task, being associated with higher trait emotional well-being, and spontaneous off-task mind-wandering, being associated with lower trait emotional well-being (Wang et al., 2018). However, in addition to the absence of a control condition, these associations were based on performance during a monotonous laboratory task, raising the question whether results generalize to everyday life activity. Nevertheless, Wang et al. (2018) showed a convincing case for the notion of mind-wandering most likely being a heterogenous construct, of which different facets may have different functional consequences.

It has been argued that consequences of mind-wandering may be depending on factors related to the context of mind-wandering and content of mind-wandering (Smallwood & Andrews-Hanna, 2013). The context refers to the situational context in which mind-wandering takes places, such as the different activities one may employ. In experimental studies outcomes may be depending on characteristics of the task, such as task difficulty. In daily life outcomes of mind-wandering may also depend on task complexity and, more broadly speaking, on the kind of activity one is involved in at the moment. The content of mind-wandering refers to the content of the thoughts one is having, such as time focus (e.g., past, present, future), or object focus (e.g., self, other).

A limited number of attempts have been made to address these potential influences. In a laboratory setting, the off-task thought content was associated with mood in a bidirectional way: a more negative mood predicted increased later mind-wandering and vice versa. In addition, negative past- and other-focused thoughts predicted decreased later mood when mood was high first (Ruby et al., 2013), while in another study the temporal order was reversed: lower induced mood was associated with more thoughts about the past at a later time later in the experiment (Smallwood & O’Connor, 2011).

1.2. Ecological monitoring studies

Daily life studies using experienced sampling methodology (ESM) are more sparse. They show conflicting results regarding the association between mind-wandering and mood, which is not surprising, when considering the notion of heterogeneity of mind-wandering. In two ESM studies general mind-wandering was associated with a more negative mood. In one small study, this association was mainly regarding thinking about the past (Poerio et al., 2013). The other, widely cited, study by Killingsworth and Gilbert (2010) showed that mind-wandering was associated with a lower mood across a range of situations. This effect was also obtained in time lagged analyses in which mind-wandering versus not mind-wandering preceded mood assessment. However, another recent study showed mind-wandering to predict later positive mood in a daily life ESM study when controlling for previous mood in a sample of students (Welz et al., 2018). In that study the relevant context might have been the study sample (healthy students) in addition to the methodological effect of controlling for previous mood. Controlling for previous mood has both potential advantages and disadvantages. It seems that in doing so one is testing the pure association between mind-wandering and later mood, controlling for longer-term baseline mood. However, in the case that mind-wandering has immediate effects on mood that are lasting until the next measurement moment, controlling for previous mood would actually remove a part of the variance of interest. Unfortunately, to the best of our knowledge, no theoretical model in which the various temporal dynamic associations between mind-wandering and mood include different time scales are outlined, has been published. Nevertheless, the model including the potential influencing factors of the context and content of mind-wandering on emotional consequences (Smallwood & Andrews-Hanna, 2013) provides avenues for research. Specifically, these influencing factors imply possible moderation effects by these factors on the association between mind-wandering and mood. In addition, the interaction between the content and context factors of mind-wandering has not been explored to date. The interaction between these characteristics may be an additional factor influencing mood. For instance, mind-wandering during work about work related issues may have a totally different function and effect on mood, compared to mind-wandering during leisure time about work related issues.

1.3. Present research

Therefore, in the present study, the dynamic association between on- and off-task thought and mood has been examined, extending previous findings mainly by (i) examining various dimensions of the content of thought simultaneously, and (ii) examining their interaction with the context of thought. To this end, an ESM study was conducted during a week of daily life of university students. The contextual factors were the daily activities employed and the content factors were along two dimensions based on previous research. The first dimension reflected the time focus of the thoughts (past, present, future) and the second dimension reflected the object focus of the thoughts (e.g., self, other, work, leisure). In addition, the interaction effects between the context and content dimensions were determined. The temporal association between the factors and mood were examined applying lagged analyses, which examine the associations across time. Considering the dilemma of including previous mood as covariate, we addressed this by performing the analyses both with and without controlling for previous mood in order to be better able to interpret the results.

