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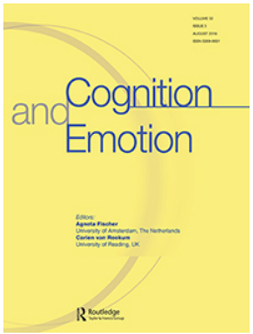

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BRIEF ARTICLE

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Exploring the relation between visual mental imagery and affect in the daily life of previously depressed and never depressed individuals

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ABSTRACT

Previously depressed individuals experience disturbances in affect. Affective disturbances may be related to visual mental imagery, given that imagery-based processing of emotional stimuli causes stronger affective responses than verbal processing in experimental laboratory studies. However, the role of imagery-based processing in everyday life is unknown. This study assessed mental imagery in the daily life of previously and never depressed individuals. Higher levels of visual mental imagery was hypothesised to be associated with more affective reactivity to both negatively and positively valenced mental representations.

This study was the first to explore mental imagery in daily life using experience sampling methodology. Previously depressed ($n = 10$) and matched never depressed ($n = 11$) individuals participated in this study. Momentary affect and imagery-based processing were assessed using the "Imagine your mood" smartphone application. Participants recorded on average 136 momentary reports over a period of 8 weeks.

The expected association between visual mental imagery and affective reactivity was not found. Unexpectedly, in both previously and never depressed individuals, higher levels of imagery-based processing of mental representations in daily life were significantly associated with better momentary mood and more positive affect, regardless of valence.

The causality of effects remains to be examined in future studies.

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Major Depressive Disorder (MDD) is a highly recurrent mood disorder. Individuals who have previously experienced multiple depressive episodes are at a 60%–90% risk of relapse (Richards, 2011). Affective reactivity in previously depressed individuals, i.e. changes in affect in response to internal or external events, may play an important role in depressive relapse. Previously depressed individuals who responded to a sad mood induction with greater mood reactivity on a one-item mood scale running from happy to sad had shorter time to relapse (van Rijsbergen et al., 2013). Conversely, stronger positive affective reactivity to positive events in daily life was found protective of recurrence of depressive symptomatology (Wichers et al., 2010).

Affect and depression seem closely related to mental imagery, as has been demonstrated by both laboratory studies and clinical research (for a review, see Holmes, Blackwell, Burnett Heyes, Renner, & Raes, 2016). Mental imagery, defined as

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"representations and the accompanying experience of sensory information without a direct external stimulus" (Pearson, Naselaris, Holmes, & Kosslyn, 2015), can be described as "seeing with the mind's eye." Mental imagery encompasses all modalities, although it is often predominantly visual, and visual mental imagery has accordingly been the focus of most previous studies (Weßlau & Steil, 2014). In non-clinical samples, imagery-based processing of positively valenced stimuli has been found to reduce negative affect (e.g. Holmes, Mathews, Mackintosh, & Dalgleish, 2008), increase positive affect (e.g. Nelis, Holmes, Palmieri, Bellelli, & Raes, 2015), and to dampen the affective impact of a sad mood induction (Holmes, Lang, & Shah, 2009). Conversely, imagery-based processing of negatively valenced stimuli resulted in more anxiety (e.g. Holmes & Mathews, 2005). Thus, in non-clinical samples, (multi-modal) imagery-based processing may strengthen affective responses to both positively and negatively valenced stimuli.

In clinical studies, depression was associated with impairments in mental imagery, such as a reduced capability to imagine positive but not negative events (for a review, see Holmes et al., 2016). Previously depressed individuals reported lower vividness of positive memories after a sad mood induction than never-depressed individuals (Werner-Seidler & Moulds, 2011). They also derived less affective benefit from recall of positive memories after a sad mood induction (Joormann, Siemer, & Gotlib, 2007), potentially due to a paucity of imagery-based processing (Werner-Seidler & Moulds, 2012). Indeed, experimentally induced concrete (imagery-based) processing of a positive memory facilitated mood repair compared to abstract verbal processing in both previously and never depressed individuals (Werner-Seidler & Moulds, 2012). These clinical studies indicate that impairments in positive imagery remain in previously depressed individuals and that affective disturbances may be related to imagery-based processing of positively valenced stimuli.

