



# From brooding to detachment: Rumination longitudinally predicts an increase in depersonalization and derealisation

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**Objectives.** Depersonalization–derealization (DEP-DER) is a dissociative experience which is related to psychopathology and distress. Yet, the aetiological factors leading to DEP-DER are not sufficiently clear. In this study, we suggest rumination as one possible antecedent. Thus, the goal of the study was to explore the longitudinal relationship between rumination and DEP-DER.

**Design.** Longitudinal self-report study; mixed clinical and community sample.

**Methods.** The study was conducted on 98 participants, 49 of them were diagnosed with depression, anxiety disorders, or obsessive–compulsive disorder, and the other 49 were healthy, matched community controls. The participants underwent a structured clinical interview and completed a battery of questionnaires. Then, the participants completed the same battery again once a month, for five additional assessment points (6 months in total). The data were analysed using multilevel linear modelling with time-lag analysis.

**Results.** We found that levels of rumination and DEP-DER increased and decreased simultaneously, meaning that on assessments in which people reported that they tended to ruminate, they also reported higher levels of DEP-DER symptoms. In addition, we found support for a unidirectional association, consistent with our theoretical hypothesis. Specifically, rumination levels on a certain month longitudinally predicted a higher likeliness for reporting DEP-DER on the following month, even when controlling for the contemporaneous relationship. Conversely, DEP-DER symptoms did not longitudinally predict increased rumination.

**Conclusions.** These findings suggest that rumination may be an antecedent of DEP-DER, but not vice versa. Possible mechanisms to explain this link are discussed.

## Practitioner points

- Rumination and DEP-DER oscillate together over time; additionally, rumination predicts a longitudinal increase in DEP-DER.

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This manuscript is partially based on Miriam Vannikov-Lugassi's doctoral research, supervised by Dr. Nirit Soffer-Dudek, head of the Consciousness and Psychopathology Lab.

- Clinicians noticing ruminative thought followed by decreased emotionality should distinguish between an authentic decrease of distress versus detachment.
- The findings provide one possible explanation for the frequency of DEP-DER symptoms in anxiety and depressive disorders.
- Poor sleep quality and emotion regulation difficulties should be explored as potential mediators explaining this link.

Depersonalization and derealization (DEP-DER) is an experience of unreality, unfamiliarity, or detachment from the self or the surroundings, respectively (DSM-5; American Psychiatric Association, 2013). DEP-DER is related to psychopathology and distress; however, it is an under-researched dissociative experience (Michal, Beutel, & Grobe, 2010; Simeon, 2014). Dissociative experiences have been studied extensively in the context of trauma, but their role in other disorders has received less attention (Soffer-Dudek, 2014). Our goal in the present investigation is to focus on DEP-DER experiences in the context of anxiety, depression, and obsessive-compulsive disorder (OCD) by exploring rumination as a possible antecedent of DEP-DER.

Dissociation is defined as a disruption of the integration of consciousness (DSM-5; American Psychiatric Association, 2013), that is, a discontinuity between clusters of mental contents. It is considered to be maladaptive and indeed, it is related to psychological distress (e.g., Briere *et al.*, 2005; Dalenberg *et al.*, 2012; Gershuny & Thayer, 1999; Soffer-Dudek, 2014), and to psychopathological symptoms, such as those of post-traumatic stress disorder (PTSD), depression, anxiety, and OCD (e.g., Lipsanen, Saarijarvi, & Lauerma, 2004; Muris, Merckelbach, & Peeters, 2003; Paradisis, Aardema, & Wu, 2015; Pastucha *et al.*, 2009; Soffer-Dudek, 2017; Watson, Wu, & Cutshall, 2004; Wise, Mann, & Sheridan, 2000). Notably, the concept of dissociation is multifaceted (Briere *et al.*, 2005). Holmes *et al.* (2005) identify two categories of dissociation, compartmentalization and detachment. Compartmentalization is characterized by a difficulty in conjuring up into conscious awareness, information which is normally accessible. Compartmentalization includes conditions such as dissociative identity disorder or somatization disorder (Holmes *et al.*, 2005). The concept of detachment encompasses DEP-DER and related phenomena such as out-of-body experiences. Subjects experiencing detachment often describe it as 'one part of the self-acting/participating, while the other part is observing' (Simeon, 2004), emphasizing the experience of multiplicity of the self. However, the DSM-5 (American Psychiatric Association, 2013) suggests a somewhat broader definition; specifically, depersonalization is defined as 'a feeling of unreality or detachment from, or unfamiliarity with, one's whole self or aspects of the self' and derealization as 'a feeling of unreality or detachment from, or unfamiliarity with, the world. . .' (p. 302).