Based on previous findings discussed (Poerio et al., 2013; Ruby et al., 2013; Smallwood & O’Connor, 2011) and the rationale provided above, it was hypothesized that (i) a simultaneous and bidirectional temporal association would emerge between certain type of thoughts (i.e., having as contents events from the past) and lower mood; (ii) the association between thought content and mood would be dependent on the activity the person was involved in. Because no clear specific hypotheses could be formed regarding which
specific interaction effects to expect based on previous literature, the second hypothesis was formulated as an exploratory general proof of principle, potentially generating more specific hypotheses to be tested in the future.

2. Methods

2.1. Participants

Participants were undergraduate students of a Dutch university. They received course credit for participation. They were invited via an online portal of the university where they could subscribe to various studies. Inclusion criterion was at least 18 years of age. Exclusion criterion was self-reported psychopathology. Informed consent was obtained for all participants. The study was approved by the Ethical Review Board of Tilburg University.

2.2. Procedure

First, participants attended a session at the university with two or three other participants during which the procedure was explained. Experience sampling methodology was used to obtain ecologically valid data (Hurlburt, 1979; Welz et al., 2018). For seven days, participants were requested to answer 10 questions on their mood, thoughts, activities, and circumstances every 1:55 h during daytime (between waking up and going to sleep). The questions were answered online on their own smartphone.

2.3. Instruments

The questions participants answered on their smartphones were largely based on previous research (Killingsworth & Gilbert, 2010; Poerio et al., 2013; Ruby et al., 2013), adapted for the aims of the present study. Mood was assessed asking the question “How are you feeling right now?”, which was answered on a continuous sliding scale from 0 (“extremely bad”) to 100 (“extremely good”) following Killingsworth & Gilbert (2010). The assessment of activities persons were involved in just before the measurement were also in line with Killingsworth & Gilbert (2010), including activities ranging from inactive (e.g., sleeping), to active (e.g., working, exercising) and from solitary to social (e.g., conversation) activities. The activities were not mutually exclusive (e.g., resting and watching television).

Regarding thoughts, participants were first asked “Just before the signal, were you thinking about something?”. Next, participants were asked about the object of their thoughts by asking the question “What were you thinking about?”, which they could answer with the options: “About myself”, “About someone else”, “About work or college”, “About other obligations”, “About leisure time”, or “Not applicable”. Then, the time frame the thoughts were in was assessed by means of the question “Where were your thoughts situated regarding time?” with the response options being “About something that happened earlier”, “About something that will or may happen later”, “About what I was just doing”, “About what I was just experiencing (saw, heard, felt, etc.)”, and “Not applicable”. The participants were allowed to indicate multiple responses, because one may have been thinking about different contents, even in a short period of time.

2.4. Analysis

To examine the associations between thought content, thought context, and mood, linear mixed-effects models were performed using lme in R. In all analyses subject was included as random intercept by adding ‘(1|Subject)’ to the formulas defining the models. The resulting models were evaluated with t-tests and p-values to assess the statistical significance of the fixed factor(s) in the model. Both marginal and conditional R^2 were computed using the function ‘r2 functions R^2 expressing the proportion of variance explained by the fixed factors and conditional R^2 expressing the proportion of variance explained by both the fixed and random factors (Nakagawa & Schielzeth, 2013).

Analyses were performed in three phases. In the first phase, only simple effects (i.e., including only thought object, thought time frame, or activity categories) were included in the model. Because answers were not mutually exclusive (for example, participants could be thinking about the present and future simultaneously), this was done twice: (1) including only effects of single categories, and (2) including all effects, including combinations of categories.