Imagery-based processing of negatively valenced stimuli, in contrast, has been hypothesised to strengthen negative affective reactivity in previously depressed individuals (Werner-Seidler & Moulds, 2012). However, how their imagery-based processing of negatively valenced stimuli may be associated with affect has, to the best of our knowledge, not yet been explored. Furthermore, the role of spontaneous mental imagery requires further elucidation, given that disturbances in positive mental imagery in depression may diminish when mental imagery is manipulated (Holmes, Lang, Moulds, & Steele, 2008).

This study explored how spontaneous use of visual imagery-based processing of positively and negatively valenced stimuli is associated with affect in the daily life of previously and matched never depressed individuals. Affect and mental imagery were repeatedly assessed in the flow of daily life using experience sampling methodology (ESM; Myin-Germeys et al., 2009). Affective reactivity was non-causally assessed, similarly to Wichers et al. (2010). It was operationalised as the levels of momentary mood, positive affect, and negative affect while processing positively or negatively valenced mental representations, relative to those while processing neutrally valenced mental representations. It was hypothesised that, within individuals, higher levels of imagery-based processing would be associated with more affective reactivity to both positively and negatively valenced mental representations.

Materials and methods

Participants

Previously depressed participants were recruited from an extension of an ongoing trial "Disrupting the rhythm of depression" (for details of this study, see Bockting et al., 2011). Individuals with a history of multiple depressive episodes, currently remitted, and using antidepressant medication in the last six months were included in that study. Only participants randomised to the control arm of the trial were included in the current study, because the therapy administered in the other arms potentially alters affect.

Never depressed participants were recruited via advertisements on social media, posters, and word of mouth. They were selected to match the previously depressed participants on age, gender, and educational level. Exclusion criteria were: current axis-I disorder or antidepressant medication use or a depressive episode in the past. These participants received a €10 gift certificate.

Of the 22 previously depressed participants eligible for this study, 12 were not included in the final analyses, because they dropped out of the RCT ($n = 7$), refused to participate in the ESM addition ($n = 4$), or completed less than 30% of the questionnaires ($n = 1$; in line with Delespaul, 1995), resulting in a final sample of 10.

Table 1. Baseline characteristics of previously and never depressed participants.

	Previously depressed ($n = 10$)	Never depressed ($n = 11$)
Age, median (range)	48 (33–65)	50 (21–60)
Female, *n* (%)	9 (90)	9 (82)
Marital status, *n* (%)		
Single	3 (30)	3 (27)
Married/cohabiting	6 (60)	8 (72)
Divorced/widowed	1 (10)	0 (0)
Education ≥ college *n* (%)	5 (50)	6 (55)
Employed, *n* (%)	7 (70)	11 (100)
Current psychological treatment, *n* (%)	3 (30)	n.a.
Number of depressive episodes, median (range)	5 (3–6)	n.a.
4 to 6 previous episodes, *n* (%)	8 (80.0)	n.a.

Note: n.a. = not applicable.

Of the 15 included never depressed participants, 4 were excluded because they completed less than 30% of the questionnaires (Delespaul, 1995), resulting in a final sample of 11. Baseline characteristics are presented in Table 1. Ethical approval was obtained for the previously depressed participants from the University Medical Center Groningen ethics committee (METc 2009/158) and for the never depressed participants from the University of Groningen Ethical Committee of the Psychology Department (ppo-014-043). All participants provided written informed consent.

Experience sampling method

The app "Imagine your mood" was developed using TEMPEST software (Batalas & Markopoulos, 2012). Participants filled out the questionnaires on a smartphone. Triggers were set for questionnaires ten times a day, three days a week (on Thursdays, Fridays and Saturdays), for eight weeks, resulting in a maximum of 240 responses. The triggers were set semi-randomly, between the hours of 7.30 AM and 10.30 PM, with a maximum of one trigger per 90-minute interval and a minimum of 30 min between triggers.

During an approximately one-hour face-to-face briefing, a trained assistant installed the app, explained the ESM procedure, and helped practice the questionnaire. Participants were requested to respond to a trigger as soon as possible and were not informed about the five-minute time limit, to prevent strategic responding and maximise the validity of results. Participants were instructed to answer the questionnaire about the moment just before the trigger. The ESM process was monitored using weekly brief telephonic interviews.

