



The role of avoidance and beliefs on perseverative cognitions in the link between task-unrelated thoughts and psychopathology symptoms

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ABSTRACT

Rumination, mind-wandering (MW), and daydreaming are maladaptive task-unrelated thoughts (TUT). All three processes are transdiagnostic, making them one of the targets of processed-based CBT. Although extant empirical data supports many mechanisms underlying maladaptive features of TUT, one primary mechanism – avoidance still lacks convincing empirical evidence. The present study aimed to test, from a longitudinal perspective, the mediator role of cognitive avoidance in the link between rumination, daydreaming, MW, and their maladaptive outcomes (depression, anxiety, and sleep disturbance). Additionally, the study will test the role of beliefs on emotions/rumination and inhibitory control in those models.

397 volunteers filled in a series of self-reported questionnaires in two waves with a 3-month interval. The results suggest that cognitive avoidance plays a mediator role in the link between MW or daydreaming and anxiety, depression, and sleep disturbance. However, these mediation models were not significant for rumination. Moreover, beliefs about perseverative cognition moderated the MW mediation model.

This is the first study suggesting that avoidance mechanisms and beliefs on cognition controllability might differentiate types of TUT and their impact on psychopathology symptoms. However, the results are based only on self-reported measures, which is particularly challenging for measuring avoidance.

1. Introduction

1.1. Rumination, mind-wandering, and daydreaming as transdiagnostic task-unrelated thoughts

Rumination, mind-wandering, and daydreaming are considered emotion regulation strategies which, under certain circumstances, might lead to maladaptive outcomes and increased risk of psychological disorders (Bigelsen et al., 2016; Marchetti et al., 2014, 2016; Watkins, 2008). Currently, the literature lacks consensus regarding whether these processes should be considered as distinct (because they differ in crucial characteristics), or as different forms of one process (because they share main features, differing only on secondary details). Generally, task-unrelated thinking (TUT) could be defined as an attentional shift towards internal information without any environmental demands requiring this shift (Smallwood & Schooler, 2006). On one hand, researchers advocating for the distinction between different forms of TUT underline that rumination (i.e. repetitive dwelling on one or more

negative subjects perceived as difficult to control; Ehrling & Watkins, 2008) is more constrained, while mind-wandering (MW, i.e. thoughts that are not tied to either the immediate sensory input or the ongoing task, Stawarczyk et al., 2011) is characterised by freely moving feature (Christoff et al., 2018). Maladaptive daydreaming is usually defined as engaging in prolonged fantasy experiences that interfere with social interactions or disrupt academic, interpersonal, or vocational functioning (Somer, 2002) and according to a recent study should differ from MW by not interfering with an ongoing task - daydreaming occurs when one is not focused on any particular activity, while in contrast, thoughts occurring during another activity are considered as MW (Shimoni & Axelrod, 2024). This might suggest that the maladaptive consequences of daydreaming described by Somer (2002) might not be linked to the current task impairment but rather to TUT being used as a general avoidance strategy. It seems crucial to underline that nowadays most of the authors stress that the terms describing TUT (particularly daydreaming and MW) are often used interchangeably and the definitions are heterogeneous across the literature in term of, for example, stimulus

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dependence-independence, self-referential content or intentionality (Christoff, 2012; Shimoni & Axelrod, 2024; Van den Driessche et al., 2025). Seli et al. (2018) suggest that MW, daydreaming, and rumination are subtypes of a bigger class of cognitions which should be considered from the family-resemblance perspective, as all are a form of task-unrelated thinking (Seli et al., 2018). Finally, some others suggest that mind-wandering and rumination might be two (adaptive and maladaptive) end-points of the same continuum (Ottaviani et al., 2013) and that the emotional valence of TUT may mainly affect its' maladaptive outcomes (Welhaf & Banks, 2024).

The focus on different forms of TUT is particularly interesting from the perspective of process-based therapy, treating transdiagnostic processes rather than a particular diagnosis (Hofmann & Hayes, 2019). In the case of different forms of TUT, in spite of its divergent conceptualisations, it seems all processes might share a common mechanism in their maladaptive form – as forms of experiential avoidance (Giorgio et al., 2010; Kruger et al., 2020; Smith, 2009; Somer, 2002). Experiential avoidance (EA) is a maladaptive mechanism comprising an effort to avoid aversive private experiences (e.g. emotions, thoughts, memories; Chawla & Ostafin, 2007). Although the theoretical background for the avoidance mechanism of TUT is strongly present in the literature (e.g. Giorgio et al., 2010; Newman & Llera, 2011; Somer, 2002; Stroebe et al., 2007; Watkins, 2018), little confirmatory empirical evidence exists. It is therefore unclear whether the avoidance mechanism can differentiate the impact of daydreaming, mind-wandering, and rumination on psychopathological outcomes. The lack of empirical evidence might be caused by several factors. First, measuring avoidance is challenging, particularly in its cognitive form (Ball & Gunaydin, 2022; Kornacka et al., 2023). Second, the link between avoidance and TUT might be impacted by other psychological variables: e.g. one's beliefs on negative emotions (Choi & Miyamoto, 2023; Tamm et al., 2025), particularly its controllability (Kornacka et al., 2023) or by beliefs on task-unrelated cognitions (Cano-López et al., 2022). Those beliefs might also be linked with executive control over TUT itself (e.g. Tamm et al., 2024). Moreover, to our best knowledge, no previous studies linking avoidance to TUT have accounted for different types of task-unrelated cognitions within the same sample, which seems particularly important considering the heterogeneity of TUT definitions. Thus, the present study aimed to test whether avoidance can play a mediator role between rumination, mind-wandering, daydreaming, and psychopathological symptoms and to test potential moderators of this mediation model.

1.2. Rumination, mind-wandering, and daydreaming as experiential avoidance

Mind-wandering (MW, Kornacka et al., 2023), daydreaming (Somer, 2002) and rumination (Giorgio et al., 2010; Watkins, 2011) may all be used as avoidant responses to negative affect. In the case of rumination, instead of experiencing negative emotions, engagement in highly abstract repetitive negative thinking (RNT) affords reduced connection and distracts from current aversive experiences (Watkins, 2011). Additionally, rumination is also hypothesised to be maintained by the behavioural avoidance mechanism – engaging in repetitive thinking often prevents or delays engagement in actual actions, thus reducing risk of failure (Watkins, 2011). One of the rare empirical studies linking avoidance to rumination found a link between rumination and self-reported avoidance but not between avoidance behaviour measured in the lab (Giorgio et al., 2010). The link between mind-wandering and daydreaming with avoidance is often discussed in the literature (e.g. Somer, 2002), however, empirical studies are also scarce. An ecological momentary assessment study suggested that the negative valence of a currently performed task is linked to higher levels of TUT, concluding that this kind of cognition might be used as an avoidance strategy (Kornacka et al., 2023). In an experimental task, deliberate mind-wandering was related to avoidance in a specific sample of problematic gamblers (Kruger et al., 2020). Following a qualitative study, Somer

(2002) suggested maladaptive daydreaming can be at least partially explained by avoidance in patients with personality and dissociative disorders, but also underlined the need for further research. Moreover, the complexity of the relationship between TUT and avoidance might also be due to numerous potential moderators or mediators.

1.3. Beliefs about emotions' controllability and about perseverative cognitions as factors potentially affecting avoidance in the context of task-unrelated thoughts

How people perceive their emotions and cognitions and the extent to which they feel confident about regulating and controlling them is linked to their choice of emotion regulation strategies (including avoidance [Fergus et al., 2013; Ford & Gross, 2019]), but also to their general mental health (De Castella et al., 2018; Kim et al., 2024; Kneeland et al., 2016). People convinced that their emotions are impossible to control or change would be more prone to avoid them (Kim et al., 2024; Schell et al., 2023; Zimmermann et al., 2021). De Castella et al. (2018) showed in an experimental study that one's beliefs about emotions predict readiness to engage in avoidant emotion regulation strategies. In an experience sampling study, Kornacka et al. (2023) showed that beliefs on negative emotion controllability can moderate the link between task characteristics (including valence) and TUT level, raising another argument for the role of beliefs on emotions in the avoidance mechanism of TUT. Some empirical evidence suggests that different kinds of TUT are related not only to beliefs on emotions, but also to meta-cognitive beliefs about cognition controllability and usefulness (Carciofo et al., 2017; Tamm et al., 2024). However, some other studies failed to confirm the link between TUT (particularly rumination) and beliefs on emotion controllability (Johnston et al., 2025). In sum, initial results suggest that negative meta-cognitive beliefs about emotions and thoughts may affect the relationship between TUT and avoidance. However, there is not yet sufficient empirical evidence to strongly support either a mediation or moderation hypothesis. Nevertheless, while the link between meta-cognitions and avoidance appears relatively well-established in the literature (e.g., De Castella et al., 2018; Kim et al., 2024; Schell et al., 2023; Zimmermann et al., 2021) findings connecting TUT to meta-cognitions are more heterogeneous and limited (e.g. Carciofo et al., 2017; Kornacka et al., 2023). Considering that meta-cognition may be independent of TUT, we chose to examine negative beliefs about the controllability of emotions and negative beliefs about rumination as moderators in the present study.

While linking TUT to one's beliefs on the controllability of cognitions or emotions, it seems essential to consider the actual executive control one has over their cognitive processes. Particularly, numerous studies suggest that the key element affecting TUT would be the beliefs on lack of controllability (Greene et al., 2020; Gutentag et al., 2023; Kornacka et al., 2023; Tamm et al., 2024), as individuals with poor control over their cognitions and regulation strategies might potentially develop a set of negative beliefs and expectancies regarding their negative emotions and their regulation (Fergus et al., 2013).

1.4. Aim of the study

The present study aimed to test, from a longitudinal perspective: (1) The mediator role of cognitive avoidance in the link between rumination, daydreaming and MW and their main maladaptive outcomes (depression, anxiety, and sleep disturbance; Cárdenas-Egúisquiza & Berntsen, 2022); (2) whether beliefs on emotions and rumination can play a moderator role in this mediation model; and (3) whether the inhibitory control can affect the link between MW, daydreaming, rumination and negative beliefs on rumination or negative emotion. Thus we hypothesised that:

1. Cognitive avoidance will play a mediator role in a positive relation between (a) rumination/(b) MW/(c) daydreaming and anxiety; depression; sleep disturbance.
2. Negative beliefs on negative emotions' controllability and negative beliefs on rumination will moderate the link between rumination and cognitive avoidance in the mediation models. Higher negative beliefs on emotions' controllability and higher negative beliefs on rumination will lead to a stronger link between rumination and avoidance.
3. The inhibitory control will play a mediator role in a positive relation between (a) rumination, (b) MW, (c) daydreaming, and negative beliefs on emotion controllability.
4. The inhibitory control will play a mediator role in a positive relation between (a) rumination, (b) MW, and (c) daydreaming and negative beliefs on rumination controllability.

2. Material and methods

2.1. Participants and procedure

Healthy volunteers were invited to participate through an internal research recruitment system at SWPS University, Poland. 1520 participants agreed to participate in the study. 1301 participants (1110 female, 169 male, 16 other gender, 6 no gender provided; mean age 25.72; SD = 8.04) completed the questionnaire at timepoint 1 (T1). Of these, 1097 participants agreed to be contacted for the second part of the study after 3 months (T2). The final sample comprised 397 participants (353 female, 40 male, 2 other gender, 2 no gender provided; mean age 25.72; SD = 8.32), who completed both waves of the questionnaires. Due to a significant dropout between measurement points 1 and 2, we examined whether any of the measured variables predicted dropout from the study. The two significant predictors were depressive and anxious symptoms (see Supplementary materials, Tables S1a and S1b). All participants completing both waves received course credit for their participation. The study was approved by the local ethical committee WKEB69/03/2021 and was run in accordance with the Declaration of Helsinki. Hypotheses were preregistered at osf: DOI [10.17605/OSF.IO/S64C8](https://doi.org/10.17605/OSF.IO/S64C8).

2.2. Materials

2.2.1. Mind-wandering: Mind-Wandering Questionnaire (MWQ; [Mrazek et al., 2013](#))

A 5-item self-report scale assessing mind-wandering. Cronbach's α for all questionnaires and both measure points are presented in [Table 1](#).

2.2.2. Daydreaming Frequency Scale (DDFS; [Giambra, 1993](#))

A 12-item self-report questionnaire assessing daydreaming.

2.2.3. Rumination: Perseverative Thinking Questionnaire (PTQ, [Ehring et al., 2011](#))

A 15-item self-report measure, assessing the main characteristics of repetitive negative thinking (core features, unproductiveness, mental capacity captured by RNT).

2.2.4. Cognitive avoidance: Cognitive Avoidance Scale (CAQ, [Sexton & Dugas, 2008](#))

A 25-item questionnaire measuring five cognitive avoidance strategies (thought suppression, thought substitution, distraction, avoidance of threatening stimuli, transformation of images into thoughts).

2.2.5. Beliefs about negative emotions: Emotion Beliefs Questionnaire (EBQ, [Becerra et al., 2020](#))

A 16-item self-report questionnaire assessing beliefs about controllability and usefulness of emotions. Scores for controllability and usefulness can be calculated as a composite score or separately for negative and positive emotions.

2.2.6. Beliefs on rumination: Positive & Negative Beliefs on Rumination Scale (PNBRS; [Yang et al., 2020](#))

This consists of three sub-scales measuring metacognitive beliefs on rumination (positive beliefs: 9-items, negative beliefs: controllability and harm, 8-items in its original version,¹ and negative beliefs: social consequences, 5-items).

2.2.7. Depression and anxiety: Hospital Anxiety and Depression Scale (HADS; [Zigmond & Snaith, 1983](#))

A measure of possible and probable presence of anxiety disorders and depression, comprising seven items for depression and seven items for anxiety.

2.2.8. Sleep Quality: Sleep Quality Scale (SQS; [Shahid et al., 2011](#))

A 28-item self-report measure of sleep quality, including restoration after sleep, difficulties in falling asleep, difficulties in getting up, satisfaction with sleep, and difficulties maintaining sleep.

2.2.9. Executive control: NAS-50 ([Wójcik et al., 2016](#))

A 50-item self-report questionnaire assessing self-control at trait level, containing 5 subscales (initiative and persistence, proactive control, switching and flexibility, inhibition and adjustment, and goal maintenance).

3. Results

Descriptive statistics and correlations are presented in [Tables 1 and 2](#). The data collected in this study is available at [blinded for the review]. To test mediation and moderated mediation models, we used Haye's Process for SPSS setting up bootstrap level to 10,000. The normality of the residuals distribution is presented in the Supplementary materials, Table S2.

3.1. The mediating role of cognitive avoidance in the link between rumination, mind-wandering, daydreaming, and psychopathology symptoms

First, we tested whether cognitive avoidance measured at T1 is a mediator between mind-wandering measured at T1 and psychopathology symptoms measured 3 months later (T2). The indirect effects from mind-wandering through cognitive avoidance on depression ($b = 0.03$, bootSE = 0.02, 95 % bootCI [0.001, 0.07]), anxiety ($b = 0.08$, bootSE = 0.02, 95 % bootCI [0.04, 0.13]), and sleep disturbance ($b = 0.16$, bootSE = 0.05, 95 % bootCI [0.05, 0.27]) were positive and significant. The direct effect of mind-wandering on depression ($b = 0.12$, SE = 0.04, 95 % CI [0.03, 0.21], $p = .007$), anxiety ($b = 0.28$, SE = 0.05, 95 % CI [0.18, 0.38], $p < .001$) and sleep disturbance ($b = 1.03$, SE = 0.13, 95 % CI [0.77, 1.28], $p < .001$) were also significant and positive.

Second, we tested similar mediation models for daydreaming. The indirect effect between daydreaming and depression ($b = 0.01$, bootSE = 0.006, 95 % bootCI [0.004, 0.027]), anxiety ($b = 0.03$, bootSE = 0.009, 95 % bootCI [0.0137, 0.0496]) and sleep disturbance ($b = 0.07$, bootSE = 0.02, 95 % bootCI [0.0320, 0.1248]) through avoidance were significant. The direct effect of daydreaming on depression was not significant ($b = 0.015$, SE = 0.02, 95 % CI [-0.25, 0.0552]) while the direct effect for anxiety ($b = 0.0718$, SE = 0.02, 95 % CI [0.0262, 0.1174], $p < .01$) and sleep disturbance ($b = 0.25$, SE = 0.06, 95 % CI [0.1260, 0.3724], $p < .001$) were significant and positive.

Third, we tested whether cognitive avoidance play mediator role between rumination and psychopathology symptoms. Although, rumination was positively related to cognitive avoidance ($b = 0.71$, SE = 0.07, $\beta = 0.46$, 95 % CI [0.57, 0.85], $p < .001$) and the direct effect of

¹ In the present study, the item "Ruminating can make me harm myself" was removed for ethical reasons considering the online administration of the survey.

Table 1
Descriptive statistics.

	Time 1				Time 2			
	N	Mean	SD	Cronbach's α	N	Mean	SD	Cronbach's α
Mind Wandering Questionnaire	1301	17.68	4.62	0.839	397	17.39	4.48	0.837
Daydreaming Frequency Scale	1301	39.42	9.38	0.926	397	39.76	9.18	0.930
Perseverative Thinking Questionnaire total score	1301	47.50	12.11	0.953	397	46.56	12.43	0.957
Cognitive Avoidance Questionnaire total score	1301	77.73	18.45	0.912	397	78.38	18.62	0.922
Emotions Beliefs Questionnaire: Negative Emotions Controllability	1301	7.91	4.62	0.832	397	8.43	4.93	0.846
Emotions Beliefs Questionnaire: Negative Emotions Usefulness	1301	7.30	4.41	0.800	397	7.78	5.00	0.844
Negative Beliefs about Ruminations Scale: Controllability and harm	1301	15.64	5.09	0.808	397	15.96	5.22	0.827
Negative Beliefs about Ruminations Scale: Social Consequences	1301	8.06	3.51	0.805	397	8.40	3.84	0.829
Negative Beliefs about Ruminations Scale: total score	1301	23.70	7.68	0.892	397	24.36	8.09	0.903
Hospital Anxiety and Depression Scale: Depression	1301	5.31	3.68	0.758	397	5.15	3.73	0.758
Hospital Anxiety and Depression Scale: Anxiety	1301	9.71	4.44	0.820	397	9.28	4.45	0.818
Sleep Quality Scale total score	–	–	–	–	397	37.39	12.04	0.881
Executive control: NAS-50 total score	–	–	–	–	397	156.76	19.84	0.851

Table 2
Correlations between Time 1 and Time 2 measures.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
Time 1 (N=1301)																					
MWQ	–																				
DDFS	.503**	–																			
PTQ	.612**	.459**	–																		
CAQ	.328**	.236**	.418**	–																	
EBQ: NC	.065*	.034	.159**	.099**	–																
EBQ: NU	.023	.000	.107**	.116**	.682**	–															
NBRS: CH	.464**	.316**	.695**	.394**	.313**	.281**	–														
NBRS: SC	.235**	.164**	.391**	.207**	.488**	.523**	.583**	–													
HADS: D	.251**	.105**	.417**	.129**	.268**	.258**	.448**	.453**	–												
HADS: A	.387**	.282**	.612**	.287**	.191**	.148**	.583**	.424**	.652**	–											
Time 2 (N=397)																					
MWQ	.652**	.433**	.478**	.335**	.072	.004	.386**	.169**	.215**	.353**	–										
DDFS	.437**	.709**	.403**	.264**	.072	.024	.356**	.190**	.111*	.309**	.589**	–									
PTQ	.436**	.421**	.706**	.385**	.155**	.092	.556**	.314**	.349**	.540**	.649**	.559**	–								
CAQ	.331**	.245**	.367**	.610**	.079	.053	.336**	.218**	.176**	.315**	.417**	.319**	.451**	–							
EBQ: NC	.122*	.086	.152**	.108*	.491**	.410**	.198**	.296**	.214**	.176**	.134**	.104*	.230**	.139**	–						
EBQ: NU	.065	.001	.046	.106*	.377**	.486**	.121*	.295**	.146**	.085	.051	.054	.101*	.113*	.756**	–					
NBRS: CH	.377**	.326**	.607**	.364**	.161**	.163**	.636**	.407**	.355**	.489**	.468**	.419**	.701**	.384**	.349**	.245**	–				
NBRS: SC	.198**	.180**	.307**	.210**	.338**	.325**	.364**	.520**	.301**	.313**	.260**	.225**	.410**	.267**	.563**	.517**	.586**	–			
HADS: D	.185**	.071	.325**	.163**	.264**	.244**	.323**	.370**	.537**	.428**	.251**	.153**	.396**	.140**	.373**	.279**	.408**	.479**	–		
HADS: A	.362**	.212**	.548**	.318**	.171**	.126*	.472**	.338**	.476**	.672**	.432**	.372**	.664**	.308**	.236**	.116*	.592**	.464**	.645**	–	
SQS	.442**	.248**	.471**	.298**	.156**	.098	.458**	.360**	.420**	.503**	.507**	.397**	.561**	.337**	.222**	.123*	.529**	.388**	.482**	.618**	–
NAS-50	-.456**	-.248**	-.457**	-.264**	-.130**	-.114*	-.417**	-.288**	-.297**	-.340**	-.539**	-.321**	-.498**	-.308**	-.249**	-.197**	-.493**	-.385**	-.419**	-.457**	-.537**

MWQ - Mind-Wandering Questionnaire, DDFS – Daydreaming Frequency Scale, PTQ – Perseverative Thinking Questionnaire, CAQ - Cognitive Avoidance Scale, EBQ: NC - Emotion Beliefs Questionnaire: Negative emotions controllability, EBQ: NU - Emotion Beliefs Questionnaire: Negative emotions usefulness, NBRS: CH - Negative Beliefs on Rumination Scale: Controllability and Harm, NBRS: SC - Negative Beliefs on Rumination Scale – Social Consequences, NBRS - Negative Beliefs on Rumination Scale – total score, HADS: D - Hospital Anxiety and Depression Scale: Depression, HADS: A - Hospital Anxiety and Depression Scale: Anxiety, SQS - Sleep Quality Scale, NAS-50 – Total score of NAS-50 questionnaire measuring executive control.

* $p < .05$.

** $p < .01$.

rumination on depression ($b = 0.09$, $SE = 0.02$, $\beta = 0.32$, 95 % CI [0.06, 0.13], $p < .001$), anxiety ($b = 0.18$, $SE = 0.02$, $\beta = 0.51$, 95 % CI [0.15, 0.21], $p < .001$), and sleep disturbance ($b = 0.41$, $SE = 0.05$, $\beta = 0.42$, 95 % CI [0.31, 0.50], $p < .001$) were also positive and significant, the indirect effects from rumination through cognitive avoidance on depression ($b = 0.003$, $bootSE = 0.008$, 95 % bootCI [–0.01, 0.02]), anxiety ($b = 0.01$, $bootSE = 0.01$, 95 % bootCI [–0.002, 0.03]), sleep disturbance ($b = 0.05$, $bootSE = 0.02$, 95 % bootCI [–0.001, 0.10]) were not significant. Cognitive avoidance was significantly related only to sleep disturbance ($b = 0.07$, $SE = 0.03$, 95 % CI [0.004, 0.13], $p = .036$) in this model. The effect of cognitive avoidance on depression ($b = 0.004$, $SE = 0.01$, 95 % CI [–0.02, 0.02], $p = .735$) and anxiety ($b = 0.02$, $SE = 0.01$, 95 % CI [–0.002, 0.04], $p = .074$) was not significant.

3.2. The moderating role of beliefs on negative emotions' controllability and negative beliefs on rumination

To test our second hypothesis we verified whether negative beliefs on emotions (negative emotions uncontrollability) and negative beliefs on rumination measured at T1 can moderate the link between mind-wandering, daydreaming, rumination, and avoidance in the mediation model presented above, hypothesising that stronger negative beliefs on TUT and negative emotion uncontrollability will lead to a stronger relation between TUT and avoidance (see Fig. 1). The results suggest that beliefs on negative emotions controllability do not moderate the mediation between mind-wandering or daydreaming and psychopathology symptoms (depression, anxiety, sleep disturbance), as the partial moderated mediation indexes were not significant: for MW ($b = 0.0017$, 95 % bootCI [–0.0006, 0.0044]; $b = 0.0039$, 95 % bootCI [–0.0012, 0.0090]; $b = 0.0077$, 95 % bootCI [–0.0025, 0.0187]) and for daydreaming ($b = 0.0007$, 95 % bootCI [–0.0007, 0.0026]; $b = 0.0015$,

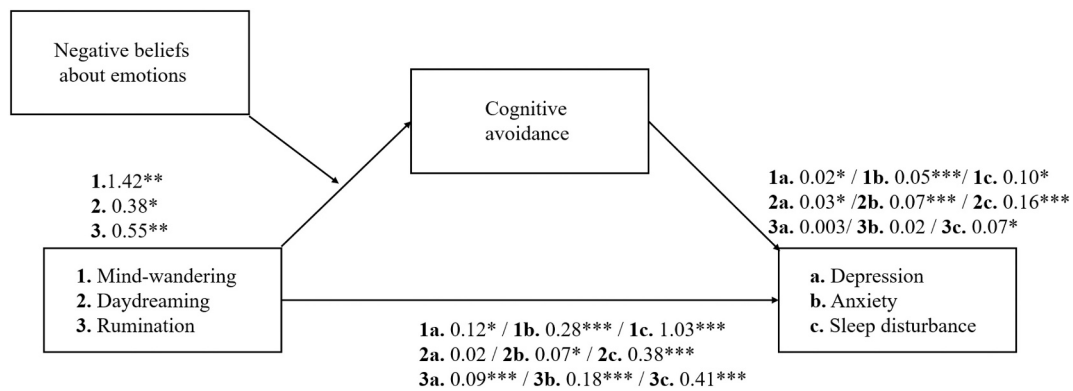


Fig. 1. The moderated mediation model examining whether cognitive avoidance serves as a mediator between mind-wandering, daydreaming, or rumination and psychopathological symptoms, and whether negative beliefs about negative emotions' uncontrollability and negative beliefs about rumination moderate this mediation.

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

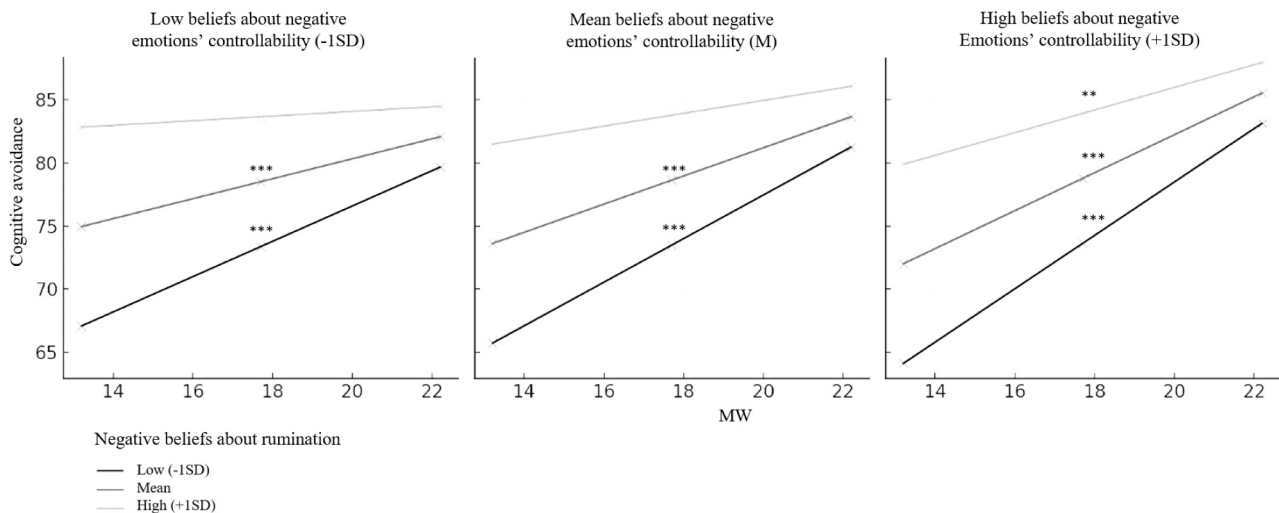


Fig. 2. Interaction between predictor (mind-wandering), moderators (beliefs about rumination controllability, beliefs about negative emotions controllability), and mediator (avoidance) in the moderated mediation model.

Note: ** $p < .01$, *** $p < .001$.

95 % bootCI [-0.0017, 0.0051]; $b = 0.0036$, 95 % bootCI [-0.0040, 0.0125]). The moderated mediation indexes were not significant also in the model including rumination as predictor: $b = 0.0001$, 95 % bootCI [-0.0008, 0.0006]; $b = 0.0007$, 95 % bootCI [-0.0001, 0.0022]; $b = 0.0023$, 95 % bootCI [-0.0003, 0.0069]. However, negative beliefs on rumination significantly moderated the link between MW and cognitive avoidance in models predicting anxiety ($b = -0.0037$, 95 % bootCI [-0.0071, -0.0007]) and sleep disturbance ($b = -0.0073$, 95 % bootCI [-0.0152, -0.0010]). It seems that simple slopes for the link between MW and cognitive avoidance were significant for low (-1 SD) and mean level of negative beliefs about rumination (and that independently of the level of negative beliefs about emotions controllability, $p < .001$ at each level of EBQ) but this link was not significant for participants with high level of negative beliefs about rumination ($p = .69$ for low EBQ and $p = .09$ for mean level of EBQ) apart from those with high level of negative beliefs about emotions uncontrollability and high level of negative beliefs about rumination simultaneously ($p = .0024$). Those interactions are presented in Fig. 2. We observed similar pattern of results for the indirect effect, which was significant for all levels of moderator apart from participants with high levels of negative beliefs on rumination and low ($b = 0.0089$, 95 % bootCI [-0.0343, 0.0580]) to medium ($b = 0.0246$, 95 % bootCI [-0.0079, 0.0644]) levels of negative beliefs about emotion uncontrollability simultaneously. The index of partial

moderated mediation was not significant for depression as outcome ($b = -0.0016$, 95 % bootCI [-0.0037, 0.0001]). The index of partial moderated mediation for negative beliefs about rumination was not significant for daydreaming ($b = -0.0006$, 95 % bootCI [-0.0018, 0.0003]) for depression as outcome; $b = -0.0014$, 95 % bootCI [-0.0035, 0.0007] for anxiety as outcome; $b = -0.0034$, 95 % bootCI [-0.0091, 0.0016] for sleep disturbance as outcome) and rumination ($b = -0.0001$, 95 % bootCI [-0.0008, 0.0006] for depression as outcome; $b = -0.0006$, 95 % bootCI [-0.0015, 0.0001] for anxiety as outcome; $b = -0.0022$, 95 % bootCI [-0.0050, 0.0001] for sleep disturbance as outcome) as predictors. Similar results were found for the Uncontrollability and harm subscale of NBRS (see Supplementary materials, Table S3).

3.3. Executive control as a mediator between TUT and negative beliefs on emotions

In order to test to what extent perceived general executive control affected the link between TUT and beliefs on emotion controllability, we tested three mediation models including mind-wandering, daydreaming, and rumination as predictors, beliefs on negative emotions controllability as outcome, and executive control as mediator. The indirect effects were not significant in any of the models ($b = 0.04$, bootSE

= 0.03, 95 % bootCI [-0.0154, 0.1041] for mind-wandering); ($b = 0.01$, bootSE = 0.008, 95 % bootCI [-0.006, 0.0317] for daydreaming) and ($b = 0.01$, bootSE = 0.01, 95 % bootCI [-0.0066, 0.0340] for rumination). The direct effects were significant in rumination ($b = 0.04$, $SE = 0.02$, 95 % CI [0.0021, 0.0863], $p = .036$), but not in the mind-wandering ($b = 0.09$, $SE = 0.06$, 95 % CI [-0.0285, 0.2053]) and in daydreaming ($b = 0.04$, $SE = 0.03$, 95 % CI [-0.0115, 0.0927]) models.

3.4. Executive control as a mediator between TUT and negative beliefs on rumination

Similar models were tested for beliefs on ruminations' controllability as outcome. Contrary to beliefs on negative emotions, it seems that for all three predictors - mind-wandering ($b = 0.13$, bootSE = 0.03, 95 % bootCI [0.0775, 0.1985]), daydreaming ($b = 0.05$, bootSE = 0.01, 95 % bootCI [0.0269, 0.0753]) and rumination ($b = 0.02$, bootSE = 0.008, 95 % bootCI [0.0048, 0.0362]) executive control was a significant mediator of the relation with beliefs on negative beliefs on ruminations controllability. Also the direct effect was significant in all three models: $b = 0.43$, $SE = 0.06$, 95 % CI [0.3236, 0.5459]; $b = 0.14$, $SE = 0.03$, 95 % CI [0.0942, 0.1964]; and $b = 0.29$, $SE = 0.02$, 95 % CI [0.2616, 0.3252] respectively.

4. Discussion

The present study examined whether avoidance can mediate the impact of different TUT types on psychopathology symptoms measured 3 months later. It appears cognitive avoidance plays a mediator role in the link between mind-wandering and daydreaming and anxiety, depression, and sleep disturbance. However, these mediation models were not significant for rumination. These results, based on self-reported questionnaires, suggest that the avoidance mechanism might differentiate types of TUT. It appears that the maladaptive feature of MW or daydreaming might not (or not only) depend on their characteristics, for example freely moving character (Christoff et al., 2018) or their valence (Welhaf & Banks, 2024) as shown by previous studies, but also on the purpose for which one uses them to regulate emotion - when used as an avoidance strategy, they are linked to maladaptive outcomes. These conclusions might be particularly relevant from the clinical perspective, suggesting, as some previous qualitative studies (Somer, 2002), that avoidance is crucial to evaluate while treating maladaptive TUT.

Additionally, beliefs about perseverative cognition moderated the mediation model in the case of MW affecting anxiety and sleep disturbance, but not in daydreaming and rumination models. It seems that Mind-wanderers with high beliefs about perseverative cognition negative outcomes will present a higher level of avoidance, but in their case, avoidance will mediate only the link between MW and anxiety/sleep disturbance, but not depression. The mediation was significant for those with mean and low negative beliefs about perseverative cognitions. The role of meta-cognitions in rumination was recently shown by Tamm et al. (2024). The present study reports additional information about their role in other types of TUT. However, it is necessary to underline that the measure of beliefs about perseverative cognitions used in this study addressed rumination. Thus, developing and evaluating a tool enabling this assessment with a larger perspective of TUT would be interesting.

Contrary to our predictions, beliefs about negative emotions' controllability did not affect the link between TUT and avoidance, despite previous studies showing that such beliefs might determine to what extent one is using avoidant emotion regulation strategies (e.g. De Castella et al., 2018) and that beliefs regarding negative emotions might moderate the level of TUT in tasks with negative valence (Kornacka et al., 2023). Considering divergent results and a small number of studies testing the role of beliefs on emotions in the context of TUT, it seems necessary to further explore their role in MW, daydreaming, and rumination.

Finally, considering previous studies concerning the role of executive control on rumination (e.g. Roberts et al., 2017) and the hypothesis that beliefs about emotions or perseverative cognition controllability might be affected by the general perception of self-control, we tested how perceived executive control mediates the link between type of TUT and beliefs. Our findings suggest executive control mediates the link between all three TUT types and beliefs about their controllability. Some previous studies (e.g. Carciofo et al., 2017; Tamm et al., 2024) found metacognitive beliefs on cognition controllability might lead to maladaptive outcomes - our results suggest that those beliefs are not independent of perceived general executive control.

The main limitation of the present study concerns measuring psychological processes through self-reported measures. Although this approach is the most popular in the context of TUT, and is also applied for measuring executive control (e.g., Tamm et al., 2024), some studies suggest that self-reported trait-like measures might not reflect everyday life functioning (Koval et al., 2023). This discrepancy was also shown specifically for MW, daydreaming, and rumination (Wei et al., 2024). This limitation might be particularly appealing in the context of measuring cognitive avoidance, as, first, cognitive avoidance may be difficult to self-assess, and second, retrospective questionnaires may be influenced by one's meta-cognitions. Future studies might consider assessing avoidance through more objective measures (e.g., physiological indicators; Leonidou & Panayiotou, 2022). Moreover, the distinction between MW and daydreaming in the present study is based on the DDFS and MWQ - the authors of these questionnaires have not explicitly differentiated these two types of TUT based on whether they occur during another activity or not, as suggested by a more recent study by Shimoni and Axelrod (2024). Finally, the current literature does not provide enough empirical evidence to strongly support moderated mediation or serial mediation models while including meta-cognitions about emotions or rumination in the context of TUT. To address this limitation, we compared the fit indicators of those two models (see Supplementary materials, Table S4). Moreover, in further research, it might be justified to consider TUT as a latent variable with observable measures of MW, daydreaming, or perseverative cognitions. However, at this stage, given the theoretical heterogeneity of TUT definitions, it seemed more justified to assess the unique contribution and provide a more granular understanding of the specific forms of TUT and their impact on mental health within the same sample, which appears to be lacking in the current literature.

Finally, it is necessary to further explore why cognitive avoidance emerges as a significant mediator between MW and psychopathological outcomes, while this is not the case for rumination and daydreaming. Moreover, the indirect link between MW and psychopathological outcomes through cognitive avoidance is not significant among individuals with high negative beliefs about perseverative cognition. One possible explanation is provided by Watkins and Nolen-Hoeksema's (2014) habit-goal framework, which suggests that maladaptive rumination may become habitual and thus automatically triggered in situations involving negative emotion regulation. As a result, once this habitual strategy is established, mediation or moderation mechanisms may no longer apply. It seems also necessary to evaluate in further studies to what extent maladaptive daydreaming could be used as an automatic, habitual emotion regulation strategy. Alternatively, it is possible that for high ruminators or individuals who believe that task-unrelated thinking is harmful, other mediating or moderating factors should be considered. The most recent HEXAGoN model of rumination (Watkins & Roberts, 2020), consistent with empirical findings (e.g., Altan-Atalay et al., 2022; Kornacka et al., 2019; Moberly & Watkins, 2006), suggests that factors such as abstract processing mode and cognitive flexibility may play a key role.

In sum, this is the first study showing that the role of cognitive avoidance as a mediator between TUT and maladaptive outcomes in terms of depression, anxiety, and sleep disturbance might differentiate MW, daydreaming, and rumination, with avoidance being a significant

mediator for the first two, but not for rumination. Additionally, we demonstrated the role of negative beliefs about perseverative cognition as a moderator of this mediation model, but only for MW. Notably, according to our results, these beliefs might depend on the actual level of self-control. Although these findings need to be replicated and some limitations of the present study should be addressed in future research, the results provide important clinical implications from the perspective of a process-based approach addressing maladaptive TUT. It seems that the impact of TUT on emotion dysregulation may depend not only on attentional or executive factors but also on meta-cognitions about TUT and their function (particularly avoidance), which should be taken into account in the clinical picture, in line with suggestions from previous qualitative studies (Somer, 2002).

CRediT authorship contribution statement

Monika Kornacka: Writing – review & editing, Writing – original draft, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Steven Barnes:** Writing – review & editing, Conceptualization. **Malgorzata Para:** Methodology, Investigation, Data curation, Conceptualization. **Michał S. Skorupski:** Methodology, Conceptualization. **Zofia Kostrzewa:** Methodology, Data curation. **Marta Szastok:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Monika Kornacka reports financial support was provided by National Science Centre Poland. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.paid.2025.113277>.

Data availability

Data will be made available on request.

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OŚWIADCZENIE DOT. WSPÓLAUTORSTWA PUBLIKACJI
/STATEMENT ON CO-AUTHORSHIP PUBLICATION

Kornacka, M., Barnes, S., Para, M., Skorupski, M. S., Kostrzewa, Z., & Szastok, M. (2025). The role of avoidance and beliefs on perseverative cognitions in the link between task-unrelated thoughts and psychopathology symptoms. *Personality and Individual Differences*, 246, 113277. <https://doi.org/10.1016/j.paid.2025.113277>

Wkład poszczególnych autorów_ek/Authors' contribution

Monika Kornacka: Writing – review & editing, Writing – original draft, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization.

/Redakcja i weryfikacja tekstu, przygotowanie pierwszej wersji tekstu, administracja projektem, opracowanie metody badania, pozyskanie finansowania, analiza danych, opracowanie koncepcji badania.

Szczegółowy wkład autorki: Opracowała koncepcję i model badawczy, pozyskała finansowanie, opracowała metodę badania oraz przeprowadziła analizy formalne. Była również odpowiedzialna za napisanie pierwszej wersji tekstu oraz jego późniejszą edycję, w tym za przygotowanie odpowiedzi na recenzje. Jest pierwszą i korespondującą autorką publikacji. Badania były finansowane w ramach grantu SONATA 15, Narodowego Centrum Nauki „Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach” (2019/35/D/HS6/02364), którego autorka był kierowniczką.

