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Role of self-focus in the relationship between depressed mood and problem solving

Masaki Mori · Keisuke Takano · Yoshihiko Tanno

Abstract We investigated the effects of adaptive and maladaptive forms of self-focus—specifically, self-reflection and self-rumination—on the relationship between depressed mood and everyday problem-solving behavior. Although previous research has consistently suggested that self-rumination disturbs problem solving and self-regulatory processes, thereby aggravating depressive symptoms, the association between self-reflection, problem solving, and its emotional consequences has not been demonstrated. Therefore, we assessed whether self-reflection can facilitate the emotion regulation function of problem solving through a daily diary method. Thirty-nine Japanese undergraduate and graduate students recorded daily depressed mood, the most stressful problem encountered each day, and whether they utilized problem-solving behaviors for seven consecutive days. Multilevel model analyses showed that individuals with higher levels of self-reflection reported lower depressed moods after enacting problem-solving behaviors, even if the problem that they had on that day was highly stressful. These results suggest that self-reflection enhances the mood regulation function of everyday problem-solving behavior, and may contribute to mental well-being and resilience to stress.

Keywords Self-reflection · Self-rumination · Problem solving

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Introduction

The past three decades of research on the self and depression have suggested that excessive focus on one's self has maladaptive influences on our mental and physical health (Mor and Winquist 2002). Earlier works on private self-consciousness suggested that the tendency to attend to the internal self is associated with increased depressive symptomatology (Fenigstein et al. 1975; Smith and Greenberg 1981). More recently, a number of studies have shown that rumination—an excessive and perseverative focus on the negative self (or one's depressive symptoms and its causes and consequences; Nolen-Hoeksema et al. 2008)—is one of the most severe cognitive risk factors for depression, as shown in its significant predictive power on future onset and maintenance of depressive disorders (Kuehner and Weber 1999; Nolen-Hoeksema 2000). Although being repeatedly faced with the negative aspects of one's self per se exacerbates negative and depressed feelings, researchers have argued that impaired problem solving may play a key role in the association between rumination and depression. Indeed, rumination has been found to be associated with low levels of goal success and delayed progress of self-regulation (Martin and Tesser 1996; Moberly and Watkins 2010), resulting in increased negative affect (Carver and Scheier 1990). This association has been demonstrated through experimental studies, suggesting that dysphoric individuals induced to engage in ruminative self-focus tend to generate less effective solutions to, and more negatively biased interpretations of, challenging situations; this, consequently, decreases motivation to resolve the problems and reduces self-confidence in one's own ability through increased feelings of hopelessness (Lyubomirsky and Nolen-Hoeksema 1995; Lyubomirsky et al. 1999).

Researchers, however, have argued that self-consciousness may contribute to beneficial outcomes in self-regulation and problem-solving processes, since self-focus was originally considered to be a functional cognitive activity that is normatively involved in the self-regulatory cycle and may improve the extent and accuracy of self-knowledge (Martin and Tesser 1996; Trapnell and Campbell 1999; Watkins 2008). In order to extract the adaptive functioning aspect of self-focus—specifically, one that could be separated from the harmful aspects of self-rumination—Trapnell and Campbell (1999) proposed *self-reflection* as a beneficial aspect of private self-consciousness. Self-reflection is defined as self-focused attention motivated by curiosity and epistemic interest in self, which has been shown to be associated with openness to experience, need for self-knowledge, and need for cognition (Trapnell and Campbell 1999). Although the content of self-reflection is not always emotionally loaded (e.g., I'm very self-inquisitive by nature), an empirical study has demonstrated that, in contrast to self-rumination, self-reflection is associated with reduced levels of depressive symptoms (Takano and Tanno 2009). Providing other illustrations of the adaptivity of self-reflection, previous studies have indicated that self-reflection tends to be associated with autonomous self-regulation (Thomsen et al. 2011), interpersonal skills (Takano et al. 2011), and positive reappraisal tendencies of individuals who have experienced failures, which allows them to generate alternative solutions (Jones et al. 2009). Furthermore, self-reflection is associated with self-knowledge accuracy (Simsek et al. 2013; Trapnell and Campbell 1999); therefore, it may contribute to generating solutions that are both suitable for oneself and easily implementable. These findings suggest that self-reflection may play an adaptive role in facilitating the progress of problem solving, which would consequently contribute to efficient emotion regulation after experiencing stressful and troublesome events.