Momentary mood (happy-sad)

Momentary mood was assessed with the one-item mood scale (van Rijsbergen et al., 2013). Participants rated the question "at the moment, I feel … " on a visual analogue scale (VAS) ranging from happy (0) to sad (100).

Momentary positive affect and negative affect

Adjectives to assess positive affect (PA) and negative affect (NA) were selected based on previous research (e.g. Wichers et al., 2015) and discussions in our research team. Ratings of the adjectives (on 0–100 VASs) were averaged to a PA (*cheerful, enthusiastic, hopeful, content, energetic*) and NA (*anxious, angry, lonely, irritated, down, suspicious, helpless, guilty, insecure*) scale per moment per individual.

Degree of visual mental imagery and valence of mental representation

During the briefing, participants were familiarised with identifying what they had in mind, i.e. their mental representation, as follows:

> You (almost) always have something in mind. Please take your time to recall what you had in mind just before the trigger. If you do not remember what you had in mind just before the trigger, please select the most recent thing you had in mind that you can remember.

Participants then received the following information about visual mental imagery:

> Sometimes you see things in your mind that you do not see with your eyes at that moment. For example, when you recall a memory or when you imagine yourself doing something in the future. Can you for example remember the last time you did groceries, or that you were on vacation? What do you see in your mind's eye?

In every questionnaire, participants were first presented with instructions to identify what they had in mind just before the trigger. Participants then rated the *degree of visual mental imagery* of the mental representation answering the question "*I see it in my mind's eye*" on a 0–100 VAS. Other aspects of the mental representation, such as vividness and levels of verbal processing, were also assessed but are not used in the current study. Descriptions of visual mental images participants had experienced that week were obtained in the weekly telephonic interviews.

Participants rated the valence of their mental representation on a VAS ranging from negative (0) to positive (100). Participants were instructed to maintain the standard value (50) to refer to a neutral state. Valence was recoded into a negative valence dummy variable (<50) and a positive valence dummy variable (>50), with neutral valence (50) as reference category.

Statistical analyses

Predictor variables were person-mean centred to prevent between-individual differences to confound within-individual effects (Curran & Bauer, 2011). To prevent spurious correlations resulting from trends in the data, the dependent variables and the degree of imagery-based processing were detrended as well as person-mean centred (saving residuals from fitting time as predictor in a linear regression).

Mixed linear models in STATA were used to account for the hierarchical structure of the data. The momentary observations (level 1) were nested within days (level 2), within weeks (level 3) within individuals (level 4). The model included the valence of the mental representation (dummy positive and dummy negative), the degree of imagery-based processing and the interaction terms between imagery and the valence dummies. Significant random effects were included in the model to allow coefficients to differ across individuals. Robust variance estimation was used to handle non-normal distributions (using the option "vce(robust)") and an autoregressive (AR1) covariance structure was fitted to account for temporal dependency in the data. To maximise power for the expected interaction effect, all participants were included in the primary analyses. Post-hoc analyses examined whether findings hold in the previously depressed and never depressed groups.

Results

Examples of reported visual mental images

The responses during the weekly interviews displayed a broad range of mental images. Previously depressed participants reported imagery-based anticipation of everyday chores, such as going to the supermarket or feeding the cat. A variety of memories were reported on, including recalling making cookies as a kid, replaying an argument at work, or memories of a dying mother. Future-oriented images included imagining receiving vaccines, and looking forward to a planned outing. Other examples were mentally redecorating a terrace and thinking of not being able to ski while imagining others enjoying skiing. Two previously depressed participants often reported not to have experienced mental images, and to have thought in words and sentences only.

In the never depressed group, reported images included an image of a dish while trying to find the recipe, memories of heated discussions during a work-meeting, picturing potential decoration of a new house, and imagining a deceased friend still being alive. One never depressed individual reported to be often too busy to experience mental images.

Description of individual differences

Two observations can be made from the individual mean scores per group (summaries can be found in the supplemental materials). First, there were large individual differences in individual mean levels of imagery-based processing, ranging from 10 to 78 in the previously depressed group, and from 21 to 96 in the never depressed group. Second, mean levels of negative affect were low, ranging from 2 to 27 in the previously depressed group and from 2 to 9 in the never depressed group.