/Author's detailed contribution: She developed the research concept and model, acquired funding, designed the methodology, and conducted formal analyses. She was also responsible for writing the original draft and its subsequent editing, including preparing the responses to reviewers' comments. She is the first and corresponding author of the publication. The research was funded by the SONATA 15 grant from the Polish National Science Centre, titled "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364), for which she was the Principal Investigator.

Steven Barnes: Writing – review & editing, Conceptualization.

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Protocol

A Mobile Ecological Momentary Intervention for Reducing Experiential Avoidance in the Context of Rumination: Protocol for a Randomized Controlled Trial

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Abstract

Background: Rumination is a transdiagnostic process present in several psychological disorders, involving repetitive negative thinking that individuals may perceive as difficult to control. While the roles of numerous mechanisms underlying rumination have been supported, experiential avoidance (EA) still lacks empirical backing, despite a strong theoretical foundation, partly due to difficulties in examining EA in an ecologically valid context. One promising approach to addressing this challenge is through reducing EA using mobile health (mHealth) and ecological momentary intervention (EMI), and assessing any subsequent decrease in rumination's deleterious outcomes.

Objective: This paper outlines the protocol for a randomized controlled trial using a novel mHealth EMI to address EA in the context of rumination. The app was developed by a multidisciplinary team, incorporating feedback from potential end users.

Methods: Consenting individuals (target N=60) who meet the inclusion criteria (self-reporting problems with repetitive negative thinking) will be randomly assigned to 1 of 4 conditions: (1) intervention with therapist support and daily sampling, (2) intervention without support and with daily sampling, (3) partial intervention (emotion validation EMI only) with daily sampling, or (4) control (daily sampling only). The intervention consists of a series of modules delivered over 4 weeks, with assessments conducted before and after intervention, and again at 1-month follow-up (plus an additional 3-month follow-up for intervention participants). Data will be collected both through online self-report assessments and via the app itself. The potential of the EMI to modify the maladaptive feature of repetitive negative thinking will be assessed using mixed-design ANOVA, while the links between avoidance-mood and rumination-mood, in terms of the moderating effect of trial condition, will be evaluated using multilevel models. These will be assessed as primary outcomes. Secondary outcomes are the effects of a supporting therapist on postintervention outcomes in the intervention groups, and time spent using the app as a measure of engagement (analyzed using the mixed-design analysis of covariance). Compliance will be defined as completing both of the first 2 weeks of intervention content in full, and 5 out of the 6 exercises from weeks 3 and 4. Additionally, the study will control for both the amount of time spent in the app and the length of responses to open-ended questions.

Results: Recruitment and enrollment for the trial are expected to begin in May 2025 and be completed by July 2025. Data collection will conclude once the target sample size for each of the 4 conditions has been reached. The main results of the trial are expected to be submitted for publication in October 2025.

Conclusions: The outcomes of this research trial will not only provide insights into the clinical capabilities of the app, including its usability and acceptability in real-world contexts (and its potential future viability as a scalable product), but will also offer valuable theoretical insights into the role of EA in maladaptive rumination.

Trial Registration: ClinicalTrials.gov NCT06570694; <https://clinicaltrials.gov/ct2/show/NCT06570694>

International Registered Report Identifier (IRRID): PRR1-10.2196/66067

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KEYWORDS

rumination; experiential avoidance; mHealth; ecological momentary intervention; transdiagnostic processes; low-intensity intervention; repetitive-negative thinking; cognitive avoidance; psychoeducation

Introduction

Rumination and Psychopathological Outcomes

Epidemiological data suggest that comorbidity is the rule rather than the exception [1], with it frequently observed in at least half of the diagnosed population [2]. The experience of comorbidity has significant negative implications for clinical severity and prognosis [3,4]. Additionally, the persistently moderate outcomes of treatment programs and high levels of posttreatment relapse indicate a still limited understanding of the mechanisms that initiate, underpin, and maintain a number of psychiatric disorders [5].

Transdiagnostic models represent a shift away from disorder-centric approaches to the understanding and treatment of psychological disorders. Instead of focusing on a specific nosological diagnosis, they suggest focusing on processes that may serve as risk, maintenance, and relapse factors across multiple psychological disorders, thereby more effectively addressing the frequent comorbidity observed in mental disorders. Interventions based on transdiagnostic approaches have demonstrated positive outcomes in reducing symptom presentation across several disorders [3,6-10].

Rumination is a transdiagnostic process present in several psychological disorders [11]. Traditionally, rumination was explored in the context of mood disorders and defined as a mode of responding to distress that involves repetitively and passively focusing on symptoms of distress and the possible causes and consequences of these symptoms. Nevertheless, rumination is now recognized as being involved in numerous psychological disorders and adopts a broader definition—a form of repetitive thinking about 1 or more concerns perceived to be difficult to control [12]. While rumination may not necessarily be wholly maladaptive, it can become so when overgeneralized and used inflexibly [13], in which case it has been shown to impair emotional regulation and increase negative affect [14]. Thus, one can expect that addressing this maladaptive transdiagnostic process will result in a reduction of psychopathology symptoms (eg, [11]). Experimental studies that induce rumination in distressing contexts demonstrate elevated depressed and anxious mood [15]. Similarly, self-report studies find rumination to be a risk factor in numerous issues, including as a risk factor and consequence of depressive symptoms [16]; the onset, number, and duration of major depressive episodes [17-19]; and the development of generalized anxiety [19], social anxiety [19], eating disorders [19], posttraumatic stress [20], and borderline

symptoms [21]. In addition to its symptomatological impact, rumination has also been shown to reduce the efficacy of psychological interventions [12].

Currently, several models explain the maladaptive nature of rumination—these involve abstract processing and dysregulation at the goal/action identification level (ie, adapting a specific processing mode to current requirements [22]); impairments in executive or attentional functioning [23,24]; or rumination as a learned, habitual response [13,23,24]. A recent H_Ex_A_Go_N model of rumination attempts to integrate the most prevalent theories with a relatively strong empirical background on the mechanisms maintaining maladaptive rumination, identifying rumination as a *habit*, *executive function* impairment, *abstract processing mode*, *goal discrepancies* triggering rumination, and the *negative valence* of rumination content [12]. Thus, the authors suggest that rumination becomes a maladaptive, transdiagnostic process when it is used as a habitual, overgeneralized response to negative affect [12,25].

Nevertheless, the literature suggests that another mechanism could be involved in making rumination maladaptive and in reinforcing it as a habitual response—namely, experiential avoidance (EA). Although this mechanism features prominently in the theory of repetitive negative thinking (RNT), it has received very limited empirical support. This is not necessarily due to a lack of supportive data (eg, [25]), but rather to the small number of studies testing this hypothesis, largely because of the challenges involved in evaluating EA in empirical research.

Mechanisms Underpinning Rumination: Examining the Role of Experiential Avoidance

EA refers to attempts to eschew emotional distress by engaging in maladaptive behaviors that temporarily allow escape from negative emotional experiences. Through the use of EA, individuals may disconnect from unpleasant emotions by altering the form or frequency of these experiences [26], even when such avoidance causes behavioral harm by interfering with goal pursuit and impairing learning through experience. This often leads to the adoption of additional maladaptive coping strategies, such as substance use [27].

Engagement in EA has adverse effects on the development, maintenance, and modification of chronic psychological disorders such as depression, due to its tendency to generate negative mood and initiate a maladaptive cycle of emotional distress and avoidance [28]. Consequently, EA may represent a core vulnerability for emotional distress [29]. To this end,

randomized controlled trials delivering therapeutic interventions focused on reducing EA (such as acceptance and commitment therapy) have found that decreases in EA are associated with reductions in depressive and anxious symptoms [28,30,31].

As a mechanism underpinning rumination, however, despite some empirical evidence emerging to examine its role [12,32], EA continues to lag in terms of supporting data. This is despite the theoretical basis for the role of EA in rumination [22,33], where rumination serves as a means to avoid increased arousal and distress through an overgeneral, abstract style of thinking, despite its maladaptive implications for real-world problem-solving and long-term deleterious consequences for emotion regulation [22,24,25]. Of note, a study examining multiple indices of avoidance reported differential outcomes across the 3 modes of investigation (self-report, dichotic listening tasks, and psychophysiological measures), lending only partial support to the avoidance conceptualization of rumination [34].

Difficulties in examining the role of EA may, in part, be due to several methodological challenges associated with assessing EA in ecologically valid contexts. While experimental studies appear to lend support to an EA conceptualization of rumination [29,35], the tasks used to evaluate it in laboratory settings (eg, approach-avoidance task or dichotic listening task) do not reflect the real-world occurrences of EA. Similarly, while self-report evaluations connect EA with rumination [34,36], such data rely heavily on retrospective recollection, assuming that participants were aware of their use of (and the extent of their use of) avoidance. One alternative approach to examining the role of EA may involve adopting the experimental method, that is, reducing EA through ecological momentary intervention (EMI) [37], and examining any resulting reduction in the deleterious outcomes of rumination.

Mobile Health as a Vehicle for Ecological Momentary Intervention

The availability of mental health services has struggled to keep pace with the growing demand for treatment [38,39]. One means of addressing this imbalance has been through the use of digital interventions, which offer the potential to provide accessible, rapid, and scalable pathways to intervention [40].

Mobile health (mHealth) apps represent a dimension of digital health provision and allow for the delivery of validated psychological interventions on-demand via smartphones. Because of the ubiquity of smartphones [41] and the opportunities afforded for personalization of provision, mHealth apps offer the potential to deliver rapidly scalable interventions that can expand the reach of mental health services while overcoming a number of barriers faced by traditional forms of treatment [42].

EMI further represents an opportunity to utilize ubiquitous devices, such as smartphones, to integrate treatment protocols into people's everyday lives. Treatment can be delivered in natural environments as either a standalone intervention or as an addendum to existing treatment [43], and can be based on the outcomes of real-time daily sampling assessments also conducted in the real world (ecological momentary assessment

[EMA]). The use of real-time assessment data allows for provision to be personalized and tailored to the general requirements of an individual client and, on a micro-level, as a form of opportune intervention within a specific environmental context [44]. As an assessment tool, EMA also helps overcome the limitations of global self-report measures, where retrospective recollections of emotions and events may be distorted by subsequent use of regulation strategies [45].

Literature has begun to explore the capabilities of mHealth EMIs as tools for mental health intervention, with promising results emerging across a range of conditions [46,47]. In addition to their potential therapeutic benefits, EMIs represent several methodological opportunities to improve ecological validity. First, the use of ubiquitous devices such as smartphones allows research to be conducted in real-world settings, reducing the reliance on laboratory-based experimental studies, where outcomes may, in part, be a product of the artificiality of the environment. Instead, the real-world nature of treatment delivery allows for the examination of intervention effects (eg, in the context of transdiagnostic processes) in real-world contexts. Second, while EMAs may not always be conducted in "real time" (eg, at the moment of symptom experience), data can be collected within a short period thereafter. The implementation of regular EMA also reduces the reliance of treatment efficacy studies on postintervention self-report data, which can be vulnerable to retrospective bias, particularly for individuals experiencing depressive disorders [48,49].

Uptake and engagement with mHealth, however, may be negatively associated with poor app design, technical issues, digital literacy, poor suitability of content, lack of professional support, and pathological factors (eg, low motivation), when content is delivered in a manner unsuited to user requirements, or when engagement is considered by users to be too labor intensive [50-55]. Numerous factors at both the individual and group levels have been identified that may affect the intention to use or uptake of digital interventions [56,57]. Effective multidisciplinary collaboration in app development, which acknowledges the intricate needs of target end users and incorporates these into the design of the intervention, is essential for improving acceptability, usability, and accessibility [58], particularly when interventions are deployed in unsupervised settings [59]. EMIs require unique considerations in their design, deployment, and evaluation [60], which help specify the procedures for collecting and examining user data and the circumstances under which the intervention may be delivered. Where EMIs actively respond to user data in real time, processes for determining appropriate intervention (while respecting user privacy) must also be considered.

Study Objectives

The scientific verification of processes that underpin several transdiagnostic maladaptive cognitive processes and psychopathological outcomes has several benefits. First, successfully identifying such processes advances the theoretical understanding of transdiagnostic processes themselves and their contributing roles in psychopathology. Second, it has the potential to improve several psychological treatment programs by identifying valuable targets for intervention [21], which is

particularly valuable in treating cases of comorbidity. Using EMI and EMA in clinical trials offers a unique opportunity to evaluate the mechanisms underlying transdiagnostic processes that are difficult to assess through traditional self-report or laboratory methods (eg, avoidance). This study aims to examine whether the avoidance-focused EMI for rumination can modify the maladaptive feature of RNT, as understood through the link between daily RNT and well-being, depressive, and anxiety symptoms, compared with an active control group. We anticipate that the link between daily rumination and its maladaptive outcomes (lower well-being and higher depressive and anxiety symptoms) will be weaker in the intervention groups compared with the control group. Additionally, the study aims to confirm the role of avoidance in RNT.

Furthermore, by splitting the intervention condition into 2 groups (1 receiving concurrent therapist support and 1 not receiving concurrent therapist support), the study aims to evaluate whether intervention outcomes may be enhanced by the added availability of a supporting therapist [61].

Finally, the study aims to examine whether the impact of the avoidance-focused EMI for rumination on depressive and anxious symptoms can, compared with an active control group, be mediated by changes in beliefs about emotion (valuation of negative emotions) [62]. Similarly, the study aims to assess the

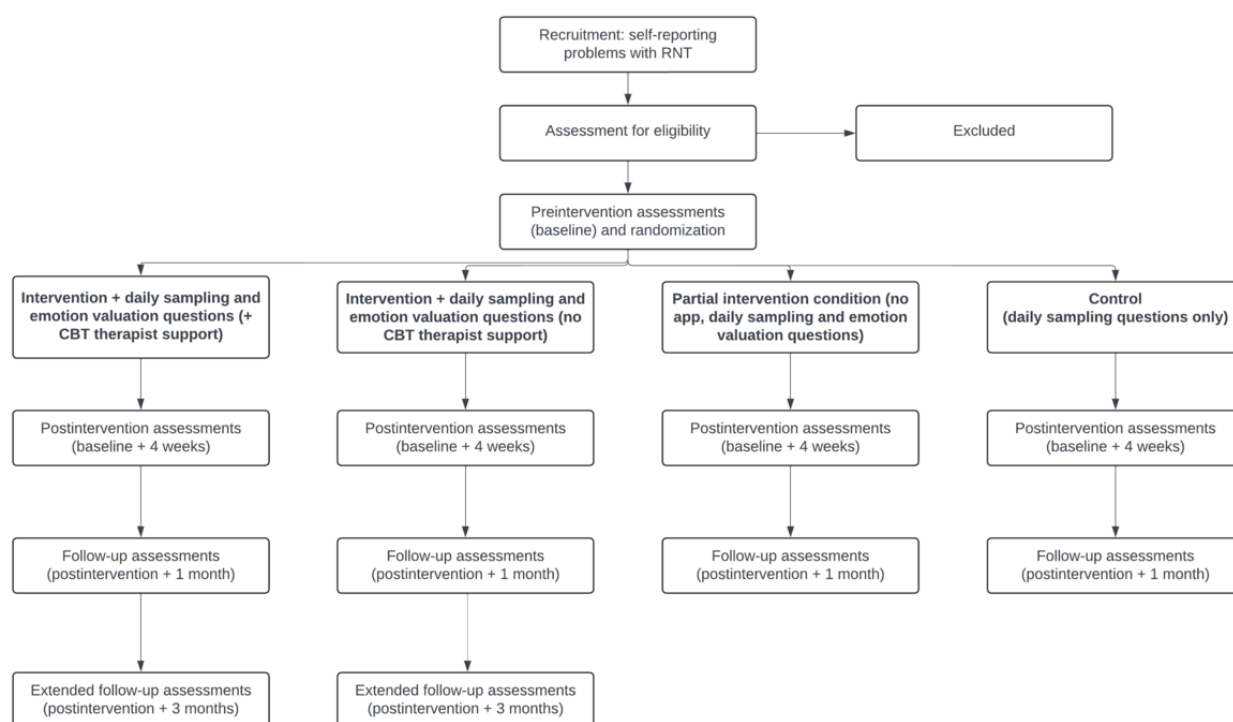
EMI in terms of similar mediation effects of beliefs about rumination [63].

Methods

Study Design

The study takes the form of a 4-arm, parallel-group randomized controlled trial. Total study participation will last approximately 2 months, including preintervention eligibility screening, a 4-week intervention period using the app content and daily sampling, postintervention assessments at the end of the intervention, and a 1-month follow-up period (during which the app will remain available for self-directed use without daily sampling), concluding with follow-up assessments and measurement of any engagement with the app during this period. At this point, control participants will receive the app (minus daily sampling) and guidance on how to use the content. An initial follow-up period of 1 month has been chosen for ethical purposes to minimize the amount of time control participants will wait before receiving the app. For participants in the intervention groups, the study aims to conduct an additional evaluation of outcomes 3 months following the intervention. A graphical summary of the study design is presented in Figure 1.

Figure 1. Graphical representation of the randomized controlled trial protocol. CBT: cognitive behavioral therapy; RNT: repetitive negative thinking.



Participants will be randomly assigned, using a random-number generator, to 1 of 4 conditions: (1) intervention condition (therapist support); (2) intervention condition (no therapist support); (3) partial intervention (daily sampling and emotion valuation questions); or (4) control group (only daily sampling questions). Active control groups will be utilized to avoid artificially inflating comparisons with intervention condition outcomes [64]. The specific group allocations and the nature of

other study conditions will be concealed from participants. Block/random stratification will not be used, as participants will be randomly allocated to 1 of the groups after agreeing to participate in the study. During analysis, demographic characteristics across groups will be compared, and any significant differences identified will be included as control variables.

Therapist support has been shown to improve outcomes in studies of digital mental health interventions [61]. In this study, therapist support will take the form of asynchronous written communication with a cognitive behavioral therapy (CBT) practitioner—either fully qualified or in at least their second year of training—via WhatsApp (Meta Platforms, Inc). This support will be available 2 times a week to relevant participants at specific times predetermined by the therapist. Participants will have the option to utilize this support, but will not be directed to do so. Supporting therapists will be paid at their standard hourly rate for regular patients and will receive an introduction to the app and intervention—while remaining blinded to the full aims of the study—through an online workshop conducted by members of the research team experienced in delivering rumination-focused cognitive behavioral therapy (RFCBT), before the study.

Participants and Power Analysis

Participants who self-report problems with RNT will be sought. The first participation in the trial is planned to commence in May 2025. As the study will be conducted remotely and recruitment will continue beyond this date, participants are expected to begin their engagement asynchronously.

To be eligible for the trial, participants must self-report problems with RNT. Participants will be excluded if (1) they are under 18 years of age at the start of the trial; (2) they are currently receiving any form of psychotherapy; or (3) they are currently receiving any form of psychiatric medication. Participants with a psychiatric diagnosis will not be excluded, provided they meet the inclusion criterion and do not meet any of the exclusion criteria listed above.

Sample size was calculated using G*Power version 3.1 [65] for a repeated-measures design with 4 independent conditions measured at 3 time points and assuming a medium effect size. This indicated a required sample size of 60 with equal randomization of participants across groups, which aligns with previous intervention studies in the field [66-68]. As our initial feasibility study during the development of the app content experienced an attrition rate of approximately 60% [69], this study aims to recruit at least double that number to mitigate the risk of significant dropout throughout the trial.

Recruitment Strategy

Participants will be recruited through online advertising on social media platforms (Facebook/Instagram; Meta Platforms, Inc) and via the laboratory website, where a contact email address will be provided for interested individuals to express their interest in participating. Full study information will be sent by email to all interested participants, and informed consent will be obtained via email response before the delivery of the app and the commencement of participation. To minimize information sharing across groups, participants will not have access to one another's contact or identity details. Additionally, the current version of the app does not allow users to contact other participants or to determine how many others are using the app.

Recruitment is expected to begin in early May 2025 and will continue until the target number of participants in each condition

has been reached. Participants may withdraw from the study at any time by contacting the research team via a designated email address provided in the study information form or through a link within the app. All data associated with participants who choose to withdraw will be fully removed from the study and destroyed. Participants will receive financial compensation of €50 (US \$56) for taking part in the study.

Measures

Pre-Post and Follow-Up Measures

The following measures will be collected from all participants before/during the intervention, after the intervention, and at follow-up:

The Perseverative Thinking Questionnaire (PTQ) [70], a 15-item self-report measure that assesses the main characteristics of RNT: (1) core features (9 items); (2) unproductiveness (3 items); and (3) capturing mental capacity (3 items). Responses are recorded on a scale from 0 (never) to 4 (almost always). The PTQ has demonstrated good internal consistency and test-retest reliability [70], not only in clinical samples, but also in nonclinical populations and when administered online.

Emotions Beliefs Questionnaire (EBQ), a 16-item self-report questionnaire designed to measure the controllability of emotions and respondents' beliefs about the usefulness of emotions, which also demonstrates good internal consistency [71]. Respondents answer using a 7-point Likert scale, ranging from "1" (totally disagree) to "7" (totally agree), with higher scores indicating a belief that emotions are uncontrollable or useless.

The Positive and Negative Beliefs About Rumination Scales (PBRs and NBRs, respectively), which comprise 2 scales (positive beliefs: 9 items; negative beliefs: 13 items) that measure metacognitive beliefs related to depressive rumination. Respondents rate the extent to which they agree with each item using a 4-point Likert-type scale, ranging from "1" (do not agree) to "4" (agree very much), with higher scores on each subscale indicating greater positive or negative beliefs, respectively. Both the PBRs and NBRs demonstrate adequate to good internal consistency [72].

Hospital Anxiety and Depression Scale (HADS), a measure of the possible and probable presence of anxiety disorders and depression, comprising 7 items, developed by Zigmond and Snaith [73]. It has been shown to possess good internal consistency, with sensitivity and specificity comparable to the General Health Questionnaire [74]. Respondents rate each item on a scale of 0-3, with higher total scores for each subdomain (anxiety and depression) indicating a greater presence of the disorder. Thresholds for determining the clinical presence of the disorder are as follows: 0-7=normal, 8-10=borderline abnormal (borderline case), and 11-21=abnormal (case).

Cognitive Avoidance Questionnaire (CAQ), developed by Gosselin et al [75], is a 25-item measure of 5 worry-related cognitive avoidance strategies (thought suppression, thought substitution, distraction, avoidance of threatening stimuli, and transformation of images into thoughts), demonstrating good to excellent internal consistency and test-retest reliability [76].

The scale comprises 5 subscales, each containing 5 items that represent individual cognitive avoidance strategies (avoidance of threatening stimuli, distraction, thought substitution, thought suppression, and transformation of images into thoughts). Respondents answer on a 5-point scale (1=not at all applicable to 5=very applicable), with higher scores indicating a greater presence of cognitive avoidance.

The Brief Experiential Avoidance Questionnaire (BEAQ) is a 15-item short version of the Multidimensional Experiential Avoidance Questionnaire, measuring EA content across 6 dimensions. Respondents provide answers to predetermined statements along a 6-point Likert scale (1=strongly disagree to 6=strongly agree), demonstrating good internal consistency and strong convergence with the original Multidimensional Experiential Avoidance Questionnaire dimensions [77].

Additionally, 2 attentional checks are included in the pre-, post-, and follow-up measures. Participants will be explicitly asked to choose a response option (eg, “This is an attentional check; please select the option ‘sometimes’ in response to this question”).

Ecological Momentary Assessment

Users are provided with a daily notification (at a time in the evening of their choosing and for a total of 30 days) to respond to a series of items drawn from existing scales for depression [78], anxiety, well-being, daily goals (and the achievement thereof) [79], emotional experience during the day adapted from Pe et al [80], and RNT [81]. Upon first using the app, users are invited to personalize a time to receive the notification to complete the daily assessment. While a time in the evening is encouraged, flexibility is provided, for example, for individuals working nights. Assessment items can be found in English in [Multimedia Appendix 1](#).

User Experience (Contextual, One-Item, Repeated, Timely, Open-Ended [CORTO])

To obtain data regarding the acceptability and usability of the app and to aid its future development, the CORTO (Contextual, One-Item, Repeated, Timely, Open-Ended) method was used, a novel qualitative EMA for obtaining user-experience data in real time [82]. Although originally designed to capture user experiences in relation to games, the method is also relevant in app design as a means of collecting real-time feedback. Data are obtained by presenting users, after each in-app exercise, with 2 closed-ended questions assessing their enjoyment of the app and any difficulties using it, plus 1 open-ended question allowing users to provide detailed, specific feedback on the exercise. Items were amended to replace original instances of “game” with “app” and can be found in English in [Multimedia Appendix 2](#).

Additional Control Measures

In addition to the aforesaid measures, data regarding digital health literacy and intervention credibility/expectancy effects will be collected using the eHealth Literacy Scale (eHEALS) and CEQ, respectively [83,84]. The eHEALS assesses respondents’ abilities and skills in sourcing, evaluating, and using electronic health information to address health-related

concerns. The scale consists of 8 items measured on a 5-point Likert scale (1=strongly disagree, 7=strongly agree). Total scores range from 8 to 40, with higher scores indicating stronger perceptions of digital literacy in relation to electronic health. The eHEALS-PL demonstrates strong internal consistency ($\alpha=.94$) [85].

The CEQ consists of 6 items measuring expectations of treatment and the credibility of its rationale in clinical outcome studies. The items are split into 2 sections (“think” and “feel”), with responses for 4 items measured on a Likert scale of 1-9 and for 2 items on an analogue scale from 0% to 100%. Credibility is derived from the first 3 “think” items, and expectancy is derived from the fourth “think” item and the 2 “feel” items. Test-retest reliability is high (expectancy: $r=0.82$; credibility: $r=0.75$; and composite: $r=0.83$) and demonstrates high internal consistency (expectancy: $r=0.79-0.90$; credibility: $r=0.81-0.86$; and composite: $r=0.84-0.85$).

Intervention

OverThinking

OverThinking version 0.3.1(4) is a mobile EMI for iOS and Android platforms, designed to reduce EA in the context of rumination. The app primarily consists of psychoeducation content and related exercises, intended to be delivered over a 4-week period. To examine the effectiveness of the app during the intervention and to assess user experiences with using the app for rumination intervention, several self-report tools are embedded.

Development, Content, and User Evaluations

The development of the app was undertaken by a multidisciplinary team of active RFCBT practitioners; research psychologists with experience in transdiagnostic processes, digital mental health interventions, and user experience; and experienced developers of digital tools from the Polish-Japanese Academy of Information Technology.

The intervention comprises psychoeducational content based on RFCBT, an effective intervention for maladaptive rumination [86]. The reduction of EA is targeted through (1) the provision of a functional analysis of rumination to identify the triggers and functions of this process (a classical component of RFCBT), and (2) the modification of beliefs concerning negative emotions and their experience [87,88]. Previous research on the use of RFCBT has also found it to be an effective rumination intervention when delivered in digital contexts [89].

Intervention content was initially developed by members of our team with expertise in RFCBT. The content is divided into 4 weeks, with the first 2 weeks containing several individual modules targeting specific learning outcomes (eg, learning about the function of emotion, learning about the avoidance of emotions). The delivery of informative content is interspersed with several small exercises in different formats (multiple choice or open-ended text entry). Weeks 3 and 4 provide users with a series of exercises designed to consolidate learning and offer an opportunity for users to apply the psychoeducational content to their personal lives. Individual modules are designed to take no longer than 10-15 minutes to complete. The app content is

delivered linearly, with subsequent weeks unlocking only once previous ones are fully completed. On each day of the intervention, all users are required to complete an emotion valuation question. All user inputs when completing app content are stored remotely and securely via Firebase (Google LLC), accessible only to the research team and solely for analysis

purposes. In addition to user inputs and assessment outcomes, the time taken to complete app content and assessments is also recorded to observe the time burden caused by app use. A summary of the app intervention content can be found in [Table 1](#).

Table 1. Overview of intervention content.

Week, module, and module name	Module objectives
Week 0	
Module 1	
Introduction	<ul style="list-style-type: none"> To provide an introduction to the aims of the app. To introduce the daily assessments and their purpose.
Week 1	
Module 1	
Introduction	<ul style="list-style-type: none"> To introduce the aims of module 1 (eg, to inform the user about the nature and function of emotions and their potential negative consequences).
Module 2	
The nature of emotions	<ul style="list-style-type: none"> To examine the nature of depression and anxiety through individual dimensions (thoughts, emotions/feelings, and behavior) in users' daily lives.
Module 3	
The function of emotions	<ul style="list-style-type: none"> To examine the positive and negative functions of emotions.
Module 4	
The avoidance of emotions	<ul style="list-style-type: none"> To examine the reasons for avoidance of emotions. To identify how users avoid negative emotions. To examine the consequences of avoidance.
Week 2	
Module 1	
Introduction	<ul style="list-style-type: none"> To introduce the second week, which places greater focus on rumination.
Module 2	
Ruminating	<ul style="list-style-type: none"> To identify and define rumination. Via fictional case studies, to identify situations in which users engage in rumination.
Module 3	
Why do we ruminate?	<ul style="list-style-type: none"> To examine motivations for engaging in rumination. To identify some of the negative consequences of rumination.
Module 4	
Rumination and avoidance	<ul style="list-style-type: none"> To examine rumination as a means of avoidance/as an emotional regulation strategy.
Week 3	
Module 1	
Introduction	<ul style="list-style-type: none"> To introduce the aims of the third and fourth weeks of the intervention—consolidation exercises to apply the psychoeducational content.
Module 2	
Exercise 1	<ul style="list-style-type: none"> Identifying the content and context of the users' ruminative thinking.
Module 3	
Exercise 2	<ul style="list-style-type: none"> Identifying the triggers of the users' ruminative thinking.
Module 4	
Exercise 3	<ul style="list-style-type: none"> Identifying the short-term consequences of the users' engagement in rumination.
Week 4	

Week, module, and module name	Module objectives
Module 1	
Exercise 1	<ul style="list-style-type: none">Examining the use of rumination as a means of avoidance (and identifying what is being avoided).
Module 2	
Exercise 2	<ul style="list-style-type: none">Reducing/stopping the use of maladaptive rumination.Identifying activities that help users reduce their use of rumination.
Module 3	
Exercise 3	<ul style="list-style-type: none">Summarizing learning: identifying the context, content, consequences of users’ rumination, and how to reduce rumination and its maladaptive consequences.

During the development process, an initial feasibility study was conducted to consult with prospective end users. Participatory workshops were held to obtain feedback on the usability and acceptability of the app content and to discuss preliminary plans for the app structure, visual layout, and features [69]. Before these workshops, participants, selected based on their rumination levels, were asked to engage with a web-based version of the proposed app content (hosted via Qualtrics; SAP SE) for 4 weeks. Participants were asked to complete a series of pre- and posttests online, designed to mimic the randomized controlled trial protocol for this trial (see the “Methods” section, except for the BEAQ measure). A series of attentional tests was also included in the online assessment to control for response reliability. To be included in the analysis, participants were required to complete the first 2 weeks of content in full, followed by 5 of the 6 exercises from weeks 3 and 4.

Of the initial 687 participants who registered interest in participating, a sample of 55 was selected through prescreening using the PTQ. Participants were selected if their overall score was 1 SD above average. Of these, 21 participants completed all measures and were included in the quantitative analysis. Four participants volunteered to engage in participatory workshops and took part in semistructured interviews with members of the research team. The semistructured interviews focused on (1) factors determining compliance and strategies to overcome challenges in following the 4-week program; (2) strong and weak aspects identified in the program content; (3) accessibility of psychoeducational content in terms of language, clarity, and length; (4) strong and weak aspects of the user experience; (5) evaluation of different exercise types; and (6) evaluation of a mock-up for apps, with users having previous experience following the 4-week program.

Overall, data from the developmental feasibility study suggested that engagement with app content resulted in reductions in EA (comparison of pre- and postintervention measures; $P<.001$) and perseverative thinking ($P<.001$), including across all 3 subscales: mental load ($P=.001$), unproductiveness ($P=.003$), and core features ($P=.002$). While cognitive avoidance did not reduce significantly overall ($P=.07$), the descriptive reduction suggested an impact of the psychoeducational program on awareness. Thought substitution was significantly elevated after participation ($P=.06$), which may indicate increased awareness of this mechanism.

Because of the small sample size for participatory workshops, the data were not subjected to a formal analysis protocol and are unlikely to have reached saturation at this stage. However, feedback indicated that users found the intervention content and exercises interesting, with some participants reporting that they would have preferred more content to engage with. Additionally, participants requested that the app include an option to make personal notes invisible to the research team, provide links to additional information relevant to rumination and avoidance, and allow for text narration and audio recordings as alternatives to text entry.

Following user feedback, the app was updated to include a link providing further information about the research and the research team, along with relevant content details and additional external resources. Future versions of the app aim to incorporate further personalization options, such as voice narration, audio recording features, and a private notes function.

Remote Acquisition/Storage of Assessment Data

Data obtained through daily sampling are securely stored remotely via Firebase and are accessible only to authorized members of the research team, in compliance with General Data Protection Regulation (GDPR) requirements.

To capture user experiences during testing, the app also uses the CORTO method [82]. These data are likewise securely stored via Firebase and are accessible only to members of the research team.

Statistical Analysis

Data Exclusion

Compliance will be defined as the completion of both the first and second weeks of the intervention content in full, along with at least 5 out of 6 exercises from weeks 3 and 4. For EMA, a compliance threshold of 80% will be used, consistent with previous research using EMIs in adult populations [90]. Additionally, the study will control for time spent within the app and the length of responses to open-ended questions.

In addition to the aforementioned compliance measures, participants who fail both attentional checks embedded within the assessments will be excluded from analyses.



Analysis of Trial Outcome Data

Primary Outcomes

Changes in outcomes across pre-, post-, and follow-up assessments (PTQ, EBQ, PBRs, NBRs, HADS, CAQ, and BEAQ) will be analyzed using mixed-design ANOVA across all 4 conditions. Additionally, multilevel models—treating daily observations as level 1 and participants as level 2—will be used to assess associations between avoidance and mood, as well as between rumination and mood, and to examine whether these associations are moderated by condition.

Secondary Outcomes

Mixed-design analysis of covariance will be conducted within the 2 intervention groups to examine whether time spent engaging with the app content serves as a covariate influencing intervention outcomes.

In-app user feedback collected through the CORTO method will be deductively coded following the process outlined by Saldana [91], using the 4 overarching categories proposed by Lukka et al [82]—(1) contextual use, (2) interaction-elicited emotional experience, (3) usability, and (4) technical issues—as a guiding framework. More detailed subdomains will be explored within each category.

Ethics Approval

Ethical approval for the trial was obtained from the Ethics Committee of SWPS University, Katowice Faculty (ethical approval number WKEB90/11/2023).

Results

Recruitment and enrollment for the trial are expected to begin in May 2025, with completion anticipated by July 2025. Data collection will conclude once the target sample size for each of the 4 conditions has been met. The main results of the trial are expected to be submitted for publication by October 2025. In addition to a formal publication in a peer-reviewed journal, the trial outcomes are anticipated to be presented in a summarized form at a relevant international conference.

Discussion

Study Strengths and Challenges

This paper outlines the protocol for a randomized controlled trial of an mHealth EMI aimed at reducing EA in the context of rumination. The primary objective of the trial is to investigate whether a reduction in EA through EMI intervention can lead to a decrease in RNT and its maladaptive consequences. Additionally, by implementing the CORTO method, the trial will gather user data on app usability and acceptability, identifying areas for continuous improvement and development.

While the primary objective of this study is to examine the role of EA, we are also collecting data on the use of the app itself. This information will inform its further development and potential efficacy testing in various settings. The app, as it currently stands, and its intervention content have been developed based on our formative user-experience research. While this approach is expected to enhance acceptability,

usability, and user retention, and despite the app being thoroughly tested for issues, potential challenges during deployment to real-world users cannot be ruled out. For example, the app currently does not time-lock intervention modules and instead allows users to progress to the next week's content once the preceding week's material has been successfully completed. While this approach provides users with flexibility in how they complete the intervention, as recommended by prior studies [92,93], there is a possibility that some users may progress through the content more quickly than intended. This could potentially lead to poor information retention and a diminished impact of the intervention.

Definitions and reporting of compliance can vary significantly across studies of digital interventions [46]. The design of our app enables the remote collection of both daily assessment data and app usage metrics, allowing for precise measurement of engagement and, consequently, intervention compliance. For this study, we have adopted a compliance rate of 80%, consistent with a previous study using EMI and daily assessments with adult populations [89].

The incorporation of CORTO implementation enables the collection of real-time feedback from users regarding app usability and acceptability, addressing some of the limitations of retrospective interviews [82]. This approach acknowledges the central role of users as active participants in the treatment program and enhances the specificity of the feedback obtained [94]. As CORTO depends on sustained engagement with the digital tool under review, authors recommend considering survivorship bias when interpreting the data [82].

To address some of the limitations associated with using retrospective measures alone, the effectiveness of the intervention will also be assessed by analyzing daily sampling measures, as recommended by Heron and Smyth [43]. Additionally, we plan to compare the standalone version of the intervention with one that includes asynchronous support from CBT professionals. A recent meta-review of meta-analyses [95] suggested that guided interventions may be more effective and improve compliance; however, it notes that the quality of evidence is often low and that not all meta-analyses systematically compare the impact of guidance. Therefore, it is important to explore the effect of guidance. While including professional support can significantly enhance the intervention's effectiveness, it also increases the cost of large-scale implementation and limits its potential for widespread dissemination. For this reason, a compromise solution involving asynchronous support was chosen.

The outcomes of the trial will be reported in a peer-reviewed publication following the mHealth Evidence Reporting and Assessment guidelines, as outlined by the World Health Organization mHealth Technical Evidence Review Group [96]. These guidelines are designed to enhance the quality and clarity of mHealth evaluation reporting by specifying where detailed information should be provided regarding intervention content, implementation context, and relevant technical aspects.

Conclusions

It is anticipated that the outcomes of this trial will not only provide insights into the clinical effectiveness of the app but also will primarily offer valuable theoretical understanding of

the role of EA in maladaptive rumination. Additionally, the user feedback collected through the CORTO implementation will contribute to improving the app's usability and acceptability in future iterations and further enrich the growing body of literature in this field.

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Data Availability

Once the outcomes of the trial have been published, data will be made publicly available via the Open Science Framework.

Use of Generative Artificial Intelligence

The authors confirm that generative artificial intelligence was not used at any point during the generation of the manuscript.

Authors' Contributions

SB was responsible for writing the original draft, project administration, methodology, and coordinating user experience aspects of the project. MS contributed to creating the content of the psychoeducational intervention, analyzing data from the initial feasibility study, and the methodology. MP was involved in creating the content of the psychoeducational intervention, collecting data in the initial feasibility study, analyzing the data, and the methodology. FM and WK contributed to software development, co-designing the app architecture and data model, and supervised the implementation and rollout of the app. MG worked on software development, as well as the implementation and rollout of the mobile app and backend infrastructure. PZ and AJ were involved in software development, verification, and testing of the app prototype. BK supervised the co-design processes, including the architecture and implementation of the mobile app and backend. MK contributed to conceptualization, analyzing data from the initial feasibility study, writing—review and editing, project administration, funding acquisition, and methodology.

Conflicts of Interest

Authors have no financial interests to disclose, but, in the spirit of full disclosure, wish to disclose a personal interest in the app, having been involved in its conceptualization and development. To this end, and following the principles of open science, all study data (in anonymized form) will be made available following publication of the results via the Open Science Framework.

Multimedia Appendix 1

Daily assessment items.

[\[DOCX File , 8 KB-Multimedia Appendix 1\]](#)

Multimedia Appendix 2

In-app CORTO (Contextual, One-Item, Repeated, Timely, Open-Ended) items.