In the second phase, lagged analyses were performed to examine the temporal sequence of the relationship between the variables in both directions: does thought content or thought context at the previous data point (t-1) precede subsequent mood (t) or the reverse, mood at previous data point (t-1) preceding subsequent thought content and/or context (t). In the case lagged analyses would show significant associations in both time directions, the two models were compared using likelihood ratio tests using Chi-Square (χ2) (Winter, 2013). All lagged analyses were performed twice: with and without adjusting for the autoregressive effect of mood at the previous data point by including it as a random intercept (Mood ~ ....+ (1|Mood.t-1) + (1|Subject). These two first phases would test these associations in general, including the first hypothesis.

In the third phase, testing the second hypothesis, the interaction between thought content and context regarding its effect on mood was examined by including all possible combinations of categories of thought content and combinations of categories of thought context in a model. However, because this resulted in too many terms in the model in light of the number of observations (Babyak, 2004), combinations of categories with a low prevalence (<5%) were removed. In addition, to reduce the number of variables along meaningful ways and to enhance interpretation of the results, a second analysis was performed. To this end, the 19 activity categories were reduced along two dimensions: (i) at least marginally significant (p < .10) simultaneous association with mood (positive,
negative, or neutral), and (ii) level of mental activity presumably involved (low versus high; based on the judgment of first author), resulting in six categories (see Table 4). The rationale for these two dimensions was that interaction effects may be most prominent when (i) the mood associated with the activity would not match the mood of the content of thought (e.g., thinking about the past expected to be associated with more negative mood, while engaged in an activity associated with a positive mood), and (ii) mind-wandering may be more easy to occur, i.e. when current mental activity is low, such as when underway or relaxing. Thus, in the third phase, models were built in a hierarchic way to examine to what extent the hypothesized interactions between thought content and context on mood would show significant effects over and above the effects of the simple (main) effects.

3. Results

3.1. Descriptive statistics

Seventy-five people subscribed, came to the instruction session, and started the app. However, because some participants did not adhere to the instructions, resulting in too few data entries (between 1 and 41), data of 50 participants who had at least 42 entries (6 per day) were analysed. These participants were on average 20.1 (SD = 2.1) years of age (range 18 – 31), 41 (82%) were female. These figures were not different from those of the 25 non-adherers.

First, Spearman correlation coefficients were computed to explore how the various time and object aspects of thoughts were related. Significances are not reported as the associations are based on all 2100 data points, implying a mixture of between- and within-subject data. Within both the time and object domains, most correlations were very low (rho < 0.20). Only one correlation per domain exceeded rho of 0.20, namely (i) between thoughts about the current activity and thoughts about the future (rho = -0.20), and between thoughts about study or work and thoughts about leisure time (rho = -0.29). Between these domains, three correlations exceeded 0.20: thinking about another person was associated with thinking about the current experience (rho = 0.26) and about the past (rho = 0.28), while thinking about school or work was associated with thinking about the current activity (rho = 0.27).

3.2. Time related thought content and mood

In the first phase of testing linear mixed-effects models, the time aspect of thought content was examined first in its simultaneous relation with mood. The model, including all effects of potential combinations of the four time categories (15), was significant (F(15, 2048) = 5.39, p < .001; conditional R^2 = 0.40; marginal R^2 = 0.03). All five significant simple effects included thinking about the current activity, alone or in combination with thoughts reflecting different time frames. However, in this analysis the contribution of some effects may have been inflated by combinations with a very low occurrence: e.g., the strongest effect was shown by the combination of thinking about the current activity, current experience, and future events (coefficient = 10.50, SE = 2.68, p = .00009), which occurred only 27 out of 2100 times. When including only effects of the four single time categories, not combinations, the proportion of explained variance was comparable to that of the model with all combinations of categories (conditional R^2 = 0.39; marginal R^2 = 0.02). When examining the contribution of each time aspect as a single category, the strongest association was found for thinking about the current activity, which was associated with higher mood (coefficient = 3.59, SE = 0.63, p < .001). Thoughts directed at the future were also associated with higher mood, while thoughts about the past were associated with lower concurrent mood (Table 1).

