

# An experimental test of the habit-goal framework: Depressive rumination is associated with heightened habitual characteristics of negative thinking but not habit-directed behavior control

Journal of Experimental Psychopathology  
October-December 2020: 1–17  
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sagepub.com/journals-permissions  
DOI: 10.1177/2043808720977168  
journals.sagepub.com/home/jepp



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## Abstract

Habitual thinking may underpin a heightened disposition to engage in rumination in response to negative mood, a widely held notion that has rarely been directly tested. The purpose of the current study was to investigate whether rumination is associated with habitual attributes and whether it is related to an imbalance in habit relative to goal-directed behavior control. University students ( $N=115$ ) completed self-report questionnaires, a rumination induction paradigm and an outcome devaluation task that measures habitual vs goal-directed behavior control. Greater habitual characteristics of negative thinking (e.g., automaticity, lack of conscious awareness, control, and intent) were associated with ruminative brooding but not ruminative reflection and predicted more persistent dysphoric mood following rumination induction. Rumination was not, however, consistently associated with an imbalance in habit versus goal-directed behavior control. These findings indicate that depression vulnerability may be in the form of rumination being habitually triggered (without

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awareness or intent) with deleterious effects on mood. Although habitual, rumination may not be related to an imbalance in habit relative to goal-directed behavior control. These findings provide support for current theoretical accounts of rumination and set important boundary conditions in the search for specific factors that contribute to rumination as a habit.

## Keywords

Cognitive vulnerability, depression, habit, rumination

Date received: 26 February 2020; accepted: 6 November 2020

When bad things happen in life, most people feel down or mildly depressed, at least occasionally. For most individuals, such negative mood states are fleeting and relatively short-lived. For others, however, negative mood lingers and becomes progressively more severe over time. The severity of such negative emotional reactions is predicted by the degree to which people tend to engage in rumination in response to their negative mood. Rumination is a form of negative thinking that involves repetitively and passively dwelling on the causes, meanings, and consequences of one's feelings and distress (Nolen-Hoeksema, 1991). Thus, to understand individual differences in depression vulnerability, it becomes necessary to delineate the causal processes that lead to a ruminative disposition.

Ample evidence supports rumination as a vulnerability marker for the development and maintenance of depressive symptoms and episodes (Nolen-Hoeksema et al., 2008; Watkins, 2008). Prospective longitudinal studies using the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991) have found that people who tend to ruminate in response to negative mood are more likely to develop depressive disorders and experience more persistent periods of dysphoric mood than low ruminating individuals (Just & Alloy, 1997; Nolen-Hoeksema, 2000; Spasojevic & Alloy, 2001). Experimental studies using the rumination induction procedure developed by Nolen-Hoeksema and Morrow (1993) have found that rumination leads to heightened and prolonged negative affect and cognition in both dysphoric (Nolen-Hoeksema & Morrow, 1993) and clinically depressed individuals (Donaldson & Lam, 2004; Lavender & Watkins, 2004). Rumination induction also results in greater persistence of negative mood in non-dysphoric participants when first induced into a negative mood state (e.g., Burkhouse et al., 2017; Ciesla & Roberts, 2007; Joormann & Siemer, 2004).

Depression appears to be specifically characterized by high levels of ruminative brooding (Joormann

et al., 2006), a subtype of rumination that involves passively focusing on symptoms of one's distress and the possible meaning and implications of those symptoms (Treyner et al., 2003). In contrast, ruminative reflection, which consists of active cognitive problem-solving that may improve one's mood, has traditionally been thought less associated with depression (e.g., Burwell & Shirk, 2007). Brooding is thought to involve a more self-critical, evaluative, and judgmental type of self-focus that leads to a greater persistence of negative mood (Rude et al., 2007). However, ruminative reflection is elevated in both currently and formerly depressed samples (Joormann & Gotlib, 2010), which suggests that adaptive self-reflection may turn into maladaptive brooding, when individuals attempting to understand their problems repeatedly fail to come up with solutions (Takano et al., 2011).

## *Rumination as a mental habit*

Habitual thinking may explain why some people respond to negative affect with a ruminative response style. According to the Response Styles Theory, rumination is an enduring, stable, and habitual-like tendency (Nolen-Hoeksema et al., 2008). This is consistent with Hertel's (2004) conceptualization of rumination as a habit of thought that is automatic and often involuntary. More recently, Watkins and Nolen-Hoeksema (2014) proposed a habit-goal framework of depressive rumination, where rumination is seen as a mental habit that is initiated without awareness or conscious intent in response to negative mood. Habits are formed by learned associations between responses and their performance contexts. Once formed, context cues become automatic triggers for the behavior, such that it is controlled solely by the presence of the context cue, rather than individual's goals or motivations (Triandis, 1977; Wood & Neal, 2007). Habitual accounts of rumination therefore differ from other conceptualizations of repetitive

behaviors (e.g., the perseverative cognition hypothesis; Brosschot et al., 2006) in that rumination is seen as a stimulus-triggered response that persists despite changes in outcome value.

According to the habit-goal framework, transient episodes of goal-directed ruminative thoughts arise in response to a perceived discrepancy between one's goals and the status of progress toward these goals (Watkins & Nolen-Hoeksema, 2014). The process can be considered adaptive when the repetitive thinking helps to reach goals. However, when goals are repeatedly not reached, ruminative thoughts may persist (Martin & Tesser, 1996; Watkins, 2008). Because unresolved goal conflict leads to increased negative affect, episodes of goal-directed rumination may develop into a mood-linked habit over time when it repeatedly occurs contingent on the same context (i.e., negative mood). Both situational factors that systematically thwart important goals and are associated with low mood (i.e., chronic stress, emotional, physical, or sexual abuse and neglect) and person-specific factors that contribute to a lack of flexible responding (i.e., restricted coping repertoire and cognitive inflexibility) should facilitate the formation of rumination as a habit (Watkins & Nolen-Hoeksema, 2014). Analytical and abstract depressive brooding is more likely to develop into a mental habit compared to ruminative reflection, a more flexible and concrete way of thinking. According to the framework, brooding leads to the recurrent pairing of negative mood with ruminative thoughts which develops into a mood-driven habit over time, whereas reflection is not assumed to play such a role (Watkins & Nolen-Hoeksema, 2014). Nonetheless, given the inconclusive evidence regarding a clear distinction between ruminative brooding and reflection, this is an assumption that remains to be tested.