[\[DOCX File , 7 KB-Multimedia Appendix 2\]](#)

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Abbreviations

- BEAQ:** Brief Experiential Avoidance Questionnaire
CAQ: Cognitive Avoidance Questionnaire
CBT: cognitive behavioral therapy
CORTO: Contextual, One-Item, Repeated, Timely, Open-Ended
EA: experiential avoidance
EBQ: Emotions Beliefs Questionnaire

eHEALS: eHealth Literacy Scale

EMA: ecological momentary assessment

EMI: ecological momentary intervention

GDPR: General Data Protection Regulation

H_Ex_A_Go_N: habit, executive function impairment, abstract processing mode, goal discrepancies triggering rumination, and the negative valence of rumination content

HADS: Hospital Anxiety and Depression Scale

mHealth: mobile health

NBRs: Negative Beliefs About Rumination Scale

PBRs: Positive Beliefs About Rumination Scale

PTQ: Perseverative Thinking Questionnaire

RFCBT: rumination-focused cognitive behavioral therapy

RNT: repetitive negative thinking

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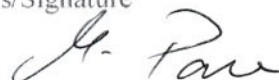
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Podpisany elektronicznie przez

Barbara Karpowicz

03.10.2025

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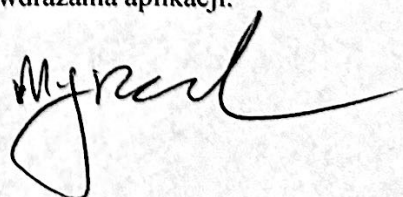
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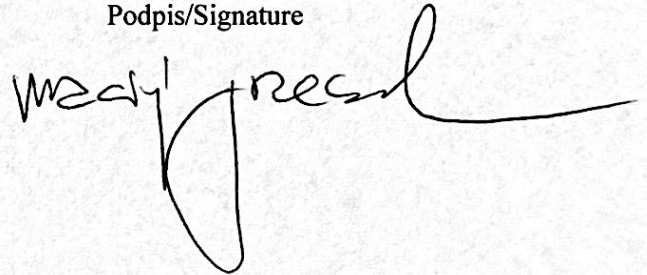
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Podpis/Signature

A handwritten signature in black ink, appearing to read 'Maciej Grzeszczuk', with a long horizontal flourish extending to the right.

mgr inż. Pavlo Zinevych

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Peer reviewed

The Role of Task-Unrelated Thinking Characteristics and Function in Affect Regulation During Online and On-site Classes

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Abstract

Task-unrelated thinking (TUT) can impact both performance and well-being, yet its role in affect regulation remains underexplored, especially in an educational context. This study examined TUT level, characteristics, and functions in 173 on-site and 143 online students, assessing their affect and class experiences in an ecological setting. While overall TUT levels did not differ between groups, distinctions emerged in characteristics (e.g., inner speech) and functions (e.g., stimulation or avoidance). Valence was the only characteristic predicting prospective sadness or anxiety. Using TUT for problem-solving or avoidance was linked to increased sadness, whereas using it for stimulation was linked to reduced anxiety. These findings highlight that TUT's effects depend more on its nature and purpose than its frequency. The observed link between avoidance-related TUT and negative affect has significant implications for clinical psychology and educational settings, particularly in understanding emotion regulation in online and on-site learning.

Keywords: task-unrelated thinking; mind-wandering; affect regulation; online learning

Task-unrelated thinking in educational activities

Task-unrelated thoughts, often referred to as mind-wandering or daydreaming (Seli et al., 2018) have already been studied in an educational context for several decades (Pachai et al., 2016; Szpunar et al., 2013). However, most of the studies before 2020 were focused on task-unrelated thoughts, daydreaming, or mind-wandering in the context of learning in the classroom (Risko et al., 2012) or distance learning based on pre-registered videos lectures (like in massive online courses (Lindquist & McLean, 2011)). The COVID-19 pandemic increased the popularity of another type of online learning (i.e., live online classes through tools like Meet, Teams, or Zoom) across the globe. Thus, it seems crucial to re-examine the role of task-unrelated thoughts like daydreaming or mind-wandering in the context of live online education. Consequently, the main goal of the present study was to assess the features of task-unrelated thoughts (e.g., valence, temporal orientation, personal significance,

control, visualization, repetitiveness, (Andrews-Hanna et al., 2013; Kornacka et al., 2022) and the function of task-unrelated thoughts in students during live online vs. on-site classes. Moreover, we assessed how those features were related to students' mood while controlling for class features (e.g., interest, difficulty level, and students motivation) in both online and on-site learning.

In the literature, one can find numerous definitions of mind-wandering, daydreaming, or thought meandering that can be gathered under one umbrella term of task-unrelated thinking (TUT, Seli et al., 2019). The main common feature of TUT is the fact that it is not related to one's current activity and is often perceived as difficult to control (Seli et al., 2019). In the perspective of family resemblance, Seli and colleagues (2019) suggested including all sorts of task-unrelated thoughts that are characterized by those main features under one term. TUT might however differ on the other features like intentionality, stimulus dependence, or being a structured flow of thoughts. Moreover, particular features of TUT can be crucial for its adaptive vs. maladaptive character (Andrews-Hanna et al., 2013; Kornacka et al., 2022).

The research on TUT suggests that they can play an important adaptive role in our behavior and emotion regulation (Christoff et al., 2018; Gorgolewski et al., 2014; Ottaviani et al., 2013), they might be connected with enhanced creativity (Agnoli et al., 2018; Baird et al., 2012; Smeekens & Kane, 2016), improved planning process, problem solving (Mooneyham & Schooler, 2013) and they provide relief from boredom (Martarelli & Baillifard, 2024). However, it is necessary to underline that TUT might also have maladaptive consequences (Killingsworth & Gilbert, 2010), particularly if they serve as emotional or behavioral avoidance (Kornacka et al., 2023; Somer, 2002). Some studies suggest that TUT might be responsible for emotion regulation impairment or even increase the risk for mental disorders (Marchetti et al., 2016). TUT might also negatively impact everyday life activities (Yanko & Spalek, 2014).

Lindquist and McLean (2011) underline that the result of research on TUT in a general context cannot be easily transferable to learning. In the context of education, it seems that TUT can be generally defined as involuntary task-unrelated thoughts. It can be assumed that during the class one of the main goals is to stay focused on the class content contrary to automatic activities (e.g., driving a car or jogging in the park) when TUT can be used with its adaptive function of planning or increasing creativity without any interference with the ongoing main task (Lindquist & McLean, 2011; Schimmenti et al., 2019; Seli et al., 2018). Thus, in everyday life daydreaming is often adaptive, by default activity while having free cognitive resources available, while during the classes students attention is rather required to be focused on task almost all the time and frequent mind-wandering might impaired understanding, learning and academic performance in general (Hollis & Was, 2016; Lindquist & McLean, 2011), but also affect self-perceived efficiency of judgement of learning (Was et al., 2019). A recent meta-analysis suggests that mind-wandering is associated with learning with a small

to moderate effect size, but it is less apparent in live online classes (Wong et al., 2022).

Paradoxically, according to some studies, TUT seem to appear more often during education than other activities in a social or professional context (Unsworth & McMillan, 2013) Unsworth et al. (2012) study involving 100 students has revealed that the majority of attention failures due to mind-wandering occur in the classroom or while studying. Participants reported the presence of TUT in learning-related situations more frequently than at work or during everyday activities such as cooking or driving a car. Wong et al. (2022), based on their meta-analytic study suggest that TUT might take up to 30 % of time during learning.

The literature on TUT outcomes in the educational context suggests that TUT might be responsible for comprehension failure in reading, might harm the understanding of a lecture, and impair cognitive processes such as implicit learning (Bonifacci et al., 2023; Franklin et al., 2011, 2016). The students who have high levels of MW also seem to be less involved in other activities that might improve learning, for example in note-taking (Lindquist & McLean, 2011).

Sanchez et al. (Sanchez & Naylor, 2018) showed in a series of studies that mind-wandering has a double negative effect on overall text comprehension. Learners who reported a higher level of TUT not only remembered less correctly scientific information but also were more likely to generate content misunderstandings and incorrect associations of the material. Mindwanderers attempt to fill in the gaps in their knowledge by combining concepts in an inadequate way, thus creating erroneous information.

However, it is important to underline that all the aforementioned studies, if referring to online learning, are referring to prior to pandemic situations and thus are based rather on recorded video lectures and not on real-time online learning (Hollis & Was, 2016; Szpunar et al., 2013). One recent and rare study comparing TUT in online and on-site classes suggests that online students are more engaged in off-task thinking and spend more time on off-task digital activities (Ochs et al., 2024).

In a literature review, Szpunar et al. (2013) underlined that one of the challenges in studying TUT is how to measure it in both laboratory and ecological conditions. Although numerous studies have used various methods (from measuring visual attention through eye-tracking, note taking, and retention of information), it seems that the most efficient method of measuring TUT is using thought probs (Kane et al., 2021; Zanesco et al., 2024). However, most of the studies used this method in laboratory conditions (Risko et al., 2012) and evaluating TUT in the ecological context of education is still very scarce.

Measuring TUT in ecological settings seems to be particularly relevant, as some studies suggest that not only TUT features and function might determine TUT adaptive or maladaptive character, but those variables are in interaction with the situational context (e.g., the interest in the given course; Kane et al., 2021; Lindquist & McLean, 2010) or motivation (Smith et al., 2022).

In sum, TUT seem to be one of the key variables involved not only in the efficiency of online learning but also in affecting students' well-being. Although task-unrelated cognitions have already been studied for several years, the pandemic situation raised new questions about TUT mechanisms and functions in real-time online learning. Moreover, most of the studies examined TUT in an educational context only in laboratory settings, and thus data from ecological conditions are still missing. Consequently, the aim of the present study was to examine TUT using thought probes in ecological momentary assessment during real-time online and on-site classes.

Methods

Participants

317 (204 female, 109 male, 4 participants did not provide their gender) university students volunteers agreed to participate in the study ($n = 143$ for Time 1, $n = 114$ for Time 2 measure during online and $n = 173$ for Time 1, $n = 153$ for Time 2 measure during on-site classes). The mean age of the participants was 29,76 ($SD = 10,72$) in the online group and 21,51 ($SD = 5,67$) in the on-site group.

Measures

TUT level. Participants were asked to evaluate on a 7 Likert point scale from (1- not at all to 7- totally) to what extent their thoughts were focused on the current class when they heard the signal.

TUT function (adapted from Stawarczyk et al., 2011). Participants were asked to evaluate on a 7 Likert point scale from (1- not at all to 7- totally) what the function of their STUT just before the signal (problem-solving, planning, reappraisal, improving mood, stimulation, avoiding difficult issues, other, no function at all).

TUT main features (adapted from Kornacka et al., 2022). Participants were asked to assess on a 7-point Likert scale from (1- not at all to 7- totally) the main characteristics of their STUT just before the signal (inner-speech form, possibility of visualizing, control, probability, importance congruence with a goal, repetitiveness, valence, being a part of structured thinking as opposite to freely moving thoughts).

Class features. Participants were asked to evaluate on a 7-point Likert scale from (1- not at all to 7- totally) to what extent their classes were interesting, difficult, and to what extent they felt motivated to take part in the class.

Mood (adapted from Koster et al., 2015). Participants were asked to assess on two 7-point bipolar scales (happy-sad; calm-anxious) their current mood.

Procedure

The procedure was similar in both online and on-site classes. After receiving consent from the teacher, at the beginning of the class, the experimenter explained the idea of the study, the main goal, and answered all the potential questions. During the class, volunteer participants were asked twice (around the 25th (Time 1) and 70th (Time 2) minute of the class) to answer a thought probe on their mobile phones. Participants could access the form provided through Qualtrics with a printed QR code. The first probe was preceded by a consent form and a short demographic questionnaire. Participants were asked to provide a login at each stage of the survey in order to merge two measure points without harming the anonymity.

Results

Comparing TUT level, characteristics and functions in students following online vs. on-site classes.

Descriptive statistics and 2(Time:1,2) x 2(Class type: online, on-site) mixed design ANOVAs results are presented in supplementary materials Table S1 (<https://doi.org/10.17605/OSF.IO/TC8HA>). It seems that the level of TUT does not differ in students following online and on-site classes. It also does not seem to significantly increase over time. However, Online and on-site students' TUT seem to differ in some characteristics and functions. On-site students' TUT has more inner-speech form and be more repetitive compared to online students. We also observed a significant time effect suggesting that TUT become less like inner-speech over time. Also, the TUT content was assessed as less probabilistic and less important over time independently of class type.

On-site students seem to use TUT more often as an emotion regulation strategy (particularly problem-solving strategy, reappraisal, mood improvement and avoidance) compared to online students. We also found a Time x Class type interaction for using TUT as looking for stimulation, where on-site students used TUT for this purpose significantly more in the first measuring point, but those differences were no longer significant at the second measure point ($p = .017$ for post-hoc testing with Bonferroni correction). The use of TUT for planning decreased over time independently of class (online vs. on-site form).

Class characteristics and participants affect

It is important to note that we also found an interaction, group and time effects in ANOVAs with class characteristics as dependent variables. The classes were generally assessed as more interesting at the second measure point, but the first-second point difference was only significant for online students ($p = .038$ for post-hoc test with Bonferroni correction). Students seem to evaluate classes generally as more difficult at the second measure point compared to the first one, and online students reported that their classes were more difficult compared to the on-site ones.

Finally, participant reported generally more negative affect over time independently of class type, and they felt more sad

over time but only in online classes ($p = .004$ for post-hoc testing with Bonferroni correction).

Table 1 : Hierarchical regression of TUT function (measured at Timepoint 1) on Negative affect (Sadness and Anxiety measured at Timepoint 2).

Variable	Outcome : Time 2 Sadness					Outcome: Time 2 Anxiety				
	<i>B</i>	95% CI		<i>SE</i>	β	<i>B</i>	95% CI		<i>SE</i>	β
		LL	UL				LL	UL		
Step 1					.105					.053
<i>Constant</i>	1.91***	1.21	2.60		5.39	3.08***	2.39	3.76	0.35	
Problem-solving	0.27***	0.14	0.41	0.29	4.06	0.13*	0.00	0.26	0.07	0.14
Planning	-0.07	-0.19	0.06	-0.08	-1.10	-0.01	-0.13	0.11	0.06	-0.01
Reappraisal	0.06	-0.06	0.18	0.07	1.00	0.07	-0.05	0.19	0.06	0.08
Improving mood	-0.03	-0.15	0.09	-0.04	-0.55	-0.03	-0.15	0.08	0.06	-0.04
Stimulation	-0.06	-0.19	0.07	-0.07	-0.97	-0.15*	-0.28	-0.02	0.07	-0.16
Avoidance	0.12*	0.01	0.23	0.14	2.13	0.07	-0.04	0.18	0.06	0.09
Step 2					.110					.053
<i>Constant</i>	1.86***	1.16	2.56		5.24	3.07***	2.38	3.76	0.35	
Problem-solving	0.28***	0.15	0.41	0.30	4.15	0.13*	0.00	0.26	0.07	0.14
Planning	-0.08	-0.20	0.05	-0.08	-1.18	-0.01	-0.14	0.11	0.06	-0.01
Reappraisal	0.07	-0.06	0.19	0.07	1.05	0.07	-0.05	0.19	0.06	0.08
Improving mood	-0.03	-0.15	0.09	-0.03	-0.50	-0.03	-0.15	0.09	0.06	-0.04
Stimulation	-0.06	-0.19	0.07	-0.06	-0.88	-0.15*	-0.28	-0.02	0.07	-0.16
Avoidance	0.13*	0.01	0.24	0.15	2.23	0.08	-0.03	0.19	0.06	0.09
Class type	-0.12	-0.32	0.08	-0.07	-1.16	-0.02	-0.22	0.17	0.10	-0.02
Step 3					.137					.283
<i>Constant</i>	1.89***	0.97	2.82		4.03	4.58***	3.77	5.39	0.41	
Problem-solving	0.29***	0.16	0.42	0.30	4.27	0.15*	0.03	0.26	0.06	0.16
Planning	-0.08	-0.20	0.05	-0.08	-1.23	-0.04	-0.15	0.07	0.06	-0.05
Reappraisal	0.06	-0.06	0.18	0.06	0.93	0.06	-0.05	0.16	0.05	0.06
Improving mood	-0.05	-0.17	0.07	-0.06	-0.83	-0.07	-0.18	0.03	0.05	-0.09
Stimulation	-0.04	-0.17	0.09	-0.04	-0.57	-0.07	-0.18	0.04	0.06	-0.08
Avoidance	0.12*	0.01	0.23	0.14	2.10	0.05	-0.04	0.15	0.05	0.07
Class type	-0.12	-0.32	0.08	-0.07	-1.21	-0.11	-0.28	0.07	0.09	-0.07
Interest	-0.12	-0.31	0.07	-0.12	-1.21	-0.20**	-0.36	-0.03	0.08	-0.20
Difficulty	0.17*	0.03	0.31	0.15	2.44	0.22***	0.10	0.34	0.06	0.20
Motivation	0.00	-0.18	0.17	0.00	-0.05	-0.29***	-0.45	-0.14	0.08	-0.32

Note. * $p < .05$; ** $p < .01$; *** $p < .001$; SE = Standard error ; CI = Confidence interval.

The role of TUT function and characteristics in prospective negative affect

In order to test how TUT function and characteristics are linked to affect regulation we run a series of hierarchical linear regressions. In models explaining sadness and anxiety measured at Time 2 we introduced TUT function (see Table 1) or characteristics (see Table 2) measured at Time 1 as predictors in Step 1, added class type in Step 2 and reported class characteristics measured at Time 2 in Step 3. The results of hierarchical regression on affect measured at Time 1 are

included in Table S2 and S3 in supplementary materials (<https://doi.org/10.17605/OSF.IO/TC8HA>).

The results suggest that problem solving and avoidance are significant predictors of prospective sadness, they remain significant also after including class type (Step 2) and class characteristics (Step 3) in the model.

Among TUT characteristics, only their valence seems to be a significant predictor of prospective sadness or anxiety, also in models including class type and class characteristics. It is important to note that in all four models adding class type into the regression did not on only slightly affected the percentage of variance explained by the model (ΔR^2 varied from 0 to .005).

Table 2 : Hierarchical regression of TUT characteristics (measured at Time 1) on Negative affect (Sadness and Anxiety measured at Time 2).

Variable	Outcome : Time 2 Sadness					Outcome: Time 2 Anxiety				
	<i>B</i>	95% CI		<i>SE</i>	β	<i>B</i>	95% CI		<i>SE</i>	β
		LL	UL				LL	UL		
Step 1					.179					.118
<i>Constant</i>	3.69***	2.95	4.43	0.38		2.79***	1.99	3.58	0.40	
Visualization	-0.02	-0.14	0.10	0.06	-0.02	-0.05	-0.18	0.08	0.07	-0.05
Inner-speech	-0.03	-0.18	0.07	0.05	-0.04	-0.01	-0.11	0.11	0.06	-0.01
Control	0.01	-0.12	0.12	0.06	0.01	0.07	-0.06	0.20	0.07	0.07
Structured	-0.06	-0.19	0.06	0.06	-0.07	-0.07	-0.20	0.07	0.07	-0.07
Probability	0.03	-0.10	0.15	0.06	0.03	-0.12	-0.25	0.01	0.07	-0.13
Goal congruence	-0.03	-0.16	0.09	0.06	-0.04	0.10	-0.04	0.23	0.07	0.12
Importance	0.06	-0.09	0.22	0.08	0.07	0.11	-0.06	0.27	0.08	0.12
Repetitiveness	0.06	-0.06	0.18	0.06	0.07	0.04	-0.09	0.17	0.06	0.04
Valence	-0.42***	-0.57	-0.28	0.07	-0.37	-0.31***	-0.46	-0.15	0.08	-0.25
Step 2					.179					.118
<i>Constant</i>	3.67***	2.96	4.44	0.38		2.79***	1.99	3.59	0.40	
Visualization	-0.02	-0.14	0.10	0.06	-0.02	-0.05	-0.18	0.08	0.07	-0.05
Inner-speech	-0.04	-0.14	0.07	0.05	-0.04	-0.00	-0.12	0.11	0.06	-0.01
Control	0.01	-0.12	0.12	0.06	0.00	0.07	-0.06	0.20	0.07	0.07
Structured	-0.06	-0.19	0.07	0.06	-0.07	-0.07	-0.20	0.07	0.07	-0.07
Probability	0.02	-0.10	0.15	0.06	0.03	-0.12	-0.25	0.01	0.07	-0.13
Goal congruence	-0.03	-0.16	0.10	0.06	-0.04	0.10	-0.04	0.24	0.07	0.13
Importance	0.07	-0.09	0.22	0.08	0.08	0.11	-0.06	0.28	0.09	0.12
Repetitiveness	0.05	-0.07	0.17	0.06	0.06	0.04	-0.09	0.17	0.07	0.042
Valence	-0.43***	-0.57	-0.28	0.07	-0.37	-0.31***	-0.46	-0.15	0.08	-0.26
Class type	0.04	-0.15	0.23	0.10	0.02	0.013	-0.19	0.22	0.10	0.01
Step 3					.273					.131
<i>Constant</i>	4.75***	3.90	5.60	0.43		2.69***	1.68	3.71	0.52	
Visualization	-0.04	-0.15	0.07	0.05	-0.04	-0.06	-0.19	0.07	0.07	-0.06
Inner-speech	-0.03	-0.12	0.062	0.05	-0.03	-0.01	-0.12	0.11	0.06	-0.01
Control	-0.01	-0.12	0.1	0.05	-0.01	0.07	-0.07	0.20	0.07	0.07
Structured	-0.01	-0.13	0.10	0.06	-0.01	-0.05	-0.19	0.09	0.07	-0.06
Probability	0.01	-0.10	0.12	0.06	0.01	-0.12	-0.25	0.02	0.07	-0.13
Goal congruence	0.01	-0.11	0.12	0.06	0.01	0.10	-0.04	0.24	0.07	0.13
Importance	0.08	-0.06	0.22	0.07	0.09	0.11	-0.06	0.28	0.09	0.12
Repetitiveness	0.04	-0.06	0.15	0.05	0.05	0.03	-0.10	0.17	0.07	0.04
Valence	-0.35***	-0.49	-0.22	0.07	-0.31	-0.29***	-0.45	-0.13	0.08	-0.24
Class type	-0.04	-0.21	0.13	0.09	-0.02	0.01	-0.20	0.21	0.10	0.00
Interest	-0.11	-0.27	0.05	0.08	-0.11	-0.01	-0.21	0.18	0.10	-0.01
Difficulty	0.17**	0.053	0.29	0.06	0.15	0.12	-0.02	0.26	0.07	0.10
Motivation	-0.31***	-0.48	-0.17	0.08	-0.36	-0.07	-0.25	0.12	0.09	-0.07

Note. ** $p < .01$; *** $p < .001$; SE = Standard error ; CI = Confidence interval.

Discussion

Task-unrelated thinking (TUT) is a naturally occurring cognitive process that has been studied in various contexts, including education, for several decades. However, the rapid expansion of online learning and the growing body of research indicating that TUT can have both adaptive and maladaptive consequences highlight the need for further

investigation. The present study is among the few that explore not only the level of TUT but also its characteristics and functions in both on-site and online students. Moreover, our primary focus was not on learning performance itself but rather on the consequences of TUT in the context of affect regulation.

Although our results suggest no significant differences in TUT levels over time or between on-site and online

learners—aligning with previous findings (e.g., Wammes et al., 2019)—they shed light on the role of TUT characteristics and functions in learning, regardless of the class format. Among TUT characteristics, only valence was significantly related to prospective negative affect. These findings support previous research suggesting that TUT valence plays a crucial role in its maladaptive outcomes (e.g., Welhaf & Banks, 2024). Similarly, Andrews-Hanna et al. (2013) demonstrated that negative TUT valence, along with personal relevance, was linked to negative psychological outcomes such as depression and trait negative affect. Other studies have also indicated that certain TUT characteristics, such as interest (Franklin et al., 2013) and subjective control (Kornacka et al., 2023), may be essential for affect regulation. The role of control over thoughts in maladaptive TUT outcomes aligns with existing theories, such as McVay and Kane's (2009) proposition that mind-wandering results from an interaction between contextual and self-control failures. Subsequent research has confirmed that this effect extends to subjective control over thoughts (Kornacka et al., 2023).

An important question remains as to whether the lack of significant effects of other TUT characteristics in the present study is due to the specific educational context or the method of assessment. The observed link between TUT valence and affect also supports the idea that mind-wandering and rumination may be a two (adaptive and maladaptive) end points of the same continuum (Ottaviani et al., 2013), with rumination characterized as off-task thinking focused on negative content that is difficult to control (Ehring & Watkins, 2008). However, if this is the case, other TUT characteristics—such as a lack of control (Watkins & Roberts, 2020) or a structured, less freely-moving form (Christoff et al., 2018)—should also be considered in the context of affect regulation.

To our knowledge, this study is among the few that examine different TUT functions in general. Our findings suggest that using TUT as a problem-solving or avoidance strategy is linked to higher levels of sadness. Additionally, on-site learners were more likely to use TUT for avoidance and problem-solving than online learners. These results align with current concerns theory, which posits that mind-wandering is triggered by personally relevant unresolved concerns (Klinger, 2013). They also support experimental studies suggesting that mind-wandering (e.g., Somer, 2002) and rumination (e.g., Giorgio et al., 2010; Kornacka et al., 2023) function as avoidance-based regulation strategies. Viewing TUT as an avoidance strategy may also help explain the differences between online and on-site learners: while online learners have multiple external distractions available (e.g., browsing other websites or social media), on-site learners may be more limited to cognitive distraction strategies such as mind-wandering. This explanation seems plausible, given findings that technology itself can be a significant distractor (Hollis & Was, 2016), that fear of missing out on social media contributes to mind-wandering (Sumner & Kaşıkçı, 2022), and that computer use can sometimes reduce mind-wandering (Risko et al., 2013).

Limitations and Future Directions

This study has several limitations. The assessment of TUT relied solely on self-reported thought probes, which may limit measurement reliability—particularly in the context of avoidance-related regulation strategies (Ball & Gunaydin, 2022). Moreover, the present study focused on evaluating TUT in the ecological setting of a real classroom. This decision, although it addresses an important gap in the literature, also entails several methodological consequences that could be more effectively explored in controlled experimental studies. First, the naturalistic setting limits the frequency of thought probes for ethical reasons, as they might interfere with real-life learning processes. One promising approach to overcoming this limitation could involve the use of behavioral and passive measures of mind-wandering, such as eye-tracking (Bühler et al., 2024; Wong et al., 2022). Increasing the number of TUT assessments over time might yield valuable insights into the temporal dynamics and time-dependent interactions of off-task thinking across different forms of learning.

Additionally, we controlled only for subjective class characteristics reported by participants. However, prior studies have suggested that other, more objective features—such as class size or lecture format—may also play a role in TUT (e.g., Lindquist & McLean, 2011). Finally, recruiting participants in a naturalistic context resulted in some differences between the online and on-site groups—for example, in participant age—which may also influence TUT levels and interact with thought valence (e.g., Maillet et al., 2018; Welhaf et al., 2025). Moreover, in the present paper, we examined only linear relationships between variables. Future studies could explore non-linear associations, which may be particularly relevant for examining the link between TUT characteristics (e.g., perceived control) and participants' affect.

Conclusions

In sum, this study supports previous findings that in the context of affect regulation, not only TUT levels but also its valence and functions must be considered. Our results suggest that using TUT for problem-solving and avoidance may be detrimental to affect regulation and that these strategies are more frequently used by on-site learners. These findings are particularly relevant from a clinical perspective, as quantitative research on TUT as an avoidance mechanism remains scarce. Future studies should further disentangle the role of TUT characteristics in affect regulation, both in general and in educational contexts.

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OŚWIADCZENIE DOT. WSPÓLAUTORSTWA PUBLIKACJI
/STATEMENT ON CO-AUTHORSHIP PUBLICATION

Cichecka, N., Marszolek, A., Gelner, H., Orpych, K., Para, M., Skorupski, M., & Kornacka, M. (2025). The Role of Task-Unrelated Thinking Characteristics and Function in Affect Regulation During Online and On-site Classes. In *Proceedings of the Annual Meeting of the Cognitive Science Society 47*. Retrieved from <https://escholarship.org/uc/item/8d87t5kg>

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Monika Kornacka: Conceptualization, Writing – review & editing, Writing – original draft, Project administration, Methodology, Funding acquisition, Formal analysis, Project supervision.

/Opracowanie koncepcji badania Redakcja i weryfikacja tekstu, przygotowanie pierwszej wersji tekstu, administracja projektem, opracowanie metody badania, pozyskanie finansowania, analiza danych, opiek nad projektem.

Szczegółowy wkład autorki: Wkład autorki w powstanie tej pracy polegał na stworzeniu modelu badawczego, pozyskaniu finansowania, opracowanie metodologii, przeprowadzeniu analiz formalnych, a także napisaniu pierwszej wersji tekstu oraz jego późniejszej edycji, również w ramach odpowiedzi na recenzje, a także opieka nad grupą badawczą. Jest ostatnią (senior author) i korespondującą autorką publikacji. Publikacja była finansowana w ramach grantu SONATA 15, Narodowego Centrum Nauki "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364) kierowanego przez autorkę.

/Author's detailed contribution: She developed the research concept and model, acquired funding, designed the methodology, and conducted formal analyses. She was also responsible for writing the original draft and its subsequent editing, including preparing the responses to reviewers' comments and supervising the project. She is the senior and corresponding author of the publication. The research was funded by the SONATA 15 grant from the Polish National Science Centre, titled "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364), for which she was the Principal Investigator.

Natalia Cichecka: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

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Katarzyna Orpych: Methodology, Data collection.

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Wkład poszczególnych autorów_ek/Authors' contribution

Monika Kornacka: Conceptualization, Writing – review & editing, Writing – original draft, Project administration, Methodology, Funding acquisition, Formal analysis, Project supervision.

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Szczegółowy wkład autorki: Wkład autorki w powstanie tej pracy polegał na stworzeniu modelu badawczego, pozyskaniu finansowania, opracowanie metodologii, przeprowadzeniu analiz formalnych, a także napisaniu pierwszej wersji tekstu oraz jego późniejszej edycji, również w ramach odpowiedzi na recenzje, a także opieka nad grupą badawczą. Jest ostatnią (senior author) i korespondującą autorką publikacji. Publikacja była finansowana w ramach grantu SONATA 15, Narodowego Centrum Nauki "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364) kierowanego przez autorkę.

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Angelika Marszolek: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

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Hanna Gelner: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

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Katarzyna Orpych: Methodology, Data collection.

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Malgorzata Para: Methodology, Data collection.

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WNSO 12/4

Michał S. Skorupski, Conceptualization, Methodology.
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Podpis/Signature

A handwritten signature in black ink, appearing to read 'Michał S. Skorupski', written in a cursive style.

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**OŚWIADCZENIE DOT. WSPÓLAUTORSTWA PUBLIKACJI
/STATEMENT ON CO-AUTHORSHIP PUBLICATION**

Cichecka, N., Marszolek, A., Gelner, H., Orpych, K., Para, M., Skorupski, M., & Kornacka, M. (2025). The Role of Task-Unrelated Thinking Characteristics and Function in Affect Regulation During Online and On-site Classes. In *Proceedings of the Annual Meeting of the Cognitive Science Society 47*. Retrieved from <https://escholarship.org/uc/item/8d87t5kg>

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Szczegółowy wkład autorki: Wkład autorki w powstanie tej pracy polegał na stworzeniu modelu badawczego, pozyskaniu finansowania, opracowanie metodologii, przeprowadzeniu analiz formalnych, a także napisaniu pierwszej wersji tekstu oraz jego późniejszej edycji, również w ramach odpowiedzi na recenzje, a także opieka nad grupą badawczą. Jest ostatnią (senior author) i korespondującą autorką publikacji. Publikacja była finansowana w ramach grantu SONATA 15, Narodowego Centrum Nauki "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364) kierowanego przez autorkę.

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Natalia Cichecka: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

/Opracowanie koncepcji badania, opracowanie metody badania, przygotowanie pierwszej wersji tekstu, redakcja i weryfikacja tekstu, zbieranie danych, przygotowanie danych do analizy.

Angelika Marszolek: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

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Hanna Gelner: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

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Katarzyna Orpych: Methodology, Data collection.

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Malgorzata Para: Methodology, Data collection.

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Michał S. Skorupski: Conceptualization, Methodology.
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OŚWIADCZENIE DOT. WSPÓŁAUTORSTWA PUBLIKACJI
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Cichecka, N., Marszolek, A., Gelner, H., Orpych, K., Para, M., Skorupski, M., & Kornacka, M. (2025). The Role of Task-Unrelated Thinking Characteristics and Function in Affect Regulation During Online and On-site Classes. In *Proceedings of the Annual Meeting of the Cognitive Science Society* 47. Retrieved from <https://escholarship.org/uc/item/8d87t5kg>

Wkład poszczególnych autorów_ek/Authors' contribution

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Szczegółowy wkład autorki: Wkład autorki w powstanie tej pracy polegał na stworzeniu modelu badawczego, pozyskaniu finansowania, opracowanie metodologii, przeprowadzeniu analiz formalnych, a także napisaniu pierwszej wersji tekstu oraz jego późniejszej edycji, również w ramach odpowiedzi na recenzje, a także opieka nad grupą badawczą. Jest ostatnią (senior author) i korespondującą autorką publikacji. Publikacja była finansowana w ramach grantu SONATA 15, Narodowego Centrum Nauki "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364) kierowanego przez autorkę.

/Author's detailed contribution: She developed the research concept and model, acquired funding, designed the methodology, and conducted formal analyses. She was also responsible for writing the original draft and its subsequent editing, including preparing the responses to reviewers' comments and supervising the project. She is the senior and corresponding author of the publication. The research was funded by the SONATA 15 grant from the Polish National Science Centre, titled "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364), for which she was the Principal Investigator.

Natalia Cichecka: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

/Opracowanie koncepcji badania, opracowanie metody badania, przygotowanie pierwszej wersji tekstu, redakcja i weryfikacja tekstu, zbieranie danych, przygotowanie danych do analizy.

Angelika Marszolek: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

/Opracowanie koncepcji badania, opracowanie metody badania, przygotowanie pierwszej wersji tekstu, redakcja i weryfikacja tekstu, zbieranie danych, przygotowanie danych do analizy.

Hanna Gelner: Conceptualization, Writing – original draft, Writing – review & editing, Method, Data collection, Data curation.

/Opracowanie koncepcji badania, opracowanie metody badania, przygotowanie pierwszej wersji tekstu, redakcja i weryfikacja tekstu, zbieranie danych, przygotowanie danych do analizy.

Katarzyna Orpych: Methodology, Data collection.

/Opracowanie metody badania, zbieranie danych.

Małgorzata Para: Methodology, Data collection.

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Michał S. Skorupski: Conceptualization, Methodology.
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Podpis/Signature

A handwritten signature in black ink, appearing to read "M. Para". The signature is written in a cursive, flowing style with a large initial "M" and a long, sweeping underline.

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**OŚWIADCZENIE DOT. WSPÓŁAUTORSTWA PUBLIKACJI
/STATEMENT ON CO-AUTHORSHIP PUBLICATION**

Barnes, S., Szastok, M., Para, M., Morawiec, F., Grzeszczuk, M., Wójcik, S., Karpowicz, B., Zinevych, P., Jaskulska, A., Kopeć, W., & Kornacka, M. (2025). A Mobile Ecological Momentary Intervention for Reducing Experiential Avoidance in the Context of Rumination: Protocol for a Randomized Controlled Trial. *JMIR Research Protocols*, 14(1), e66067. <https://doi.org/10.2196/66067>

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Monika Kornacka: Conceptualization, Methodology, Analyzing data from the initial feasibility study, Writing—review and editing, Project administration, Funding acquisition.
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Szczegółowy wkład autorki: Wkład autorki w powstanie tej pracy polegał na opracowaniu koncepcji i modelu badawczego, opracowaniu metody badania, analizie danych ze wstępnego studium wykonalności, edycji pierwszego draftu manuskryptu napisanego przez SB, zarządzaniu projektem, pozyskaniu finansowania. Jest ostatnią (senior author) i korespondującą autorką publikacji. Publikacja była finansowana w ramach kierowanych przez autorkę grantów SONATA 15, Narodowego Centrum Nauki "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364) oraz grantu Instytutu Psychologii Uniwersytetu SWPS „The role of avoidance in the maladaptive feature of rumination – an experience sampling intervention study” (1305-11).

/Author's detailed contribution: She developed the research concept and model, acquired funding, designed the methodology, and conducted formal analyses for the pilot study. She was also responsible for the original draft editing, including preparing the responses to reviewers' comments. She is the senior and corresponding author of the publication. The research was funded by the SONATA 15 grant from the Polish National Science Centre, titled "Toward an Integrative Model of Maladaptive Spontaneous Task-Unrelated Thoughts (STUT): A Processual and Functional Approach" (2019/35/D/HS6/02364) and SWPS University Institute of Psychology research grant „The role of avoidance in the maladaptive feature of rumination – an experience sampling intervention study” (1305-11) for which she was the Principal Investigator.

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Marta Szastok: Creating the content of the psychoeducational intervention, Conceptualization, Preparing data for analysis, Analyzing data from the initial feasibility study, Methodology, Writing—review and editing.
/Stworzenie treści modułów użytych w interwencji, opracowanie koncepcji badania, opracowanie metody badania, analiza danych z badania pilotażowego, przygotowanie danych do analizy, redakcja i weryfikacja tekstu.

Malgorzata Para: Creating the content of the psychoeducational intervention, Collecting data in the initial feasibility study, Analyzing the data, Methodology.
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Fabian Morawiec: Software development, Co-designing the app architecture and data model, Supervision of the implementation and rollout of the app.

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Maladaptive task-unrelated thoughts: Self-control failure or avoidant behavior? Preliminary evidence from an experience sampling study

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Introduction: Task-unrelated thoughts (TUT) play an important role in everyday life functioning (e.g., anticipating the future, or providing a mental break). However, TUT might also be maladaptive, impairing cognitive performance emotion regulation, and increasing the risk of psychological disorders. In the present study, we aimed to test how self-reported control over TUT and task valence moderate the link between task difficulty and TUT intensity, testing the context regulation and avoidant alternative hypotheses of TUT occurrence.

Method: Forty-nine participants took part in an experience sampling study. They were asked to answer five times a day for 5 days a series of questions assessing the intensity, valence, control over TUT, and their momentary affect along with characteristics of the task they were currently performing. They also filled in trait questionnaires assessing their tendency to daydream, ruminate, and their beliefs on emotions' usefulness and controllability.

Results: The results showed that both task difficulty and one's lower control over thoughts along with their interaction significantly increased TUT intensity. Task negative valence significantly predicted TUT intensity and moderated the link between task difficulty and TUT intensity. In addition, the tendency to daydream and beliefs in the controllability of negative emotions affect the relations in this model.

Discussion: To the best of our knowledge, this study is the first to provide quantitative evidence from an experience sampling study on the role of the valence of currently performed tasks and beliefs on emotions on TUT intensity. It might be an important indication for research and clinical practice that maladaptive TUT might not be only linked to self-control failure but also to emotion regulation strategies one is using.

KEYWORDS

task-unrelated thoughts, avoidance, self-control, emotion regulation, rumination

Introduction

Task-unrelated thoughts (TUT), defined as an engagement in mentation that occurs unintentionally and is unrelated to one's current activity and surroundings (1), are considered a default mental activity occurring on a daily basis (2). Some studies suggest that off-task thinking might take more than one-third of our waking activity (3, 4). TUT play numerous adaptive functions, from planning and anticipating the future and enhancing goal progress to providing a break from difficult or boring activities to increasing creativity by letting our mind move freely to new directions (5–8). However, other studies suggest

that task-unrelated thoughts, under certain circumstances, might also be maladaptive and not only lower current task performance [for a review, refer to: (7)] but also impair emotion regulation and increase the risk of psychological disorders (9–11).

The literature suggests several hypotheses to explain these potential maladaptive outcomes of TUT, for example, the context regulation theory (2) and the avoidant alternative hypothesis (12). The context regulation theory (2) suggests that adaptive TUT occur when an individual performs a task not requiring a full engagement of cognitive resources. However, when the task becomes cognitively demanding, one should recruit executive resources to stop off-task thinking and focus on the ongoing activity. Thus, the adaptive feature of TUT would depend on the interaction between contextual factors (task difficulty) and personal disposition (executive resources), thus, TUT occurrence during a demanding task can manifest executive resources failure.

However, the literature suggests that the TUT occurrence during difficult tasks might depend not only on self-control resources but also on TUT function (12). TUT can be also an avoidant alternative for a difficult or distressing task. In this case, TUT occurrence during a difficult and cognitively demanding task might not (or not only) depend on the self-control resources but also on the emotion regulation strategy one is using (i.e., escaping from a distressing task into daydreaming). Thus, we can hypothesize that TUT intensity would be higher when one is performing a difficult, negatively valence task compared to the task of positive or neutral valence.

Although the involvement of executive resources in TUT is relatively well described in empirical studies, particularly those conducted in laboratory settings [e.g., (2, 13, 14)], the TUT as an avoidance mechanism remains described only in theoretical models and few qualitative studies [e.g., (12, 15)]. The present experience sampling study's aim was 2-fold. First, we tested the role of subjective control over one's TUT in the link between task difficulty and TUT level during participants' everyday activities testing the context regulation theory (2). Second, we examined the role of task valence in the link between task difficulty and TUT level testing the avoidant alternative hypothesis (12).