When examining the temporal dynamics of the association between these variables in phase 2, the first model tested the association of previous time related thought content (t-1) with subsequent mood (t). This model was significant (F(15, 1998) = 2.12, p = .007, conditional R^2 = 0.39; marginal R^2 = 0.011), also when correcting for the effect of previous mood (t-1) (model F(15, 1965.8) = 1.87, p = .022, conditional R^2 = 0.38; marginal R^2 = 0.010). When examining the contribution of each time aspect, only thinking about one’s current activity explained subsequent higher mood, also when correcting for the effect of previous mood (coefficient = 1.45, SE = 0.64, p = .02). The second lagged model, testing the association in the opposite direction—previous mood (t-1) explaining subsequent thought content (t)—was also significant, even when adjusted for the autoregressive effect of thought content (t-1)(model F(15, 1869.7) = 2.43, p = .002, conditional R^2 = 0.39; marginal R^2 = 0.002). Single effects showed that higher mood only explained lower subsequent incidence of thoughts about the past, controlled for the autoregressive effect of previous similar thoughts (coefficient = -1.95, SE = 0.86, p = .02). The two lagged models testing the association in the different directions (thought content preceding mood versus mood preceding thought content) did not differ regarding their explanatory power (p > .10).

Table 1

<table>
<thead>
<tr>
<th>Time orientation</th>
<th>Grand Mean</th>
<th>Standard Deviation</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td></td>
<td>56.34</td>
<td>1.51</td>
<td>37.24</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Current Activity</td>
<td>0.46</td>
<td>0.50</td>
<td>3.59</td>
<td>0.63</td>
<td>5.72</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Current Experience</td>
<td>0.25</td>
<td>0.43</td>
<td>−0.39</td>
<td>0.70</td>
<td>0.56</td>
<td>0.575</td>
</tr>
<tr>
<td>Past</td>
<td>0.14</td>
<td>0.35</td>
<td>−2.51</td>
<td>0.84</td>
<td>3.00</td>
<td>0.003</td>
</tr>
<tr>
<td>Future</td>
<td>0.29</td>
<td>0.46</td>
<td>1.43</td>
<td>0.66</td>
<td>2.17</td>
<td>0.030</td>
</tr>
</tbody>
</table>

Note. Means are overall means across participants (between-subject) and time (within-subject) answers coded 0 (not present) or 1 (present).
3.3. Object related thought content and mood

When the object aspect of thought content was examined in its relation to mood, only a model testing the simultaneous association was significant ($F (30, 2029.7) = 7.56, p < .001$). Similar proportions of explained variance emerged when including effects of all 28 combinations of the five object categories (conditional $R^2 = 0.42$; marginal $R^2 = 0.07$), and when including effects of the five single categories only (conditional $R^2 = 0.41$; marginal $R^2 = 0.05$). Examining the explanatory power of each single object of thought, the strongest contributing factor was thinking about leisure time, showing a positive association with current mood (coefficient = 8.65, SE = 0.70, $p < .001$). The only other thought object showing a significant association was thinking about another person, also showing a positive association with mood (Table 2). However, lagged analyses did not reveal any significant associations across time, with or without adjusting for mood at the previous moment ($p > .10$).

3.4. Situational context and mood

When the situational context was examined in its relation to mood, again only the model testing the simultaneous association was significant ($F (233, 1822) = 1.42, p < .001$; conditional $R^2 = 0.44$; marginal $R^2 = 0.09$ for effects of all combinations of categories and conditional $R^2 = 0.40$; marginal $R^2 = 0.03$ when including effects of single categories only). When examining the association of each activity, the strongest contributing factors to current mood were resting/sleeping showing a negative association with mood (coefficient = -4.14, SE = 0.88, $p < .001$) and talking to someone being positively associated with current mood (coefficient = 2.84, SE = 0.84, $p < .001$). Significant associations were also obtained for listening to music/radio, taking care of children and exercising, all showing positive associations (Table 3). However, lagged analyses did not reveal any significant associations across time, with or without adjusting for mood at the previous moment (likelihood ratio $\chi^2 = 0.00, p > .10$).