DEP-DER experiences are common among both clinical and non-clinical populations (Hunter, Phillips, Chalder, Sierra, & David, 2003; Hunter, Sierra, & David, 2004). The milder expressions of DEP-DER include common experiences such as looking in the mirror and not recognizing oneself. When these experiences become frequent and intensive, they are defined as depersonalization/derealization disorder (DSM-5; American Psychiatric Association, 2013). Whereas disorders characterized by compartmentalization are considered to be aetiologically related to trauma (e.g., Coons, 2000; Dorahy, Middleton, Seager, Williams, & Chambers, 2015; Freyd & Birrell, 2013; Loewenstein, 1996; Ross & Halpern, 2009; Van der Hart, Nijenhuis, & Steele, 2006), depersonalization/derealization disorder does not appear to be related to discrete traumatic events (Scott, Ross, Dorahy, Read, & Schäfer, 2019). For example, among patients with depersonalization/derealization disorder, depersonalization symptoms were only moderately

correlated with emotional abuse and were not associated with childhood neglect or abuse (Simeon *et al.*, 2008). Thus, additional aetiological factors should be explored.

One probable path to DEP-DER is a sense of overwhelming negative emotion. DEP-DER symptoms are related to psychopathology (e.g., Choi *et al.*, 2017; Kendler, 2017; Michal *et al.*, 2016; Simeon *et al.*, 1997; Trueman, 1984) and are included as a symptom in DSM-5 criteria for several non-dissociative disorders, specifically PTSD, panic disorder, and borderline personality disorder (American Psychiatric Association, 2013). All of these disorders are characterized by an overwhelming affective experience. Indeed, in accordance with the phenomenology of DEP-DER, neurophysiological findings also suggest that it may represent a shutdown of affective responsivity in the face of affective overload (which may not necessarily be of a traumatic origin). Specifically, it has been proposed that DEP-DER is generated by a fronto-limbic (particularly anterior insula) suppressive mechanism which manifests phenomenologically as emotional numbing (Sierra & David, 2011). People diagnosed with depersonalization/derealization disorder show increased prefrontal activation alongside decreased activation in insula/limbic related areas (Lemche *et al.*, 2007, 2008; Phillips *et al.*, 2001; Sierra & David, 2011), suggesting that DEP-DER is associated with reduced neural activation in emotion-sensitive regions alongside increased activation in regions associated with emotion regulation (Phillips *et al.*, 2001).

Another line of inquiry relevant for the understanding of the aetiology of DEP-DER is the recent literature suggesting that dissociation stems from a labile sleep–wake cycle and possibly represents intrusions of sleep elements into waking consciousness (van der Kloet, Merckelbach, Giesbrecht, & Lynn, 2012; Koffel & Watson, 2009; Lynn, Lilienfeld, Merckelbach, Giesbrecht, & van der Kloet, 2012; Mahowald & Schenck, 2001). DEP-DER symptoms have been characterized as dream-like (Holmes *et al.*, 2005), and depersonalization has been described by van der Kloet *et al.* (2012) as a state between dreaming and waking in which there is a gap, that usually occurs in dreams and in dream-like states, between the experiencing and the observing self.<sup>1</sup> Indeed, state dissociation, which is measured mainly by items assessing DEP-DER, was increased following sleep deprivation (Giesbrecht, Smeets, Leppink, Jelicic, & Merckelbach, 2007; Soffer-Dudek *et al.*, 2017; van Heugten–van der Kloet, Giesbrecht, & Merckelbach, 2015). Moreover, DEP-DER is related to low levels of urinal norepinephrine (Simeon, 2004), a neurotransmitter that regulates arousal and alertness, supporting the possible link of DEP-DER to sleep–wake abnormalities.

Recently, poor sleep quality was also identified as an important factor responsible for the link between dissociation and rumination (Vannikov-Lugassi & Soffer-Dudek, 2018a). Rumination is defined as a repetitive focusing on one's distress and on the circumstances associated with those feelings (Conway, Csank, Holm, & Blake, 2000; Nolen-Hoeksema, 1991). Specifically, ruminative individuals slept poorly and reported more dissociative symptoms (Vannikov-Lugassi & Soffer-Dudek, 2018a). Thus, rumination, which leads to poor sleep quality (Guastella & Moulds, 2007; Takano *et al.*, 2012; Zoccola, Dickerson, & Lam, 2009), may bring about or increase DEP-DER symptoms.

Another mechanism potentially responsible for the link between rumination and DEP-DER may be maladaptive emotion regulation, reviewed above regarding DEP-DER, as it is also related to rumination (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, &

<sup>1</sup> An anonymous reviewer noted that this experience is a duplication of the self (rather than a gap); the two selves co-occur instead of alternating.