Consistent with the habit-goal framework, rumination has often been described as being habitual in the depression literature (e.g., see Hertel, 2004), however, this has rarely been directly tested. Habits are automatic in the sense that they are initiated without conscious awareness, intent, or effort and are therefore difficult to control (Verplanken et al., 2007). Indeed, Watkins and Baracaia (2001) found that self-identified ruminators reported that rumination occurs without conscious intent and is difficult to control. Furthermore, recent theoretical conceptualizations of depression vulnerability have characterized rumination, in some way or another, as a mental habit that traps the individual in a vicious cycle of greater

attentional fixation on and processing of negative information (e.g., Farb et al., 2015; Koster et al., 2011). A study by Verplanken et al. (2007) found in a sample of university students that rumination was associated with self-reported lack of conscious awareness, lack of deliberate intent, and greater difficulties in controlling negative thinking. Notably, greater self-reported habitual characteristic of negative thinking prospectively predicted additional variance in future depression, above measures of negative content of thought alone (Verplanken et al., 2007). Van Vugt et al. (2018) showed, in a novel simulation study, that modeling rumination as a habit best predicted the impairments of depressed participants on a sustained attention task, concluding that rumination might be caused by maladaptive habits of thought. More recently, a study by Ólafsson et al. (2020) found that ruminative brooding, but not reflection, was associated with heightened self-reported habitual attributes measured with the Self-Report Habit Index (Verplanken & Orbell, 2003).

Thus, there exists preliminary evidence for the notion of rumination as a mental habit. However, the existent findings do not address some of the key assumptions of the habit-goal framework. At present, little research is available on whether depressive brooding, but not ruminative reflection, is associated with habitual attributes and, importantly, it remains to be directly tested whether heightened habitual characteristics are associated with greater detrimental effects of rumination.

### *Habitual and goal-directed behavior control*

There is limited research into the specific factors that might contribute to rumination becoming habitual in the first place. The habit-goal framework broadly defines personal and environmental factors that lead to inflexible responding as possible mechanisms (Watkins & Nolen-Hoeksema, 2014). Similarly, Hertel's (2004) earlier conceptualization suggested that external factors that impair guided attention (e.g., impairments in working memory and sustained attention) could contribute to the formation of habitual rumination. A more recent model by Shaw et al. (2019) proposes that certain risk factors (e.g., stressful environments, temperament, genetic vulnerability, and parenting styles) contribute to higher levels of negative affect, which in turn may perpetuate state levels of rumination. Over time, this repeated coupling with negative affect may consolidate rumination

into a habitual trait-like response style, especially among those with cognitive control deficits.

There is growing evidence that there are individual differences in the propensity to form habits, with greater habit propensity implicated in disorders such as addiction, eating disorders, and obsessive-compulsive disorder (De Wit, 2017). More specifically, research has shown behaviors to be guided by distinct but interrelated habit and goal-directed control systems, presumably underpinned by different biological brain systems. Goal-directed control is implicated in the adjustment of behavior based on predictions of future outcomes, whereas habitual control is driven primarily by experiences of past outcomes (Dolan & Dayan, 2013). Impairments in goal-directed control (e.g., at times of stress and increased working memory load) might contribute to faster and stronger formation of habit because of greater reliance on habit-directed behavior control (Linnebank et al., 2018).

Individual differences in habit versus goal-directed behavioral control have been studied with a computerized outcome devaluation task that taps people's ability to alter behavior when outcome value changes. In this experimental paradigm (De Wit, 2017), previously trained responses that resulted in valued outcomes (i.e., were reinforced) lose their value as the outcome becomes devalued. Repeating previously reinforced but currently devalued responses (i.e., slips-of-action) can be taken as a persistence of previous goal-directed behavior that has become habitual through overtraining, and insensitive to outcome value (De Wit, 2017; Linnebank et al., 2018). Self-report measures such as the Creature of Habit Scale (COHS; Ersche et al., 2017) have also been utilized to study individual differences in habit proneness, and shows that experiences of adversity during childhood — a well-known risk factor for depression (Nelson et al., 2017), is associated with increased automatic habitual responding in everyday life. A study by Ólafsson et al. (2020) found that on an outcome devaluation task, stronger habit relative to goal-directed behavior control was associated with a greater number of previous depressive episodes in a group of formerly depressed individuals. Moreover, Heller et al. (2018) found that on a two-stage decision-making task, individuals high in depression demonstrated greater habitual and less goal-directed decision-making in the face of stress.

Thus, depression may be associated with difficulties modulating behaviors in service of goals, making

people more prone to habitual responding. Consistent with this, depression is strongly associated with stressful life events (Hammen, 2005; Monroe & Cummins, 2017) and more chronic forms of stress and early adversities (Nelson et al., 2017), that can impair the ability to use effortful and goal-directed behavioral control (Beevers, 2005; Snyder, 2013), which may make people more prone to habitual responding (Schwabe & Wolf, 2009; Wood & Rünger, 2016). A novel prediction is that an imbalance between the habit and goal-directed control strategies might predispose people to develop rumination as a habit, especially when faced with a frequent lack of progress toward goals and a lack of flexible responding (Watkins & Nolen-Hoeksema, 2014).

### *Aim of the present study*

The aim of the present study was to empirically test the notion that rumination is a form of mental habit. Given the pivotal role rumination plays in the etiology of depressive affect, identifying the cognitive factors that contribute to a ruminative disposition is of vital importance (Nolen-Hoeksema et al., 2008; Southworth et al., 2017).

Although there exists preliminary evidence for the notion of rumination as a mental habit, the existent findings do not address some of the key assumptions of the habit-goal framework. Little research is available on whether depressive brooding, but not ruminative reflection, is associated with habitual attributes and, importantly, it remains to be directly tested whether heightened habitual characteristics are associated with greater detrimental effects of rumination. We also explore to what extent ruminative brooding may be related to more general difficulties in modulating behaviors in service of goals, that can make people more prone to forming habits. In the present study, we investigate this using a combination of both self-report measures and experimental tasks.

First, consistent with the habit-goal framework of rumination (Watkins & Nolen-Hoeksema, 2014) we expected greater self-reported habitual characteristics of negative thinking (i.e., repetition, lack of conscious awareness and intent, mental efficiency, lack of control, and self-descriptiveness) to be associated with increased ruminative brooding but not ruminative reflection. Second, to expand on this, we also utilized a rumination induction task to assess brooding-like rumination in an experimental setting. Rumination that has become habitual should be associated with

more adverse consequences (Hertel, 2004; Watkins & Nolen-Hoeksema, 2014). It was therefore expected that habitual characteristics of negative thinking would predict a greater persistence of negative affect and cognition following induction of ruminative brooding.