3.5. Interactions between content and context

When interaction effects between the time component of thought content and the situational context were added to a model testing the above described main effects of these factors in their simultaneous association with mood (including only the 35 terms with at least 5% prevalence), the interaction term was not significant ($F (24, 677) = 1.29, p = 0.160$, model’s conditional $R^2 = 0.42$ and marginal $R^2 = 0.07$). The second analysis, including only the six condensed activity categories (Table 4), also resulted in 35 terms and also did not show a significant interaction effect ($F (24, 1156) = 1.28, p = 0.163$, model’s conditional $R^2 = 0.39$ and marginal $R^2 = 0.06$). In addition, none of the lagged analyses including the interaction between the time component of thought content and the situational context showed significant explanatory power across time, both with and without correction for previous mood ($p > 0.10$).

Adding the interaction between the object component of thought and the situational context of combinations with a prevalence of at least 5% resulted in 30 terms included in the model, including the intercept. The interaction term was significant ($F (20, 636.54) = 2.24, p = 0.002$, model’s conditional $R^2 = 0.47$ and marginal $R^2 = 0.09$). The second analysis based on the reduced number of 6 combined activity categories and having at least 5% prevalence, also resulting in 30 terms in the model, including the intercept, also showed a significant interaction effect ($F (20, 1062.2) = 2.16, p = 0.002$, model’s conditional $R^2 = 0.44$ and marginal $R^2 = 0.08$). Of the 29 content based terms, 18 were significant, of which 9 showed a $p < .01$ (Table 4). While the strongest positive association with mood was shown by the main effect of thinking about leisure without any present activity, the three strongest negative associations with mood were also shown by thinking about leisure, but combined with a passive negative activity (i.e., resting), or a passive or active neutral activity (e.g., working, smartphone). However, none of the lagged analyses showed significant explanatory power across time, both with and without correction for previous mood ($p > .10$).

4. Discussion

The aim of the present investigation was to examine the role of both content of thought and context of thought in daily life mood (i) simultaneous and across time, and (ii) as simple effects and as interactions between these factors. First, in line with previous research, both the time and the object aspects of thought content showed significant associations with mood. Regarding the specific hypotheses based on previous studies, the association between thinking about past experiences and current mood was negative as expected. This association was obtained when both variables were assessed at the same time, as well as in lagged analyses with previous mood

<table>
<thead>
<tr>
<th>Thought object</th>
<th>Grand Mean</th>
<th>Standard Deviation</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>55.72</td>
<td>1.44</td>
<td></td>
<td></td>
<td>38.63</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Myself</td>
<td>0.25</td>
<td>0.43</td>
<td>-1.24</td>
<td>0.69</td>
<td>1.78</td>
<td>0.074</td>
</tr>
<tr>
<td>Other person</td>
<td>0.20</td>
<td>0.40</td>
<td>1.95</td>
<td>0.75</td>
<td>2.59</td>
<td>0.010</td>
</tr>
<tr>
<td>Work or school</td>
<td>0.29</td>
<td>0.46</td>
<td>0.36</td>
<td>0.68</td>
<td>0.52</td>
<td>0.600</td>
</tr>
<tr>
<td>Other obligations</td>
<td>0.13</td>
<td>0.33</td>
<td>-0.01</td>
<td>0.86</td>
<td>0.01</td>
<td>0.991</td>
</tr>
<tr>
<td>Leisure</td>
<td>0.24</td>
<td>0.43</td>
<td>8.65</td>
<td>0.70</td>
<td>12.28</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