Lyubomirsky, 2008). Ruminative people focus on their negative emotional states in order to achieve some understanding and resolution (Nolen-Hoeksema, 1991; Papageorgiou & Wells, 2001, 2003), leading to increased distress. The desire to gain control over this distress can lead to thought suppression (Wenzlaff, 2004). However, the suppressed thoughts tend to reappear with repetitive intensity and thus such suppression can in fact fuel rumination (Wenzlaff & Luxton, 2003). Thus, ruminative people often lapse into a depressive cycle, alternating between focusing on the distress and suppressing it (Wenzlaff, 2004; Wenzlaff & Luxton, 2003). DEP-DER may be a part of this vicious cycle; individuals who consistently try to suppress their distressful thoughts may distance them from conscious awareness or strip them of their emotional meaning, resulting in numbing and detachment.

These findings theoretically suggest that ruminative thinking may increase symptoms of DEP-DER over time. Although the link between rumination and dissociation has been shown (Vannikov-Lugassi & Soffer-Dudek, 2018a, 2018b), the directionality between them has never been explored, and their relationship was examined only in non-clinical samples. To address these limitations, the current study set out to examine whether levels of rumination and DEP-DER could predict each other across several months in order to detect a possible cumulative effect over a long time frame, in a mixed sample of participants suffering from depression, anxiety, or OCD and matched healthy participants from the general population.

## Method

### *Participants and procedure*

The sample included 98 participants (49 clinical participants and 49 healthy controls, 63.26% females,  $M_{\text{age}} = 38.9$ ,  $SD_{\text{age}} = 12.4$ ).

The clinical group consisted of psychiatric outpatients recruited from Soroka Medical Center, diagnosed with a depressive disorder, an anxiety disorder, or OCD, aged between 18 and 65. A member of the research team contacted them by phone, described the study, and offered them to participate in exchange for monetary reimbursement (700 NIS, approximately 193.27\$).

Interested participants arrived at the laboratory at Ben-Gurion University for a 3-hr session, during which they signed a consent form, and underwent a structured clinical interview in order to establish their diagnosis. From the initial 100 clinical participants who underwent an interview, 43 participants were excluded because they reported a lifetime history or current PTSD, bipolar, psychotic, or a neurological disorder, or illegal substance or alcohol abuse in the last year. Fifty-seven participants were diagnosed with a depression, OCD, or an anxiety disorder and were eligible for inclusion; however, eight of them decided not to continue their participation, for different personal reasons. Thus, the final clinical longitudinal subsample included 49 participants. To these clinical participants, 49 healthy community control participants were matched by age and gender. The healthy controls were recruited at the maternity ward lobby of Soroka Medical Center and via online ads. The healthy controls underwent a similar procedure and were excluded with the same criteria. In addition, they were excluded if they had depression, an anxiety disorder, or OCD, according to the structured interview conducted at the first session. The characteristics of both groups are presented in Table 1.

After the interview, participants performed two short tasks in the laboratory which are outside the scope of the current exploration. Finally, the participants completed a set of questionnaires, taking approximately an hour. After this meeting, the participants

**Table 1.** Demographic characteristics of the samples for study 1 and study 2

Variable	Clinical group, N = 49	Healthy controls, N = 49
Age mean (SD)	38.95 (12.62)	38.85 (12.19)
Gender		
Male	19 (38.7%)	17 (34.6%)
Female	30 (61.2%)	32 (65.3%)
Diagnosis		
Anxiety disorders (panic disorder, general anxiety, or social phobia)	18 (36.7%)	—
Depression	6 (12.2%)	—
Obsessive-compulsive disorder (OCD)	4 (8.16%)	—
Comorbidity between anxiety disorders, depression, or OCD	21 (42.85%)	—

Note. SD = standard deviation.

completed the same set of questionnaires again once a month, for five additional assessment points (six in total). They filled the questionnaires from their home computers, via a link that was sent to their personal e-mails. During each assessment point, they were asked to report their answers based on their experiences in the preceding couple of weeks. The order of the questionnaires was randomly counterbalanced. Some participants completed either less or more assessment points, resulting in a variable amount of overall assessments (range = 2–7,  $M = 5.77$ ,  $SD = .86$ ). Notably, the participants completed two batteries of cognitive tasks at the laboratory, also outside the scope of the current exploration. The ethical considerations of the study were approved beforehand by Soroka Medical Center's Helsinki Committee, for most participants, and by Ben-Gurion University's institutional ethics committee, for some of the non-clinical participants.

## Measures

### Clinical diagnosis

The Mini-International Neuropsychiatric Interview (M.I.N.I.) for DSM-IV axis I disorders was used.<sup>2</sup> The MINI is a reliable and valid structured diagnostic interview (Sheehan *et al.*, 1998). It is organized in diagnostic modules. The interview lasts approximately 1 hr, during which the interviewer asks the participant yes/no questions. For each disorder, several criteria should be met in order to receive a diagnosis. Following training of the research staff, the first 16 interviews were conducted by two interviewers, in order to estimate inter-rater reliability. Cohen's kappa was calculated for each diagnosis separately. The results ranged from kappa of .83,  $p < .001$  for lifetime panic disorder to kappa of 1,  $p < .001$  for depression, dysthymia, current panic disorder, agoraphobia, social phobia, PTSD, alcohol dependence/abuse, drug dependence/abuse, psychotic disorders, GAD, anorexia, and bulimia nervosa. These results suggested very good reliability and thus, the rest of the interviews were conducted by one interviewer.