Finally, because depression may be associated with difficulties modulating behaviors in service of goals, we investigated whether rumination, as indexed by both self-report and experimental induction, is associated with greater habitual responding, measured with a questionnaire of habit propensity in everyday life and an experimental outcome devaluation task. We expected rumination to be associated with greater self-reported daily habits and greater slips-of-action on the outcome devaluation task.

## Method

### Participants

Participants were 115 students (27 males, 88 females) between the age of 19 and 56 years ( $M = 23.8$ ;  $SD = 4.4$ ) who responded to an introductory e-mail sent out to all registered students at the University of Iceland. Inclusion criteria were an age between 18 and 65 years and having a good command of both spoken and written Icelandic. Informed consent was obtained from all participants. All participants were volunteers but received a financial compensation for their participation (value: 4,000 ISK, approximately US\$30).

### Materials

#### Self-report measures

**Demographic information.** Participants completed a self-report demographic form inquiring about their age, gender, marital status, and level of education.

**Psychiatric symptoms.** Depressive symptoms were assessed with the Beck Depression Inventory-II (BDI-II; Beck & Steer, 1990), a 21-item self-report questionnaire. Items are rated on a 4-point scale ranging from 0 to 3, with a maximum total score of 63. Higher scores indicate increased symptom severity. The Icelandic version of the BDI-II (Arnarson et al., 2008) has shown good psychometric properties.

**Ruminative Responses Scale.** The RRS (Nolen-Hoeksema & Morrow, 1991; Treynor et al., 2003) is a self-report measure of ruminative disposition. The RRS consists of 22 items that require participants to indicate the extent to which they engage in particular

ruminative responses when in a negative mood. Items are rated on a 4-point Likert-type scale ranging from “never or almost never” to “always or almost always.” Factor analysis has found the RRS to yield two 5-item subscales; of passive, analytical, and maladaptive (brooding) and more active and adaptive (reflection) forms of ruminative thinking. The Icelandic version has good psychometric properties (Pálsdóttir & Pálsdóttir, 2008).

**Habit Index of Negative Thinking.** The habitual quality of negative self-thinking was measured with the Habit Index of Negative Thinking (HINT; Verplanken et al., 2007). The HINT is a 12-item self-report scale that measures the degree to which negative self-thoughts occur frequently, are initiated without awareness, are unintended, are difficult to control, and are self-descriptive. Each item is rated on a 7-point scale in response to the general prompt, “Thinking negatively about myself is something . . .,” and included items such as “I do unintentionally” and “I start doing before I realize I’m doing it.” The HINT thus taps the process aspects—the repetitive and automatic nature of the thoughts—which are considered as key elements of mental habits and which can be distinguished from the content and valence of the thoughts themselves (e.g., Verplanken et al., 2007; Watkins, 2008). The Icelandic version of the HINT has high internal consistency and good discriminant validity (Jóhannesdóttir & Jóhannesdóttir, 2019).

**The Creature of Habit Scale.** The COHS (Ersche et al., 2017) was used to assess individual differences in participants’ propensity to habits in everyday life. The COHS is a 27-item self-report questionnaire that assesses two aspects of habitual responding, routine and automaticity, in a variety of domains. Items were rated on a 5-point scale ranging from “strongly disagree” to “strongly agree” and included items such as “whenever I go into the kitchen, I typically look in the fridge” and “I often find myself running on autopilot.” The Icelandic version of the COHS has good psychometric properties (Jóhannesdóttir & Jóhannesdóttir, 2019).

**Experimental measure of ruminative disposition.** Rumination was also assessed using a standard rumination induction task (Nolen-Hoeksema & Morrow, 1993). The task was modified to include a negative mood manipulation to facilitate the emergence of ruminative processing (e.g., see Burkhouse et al., 2017;

Ciesla & Roberts, 2007; Joormann & Siemer, 2004). Measures of mood and negative self-judgments were collected with visual analog scales (VAS) throughout the task.

**Mood manipulation.** All participants listened to an 8-min musical excerpt from Prokofiev's "Russia Under the Mongolian Yoke," remastered at half speed, while thinking about a sad autobiographical event from their life. This combination of music and autobiographical recall has been found to be effective in inducing a transient dysphoric mood in previous research (Jarrett et al., 2012; Lau et al., 2004; Martin, 1990).

**Rumination induction.** Participants were then instructed to engage in a ruminative cognitive task developed by Nolen-Hoeksema and Morrow (1993), which has been used extensively in prior experimental research to induce an analytical and brooding thinking style (see Nolen-Hoeksema et al., 2008; Rimes & Watkins, 2005). Participants focused on the meaning, consequences, and causes of their current feelings for 8 min when reading 28 prompts adapted from Nolen-Hoeksema and Morrow (1993). They were instructed to "for the next few minutes, try your best to focus your attention on each of the ideas on the following pages. Read each item slowly and silently to yourself. As you read the items, use your imagination and concentration to think about the causes, meanings and consequences of the items. Spend a few moments visualizing and concentrating on each item, attempting to make sense of and understand the issues raised by each item." Items were presented on sheets of paper. The items consisted of self- and emotion-focused sentences such as "think about the way you feel" and "think about the level of motivation you feel right now."