It should be noted that the term "rumination" can be characterized as a stable, negative, broadly construed way of responding to goal discrepancies (Smith and Alloy 2009), but theorists have proposed several definitions. We based the present study on the theory of Trapnell and Campbell (1999) in which self-rumination is defined as a negative type of self-focus motivated by loss, threat, or injustice to self. As another conceptualization of rumination, Nolen-Hoeksema et al. (2008) defined depressive rumination as passive and non-instrumental responses to one's depressive symptoms or their cause and results. A more general form of rumination (Martin and Tesser 1996) is conceptualized not as responses to depressive symptoms but as instigated by goal discrepancies. Based on Martin and Tesser's theory, Watkins (2008) has argued that such ruminative thinking may be maladaptive or adaptive

depending on construal level, but this conceptualization differs from the theory of Trapnell and Campbell (1999) in that they distinguished between maladaptive and adaptive self-focused attention. Although our review of literatures includes the research that measured depressive rumination, there is evidence suggesting significant overlap between self-rumination and depressive rumination (Siegle et al. 2004; Schoof et al. 2010).

In order to test the maladaptivity of self-rumination and the adaptivity of self-reflection, the present study examined the differential influences of ruminative and reflective forms of private self-consciousness on the mood regulation function of problem solving. As proposed by control theory (e.g., Carver and Scheier 1990), the self-regulatory system forms a feedback loop in which self-focused attention compares the ideal and real self, and if it detects a discrepancy, the individual performs self-regulatory behavior including problem-solving behavior to reduce the discrepancy. Self-focused attention, which monitors the progress rate of discrepancy reduction, is necessary for this feedback system and relevant to emotional outcomes; if the monitoring system detects the progress to be faster than expected, positive affect is experienced; if the progress is slower, negative affect is aroused (Fig. 1; Carver and Scheier 1990). Previous findings have suggested that self-rumination inhibits the self-regulatory cycle (i.e., impairing problem solving; Lyubomirsky and Nolen-Hoeksema 1995; Lyubomirsky et al. 1999) while self-reflection can facilitate the progress in this cycle (i.e., enhancing problem solving; Jones et al. 2009; Şimşek et al. 2013; Takano et al. 2011; Thomsen et al. 2011). In turn, perceived fast progress in self-regulation, even though the discrepancy has not
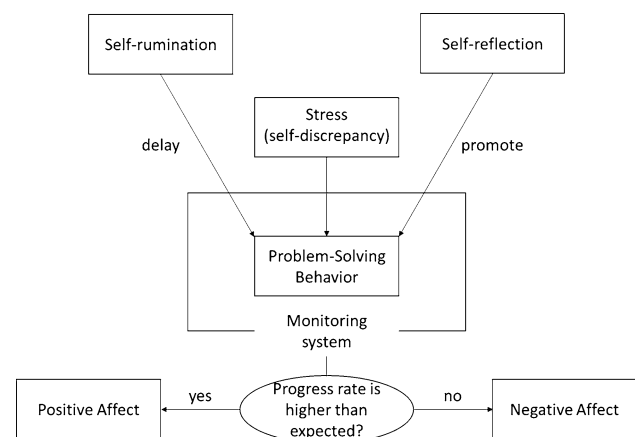

Fig. 1 Meta-monitoring system of self-regulation. Perceived self-discrepancy and its stress initiate self-regulatory process such as problem-solving behavior. Self-focus affects progress rate of problem-solving behavior, and simultaneously monitors the progress rate. Perceived progress rate generates positive or negative affects

been completely resolved, is likely to decrease negative feelings.

Problem solving is counted as a core factor of the self-regulatory process, which is defined as a course of actions with intention to gather information, generate solutions, or directly resolve the problem (Stone and Neale 1984). Examples include studying harder for tomorrow's test, asking a colleague for job advice, and having a talk to reconcile with a boyfriend. Such problem-solving behaviors can be captured by the Daily Coping Inventory (DCI; Stone and Neale 1984), which asks participants to record their most bothersome problems of the day and how they handled them. Problem solving is also conceptualized as one of the adaptive emotion regulation strategies (Aldao et al. 2010). Although problem-solving behavior is not necessarily a specific and direct action aimed at reducing negative emotions, it may, nevertheless, lead to beneficial emotional outcomes by modifying or eliminating stressors (Aldao et al. 2010). Supporting the importance of problem solving in negative emotion regulation, studies have shown that impaired problem-solving ability is associated with emotional dysfunction and psychopathology, including depression (Aldao et al. 2010; Anderson et al. 2007; Ciarrochi and Scott 2006; Nezu and Ronan 1988).