Role of executive resources and thoughts control in TUT

Several laboratory and experience sampling studies showed that executive functions might be involved in the maintenance of unintentional task-unrelated thoughts often impairing one's performance in the current task [e.g., (1, 16–18)]. In line with the context regulation theory, Kane and McVay (2) suggested that cognitive abilities might interact with the situational context (e.g., task characteristics) to determine the adaptive feature of TUT. Rummel and Boywitt (14) brought up evidence through a laboratory study that working memory capacity enables participants to adjust their TUT level to situational demands. Moreover, the link between executive functions and task-unrelated thoughts might also depend on the ongoing task difficulty.

The relation between executive resources and TUT intensity is positive when the task is not demanding, and negative when it requires cognitive resources—in this case, executive functions help to adjust TUT intensity to situational demands. In a recent study, Marcusson-Clavertz et al. (19) showed that executive functions measured in the laboratory predict the TUT intensity in experience sampling measures—better updating leads to a decrease in TUT when one is trying to focus on the task in everyday life.

Surprisingly, Barrington et al. (20) remark that some studies showed that mind-wandering (MW) can also increase with task difficulty. One possible explanation might be that the relationship between task difficulty and TUT level can take the form of a U-shape, and the TUT level is relatively high when the ongoing task is easy and decreases with the task difficulty but only to a certain point when the task becomes too difficult and TUT starts to increase again due to the cognitive overload (21). However, Barrington et al. (20) found, in a set of two laboratory studies, that the relationship between task difficulty and TUT intensity might not depend only on objective executive resources efficiency but also on subjective evaluation of the task (e.g., a subjective difficulty or motivational factors).

Avoidance role of task-unrelated thoughts

The involvement of motivational factors in the level of TUT during difficult tasks seems to be congruent with another line of research on TUT maladaptive outcomes, suggesting that TUT might be an emotion regulation strategy based on avoidance. In a qualitative study, Somer (12) showed that one of the main functions of TUT might be avoiding emotionally difficult or distressing experiences. When the task is distressing, TUT might be used as a form of experiential avoidance, and thus, its level might increase even if the ongoing task is demanding (12). The hypothesis of TUT as an avoidant alternative to a distressing task seems to be endorsed by both theory and empirical evidence linking TUT to affect. First, the theoretical support of the TUT avoidance function comes from the theory of repetitive negative thinking. Although there is still no consensus whether adaptive mind-wandering or daydreaming and rumination might be two opposite end points on the continuum of task-unrelated thoughts [see: (22, 23)], repetitive negative thinking is often considered a “sticky form” of off-task thinking (24). This similarity is particularly visible in light of the goal theory of current concerns (25), which suggest that in a situation when goal progress is not available through operant behavior, the goal striving will occur as a purely cognitive response (i.e., mind-wandering or daydreaming about that goal/concern). A diary study of daydreaming by van Rijn et al. (26) showed that daydreaming seems to incorporate one's current concerns from the 2 previous days. In line, Martin and Tesser (27) in their control theory of rumination suggest that this kind of cognition will be triggered by actual-ideal self-discrepancy resulting from an unresolved personally relevant goal. Second, in the field of repetitive negative thinking theory, Thomas Borkovec developed the avoidance theory of worry (28) suggesting that paradoxically

worrying might serve as a cognitive avoidance response to perceived threats. In one of the rare experimental studies, Giorgio et al. (29) tested experimentally the hypothesis of rumination as avoidant behavior but without conclusive results. They found that trait rumination is linked to self-reported avoidant behavior, but those results were not replicated in the laboratory avoidance task (29).

Moreover, previous studies suggested that negative affect might trigger TUT [e.g., (30)]. Kane et al. (31) showed also that anxious individuals characterized by avoidant behavior tend to have a higher level of mind-wandering. Apart from a qualitative study by Somer (12) showing that MW is associated with anxious avoidance and that this behavior might be maintained by negative reinforcement—a mechanism classical for anxiety disorders—a recent experience sampling study (32) showed that participants under chronic stress reported more MW. In addition, they found that those participants also tended to reject their current experience more. Those results seem to be particularly interesting in the context of TUT as experiential avoidance, suggesting also that the willingness to accept negative emotion or one's beliefs on how helpful or controllable negative emotions are (33) might play a role in a potential avoidance function of TUT.

However, in spite of a relatively strong theoretical background, the avoidance role of task-unrelated thoughts is very rarely experimentally tested—one of the main reasons might be the lack of a direct and valid measure of avoidance. On the one hand, self-reported measures of avoidance are available [e.g., (34)]; nevertheless, it seems that most people struggle to identify this function of their cognition; thus, self-reported measures are subject to biases. On the other hand, many studies measure avoidance in laboratory conditions [e.g., using an approach–avoidance task; for a review, refer to (35)]; however, these kinds of measures are often not ecologically valid and seem to be not applicable to measure TUT function. Thus, in the context of TUT appearing in participants' daily life, the first step to explore the potential role of avoidance in TUT occurrence seems to be testing whether task difficulty, but also task valence, might be linked to TUT occurrence. If TUT plays an avoidance function, it should occur not only during an easy task, but its level should be higher also when the task has a negative valence, compared to the task with positive valence.

Aim of the present study

In the present study, we aimed to test how self-reported control over TUT and task valence moderate the link between task difficulty and TUT intensity in participants' everyday lives, testing both the context regulation and avoidant alternative hypothesis of TUT occurrence. In addition, we checked whether trait measures—general tendency to daydream, ruminate, and beliefs about negative emotion—can affect those relations. An important strength of the present study was to test all the variables using the ecological momentary assessment (EMA). The use of ESM is especially relevant when studying changes in affect and thought content, as both of these phenomena

change dynamically throughout the day and can be more prone to misrepresentation when probed with retrospective methods than with repeated measurements in an ecological environment (36, 37).

Methods and materials

Participants

Seventy-two volunteers from a community sample took part in the study on day 1 by filling in the online trait questionnaires. Sixty-two participants agreed, at the end of the questionnaire part, to follow up with the experience sampling part of the study and installed the MovisensXS application (38) on their mobile phones. The participants with compliance rates lower than 30% in the EMA part of the study were excluded from the analyses. The use of this criterion is popular in EMA studies (39), as participants' compliance under 30% is considered poor (40, 41) and potentially unreliable (42, 43). This resulted in the final sample consisting of 49 participants (mean age = 30.73, SD = 5.82, 38.8% women). Those 49 participants provided 862 momentary assessments with a mean compliance rate of 70.04%, which can be considered an acceptable compliance rate for short, 4–6 days, experience-sampling studies according to recent recommendations (44).

Materials

Trait measures

Mind-wandering

Trait MW was evaluated through Daydreaming Frequency Scale [DDFS; (45–47)]. This 12-item self-reported questionnaire assesses the general frequency of stimulus-independent and task-unrelated thoughts. We used the Polish version of DDFS (48), which has excellent internal consistency (Cronbach's $\alpha = 0.92$) and good criterion validity. Cronbach's α in the present study was 0.93.

Repetitive negative thinking

Trait RNT was evaluated through the transdiagnostic Perseverative Thinking Questionnaire [PTQ; (49)]. This 15-item questionnaire assesses the main features of RNT (unproductiveness, repetitive features, and mental capacity captured by RNT) from a transdiagnostic disorder-independent perspective. The internal validity of the RNT score was satisfying with Cronbach's α of 0.92.

Beliefs on emotion

Beliefs on emotion were assessed through the Emotion Beliefs Questionnaire (50). The questionnaire assesses general beliefs on emotions along with the usefulness and controllability subdimension for both positive and negative emotions. It is worth noting that higher scores on the usefulness subscale mean stronger beliefs about the usefulness of certain emotions, and higher scores on the controllability subscale mean stronger beliefs about the uncontrollability of emotions. The internal validity of the questionnaire was satisfying with Cronbach's α of 0.87.

EMA measures

TUT intensity and characteristics—control and valence

TUT evaluation was adapted from Kornacka et al. (51). Participants were asked three questions assessing the task-unrelated character of their thoughts: “Just before the bip, (1) to what extent you were focused on your current main task” (not at all–totally); (2) “you had control over your thoughts” (not at all–totally); and (3) “what was the valence of your thoughts” (negative–positive). They provided answers on a visual analog scale (VAS) from 0 to 100.

Context–task characteristics

Task characteristic evaluation was adapted from Granholm et al. (52). Participants were asked to characterize their ongoing task by answering the following questions: “To what extent the task you are currently performing is”: (1) difficult; (2) interesting; and (3) pleasant. They provided answers on the VAS from 0—not at all, to 100—totally. Those questions evaluate the main task characteristics that might be crucial in the context of TUT according to the theoretical context of the present study. Evaluating task characteristics instead of the ongoing task type (e.g., leisure, work, family time, as in some of the previous studies) seems to be important, particularly in the context of exploring TUT using EMA—in the ecological condition, the same/similar task but performed in the other context or by another individual might have different subjective valence and difficulty. Thus, the task type seems to be less informative, and evaluating task characteristics directly seems to be more relevant.

Mood

Mood evaluation was adapted from Pe et al. (53). Participants were asked to evaluate on the VAS scale from 0 (not at all) to 100 (totally) to what extent they felt happy, interested, anxious, sad, or angry.

Procedure

Participants were recruited online through social media. They were informed that they would take part in a daily sampling study on daydreaming. They expressed informed consent and filled in online trait questionnaires on day 1.¹ They were contacted by an experimenter, and the daily sampling procedure was explained. All the EMA data were collected through the MovisensXS application installed on participants’ personal mobile phones. On days 2–6, participants responded to five signals a day randomly sent in daily activity slots (from 8 a.m. to 10 p.m.). The minimal interval between the signals was set up to 60 min. The study was run fully remotely, without any financial gratification for the participants, and was approved by a local ethics committee (WKEB69/03/2021).

¹ A total of 10 participants who did not fully complete the trait-level evaluation on day 1 were contacted after the end of the experience sampling part of the study and completed the questionnaires at that time.

Statistical analysis plan

The interval-contingent data collected in the present study should be analyzed with multilevel random coefficient modeling. Each momentary entry will be nested within each individual. In order to examine whether subjective control over one’s thoughts and task valence moderate the link between task difficulty and TUT intensity, and to further explore the moderating role of trait daydreaming tendency and metacognitive beliefs on emotion, we used multilevel models analyses, computed in R [version 4.2.1; (54)] with the “lme4” package [version 1.1-30; (55)].

Task characteristics (difficulty, valence) and TUT characteristics (subjective level of control over them) were treated as level 1 predictors and nested in participants (level 2). Trait-level variables measured with Daydreaming Frequency Scale, Emotional Beliefs Questionnaire, and PTQ were entered separately into the model described earlier as level 2 predictors. Before entering the analyses, all level 1 variables were group mean-centered and level 2 variables were grand mean-centered. The descriptive statistics and correlations for the level 1 and 2 variables are presented in Table 1.

A likelihood-ratio test was used to compare all the multilevel models tested. A deviance drop comparison to an unconditional model was also computed. The unconditional model (with no predictors) for TUT intensity as an outcome variable is presented as follows:

$$TUT\ intensity_{ij} = \gamma_{00} + u_{0j} + r_{ij}.$$

The multicollinearity of variables included in all models presented in the following section was tested by computing variance inflation factors (VIFs). As the VIF values never exceeded 2.5, no multicollinearity has been detected (56, 57).

Results

Testing the context regulation hypothesis

First, we tested how task difficulty and thought control and their interaction predict TUT intensity using the model specified as follows:

$$TUT\ intensity_{ij} = \gamma_{00} + u_{0j} + \beta_{1j}(Task\ difficulty_{ij}) + \beta_{2j}(Thought\ control_{ij}) + \beta_{3j}(Thought\ control_{ij} \times Task\ difficulty_{ij}) + r_{ij}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + u_{3j}.$$

The results suggest that both task difficulty and thought control are statistically significant predictors of TUT intensity. As we anticipated on the basis of the context regulation hypothesis, a rise in both task difficulty and thought control was related to the decline of TUT intensity (see Model 1 in Table 2).

The interaction turned out to be also significant (refer to Model 1 in Table 2), with a steeper slope ($Coeff = -0.22$, $t = 4.88$, $p < 0.001$) for low thought control than for high thought

TABLE 1 Descriptive statistics and correlations of level 1 and 2 variables.

Level 1 variables (N = 49)								
Variable	Descriptive statistics		Correlations					
	Mean	SD	1.	2.	3.	4.	5.	
1. TUT intensity	32.77	32.85	-					
2. Thought control	69.42	28.09	-0.66***	-				
3. TUT valence	71.75	26.27	-0.33***	0.42***	-			
4. Task difficulty	26.15	29.32	0.25***	0.20***	-0.14***	-		
5. Task interest	59.38	32.27	-0.41***	0.34***	0.37***	0.23***	-	
6. Task valence	67.87	26.78	-0.23***	0.24***	0.53***	-0.24***	0.57***	
Level 2 variables (N = 49)								
	Mean	SD	7.	8.	9.	10.	11.	12.
7. DDFS	38.51	9.26	-					
8. PTQ	44.39	10.21	0.32*	-				
9. EBQ total score	31.32	11.97	0.10	-0.05	-			
10. EBQ negative controllability	9.02	3.96	0.17	0.12	0.81***	-		
11. EBQ positive controllability	9.77	5.09	0.09	-0.06	0.80***	0.70***	-	
12. EBQ negative usefulness	7.81	4.72	-0.05	-0.13	0.71***	0.23	0.30*	-
13. EBQ positive usefulness	4.87	2.30	0.06	-0.03	0.59***	0.38**	0.12	0.57***

DDFS—Daydreaming Frequency Scale, PTQ—Perseverative Thinking Questionnaire, EBQ—Emotional Beliefs Questionnaire. Correlations for level 1 variables were computed using the repeated measures correlation method. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

TABLE 2 Testing level 1 predictors and their interactions link to momentary TUT intensity.

	Coeff	SE	t-value
Model 1—Task difficulty and thought control interaction			
Task difficulty	-0.15	0.03	5.03***
Thought control	-0.79	0.03	23.47***
Task difficulty x thought control	0.003	0.001	2.02*
Deviance drop compared to unconditional model			488.1
Significance of likelihood ratio test			$p < 0.001$
Model 2—Task difficulty and task valence interaction			
Task difficulty	-0.36	0.04	9.85***
Task valence	-0.39	0.04	9.59***
Task difficulty x task valence	0.004	0.001	2.97**
Deviance drop compared to unconditional model			146.2
Significance of likelihood ratio test			$p < 0.001$

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

control ($Coeff = -0.08$, $t = 2.17$, $p < 0.05$), suggesting that the link between TUT intensity and task difficulty is stronger in situations where a participant has less control over thoughts (refer to Figure 1). Although this result might seem surprising, the data suggest that participants with lower control over their thoughts have significantly higher levels of TUT compared to participants with better control over their thoughts. Difficult task causes a drop in the TUT level, and this drop is larger for participants with a lower level of control over their TUT; however, their level of TUT still remains significantly higher compared to participants with good control over their thoughts (refer to Figure 1).

Testing the avoidant alternative hypothesis of TUT occurrence

To test how task difficulty and task valence along with their interaction predict momentary TUT intensity, we used the model specified as follows:

$$TUT_{intensity_{ij}} = \gamma_{00} + u_{0j} + \beta_{1j}(Task\ difficulty_{ij}) + \beta_{2j}(Task\ valence_{ij}) + \beta_{3j}(Task\ difficulty_{ij} \times Task\ valence_{ij}) + r_{ij}$$

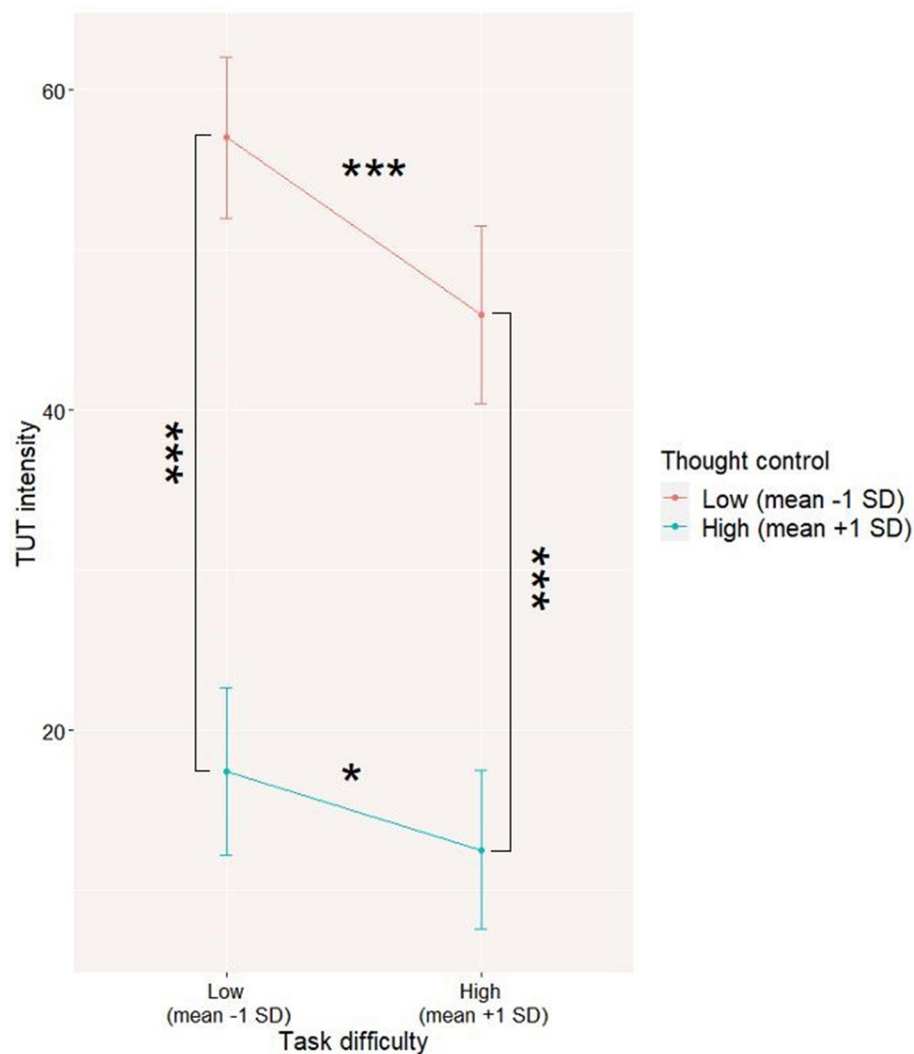


FIGURE 1

Level 1 interaction between thought control and task difficulty on task-unrelated thoughts (TUT) level. The interaction was visualized by computing slopes for high (mean +1SD) and low (mean -1SD) levels of predictor and moderator. * $p < 0.05$; *** $p < 0.001$.

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + u_{3j}$$

The results (Model 2 in Table 2) suggest that both task difficulty and task valence are statistically significant predictors of TUT intensity. A rise in task difficulty and a more positive task valence of the task were both related to a decline in TUT intensity.

We tested the same predictors with an added interaction term (task difficulty x task valence). The interaction turned out to be significant (refer to Model 2 in Table 2), with a steeper slope (Coeff = -0.48, $t = 9.60$, $p < 0.001$) for negative valence than for positive task valence (Coeff = -0.28, $t = 5.28$, $p < 0.001$), suggesting that the link between TUT intensity and task difficulty is stronger for less positive tasks; however, the TUT level remains significantly higher when the task is unpleasant for both easy and difficult tasks (refer to Figure 2).

Trait characteristics as moderators of level 1 interactions

We then tested how trait characteristics moderate the aforementioned models. To do this, we incorporated the trait measures separately into Models 1 and 2 as level 2 predictors. In each of the models presented in the following equation, a single level 2 variable was added to the model, as in Model 1a presented in the following equation:

$$TUT_{intensity_{ij}} = \gamma_{00} + u_{0j} + \beta_{1j}(Task\ difficulty_{ij}) + \beta_{2j}(Task\ valence_{ij}) + \beta_{3j}(Task\ difficulty_{ij} \times Task\ valence_{ij} \times DDFS_{ij}) + r_{ij}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + u_{3j}$$

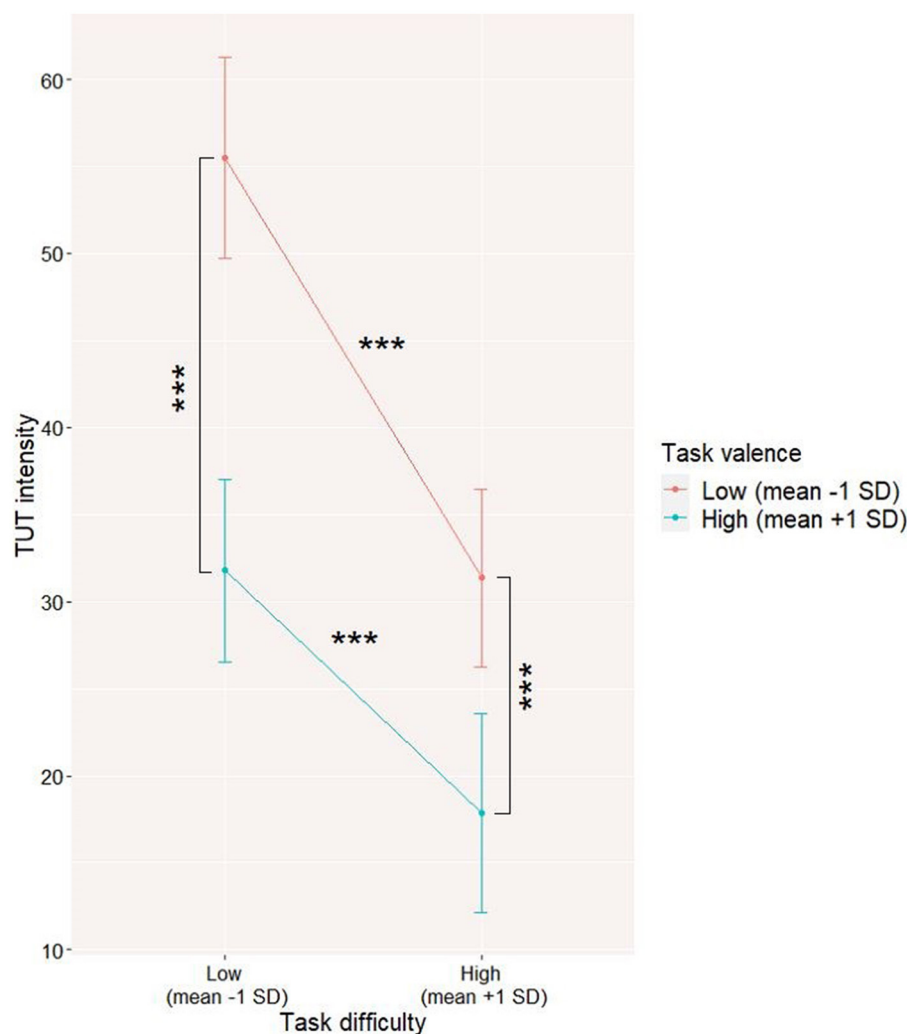


FIGURE 2

Level 1 interaction between task valence and task difficulty on task-unrelated thoughts (TUT) level. The interaction was visualized by computing slopes for high (mean +1SD) and low (mean -1SD) levels of predictor and moderator. *** $p < 0.001$.

First, we constructed the models testing the moderation of the task difficulty \times thought control interaction by trait-level characteristics. Only the DDFS score seems to moderate the level 1 interaction between thought control and task difficulty (refer to Model 1a in Table 3). It seems that TUT level decreases during difficult tasks compared to the easier ones but only for participants with a low level of thought control and a low level of trait tendency to daydream. This effect predicted by the context control hypothesis is not observed in frequent daydreamers (refer to Figure 3). Neither EBQ total score nor EBQ subscales or PTQ score turned out to be significant moderators of the interaction slope (refer to Models 1b–1e in Table 3).

Then, we constructed the models testing the moderation of the task difficulty \times task valence interaction by trait-level characteristics. DDFS score significantly moderates the task difficulty \times task valence interaction (refer to Model 2a in Table 4). The results suggest that the interaction between task difficulty and

task valence can be stronger for people with higher levels of a trait tendency to daydream (refer to Figure 4).

The total score of EBQ does not moderate the analyzed interaction (refer to Model 2b in Table 4); however, the negative controllability scale score of EBQ turned out to be a significant moderator of it (refer to Model 2c). The results suggest that stronger metacognitive beliefs about the uncontrollability of negative emotions can be associated with a stronger interaction between task difficulty and task valence (refer to Figure 5).

Discussion

The main aim of the present study was to test whether avoidance mechanisms can be an alternative explanation to self-control failure for the high level of maladaptive task-unrelated thoughts (i.e., task-unrelated thought occurring when the ongoing

TABLE 3 Testing level 2 variables as moderators of level 1 interactions in Model 1.

Models based on Model 1			
	<i>Coeff</i>	<i>SE</i>	<i>t</i> -ratio
Model 1a—DDFS score as level 2 moderator			
Task difficulty	0.01	0.003	1.72
Thought control	−0.01	0.004	1.98*
Task difficulty x thought control	−0.0003	0.0001	2.08*
Deviance drop compared to unconditional model			497.93
Significance of likelihood ratio test			$p < 0.001$
Model 1b—EBQ score as level 2 moderator			
Task difficulty	−0.003	0.003	1.01
Thought control	0.005	0.003	1.47
Task difficulty x thought control	0.0001	0.0001	0.94
Deviance drop compared to unconditional model			493.22
Significance of likelihood ratio test			$p < 0.001$
Model 1c—EBQ negative controllability score as level 2 moderator			
Task difficulty	−0.01	0.01	1.31
Thought control	0.003	0.01	0.41
Task difficulty x thought control	0.0002	0.0003	0.54
Deviance drop compared to unconditional model			493.88
Significance of likelihood ratio test			$p < 0.001$
Model 1d—EBQ negative usefulness scale as level 2 moderator			
Task difficulty	0.0008	0.01	0.11
Thought control	0.02	0.01	2.46*
Task difficulty x thought control	−0.0001	0.0004	0.22
Deviance drop compared to unconditional model			494.5
Significance of likelihood ratio test			$p < 0.001$
Model 1e - PTQ score as level 2 moderator			
Task difficulty	0.0001	0.003	0.31
Thought control	−0.01	0.004	1.36
Task difficulty x thought control	0.0001	0.0001	0.44
Deviance drop compared to unconditional model			497.74
Significance of likelihood ratio test			$p < 0.001$

TUT intensity is the outcome in all of the models.

DDFS—Daydreaming Frequency Scale, PTQ—Perseverative Thinking Questionnaire, EBQ—Emotional Beliefs Questionnaire.

* $p < 0.05$.

task is difficult and one should fully focus on it). To the best of our knowledge, this is the first attempt of testing this hypothesis in a quantitative, experience sampling study. Determining the precise mechanisms of maladaptive TUT occurrence and maintenance seems to be crucial from the clinical perspective, as the literature suggests clearly that in spite of its numerous adaptive functions [e.g., (5–8)], TUT might also have maladaptive consequences, from impairing cognitive performance to emotion deregulation and increased risk of psychological disorders (7, 9, 11, 58). One of the hypotheses linking the contextual factors to TUT occurrence

is the context regulation hypothesis (2), suggesting that a high level of TUT while performing cognitively demanding tasks might be due to self-control failure and the impossibility to inhibit off-task thinking. However, some empirical studies did not find support for this hypothesis suggesting that, in spite of good executive resources, participants can experience a high level of TUT during difficult tasks (21). An alternative hypothesis to explain the high level of TUT while performing a cognitively demanding task is TUT being an avoidance of a current difficult experience, but this hypothesis, in spite of a good theoretical

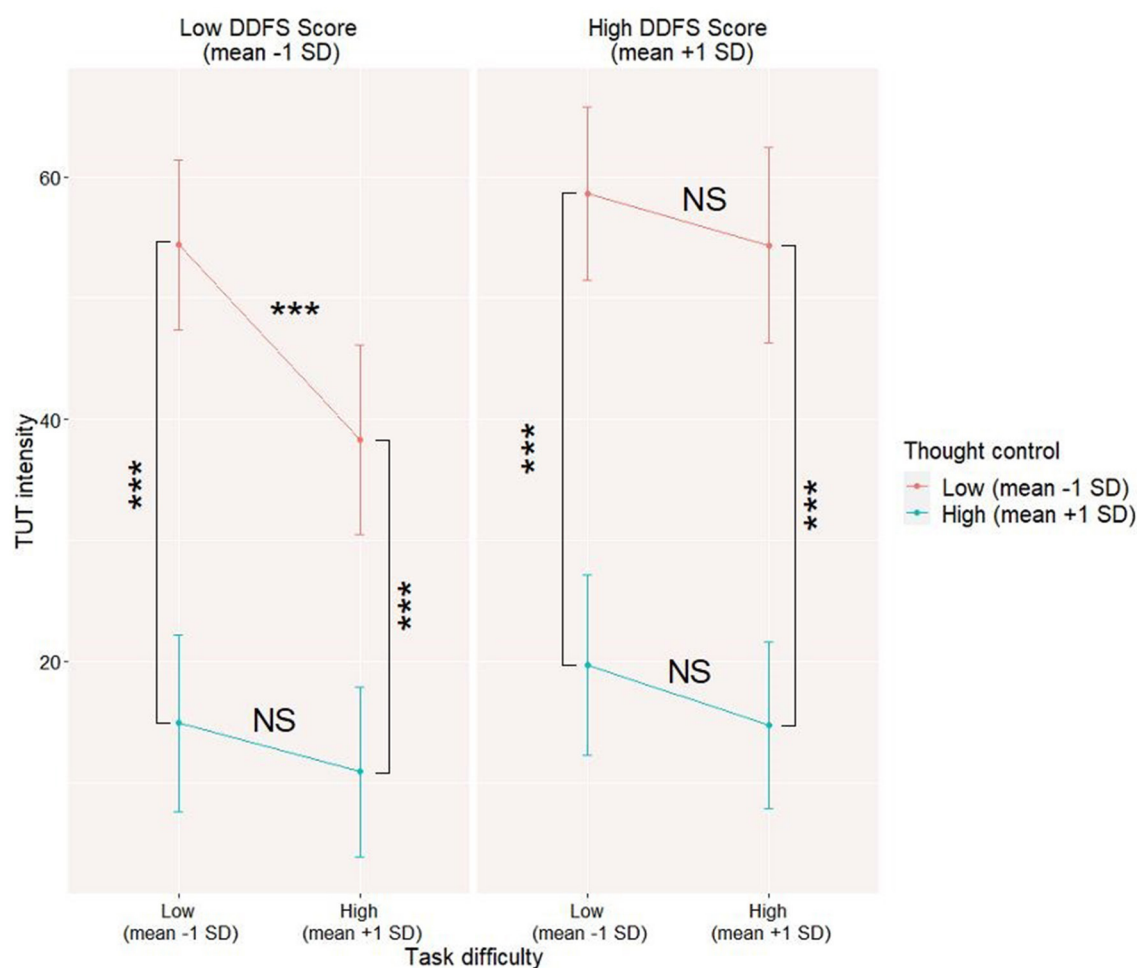


FIGURE 3

Daydreaming Frequency Scale (DDFS) moderating level 1 interaction between thought control and task difficulty on task-unrelated thoughts (TUT) level. The data for the moderation model were visualized by computing slopes for high (mean +1SD) and low (mean-1SD) levels of each predictor and moderator. NS—not significant; *** $p < 0.001$.

finding [e.g., (59)], was only tested in qualitative studies (12, 15). The results of our study shed some new light on both potential mechanisms.

First, from the perspective of the context regulation hypothesis, we showed that both task difficulty and one's control over the thoughts significantly decrease the TUT level in participants' daily life. Moreover, the interaction between task difficulty and control over one's thoughts was a significant predictor of TUT level. It seems that in general, participants with lower subjective control of thoughts present a higher level of TUT. In spite of the fact that when they are performing a difficult task, the level of TUT decreases more in those participants compared to participants with a higher level of thought control, the level of TUT in participants with low control remains, however, significantly higher in general. Thus, it seems that participants with better subjective control over their thoughts can better manage TUT during a cognitively demanding task. These results complete the results of previous laboratory studies [e.g., (13, 14)] by testing the relation between task difficulty and control over thoughts in

ecological settings. Although the impact of executive functions measured in the laboratory on experience sampling measures of TUT was previously shown by Marcusson-Clavertz et al. (19), to the best of our knowledge, only one study measured both task difficulty and thought control in participants' daily life and found an interaction between those factors in their impact on TUT level (51). However, those results are still limited by the fact that one's control over thoughts was only measured through self-reported assessment.

A similar pattern of results was found for the model testing the avoidant alternative mechanisms of TUT. Once again, it seems that participants report a higher level of TUT when the task is easy compared to a difficult one. Moreover, the TUT level is generally higher when participants are performing unpleasant tasks. Although the TUT level drops for both pleasant and unpleasant difficult tasks, the TUT level for difficult unpleasant tasks remains significantly higher compared to the pleasant ones. Thus, task valence can also play a key role in the TUT occurrence, suggesting that TUT can be used as an escape from unpleasant,

TABLE 4 Testing level 2 variables as moderators of level 1 interactions in Model 2. TUT intensity is the outcome in all of the models.

Models based on model 2			
	<i>Coeff</i>	<i>SE</i>	<i>t</i> -ratio
Model 2a—DDFS score as level 2 moderator			
Task difficulty	−0.005	0.004	1.30
Task valence	−0.02	0.0004	5.78***
Task difficulty x task valence	0.0003	0.0001	2.06*
Deviance drop compared to unconditional model			185.73
Significance of likelihood ratio test			$p < 0.001$
Model 2b—EBQ score as level 2 moderator			
Task difficulty	−0.01	0.003	2.36*
Task valence	−0.04	0.004	1.01
Task difficulty x task valence	0.0001	0.0001	1.03
Deviance drop compared to unconditional model			152.91
Significance of likelihood ratio test			$p < 0.001$
Model 2c—EBQ negative controllability score as level 2 moderator			
Task difficulty	−0.03	0.01	3.37**
Task valence	−0.02	0.01	1.87
Task difficulty x task valence	0.0007	0.0003	2.05*
Deviance drop compared to unconditional model			165.97
Significance of likelihood ratio test			$p < 0.001$
Model 2d—EBQ negative usefulness score as level 2 moderator			
Task difficulty	0.006	0.01	0.76
Task valence	−0.01	0.01	1.05
Task difficulty x task valence	−0.0001	0.0004	0.25
Deviance drop compared to unconditional model			148.19
Significance of likelihood ratio test			$p < 0.001$
Model 2e—PTQ score as level 2 moderator			
Task difficulty	−0.006	0.004	1.66
Task valence	−0.007	0.004	1.59
Task difficulty x task valence	−0.0001	0.0001	0.69
Deviance drop compared to unconditional model			160.08
Significance of likelihood ratio test			$p < 0.001$

DDFS—Daydreaming Frequency Scale, PTQ—Perseverative Thinking Questionnaire, EBQ—Emotional Beliefs Questionnaire.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

difficult tasks, corroborating the results of previous studies showing that TUT might be triggered by negative affect [e.g., (30)].

It is also interesting to note that not only the trait tendency to use daydreaming might moderate the link between task valence and task difficulty on their impact on momentary TUT level but also the role of a trait moderator might be affected by one's beliefs on emotion and particularly on the possibility of controlling one's negative emotions. Surprisingly, those beliefs affect particularly TUT levels while performing unpleasant but easy tasks. The involvement of beliefs on emotion in the occurrence and maintenance of off-task thinking serving as an avoidance strategy

is particularly important, as previous studies showed that beliefs on uncontrollability and lack of usefulness of emotions might lead to greater use of avoidance strategies (60).

Although the present study is the first to empirically test the avoidance hypothesis through the daily sampling method and shows that task valence and participants' beliefs on emotion play a significant role in TUT maintenance and its adaptive feature, some important questions remain unanswered and need to be addressed in the further studies. First, in the experience sampling methods, it is difficult to test simultaneously and detangle the effect of task valence and TUT on participants' affect, as affect and task

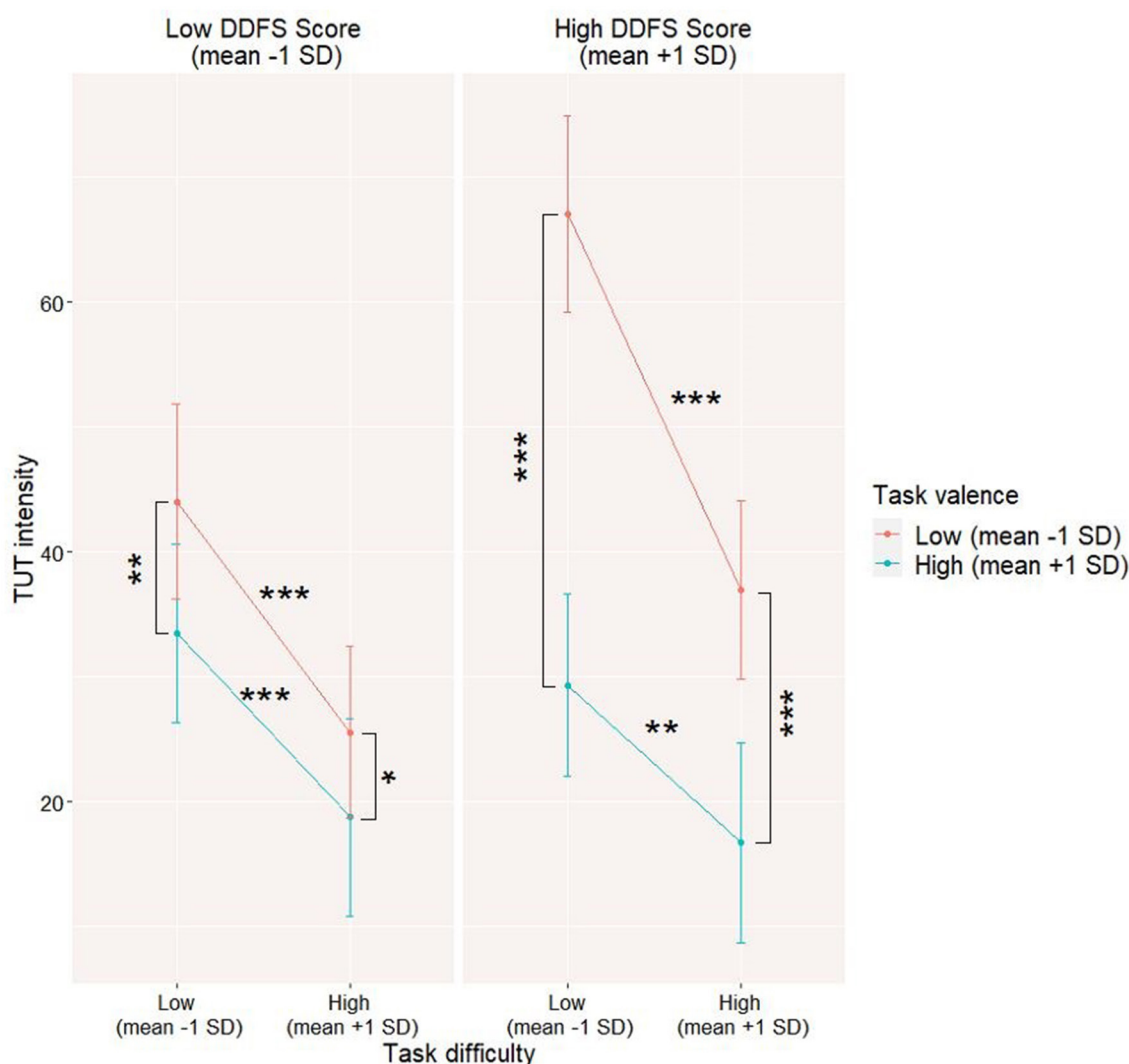


FIGURE 4
Daydreaming Frequency Scale (DDFS) moderating level 1 interaction between task valence and task difficulty on task-unrelated thoughts (TUT) level. The data for the moderation model were visualized by computing slopes for high (mean +1SD) and low (mean-1SD) levels of each predictor and moderator. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

valence are closely correlated—in the present study the correlation coefficients between affect variables (“happy,” “interested,” “sad,” “angry,” and “anxious”) and task valence had absolute values ranging from 0.30 to 0.61 ($p < 0.001$ for all). One of the possible solutions is to test the effect of TUT as avoidant behavior on lagged affect; however, as suggested by the theoretical models of anxiety disorders, it is possible that TUT as an avoidant emotion regulation strategy might have a paradoxical effect of increasing negative affect in the next measure point (59). Thus, it seems necessary to design an experimental study and control for the task valence.