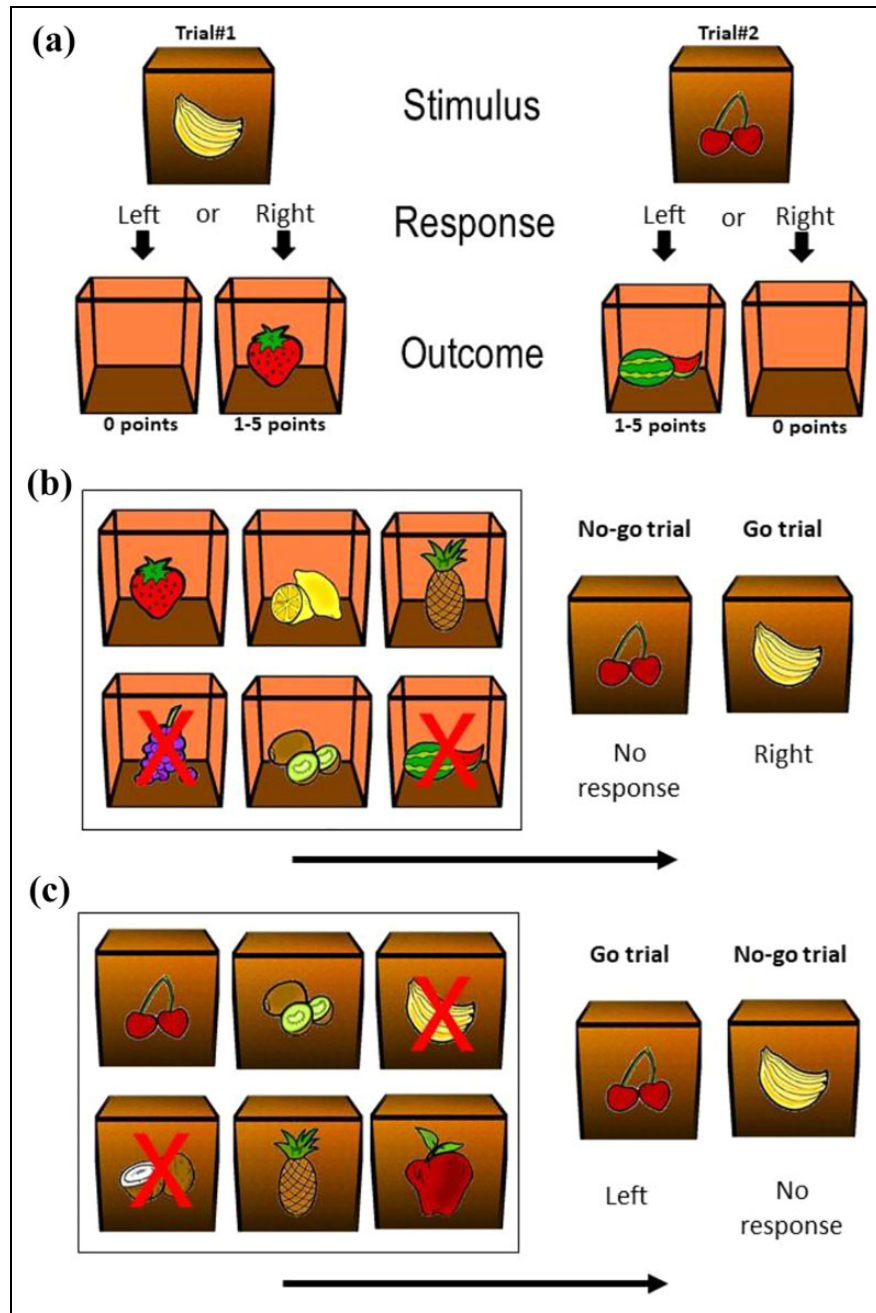
**Assessment of dysphoric mood.** Ratings of mood were obtained with a VAS that was administered before and after the mood manipulation, and following the rumination induction. Each VAS consisted of a 152 mm line with arrows indicating increased strength of happy and sad moods from the middle of the scale (scale labeled "sad" and "happy" at each extreme). Responses were scored on a scale ranging from 0 to 152 with higher scores indicating greater dysphoric mood.

**Negative self-judgments.** In line with prior studies (Rimes & Watkins, 2005), measures of negative self-judgments were obtained to assess the impact of rumination on participants' cognition. Ratings of

"worthless," "unlovable," "acceptable," and "competent" (final two reverse scored) were obtained with four VAS before and after the mood manipulation and immediately following the rumination induction. Each scale consisted of a 152 mm line (labeled "Not at all" to "Totally" at each extreme) and were scored on a scale ranging from 0 to 152, where increased scores indicated greater negative self-judgments. To ease interpretation and comparison with prior research, ratings of worthlessness and incompetency were combined to form a total score of autonomy-type judgments (i.e., achievement-based evaluations), whereas ratings of unacceptability and unlovability were combined to form a total score of sociotropy-type judgments (i.e., interpersonal evaluations; Rimes & Watkins, 2005).

**Experimental task of habit versus goal-directed behavior control.** The Fabulous Fruit Game (FFG; see Figure 1) is a computerized outcome devaluation task (programmed in Visual Basic 6.0) designed to measure the extent to which instrumental performance is under the control of habitual versus goal-directed action strategies. We used a modified version (see Worbe et al., 2015) of the original FFG (De Wit et al., 2007; Gillan et al., 2011). This experimental task infers an increased reliance on habit over goal-directed behavior control when a previously rewarded and overlearned response to a cue (instrumental training) persists even though the reward is devalued (i.e., slips-of-action; for a detailed summary, see Worbe et al., 2015).

**Instrumental training.** Participants were presented with a series of six boxes with pictures of fruits on them (see Figure 1), presented one at a time at the center of the screen. Each box had a unique fruit image on the front (e.g., bananas) and a different fruit image inside (e.g., pineapple). Participants learned two instrumental responses (left or right button-presses) to gain rewarding outcomes (earn points by collecting fruits inside boxes). The fruits inside the boxes were worth points (cumulative scores shown on the screen). Correct responses revealed the fruit outcome inside (points awarded) but incorrect responses showed an empty box (no points awarded). The fruits on the outside served as discriminative stimuli (three fruits signaled that the right response was correct, and the other three that the left response was correct). Participants were instructed to learn by trial and error which was the correct response (left versus right) for each outcome (fruit inside) and to try to earn



**Figure 1.** The Fabulous Fruit Game. (a) Instrumental learning phase. Two example trials are shown. On each trial, participants were presented with a closed box with a fruit image on the front (i.e., banana or cherry). Participants could open each box with either left or right button-press. If the correct response was selected (e.g., the right button-press for the banana box), another fruit reward was shown inside the box. If the incorrect response was selected, an empty box was shown. Participants could earn 1–5 points for each correct response (depending on how fast the response was made) and 0 points for an incorrect response. (b) The slips-of-action test. In this example, participants were presented with a display of six boxes with fruits inside. Two of the fruits were marked with a red cross which meant they were devalued and that participants would lose points if they opened boxes that included these fruits. Following the display, each box was presented in rapid succession (2 s per trial). Participants were instructed to withhold responses to boxes with devalued fruits (“no-go” trials) but respond to other boxes (“go” trials). In this example, the box with cherry on the front represents a “no-go” trial (as it contains the devalued melon inside) and the box with banana on the front represents a “go” trial (as it contains the still-valuable strawberry inside). (c) The baseline control test. In this example, the display shows six closed boxes with fruit stimuli on the front. Again, two boxes are marked with red crosses which means they are devalued. Following the display, each box was presented in rapid (2 s) succession. Participants were instructed to withhold responses to boxes with devalued fruits on front (“no-go” trial) but respond to other boxes (“go” trials).

as many points as possible, with more points awarded for faster correct responses (from 1 to 5 points).