<sup>2</sup> The collection of the data started at 2013, and a validated Hebrew version of the M.I.N.I. for DSM-5 was not available yet at this time.

### Rumination

The 22-item Ruminative Response Scale (RRS) is a reliable and valid measure of rumination (Nolen-Hoeksema & Morrow, 1991). The items assess rumination on a 4-point scale (1 – almost never, 4 – almost always). According to Treynor, Gonzalez, and Nolen-Hoeksema (2003), the RRS contains three subscales: depression, reflection, and brooding. The latter refers to a passive and repetitive focus on the negative symptoms, which best suits the definition of rumination. Thus, we relied solely on the 5-item brooding factor as a measure of rumination. Cronbach's alphas in the six assessment points for brooding were .82, .78, .87, .89, .86, and .88.

### Dissociation

The 28-item revised version of the Dissociative Experiences Scale (DES-II) measures the percentage of time that the individual experiences dissociation on an 11-point scale (0% – never, 100% – always). The DEP-DER scale was computed based on a large-scale factor analysis including both psychiatric and non-clinical subjects (Carlson *et al.*, 1991). The DES-II possesses excellent reliability and validity (Carlson & Putnam, 1993). Cronbach's alphas for the 6 assessment points, respectively, were .87, .94, .94, .95, .90, and .92 for the total score; and a rather low .57, .85, .89, .92, .75, and .84 for DEP-DER.

### Data analyses

The longitudinal design of the study produced a multilevel data structure (Raudenbush *et al.*, 2001; Singer & Willett, 2003). Thus, multilevel linear modelling (MLM) was used (with SPSS version 24). The covariance structure type was UN (unstructured) in which the level-2 matrix is allowed to be freely estimated, resulting in a random intercept, a random slope, and a random covariance between intercept and slope. Level-1 data were the rumination and DEP-DER scores at each assessment point, nested within level-2 units, that is, participants. We expected that level-1 rumination would relate to level-1 DEP-DER, meaning that on months in which one is increased, the other is also likely to be increased (contemporaneous relationship). In addition, we used time-lag analyses to explore directional relationships.

Notably, the DEP-DER variable was extremely skewed and not normally distributed (skewness = 4.19, Kurtosis = 20.74). The standard MLM makes a strong assumption about continuity and normality of the dependent variable used in the analysis. Thus, we defined rumination as the dependent variable and DEP-DER as the predictor (as our interest is in their mutual oscillations, the decision to define one or the other as the dependent variable was of no particular consequence). In addition, due to some extremely high values in the DEP-DER distribution, we used a natural log transformation of this variable, which substantially improved the measures of symmetry and normality (skewness = 1.69, Kurtosis = 1.73).

We person-mean-centred DEP-DER for use at level 1 and used the person-mean as a predictor at level 2; this procedure gives a pure disaggregation of within- and between-person effects of DEP-DER predicting rumination (Curran & Bauer, 2011).

In order to examine the contemporaneous relationship between rumination and DEP-DER, we computed an unconditional model for rumination, with the time variable, the person-mean of the DEP-DER variable, and person-mean-centred DEP-DER as the predictors.



In order to explore directionality between rumination and DEP-DER, we used time-lag analyses. Specifically, we predicted  $Y$  (rumination) at time  $T$  by either  $X$  (DEP-DER) at time  $T - 1$ , or  $X$  (DEP-DER) at time  $T + 1$ , while also controlling for  $X$  at time  $T$  (see, e.g., Killingsworth & Gilbert, 2010). Controlling for  $X$  at time  $T$  means that the effect of  $X$  at time  $T - 1$  or  $T + 1$  represents the unique contribution of the previous or next assessment, respectively, over and above the contemporaneous relationship. This enabled us to explore the direction of the relationship, using one lag (which means 1 month). Finding a significant effect for  $T + 1$  would suggest that a certain month's rumination predicts the next month's DEP-DER, whereas finding a significant effect for  $T - 1$  would suggest that a certain month's DEP-DER predicts the next month's rumination.<sup>3</sup> Each model included the time variable, the person-mean of the DEP-DER variable, person-mean-centred DEP-DER at time  $t$ , and DEP-DER at either time  $t + 1$  or  $t - 1$  as predictors of rumination.

We report standardized effect sizes for fixed effects based on the *semi-partial*  $R^2$  parameter (Edwards, Muller, Wolfinger, Qaqish, & Schabenberger, 2008).

Notably, we examined all the above-presented models while controlling for age and gender. The results were not affected by these two additional predictors. Thus, we report results without them and do not discuss them further.