*Note: Means are overall means across participants (between-subject) and time (within-subject) answers coded 0 (not present) or 1 (present).*
explaining current thinking: lower previous mood was associated with more current thinking about past experiences. This is in accordance with most of the literature showing that task-related thought is associated with better mood compared with off-task thought, found both when simultaneously assessed as well as in time-lagged analyses (Franklin et al., 2013; Killingsworth & Gilbert, 2010; Poerio et al., 2013; Ruby et al., 2013). One exception has been the study by Welz et al. (2018), showing that off-task thought was associated with later more happy mood in daily life in a sample of college students, when controlled for previous mood. These results of Welz et al. (2018) might be different because of the fact that in their study almost half of the participants had experience with mindfulness meditation, which is known to enhance positive affect (Nyklicek & Kuijpers, 2008). Indeed, the scores of the sample of that study on daily positive affect was twice as high compared to scores on negative affect. It may be speculated that in such a sample, the valence of thoughts is more positive in general, influencing mood in a more positive way. This explanation would be in line with the theoretical model of Smallwood and Andrews-Hanna (2013) claiming that the effect of mind-wandering is depending on various factors regarding both the content and context of mind-wandering.

Regarding the effects found on the object aspect of thoughts, in the current study thinking about another person and especially thinking about leisure were associated with higher mood. However, these associations were found only when both variables were assessed at the same time. The association of thinking about leisure with higher mood seems unsurprising, as leisure is generally viewed as pleasurable. The association of thinking about another person with higher mood may be viewed as somewhat in contrast with a previous investigation showing other-and-past related mind-wandering being associated with lower mood (Ruby et al., 2013). However, the context of Ruby et al.’s study was the performance of a 14-min continuous response task, which is a relatively boring activity.

### Table 3
Fixed simple effects of activity context explaining simultaneous mood.

<table>
<thead>
<tr>
<th>Activity Grand Mean</th>
<th>Standard Deviation</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>57.32</td>
<td>1.53</td>
<td>37.35</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sleeping/resting</td>
<td>0.16</td>
<td>0.37</td>
<td>-4.14</td>
<td>0.88</td>
<td>4.70</td>
</tr>
<tr>
<td>Working</td>
<td>0.18</td>
<td>0.39</td>
<td>0.07</td>
<td>0.86</td>
<td>0.08</td>
</tr>
<tr>
<td>Watching video/TV</td>
<td>0.12</td>
<td>0.32</td>
<td>0.73</td>
<td>0.94</td>
<td>0.78</td>
</tr>
<tr>
<td>Smartphone/computer</td>
<td>0.23</td>
<td>0.42</td>
<td>0.56</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Reading</td>
<td>0.08</td>
<td>0.28</td>
<td>-2.06</td>
<td>1.11</td>
<td>1.86</td>
</tr>
<tr>
<td>Music/radio listening</td>
<td>0.06</td>
<td>0.24</td>
<td>3.09</td>
<td>1.25</td>
<td>2.47</td>
</tr>
<tr>
<td>Relaxing</td>
<td>0.11</td>
<td>0.32</td>
<td>0.82</td>
<td>0.94</td>
<td>0.87</td>
</tr>
<tr>
<td>Underway</td>
<td>0.11</td>
<td>0.31</td>
<td>0.08</td>
<td>1.00</td>
<td>0.08</td>
</tr>
<tr>
<td>Self-care</td>
<td>0.05</td>
<td>0.22</td>
<td>1.13</td>
<td>1.32</td>
<td>0.86</td>
</tr>
<tr>
<td>Household</td>
<td>0.03</td>
<td>0.16</td>
<td>-0.79</td>
<td>1.78</td>
<td>0.45</td>
</tr>
<tr>
<td>Taking care of kids</td>
<td>0.01</td>
<td>0.10</td>
<td>7.43</td>
<td>2.96</td>
<td>2.51</td>
</tr>
<tr>
<td>Grocery/shopping</td>
<td>0.01</td>
<td>0.12</td>
<td>4.09</td>
<td>2.33</td>
<td>1.76</td>
</tr>
<tr>
<td>Preparing meal</td>
<td>0.04</td>
<td>0.19</td>
<td>2.79</td>
<td>1.56</td>
<td>1.78</td>
</tr>
<tr>
<td>Eating</td>
<td>0.08</td>
<td>0.27</td>
<td>1.19</td>
<td>1.11</td>
<td>1.07</td>
</tr>
<tr>
<td>Walking</td>
<td>0.01</td>
<td>0.12</td>
<td>2.19</td>
<td>2.51</td>
<td>0.87</td>
</tr>
<tr>
<td>Playing</td>
<td>0.01</td>
<td>0.08</td>
<td>2.43</td>
<td>3.37</td>
<td>0.72</td>
</tr>
<tr>
<td>Talking to someone</td>
<td>0.16</td>
<td>0.36</td>
<td>2.84</td>
<td>0.84</td>
<td>3.37</td>
</tr>
<tr>
<td>Exercise/sports</td>
<td>0.02</td>
<td>0.15</td>
<td>5.41</td>
<td>1.89</td>
<td>2.86</td>
</tr>
<tr>
<td>Other</td>
<td>0.02</td>
<td>0.12</td>
<td>-0.64</td>
<td>4.91</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Note. Means are overall means across participants (between-subject) and time (within-subject) answers coded 0 (not present) or 1 (present).