**Slips-of-action test.** This test was designed to assess the relative contribution of habitual versus goal-directed control over instrumental responses learned during the instrumental training phase. Each of the nine test blocks consisted of a 10-s screen that presented all the six different fruit outcomes (i.e., the six fruit outcomes inside the boxes) from the initial learning phase. Two of the six fruits had a red cross on them, indicating that they were now devalued and collecting them would result in subtraction of points. Following the 10-s presentation, each of the boxes was presented one at a time in quick succession, showing only the discriminative stimulus (the fruit image outside the box). Participants earned points by pressing the correct response to collect the still-valuable fruit outcomes inside. However, they were instructed to refrain from responding to the boxes that contained the devalued fruit inside, since it led to subtraction of points (see Figure 1). No feedback of correct or incorrect responses was provided during this stage (i.e., the boxes remained closed). Failure to withhold responses to stimuli linked with devalued outcomes (i.e., “slips-of-actions”) is thought to reflect an increased reliance on stimulus–response habits. In contrast, selective responses to valuable as opposed to devalued outcomes, on the basis of current outcome value, are thought to reflect goal-directed action control. Participants completed 108 trials over nine blocks with each of the six discriminative stimuli presented two times per block in random order. Each outcome was devalued three times across all blocks. Although similar to traditional cognitive inhibition tasks (e.g., go/no-go tasks), that tap the ability to override prepotent responses and inhibiting the processing of irrelevant material (i.e., inhibiting stimulus–response associations), outcome devaluation was designed to measure the ability to alter an overtrained response based on changes in outcome contingencies (i.e., altering response–outcome associations). However, it is possible that outcome devaluation involves some form of higher order cognitive control processes. The outcome devaluation task therefore includes a control test (see baseline test below) to account for general test demands on working memory and response inhibition (De Wit, 2017).

**Baseline test.** This additional test was randomly performed either before or after the slips-of-action test (see Figure 1). The baseline test was designed to

control for general test demands on working memory and response inhibition of the slips-of-action test. It had an identical structure to the slips-of-action test, the only difference being that the discriminative stimuli (fruits outside the box) were devalued rather than the outcomes (fruits inside the box). Therefore, this test did not require an evaluation of the anticipated outcome of one’s action as the slips-of-action test and was intended to account for individual differences in general executive control on the task, independent of sensitivity to outcome devaluation.

### Procedure

The study was approved by the National Bioethics Committee and reported to the Icelandic Data Protection Authority. The measures were administered over a single session in a quiet and well-lit room. Participants first answered self-report questionnaires (BDI-II, RRS, HINT, and COHS) and partook in the rumination induction task (administered in a counterbalanced order). Finally, they participated in the FFG experimental task. This study is part of a larger multi-study research project that also included measures of emotion regulation, depression vulnerability, and experience sampling of mood and cognition.

### Statistical analyses

A priori power analyses using G\*power (Faul et al., 2007) indicated that a sample of 110 participants would yield .9 power to detect small regression effect sizes ( $f = .15$ ) with four predictor variables and medium bivariate correlations ( $p = .3$ ). We therefore aimed for recruiting a sample of 110–120 participants. The IBM SPSS 24 Statistics package was used to calculate Pearson’s correlation, hierarchical linear regressions, and mixed ANCOVA with Greenhouse–Geisser correction if assumption of sphericity was violated. To assess multicollinearity in the regression analyses, we looked at the variance inflation factor (VIF) which did not indicate problems due to multicollinearity in any of the analyses (VIF values ranged between 1.000 and 1.720). All statistical tests were two-sided ( $\alpha$  level = .05) with confidence intervals (CIs) of 95%. Effect sizes were estimated using Cohen’s  $d$ , partial eta-squared (partial  $\eta^2$ ), and change in  $R^2$ . For discriminative performance on the FFG, a Devaluation Sensitivity Index (DSI; see also Snorrason et al., 2016) was computed for the slips-of-action test and baseline test. The DSI was constructed by subtracting the percentage of responses to cues linked



**Table 1.** Descriptive statistics of self-report questionnaires and the rumination induction and habit control tasks used in the study ( $N = 115$ ).

	Mean (SD)	Range	Cronbach's $\alpha$
Self-report questionnaires			
BDI-II	15.25 (10.16)	0–43	.91
RRS	49.21 (11.79)	24–82	.90
Brooding	11.21 (3.43)	5–20	.80
Reflection	10.08 (3.42)	5–18	.76
HINT	51.33 (16.72)	12–84	.93
COHS automaticity	33.53 (7.71)	17–51	.78
COHS routine	55.72 (10.27)	24–79	.85
Rumination induction task			
Mood			
T1: Baseline	57.64 (26.99)	1–138	
T2: Post-mood manipulation	83.47 (32.50)	1–147	
T3: Post-rumination induction	69.43 (29.47)	0–152	
Worthlessness/incompetency			
T1: Baseline	74.39 (55.07)	0–207	
T2: Post-mood manipulation	83.13 (60.32)	0–204	
T3: Post-rumination induction	76.13 (65.09)	0–242	
Unlovability/unacceptability			
T1: Baseline	66.19 (52.23)	0–190	
T2: Post-mood manipulation	77.00 (60.79)	0–251	
T3: Post-rumination induction	74.92 (62.26)	0–245	
Habit control task			
Slips-of-action test			
Valued outcome	89.83 (9.93)	60–100	
Devalued outcome	28.08 (25.12)	0–97	
Baseline test			
Valued outcome	96.15 (4.65)	76–100	
Devalued outcome	14.09 (13.41)	0–100	

Note. HINT = Habit Index of Negative Thinking; COHS automaticity = Creature of Habit Scale–automaticity subscale; COHS routine = Creature of Habit Scale–routine subscale; brooding = Rumination Responses Scale–brooding subscale; reflection = Rumination Responses Scale–ruminative reflection subscale; RRS = Rumination Responses Scale–total score; BDI-II: Becks Depression Inventory-II; T1 = Time 1; T2 = Time 2; T3 = Time 3.

to devalued outcome from the percentage of responses to cues linked to valued outcomes. Thus, lower DSI values on the slips-of-action test reflected less sensitivity to devaluation (i.e., habitual responding).