## Results

MLM is a flexible method which is suitable for exploring linear associations even in the face of a variable number of repeated assessment points for each individual (Tabachnick & Fidell, 2007). However, other types of missing data (e.g., skipping items) should be evaluated. Missing data patterns were estimated with missing values analysis and varied between 0.3% and 1.6% for all variables. Little's MCAR test was non-significant ( $\chi^2 = 106.37$ ,  $p = \text{ns}$ ) suggesting that data were missing completely at random. The low percentage of the missing values and the random pattern of the missingness suggest that non-response in these data is ignorable (Tabachnick & Fidell, 2007).

In order to examine the components of between-subjects versus within-subjects variance for rumination (the dependent variable), we first computed an intercept-only (null) model for rumination, in which no predictors were specified. Both between- and within-person variability were significant ( $p < .001$ ), and the intraclass correlation (ICC) was .72. The ICC value represents the proportion of between-subject variance (i.e., the extent to which participants' means vary from the general mean) out of the total variance. These findings suggest that despite being somewhat more trait-like, there was a significant amount of within-person variance in rumination to be explained.

In the unconditional model with only 'month' predicting rumination to test for growth, we found a significant fixed effect for the rate of change over time ( $b = -.19$  [ $-.28, -.10$ ],  $SD = .04$ ,  $t(83.47) = -4.24$ ,  $p < .001$ ,  $R^2_\beta = .18$ ). Thus, we included the measurement number variable in order to de-trend the model. This variable was specified as a both fixed and a random effect.

<sup>3</sup> Notably, whereas it is more intuitive to 'predict' the future using the past as a predictor, the word 'prediction' in the context of regression analyses does not imply past-future directionality, but rather the extent to which knowledge of one variable enables us to reasonably hypothesize about the other variable. It is important to keep the identity of the dependent variable constant in an MLM model, and not to 'swap places' between rumination and DEP-DER, because differing characteristics such as rate of change across time, skewness, or ICC of the variable will preclude the ability to make a valid comparison between the models.

**Table 2.** The rumination and DEP-DER scales at each time point for the combined sample, as well as separately for each group

Time point	Combined sample	Clinical group	Healthy controls
0 (baseline)			
Rumination mean (SD)	8.86 (3.24)	10.37 (3.25)	7.34 (2.46)
DEP-DER mean (SD)	2.14 (4.71)	3.23 (5.63)	1.05 (3.25)
1			
Rumination mean (SD)	8.03 (2.61)	9.04 (2.76)	7 (2)
DEP-DER mean (SD)	3.29 (8.44)	5.67 (11.28)	.92 (2.32)
2			
Rumination mean (SD)	8.11 (3.14)	9.5 (3.47)	6.79 (2.07)
DEP-DER mean (SD)	2.73 (7.14)	4.58 (10.18)	1.04 (2.76)
3			
Rumination mean (SD)	7.79 (3.17)	9.36 (3.47)	6.36 (2.02)
DEP-DER mean (SD)	2.61 (7.57)	4.58 (10.39)	.81 (2.28)
4			
Rumination mean (SD)	7.47 (3.09)	9.35 (3.48)	5.94 (1.53)
DEP-DER mean (SD)	2.09 (5.03)	3.29 (6.31)	1.12 (3.44)
5			
Rumination mean (SD)	7.75 (3.17)	9.36 (3.58)	6.43 (2.03)
DEP-DER mean (SD)	2.19 (6.82)	4.29 (9.44)	.48 (2.48)

Note. SD = standard deviation.

The covariance elements associated with the random effect of DEP-DER were all non-significant. Thus, although DEP-DER was a level-1 variable, it was specified only as a fixed effect. Level-2 predictors (person-mean DEP-DER, age, and gender) were specified only as fixed effects. The rumination and DEP-DER scales at each time point are presented in Table 2 (for the combined sample and for each of the groups separately). The results of the main analyses are detailed in Table 3. As can be seen in the table, we found positive and significant contemporaneous within-person and between-person effects, suggesting that the two constructs varied together both across individuals and across months, within individuals. Next, we explored time-lagged effects. We found a significant positive effect of DEP-DER at  $t + 1$  on rumination, whereas the effect of DEP-DER at  $t - 1$  did not reach statistical significance. Thus, increased rumination on 1 month was associated with high DEP-DER on the next month, over and above the variance shared with DEP-DER on the same month. Conversely, no such effect was found for DEP-DER preceding rumination.<sup>4</sup>

## Discussion

The main purpose of the study was to explore the long-term longitudinal relationship between rumination and DEP-DER experiences. First, we found a positive link between