Second, in the experience sampling part of the present study, we purposefully asked the questions about activity/task characteristics and not the particular task participants were exercising at the given moment. According to our hypothesis and previous studies [e.g., (51)], it is not the task type itself but the task characteristics that seem to be crucial in TUT occurrence. This differentiation between activity type and characteristics might be important particularly

in the context of ecological assessment—the same/similar task but performed in the other context or by another individual might have different subjective valence and difficulty. However, this methodological decision found on theoretical reasons might be an additional source of variance in the present study as we were not able to control the type of activity participants were performing at the time of sampling. This issue also stresses that in order to fully test the avoidant alternative hypothesis of TUT, it is necessary to merge both experience sampling and controlled laboratory studies.

Third, future studies may go beyond the self-reported assessment of the control over one's thoughts to merge experience sampling methods with an objective measure of cognitive control through tasks measuring executive functions. Finally, further studies may test whether and how both hypotheses of TUT occurrence—the context regulation and avoidant alternative, might be related to each other.

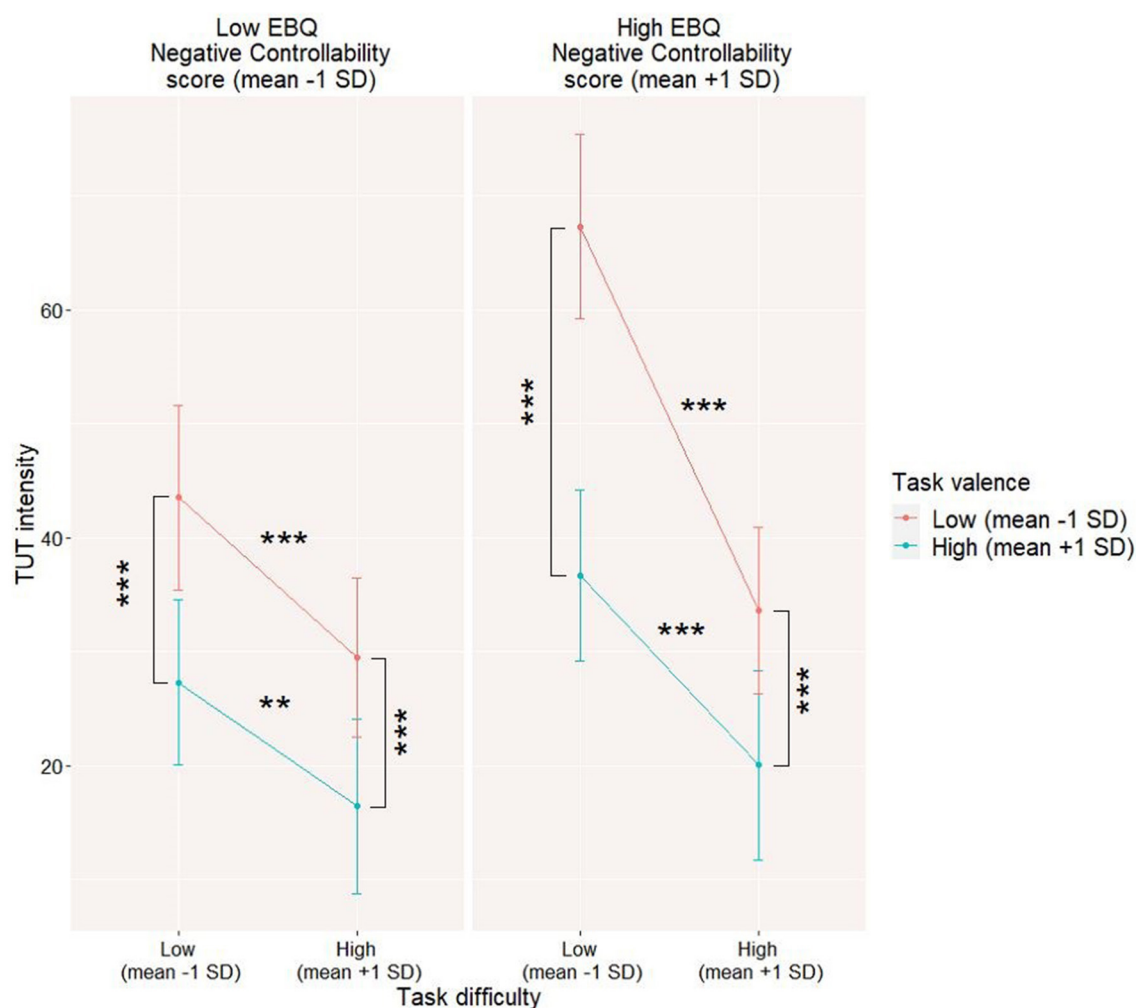


FIGURE 5

Emotion Beliefs Questionnaire (EBQ)—negative emotions controllability moderating level 1 interaction between thought control and task difficulty on task-unrelated thoughts (TUT) level. The data for the moderation model were visualized by computing slopes for high (mean +1SD) and low (mean-1SD) levels of each predictor and moderator. ** $p < 0.01$; *** $p < 0.001$.

In addition, it is necessary to underline that the results of the present study should be treated as preliminary. First, the sample size is relatively low (49 participants in the final analysis). Moreover, the study was run fully online and without paying the participants resulting in a considerable dropout between the trait and experience sampling part of the study (10 participants). In total, 13 participants needed to be excluded due to a low compliance rate in experience sampling [lower than 30%; (40–43)]. Second, although we tested some potential trait-level moderators of the presented models (the ones classically used in TUT studies—like propensity to daydream or use repetitive negative thinking and the one linked directly to the avoidant alternative hypothesis—beliefs on emotions), it seems important to note that also other personality level variables are suggested by the literature to affect the level of TUT [e.g., neuroticism, (13)] and should be included in further studies.

In spite of those shortcomings and the general difficulty to assess avoidance outside the lab, we believe that studying TUT function is crucial from the clinical perspective. First, studies

testing avoidance in anxiety disorders bring some evidence that this mechanism might be a key element in the maintenance of psychopathology (35). Second, there is an ongoing debate about whether we should consider maladaptive daydreaming as a psychological disorder or a potential transdiagnostic risk factor (11). Thus, it seems crucial to understand not only what mechanism is responsible for the occurrence of maladaptive TUT but also what mechanism(s) should be taken into account and addressed during the therapeutic process. According to the results of our study, while addressing maladaptive TUT both in research and clinical settings, one should not only focus on the contextual factors like task difficulty and patients' executive functioning but also mechanisms linked to emotion regulation like experiential avoidance and metacognitive beliefs on emotion. Although more research is needed to support the mechanism of avoidance in TUT and to explore the role of beliefs on emotions, we believe this study is one of the first important indicators bringing preliminary empirical evidence that these factors might matter in the maladaptive task-unrelated thoughts.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Commission, SWPS University of Social Sciences and Humanities, Katowice, Poland. The participants provided their written informed consent to participate in this study.

Author contributions

MK: conceptualization, methodology, writing—original draft, and supervision of the project. MS: formal analysis, data curation, visualization, and writing—original draft. IK: writing—review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsy.2023.1037443/full#supplementary-material>

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OPEN The impact of rumination on fibromyalgia pain after physical activity: an experimental study

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Some fibromyalgia (FM) patients engage in rumination (i.e. a chain of repetitive, passive and relatively uncontrollable thoughts focused on negative content) to cope with the pain and discomfort of daily activities. The partial model of rumination in chronic pain suggests that rumination processes may play a causal role in maintaining pain. Rumination might also be one of the key factors interfering with the reestablishment of adapted physical activity. The objective of this study was to test how rumination vs. distraction induction influence FM patients' pain intensity, discomfort linked to pain, and affect after physical activity. Forty-seven participants with a diagnosis of FM were randomly assigned to undergo distraction induction vs. rumination induction after performing a physical activity in ecological setting. Their pain intensity, pain-related discomfort, and affect were measured at the baseline, after physical activity, and after rumination versus distraction induction. A series of mixed-design ANOVAs showed that rumination induction after physical activity impairs patients' recovery in terms of pain intensity and discomfort, but not affect, as compared to the distraction condition. In conclusion, participants with fibromyalgia who engage in rumination following a physical activity recover less from their pain experience as compared to distraction induction. These results are consistent with the partial model of rumination in chronic pain and support the idea that rumination may play a causal role in the development and maintenance of pain.

Fibromyalgia (FM) is a chronic diffuse dysfunctional pain syndrome that affects around 2% of the population of Western countries^{1–4}. Systematic literature reviews and epidemiologic studies indicate that fibromyalgia is associated with a deterioration in quality of life⁵, increased mortality⁶ and with a strong psychopathological comorbidity, particularly with depression^{7,8}. Although its pathogenic mechanisms are not fully explored, the literature suggests that one of the main mechanisms of FM is linked to a deregulation of pain control at different levels of the nervous system⁹. According to the evidence-based recommendations, optimal treatment of FM requires a transdisciplinary approach combining pharmacological and non-pharmacological treatments including resuming of physical activities¹⁰.

However, resuming adapted physical activities is challenging for FM patients from a clinical point of view^{11,12}. On the one hand, patients are often aware that adapted physical activity is crucial to the therapeutic process, but on the other hand their previous experiences of physical activity causing discomfort and pain sustain a vicious circle of fear and avoidance^{13,14}. According to the fear avoidance model (FAM¹⁵), pain can lead to a catastrophizing thinking about movement and activities, which can develop into an excessive, irrational and debilitating fear of movement (kinesiophobia) and having the feeling that one is more prone to experience a painful injury or re-injury¹⁵. This feeling might lead to avoidance of both, movement in general and physical activity, and avoidance in turn, leads to more fear¹⁵. In spite of the lack of consensus on the theoretical background of pain catastrophizing (i.e. a form of abstract and intrusive repetitive negative thinking, which is difficult to disengage from^{16,17}), rumination about the consequences of physical activity, negative affect and pain seems to be one of the key mechanisms involved in this process (the partial model of rumination in pain¹⁸). Thus, addressing rumination

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while resuming physical activity in FM patients might be a promising path for improving adapted physical activity compliance and consequently enhancing FM patients' wellbeing. Although the link between pain and rumination was already shown in several qualitative (e.g.,¹⁹), correlational (for a review see:²⁰) or experimental (e.g.,²¹) studies, the impact of rumination on pain was not experimentally tested in the context of physical activity.

Rumination, defined as a chain of repetitive, passive and relatively uncontrollable thoughts focused on negative content (including pain and its consequences in the FM context)²², might have a causal role in decreasing physical activity in chronic pain for several reasons. On the one hand, rumination has been shown to be associated with higher pain intensity^{18,23,24} and poorer therapeutic outcomes²⁵. A neuroimaging study suggested that rumination might be linked to impaired anticipatory treatment of aversive stimuli related to pain in healthy population resulting in exaggerated response of pain²¹. This mechanisms might also potentially explain how rumination affects avoidant behaviors by modifying the expected outcomes of pain. On the other hand, qualitative research¹⁹ along with the conclusions from a literature review²⁶ suggest that rumination might be also triggered by the experience of pain itself. Moreover, it seems that patients with chronic pain may have positive metacognitive beliefs about rumination—they tend to think that rumination might help to cope and serve as a problem solving strategy^{18,19}. This kind of metacognitive beliefs might also mediate the positive relation between pain intensity and catastrophizing²⁷.

Additionally, rumination theory²⁸ sheds some light on the link between rumination and avoidance that can be applied to the perspective of chronic pain and kinesiophobia. Watkins and Nolen-Hoeksema²⁸ suggest that maladaptive, abstract rumination might be considered as emotional avoidance by disconnecting the patient from their current experience; this mechanism might provide momentary relief, but will have deleterious long-term consequences (e.g. increasing depression and/or anxiety) as it impairs emotion regulation and might be also linked to deregulation in the level of goal and action identification, i.e. flexibly adjusting the level of abstract vs. concrete processing to the ongoing situation^{28,29}. The overuse of abstract processing, on its turn, might result in decreased general motivation and commitment for pursuing a goal³⁰, which might be of a particularly relevance in the context of resuming adapted physical activity in chronic pain patients. Moreover, experiential avoidance (i.e. deliberate effort to alter the form or frequency of aversive experience such as negative emotions or unwanted cognitions) has been experimentally shown to reduce the pain tolerance³¹. This mechanism, in line with patients' positive metacognitive beliefs, might explain how rumination can become a preferential strategy in pain regulation and reduce the use of other emotion regulation strategies¹⁸ such as distraction which could be considered as a more effective strategy to cope with pain³² and as an adaptive alternative for rumination³⁰. Finally, the literature provides some evidence that rumination might be a mediator or moderator between certain risk factors of pain (e.g., gender³³; pain anticipation²¹; maladaptive coping strategies³⁴; functional disabilities³⁵) and pain itself. Furthermore, rumination might play a mediator role in the link between pain and psychological distress³⁶ and be a mediator between pain and depressive symptoms in a non-clinical population suffering from pain³⁷. It can also mediate the negative relation between protective factors (e.g. mindfulness) and depression in chronic pain patients³⁸. Thus, addressing rumination in FM patients might also potentially reduce the risk of other comorbid psychological disorders.

In sum, the use of rumination to respond to the discomfort of daily physical activities might maintain a higher pain after exercise compared to other strategies (e.g., distraction) through cognitive and attentional processes, but also impair long term emotion regulation through the mechanism of experiential avoidance. However, the direct impact of rumination as a regulation strategy in FM has never previously been tested in experimental settings. Exploring this path seems to be particularly appealing as, according to a recent study, FM patients might be more prone to ruminative style of thinking³⁹ and to anger rumination⁴⁰ compared to non FM chronic pain patients.

Thus, the aim of this study was to test how rumination induction versus distraction induction impact the evolution of pain (pain intensity and discomfort caused by pain) and affect in FM patients after they performed an ecological physical activity (climbing stairs). To our knowledge, this is the first time that this kind of experimental protocol has been used in the context of the evaluation of repetitive negative thinking in FM. We hypothesized that patients using a rumination strategy just after an uncomfortable physical activity will show a poorer evolution of pain, subjective discomfort and negative affect as compared to patients using a distraction strategy.

Materials and method

Study design

Participants were divided randomly into two experimental groups (rumination vs. distraction induction). The dependent variables (affect and state rumination) were measured at the baseline and after experimental induction (time 1 and 3 in Fig. 1). The pain (intensity and discomfort) was measured at the baseline, after physical activity, and after rumination vs. distraction induction (see Fig. 1). Thus, we expected interaction between measure time (1 and 3 for affect and state rumination; 2 and 3 for pain) and group in the mixed-designed 2×2 ANOVA analysis. The total sample size required to test mixed-design 2×2 ANOVA, computed prior to the experiment through GPower 3.1.9.4,⁴¹ to detect a medium effect size, with a power of 0.90, was 46 participants.

This research was approved by Comités de protection des personnes (French central research ethics committees), CPP Centre-Ouest I nr. 2018T2-16 dated 08/28/2018. All methods described below were performed in accordance with the relevant guidelines and the study was run in accordance with the Declaration of Helsinki.

Participants and procedure

Forty-seven adult patients (44 female, 3 male; mean age = 50.6, $SD = 8.1$) meeting the 1990 American College of Rheumatology (ACR) criteria¹ for FM were recruited by a pain physician and psychiatrist in Amiens University Hospital Center (France) during a usual consultation.

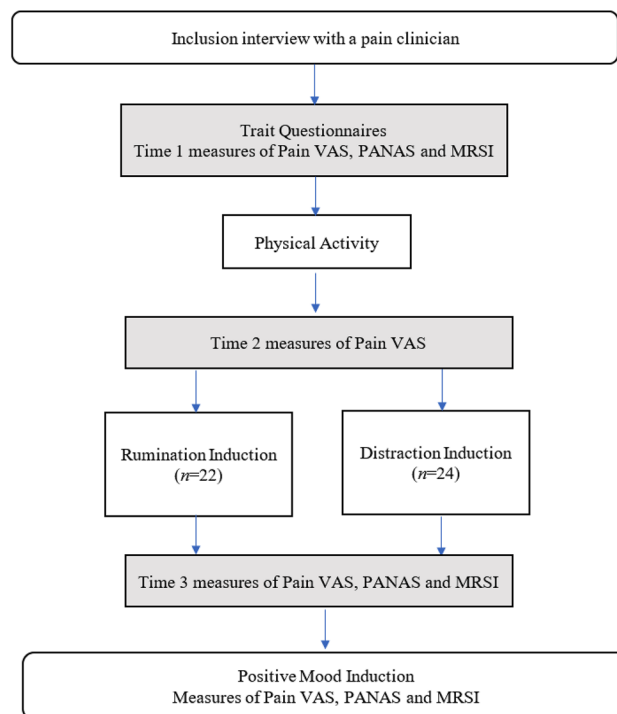


Figure 1. Schematic procedure flow. *Note:* Pain Vas – Pain Analogue Visual Scale ; PANAS – Positive and Negative Affect Schedule, MRSI – Momentary Rumination State Inventory.

The inclusion criteria were as follows: meeting the FM ACR 1990 criteria¹, with stable treatment for at least 1 month, ability to understand and read French. The exclusion criteria were: being deprived of liberty or being a protected adult (under guardianship or curatorship), suffering from psychosis or severe depression or severe anxiety, or being characterized by impulsivity disallowing given participant to complete the questionnaires or take part in the study, according to the clinician's assessment.

Participants were randomly assigned to two experimental groups: a rumination induction group ($n = 22$; 20 women; mean time from the FM diagnosis in years = 5.18, $SD = 5.05$; mean education level in years after obtaining A level = 1.77, $SD = 0.81$) and distraction induction group ($n = 25$; 24 women; mean time from the FM diagnosis in years = 6.64, $SD = 5.20$; mean education level = 1.76, $SD = 0.72$). The two groups did not differ in age ($t_{(45)} = -0.652$, $p = 0.518$), time from the diagnosis of FM in years ($t_{(45)} = -0.972$, $p = 0.336$) or in education level ($\chi^2_{(2, N=47)} = 0.81$, $p = 0.451$). There was no significant difference between the two groups in terms of tendency for rumination ($t_{(45)} = 0.25$, $p = 0.803$), in terms of anxiety ($t_{(45)} = 0.57$, $p = 0.573$), in level of depression ($t_{(45)} = 0.06$, $p = 0.961$), or disability related to FM ($t_{(45)} = -1.5$, $p = 0.132$). Descriptive statistics for each group are presented in the Table 1.

Patients were recruited during a standard consultation with their pain physician (being also a psychiatrist) at the pain consultation unit of the Amiens Hospital Center, France. The whole recruitment was performed by one practitioner. Each patient fulfilling the inclusion criteria was systematically invited to participate in the study by the investigator. The study was run by two investigators—clinical psychologists. Before any examination related to the research, the investigator provided all the necessary information about the study and answered potential questions concerning the objective, nature, and constraints of the research. He/she also clarified patient rights and verified eligibility criteria. Before starting the experiment, the informed consent was obtained from all participants and a copy of the information note and consent form was given to each participant.

Variable	Rumination induction group	Distraction induction group
	Mean (SD)	Mean (SD)
Age	49.77 (8.32)	51.32 (7.95)
Rumination (PTQ)	23.95 (10.02)	23.20 (10.49)
Anxiety (HADS)	13.00 (3.95)	12.32 (4.22)
Depression (HADS)	9.95 (3.93)	9.88 (4.26)
Disability related to FM (FIQ)	49.23 (12.78)	54.25 (9.61)

Table 1. Descriptive statistics of questionnaire measures and age for each experimental group. *PTQ* Perseverative Thinking Questionnaire, *HADS* Hospital Anxiety and Depression Scale, *FIQ* Fibromyalgia Impact Questionnaire, *FM* Fibromyalgia.

After inclusion, participants were randomly assigned to one or other study group (Rumination group; Distraction group). This randomization was conducted by one of the collaborating members according to a randomization list generated randomly with an algorithm created using MS Excel software. The investigator had no access to this randomization at any time.

First, the participants filled in trait questionnaires in order to control for baseline group differences in trait tendency to ruminate (PTQ^{42,43}), disability related to FM (FIQ^{44,45}) anxiety and depression (HADS^{46,47}). After filling in the questionnaires, participants filled in a baseline measure of Pain on visual analogue scale (VAS) and affect and they underwent pain activation by performing physical activity. After reevaluating pain, they underwent rumination vs. distraction induction followed by the same state measures as in Time 1. It is important to note that in Time 2 only measure of Pain was performed in order to reduce the number of measures and shorten the gap between pain activation and rumination induction. The procedure flow is presented in Fig. 1.

After the final measures, participants underwent a positive mood induction procedure (by presentation of positive images from the International Affective Picture System⁴⁸). This induction was not a part of the experiment and was performed for ethical reasons in order to restore positive affect. A new evaluation of pain and affect was performed in order to check whether those variables' level returned to baseline (this measure was not included in the analysis).

It is important to underline that the distraction vs. rumination induction procedure did not allow for double-blind work. The differences between distraction and rumination were possible to identify by the investigator performing the experiment from the start of rumination vs. distraction induction. To ensure a form of blinding for the patients, they were informed that we were testing pain regulation strategies without the strategy they were using being explicitly named and they were not aware of the strategy of the other group. In addition, the instructions were given in such a way as not to imply that one strategy was more effective than the other.

Materials

Trait questionnaires

Perseverative thinking questionnaire^{42,43}

The trait tendency to use rumination was assessed through a 15-item Perseverative Thinking Questionnaire. The scale measures ruminative thoughts, regardless of their content, from a transdiagnostic perspective (e.g., "My thoughts repeat themselves"). Participants responded on a five-point Likert scale, from "0" (never) to "4" (almost always). The total score range between 0 and 50. A higher score on PTQ reflects a higher level of rumination. The internal consistency of the scale in the present study was excellent ($\alpha = 0.95$).

Fibromyalgia impact questionnaire^{44,45}

To assess disability related to FM, the Fibromyalgia Impact Questionnaire was used. It is a valid instrument for measuring the impairment associated with FM in the daily lives of patients. Items in the part 1 of the questionnaire (item 1a to 1j) exploring functional abilities ranged from 0 to 3 (the average of the questions to which the patient answered). Patients responded on a Likert scale from 0 (always) to 3 (never) assessing their ability to perform given activity during the previous week. (e.g., "during the last week, could you do the market?"). In part 2 (items 2 and 3) patients reported the number of days they felt well and the number of days they missed work during the previous week. In the part 3 (items 4 to 10) patients are asked to report their current condition (e.g., "over the past seven days how much pain did you have?") on the visual analogue scales of 10 cm. The total score ranges from 0 to 100. A higher score on the Fibromyalgia Impact Questionnaire reflects a higher level of functional disabilities related to FM. Internal consistency of the questionnaire in the present study was good ($\alpha = 0.84$).

Hospital anxiety and depression scale^{46,47}

The HADS enabled screening for anxiety and depressive disorders. It comprised 14 items rated from 0 (never) to 3 (almost always). HADS contained seven questions assessing anxiety (e.g., "I feel tense or upset") and seven assessing depression (e.g., "I'm in a good mood"). A higher score on each dimension reflected a higher level of anxiety or depression respectively. For each dimension the total score range between 0 and 21. Anxiety or Depression is considered clinically significant from the cut-off score of 11. Internal consistency was satisfactory for Anxiety ($\alpha = 0.77$) and for Depression dimensions ($\alpha = 0.80$).

Experimental measures and materials

Physical activity induction in ecological setting

Participants were asked to climb stairs at sustained pace, in the presence of a member of the research team/clinician who regularly assessed patient's pain intensity. The objective was to obtain an increase in pain of at least 10% on the VAS by engaging patients in moderate-intensity physical activity in an ecological setting as similar as possible to those patients experience in their daily lives. In agreement with the medical team of the hospital pain consultation unit, we estimated that a 10% increase in pain following this activity would be a good indicator of the significance of this activity. An additional limit of 6 floors was added after a pre-test performed on 10 participants. We had initially judged that going up one floor at a sustained pace would be enough to achieve this objective. However, we could see that, for the first 10 participants who served as a pretest, even if they considered the exercise physically significant, we only obtained the desired increase in pain intensity for 5 of them. After discussion with the research team and the medical team, we modified the task and instructed participants to continue to climb the floors until they reported a 10% increase or until they reached the 6th floor, the last floor of the hospital. This additional limit was set in order to avoid to continue indefinitely the task with patients who were already in pain at the baseline and which was deemed as a significant effort for FM patients by the medical

team. The participants therefore stopped physical activity when they reached an increase of at least 10% in their pain on the Pain Visual Analog Scale-intensity or when they had reached the sixth floor of the hospital.

Rumination versus distraction induction

The rumination induction, adapted from Nolen-Hoeksema and Morrow⁴⁹, in French version⁵⁰, was used to induce rumination vs. distraction. Participants were presented with a series of 15 sentences displayed on the screen, each for 40 s. The instructions differed depending on the experimental condition. In the rumination condition, participants were instructed to focus on the causes, consequences and signification of each of the sentences (e.g., “Analyze the causes, the consequences and the signification of the tension in your muscles”, “Analyze the causes, the consequences and the signification of the way you react”, “Analyze the causes, the consequences and the signification of how quick or slow your thinking is right now”). In the distraction condition, participants were asked to imagine a situation or an object (e.g., “Imagine the shape of a large black umbrella”, “Imagine the layout of a typical classroom”). The full task lasted for 10 min in each experimental condition.

Positive and negative affective scale—state version^{51,52}

This 20-item scale in the French version distinguishes between three components: positive affect, anxiety and dysphoria. (e.g., “Right now, I feel interested”). Participants respond on a five-point Likert scale from 1 (not) to 5 (extremely), to a list of 20 adjectives describing affective states. Higher score on each dimension reflected higher positive affect, higher anxiety or higher dysphoria respectively. The total score on positive affect ranged from 10 to 50 and on dysphoria and anxiety from 5 to 25. Internal consistency for the PANAS dimensions (was satisfactory at all three measurement times (ranging from: $\alpha = 0.79$ to $\alpha = 0.92$).

Pain visual analogue scales

Visual Analogue Scales (VAS) were commonly used in research and clinical practice to assess pain in patients. In the present study VAS for the intensity of pain (VAS-intensity) and a VAS for the emotional discomfort linked to pain (VAS-discomfort) scales were used³⁷. Intensity and discomfort linked to pain were reported by participants on a 100 mm (coded a posteriori from 0 to 100) scale where the highest score indicates that the pain is judged to be the most intense or causing the highest possible discomfort.

Momentary ruminative self-focus inventory (Mor, Marchetti & Koster, unpublished manuscript, 2013)

In this 6-item questionnaire assessing the use of state rumination in a given context, participants responded on a 7-point scale from “strongly disagree” to “strongly agree” To assess their current level of rumination (e.g., “Right now, I am thinking about the possible meaning of the way I feel”). The total score ranges from 6 to 42. This scale was adapted and used in a French population³⁸. The internal consistency was good at both measurement times (respectively: $\alpha = 0.85$, $\alpha = 0.88$).

Statistical analysis plan

First, we checked whether the pain activation procedure had a similar effect in both groups by performing a two-way mixed-design ANOVA 2 (experimental group: distraction, rumination) \times 2 (measure time: 1—baseline, 2—after physical activity) on both Pain VASs.

In order to test the rumination vs. distraction induction on pain we planned to perform a two-way mixed-design ANOVA 2(experimental group: distraction, rumination) \times 2(measure time: 2—after physical activity, 3—after experimental induction). In order to check this effect on affect, we computed a two-way mixed-design ANOVA 2(experimental group: distraction, rumination) \times 2(measure time: 1—baseline, 3—after experimental induction). Additionally, a two-way mixed-design ANOVA 2 (experimental group: distraction, rumination) \times 2 (measure time: 1—baseline, 3—after experimental induction) was computed on the MRSI score in order to check the efficiency of experimental manipulation in inducing rumination. The significance threshold was set at $p < 0.05$. All the post-hoc comparisons were performed with Bonferroni correction for multiple testing. The descriptive statistics for dependent variables are presented in Table 2.

Variable	Rumination induction group			Distraction induction group		
	Mean (SD)			Mean (SD)		
	Time 1	Time 2	Time 3	Time 1	Time 2	Time 3
Pain VAS- intensity	47.27(26.76)	61.23(24.09)	50.77 (28.56)	51.24 (22.27)	61.75(22.04)	39.60 (20.25)
Pain VAS—discomfort	44.23(27.94)	60.36(27.92)	51.23 (29.89)	60.72(24.79)	65.00(25.03)	43.16 (26.19)
Affect- positive (PANAS)	25.68(6.27)	–	26.41 (7.01)	28.24(6.27)	–	30.24(6.38)
Affect- anxiety (PANAS)	11.63(5.67)	–	11.09 (5.32)	10.76(5.02)	–	9.20 (5.18)
Affect- dysphoria (PANAS)	10.09 (5.76)	–	9.95 (5.09)	7.76 (4.13)	–	8.04(5.26)
State rumination (MRSI)	24.50 (9.71)	–	24.41(10.25)	24.60(8.93)	–	23.48(9.96)

Table 2. Descriptive statistic – mean and standard deviation for pain, affect, and state rumination measured at time 1, 2 and 3 for each group. Pain Vas—Pain Analogue Visual Scale; PANAS—Positive and Negative Affect Schedule, MRSI—Momentary Rumination State Inventory.

Results

The effect of physical activity–manipulation check of pain activation procedure

The mixed design ANOVA with VAS-intensity scores as the dependent variable revealed a significant main effect of time (1—baseline vs. 2—post physical activity) ($F(1, 44) = 13.75, p < 0.001, \eta^2 = 0.238$), but the time by group interaction effect was not significant ($F(1, 44) = 0.366, p = 0.549$) suggesting that after physical activity pain intensity increased similarly in both groups. It is important to underline that at this stage of the experiment both groups underwent exactly the same procedure (see Fig. 1, measure time 1 and 2). Similar effects were observed for discomfort linked to pain, with the significant effect of time ($F(1, 44) = 4.718, p = 0.035, \eta^2 = 0.097$) and non-significant effect of interaction ($F(1, 44) = 1.604, p = 0.212$).

The effect of rumination versus distraction on pain intensity and discomfort linked to pain

The mixed design ANOVA with VAS-intensity scores as the dependent variable and induction group (rumination vs. distraction) and measure time (measure time: 2—after physical activity, 3—after experimental induction) revealed a significant main effect of time ($F(1, 44) = 31.701, p < 0.001, \eta^2 = 0.419$). The main effect of the group variable was not significant ($F(1, 44) = 0.747, p = 0.392$). However, we observed a significant interaction effect between measure time and experimental group ($F(1, 44) = 4.27, p = 0.045, \eta^2 = 0.089$). It seems that both induction groups reported a drop in pain intensity, but it was greater among the participants using distraction. The interaction effect with significance level and confidence interval for each slope is presented in Fig. 2a. Similar results were found for discomfort linked to pain, with a main effect of time ($F(1, 44) = 22.712, p < 0.001, \eta^2 = 0.340$) and significant interaction effect ($F(1, 44) = 4.356, p = 0.043, \eta^2 = 0.090$). It seems that only participants using distraction, not rumination, reported a significant decrease in discomfort linked to pain. The interaction effect with significance level and confidence interval for each slope is presented in Fig. 2b. The main effect of group was not significant ($F(1, 44) = 0.118, p = 0.733$).

Effect of rumination versus distraction on affect

The mixed-design 2(experimental group: distraction, rumination) \times 2(measure time: 1—baseline, 3—after experimental induction) ANOVA with general negative affect as dependent variable revealed a non-significant main effect of time ($F(1, 45) = 0.736, p = 0.396, \eta^2 = 0.016$). Contrary to our prediction, the main effect of group and interaction effects were also not significant ($F_s < 1, p > 0.05$). The ANOVA with negative affect—anxiety also revealed a non-significant effect of time ($F < 1, p > 0.05$), the effect of group and interaction effect were neither significant ($F_s < 1, p > 0.05$). Similar results were found for negative affect—upset, with non-significant main effect of time, group or interaction effect ($F_s < 1, p > 0.05$). The ANOVA with the positive affect as outcome revealed no significant main or interaction effects ($F_s < 1, p > 0.05$).

The effect of induction on state of rumination

In order to test the experimental manipulation, we performed a mixed-designed ANOVA with MRSI score as outcome. Contrary to our expectation, the interaction effect of time and experimental group was not significant ($F_s < 1, p > 0.05$) which indicates that the change in state rumination between pre and post induction measure did not differ in rumination and distraction group.

Discussion

According to the partial model of rumination in pain¹⁸, rumination is causally involved in the maintenance of pain and associated negative affect. One way to break the circle of self-sustaining pain at the cognitive level would be to reduce rumination by engaging in distraction activities that take ones' attention away from pain¹⁸.

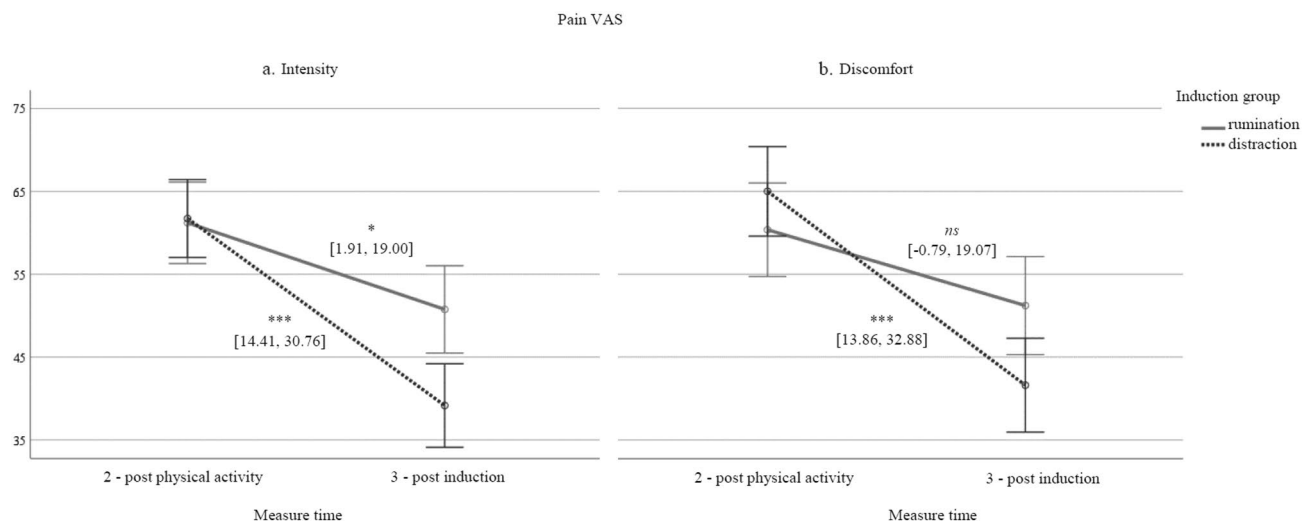


Figure 2. The effect of rumination versus distraction induction on pain intensity and discomfort. *Note:* ** $p < .05$, *** $p < .001$, ns – not significant; 95% confidence intervals are presented in square brackets.

Ruminative thinking might also be one of the processes maintaining avoidance behavior in FM patients⁵³. Although the link between rumination and FM is already described in the literature (for a review see:²⁰), very little attention has been paid to this process in empirical research in the context of chronic pain, and most of that research has been based on correlational (e.g.,⁵⁴), longitudinal (e.g.,^{55–57}) or qualitative studies (e.g.,¹⁹). Thus, the aim of this study was to experimentally test how rumination induction versus distraction induction impact the evolution of pain and affect in FM patients.

The results of this study provide empirical support for the partial model of rumination¹⁸. We observed a differential effect of rumination and distraction induction on the change in pain patterns, for both pain intensity and discomfort linked to pain. After performing a physical activity triggering pain, followed by the rumination vs. distraction induction procedure, participants who used distraction report a decrease in pain intensity and discomfort. This effect is significantly lower (for pain intensity) or not observed (for pain discomfort) in the rumination induction group. In other words, rumination interferes with recovery after physical activity in terms of subjective pain, as compared to patients using distraction. These results not only support the partial model of rumination in chronic pain, but are also in line with the literature describing the effects of distraction in pain³². However, one interesting result of our study is the lack of effect of rumination vs. induction procedure on patients' affect (both positive and negative). The results of our induction procedure on pain and affect taken together are particularly appealing when compared to the results of an experimental study by Brookes et al.⁵⁸. They tested the effect of an experimental procedure of rumination versus distraction induction similar to the one used in the present study, on the attentional patterns of undergraduates students who received a threat-inducing information about the cold pressor task⁵⁹. The result suggests that in the trials with shorter exposition, rumination induces a bias toward stimuli linked to pain, while in the trials with longer exposition, it induces experiential avoidance behaviors. These results, alongside the rumination and FM literature, might explain why, on the one hand, rumination might increase the subjective experience of pain through attentional focus on interoceptive stimuli, while on the other hand it does not necessarily have to increase short term negative affect due to its experiential avoidance function. The attentional scope model of rumination⁶⁰ suggest that individuals engaging in ruminative process will struggle to disengage attention from the rumination content. Additionally, a group of studies have already shown that FM is also linked to attentional biases toward pain stimuli^{61–63} and that trait rumination might modify the treatment of pain stimuli also in non-clinical population²¹. Moreover, the FM literature provides some evidence that pain itself might be linked to avoidance tendencies^{31,64}. In the present study, rumination at the same time may operate at an overly general, abstract level of processing and might disconnect the patient from their direct emotional experience, even though it is still focused on negative content—pain significance and its consequences^{28,29}. This overgeneralization might result in short-term emotional relief, but it also deregulates long-term emotion regulation. In sum, rumination might enclose FM patients in a vicious circle where their attention is sustainably focused on pain stimuli and experience, but at an overly general level, preventing the use of adaptive emotion regulation strategies.

Beyond the aforementioned results, this study was also an opportunity to test the feasibility of an ecological pain activation procedure. This procedure has never been used in the fibromyalgia field. Activating pain to understand its evolution and mechanisms is not a new idea in research. Classically, such activation is conducted using standardized laboratory procedures, for example an activation of C-fibers by thermodes, of A-Beta fibers by pressure⁶⁵, by repeating localized nociceptive stimulation⁶⁶ or by the classical cold pressor task⁵⁹. While pain activation methods may be essential to understand the neurological mechanisms involved in the processing of nociception, such laboratory procedures nevertheless do not reflect chronic pain patients' everyday life experience, in particular, because they lack an appropriate ecological context. In this study, in order to enable patients to process the pain experience at the cognitive level in ecological setting, we used an everyday-life activity that patients do regularly at home, while working, shopping, etc. All participants who agreed to participate in the research were compliant and completed the task, either until their initial pain increased by 10% or until they reached the sixth floor. We did not record any dropouts. This physical activity allowed a significant increase in pain in our two groups. We did not record any adverse events during our procedure. This is therefore an ecological activity, accessible and easy to set up in a clinical situation, which makes it possible to activate pain without using laboratory equipment.

One of the limitations of the present study is that the measure of rumination (MRSI) did not show any significant differences between the distraction and rumination groups, in spite of the differences reported by participants in their subjective pain intensity and discomfort. One possible explanation for this unexpected result is the choice of the Momentary Ruminative Self-focus Inventory. Although this scale was cited in previous studies as a tool for measuring state rumination^{67–70}, its validation has never been published. The tool was published in a modified version as the Brief State Rumination Inventory—BSRI⁷¹, but unfortunately the data collection in our present study had started prior the publication of BSRI. An alternative relevant solution might also be to use recently validated items assessing rumination in an ecological momentary assessment setting⁷².

The absence of a control group accounting for the spontaneous recovery of pain is also a significant limitation of the present study. It constrains the drawing of conclusions on the causal role of rumination in the maintenance of pain, particularly taking into account that distraction is suggested to have a positive effect on pain recovery³². It remains therefore unclear whether rumination really impairs pain recovery or that distraction is an effective method of coping with pain. However, such a control group seems difficult to design, especially given that one can hypothesize that, if left without any precise instruction, patients will use their habitual regulation strategy. Thus, designing a passive control group for this kind of experiment is challenging, and should definitely be the subject of reflection for further studies. Moreover, one of the challenges in the study design was to reduce the amount of cognitive activities (e.g., questionnaires to fill in) between physical activity and rumination vs. distraction induction. Thus, we do not have the data on patients' affect just after physical activity induction and cannot evaluate whether patients' emotional reactivity to physical activity impacts further use of rumination or distraction. It

would be interesting to consider in future studies alternative methods of evaluating affect that would interfere less with rumination induction, for example passively collecting psychophysiological data.