## Results

### *Rumination and habitual characteristics*

Descriptive statistics for self-report measures and experimental tasks are presented in Table 1. To determine whether the heightened disposition to engage in ruminative brooding was associated with greater habitual characteristics, we first computed bivariate zero-order correlations between trait rumination (RRS) and self-report measures of habits (see Table 2). As expected, HINT was positively correlated with

ruminative brooding but not ruminative reflection, indicating that only brooding shares habitual characteristics with negative thinking. The same pattern was observed in the relationship between rumination and the automaticity and routine scores of the COHS, where brooding, but not reflection, was significantly and positively correlated with scores on both facets. Thus, heightened ruminative brooding, but not reflection, was associated with greater habitual characteristics of negative thinking and general propensity to habitual responding.

### *Rumination induction and habitual characteristics*

Two participants did not follow the instructions for the rumination task, since both had multiple ratings of mood and negative self-judgments on each

measurement occasion. Their data were therefore removed, leaving data from 113 subjects to be analyzed for the rumination task.

**Mood manipulation.** A paired samples *t*-test confirmed an expected increase in dysphoric mood from baseline (Time 1) to post-mood manipulation (Time 2),  $t(114) = -9.768, p < .001, CI = -30.22, -20.82, d = 1.027$  (Table 1). There was also a significant

increase from Time 1 to Time 2 in negative self-judgments of worthlessness/incompetency,  $t(114) = -2.609, p = .010, CI = -15.38, -2.10, d = .243$ , and unacceptability/unlovability,  $t(114) = -3.613, p < .001, CI = -25.99, -6.96, d = .165$ . The mood manipulation therefore had a detrimental effect on both mood and the evaluation of self-worth (Table 1).

**Table 2.** Bivariate correlations between RRS, HINT, and COHS scores ( $N = 115$ ).

	RRS brooding	RRS reflection
	$r(113)$	$r(113)$
HINT	.428**	.157
COHS automaticity	.294*	.174
COHS routine	.311**	.069

Note. HINT = Habit Index of Negative Thinking; COHS automaticity = Creature of Habit Scale-automaticity subscale; COHS routine = Creature of Habit Scale-routine subscale; RRS brooding = Rumination Responses Scale-brooding subscale; RRS reflection = Rumination Responses Scale-ruminative reflection subscale.

\* $p < .01$ . \*\* $p < .001$ .

**Rumination induction.** To test the hypothesis that greater habitual characteristics (HINT) and habit propensity (COHS) would be associated with greater persistence of dysphoric mood during rumination induction, we performed a three-step hierarchical regression using post-rumination induction (Time 3) mood scores as the dependent variable. The results are summarized in Table 3. Mood scores at Time 2 were entered at Step 1 to control for mood at the start of the rumination induction.<sup>1</sup> Given the high correlation between self-report measures of ruminative brooding and habit in the current study, ruminative brooding (RRS) was entered at Step 2 as a more conservative test of the relation between the effects of rumination induction and habitual responding. Ruminative brooding (RRS) entered at Step 2, significantly added

**Table 3.** Result from hierarchical regression analyses (final step) using ruminative brooding, habitual characteristics of negative self-thinking, and general habitual response tendencies to predict mood and negative self-judgment scores in the rumination induction task ( $N = 113$ ).

	B	SE B	$\beta$	95% CI
DV: Mood, T3				
Step 1 ( $\Delta R^2 = .658^{***}$ )				
Mood, T2	.654	.052	.721***	.550, .757
Step 2 ( $\Delta R^2 = .029^{**}$ )				
Brooding	1.177	.505	.137*	.176, 2.178
Step 3 ( $\Delta R^2 = .012^*$ )				
HINT	.224	.108	.126*	.011, .438
DV: Worthlessness/incompetency, T3				
Step 1 ( $\Delta R^2 = .766^{***}$ )				
Worthlessness/incompetency, T2	.910	.065	.842***	.780, 1.039
Step 2 ( $\Delta R^2 = .009^*$ )				
Brooding	2.123	.974	.112*	.193, 4.053
Step 3 ( $\Delta R^2 = .000$ )				
HINT	-.091	.235	-.023	-.557, .375
DV: Unlovability/unacceptability, T3				
Step 1 ( $\Delta R^2 = .777^{***}$ )				
Unlovability/unacceptability, T2	.847	.055	.827***	.738, .955
Step 2 ( $\Delta R^2 = .004$ )				
Brooding	1.005	.912	.055	-.804, 2.813
Step 3 ( $\Delta R^2 = .003$ )				
HINT	.239	.203	.064	-.164, .642

Note. HINT = Habit Index of Negative Thinking; brooding = Rumination Responses Scale-brooding subscale; T2 = Time 2; T3 = Time 3. \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

to the model and was associated with greater persistence of dysphoric mood. Finally, HINT, entered at Step 3, was a significant predictor of greater persistence of dysphoric mood over and above all previously entered variables. Neither COHS routine nor automaticity scores significantly contributed to the prediction of mood when entered simultaneously at Step 3 instead of HINT (all  $ps > .37$ ). In summary, after controlling for ruminative brooding, habitual characteristics of negative thinking (HINT), but not general automatic and routine response tendencies (COHS), significantly predicted greater persistence of dysphoric mood following rumination induction.

We next determined whether greater habitual characteristics were associated with a greater persistence of negative self-judgments during rumination induction. We repeated the three-step regression analysis with Time 3 negative self-judgments as the dependent variable (see Table 3). The results showed, that for worthlessness/incompetency as the outcome, ruminative brooding (Step 2), but not HINT (Step 3), emerged as a significant predictor after controlling for Time 2 worthlessness/incompetency scores. Neither ruminative brooding nor HINT added significantly to the prediction of negative self-judgments when unacceptability/unlovability was the outcome. When performing the same analyses using COHS routine and automaticity scores, neither significantly added to the prediction of worthlessness/incompetency nor unacceptability/unlovability (all  $ps > .44$ ). Thus, only ruminative brooding showed a significant association with the detrimental effects of rumination induction on the evaluation of self-worth.