Because of the small sample size, differences between groups were examined for informative purposes only. There were no significant differences between groups in imagery-based processing, PA, or valence of the mental representation (all Mann–Whitney $Us > 28.0$, all $ps > .06$). Levels of momentary mood (Mann–Whitney $U = 20.0$, $p = .01$) and NA (Mann–Whitney $U = 16.0$, $p = .01$) were higher in the previously depressed group.

The relation between imagery-based processing, valence, and affect

Parameter estimates from the multilevel models can be found in Table 2.

Momentary mood (happy-sad)

Visual mental imagery was not significantly associated with greater mood reactivity; the interactions between imagery-based processing and valence were not significant. A main effect of imagery-based processing was found, indicating that higher levels of visual mental imagery were associated with better mood. The main effects for the positive and negative valence dummies were significant and the latter was

Table 2. Parameter estimates from the multilevel models of the primary outcome measures.

	Momentary mood (happy-sad)	PA	NA
Fixed effects	*B [95% CI]*	*B [95% CI]*	*B [95% CI]*
Positive valence	−3.38 [−4.80, −1.97]**	4.52 [2.79, 6.25]**	−0.47 [−0.94, 0.01]
Negative valence	4.18 [1.50, 6.89]*	−2.92 [−4.75, −1.10]**	2.45 [1.16, 3.72]**
Imagery	−0.04 [−0.06, −0.02]**	0.07 [0.04, 0.11]**	−0.007 [0.04, 0.11]
Imagery*Positive valence	−0.02 [−0.06, 0.01]	−0.03 [−0.11, 0.05]	−0.01 [−0.04, 0.01]
Imagery*Negative valence	−0.06 [−0.15, 0.03]	−0.03 [−0.11, 0.06]	−0.04 [−0.07, −0.01]*
Random effects	*SD2 [95% CI]*	*SD2 [95% CI]*	*SD2 [95% CI]*
Positive valence		10.74 [4.89, 23.63]*	
Negative valence	29.92 [13.36, 66.98]*		6.61 [2.34, 18.65]*

Notes: PA = positive affect, NA = negative affect. Positive and negative valence are dummy coded (0/1). Neutral valence is the reference category.
*$p < .05$, **$p < .001$.

qualified by a significant random effect. This indicates individual differences in mood reactivity in response to negatively valenced mental representations.

Momentary positive affect

Visual mental imagery was not significantly associated with positive affective reactivity. Unexpectedly, a main effect of imagery-based processing was found, indicating that higher levels of imagery-based processing were associated with more PA, regardless of valence. The main effects for positive and negative valence were significant as well. Individual differences were found in positive affective reactivity in response to positively valenced mental representations, as expressed by a significant random effect.

Momentary negative affect

For NA, visual mental imagery was associated with affective reactivity, as evidenced by a significant interaction effect between negative valence and imagery-based processing. However, opposite to expectation, higher levels of imagery-based processing were associated with dampened negative affective reactivity in response to negatively valenced mental representations. There were no significant main effects for positive valence or imagery-based processing, nor was there a significant interaction between positive valence and imagery-based processing. The main effect of negative valence was qualified by a random slope, indicating significant individual differences in negative affective reactivity.

Additional analyses

The additional analyses are described in the supplemental materials. Post-hoc analyses for the previously depressed and never depressed individuals demonstrate that the unexpected main effect of visual mental imagery on PA and mood held in both groups. However, the association between imagery-based processing and negative affective reactivity to negative valence was not significant in either group. In line with the primary analyses, imagery-based processing was not associated with affective reactivity in either group.

Additional exploratory analyses were performed to further explore the absence of the expected association between visual mental imagery and affective reactivity. The hypothesised interaction effect was also absent when the contrast between the valence dummies was maximised, i.e. the valence dummies were recoded, so that positive valence served as the reference category. Also, analyses of the single NA items (such as anxious or helpless) did not reveal the expected interaction (with the exception for the single item down, where imagery-based processing was associated with more reactivity to positively valenced mental representations). Finally, removing trends from the data did not have a significant impact on the results.