Additionally, it would be interesting, in further studies, to take into account not only the maladaptive, abstract form of rumination, but to also test the impact of an adaptive concrete experiential rumination processing mode on pain^{73,74}. In line with the processing mode theory⁷³, some studies have experimentally shown that abstract versus concrete rumination might have a differential impact on affect and emotion regulation^{50,74}. Testing this hypothesis in the FM context would be particularly appealing in the light of the lack of a significant impact of the induction procedure on affect in the present study. We can hypothesize that this lack might be linked to emotional avoidance, thus, testing also concrete experiential processing mode might provide an interesting insights into the role of avoidance in FM. Testing the adaptive rumination mode or comparing maladaptive rumination to other strategies, e.g. relaxation, might be also crucial in the perspective of the studies suggesting that distraction, in the long term, can become problematic in chronic pain, as it can also be seen as an avoidance/escape strategy^{13,30}.

Despite these limitations, the results obtained are relevant from a clinical point of view and suggest that addressing ruminations in FM treatment could have a direct effect on pain level, but also on avoidance behaviors. Thus, rumination-focused treatments⁷⁵ could be potentially adapted for the management of pain and its comorbidities in FM—particularly given that a key element in FM treatment is to gradually restart an appropriate physical activity. Russel et al.¹² underlined that FM patients may find themselves in great difficulty facing this activity resumption, which may be associated with a feeling of loss and decreased self-efficiency. The feeling of loss results from the perceived discrepancy between their current condition and their past abilities. The perception of this gap is hypothesized to trigger rumination processes according to control theory^{28,76}. Additionally, some studies suggest that kinesiophobia is also linked to a higher level of rumination¹¹. Therefore, it seems necessary to support the resumption of physical activity in FM by also anticipating the risk of engaging in rumination which could alter the physical activity benefits, but also patients' self-efficiency. Moreover, underlining the role of cognitive processes when training teachers of adapted physical activity could limit the risks of post-activity rumination and potentially reduce avoidance mechanisms. This path seems particularly promising considering that the first study testing Rumination-Focused Cognitive Behavioral Therapy in chronic pain patients (chronic low back pain) suggests that it might reduce depression, anxiety and pain severity⁷⁷.

In conclusion, participants with FM who engage in a process of rumination following a physical activity seem to recover less from their pain experience compared to those who engage in a distracting activity. These results endorse Edwards' partial model of ruminations in pain¹⁸, which highlights the causal role of rumination in the development and maintenance of pain and its comorbidities. If this causality is confirmed in larger studies, psychological and physical FM treatment will have to evolve to better take into account this cognitive process of pain maintenance.

Data availability

The datasets generated and analysed during the current study are available from the corresponding author, MK.

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Conception or design of the work : J.F., M.K., E.S., T.K., V.M., S.R.; data collection : J.F., E.S., V.M., N.R., data analysis and interpretation : M.K., T.K., J.F., drafting the article : M.K., J.F., E.S.; critical revision of the article : S.R., L.J., T.K., final approval of the version to be published : J.F., M.K., ES, TK, VM, SR, LJ, NR.

Competing interests

The authors declare no competing interests.

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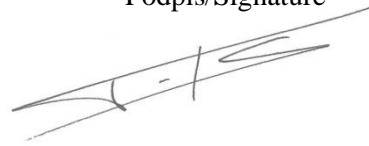
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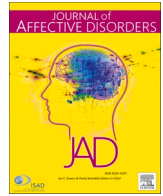
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Research paper

The bidirectional associations of rumination with values-based action and depression among young adults in the school-to-work transition

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ABSTRACT

Background: School-to-work transition is crucial for young adults, requiring them to maintain their values-based action, even though this task is likely to cause rumination associated with depression. In the HEXAGoN model, individuals with rumination tend to engage in abstract-analytic thought (AAT) but not in concrete-experiential thought (CET). Although this inflexible style of thought is assumed to decrease values-based action and increase depression, no empirical research has examined these relationships in young adults during their transition period. Therefore, this study examined the bidirectional relationships between AAT, CET, depression, and values-based action in young adults.

Methods: A one-year five-wave longitudinal survey was conducted on 756 third-year university students who engaged in job searches in Japan. Cross-lagged panel model and random-intercept cross-lagged panel model were used to estimate the bidirectional relationships at the between-person and within-person levels, respectively.

Results: AAT and CET had bidirectional associations with depression and values-based action at the between-person level. Furthermore, CET decreased depression and marginally improved values-based action at the within-person level.

Limitations: The study comprised only university students in Japan and had a high attrition rate.

Conclusions: The findings suggest that CET can reduce depression and improve values-based action in young adults undergoing the transition. It may also expand the understanding of the treatment and prevention of depression in young adults.

1. Introduction

Depression is considered a major global problem, particularly during young adulthood (Ishikawa et al., 2016). Depressed young adults are at a high risk of developing clinical diseases and exhibiting poor academic performance in the future (Thapar et al., 2012). On the one hand, prior studies have revealed that some university students experience dysphoria (Jinnin et al., 2017). On the other hand, values-based action, which involves a practice aligned with one's values, might be considered a protective factor for the well-being of young adults as it is associated with their mental health, resilience, and life satisfaction (Christie et al., 2017).

While transitioning from an educational setting to a work environment, young adults are expected to achieve their transition tasks and maintain their values-based actions despite having to address negative moods (Pan et al., 2018; Sortheix et al., 2015). This transition might be stressful and cause negative affect as individuals are confronted with the discrepancy between their ideal and actual selves, evoking rumination (Martin and Tesser, 1996; Nolen-Hoeksema, 1991; Watkins and Roberts, 2020). Furthermore, rumination might increase the risk for depression and impair values-based actions. For instance, rumination accentuates negative emotional reactions to failure (Watkins et al., 2008). Ruminators are less likely to engage in values-based action (Martell et al., 2001), and are less successful in goal pursuit in general (Moberly and

Abbreviations: AAT, Abstract-analytic thought; CET, Concrete-experiential thought; CES-D, Center for Epidemiologic Studies Depression Scale; CFI, Comparative fit index; CLPM, Cross-lagged panel model; RI-CLPM, Random-intercept cross-lagged panel model; RMSEA, Root mean square error of approximation; SEM, Structural equation modeling; VQ, Value Questionnaire.

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Watkins, 2010).

1.1. Rumination during transition: explanation of the processing mode theory

Rumination is a psychological risk factor for mental health among young adults (Nolen-Hoeksema and Morrow, 1991). It refers to repetitive negative thoughts that focus on the abstract meaning, implications, and consequences of adverse events, the self, and feelings (Watkins, 2008). Rumination has been studied through various theories. First, the response style theory developed by Susan Nolen-Hoeksema (1991) focused mainly on rumination from a perspective of depression. She suggested that rumination is a response to depressive mood, characterized by focusing on one's low mood and depressive symptoms (Nolen-Hoeksema, 1991). Second, a substantial contribution in explaining the occurrence of rumination was brought by Martin and Tesser's control theory suggesting that rumination can be triggered by an actual-ideal self-discrepancy (Martin and Tesser, 1996). In further works, Watkins (2008) presented a distinction between abstract and concrete processing modes in rumination, showing that these processing modes might have opposite effects on emotional regulation, cognitive biases, and depressive symptoms (Moberly and Watkins, 2006; Watkins et al., 2008; Watkins and Moulds, 2005). Finally, the habit-goal framework sheds a new light on rumination maintenance despite its negative consequences by considering rumination as a robust and unintentional habitual response learned in goal-discrepancy contexts (Watkins and Nolen-Hoeksema, 2014). The literature also underlines the role of executive functioning in rumination, particularly attentional and inhibitory resources (e.g., Whitmer and Gotlib, 2013; Zetsche et al., 2018). Lately, these theories have been integrated into a model that explains rumination occurrence and maintenance—the HExAGoN model (Watkins and Roberts, 2020). The HExAGoN stands for the proximal factors that maintain and increase maladaptive rumination: H stands for habit, Ex for executive functioning, A for abstract processing style, Go for goal discrepancies, and N for negative biases. The previous theories and the HExAGoN model emphasize that rumination is a maladaptive thinking style triggered by negative or stressful events (particularly events when one perceives a discrepancy between the actual situation and one's goals, i.e., the “Go” in the model), which many young adults tackle during their transition phase. Additionally, the HExAGoN model stresses the importance of abstract processing style (i.e., the “A” in the model) and how rumination might become a maladaptive habit (i.e., the “H” in the model), which is particularly relevant for young adults in the transition period.

A wealth of research has been conducted using the perspective of these theories on how rumination occurs after adverse events and exacerbates depression. However, relatively little attention has been paid to testing why people engage in ruminative thinking despite being unhelpful to them (Watkins and Nolen-Hoeksema, 2014). Although the HExAGoN model is a theoretical attempt to answer this question, according to the authors not all the links between the factors causing and maintaining rumination (i.e., habit, executive functions, abstract processing mode, goal discrepancy, and negative valence) have yet been found empirically (Watkins and Roberts, 2020). For instance, although the model indicates the established causal association between abstract processing style and goal discrepancies, some aspects, such as the bidirectional association and longitudinal effect, have not been backed by sufficient empirical evidence. Nevertheless, the crucial role of abstract thinking has been highlighted in the model as it predicts rumination and goal discrepancy and rumination may become a maladaptive habitual emotional regulation strategy (Watkins and Roberts, 2020). The processing mode theory has argued that the distinction between abstract and concrete processing modes is the critical factor in explaining the unconstructive effect of rumination (Watkins, 2008). Based on the processing mode theory, the HExAGoN model hypothesizes that repetitive thoughts are divided into two types based on their processing

mode: abstract-analytic thought (AAT) and concrete-experiential thought (CET). AAT refers to evaluative thoughts focusing on the causes, meaning, implications, and consequences of one's life experiences (“why”-type thoughts; e.g., “Why did I get rejected at the last job interview?”). CET represents low-level, specific, and contextual thoughts (“how”-type thoughts; e.g., “At the last job interview, my expertise may not have been well conveyed to the interviewer.”) (Watkins, 2016, 2008).

The HExAGoN model highlights that AAT or CET is not maladaptive, but they should be flexibly used and adapted to the demands of a given situation (e.g., stressful events). High levels of rumination are characterized by excessive AAT use and infrequent CET (Nolen-Hoeksema et al., 2008). Individuals with frequent AAT often seek a general reason for facing adverse events, through abstract and evaluative thinking, and tend to focus on the negative aspects of the self, others, and events, which can lead to negativity biases (“N” in the HExAGoN model). Hence, they feel strong negative emotions and might have difficulty with constructive problem-solving due to the abstract, over general, and context-independent information processing (Watkins, 2016). Previous studies have confirmed that predominant AAT amplifies negative moods (Watkins et al., 2008), inhibits problem-solving behaviors (Kingston et al., 2014; Watkins and Moulds, 2005), and goal-strivings (Kambara et al., 2019a). Contrastingly, individuals with frequent CET think about how they face adverse events, focusing on their specific experiences and behaviors in these situations. Hence, they tend to find new insight into how they can solve situations and be relieved of negative self-evaluations (Watkins, 2016). Previous studies have revealed that individuals with high CET tend to regulate negative moods after stressful events (Watkins et al., 2008), improve problem-solving (Kingston et al., 2014; Watkins and Moulds, 2005), and goal-strivings (Kambara et al., 2019a). In summary, the processing mode is a helpful perspective to understand why young adults' thoughts about adverse events are related to adaptive versus maladaptive consequences.

1.2. Associations of AAT and CET with depression and values-based action

Young adults who graduate from university are required to make career-related decisions to begin their working lives. During this period, which is usually related to high goal discrepancy, they feel highly vulnerable and stressed. A good illustration of this burden is the phenomenon of *Hikikomori*, which is a form of severe social withdrawal likely to be observed in late adolescents (15–24 years old) facing the school-to-work transition (Koyama et al., 2010). Excessive social withdrawal in late adolescents can be viewed as a dropout state of the transition (Furlong, 2008) and is associated with poor mental health (Koyama et al., 2010) and unemployment rates (Nonaka and Sakai, 2021). Thus, the school-to-work transition is characterized by heightened vulnerability and potential for healthy growth. Additionally, the two might closely interact with AAT and CET. The present study focuses on depression and values-based action as crucial maladaptive and adaptive variables in this transition. Depression is a typical mental health problem that occurs due to adverse events during the transition period, inhibiting the progress of one's transition tasks (Crossley and Stanton, 2005; Pinquart et al., 2003). Existing studies suggest that AAT and CET may have bidirectional associations with depression. Prior longitudinal research has revealed that individuals who engage in rumination experience depression across adolescence and adulthood (Michl et al., 2013; Whisman et al., 2020). Meanwhile, recent evidence has shown that rumination increases subsequent negative moods (depressive moods) and vice versa (Blanke et al., 2021; Hjartarson et al., 2021). Within a negative context, individuals with high rumination seem to use AAT frequently and limit their use of CET (Watkins, 2008). Prior findings imply that AAT amplifies depression, while CET alleviates it and enhances adaptive emotional regulation in a stressful context. Furthermore, depression increases AAT and decreases CET. However, no

study has examined the bidirectional associations of AAT and CET with depression to the best of our knowledge.

We also address values-based action as a crucial variable in the school-to-work transition. Values-based action is the practice of living with values, an intrinsic behavior pattern capable of self-reinforcement (Christie et al., 2017). Young adults in the transition phase need to navigate decision-making about their careers by regulating their moods and goal-oriented behaviors based on their values. Thus, proactive values-based action plays an important role in successful transition (Ng and Feldman, 2007). A prior theory has indicated that value-based and goal-oriented actions might be related to thinking styles. According to the theory, goal discrepancy is a crucial factor in triggering rumination (Watkins and Roberts, 2020), and the ruminative processing mode might affect the goal progression and achievement. The level goal/action identification perspective suggests that individuals regulate their thinking style between abstractness and concreteness along with their values and goals (Watkins, 2011). Moreover, according to the action identification theory, this regulation might depend on the difficulties that an individual faces in realizing a given goal (Vallacher and Wegner, 1987). For instance, if people engage in complex, unfamiliar, or difficult goals, it is helpful for them to use a more concrete thinking style. However, individuals with inflexible regulation of the level of goal/action identification hold on to abstract thinking style, causing a stagnation of actions and lack of progression in goals. Thus, value-based actions may be influenced by abstract or concrete thinking styles or by the lack of flexibility in adapting the thinking style to the ongoing situation and staying on an abstract level, even when facing difficulties that require a switch to more concrete processing (Watkins, 2011). According to this perspective, previous evidence implies that AAT and CET may be related to values-based action in a bidirectional manner. For example, AAT may decrease values-based action as young adults with frequent AAT view adverse events as complex and uncontrollable (Kingston et al., 2014). Moreover, AAT impairs goal pursuit, particularly for the important goals (Moberly and Watkins, 2010). Meanwhile, CET may increase values-based action as young adults with frequent CET (used particularly in challenging situations) can modify negative emotional responses (Watkins et al., 2008) and engage in productive thinking about the action (Watkins, 2011). Although the effects of values-based action on AAT and CET are still unclear, individuals lacking the flexibility in switching between processing modes may have difficulty executing transition tasks and experience higher rumination due to the perceived goal discrepancy (Watkins and Roberts, 2020). Thus, proactive values-based action may negatively predict AAT and positively predict CET.

Revealing the bidirectional associations of AAT and CET with depression and values-based action can open a novel path for developing interventions based on thought processing modes. However, there is no research on these bidirectional relationships in young adults during the school-to-work transition. Additionally, recently researchers have emphasized that between- and within-person effects should be considered to fully understand longitudinal relationships (Orth et al., 2021). A positive effect of AAT on depression at the between-person level can indicate that individuals having higher AAT are likely to increase their subsequent rank order in the depression score. Meanwhile, at the within-person level, we can comprehend that individuals with a higher AAT than usual are likely to increase their depression scores. When both between- and within-person relationships are assumed, it is recommended to use approaches that assess both relationships accurately (Orth et al., 2021). Therefore, we examined the bidirectional associations of AAT and CET with depression and values-based action at both the between- and within-person levels.

1.3. Aims and hypotheses

This study aimed to examine the bidirectional associations of AAT and CET with depression and values-based action among young adults in

the school-to-work transition. We conducted a five-wave longitudinal survey and examined these relationships at the between- and within-person levels. The hypotheses of this study are as follows:

Hypothesis 1. AAT and CET would have a bidirectional relationship with depression. AAT would positively predict depression, while CET would negatively predict depression. Furthermore, depression would positively predict AAT and negatively predict CET. These results would be found at both the between- and within-person levels.

Hypothesis 2. AAT and CET would also have bidirectional associations with values-based actions. AAT would negatively predict proactive values-based action, whereas CET would positively predict proactive values-based action. Additionally, values-based actions would negatively predict AAT and positively predict CET. These results would be shown at both the between- and within-person levels.

2. Methods

2.1. Participants

Japanese university students, who were registered in the sample pool of an online research company in Japan (MyVoice Communications, Inc.; <https://www.myvoice.co.jp/>), were invited to participate in this study. The inclusion criteria were third-year students from four-year universities who planned to work after graduation. As the transition period to the labor market has been extended in Japan (Côté and Levine, 2015), most high school students (82.8 %) go for higher education (Ministry of Education Culture Sports Science and Technology in Japan, 2020). The proportion of those who entered the fourth year of university was the highest (53.7 %). Since the traditional employment system in Japan is characterized by the simultaneous recruitment of new graduates, many third-year university students attempt job searches. Thus, third-grade university students who plan to get a job after graduation reflect a large proportion of young adults in the school-to-work transition. We advertised participation by using the research company system.

Participants answered questionnaires five times, from November 2019 to November 2020, at three-month intervals. In the first wave (Time 1: T1), 756 students were recruited. The percentage of females was 78 % ($n = 597$), and the average age was 20.88 years ($SD = 0.63$). The number of participants was 335 in the second wave (Time 2: T2), 266 in the third wave (Time 3: T3), 218 in the fourth wave (Time 4: T4), and 170 in the fifth wave (Time 5: T5). The participants' residence areas were widespread in Japan. A total of 672 participants (88 %) had already started their job search at T1; 258 participants (77 %) at T2, 197 participants (74 %) at T3, 99 participants (45 %) at T4, and 47 participants (27 %) at T5 continued their job search. Many participants desired to work in private enterprises ($n = 441$), and some as government employees ($n = 82$), teachers ($n = 44$), medical staff ($n = 23$), and others ($n = 82$). A total of 328 participants (43 %) seemed to have clinically relevant depressive symptoms as they had higher scores on the depression scale (see below details of the scale) than the cut of scores (over 21 points) referred from a previous study examining a good trade-off cutoff ratio related to the clinical diagnostic interview scores (Henry et al., 2018). Respondents who answered T1, T3, and T5 of the present study were the same sample as that in Hihara et al. (2022).

We explored the impact of missingness in two steps. First, we conducted a series of t -tests to compare the scores of the main variables at T1 between participants who completed the questionnaires at all measurement waves and those who did not. There were no significant differences in the main variable scores except for CET, but the effect size for CET was small [$t(754) = 2.24, p = .02, d = 0.25$]. Second, we conducted the Missing Completely at Random test to examine the type of missingness (Little, 1988). This test suggested that the type of missingness was completely random ($\chi^2(1978) = 2026.71, p = 1.000$), indicating that missing values may not influence our results. Nevertheless, we conducted a primary analysis using full information maximum

likelihood parameter estimation to compute robust predictions against missing values (Muthén and Muthén, 2017).

2.2. Procedure

We collected data from an online research company. Registrants of this company database who met the present study's criteria (i.e., third-grade university students planning to get a job after graduation) received research invitations by e-mail. All participants were informed of this study's aims, methods, and ethical considerations. Only those who approved, answered the questionnaires using the web-based form from November 2019 to November 2020, at three-month intervals. They received a reward for each question answered, which was 60 JPY (approximately US\$ 0.5). The research protocol and procedures were approved by the Ethics Committee of Graduate School of Education, Hiroshima University.

2.3. Measures

2.3.1. Mini-CERTS Japanese Version-Revised (CERTS-J-R)

This scale was originally developed by Douilliez et al. (2014). Its Japanese version was developed and validated by Kambara et al. (2019a). This scale measures two dimensions of processing modes: AAT (item example: “My thinking tends to get stuck in a rut, involving only a few themes”) and CET (item example: “I can grasp and respond to changes in the world around me without having to analyze the details”). The factor structure, internal consistency, and criterion validity of this scale have been confirmed in previous studies (Kambara et al., 2019b). Each scale item is rated on a four-point scale (1 = *almost never*, 4 = *always*). The subscale scores range from 6 to 24. High scores on the AAT and CET subscales indicate a high tendency to engage in each type of thinking.

2.3.2. Center for Epidemiologic Studies Depression Scale (CES-D)

Depression was assessed using the Japanese version of the CES-D (Radloff, 1977; Shima et al., 1985). The CES-D comprises 20 items that assess depressive symptoms (item example: “I was bothered by things that usually don't bother me.”). Participants answered each item by how frequently they experienced a particular symptom in the last seven days. Response options ranged from zero (“rarely or none of the time; less than one day”) to three (“most or all of the time; five to seven days”). Total scale scores ranged from 0 to 60, with a higher score indicating more depressive symptoms. This scale has demonstrated good validity in assessing depression (Umegaki and Todo, 2017).

2.3.3. Value Questionnaire (VQ)

This scale assessed the degree of values-based action during the past week (Smout et al., 2013). We used the Japanese version of this scale (Doi et al., 2017), which consists of ten items that ask how participants have engaged in values-based action and felt obstructed in the process. This scale is a seven-point Likert self-report instrument ranging from zero (“not at all true”) to six (“completely true”). The VQ has two subscales: progress consisting of five items assessing the extent to which participants conducted values-based action (item sample: “I worked toward my goals even if I didn't feel motivated to”); obstruction, involving five items measuring the extent to which participants performed behaviors that were not associated with their values (item sample: “I spent a lot of time thinking about the past or future, rather than being engaged in activities that mattered to me”). Subscale scores ranged from 0 to 30, with high scores indicating that individuals had high progress for their values-based action or felt obstructions. The VQ has demonstrated clinical validity, wherein interventions for improving valued behavior significantly changed the scores of this scale (Levin et al., 2020).

2.4. Statistical analyses

We tested our hypotheses using structural equation modeling (SEM) through Mplus 8.5 (Muthén and Muthén, 2017). The analytic code for Mplus is allocated to the supplementary materials (Open Science Framework at https://osf.io/czs62/?view_only=3a210f85818c4f838df42fafefc9cb85). To examine the bidirectional associations of processing mode (AAT and CET) with depression and values-based action at both between- and within-person levels, we estimated a Cross-Lagged Panel Model (CLPM) and a Random-Intercept Cross-Lagged Panel Model (RI-CLPM). First, to examine bidirectional relationships at the between-person level, we conducted the CLPM, including AAT, CET, depression, and VQ subscales of progress and obstruction. As shown in Fig. S1, each observed variable from T1 to T5 was included in this model. We estimated stability paths (auto-regression paths of all main variables), cross-lagged paths (effect paths of variables on other variables at the next wave), T1 correlations, and correlated changes (correlations among residuals of each variable across T2 to T5). Moreover, we set control paths of age, gender (0 = women, 1 = men), and status of job seeking (0 = those who were not engaged in job seeking, 1 = those who were engaging in job seeking) at T1 for the study variables. In CLPM, the cross-lagged effect means that when individuals have a relatively higher (lower) score on one variable than others, they subsequently show a rank-order change in score on another variable compared to others (Orth et al., 2021).

Second, we conducted the RI-CLPM using the same CLPM variables. As shown in Fig. S2, this model differs from CLPM as it includes random intercepts, which capture individual differences in trait level scores in the study variables across all measurement points. Thus, this model can capture within-person effects by examining whether within-person deviation from the trait levels of the study variables predicts changes in within-person deviation from the trait levels of other variables (Hamaker et al., 2015). In RI-CLPM, the cross-lagged effect means that when individuals show higher (lower) scores in one variable than their own trait level scores, they exhibit a subsequent within-person change in another variable (Orth et al., 2021). To make the CLPM and RI-CLPM as parsimonious as possible, we compared two models (Orth et al., 2021). The first model unconstrained all stability and cross-lagged paths between different time points, whereas the second model constrained all stability and cross-lagged paths to be equal between different time points. The criteria for optimal model fitting scores were a Comparative Fit Index (CFI) higher than 0.90 and a Root Mean Square Error of Approximation (RMSEA) lower than 0.08 (Hooper et al., 2008). Furthermore, the unconstrained and constrained models were compared using the Satorra-Bentler scaled chi-square difference test (Satorra and Bentler, 2001) and differences in CFI and RMSEA. Significant differences among models were confirmed when the following criteria were matched: a statistically significant result of the Satorra-Bentler scaled chi-squared test at $p < .05$, $\Delta CFI \geq -0.010$, and $\Delta RMSEA \geq 0.015$ (Chen, 2007).

3. Results

3.1. Descriptive statistics and model comparisons

Table 1 presents the means and standard deviations of the study variables from T1 to T5. To examine the relationship between demographic variables (i.e., gender, age, and job search states) and our main variables, we computed the correlation coefficients among these variables at T1. The analyses showed that job search states were positively correlated with AAT but had a small effect size ($r = 0.088$; $p = .015$). No other significant correlations were observed. We also computed the correlations among the main variables at each wave. The results are presented in Table 2.

Before our primary analyses, we compared the model fits of the unconstrained and constrained models for CLPM and RI-CLPM. For both

Table 1
Descriptive statistics across Time 1 to Time 5.

	Time 1		Time 2		Time 3		Time 4		Time 5	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
AAT	14.63	3.79	14.17	3.86	14.12	3.92	14.32	3.85	14.02	3.69
CET	14.12	3.49	13.69	3.69	13.52	3.66	13.24	3.39	13.23	3.67
Depression	19.87	10.09	20.10	10.00	21.27	10.64	20.62	10.26	20.68	10.24
Progress	20.39	5.91	20.21	5.96	20.29	6.07	19.84	5.34	19.74	5.66
Obstruction	21.06	4.84	20.71	4.73	20.57	4.39	20.38	4.00	20.45	4.08

Note. AAT = abstract-analytic thoughts; CET = concrete-experiential thoughts.

the CLPM and RI-CLPM (see Table 3), the constrained model did not make the model fit worse than the unconstrained model and showed acceptable model fits. Therefore, we selected the constrained models for CLPM and RI-CLPM as the most parsimonious ones.

3.2. The bidirectional effects in CLPM

To examine bidirectional associations at the between-person level, we conducted the CLPM (see Fig. 1). All path coefficients and correlation values are listed in Tables S1 and S2, respectively. Regarding the bidirectional associations of AAT and CET with depression, AAT positively predicted depression ($\beta = 0.175, 0.165, 0.175, \text{ and } 0.175; ps < .01$), and depression positively predicted AAT ($\beta = 0.177, 0.188, 0.188, \text{ and } 0.180; ps < .01$). Meanwhile, CET showed a marginal negative prediction of depression ($\beta = -0.058, -0.056, -0.061, \text{ and } -0.057; ps < .10$), while depression positively predicted CET ($\beta = 0.147, 0.140, 0.164, \text{ and } 0.153; ps < .01$).

With regard to the bidirectional associations of AAT and CET with values-based action, while AAT negatively predicted VQ-progress ($\beta = -0.151, -0.158, -0.174, \text{ and } -0.171; ps < .01$), VQ-obstruction positively predicted AAT ($\beta = 0.087, 0.081, 0.081, \text{ and } 0.071; ps < .01$). On the other hand, CET positively predicted VQ-progress ($\beta = 0.241, 0.261, 0.295, \text{ and } 0.270; ps < .01$). Similarly, VQ-progress positively predicted CET ($\beta = 0.204, 0.201, 0.212, \text{ and } 0.191; ps < .01$). In contrast, CET positively predicted VQ-obstruction ($\beta = 0.090, 0.101, 0.120, \text{ and } 0.110; ps < .05$). In summary, we found that AAT and CET have bidirectional relationships with depression and values-based action at the between-person level.

3.3. The bidirectional effects in RI-CLPM

We conducted RI-CLPM to examine bidirectional relationships at the within-person level (see Fig. 2). All path coefficients and correlation values are presented in Tables S3 and S4. Regarding the bidirectional associations of AAT and CET with depression, inconsistent with the results in CLPM, we found only the influence of AAT and CET on depression. AAT marginally exacerbated depression ($\beta = 0.099, 0.097, 0.110, \text{ and } 0.102; ps < .10$), whereas CET decreased depression ($\beta = -0.156, -0.160, -0.176, \text{ and } -0.147; ps < .01$). Moreover, with regard to the bidirectional associations of AAT and CET with values-based action, CET marginally improved VQ-progress ($\beta = 0.089, 0.100, 0.119, \text{ and } 0.101; ps < .10$), while VQ-obstruction marginally increased AAT ($\beta = 0.104, 0.098, 0.089, \text{ and } 0.079; ps < .10$). In summary, our findings at the within-person level highlighted the positive effects of CET on the improvement of depression and values-based action rather than bidirectional relationships.

4. Discussion

Young adults engaging in school-to-work transition tasks have a high risk of developing depression (Ishikawa et al., 2016). Furthermore, they have a high potential to guide their lives based on their values-based action. The present study examined how these (mal)adaptations occur based on the processing mode theory (Watkins, 2008), which focuses on

the balance and flexibility between AAT and CET. Preliminary evidence suggested that bidirectional associations of AAT and CET with depression and values-based action might play significant roles in performing transition tasks. However, no previous study has examined their interplay. Clarifying these associations helps understand the high rate of depression in this period and might enhance practical support provided to young adults in transition tasks. Hence, we examined these bidirectional associations using five-wave longitudinal data from Japanese university students involved in job hunting. AAT and CET were bidirectionally associated with depression at the between-person level. However, while AAT predicted increasing and CET decreasing depression at the within-person level, depression did not predict AAT or CET. Meanwhile, CET increased subsequent values-based action at both levels, whereas AAT decreased values-based action at the between-person level but not at the within-person level. In sum, excessive AAT and less CET are factors that exacerbate depression during the transition. Moreover, increasing CET during this period may help maintain values-based action.

4.1. The bidirectional associations of AAT and CET with depression

Regarding the relationships between AAT and depression, we found bidirectional associations at the between-person level. In other words, young adults with higher AAT showed more severe depression than other young adults, and vice versa. However, the bidirectional associations between AAT and depression were dismissed at the within-person level. Young adults who had increased AAT had intensified subsequent depression. Thus, this study provided robust findings, revealing that increasing the AAT may exacerbate depression during the transition period.

Considering the relationships between CET and depression, CET had partial positive bidirectional associations with depression at the between-person level which was inconsistent with our hypothesis and previous findings (Douilliez et al., 2014). In contrast, the results at the within-person level revealed that increasing CET predicts a subsequent decrease in depression. These conflicting results may reflect the between-person association of CET with depression, in which young adults who engage in frequent CET tend to feel depressed by facing discrepancies between their ideal and actual selves. Indeed, the RI-CLPM, which divides participants' within-person variance from between-person trait-level variance (random intercepts), revealed positive correlations between random intercepts of CET and depression ($r = 0.199, p = .002$). Thus, analyses at the within-person level showed that young adults who increase CET decrease subsequent depression.

AAT had positive and CET had negative bidirectional associations with depression. These results are partially consistent with Hypothesis 1. Given the tasks involved in school-to-work transition, young adults often experience discrepancies between their actual and ideal selves (Crossley and Stanton, 2005; Renn et al., 2014). The perception of these discrepancies triggers rumination (Watkins and Nolen-Hoeksema, 2014; Watkins and Roberts, 2020), causing an inflexible processing mode with excessive AAT and infrequent CET. The inflexible processing mode disturbs problem-solving and amplifies depressive moods (Kambara et al., 2019a; Watkins et al., 2008). Therefore, these results emphasize

Table 3
Comparison of each model fit index.

	CLPM			RI-CLPM		
	CFI	RMSEA	90 % CI	CFI	RMSEA	90 % CI
No constrain model	0.890	0.057	0.051–0.062	0.989	0.018	0.007–0.027
Constrain model	0.897	0.045	0.040–0.049	0.988	0.016	0.005–0.023

Note. CFI = Comparative Fit Index; RSMEA = Root Mean Square Error of Approximation.

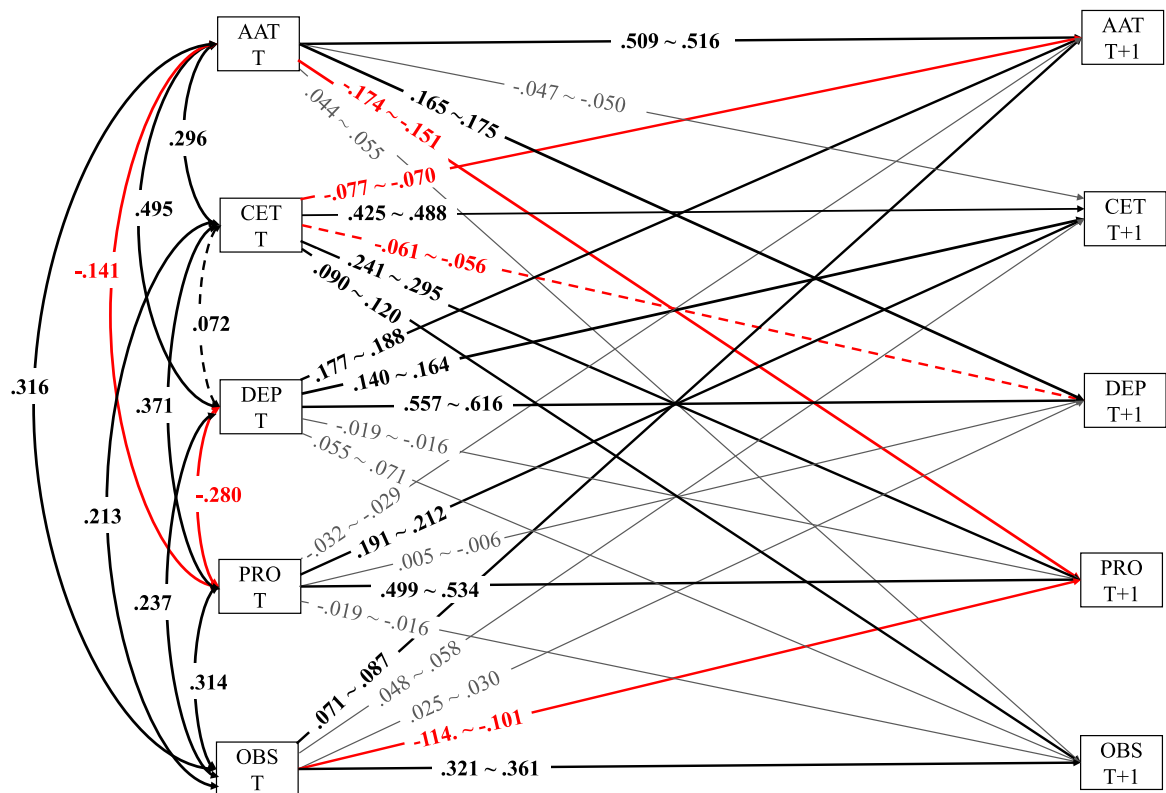


Fig. 1. The result of CLPM with constraints. All coefficients are shown in Tables S1 and S2. The black line represents the positive association, and the red line represents the negative association. Bold line means $p < .01$ significant coefficients paths, thin line means $p < .05$ significant coefficients paths, dotted line means $p < .10$ significant coefficients paths, and gray line means $p > .10$. The cross-lagged and stability path's coefficient implies the range of coefficients in T1-T2, T2-T3, T3-T4, and T4-T5. The covariate coefficient is in T1.

Note. AAT = abstract-analytic thoughts; CET = concrete-experiential thoughts; DEP = depression; PRO = progress; OBS = obstruction. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Nevertheless, it should be noted that these missing values may cause some bias in the model estimation. The attrition rate may be caused by a few incentives for answers, which is common in longitudinal surveys by Japanese research companies. Future research should be careful not to increase the attrition rate in a longitudinal survey. For instance, there should be sufficient incentives for participants to keep them motivated to provide responses. Second, the present study included only third-year university students in Japan. We aimed to capture those in the school-to-work transition phase, but our sampling strategy missed some portion of late adolescents and young adults, such as those who got a job after graduating high school. Future studies should collect various samples, including high school and graduate students. Finally, our study included only Japanese participants. Thus, the present results may not be generalizable to other countries or cultures. International comparisons of the relationship are needed to reveal whether our results are reproducible in other countries and cultures and Japan.

5. Conclusion

The present study explored the bidirectional associations of

repetitive thought (AAT and CET) with depression and values-based action among university students in school-to-work transition. Our results indicated that the low AAT and high CET modes are critical in promoting their transition and preserving good mental health. Importantly, these findings were robust, being based on analyses at both between-person and within-person levels. The present study contributes to existing research and clinical field implementation by opening a novel avenue to prevent depression among university students and promote their successful transition to the labor market, taking into account ruminative processing mode and value-based actions and their potential interplay.

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Ethics

The study was approved by the Ethics Committee of the Graduate

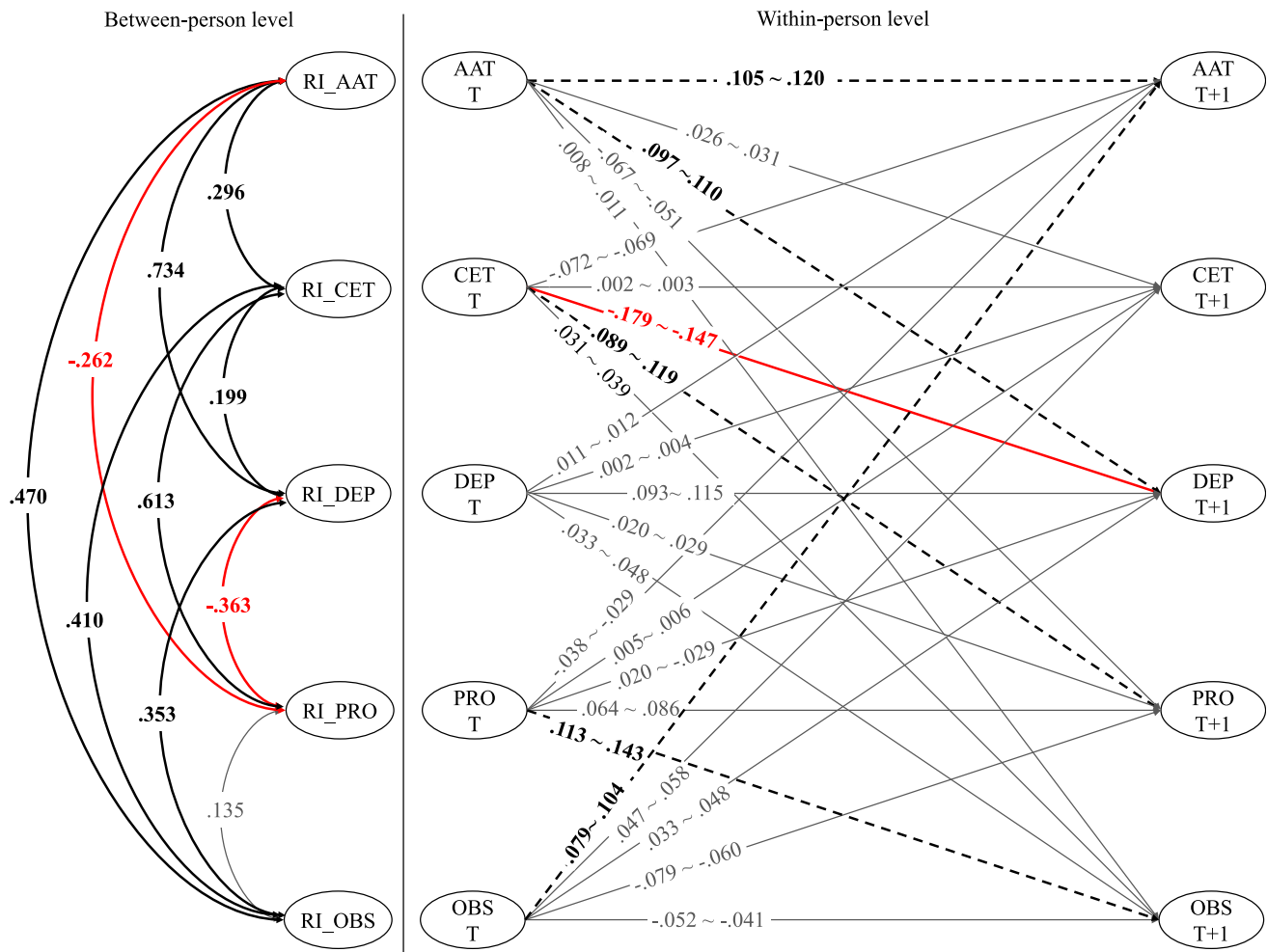


Fig. 2. The result of RI-CLPM with constraints. All coefficients are shown in Tables S3 and S4. The black line represents the positive association, and the red line represents the negative association. Bold line means $p < .01$ significant coefficients paths, dotted line means $p < .10$ significant coefficients paths, and gray line means $p > .10$. The cross-lagged and stability path's coefficient implies the range of coefficients in T1-T2, T2-T3, T3-T4, and T4-T5.