### *Habitual characteristics and the immediate response to dysphoric mood*

To assess the specificity of these findings, we also explored whether habitual characteristics (HINT) and habit propensity (COHS) were related to the immediate effects of the mood manipulation more generally. In the rumination task, Time 2 mood and negative self-judgment scores were regressed on the habit indices using six three-step hierarchical regressions. When controlling for Time 1 mood and negative self-judgment scores (Step 1), ruminative brooding, entered at Step 2, did not add to the prediction of Time 2 mood and negative self-judgments (all  $ps > .216$ ). HINT, entered at Step 3, emerged as a significant predictor of Time 2 mood ( $\beta = .478, p = .002, \Delta R^2 = .050, p = .002, 95\% \text{ CI} = .175, .781$ ),

worthlessness/incompetency ( $\beta = .243, p < .001, \Delta R^2 = .038, p < .001, 95\% \text{ CI} = .404, 1.365$ ), and unacceptability/unlovability ( $\beta = .127, p = .034, \Delta R^2 = .011, p = .034, \text{ CI} = .035, .898$ ). However, neither COHS routine nor COHS automaticity, simultaneously entered at Step 3, significantly added to the prediction of Time 2 mood and negative self-judgments (all  $ps > .10$ ). Therefore, greater habitual characteristics of negative thinking, but not more general habitual response tendencies nor ruminative brooding, were associated with greater immediate shifts in dysphoric mood and negative self-judgments in response to the mood manipulation.

### *Ruminative disposition and habit-directed behavior control*

Finally, it was investigated whether a heightened ruminative disposition was associated with a greater habit relative to goal-directed behavior control using the FFG outcome devaluation task. There was a significant main effect of block in the FFG instrumental learning stage (mixed ANCOVA),  $F(4.243, 462.453) = 11.436, p < .001$ , partial  $\eta^2 = .265$ , but no significant interaction between the effect of block and the rumination indices or BDI-II. This confirms that discriminative performance improved during the learning phase of the task and at a rate independent of the degree of ruminative disposition or depression. As expected, participants responded significantly more often to stimuli associated with valued outcome than stimuli related to devalued outcome, on both the slips-of-action test (89.8% vs. 28.1%), paired samples  $t$ -test,  $t(114) = 21.013, p < .001, \text{ CI} = 55.9, 67.6, d = 1.959$ , and the baseline test (96.2% vs. 14.1%), paired samples  $t$ -test,  $t(114) = 52.720, p < .001, \text{ CI} = 79.0, 85.1, d = 4.919$ .

Hierarchical linear regression, with slips-of-action DSI as the outcome, showed that when baseline DSI ( $\beta = .424, p < .001, \Delta R^2 = .177, p < .001, \text{ CI} = .478, 1.122$ ) was entered at Step 1, to control for general test performance variables, followed by ruminative brooding ( $\beta = -.016, p = .871, \Delta R^2 = .001, \text{ CI} = -.762, 1.410$ ) at Step 2, and rumination induction change scores in mood ( $\beta = -.172, p = .059, \text{ CI} = -.568, .08$ ) at Step 3, the baseline DSI was the only significant predictor of reliance on habit relative to goal-directed learning (slips-of-action DSI). The same pattern was found when entering rumination induction change scores in worthlessness/incompetency and unacceptability/unlovability at Step 3 (all

$p > .14$ ). Thus, a heightened ruminative disposition was not characterized by greater habit relative to goal-directed behavior control. Analyzing first-order partial correlations, while controlling for the baseline DSI, showed that slips-of-action DSI was not related to HINT,  $r(113) = -.002$ ,  $p = .979$ , nor COHS routine,  $r(113) = -.133$ ,  $p = .159$ , or automaticity,  $r(113) = .084$ ,  $p = .375$ .

## Discussion

The purpose of the present study was to investigate whether rumination can be construed as a form of habitual thinking, a widely held notion that has rarely been directly tested. It is noteworthy that no previous study has investigated this using a combination of both self-report and experimental measures of rumination, adding to the relatively small number of studies in this area (Ólafsson et al., 2020; Van Vugt et al., 2018; Verplanken et al., 2007; Watkins & Baracaia, 2001).

The hypothesis that habitual characteristics of negative thinking would be associated with the tendency to engage in ruminative brooding, but not ruminative reflection, was supported. Heightened self-reported ruminative brooding, but not ruminative reflection, was associated with greater habitual characteristics of negative thinking measured with the HINT (i.e., repetition, automaticity, lack of conscious awareness and intent, mental efficiency, lack of control, and self-descriptiveness). This novel finding is in line with Hertel's (2004) conceptualization of depressive rumination as an automatic and involuntary habitual process and with previous research (Ólafsson et al., 2020; Verplanken et al., 2007). It also provides support for the habit-goal framework of rumination (Watkins & Nolen-Hoeksema, 2014), which states that when rumination is in the form of an analytical and abstract processing style (i.e., brooding), it is more likely to develop into a mental habit when compared to a more concrete and solution-focused way of thinking (i.e., ruminative reflection). Although there is conflicting evidence regarding the relative contribution of ruminative brooding and ruminative reflection to depression vulnerability (Joormann & Gotlib, 2010), the current findings hint at differential effects between the two forms of rumination, with only brooding showing an association with habitual negative thinking. These findings are in line with the suggestion that depression vulnerability may be in the form of ruminative brooding, but not reflection, being habitually

triggered (without awareness or intent), making it difficult to control (Watkins & Nolen-Hoeksema, 2014).

Of critical importance, the association between ruminative brooding and habitual characteristics of negative thinking was also evident when rumination was experimentally induced. Rumination that has become habitual should be associated with more adverse consequences (Hertel, 2004; Watkins & Nolen-Hoeksema, 2014). It was therefore expected that habitual characteristics of negative thinking would predict increased persistence of negative affect and cognition in the rumination task. This was partially supported. Habitual characteristics of negative thinking predicted a greater persistence of dysphoric mood, indicating that rumination may be more detrimental when it is associated with habitual attributes. It is important to note that habitual characteristics of negative thinking added to the prediction of persistence of dysphoric mood on the rumination task, over and above what could be accounted for by the RRS alone—a well-established measure of depressive brooding. This underlines the possible additive value of considering habit-like automaticity of thoughts in the study of adverse consequences of ruminative thinking.