### Table 4
The most significant (p < .01) main and interaction effects of object of thought by activity context based on categories with at least 5% prevalence explaining simultaneous mood.

<table>
<thead>
<tr>
<th>Activity (% occurrence)</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>O Leisure</td>
<td>23.53</td>
<td>4.21</td>
<td>5.59</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>O Leisure A PassiveNegative</td>
<td>-22.16</td>
<td>5.18</td>
<td>4.28</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>O Leisure A ActiveNeutral</td>
<td>-19.69</td>
<td>4.88</td>
<td>4.04</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>O Leisure A PassiveNeutral</td>
<td>-19.21</td>
<td>4.92</td>
<td>3.90</td>
<td>0.0001</td>
</tr>
<tr>
<td>A PassiveNeutral</td>
<td>13.02</td>
<td>3.48</td>
<td>3.74</td>
<td>0.0002</td>
</tr>
<tr>
<td>A ActiveNeutral</td>
<td>11.55</td>
<td>3.56</td>
<td>3.24</td>
<td>0.001</td>
</tr>
<tr>
<td>O Other person A PassiveNeutral</td>
<td>-15.62</td>
<td>5.03</td>
<td>3.11</td>
<td>0.002</td>
</tr>
<tr>
<td>A ActivePositive</td>
<td>11.11</td>
<td>3.97</td>
<td>2.80</td>
<td>0.005</td>
</tr>
<tr>
<td>O Other person A ActiveNeutral</td>
<td>-13.51</td>
<td>4.98</td>
<td>2.71</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Note. O = object of thought; A = activity context reduced to 6 categories based on the dimensions of valence (positive, neutral, negative) and mental activity (active, passive) of categories with at least 5% prevalence: PassiveNegative = sleeping/resting; PassiveNeutral = relaxing, underway, self-care, and/or eating; PassivePositive = listening to music/radio; ActiveNegative = reading; ActiveNeutral = working, watching video/TV, and/or being on smartphone/computer; ActivePositive = talking to someone. Of the 29 content terms included in the model, 18 were significant (p < .05).
task. Second, their association was found in lagged analyses on later mood during the task, controlling for previous mood, which showed the strongest association with current mood. Third, the content of the thought involved a mix of other-related and past-related thought, as thoughts about another person were often accompanied by thoughts about the past, which others (Ho et al., 2020) and we in the current study also found. Finally, the effect was found in interaction with the valence of the thought: when the thought was positive, this was linked to later (on average 2 min later) lower mood. Thus, the effect found in Ruby et al.’s study is difficult to interpret, potentially reflecting a brief effect of having to proceed with the relatively boring task, when just having had a pleasant thought about another person. Also the findings of the present study might be rather specific, e.g., related to the current population of young adults, where thinking about another person may relatively more often reflect pleasant social (romantic, friendship) thoughts.