Note. AAT = abstract-analytic thoughts; CET = concrete-experiential thoughts; DEP = depression; PRO = progress; OBS = obstruction. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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CRediT authorship contribution statement

KK and SH designed the study, SH recruited the participants, collected the data, and KK conducted the statistical analyses. KK wrote the first draft of the manuscript in collaboration with HH. KM critically reviewed the manuscript. All authors have contributed to and approved the final manuscript.

Conflict of interest

The authors report no conflicts of interest.

Data availability

The data that support the findings of this study are distributed by the Open Science Framework at https://osf.io/czs62/?view_only=3a210f85818c4f838df42fafefc9cb85.

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/Author's detailed contribution: The author's contribution to this work was the conceptualization of the rumination model used in the study and the interpretation of the study results from the perspective of this model.

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Title

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Task Unrelated Thoughts (TUT) affecting mood in ecological settings: from adaptive mind-wandering to maladaptive repetitive negative thinking.

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Abstract

The literature suggests several hypotheses explaining adaptive vs. maladaptive character of task unrelated thoughts (TUT). However, it is still not clear what particular features can differentiate adaptive TUT from its maladaptive form. The main aim of the present study was to test the content and the context regulation hypothesis using daily sampling, that is to verify how TUT and task features are linked to momentary mood. 214 participants assessed their trait TUT through self-reported questionnaires and underwent a 7-day ecological momentary assessment of mood, TUT and task characteristics measured 7 times by day. The results suggest that TUT particular features (i.e. lack of control, delay from the present moment, valence) are linked to both, lower mood valence and higher anxiety. Moreover control over the thoughts moderates the link between task characteristic (effort required by the task) and participants' mood. Thus, from the clinical perspective, it seems more justified to take into account the particular TUT features instead of distinguishing specific TUT type (e.g. mind-wandering or rumination).

Keywords: mind-wandering; daydreaming; repetitive negative thinking; rumination; emotional regulation; daily sampling

Introduction

Mind-wandering (MW) is an overarching construct that encompasses a variety of phenomena e.g., daydreaming, repetitive negative thinking (RNT), unintentional thoughts, stimulus-independent thoughts, unguided thoughts and meandering (Seli et al., 2018). In the context of inclusive family resemblance perspective proposed by Seli et al. (2018), MW can be defined as an engagement in mentation that occurs unintentionally, and which is unrelated to one's current activity and surroundings (Marcusson-Clavertz, Cardeña, & Terhune, 2016). Even though MW is considered as a normal, everyday life, mental by default activity, some studies suggest that, under its maladaptive form (Schimmen-

ti, Somer, & Regis, 2019), MW might be related to negative affect, lower life satisfaction, and it represents a risk factor for psychological disorders such as depression (e.g. Marchetti, Van de Putte, & Koster, 2014). By engaging in maladaptive task unrelated thoughts (TUT) individuals tend to neglect ongoing activities and social relations (Mar, Mason, & Litvack, 2012). Moreover, under certain circumstances, TUT might take a form of maladaptive RNT, i.e. repetitive dwelling on one or more negative concerns that is perceived as difficult to control (Ehring & Watkins, 2008). An important question remains: why for some people TUT might be maladaptive and lead to increased risk of depression (Marchetti, Koster, Klinger, & Alloy, 2016), while for others, it is a normal activity not leading to negative consequences in terms of impaired emotional regulation (Gorolewski et al., 2014). The aim of the present study was to test which characteristics of TUT lead to an increased negative mood in participants' everyday life. This goal seems to be particularly relevant in the perspective of disentangling maladaptive MW (Schimmenti et al., 2019) and RNT (Watkins, 2008) and determining whether they are two ends of the same continuum or two separate, independent processes.

Mind-Wandering and Repetitive Negative Thinking: end-points of the same continuum or distinct concepts?

The link between MW and RNT, e.g. rumination and worry, remains unclear. Some authors suggest that MW is a subtype of RNT (Watkins, 2008). Conversely, others suggest that RNT is the same construct as mind-wandering, but in a maladaptive form, because the two processes share the same main characteristics, i.e. difficulties in controlling the thoughts stream (Marchetti et al., 2016; Ottaviani, Shapiro, & Couyoumdjian, 2013). In line, Ottaviani et al. (2013)

indicate that RNT and MW might be the end-points of the same process (maladaptive and adaptive, respectively).

Therefore, instead of using the term MW to describe all the task unrelated thoughts types included in the family resemblance perspective, in the present paper, we use a more general term - the TUT (Seli et al., 2018). This inclusive nomenclature encompasses both concepts (MW and RNT) and enables to avoid the confusion already present in the current literature, i.e. the theoretical validity of distinguishing maladaptive MW from RNT (Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011).

The literature on MW and RNT is largely separated, composing two distinct lines of research (Ottaviani et al., 2013). However, this cleavage seems to be based not on theoretically founded differences between the two processes, but mainly on different approaches to measure MW and RNT.

Task Unrelated Thoughts: adaptive vs. maladaptive consequences and underlying features

The consequences of TUT in terms of cognitive functioning and emotional regulation have been described over the past two decades. Among identified adaptive outcomes, it has been shown that MW would enhance the creative process (Baird et al., 2012); planning and anticipating the future (Stawarczyk et al., 2011). MW also provides a mental break, allowing recovery from boring or stressful tasks (Ruby, Smallwood, Engen, & Singer, 2013). Concurrently, a body of research has shown that MW can also lead to dysfunctional consequences in a variety of tasks and activities, e.g. reading or driving (Seli et al., 2018). Moreover, MW can be involved as a risk factor for psychological disorders (Marchetti et al., 2014, 2016).

The concept of maladaptive MW raised two important theoretical questions. First, what factors are responsible for switching from an adaptive, naturally occurring process of MW into its maladaptive form? Second, what is the difference between maladaptive MW and RNT (if there is one), as the two processes can be described as task unrelated thoughts, they share main common characteristics and might both lead to maladaptive consequences on emotional regulation?

The maladaptive consequences of RNT are also well documented in the literature. RNT can be considered as a transdiagnostic process involved not only in depression or generalized anxiety but also in other psychological disorders linked to impaired emotional regulation, e.g., eating disorders, addictions or social anxiety (Watkins, 2008). RNT is also linked to increased cognitive and attentional biases (e.g. Koster, De Lissnyder, Derakshan, & De Raedt, 2011).

Several hypotheses have been put forward to explain those adaptive and maladaptive consequences of TUT. To date, the Content Regulation Hypothesis (Andrews-Hanna et al., 2013) and the Context Regulation Hypothesis (Kane & McVay, 2012) represent the most convincing theoretical frameworks for reconciling the opposite effects of the TUT. It is important to underline that those two hypotheses on TUT mechanisms are neither independent nor exclusive.

The Content Regulation Hypothesis suggests that the form and content of TUT affect their associated functional outcomes (Andrews-Hanna et al., 2013). The main characteristics influencing the adaptive vs. maladaptive TUT character are: personal significance, valence, level of construal (concreteness) and temporal orientation (Andrews-Hanna, Smallwood, & Spreng, 2014). While enumerating TUT characteristics, it seems important to note that in the RNT literature, some additional features can be identified, for example, repetitiveness and verbal form (Watkins, 2008).

The impact of concreteness and temporal orientation of repetitive negative thinking was tested in several experiments, including laboratory (e.g., Kornacka, Krejtz, & Douilliez, 2019) and ecological assessments (e.g., Moberly & Watkins, 2006). The results suggest that those two factors might play a crucial role in adaptive vs. maladaptive RNT impact on emotional regulation with the concrete and present-focused thoughts enhancing negative affect regulation (Behar, Zuelling, Borkovec, 2005; Watkins, Moberly, & Moulds, 2008). However, the research focusing on MW tend to suggest that adaptive MW is linked to focus on the future while MW focused on the past will be linked to negative mood (Ruby et al., 2013; Smallwood et al., 2009; Smallwood & O'Connor, 2011). Thus, it seems important to disentangle whether the maladaptive feature of TUT is linked to the past vs. future thoughts orientation as suggested by MW research (e.g. Ruby et al., 2013) or to the delay from the present moment as suggested by the RNT research (e.g. Watkins, 2008).

The Context Regulation Hypothesis (Kane & McVay, 2012) posits that individuals with good cognitive control limit their MW when ongoing task is demanding and requires more cognitive resources. At the same time, they tend to produce more TUT when the environment is non-demanding (Unsworth & McMillan, 2013). In this view, the role of executive control varies as a function of the external task demands (Kane & McVay, 2014). Moreover, McVay and Kane (2010) postulated that mind-wandering represents a failure of executive control, particularly an incapacity to deal with the interfering stimuli.

Results supporting the context regulation hypothesis were mostly obtained in laboratory studies, and they suggest that task characteristics and executive resources are linked to the ongoing task performance and not necessarily to the subjective experience of TUT (Kane & McVay, 2012). There are fewer studies using experience sampling. For example, Kane et al. (2007) supported the role of interaction between task cognitive-demands and working memory. In a similar vein, Ottaviani et al. (2013) suggest the existence of a MW–RNT continuum where the RNT can be viewed as systemic inflexibility resulting from poor executive control. It is worth underlining that also RNT is often seen as an executive control failure (e.g., Zetsche, D'Avanzato, & Joormann, 2012).

To sum up, the existing literature on RNT and MW is largely separated (Ottaviani et al., 2013). These two processes, RNT and MW, are defined as task-unrelated

thoughts (Seli et al., 2018), often perceived as unintentional and difficult to control; thus, both might reflect a failure in self-control (Zetsche et al., 2012). In the present study, we merge these two lines of research to examine which TUT and task characteristics affect mood in ecological settings.

Using ecological momentary assessment (EMA) to empirically verify the content regulation hypothesis (Andrews-Hanna et al., 2013), we tested the main features of TUT that might be responsible for maladaptive or adaptive outcomes of TUT. We expect that concreteness, control over thoughts and positive valence would be linked to less negative mood. In contrast, the delay from the present moment, repetitiveness and verbal feature will be linked to more negative mood in momentary measures. Additionally, in order to examine the context regulation hypothesis (Kane & McVay, 2012), we controlled for the ongoing task characteristics: its stressfulness, and participants' interest, motivation and effort to complete it. We hypothesize that task characteristics, and particularly the effort required by the task will be linked to less TUT. Moreover, this relation can be moderated by the control over one's thoughts. Finally, we aimed at testing whether the tendency to use MW or RNT at the trait level is linked to momentary TUT or mood. The graphic outline of tested models can be found in the supplementary materials: <https://osf.io/fw78r/>.

Method

Participants

415 healthy volunteers took part in the first part of the study (trait evaluation); among them, 279 started the EMA part of the study. Sixty-five participants drop-out during the study or filled in less than 60% of EMA questions (the drop-out rate was 23%). The final sample was composed of 214 participants (mean age = 29.17, $SD = 8.93$; 169 females, 43 males, 2 participants did not want to provide their gender). The compliance rate in the EMA part of the study was 80 % resulting in 8108 momentary observations.

Procedure

Participants were invited through social networks to take part in a study on daydreaming. Prior to their participation, volunteers received information about the aim of the study, trait and EMA evaluation procedure; they also signed a consent form. First, the participants filled in an online trait evaluation through Qualtrics platform. Next, they were contacted by an experimenter in order to explain the rules and technical aspects of EMA. All EMA measures were provided through Movisens application. Participants installed the application on their personal smartphones. The EMA assessment lasted for 7 days. Participants received one signal randomly in each 2h period, 7 times per day in a 14h activity window (e.g. from 8a.m. to 10p.m.). Application sent an auditory signal and a visual pop-up asking participants to answer a series of questions (see EMA measures). Participants had 20 minutes to complete the assessment. Participants received financial compensation for their partic-

ipation (around 20\$). The protocol was approved by a local ethical committee (WKEB69/03/2021).

Measures

EMA measures.

TUT. Participants were asked two questions assessing their consciousness of ongoing thoughts and the task-unrelated character of their thoughts: "Just before the bip, to what extent [1] you were conscious of your own thoughts" (not at all conscious – totally conscious); [2] "your thoughts were task related – unrelated" They provided answers on a visual analog scale (VAS) from 0 to 100.

Content - TUT characteristics. The questionnaire was based on the TUT characteristics identified in the literature as crucial in determining the TUT impact on emotional regulation. Participants were asked to respond to the following questions by using a VAS from 0 to 100 "Just before the bip, to what extent your thoughts were:" [1] focused on past-future; middle point indicated as "here and now" (temporal orientation); [2] possible to visualize (concreteness); [3] repetitive (repetitive feature); [4] in the form of inner speech (verbal feature); [5] negative-positive (valence); [6] possible to control (control). Higher scores indicate more concrete thoughts, higher repetitiveness, form of inner speech, higher control and more positive valence.

Context – task characteristics (adapted from Granholm et al., 2020). Participants are asked to choose from the scroll-down list an answer to the question: "What kind of task are you performing at the moment?" Vocational (e.g., going to work/university); At home leisure (e.g., reading); Outside leisure (e.g. cinema); Homecare (e.g., cleaning); Self-care (e.g., shower). Moreover, participants were asked to characterize their ongoing task by answering the following questions: "Is the task you currently performing": [1] stressing; [2] interesting, [3] motivating; [4] requiring control. They provided answers on the VAS from 0 - not at all to 100-totally.

Mood (adapted from Koster et al., 2015). Mood was measured using two dichotomous VAS from 0 to 100 assessing mood valence and anxiety, where participants are asked to assess: "At the present moment do you feel:" [1] (discontent-content; higher score indicates positive valence); [2] anxious-calm (higher score indicates less anxiety).

Trait measures.

Mind-wandering. Trait MW was evaluated through Daydreaming Frequency Scale (DDFS; Giambra, 1993), which assess the general frequency of stimulus-independent and task unrelated thoughts.

Repetitive Negative Thinking. Trait RNT was evaluated from two self-reported questionnaires. First, the transdiagnostic Perseverative Thinking Questionnaire (PTQ; Ehring et al., 2011) assessing the main features of RNT (unproductiveness, repetitive feature and mental capacity captured by RNT) and, second, the Ruminative Response Scale assessing depressive rumination (RRS; Treynor, Gonzalez, & Nolen-Hoeksema, 2003).

Results

Statistical analysis plan

Taking into account the nested structure of the data, we computed multilevel analysis using HLM 8.0. Level 1 variables (data collected through EMA measures) were nested in participants (Level 2). Trait level variables were also introduced at Level 2. Although it was possible to consider the data as a 3-level model (observations nested in days, nested in participants), taking into account that most of the previous EMA studies on TUT are based on the two-level models (even if they used multiple observations by day, e.g. Kane et al., 2007; Pe et al., 2013), we decided to keep the 2-level structure. Level 1 variables were entered to the model group mean centered, Level 2 variables were grand mean centered. All the coefficients reported above were computed with the robust standard error and based on a random model as estimations of variance component for each tested variable was significant ($p < .05$).

In the first part of the analysis, we run an unconditional model for each of level 1 variables. The example of null model equation for mood valence is as follow:

Level 1 (within-person): $Mood\ valence_{ij} = \beta_{0j} + r_{ij}$

Level 2 (between-person): $\beta_{0j} = \gamma_{00} + u_{0j}$

The descriptive statistics and reliability coefficients are presented in Table 1 for Level 1 and Level 2 variables.

Additionally, following the recommendations by Garson (2013), we computed, for each model with predictors, the likelihood ratio test for the random coefficient regression model and deviance drop compared to the null model (reported in Table 2).

Table 1: Descriptive statistics and reliability of variables.

Level 1 variables		
Variable	Mean (SD)	Reliability
Consciousness of thoughts	62.39 (29.07)	.961
Task unrelated thoughts	41.54 (30.11)	.856
Main feature of TUT		
Temporal orientation	55.02(16.42)	.877
Concreteness	59.28(26.33)	.934
Repetitive feature	60.13(25.54)	.867
Verbal feature	46.93(28.76)	.948
Valence	59.10(23.53)	.927
Control	57.53(25.71)	.948
Delay form the present	11.02(13.17)	.895
Mood		
Valence	60.51(23.46)	.939
Anxiety	62.06 (25.31)	.927
Level 2 variables		
PTQ	46.66 (11.96)	.951
RRS	50.56 (12.96)	.921
DDFS	38.04 (9.15)	.915

Note. PTQ - Perseverative Thinking Questionnaire; RRS - Ruminative Response Scale Revised; DDFS – Daydreaming Frequency Scale.

TUT and mood in momentary measures

Next, in order to test the link of TUT level and mood in participant's everyday life, we tested how consciousness of thoughts and TUT predicted cross sectional mood using following equation:

Level 1 (within-person): $Mood\ valence_{ij} = \beta_{0j} + \beta_{1j} (Consciousness_{ij}) + \beta_{2j} (Task\ unrelated\ thoughts_{ij}) + r_{ij}$

Level 2 (between-person): $\beta_{0j} = \gamma_{00} + u_{0j}$

$\beta_{1j} = \gamma_{10} + u_{1j}$

$\beta_{2j} = \gamma_{20} + u_{2j}$

Both momentary consciousness of thoughts and task unrelated thoughts were significant predictors of momentary mood (valence and anxiety, see Model 1B and 1C in Table 2, respectively). A higher level of TUT predicted more anxiety and more negative valence of mood.

Main features of TUT

In order to test how TUT features predicted TUT level and mood (the content regulation hypothesis), we introduced the TUT characteristics simultaneously in the model at level 1 and TUT (2A), mood valence (2B) and anxiety (2C) as outcomes (see Table 2).

The variable “delay from the present moment” was computed as the absolute value of participants' answers to the temporal orientation question minus 50 (i.e. 0 in the new variable indicating full focus on “here and now” and 50 an extreme focus on the future or on the past).

The results suggest that more positive, concrete, and controlled thoughts were related to positive mood valence (see model 2B in Table 2). The verbal features of TUT and the delay from the present moment were associated with less positive mood. Surprisingly, the repetitive character of TUT was not related to mood valence. TUT valence and control over TUT were also associated with less anxiety reported by participants in EMA, while higher anxiety was predicted by verbal features, delay from the present moment and repetitiveness. The concreteness of TUT was not a significant predictor of anxiety (see Model 2C in Table 2).

Additionally, in order to disentangle the impact of the temporal orientation (postulated as a key factor in the MW literature) form the delay from the present moment (postulated by the RNT literature) we computed a model with temporal orientation (past-future) and delay from the present as Level 1 predictors. For the mood valence as the outcome, both predictors were significant, the mean temporal orientation slope (γ_{10}) was .13 ($p < .001$), and the mean delay from the present slope (γ_{20}) was -.41 ($p < .001$). For anxiety as an outcome, only the delay from the present moment, but not temporal orientation was a significant predictor with the mean temporal orientation slope (γ_{10}) of .04 ($p = .127$), and the mean delay from the present slope (γ_{20}) was -.36 ($p < .001$).

Task characteristics

In order to test the context regulation hypothesis (Kane & McVay, 2012), we verified whether task features and particularly effort required by the task is linked to decreased

TUT. Model 3A in the Table 2 showed that effort, but also stressfulness, interest and motivation to execute the ongoing task are all significant predictors of lower TUT. Additionally, following the procedure described by Nezlek (Nezlek, 2011; Nezlek & Plesko, 2003), we tested level 1 interaction between effort in the ongoing task and control of TUT in order to test the prediction of the Context Regulation Hypothesis, as follows:

Level 1 (within-person) : $TUT_{ij} = \beta_{0j} + \beta_{1j} (Effort_{ij}) + \beta_{2j} (Control_{ij}) + \beta_{3j} (Effort \times Control_{ij}) + r_{ij}$

Level 2 (between-person): $\beta_{0j} = \gamma_{00} + u_{0j}$

$\beta_{1j} = \gamma_{10} + u_{1j}$

$\beta_{2j} = \gamma_{20} + u_{2j}$

$\beta_{3j} = \gamma_{30} + u_{3j}$

The level 1 interaction term was created by multiplying centered around the mean control by similarly centered effort variable. The interaction term was introduced to the model uncentered. It appears that, consistent with the context regulation hypothesis, control of TUT, the effort put in the ongoing task, and the interaction between them, were all significant predictors of lower TUT level. The mean effort slope (γ_{10}) was -.013 ($p < .001$), the mean control slope (γ_{20}) was -.48 ($p < .001$) and the mean interaction slope (γ_{30}) -.001

($p = .004$). The examination of interaction effect based on within-level +/- 1 SD values suggested that the level of TUT decreases with the task demands, but only for participants with high control of thoughts.

Trait tendencies and TUT

Finally, in order to test the relation between the trait tendency to use TUT (daydreaming and RNT) and TUT level in daily life and mood, we computed the models with EMA of mood and TUT measure as the outcome and trait variables introduced as predictors at Level 2 of the model, as follow:

Level 1 (within-person): $Mood\ valence_{ij} = \beta_{0j} + r_{ij}$

Level 2 (between-person): $\beta_{0j} = \gamma_{00} + \gamma_{01} (DDFS_j) + \gamma_{02} (PTQ_j) + \gamma_{03} (RRS_j) + u_{0j}$

The analysis of the Level 2 predictors (see Model 4 in Table 2) suggest that only the tendency to use RNT (measured through PTQ) was linked to a higher level of TUT, the lower valence of mood and higher anxiety in momentary measures.

Discussion

The link between mind-wandering (MW) or repetitive

Table 2: Testing Level 1 and 2 predictors' link to TUT, mood valence and anxiety.

	Outcome								
	A. Task unrelated thoughts			B. Mood valence			C. Mood anxiety		
	Coeff.	SE	t-ratio	Coeff.	SE	t-ratio	Coeff.	SE	t-ratio
Model 1: Consciousness and TUT									
Consciousness of thoughts				0.13	0.02	7.77***	0.05	0.02	2.96**
Task unrelated thoughts				-0.12	0.01	-8.73***	-0.08	0.02	4.43***
Deviance drop comparing to null model						817.91			439.60
Significance of likelihood ratio test						< .001			< .001
Model 2: TUT features									
Concreteness	-0.13	0.02	6.58***	0.03	0.01	2.83**	0.02	0.01	1.17
Repetitive feature	-0.30	0.02	16.12***	-0.01	0.01	0.27	-0.09	0.01	8.15***
Verbal feature	0.07	0.02	4.45***	-0.02	0.01	2.72**	-0.01	0.01	1.19
Valence	-0.07	0.02	3.33**	0.65	0.02	43.66***	0.63	0.02	36.78***
Control	-0.22	0.02	11.49***	0.07	0.01	5.77***	0.08	0.01	6.47***
Delay from the present	0.61	0.04	16.45***	-0.03	0.01	2.24*	-0.05	0.02	2.13*
Deviance drop comparing to null model			3620.80			65515.49			4738.26
Significance of likelihood ratio test			< .001			< .001			< .001
Model 3: Task features									
Stressfulness	-0.04	0.02	2.14*	-0.15	0.01	11.23***	-0.34	0.02	20.91***
Interest	-0.18	0.02	8.89***	0.19	0.01	15.34***	0.15	0.01	11.55***
Motivation	-0.25	0.02	12.14***	0.15	0.01	10.99***	0.09	0.01	6.38***
Effort	-0.13	0.02	6.18***	-0.05	0.03	4.36***	-0.07	0.01	5.42***
Deviance drop comparing to null model			598.75			1919.11			2542.64
Significance of likelihood ratio test			< .001			< .001			< .001
Model 4: Trait variable									
DDFS	0.03	0.11	0.29	0.01	0.11	0.05	-0.02	0.11	0.22
PTQ	0.18	0.09	2.00*	-0.22	0.09	2.53*	-0.25	0.09	2.78**
RRS	0.12	0.09	1.49	-0.28	0.09	3.03**	-0.18	0.10	1.91+
Deviance drop comparing to null model			9.92			35.00			22.80
Significance of likelihood ratio test			.002			< .001			< .001

Note. *** < .001; ** < .01; * < .05; + < .10; TUT – task unrelated thoughts.

negative thinking (RNT) and lower mood in participants daily life was already shown in some ecological momentary assessment studies (e.g. Killingsworth & Gilbert, 2010; Moberly & Watkins, 2008). The literature offers several hypotheses on the mechanisms and characteristics involved in the maladaptive outcome of this kind of TUT. However, most of them were evaluated in laboratory or experience sampling studies testing a single feature of TUT. To our knowledge, the present study is the first to test various TUT characteristics that, according to the content (Andrews-Hanna et al., 2013) and context regulation hypothesis (Kane & McVay, 2012), along with RNT theory (Watkins, 2008; Watkins & Roberts, 2020), could affect TUT's impact on mood.

The results of the present study suggest that, in general, TUT are linked to more negative valence of mood and to more anxiety in momentary measures. However, it seems that above the fact that one's mind wander, the key factors to take into account in the context of emotional regulation are TUT's particular features. In one of the first EMA studies assessing simultaneously MW and rumination, Kuehner, Welz, Reinhard, and Alpers (2017) showed that TUT characteristics measured (e.g. having a sense of control over one's thoughts) might affect mood through the mediating role of rumination. However, in their study TUT characteristics were assessed only in the laboratory conditions. The present study extends those results by suggesting that independently of the TUT precise definition (MW or RNT) the control component plays a crucial role in TUT impact on mood. This role of control over thoughts might also potentially explain why PTQ (measuring also control resources captured by RNT) was the only trait predictor affecting momentary TUT. The role of executive control was already described in both RNT and MW literature (e.g., Ottaviani et al., 2013; Zetsche et al., 2012); however, in those studies, control of thoughts was rather considered from the perspective of individual differences without taking into account the within-person variability. The results of our study seem to support the idea that the maladaptive outcome of TUT in terms of lower mood might be due to a failure of control over one's thoughts (e.g. Ottaviani et al., 2013).

Another TUT feature worth having a closer look at is the repetitiveness of thoughts. In the present study, the repetitive feature of TUT was linked to increased anxiety, but not to mood valence. It also seems that this feature is characteristic for RNT and not necessary for MW, which should be characterized by a freely moving mind (Seli et al., 2018). Thus, it seems that repetitiveness might be one of the key elements in the switch between adaptive and maladaptive TUT. According to literature, it could be also essential in distinguishing MW from RNT (Christoff et al., 2018). It is also important to note that this repetitive feature might be dependent on self-control failure and thus strongly correlated with the control factor described above.

It is also interesting to take into account the interaction between the effort put into the ongoing task and the control of the thoughts supporting the crucial role of the control in

maladaptive outcomes of TUT. The context regulation hypothesis (Kane & McVay, 2012) states that during a demanding task one's self-control resources should enable to inhibit task unrelated thoughts and focus on the ongoing task. Momentary data from the present study suggest that this mechanism works only for those who reported having high subjective control over their thoughts.

The present study might also help to understand the role of the temporal orientation of TUT. MW literature suggests that negative affect is linked to focusing the attention on the past (e.g. Ruby et al., 2013), while the processing mode theory of RNT suggests it is the delay from the present moment and abstract thinking that might have a deleterious impact on emotional regulation (Watkins, 2008). It seems that both focusing on the past and the delay from the present moment might affect participants' mood. Nevertheless, only the delay from the present moment is linked to anxiety. Moreover, in line with the processing mode theory (Watkins, 2008) also, the concreteness of TUT is related to mood valence. However, it is necessary to underline that those two characteristics might be interrelated, as events more distant in time might also be considered as less concrete.

Several challenges need to be addressed by future studies. First, to further explore the potential distinction between maladaptive MW and RNT (or the lack of it), it seems necessary to emphasize the freely moving feature of MW suggested as a necessary element to define MW by the dynamic framework of MW, strongly critical toward the family resemblance perspective (Christoff et al., 2018).

Moreover, it is still unclear how to operationalize the control component, a crucial feature for TUT's impact on emotional regulation. It is necessary to disentangle the role of attention, working memory and inhibitory processes previously shown in laboratory studies (Kane & McVay, 2012) and the subjective perception of having control over thoughts (Kuehner et al., 2017). Additionally, particularly in EMA studies, context measures should include not only task, but also the environment characteristics. Moreover, the present study focused on the processual characteristics of TUT that should be further examined in the perspective of TUT function. It seems also necessary to take into account how this function and TUT features interaction might affect emotional regulation. Finally, it seems indispensable while assessing TUT function to go beyond its context and the content by examining motivational factors (Klinger & Cox, 2011).

In sum, the present study sheds some light on the main features involved in maladaptive TUT. More specifically, it brings arguments in favor of considering MW and RNT as a continuum of TUT, which might become maladaptive when TUT are characterized by particular features (i.e. lack of control, particular temporal orientation, repetitiveness, lack of concreteness). This integrative approach might be interesting from the perspective of process-based therapies addressing a particular psychological mechanism across various psychological disorders and not necessarily a disorder-specific type of cognition.

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Concrete vs. Abstract Processing in Repetitive Negative Thinking: Distinct Functional Effects on Emotional Reactivity and Attentional Control

Monika Kornacka^{1,2*}, Izabela Krejtz¹ and Celine Douilliez^{2,3}

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Repetitive negative thinking (RNT) is a transdiagnostic process linked to emotional regulation impairment and involved in mood, anxiety, eating disorders and addictions. Attentional disengagement impairment is one of the factors hypothesized to be responsible for the recurrent and uncontrollable character of RNT. The aim of the present study was to empirically test this hypothesis with evaluation of disengagement from negative and RNT-related stimuli separately. Sixty participants were randomly allocated to one of three experimental conditions: abstract RNT, concrete RNT, and control condition (distraction). The change in their negative affect (PANAS) and their attentional disengagement impairment (exogenous cueing task) were measured. The analysis revealed that participants in abstract RNT condition presented higher emotional reactivity comparing to concrete or distraction conditions. The results indicated no differences between induction conditions in attentional disengagement. However, participants after concrete RNT induction had longer mean response times in exogenous cueing task comparing to control induction suggesting that they detected presented stimuli slower than participants in control condition. The results raised an important, from clinical point of view, question of distinctive impact of two types of RNT on emotional reactivity and attentional processes.

Keywords: repetitive negative thinking, rumination, emotional reactivity, attentional control, attentional disengagement, dysphoria

INTRODUCTION

Research on Repetitive Negative Thinking (RNT) started with a focus on depressive rumination, that is “behaviors and thoughts that focus one’s attention on one’s depressive symptoms and on the implication of these symptoms” (Nolen-Hoeksema, 1991, p. 569). Depressive rumination was identified as an onset, maintenance and recurrence factor of depression (Nolen-Hoeksema, 1991; Watkins, 2008). Further research suggests that rumination is involved also in anxiety, eating disorders, posttraumatic stress disorder or addictions and might be classified as a transdiagnostic process (Ehring and Watkins, 2008; Watkins, 2008). This transdiagnostic perspective led

researchers to consider rumination as a broader and content-independent process (RNT) linked to psychological disorders that are characterized by impaired emotional regulation. A meta-analysis confirms that rumination is a maladaptive emotional regulation strategy related to psychological disorders with the strongest effect size comparing to other emotional regulation strategies (e.g., avoidance, suppression, reappraisal) (Aldao et al., 2010).

Watkins (2004) suggests that maladaptive character of RNT depends on the mode of information processing and it does not depend on the content of negative thoughts *per se*. In RNT, there are two alternative modes of information processing: abstract and concrete. Abstract RNT analyses causes, consequences and signification of an event. It refers to what was classically defined as rumination – repetitive and difficult to control dwelling on one or more negative issues (Ehring and Watkins, 2008). This type of RNT is characterized by a higher-order, more general processing of self-referent information and is often subject to cognitive distortions (e.g., generalization) (Ehring and Watkins, 2008; Watkins, 2008, 2015; Watkins and Nolen-Hoeksema, 2014). Abstract RNT is typically focused on reassessing the past in the search of general explanation or significance of a given event. For example, “what have I done to deserve that?”, “why it always happens to me?”. Contrary to reappraisal, abstract RNT is disconnected from the details of current situation and consequently does not lead to adaptive emotional regulation (Watkins, 2008). This kind of RNT is also focused on the discrepancy between one’s actual and ideal self and on the reasons for this discrepancy (Watkins and Nolen-Hoeksema, 2014; Watkins, 2015). Whereas, concrete RNT refers to attentional focalization on the present moment, one’s own emotional state and environmental details. The definition of concrete processing mode overlaps with mechanism of mindfulness meditation. However, it does not reflect the complexity of mindfulness construct as the non-judgemental attitude is not explicitly addressed in the concrete RNT (Watkins, 2015). Concrete RNT involves lower-order, non-conceptual and non-judgemental processing of present-moment experience (Watkins, 2008). According to the literature, abstract and concrete RNT have a distinctive impact on emotional reactivity, i.e., the changes in negative affect (Watkins et al., 2008). Abstract thinking is considered as maladaptive, while concrete thinking enhances emotional regulation (Moberly and Watkins, 2006; Watkins and Moulds, 2007; Watkins et al., 2008).

Recent literature suggests also that one of the factors responsible for the recurrence of maladaptive RNT is attentional disengagement impairment (Koster et al., 2005; Whitmer and Gotlib, 2013). However, there are only few studies testing this hypothesis and none of them took into account the processing mode theory (Donaldson et al., 2007; Morrison and O’Connor, 2008; Southworth et al., 2016) – an element that seems to be crucial for considering RNT in the perspective of emotional reactivity or emotional regulation. The distinctive impact of concrete and abstract RNT, to our knowledge, has never been explored in the context of attentional processes. In the present experimental study, we examine how abstract and concrete RNT affect emotional reactivity, i.e., the changes in negative

affect measured pre and post RNT induction and attentional disengagement from negative and RNT-related stimuli. We describe our hypotheses after a brief review of the relevant literature on the RNT and its link to attentional processes.

Theoretical Roots of RNT – The Actual-Ideal Self-Discrepancy and Abstract vs. Concrete RNT

A particular situation worth considering in the RNT perspective is the discrepancy between the actual and ideal self. According to Martin and Tesser (1989), this discrepancy between one’s actual situation and personal standards would activate RNT. Roberts et al. (2013) explored this prediction and the results of their study suggested that activating actual-ideal self-discrepancy increases significantly the level of state rumination. Additionally, this effect was moderated by trait RNT – high trait ruminators reported more state rumination in situation when actual-ideal self-discrepancy was induced comparing to low ruminators. In Roberts et al. (2013)’s study, state rumination was evaluated using the modified sustained attention to response task (SART, based on a go/no-go principle) with the hypothesis that state rumination would result in higher cognitive load and consequently in higher error rates. Surprisingly, the participants with activated actual-ideal self-discrepancy were more accurate, but slower during the SART comparing to control group. Roberts et al. (2013) impute those differences to the fact that RNT is more salient and has a greater emotional load. However, they suggest also that the results might be consistent with the hypothesis of impaired disengagement from the ruminative content in RNT. It is important to note that disengagement was not directly measured in their study. Moreover, Roberts et al. (2013) did not explore the differential impact of abstract and concrete RNT in the situation of actual-ideal self-discrepancy. Watkins, 2011 suggests that in this situation, abstract RNT may impair regulation of emotions by reducing attention to environmental details and to the present situation, increasing procrastination and rumination. On the contrary, concrete RNT would be adaptive and should reduce the emotional impact of a given situation. The differential effect of RNT on emotional reactivity after a failure induction—a prototypical situation of actual-ideal self-discrepancy—was supported in experimental studies. Participants using abstract RNT reported more negative affect comparing to those using concrete RNT (Moberly and Watkins, 2006; Watkins and Moulds, 2007; Watkins et al., 2008).

Attentional Disengagement Impairment Hypothesis

Attentional deployment is one of the key elements of emotional regulation model (Gross, 2002). The literature suggests that attentional processes, particularly those linked with attentional focalisation on self-relevant stimuli and with self-immersion state might be associated with rumination (Treyner et al., 2003; Webb et al., 2012). Attentional processes in the RNT may be operated at two aforementioned processing modes (abstract vs. concrete RNT). According to Koster et al. (2011), difficulty to disengage attention is a key element increasing the risk of maladaptive

RNT. RNT recurrence is affected by conflict identification and attentional control (Koster et al., 2011). An individual detecting a conflict between the actual and ideal self will be naturally driven to resolve this conflicting situation. There are two potential actions – resolving the problem by meeting the standards or, if the first is not possible, disengaging from the conflict, which requires reallocation of attentional resources (Carver and Scheier, 1998). An efficient disengagement enables reappraisal of the situation or the use of distraction – both enhancing an adaptive emotional regulation. In contrast, inefficient disengagement due to impaired attentional control will result in prolonged self-focus thoughts (i.e., RNT).

It is interesting to note that while Roberts et al. (2013) suggest that RNT might result in impaired disengagement, Koster et al., 2011 suggest that it is rather inefficient disengagement that is responsible for RNT. However, as further suggested by Koster et al., 2011, one might suppose that high ruminators are trapped in an impaired attentional control vicious circle where RNT becomes a habitual mode of thinking.

The literature on thoughts suppression might also enhance the explanation of the link between attentional disengagement and rumination (Wegner, 1994; Wenzlaff and Luxton, 2003). The attempts to suppress ruminative or focused on negative mood thinking might lead to changes in attentional processes causing the ironic effect of thoughts suppression and difficulties in disengaging from these repetitive negative thoughts (Wegner et al., 1987). Two mechanisms seem to be involved in the thought suppression process: monitoring of the occurrence of unwanted thoughts and distraction from those thoughts requiring more intentional control comparing to monitoring (Wegner, 1994). If an individual does not have sufficient mental control resources to perform an efficient distraction process, the attempts of control of negative or mood-related thoughts may lead to a paradoxical effect of difficulty in disengaging attention from rumination due to operating monitoring process (Wegner et al., 1993; Wegner, 1994; Wenzlaff and Luxton, 2003). Finally, Whitmer and Gotlib (2013) in their attentional scope model of rumination corroborate the hypothesis that RNT triggers attentional impairment (Roberts et al., 2013) and not the other way round. According to this model, RNT would cause a focalization on narrowed negative RNT-related content of thoughts. This restriction is reflected by an impaired attentional disengagement from RNT-related stimuli. The present study tests this hypothesis by experimentally inducing RNT and testing its impact on attentional disengagement from neutral, negative or RNT-related stimuli.

Attentional Disengagement and RNT – Empirical Evidence

The impairment of attentional disengagement was previously explored mainly in dysphoric individuals (Koster et al., 2005). The number of studies exploring the link between RNT and attentional disengagement is limited. Recently three studies measured how trait RNT (i.e., the tendency to use rumination measured on self-report questionnaire) is linked to attentional disengagement (Grafton et al., 2016; Southworth et al., 2016;

Vălenaș et al., 2017). Grafton et al. (2016) suggest that heightened ruminative disposition is associated with impaired attentional disengagement from negative information. Interestingly, they supported the effect previously noted in dysphoric participants (Koster et al., 2005) that the attentional disengagement impairment is visible only when controlled attentional processes are involved (i.e., the stimuli presentation time is around 1000 ms; Grafton et al., 2016). Southworth et al. (2016) supported those results using the same task. In their study, they not only evaluated trait disposition to use rumination, but also state RNT in response to negative event. The results suggest that both, state and trait rumination, are linked to impaired attentional disengagement. Vălenaș et al. (2017) further showed that attentional disengagement mediates the relation between rumination and exam anxiety. Moreover, in an experimental study, LeMoult et al. (2013) suggested that participants having more difficulties in disengaging their attention from negative facial expressions (on exogenous cueing task) reported also more RNT after a stress induction. However, this effect was only apparent among dysphoric individuals.

The Present Study

The aim of the present study was to explore how rumination affects attentional disengagement and emotional reactivity (i.e., the changes in negative affect) by inducing experimentally two different processing modes of RNT (abstract vs. concrete) and measuring their impact on pre-post induction negative affect and on attentional disengagement from neutral, negative and RNT-related stimuli. We aimed at evaluating whether the impaired attentional disengagement is observed for negative stimuli in general, as it is suggested by the literature concerning dysphoria (Koster et al., 2005), or whether it is apparent only for RNT-related stimuli, as it might be inferred from the attentional scope model of rumination (Whitmer and Gotlib, 2013).