Contrary to predictions, habitual characteristics of negative thinking were not associated with a greater persistence of negative self-judgments following the rumination induction. Since participants are instructed to ruminate in the rumination induction task (Nolen-Hoeksema & Morrow, 1993), it is possible that the task may not be optimally suited to capture the effects of habits because the instructions may draw attention to the habitual behavior under question, reducing its effect (e.g., Spieler & Miltenberger, 2017). Future research should endeavor to elucidate this using experimental tasks that might better capture naturally occurring ruminative thoughts in response to negative mood, such as providing a subsequent no-task delay period that allows the opportunity for spontaneous rumination (e.g., Conway et al., 2000; Thomsen et al., 2004).

Interestingly, habitual characteristics of negative thinking were also related to the initial increase in negative mood and negative self-judgments following the mood challenge. This suggests that habitual thinking may play a role in increasing mood-related vulnerability more generally. The current findings therefore highlight the need to clarify the unique role of habit in depressive rumination and whether it relates to other vulnerability factors that are also

thought to be contingent on negative mood, such as cognitive reactivity (Lau et al., 2004) and dysfunctional emotion regulation (Joormann & Stanton, 2016).

There is limited research into the specific factors that might contribute to rumination becoming habitual. The habit-goal framework broadly specifies personal and environmental factors that lead to inflexible responding as possible mechanisms (Watkins & Nolen-Hoeksema, 2014). In the current study, we tested whether rumination was associated with greater habit relative to goal-directed behavior control, since difficulties in goal-directed control might contribute to faster and stronger formation of habit (Linnebank et al., 2018) and might thus predispose some to develop rumination as a habit. Ruminative brooding, but not ruminative reflection, was correlated with greater habitual responding in everyday life on the COHS, a self-report measure of habit propensity. However, this was not the case when using an outcome devaluation task of habit formation. Thus, rumination seems to be related to self-reported automatic and routine responding in daily life, but no evidence was found for greater tendency toward general habit-related, at the expense of more goal-directed, behavior control on an experimental task involving outcome devaluation. This novel exploration therefore calls attention to the strong association of rumination with habitual responding in daily life but does not, however, find support for the notion that greater habit relative to goal-directed behavior control contributes to rumination as a habit.

Surprisingly, the two measures of habit propensity (i.e., COHS and FFG) were not significantly correlated, suggesting that they might tap different aspects of the habit construct. However, this discrepancy might also be attributed to differences in method variance and the use of a student a sample. Furthermore, it is possible that greater habit propensity only becomes evident when negative mood interferes with goal-directed control. Indeed, depression is strongly associated with negative life events and chronic forms of stress (Hammen, 2005; Nelson et al., 2017) that might impair the ability to use effortful and goal-directed behavioral control (Beevers, 2005; Snyder, 2013). It is possible that self-report measures of everyday habit propensity better capture the individuals' responses to everyday stressful and negative events, whereas the outcome devaluation task used in the present study includes only neutral stimuli. In future studies, it might be interesting to explore the

application of outcome devaluation tasks with emotional or disorder-specific stimuli.

Collectively, the findings from the current study provide initial support for the notion of rumination as a habit as defined by the habit-goal framework (Watkins & Nolen-Hoeksema, 2014) and developmental frameworks of rumination (Shaw et al., 2019). The results are in line with the suggestion that depression vulnerability may be in the form of ruminative brooding being habitually triggered (without awareness or intent), making it difficult to control. Moreover, they underscore the predictive value of considering habit when explaining the effect that rumination has on depressive mood. However, rumination was not consistently associated with a greater habit propensity, setting boundary conditions in the search for specific factors that might contribute to rumination becoming habitual. Although the results should be considered preliminary and interpreted in light of the correlational nature of the study, they represent one of the first attempts to test hypotheses directly derived from the novel habit-goal framework. It is well established that heightened ruminative brooding in response to negative mood is associated with increased depression vulnerability, although, the cognitive factors that contribute to a ruminative disposition are only now starting to become clear. A unique contribution of the current study is the assessment of individual differences in ruminative brooding using not only a self-report measure but also an experimental rumination induction approach. By showing that the heightened tendency to engage in ruminative brooding may be associated with greater habitual characteristics of negative thinking, the present study has identified habitual thinking as a possible contributor to depressive rumination.

Despite the contributions of the current study, some limitations and directions for future research are noteworthy. The majority of the sample were female students, which might preclude the generalization of the findings to males and clinical groups differing in disorder severity. Because the present study involves a correlational design, we cannot provide a definite test of rumination as a true habitual response. The causal nature of the relationship between ruminative brooding and habitual characteristics of negative thinking therefore remains uncertain. To the best of our knowledge, no such direct test of rumination as a habit exists. To address this limitation in future research, it would be of value to determine whether interventions that are presumed to target the habitual

nature of ruminative thinking (cf. Watkins, 2018) can reduce the habitual characteristics of negative thinking and thus alter the disposition to engage in ruminative brooding. Such a finding would indicate that habitual characteristics play a significant role in explaining individual differences in the disposition to engage in ruminative brooding. Future research could also address this limitation by testing context–response associations in line with the habit-goal framework using experience sampling methodology (Myin-Germeys et al., 2018). It could be tested whether habitual characteristics of negative thinking predict greater levels of momentary rumination in response to daily fluctuations in negative affect, providing conformation that habitual characteristics play an important role in ruminative brooding as it occurs in situ. The findings of the current study therefore provide clinically relevant and testable hypothesis that might lead to a greater understanding of interventions that successfully target ruminative brooding, thereby enhancing the treatment and prevention of depression

To conclude, findings from the current study provide initial support for the habit-goal framework of depressive rumination (Watkins & Nolen-Hoeksema, 2014) and underscores the predictive value of considering habit when explaining the effect that ruminative brooding has on depressive mood. Future studies should aim to test the predictions of the habit-goal framework using experimental and experience sampling methodology, to obtain information on the habitual contingency between negative mood and depressive rumination and the specific factors that might contribute to habitual rumination.

### Authors' Note

Ivar Snorrason is also affiliated with Massachusetts General Hospital, USA.

### Declaration of conflicting interests


The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by a research grant from the Icelandic Research Fund (grant number 173803-051)

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### Note

1. Another option would have been to control for mood scores at Time 1. However, this might confound changes during the rumination induction with the initial shift in mood and cognition attributable to the mood induction, which has been found to be related to other vulnerability factors in depression (e.g., cognitive reactivity, mood reactivity, and emotion regulation strategies). We therefore chose to control for T2 as a more conservative test of the relation between habit and rumination induction.

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