However, in an analysis including interaction effects between thought content and context, it was found that in the context of performing an activity that on average showed no simple association with mood (neutral activities, such as working, being on smartphone, watching TV or video), thinking about another person was associated with negative simultaneous mood. One may speculate that for an unknown reason in these contexts thinking about another person is relatively more often associated with thinking about the past. These two focusses (i) have been found to be positively interrelated in both the present study and Ruby et al.’s (2013) study, and (ii) have been found to be associated with lower mood when occurring together in Ruby et al.’s study. As this outcome is not in line with the simple effect of thinking about another person obtained in the present study, such discrepant findings support the view that mood related effects are very much both content and context specific (Smallwood & Andrews-Hanna, 2013).

In general, somewhat ambiguous findings were obtained regarding the hypothesis that the effects of the content thoughts would be dependent on the context they occur in. While analyses did not show significant interactions between the time aspect of thought and the activity context of thought, the object aspect of thought content did. Specifically, besides the above mentioned differential associations of thinking about another person becoming negative in the context of otherwise neutral activities, thinking about leisure also switched from being positively associated with simultaneous mood to a negative association with mood in the context of on average mood neutral activities or when resting/sleeping. These specific associations are difficult to explain, partly because of the simultaneous nature of these associations, not permitting any inferences along causal lines. Future research might use a more fine-grained time scale to examine the micro-temporal dynamics of such associations, including for instance the possibility that lower mood while performing an activity enhances the possibility to get involved in escapist thinking, such as thinking about leisure activities. Whatever the associations may exactly reflect, the main conclusion here is that the combination of these effects again point to the importance of the context of thinking when evaluating the associations of the content of thought with mood.

Most of the associations mentioned above were obtained only in analyses including simultaneous assessment of aspects of thought content and context and mood. Especially the simple effects of current activity and interaction effects with the current activity context did not show any association across time. This suggests that associations between cognitions, activities, and mood are often relatively short-lived in daily life. The only significant associations across time were obtained for a few specific simple effects of time and object of thought content discussed above. As shown, some of these associations were in line with previous research, some were not. In addition to the specific context of the studies, e.g. daily life versus specific laboratory tasks (Ho et al., 2020; Kane et al., 2017), the duration of time between the measurement points may be of importance. This time duration between measurement points differ considerably in research, from minutes (Poerio et al., 2013; Ruby et al., 2013) to many hours (Killingsworth & Gilbert). Effects across time may quite plausibly be depending on the duration between the time points, but a theoretical model including the duration of effects is missing to date. Future studies and theoretical accounts should incorporate this factor.

4.1. Limitations

The current study is not without its limitations. First, generalizability is limited by the characteristics of the relatively small sample: young, highly educated, and mostly female participants. In addition, the fact that the analyses on interaction effects included many partially overlapping terms may have facilitated the emergence of results that may be specific to the limited current sample. These specific interaction effects should therefore be regarded as only illustrative and preliminary. Replication and extension studies are therefore of utmost importance. Regarding extension, only a selection of possible thought content and context factors have been included. Other factors that were not assessed may have influenced the results in an unknown way and may be included in future studies, such as mental engagement in the current activity (e.g., interesting versus boring) (Ho et al., 2020; Kane et al., 2017), presence of meta-awareness of one’s cognitive activity (Konjedi & Maleeh, 2017), unresolved personal issues (Mason et al., 2013), or trait-like person characteristics, such as personality and working-memory capacity (Kane et al., 2017; Nolen-Hoeksema, 2000). Finally and importantly, despite the analyses across time, showing possible dynamics across time, it is not possible to draw any conclusions along causal lines. Additional experimental studies are needed for such a purpose, in which the thought content and thought context are manipulated. Such studies would be supplementary to the more ecologically valid studies performed in daily life of participants, such as the current study.

Data Availability Statement

The data that support the findings of this study are openly available in Open Science Framework at https://doi.org/10.17605/OSF.IO/2BRU6.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
References