<sup>4</sup> Notably, an anonymous reviewer suggested to examine whether the results hold up in the clinical sample when it is analysed separately. In the clinical sample alone, as in the full sample, increased rumination on one month was associated with high DEP-DER on the next month ( $b = .55$  [.02, 1.07],  $SD = .27$ ,  $t(134.21) = 2.04$ ,  $p < .05$ ,  $R^2_{\beta} = .03$ ), but not vice versa ( $b = -.08$  [-.53, .37],  $SD = .38$ ,  $t(157.98) = -.33$ ,  $p = .14$ ). The contemporaneous effect between rumination and DEP-DER became only a statistical trend ( $b = .35$  [-.05, .76],  $SD = .21$ ,  $t(215.52) = 1.7$ ,  $p = .09$ ,  $R^2_{\beta} = .01$ ), probably because of the decreased statistical power due to the small sample size. The between-subjects effect was not significant ( $b = .54$  [-.24, 1.31],  $SD = .38$ ,  $t(48.38) = 1.39$ ,  $p = .17$ ), probably not only because of the smaller group size but also because of the homogeneity of this group.



**Table 3.** Results depicting the models predicting rumination by contemporaneous and time-lagged DEP-DER

Effect	<i>b</i> [CI]	Std. error	df	<i>t</i>	<i>p</i>	$R^2_{\beta}$
Rumination predicted by contemporaneous DEP-DER						
Intercept	7.94 [7.31, 8.56]	.31	97.67	25.17	.00	.86
Measurement number	-.18 [-.28, -.10]	.04	82.75	-4.09	.00	.17
DEP-DER person-mean (between-subjects effect)	1.15 [.55, 1.75]	.30	95.13	3.82	.00	.13
DEP-DER centred (within- subjects effect)	.30 [.02, .59]	.15	426.4	2.07	.03	.01
Rumination predicted by DEP-DER at $t + 1$ (directionality: rumination $\rightarrow$ DEP-DER)						
Intercept	8.07 [7.43, 8.72]	.32	96.59	24.83	.00	.86
Measurement number	-.25 [-.36, -.13]	.06	87.85	-4.18	.00	.17
DEP-DER person-mean (between-subjects effect)	1.06 [.45, 1.68]	.31	94.46	3.44	.00	.11
DEP-DER centred (within- subjects contemporaneous effect)	.31 [-.02, .64]	.17	349.45	1.84	.06	.01
DEP-DER $t + 1$ (within-subject lagged effect, rumination precedes DEP-DER)	.43 [.07, .79]	.18	329.97	2.37	.01	.02
Rumination predicted by DEP-DER at $t - 1$ (directionality: DEP-DER $\rightarrow$ rumination)						
Intercept	7.59 [6.97, 8.21]	.31	95.96	24.11	.00	.86
Measurement number	-.07 [-.19, .04]	.06	86.5	-1.3	.19	.02
DEP-DER person-mean (between-subjects effect)	1.04 [.46, 1.62]	.29	94.15	3.55	.00	.12
DEP-DER centred (within- subjects contemporaneous effect)	.45 [.10, .79]	.17	331.59	2.55	.01	.02
DEP-DER $t - 1$ (within- subjects lagged effect, DEP-DER precedes rumination)	-.07 [-.40, .24]	.16	350.597	-.49	.63	.00

Note. CI = 95% confidence intervals, rounded down to two decimals.

rumination and DEP-DER, both at the trait level (i.e., those who reported higher rumination were more inclined to report DEP-DER) and within subjects (i.e., levels of rumination and DEP-DER increased and decreased simultaneously across monthly assessments). These findings replicate recent evidence regarding the link between rumination and dissociation (Vannikov-Lugassi & Soffer-Dudek, 2018a, 2018b) and extend them by: (1) broadening the time frame in which this relationship occurs; (2) focusing specifically on DEP-DER; and (3) using a mixed sample which included both clinical participants and healthy community controls.

Moreover, as we expected, rumination longitudinally predicted DEP-DER, that is, high rumination levels were followed by an increase in DEP-DER from one assessment to the next. In contrast, DEP-DER symptoms did not longitudinally predict rumination, implying that rumination is a possible long-term antecedent of DEP-DER, but not vice versa. These findings are novel and important considering the insufficiently clear origins of DEP-DER in the existing literature.

In accordance with these results, recent neurological findings show abnormal activity in areas (e.g., posterior cingulate cortex) related to the default mode network (DMN) in