The present study offers three advantages over previous research. First, previous studies on the link between attentional biases and rumination used mainly tasks which measured general attentional bias to negative stimuli (dot-probe task; Koster et al., 2004), or attentional breadth (attentional breadth task; Grol et al., 2015), but do not clearly focused on attentional disengagement. For instance, Donaldson et al. (2007) showed that an induction of rumination (vs. distraction) did not affect general attentional biases measured in a dot-probe task. Using a similar design, Morrison and O'Connor (2008) failed to observe a significant difference between conditions (rumination vs. distraction induction) in pre-post measures of attentional biases (dot-probe task). The present study used exogenous cueing task (Koster et al., 2005) specifically created to evaluate attentional disengagement.

Second, previously described studies, directly measuring attentional disengagement (e.g., Southworth et al., 2016), used a cross-sectional design which prevented determining causal direction of the link between attentional disengagement and rumination. Most of the previous studies relied on self-reported measures of rumination. In the present study, rumination is experimentally induced using a goal cueing task, designed to induce rumination by activating actual-ideal self-discrepancy

(Roberts et al., 2013). Finally, none of the previous studies explored the potential distinctive impact of the concrete vs. abstract RNT (Watkins, 2004) on attentional disengagement. Existing literature suggests that abstract RNT should increase emotional reactivity resulting in a higher level of negative affect after RNT induction comparing to concrete RNT or distraction (Watkins et al., 2008). According to previous studies (e.g., Roberts et al., 2013), abstract RNT should also impair attentional disengagement from negative stimuli.

MATERIALS AND METHODS

Participants

Sixty participants were recruited at the campus of the University of Lille. The sample size for repeated measures ANOVA with within-between interaction was determined (using GPower software) to detect medium sample size (0.25) with an alpha of 0.05 and power of 0.95. Two participants were excluded due to technical problems during one of the experimental tasks. Final sample consisted of 58 participants (34 females, $M_{\text{age}} = 24.12$, $SD = 3.85$), resulting in 20 participants in abstract RNT condition, 19 in concrete RNT, and 19 in the control condition. There were no significant differences between experimental groups in age ($F(2,55) = 3.10$, $p < 0.1$, $\eta_p^2 = 0.10$) and in gender ($\chi^2(2, n = 58) < 1$).

Materials

Goal Cueing Task (Roberts et al., 2013)

The task is designed to induce rumination by activating actual-ideal self-discrepancy. Participants were instructed to identify an ongoing and unresolved concern that had repeatedly came into their mind and caused them to feel negative or stressed during the previous week. Following the identification of the goal, in order to make the participants focus and dwell on that goal during ten minutes, they were asked to answer questions (e.g., “think about what was important about that difficulty in terms of your personal goals”) and rate the importance and recurrence of this goal on a 7-point Likert scale (e.g., “to which extent this unresolved goal has been bothering you at its worst”). Additionally, at the end of goal cueing task, participants were asked to provide six keywords that described their concern. Those personal keywords were further used in the attentional disengagement task (exogenous cueing task) as RNT-related stimuli.

RNT and Distraction Induction

The RNT induction, adapted from Watkins and Teasdale (2001), was used to induce abstract or concrete RNT and distraction. Participants were presented with a series of 15 sentences displayed on the screen, each for 40 s (see the sentences used in the task in the **Appendix 1**). The instruction differed depending on the experimental condition. In the abstract RNT condition, participants were instructed to focus on causes, consequences and signification, of each of the sentences (e.g., “Analyze the causes, the consequences and signification of the tension in your muscles,” “Analyze the causes, the consequences and signification of the way you react,” “Analyze the causes, the consequences and signification

of how quick or slow your thinking is right now”). In the concrete RNT condition, participants were to focus their attention on the sentences (e.g., “Focus your attention on the tension in your muscles,” “Focus your attention on the way you react,” “Focus your attention on how quick or slow your thinking is right now”). In the distraction control condition, participants were asked to imagine a situation or an object and the sentence content was different comparing to abstract and concrete condition (e.g., “Imagine the shape of a large black umbrella,” “Imagine the layout of a typical classroom”). The full task lasted for 10 minutes in each experimental condition.

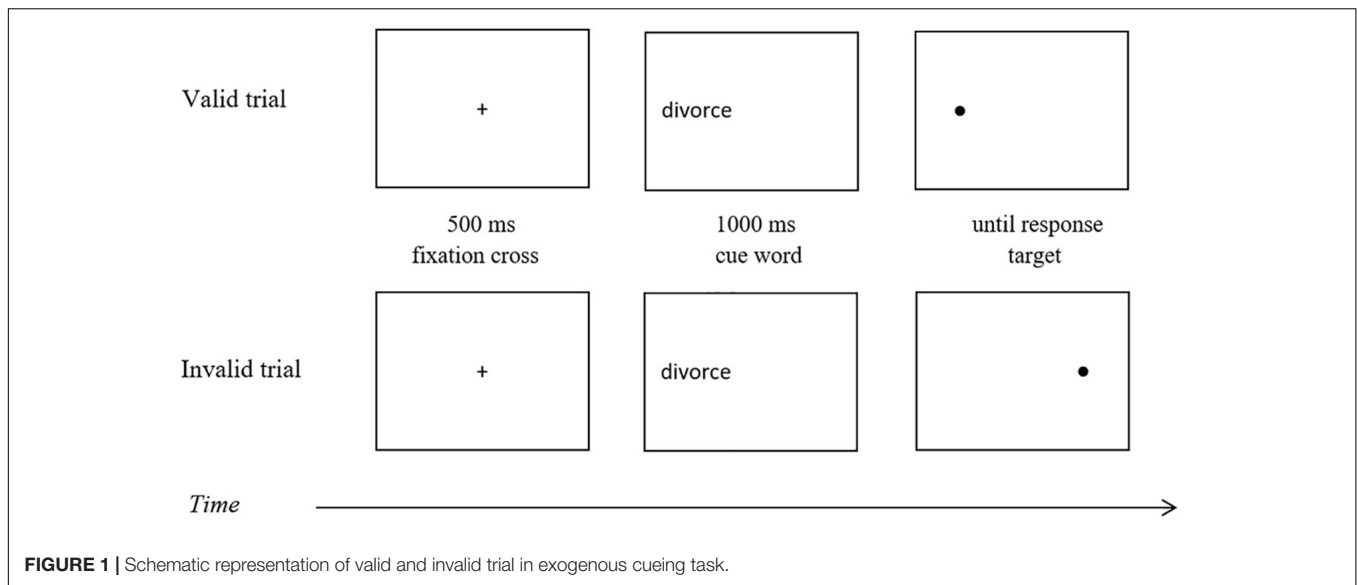
Exogenous Cueing Task

The task is designed to assess attentional disengagement (Koster et al., 2005). On every trial, a fixation cross is presented in the middle of the screen for 500 ms (see **Figure 1**). Next, a word cue appears for 1000 ms on the left or right-hand side of the screen. The target (a dot) is subsequently presented and remains on the screen until a response. Participants are instructed to indicate, as fast as possible, whether the target appeared on the right or left-hand side of the screen. They responded by pressing one of two keys (“d” for left target location and “k” for right target location) on a standard keyboard. In the valid trials, the target appears in the same location as the cue word, in invalid trials, on the opposite side. Cues consist of ten negative, ten neutral words and six RNT-relevant words. The neutral and negative cue words were selected on the basis of their affective valence and matched on familiarity and word length (the differences on frequency and length were non-significant between neutral and negative words) according to French Language Corpus (Interactive Language Toolbox; KU Leuven, 2014). RNT-related cue words were individually selected by each participant (see section “Goal Cueing Task”). The words were randomly selected from the set of each valence list. The task was preceded by 12 training trials, followed by 80 experimental trials with an equal number of valid and invalid trials.

Attentional disengagement was assessed by the attentional disengagement index proposed by Koster et al. (2005). The attentional disengagement index was calculated for negative stimuli (correct response time (CRT) to invalid trials with negative cue minus CRT to invalid trials with neutral cue). An analogous index was calculated for the RNT-related stimuli (CRT to invalid trials with RNT-related cue minus CRT to invalid trials with neutral cue). The positive value of attentional disengagement index indicates that participant had a longer disengagement time for emotional (negative or RNT-related) stimuli comparing to neutral ones, suggesting disengagement impairment. Negative or zero value of the index indicates no difficulty in attentional disengagement from negative or RNT-related stimuli.

Emotional Reactivity – Positive Affect Negative Affect Schedule

Participants’ emotional reactivity was assessed through changes in the Positive Affect Negative Affect Schedule (PANAS; Crawford and Henry, 2004; Gaudreau et al., 2006). The PANAS is a self-reported questionnaire that assesses positive and negative



affect. The questionnaire is composed of 20 adjectives describing emotional states, ten for positive affect (e.g., excited) and ten for negative affect (e.g., distressed). Participants indicated on a 7-point Likert scale the extent to which the affect-related adjective described their current emotional state. The full version of PANAS was administrated four times, at the baseline and after each task in the procedure. In the present study negative affect subscale used in the further analysis had a good internal consistency in all four measure times ($\alpha = 0.88-0.93$).

Trait Abstract RNT – Mini Cambridge Exeter Repetitive Thinking Style Questionnaire

The Mini-CERTS is a brief self-reported questionnaire assessing the processing mode of RNT (Douilliez et al., 2014). Abstract repetitive thinking was assessed using nine item subscale (e.g., “My thinking tends to get stuck in a rut, involving only a few themes”), each item is rated on a 4-point Likert scale. Abstract repetitive thinking subscale used in the present study has satisfying internal consistency Cronbach’s $\alpha = 0.70$.

Ruminative Response Scale – Revised (RRS-R; Treynor et al., 2003)

The 10-item version of a self-reported questionnaire assessing rumination was used. The short version is composed of five items evaluating brooding rumination dimension (e.g., “Think about how alone you feel”) and five items evaluating reflection dimension of rumination (e.g., “Go away by yourself and think about why you feel this way”). The internal consistency of total scale was quite low Cronbach’s $\alpha = 0.62$, the consistency of brooding was also relatively low ($\alpha = 0.64$).

Beck Depression Inventory (BDI-II; Beck et al., 1996)

The BDI-II is a 21-item questionnaire assessing the presence and severity of depressive symptoms over the previous 2 weeks. Responses range from 0 (e.g., “I do not feel like a failure”) to 3 (e.g., “I feel I am a total failure as a person”). In the present study BDI-II had a good internal consistency with Cronbach’s $\alpha = 0.88$.

Procedure

Participants were recruited on the campus by the experimenter. During the testing phase, participants were alone in the experiment room. They were instructed to solicit experimenter’s help, if needed. All the tasks (including questionnaires) were programmed in Inquisit version 4 software and displayed on a 13.3 inches screen. All participants signed an informed consent form prior to their participation.

First, participants were asked to provide demographic information: age, sex, and educational level. Then, they filled a pre-induction PANAS (PANAS 1) to assess their emotional state. The PANAS was also administrated after each of the tasks presented below (PANAS 2 – after goal cueing task; PANAS 3 – after abstract vs. concrete RNT or control induction; PANAS 4 – after exogenous cueing task. The time 4 measures were not included in the analyses as they were added for the ethical reasons only in order to check whether participants’ emotional state after the end of experiment was reinstated at a similar level as the baseline).

Next, participants completed the goal cueing task in order to activate RNT process. Subsequently, participants were randomly assigned to one of the three conditions, two RNT (i.e., abstract vs. concrete) induction conditions and one control condition (distraction). Finally, participants completed the attentional cueing task in order to assess their attentional disengagement. Finally, they were asked to fill in the Mini-CERTS, RRS-R, and BDI-II. Participants were debriefed once the study was concluded. The study, including information phase, signing a consent form and debriefing, lasted between 50 and 60 min. Participants did not receive any incentives for their participation. The whole experimental procedure was approved by Institutional Behavioral Sciences Ethics Review Committee of the University of Lille (number of the approval: 2014-3-S23) and was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

Statistical Analyses

First, to test the hypothesis of the differential impact of abstract vs. concrete on emotional reactivity, we computed a mixed design ANOVA 3 (Experimental condition: abstract, concrete, distraction) \times 2 (Time: Time 2, pre-RNT induction; Time 3, post-RNT induction) on the negative affect score from PANAS. Second, in order to test the impact of experimental induction of RNT on attentional disengagement, we run a mixed design ANCOVA 2 (Word type: negative, RNT related) \times 3 (Experimental condition: abstract, concrete, distraction) on the attentional disengagement index with negative affect measured after RNT induction as a covariate. Finally, to assess the moderated effect of trait variables, we computed moderation models using conditional process models (Hayes, 2015). The relatively small sample size is one of the limitations of the present study. To address this limitation in moderating effect analyses, we chose to compute the moderator effect with the bootstrap method (with 5000 bootstraps), that is more suitable for the small samples (Hayes, 2015).

RESULTS

Data Preparation

Erroneous responses (1.36%) on the attentional cueing task were excluded from statistical analyses. Those responses were identified following Koster et al. (2005) procedure for cleaning the data in exogenous cueing task. Reaction times shorter than 150 ms or longer than 1500 ms and RTs that deviating more than three SDs from the individual mean latency were also excluded from the data set used in the further analysis (5.45%).

Statistics and Mean Comparisons Between Abstract RNT, Concrete RNT and Control Group

Mean and standard deviations by condition for all variables are presented in the **Table 1**. One-way ANOVAs were computed for each of the variables in order to assess the group differences between the RNT conditions (abstract RNT, concrete RNT and distraction). There were no significant differences in trait measures of rumination or depressive symptomatology across the three induction conditions.

Abstract vs. Concrete RNT Effect on Emotional Reactivity

First, a mixed design ANOVA 3 (Experimental condition: abstract, concrete, distraction) \times 2 (Time: before vs. after rumination induction) was computed on negative affect subscale of PANAS in order to assess emotional reaction to RNT activation in goal cueing task and whether this change is different across experimental groups. The ANOVA revealed a significant effect of time ($F_{(1,57)} = 40.02$, $p < 0.001$, $\eta_p^2 = 0.41$), suggesting that participants' negative affect increased after rumination induction (see **Figure 2**: Time 1 and Time 2). As expected, the interaction effect between Experimental condition

and Time was not significant as at this stage of experiment all groups underwent exactly the same procedure of RNT activation ($F_s < 1$).

To test the direct effect of abstract vs. concrete RNT and distraction induction on emotional reactivity, a mixed design ANOVA 3 (Experimental condition: abstract, concrete, distraction) \times 2 (Time: Time 2, pre-RNT induction; Time 3, post-RNT induction) was computed. The effect of Time, $F_{(1,53)} = 24.40$, $p < 0.001$, $\eta_p^2 = 0.31$, the main effect of Experimental condition, $F_{(2,55)} = 3.37$, $p < 0.04$, $\eta_p^2 = 0.11$, and Experimental condition \times Time interaction effect, $F_{(2,53)} = 7.81$, $p = 0.001$, $\eta_p^2 = 0.22$, were significant. In line with expectations, *post hoc* comparisons with Bonferroni correction revealed a significant decrease of negative affect from pre-RNT induction to post-RNT induction for concrete RNT condition ($p = 0.02$; $M = 22.84$, $SD = 7.52$; $M = 20.10$, $SD = 7.16$, respectively), and distraction ($p < 0.001$; $M = 23.05$, $SD = 8.05$; $M = 16.63$, $SD = 4.71$, respectively). This difference was not significant for abstract RNT condition ($p = 0.78$; $M = 25.20$, $SD = 6.38$; $M = 24.90$, $SD = 6.90$, respectively), see **Figure 2**: Time 2 (after rumination induction) and Time 3 (after RNT processing mode induction).

RNT Induction Effect on Attentional Disengagement

We run analysis of covariance, a mixed design ANCOVA 2 (Word type: negative, RNT-related) \times 3 (Experimental condition: abstract, concrete, distraction), for the attentional disengagement index (Koster et al., 2005) measuring disengagement from negative and RNT-related words in relation to neutral words (see method section for disengagement index computation), with negative affect post-RNT induction as a covariate. As predicted, the analysis revealed a significant effect of word type ($F_{(1,54)} = 4.29$, $p = 0.04$, $\eta_p^2 = 0.11$), suggesting that participants are slower in disengaging from RNT-related words comparing to neutral words (mean attentional disengagement index = 3.05, $SD = 32.11$) and faster in disengaging from negative words relative to neutral words (mean disengagement index = -5.22 , $SD = 30.48$). All the other effects were non-significant ($F_s < 1$).

To control for potential differences in dysphoria (Koster et al., 2005), we computed a mixed design ANCOVA with BDI-II score as a covariate. ANCOVA 2 (Word type: negative, RNT-related) \times 3 (Experimental condition: abstract, concrete, distraction) computed for attentional disengagement index revealed a significant effect of Word type ($F_{(1,53)} = 7.81$, $p = 0.01$, $\eta_p^2 = 0.13$). Also the interaction effect between word type and covariate was significant ($F_{(1,54)} = 4.19$, $p = 0.04$, $\eta_p^2 = 0.07$). Participants seems to generally take longer to disengage from RNT-related words comparing to the negative ones, this effect is moderated by their dysphoria. All the other effects were non-significant.

Additionally, analyses were performed on the mean response times. A mixed design ANCOVA, 2 (Cue validity: valid, invalid) \times 3 (Word type: neutral, negative, RNT-related) \times 3 (Experimental condition: abstract, concrete, distraction) was

TABLE 1 | Mean and Standard Deviations for each variable by condition.

Variable	Type of induction			Group comparison	
	Abstract (SD)	Concrete (SD)	Distraction (SD)	$F_{(2,55)}$	η_p^2
Invalid RT					
Neutral	371.74 (78.03)	433.91 (187.91)	341.07 (55.39)	2.80 ^{2,+}	0.09
Negative	364.11 (73.69)	434.49 (175.69)	332.58 (56.59)	4.04 ^{1,2,*}	0.13
RNT-related	373.60 (68.33)	443.02 (183.78)	339.31 (63.09)	4.06 ^{1,2,*}	0.12
Valid RT					
Neutral	382.87 (77.98)	437.93 (150.81)	361.01 (50.27)	2.88 ⁺	0.09
Negative	383.84 (68.83)	442.28 (182.33)	359.12 (65.26)	2.49 ⁺	0.07
RNT-related	387.49 (62.43)	440.78 (161.29)	364.85 (52.54)	2.62 ^{2,+}	0.09
Cue validity					
Neutral	-11.13 (39.72)	-4.01 (49.81)	-19.93 (35.65)	0.68	0.02
Negative	-19.72 (40.91)	-7.78 (63.85)	-26.54 (44.38)	0.67	0.02
RNT-related	-13.88 (35.29)	2.24 (47.03)	-25.53 (23.23)	2.47 ⁺	0.08
Attentional disengagement					
Negative	-7.63 (33.17)	0.58 (33.81)	-8.49 (24.19)	0.56	0.02
RNT-related	1.86 (36.84)	9.11 (33.56)	-1.76 (25.33)	0.51	0.02
Mini-CERTS AAT	23.00 (4.12)	24.31 (4.00)	24.58 (4.02)	0.83	0.02
RRS	23.68 (4.73)	23.95 (4.35)	24.00 (4.79)	0.02	<0.01
Brooding	11.89 (2.75)	12.47 (2.78)	12.68 (3.51)	0.34	<0.01
BDI-II	16.31 (8.63)	15.05 (10.80)	14.89 (9.15)	0.15 ²	<0.01
Personal words valence	2.60 (0.80)	2.55 (1.01)	2.27 (0.74)	0.83	0.03

* $p < 0.05$; ⁺ $p < 0.10$. RT, response time; Mini-CERTS AAT, abstract analytic thinking from Mini Cambridge Exeter Repetitive Thinking Style Questionnaire; RRS, ruminative response scale; BDI-II, beck depression inventory –II. ¹Bolded values are significantly different from the other means in a row according to post hoc analysis with Bonferroni correction. ²The ANOVA was computed on a transformed variable (logarithmic transformation) in order to improve the homogeneity of variance (for reaction times) or normality of distribution (for BDI-II).

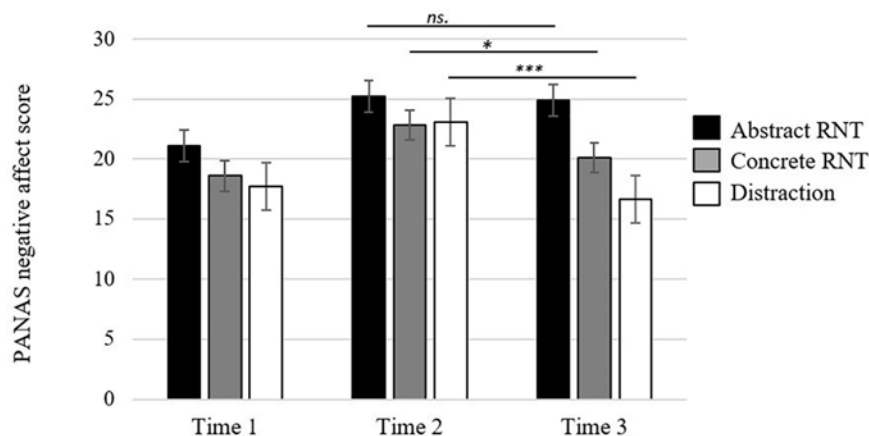


FIGURE 2 | Negative affect score (PANAS) as a function of measure time and experimental condition. * $p < 0.05$; *** $p < 0.001$, ns. non-significant. Time 1 (baseline), Time 2 (after rumination induction – goal cueing task), Time 3 (after RNT mode induction).

computed on participants CRTs to exogenous cueing task, with negative affect post-RNT induction as covariate. A main effect of cue validity was observed, $F_{(1,55)} = 4.50$, $p = 0.04$, $\eta_p^2 = 0.08$. Participants detected quicker invalid cues comparing to the valid ones ($p < 0.01$), which suggests an inhibition of return effect. The results also revealed a significant main effect of Experimental condition, $F_{(2,55)} = 3.61$, $p = 0.05$, $\eta^2 = 0.10$ (see **Figure 3**). *Post hoc* comparisons with Bonferroni correction suggested that participants in concrete RNT induction responded slower than

participants from distraction group ($p < 0.05$). The results did not reveal any significant interactions.

Moderating Effects of Trait RNT and Depressive Symptomatology on Attentional Disengagement

To explore how trait RNT and depressive symptomatology interact in their impact on attentional disengagement, we

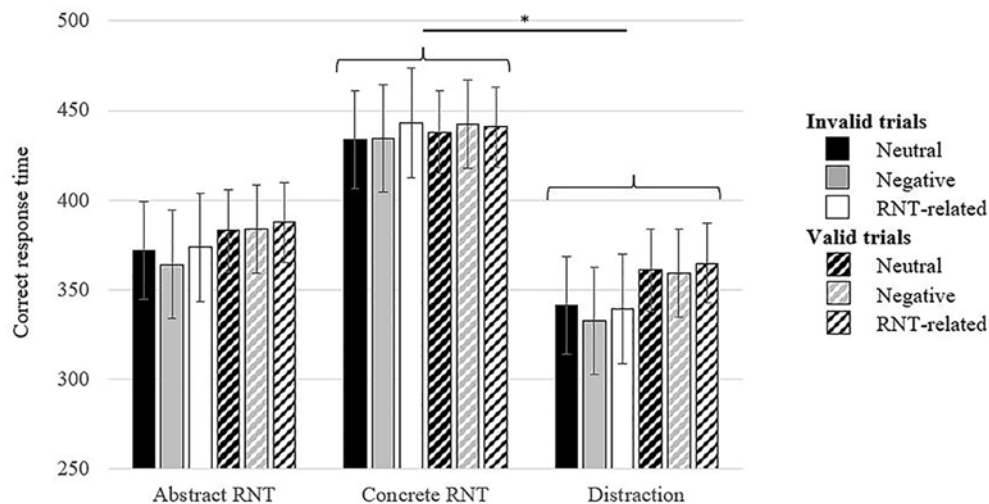


FIGURE 3 | Mean correct response time in exogenous cueing task by RNT and distraction induction condition. * $p < 0.05$.

computed conditional process moderation models (Hayes, 2015) with trait-RNT and BDI-II score entered to the models as mean centered moderators. The experimental condition, as a categorical variable with 3 levels (abstract, concrete, distraction), was transformed into 2 dummy variables, following Hayes and Preacher's (2013) guidelines. The first dummy variable created for abstract RNT (aRNT) induction was coded 1 for abstract RNT condition, and 0 for concrete RNT and distraction conditions. The second dummy variable created for concrete RNT (cRNT) induction was coded 1 for concrete RNT and 0 for abstract RNT and distraction conditions.

For testing a model with a predictor with k categories, it is necessary to run $k-1$ models (2 in our study). In both models one dummy variable was a predictor (X) and the remaining one was a covariate (C) (see **Table 2**), consequently we did not obtain one estimation of the effect, but an estimation for each category relative to the reference category in the dummy coding scheme (Hayes and Preacher, 2013).

First, attentional disengagement from negative stimuli was not affected by experimental induction (see **Table 2**). However, after including BDI-II and trait-RNT into the conditional process analysis, the results suggested that BDI-II score affected attentional disengagement from negative stimuli in a model with abstract RNT induction variable as a predictor ($p < 0.01$; see **Table 2**). BDI-II score also interacted with concrete RNT induction variable ($p < 0.01$). Thus, it seems that depressive symptomatology interferes with attentional disengagement. This interference is particularly apparent after concrete RNT induction, where dysphoric participants showed significantly higher index of attentional disengagement from negative stimuli comparing to the other conditions, suggesting that dysphoria is linked to impaired attentional disengagement from negative material (simple slopes for high BDI-II scores (+1SD) were significant: $p < 0.05$ for low abstract analytic thinking (AAT) and $p = 0.05$ for high AAT). This difference was not significant for participants with low BDI-II score (none of the simple slopes for

low BDI-II scores (−1SD) were significant: $p = 0.91$ for low AAT and $p = 0.14$ for high AAT).

The conditional process moderation models predicting attentional disengagement from negative stimuli with trait RNT as moderator were non-significant, both, for abstract RNT ($p = 0.058$), and for concrete RNT induction ($p = 0.15$).

None of the models computed for attentional disengagement from RNT-related stimuli was significant: $R^2 = 0.22$, $MSE = 898.45$; $F_{(8,48)} = 1.74$, $p = 0.11$ for Dummy aRNT and $R^2 = 0.13$, $MSE = 1007.68$; $F_{(8,48)} = 0.90$, $p = 0.52$ for Dummy cRNT when BDI-II and AAT scores were included as moderators and $R^2 = 0.21$, $MSE = 912.88$; $F_{(8,48)} = 1.61$, $p = 0.15$ for Dummy aRNT and $R^2 = 0.10$, $MSE = 1042.14$; $F_{(8,48)} = 0.67$, $p = 0.71$ for Dummy cRNT when brooding and BDI-II scores were included as moderators.

In sum, there was no effect of abstract vs. concrete RNT induction on attentional disengagement when including moderating variables. Conditional moderation process models supported previous results that disengagement is affected by trait dysphoria (Koster et al., 2005). However, abstract vs. concrete RNT induction seems to affect the response time in exogenous cueing task, suggesting that participants using abstract RNT are faster to detect the stimuli independently of their valence.

DISCUSSION

The aim of the present study was to explore how experimental induction of abstract vs. concrete RNT after a situation typically conceptualized to activate rumination (i.e., involving actual-ideal self-discrepancy) impacts emotional reactivity (i.e., the changes in negative affect) and attentional disengagement. To the authors' best knowledge this was the first study to experimentally test the link between two RNT processing modes and attentional disengagement. An additional aim was to explore whether the potential attentional impairment due to RNT is apparent only

TABLE 2 | Conditional moderation process estimating difficulties in disengagement from negative words due to experimental condition, depressive symptomatology and trait RNT.

	Model with Dummy aRNT as X					Model with Dummy cRNT as X				
	Coefficient	SE	p	LLCI	ULCI	Coefficient	SE	p	LLCI	ULCI
Intercept	−0.79	7.40	0.91	−14.98	17.94	0.36	7.44	0.96	−13.99	14.08
Dummy aRNT (cRNT) (X)	2.84	11.61	0.81	−29.26	26.71	14.04	11.34	0.22	−5.10	35.77
Mini-CERTS AAT (M ₁)	−11.79	7.68	0.13	−30.48	5.02	−6.27	6.60	0.35	−19.63	6.97
BDI-II (M ₂)	20.49	7.54	<0.01	4.02	42.83	4.97	6.93	0.47	−9.40	21.33
Dummy x Mini-CERTS AAT (X M ₁)	2.46	11.84	0.84	−25.76	30.36	−22.18	13.24	0.10	−60.12	3.47
Dummy x BDI-II (X M ₂)	−22.40	12.52	0.08	−54.43	14.29	34.29	12.67	<0.01	10.36	64.16
Mini-CERTS AAT x BDI (M ₁ M ₂)	−6.77	4.83	0.16	−16.44	2.14	−10.83	5.71	0.06	−26.60	0.75
Dummy x AAT x BDI-II (X M ₁ M ₂)	−12.96	9.65	0.19	−36.04	11.89	−0.33	8.53	0.97	−17.51	16.82
Dummy cRNT (aRNT) (C)	9.14	9.04	0.32	−10.13	27.45	−2.95	9.54	0.76	−22.14	16.23
				$R^2 = 0.30$, $MSE = 766.38$					$R^2 = 0.30$, $MSE = 760.54$	
				$F_{(8,48)} = 2.53$, $p = 0.022$					$F_{(8,48)} = 2.59$, $p = 0.019$	

aRNT, abstract RNT induction condition; cRNT, concrete RNT induction condition; AAT, Abstract thinking from Mini-CERTS; BDI-II, Beck Depression Inventory-II; LLCI, bootstrap lower level confidence interval; ULCI, bootstrap upper level confidence interval.

for negative stimuli (Koster et al., 2005), or is it specific for rumination-related stimuli as suggested by the attentional scope model of rumination (Whitmer and Gotlib, 2013).

According to the processing mode theory (Watkins, 2008), the adaptive character of rumination does not depend on the content of thoughts but is rather linked to the mode of information processing. The results of the present study seem to endorse this postulate for both, concrete and abstract RNT. We observed a distinctive impact of those processing modes on the change of pre-post induction negative affect (emotional reactivity). Participants using concrete RNT presented a lower emotional reactivity than those using abstract RNT. The results supported the theoretical predictions of processing mode theory and corroborate the results of previous studies (Watkins and Teasdale, 2004; Watkins and Moulds, 2005; Watkins et al., 2008).

However, the results concerning attentional disengagement are more complex and do not fully corroborate the theoretical predictions. It seems that concrete RNT – postulated as adaptive in a rumination situation – impairs participant's attentional disengagement resulting in longer response time comparing to participants in control condition in both valid and invalid trials, independently from stimuli valence.

The most tempting would be to explain the difference in attentional performance by the fact that participants, after concrete RNT induction, are in a less negative affective state, as some studies suggested that positive mood can impair executive functioning (Phillips et al., 2002). However, in the present study the distinctive impact of abstract vs. concrete RNT on attentional disengagement cannot be imputed to differences in affect. Participants from distraction group, who did not differ from concrete group on affect, showed significantly shorter response times in the attentional disengagement task. Consequently, the deleterious effect of concrete processing cannot be attributed to the differences in affect between abstract and concrete conditions. Moreover, the statistical analyses suggest that affect did not influence the attentional indicators in our study.

Emotional Reactivity vs. Attentional Processing

An important challenge is to explain why concrete RNT has beneficial effect on emotional reactivity, while, at the same time, and contrary to predictions, it impairs attentional disengagement. Even more challenging will be to determinate what are the consequences of this distinctive impact in the use of rumination focused clinical interventions like concreteness training (Watkins et al., 2009; Watkins, 2016). Training patients to use concrete thinking might certainly improve their short-term emotional reactivity, i.e., decrease their negative impact, but possibly impact also their attentional functioning. However, one might postulate that these differences in attentional processing are necessary to regulate negative affect and that it is rather the abstract RNT that causes an over-efficiency of disengagement from negative stimuli enhancing emotional avoidance. Nevertheless, in the present study, we have observed similar attentional results for abstract and distraction conditions, while the results were diverging in terms of emotional reactivity. Also, the lack of interaction between induction condition and type of stimuli might suggest that concrete RNT is in general linked to a less efficient attention control. The attentional impairment occurred for all types of stimuli.

On the one hand, the results are consistent with the control theory (Martin and Tesser, 1989) predicting that abstract processing should be associated with a greater self-control (increasing the focus on higher order goals and the resistance to immediate temptation). Although this pattern of results is relatively rare among experimental RNT research, it was previously observed in inhibition studies testing the link between inhibition and RNT (Altamirano et al., 2010; Zetsche and Joormann, 2011).

On the other hand, as postulated by the processing mode theory (Watkins, 2004), participants in concrete RNT condition are more focused on environmental details, their inner feelings at the moment, and consequently less focalized on the task being

an external imposed goal (Watkins, 2011). They might experience some kind of immersion sensation that interferes with controlling and monitoring objectives. Concrete processing prevents from thinking of long-term consequences, and it is possible that it disturbs the cognitive efficiency. The lost in efficiency might also be due to the fact that concrete processing is an adaptive strategy of emotional regulation for ruminators, but this strategy requires additional cognitive resources and consequently participants cannot further allocate those resources to another task (here: exogenous cueing task). The impact on cognitive efficiency would be inversed for abstract processing. Previous studies showed that inducing abstract RNT results in a greater use of self-control in experimental tasks along with a greater perseveration comparing to concrete processing (Vallacher and Wegner, 1989; Fujita et al., 2006). A complementary explanation on the role of attentional control in ruminative process comes from the studies on thought suppression (Wegner et al., 1993; Wenzlaff and Luxton, 2003). In ruminators, the paradoxical effect of thoughts suppression is observed only under high cognitive load, when an attentional control dependent process of distracting one's attention is inefficient and a more automatic and attentional control independent process of monitoring is operating (Wegner et al., 1993; Wenzlaff and Luxton, 2003).

The studies on ego-depletion provide additional arguments corroborating the idea that concrete processing (contrary to abstract one) results in lower emotional reactivity, but also in less efficiency in executive tasks. Schmeichel and Vohs (2009) suggest that abstract comparing to concrete processing can help to overcome self-control depletion and enhance the recruitment of attentional control resources. However, according to Webb and Sheeran (2003), it is the concrete processing that should result in recruiting cognitive resources. Probably the effect of concrete and abstract RNT on attentional control might be moderated by importance of the goal and its endogenous character.

It is important to underline, that our study corroborate previous findings suggesting that depressive symptoms are involved in attentional disengagement (Koster et al., 2005). An added value of the present study was to explore the interactions between RNT induction, trait RNT, and depressive symptomatology on attentional disengagement indicators. Although none of the models for attentional disengagement from RNT-related stimuli was significant, the results on attentional disengagement from negative stimuli suggest that disengagement might be impaired by dysphoria, corroborating previous results on attentional disengagement (Koster et al., 2005; Ferrari et al., 2016). Additionally, we observed that this effect was particularly apparent after concrete RNT induction (there was a tendency in the abstract RNT condition).

Future Directions and Conclusion

In the present study, we aimed at differentiating the effect of attentional disengagement from general negative stimuli and disengagement from stimuli related to rumination (more relevant for participants) in order to test the predictions of attentional scope model of rumination (Whitmer and Gotlib, 2013). One of the limitations of the present study was the lack of standardization in the RNT-related stimuli. As we enhanced

the ecological character of the stimuli by letting participants choose their own personal words, we were not able to standardize those stimuli valence. Participants seemed to choose words of different valence to describe their unresolved problem, with a mean valence score suggesting a neutral character of the words. It is important to further explore the idea of self-referent and RNT-related stimuli type, especially that Watkins (2016) suggested that abstract processing interferes with disengaging from an ongoing goal and not with attentional disengagement in general.

Additionally, the results of the present study support the hypothesis that, from a clinical perspective, some forms of cognitive control may be maladaptive (Messina et al., 2016). Participants using abstract RNT seems to present better attentional control, but, at the same time, their emotional reactivity is higher. Messina et al. (2016)'s suggestion that rumination might be linked with the ironic effect of exerting cognitive control might contribute to explain this effect and to open new therapeutic paths. However, before considering therapeutic implications and addressing the precise mechanism of maladaptive cognitive control in clinical settings, it is first necessary to evaluate the long-term interplay between different RNT types, cognitive resources and attentional control.

In the present study, we focused specifically on rumination — one of the emotional regulation strategies most related to psychological disorders — with the aim of distinguishing between abstract and concrete rumination according to processing mode theory (Watkins, 2008). This distinction seems crucial also from the clinical perspective of rumination-focused CBT, where concrete training (i.e., enhancing the use of concrete processing mode and reducing abstract processing mode) is one of the key elements (Watkins et al., 2009; Watkins, 2016). It seems interesting to further investigate the role of attentional control and its adaptive vs. maladaptive feature also beyond rumination and to test how it interplays with other emotional regulation strategies.

The present study was the first to explore the distinctive impact of abstract and concrete RNT on attentional disengagement. According to the results, the concrete RNT causes an attentional impairment for all types of stimuli (neutral, negatives and RNT-related). It is important to note that processing mode affected rather general attentional control and it is dysphoria that affected its particular component: attentional disengagement from negative stimuli. Dysphoria was the only significant predictor of the attentional disengagement from negative stimuli. However, concrete RNT enhanced a reduction of negative affect suggesting a lower emotional reactivity. Those results are particularly relevant in concreteness training perspective (Watkins et al., 2009; Watkins, 2016). It would be interesting to further explore whether an impairment in attention is a consequence of the cognitive cost of an adaptive emotional regulation in ruminators.

ETHICS STATEMENT

The study was run with University of Lille Ethic Committee approval (decision number: 2014-3-S23) and in accordance with

the recommendations of the American Psychological Association and the Declaration of Helsinki. Participants signed a consent form prior to their participation, the procedure ended by a debriefing. The experimenter explained the aim of the study and answered all questions.

AUTHOR CONTRIBUTIONS

MK designed the research, collected the data, did statistic analysis, wrote and revised the manuscript. IK did statistic analysis and revised the manuscript. CD designed the research, did statistic analysis and revised the manuscript.

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SUPPLEMENTARY MATERIAL

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Wkład poszczególnych autorów_ek/Authors' contribution

Monika Kornacka: Conceptualization, Methodology, Writing – review & editing, Writing—original draft, Data collection, Formal analysis, Funding acquisition.

/Opracowanie koncepcji badania, redakcja i weryfikacja tekstu, przygotowanie pierwszej wersji tekstu, administracja projektem, opracowanie metody badania, pozyskanie finansowania.

Szczegółowy wkład autorki: Wkład autorki w powstanie tej pracy polegał na stworzeniu koncepcji i modelu badawczego, pozyskaniu finansowania, opracowaniu metody badania, a także napisaniu pierwszej wersji tekstu oraz jego późniejszej edycji, również w ramach odpowiedzi na recenzje. Jest równorzędną pierwszą i korespondującą autorką publikacji. Publikacja była finansowana w ramach grantu Polonez, Narodowego Centrum Nauki przy współfinansowaniu European Union's Horizon 2020 Research and Innovation Program - the Marie Skłodowska-Curie (no. 665778) "Dynamic Relation between Repetitive Negative Thinking and Inhibition in Depression - Daily Process Approach" (2016/21/P/HS6/04009) kierowanego przez autorkę.

/Author's detailed contribution: She developed the research concept and model, acquired funding, designed the methodology, and conducted formal analyses. She was also responsible for writing the original draft and its subsequent editing, including preparing the responses to reviewers' comments. She is the first (with MSS) and corresponding author of the publication. The research was funded by Polonez grant from the Polish National Science Centre with the funding from the European Union's Horizon 2020 Research and Innovation Program under the Marie Skłodowska-Curie grant agreement no. 665778, titled "Dynamic Relation between Repetitive Negative Thinking and Inhibition in Depression - Daily Process Approach" (2016/21/P/HS6/04009), for which she was the Principal Investigator.

Izabela Krejtz: Formal analysis, Writing—review and editing.

/Analiza danych, redakcja i weryfikacja tekstu.

Céline Douilliez: Conceptualization, Formal analysis, Writing – review & editing.

/Opracowanie koncepcji badania, analiza danych, redakcja i weryfikacja tekstu.

Podpis/Signature

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**BRAK OŚWIADCZENIA DOT. WSPÓŁAUTORSTWA PUBLIKACJI
/MISSING STATEMENT ON CO-AUTHORSHIP PUBLICATION**

Oświadczam, że pomimo podjętych starań nie udało mi się uzyskać oświadczenia o współautorstwie od **prof. Céline Douilliez** (Laboratory for Experimental Psychopathology, University of Louvain, Louvain-la-Neuve, Belgium) dotyczącego publikacji:

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