Discussion

This study investigated the relation between visual mental imagery and affect within the daily life of previously depressed and never depressed individuals. Contrary to our hypothesis, the results showed that visual mental imagery was not significantly associated with positive, negative or mood reactivity. Instead, imagery-based processing was significantly associated with more positive affect and better mood, regardless of the valence of the mental representation. These

results were consistent across previously and never depressed individuals in post-hoc analyses. In daily life, which appears pivotal for psychopathology and well-being (Myin-Germeys et al., 2009), mental imagery may be associated with boosted positive affect and mood.

Furthermore, visual mental imagery was associated with *reduced* negative affective reactivity to negatively valenced mental representations. Variance in negative affect may have only occurred while processing negatively valenced mental representations, given that a floor effect hampered analyses of negative affect. This finding is opposite to expectation, but corresponds with the finding in this study that moments in daily life with higher levels of imagery-based processing were associated with more positive affect and better mood. This, in turn, is in line with the experimental finding that concrete (imagery-based) processing of positive autobiographical memories results in better mood repair (Werner-Seidler & Moulds, 2012). However, imagery-based processing of negatively valenced stimuli strengthened negative affective reactivity in non-clinical experimental studies (e.g. Holmes & Mathews, 2005).

Large individual differences in mean levels of visual mental imagery were observed within the groups of previously and never depressed individuals. These individual differences may be clinically relevant, because the effect of imagery-based interventions appears to be dependent on a certain baseline level of imagery-based processing (Holmes et al., 2016; Steel et al., 2010). The visual mental images described in the weekly interviews illustrate how diverse the content of mental imagery can be. It is unclear whether these weekly responses are representative of mental imagery in daily life. Some examples were of a rather extreme nature (e.g. remembering a dying mother), whereas mental imagery in daily life is possibly mostly more neutrally valenced (e.g. a mental grocery-list). The content of mental imagery in daily life needs to be examined in future research. To the best of our knowledge, this study is the first to assess imagery-based processing in previously and never depressed individuals as it occurs spontaneously in daily life. ESM may be particularly suited to overcome the "inherently private nature" of mental imagery (Pearson et al., 2015).

Importantly, in contrast to experiments showing that mental imagery strengthens affective responses, the current results are correlational in nature and do not allow for causal inferences. Several alternative explanations for the discrepancies with previous findings may be formulated. First, the relationship between affect and imagery may be reversed in daily life; better mood may allow for more imagery-based processing (Werner-Seidler & Moulds, 2011). Second, a third variable may influence both levels of imagery-based processing and affect. Third, the causal short-term effects of imagery-based processing studied in experiments may differ from the combination of short- and long-term associations that may be captured using ESM. Imagery-based processing of a negative memory, for example, may initially result in strong affective reactivity and more successful processing, resulting in less affective reactivity associated with future imagery-based recall of that memory. Alternatively, imagery in daily life may be qualitatively different from that in the experimental studies. Visual mental imagery as assessed in daily life in the current study was presumably more spontaneously generated and personally relevant. The causality of the association between affect and imagery-based processing in daily life remains to be tested in experimental experience sampling studies.

Other limitations of this study include the non-validated, single-item assessment of visual imagery-based processing. Although such measures are inherent to ESM studies (Bennik, Nederhof, Ormel, & Oldehinkel, 2014), this may have resulted in random measurement error and reduced validity. Furthermore, the small sample size poses a potential power problem and precluded investigation of potentially relevant between-subject effects. However, a recent study suggests that because of the many measurements per participant, the current study is likely to have been adequately powered do detect the hypothesised within-subject effects (Krone, Albers, & Timmerman, 2016). Generalisation to a previously depressed population might be limited given the low number of participants and given that their antidepressant use may have altered their affect and confounded the results (Peeters, Berkhof, Delespaul, Rottenberg, & Nicolson, 2006). Finally, previously depressed participants were recruited at a time of stable remission, and return of depressive symptomatology may have occurred during the study period. Structural changes in levels of affect were eliminated in the analyses, but changes in affective reactivity may have remained. Future studies may examine whether changes in affective reactivity are related to mental imagery and depressive relapse.

In conclusion, unexpectedly, higher levels of visual imagery-based processing were not significantly associated with affective reactivity in daily life. Of great interest however, within previously and never depressed individuals higher levels of visual mental imagery were significantly associated with better mood and more positive affect, regardless of valence.

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