depersonalization/derealization disorder patients (Krause-Utz, Frost, Winter, & Elzinga, 2017; Lemche *et al.*, 2016). The DMN is a brain network that has been implicated in ‘inward-directed’ (self-referential) processes, such as rumination (Greicius, 2008; Greicius *et al.*, 2003; Raichle *et al.*, 2001). Indeed, altered resting-state functional connectivity in the DMN was found in patients with dissociative subtype of PTSD, in correlation with DEP-DER severity (Tursich *et al.*, 2015), and stronger activity was found in areas implicated in self-referential processing (e.g., mPFC) while watching one’s own photographs, in correlation with depersonalization severity (Ketay *et al.*, 2014). This relationship between DEP-DER and DMN may shed light on the view of DEP-DER as sleep-like experiences, considering the link of DMN to sleep states. Specifically, a natural, sleep-induced reduction in conscious awareness is reflected in an altered correlation between DMN network components during deep sleep states (Horovitz *et al.*, 2009). Moreover, in a sleep-deprived state, there are intermittent intrusions of DMN activity during task engagement (Krause *et al.*, 2017). These intrusions may reflect intrusions of sleep phenomena into waking consciousness, which may include DEP-DER experiences (Mahowald & Schenck, 2001). Such altered DMN activity, in combination with poor sleep quality (which may be caused by rumination; Guastella & Moulds, 2007; Takano *et al.*, 2012; Zoccolai *et al.*, 2009), may play a role in the link between rumination and DEP-DER.

Another possible mediator is maladaptive emotion regulation which is related both to rumination and to DEP-DER, as has been detailed in the introduction section. Our results showed a timeline path from rumination to DEP-DER, suggesting that maladaptive emotion regulation is a possible aetiology of DEP-DER experiences. Indeed, maladaptive cognitive bedtime strategies to deal with intrusive thoughts before sleep mediated the link between rumination and dissociation (Vannikov-Lugassi & Soffer-Dudek, 2018a). Although that study was cross-sectional, those findings taken together with the present directional findings lend strong support for the idea that maladaptive emotion regulation, possibly joining forces with poor sleep, may be at the core of generating DEP-DER.

An additional possible mediator which may play a role in the rumination–DEP-DER link is the repetitive structure of thinking characterizing rumination (Nolen-Hoeksema, 1991; Nolen-Hoeksema *et al.*, 2008). Specifically, one of the characteristics of rumination is the process of recurring thoughts, alongside the negative content of those thoughts (Joormann & Gotlib, 2010). Van den Hout, Engelhard, de Boer, du Bois, and Dek (2008) explain that perseveration may provoke feelings of uncertainty and dissociation. Specifically, after a stimulus is perceived, activation spreads, making concepts that are related to the stimulus more accessible. According to Van den Hout *et al.* (2008), the prolonged fixation on the object blocks such activation, diminishing certainty and causing derealization. This theory has not been explored directly yet, and future studies should examine whether this is the mechanism that explains the link between perseveration and dissociation. However, some findings relating to the phenomenon of ‘semantic satiation’ (Pynte, 1991) support this idea. If one repeats a word 10 times, the meaning of the word is retained on an intellectual level, but the word starts to feel disconnected from its meaning on a phenomenological level (Brewin, Ma, & Colson, 2013; Brewin & Mersaditabari, 2013). Similarly, a different form of perseveration (e.g., prolonged fixation on an object, checking or repeating sentences) can bring about similar experiences of dissociation and specifically DEP-DER (Giele *et al.*, 2013, 2014; Sanbonmatsu *et al.*, 2007; van den Hout *et al.*, 2008, 2009). Notably, in these experiments the repetition was willed and neutral, whereas in rumination, the repetitive thoughts are negative and intrusive. However, the repetition itself may play a role in dissociation. Possibly in the same way, ruminative prolonged and repetitive thinking may induce or increase the feeling of detachment from

the self or the surrounding. Similarly, it may bring about a breakdown of compatibility between the intention or anticipation of the observing self and the resulting experience, namely DEP-DER. Interestingly, Masuda *et al.* (2010) found that repetition of negative self-referential thought reduced the emotional discomfort and believability of this thought and suggested this practice as an intervention. However, the reduction of the emotional discomfort that was found may perhaps have been a kind of emotional numbing, similar to that reported in DEP-DER experiences. Unfortunately, DEP-DER was not examined in that study, warranting further investigation.

A final explanation for the relationship between rumination and DEP-DER focuses on the transition from ruminative thinking to external reality. Possibly, while individuals are absorbed in intensive ruminative thinking, which includes an altered perception of the self, and then attempt to act in reality, they may feel as if reality is odd and different from their anticipation. Thus, such a transaction may be experienced as wrong, creating an anomalous experience of the self, resulting in a reduction in the sense of existing as an aware subject, which characterizes depersonalization (Medford, 2012; Sass, Pienkos, Nelson, & Medford, 2013). Indeed, ruminative moments were found to be immediately accompanied by DEP-DER experiences (Vannikov-Lugassi & Soffer-Dudek, 2018b). However, in this study, we aimed to explore whether there would be a long-term effect of ruminative thinking on intensifying long-term DEP-DER. Notably, most people suffering from DEP-DER disorder experience it continuously rather than episodically (Simeon, 2004). In fact, in a sizeable proportion of people, DEP-DER disorder may start episodically for months or years and subsequently become continuous (Simeon, 2004). Thus, it makes sense to study long-term change in DEP-DER alongside momentary changes. Moreover, it is possible that one's brain may learn to react with DEP-DER following specific moments (e.g., ruminative moments) and then experience it with greater frequency once the relevant associations have been formed (as in the 'kindling' hypothesis in psychopathology; Post, 1992; Post *et al.*, 2001). Thus, our current exploration may be directly relevant for understanding the clinical expressions of DEP-DER, adding informative value and predictive power over a momentary sampling exploration.

Several limitations in this study should be addressed. First, rumination was decreasing over time in our sample, probably due to treatment that may have been received by the outpatient group during their participation, and this may have affected results. Second, although combining clinical and healthy participants into a single sample has been conducted in published literature (e.g., Watson *et al.*, 2015), it is not the most common practice, and it may have inflated the variance at each time point and led to overestimation of the effects. However, we found evidence for one direction (rumination predicting an increase in DEP-DER) but not for the other. Thus, our results probably cannot be fully explained by inflated variance. Moreover, the separate analyses within the clinical group (footnote #4) suggest that the above-mentioned unidirectional results remain the same as in the full mixed sample. Third, Cronbach's alpha of the DEP-DER scale in the first assessment was quite low (.57). However, taking into account that we used six assessments in our analyses and the rest had appropriate reliabilities for DEP-DER, the results probably were not affected to a great extent by this single assessment. Fourth, our number of data points (six assessments for 98 individuals) may have been non-optimal, perhaps limiting our ability to show a longitudinal effect of DEP-DER on rumination. The modest size of the sample stemmed from the difficulty of recruiting and keeping clinical participants for a 6-month study, as well as from significant exclusion, which in itself may also be a limitation, impairing generalizability. Fifth, in this study we did not assess personality disorders which are strongly correlated with dissociation, such as borderline

personality disorder (e.g., Korzekwa, Dell, Links, Thabane, & Fougere, 2009; Krause-Utz *et al.*, 2017). The presence of a personality disorder may influence the specific expression of dissociative symptoms (Laddis *et al.*, 2017) and thus may play a role in the link between rumination and DEP-DER. Notably, however, our study examined this link at the intra-personal level, and thus, possible additional diagnoses of some of the participants probably cannot fully explain our results. Sixth, all of the measures were self-reported. Self-report measures may be vulnerable to bias; however, individual differences in the tendency to over-report are irrelevant to within-subjects variance, which was the focus of the present study.

Despite these limitations, the study has theoretical and methodical strengths. Both rumination and DEP-DER are dominant in psychopathology and have negative implications on therapy (e.g., Arntz, Stupar-Rutenfrans, Bloo, van Dyck, & Spinhoven, 2015; Fassino, Pierò, Tomba, & Abbate-Daga, 2009; Kuyken, Watkins, Holden, & Cook, 2006; Ross, 1996; Rufer *et al.*, 2006; Semiz, Inanc, & Bezgin, 2014; Spasojević & Alloy, 2001; Spitzer, Barnow, Freyberger, & Grabe, 2007; Waller & Ross, 1997). This was the first study to explore the link between them longitudinally across several months. In addition, unlike previous studies on this link, which were conducted on student samples (Vannikov-Lugassi & Soffer-Dudek, 2018a, 2018b), the present study was conducted on a mixed clinical and community sample, which allows generalizing these conclusions to a diverse population. Finally, we focused on rumination and DEP-DER as states rather than merely individual difference traits, and we identified directionality using our longitudinal design. Our findings broaden the understanding of possible antecedents of DEP-DER. Moreover, they may bear practical implications. Perhaps, clinicians who observe ruminative thinking should be alert to signs of DEP-DER and should distinguish between an authentic decrease of distress, to detachment from emotion (i.e., DEP-DER) following rumination.

## Acknowledgements

We are greatly thankful to Prof. Patrick J. Curran for his rigorous statistical consulting.

## Funding

This research was supported by the Israel Science Foundation Grant No. 539/13 to N. Soffer-Dudek. This research was also supported (in part) by the Israel Science Foundation Grant No. 1895/13 to N. Soffer-Dudek. The foundation had no involvement in the research other than providing financial support.

## Conflicts of interest

All authors declare no conflict of interest.

## Author contribution

Miriam Vannikov-Lugassi, Ph.D. student (Conceptualization; Data curation; Formal analysis; Investigation; Project administration; Writing – original draft; Writing – review & editing) Hadar Shalev (Project administration; Resources; Supervision) Nirit Soffer-Dudek (Conceptualization; Formal analysis; Funding acquisition; Investigation; Project administration; Supervision; Writing – review & editing)

## Data availability statement

Unfortunately, for ethical reasons, we cannot publicly share the data; participants were informed that the data will be confidential, and the data are property of Soroka Medical Center. We are willing to send the data, after receiving permission from the psychiatrist who oversaw the study, to any qualified researcher.

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