It is possible that the emotional outcomes of problem solving are moderated by the quality and quantity of the problems themselves. Specifically, a highly stressful problem (e.g., death of a loved one) possibly has more negative impact on an individual's emotional state than less stressful problem (e.g., being late for class; Myin-Germeys 2001). This means a high progress rate of problem-solving behavior for a highly stressful problem can largely reduce negative feelings because, with such a problem, the individual experiences more negative feelings in the first place. Thus, if self-reflection facilitates both the progress and the emotion regulation aspect of problem solving, individuals with higher levels of self-reflection may be less likely to experience depressed moods following problem-solving behavior for highly stressful situations, because these individuals could effectively and efficiently manage their stressful problems. On the other hand, if self-rumination disturbs the problem-solving processes, ruminative individuals will be unable to regulate depressed moods caused by stressors, despite their attempts to change their stressful circumstances. When a problem's stress level is low, the effect of problem solving may not appear regardless of the level of self-reflection or self-rumination because, under low stress, depressed mood may become low without problem-solving behavior.

The present study examined these potentially moderating roles of self-reflection and self-rumination on the relationship between problem solving and depressed mood. In particular, the main aim of the present study was to explore the adaptive effect of self-reflection on problem-solving behavior, which has not, to the best of our knowledge, been examined in prior studies. To examine our hypothesis, we employed a diary approach to assess both moods and problem-solving behaviors for seven consecutive days (Stone and Neale 1984). For daily use, Stone and Neal (1984) developed the dichotomous scale for problem-solving behavior (took the behavior or not) with a brief definition of problem-solving behavior because their study revealed that general checklist-type questionnaires tended to show less validity and internal consistency when used daily. Therefore, we used this simplistic assessment to validly capture problem-solving behavior and reduce the burden on participants. In addition, this diary method allowed us to capture within-person variations in moods and their associations with problem-solving activities that could be employed to deal with participants' everyday problems. Although most of the extant studies on problem solving and emotion regulation measured these variables as stable traits or personality-like concepts, attitudes and intended actions measured by traditional trait-based problem-solving questionnaires have limited correlations with actual behaviors (Anderson et al. 2009). For a full understanding of the emotional functions of problem solving, it is necessary to capture the roles they play "in the ebb and flow of daily life" (Nezlek and Kuppens 2008) by assessing the within-person relationships between daily problem-solving activities and emotional experiences.

Method

Participants and reporting procedure

Thirty-nine Japanese undergraduate and graduate students (16 men, 23 women) with a mean age of 20.5 years ($SD = 2.5$) participated in a 7-day diary survey. Participants completed a baseline questionnaire in the laboratory on the first day, and then kept a diary on the 7 days immediately following this. The diary was completed at the end of each day and comprised multiple measures including ratings of mood, problems encountered, and whether participants utilized problem-solving behaviors throughout the day.

Daily-level variables

Daily mood

Participants completed the profile of mood states (POMS; McNair et al. 1971) each night for 1 week. The present

study used the Japanese version of the POMS brief-form (POMS-BF; Yokoyama 2005). To rate depressed mood, 15 adjectives were used—five assessing negative mood states of depression, five assessing fatigue, and five assessing positive mood or vigor. Each adjective was rated on a 5-point Likert scale from 0 (*very much unlike this*) to 4 (*very much like this*). The fatigue and vigor subscales were used because fatigue or lack of energy is an important feature of depression (Beck 1967) and because the vigor subscale has been shown to discriminate depressed from non-depressed individuals well (Christensen and Duncan 1995). Because these three subscales exhibited moderate correlations with each other ($0.58 > r$s > 0.54, ps < 0.001) after cancelling out the between person variance (i.e., centering by within-person mean), we aggregated them into a single scale by calculating the formula Depression + Fatigue − Vigor in order to avoid the redundancy.[1] We estimated the reliability score following Nezlek (2011), which indicated that the aggregated measure was adequately reliable (the reliability score was 0.65).

Report of daily problems and problem solving

Participants completed the DCI (Stone and Neale 1984) after completing the POMS-BF. The DCI measures everyday problem-solving activities undertaken to deal with personal concerns in daily life. In this questionnaire, participants were asked to describe "the most bothersome event or issue of the day." They were instructed that this problem could be something that had happened in the past (e.g., death of a loved one), happened that day, or was expected to happen in the future (e.g., a future job interview). Participants then rated the level of stress the problem created. Scoring occurred on a scale from 1 (*a minor annoyance*) to 7 (*death of a friend or family member*). Participants were also asked to indicate, on a dichotomous scale (*Yes* = 1, *No* = 0), whether or not they had used problem-solving behavior to handle the problem. Problem-solving behavior was defined as thinking about solutions to the problem, gathering information about the problem, or doing something to try to solve the problem.

Person-level variables

Self-rumination and self-reflection

Tendencies towards self-rumination and self-reflection were assessed using the Rumination–Reflection Questionnaire (RRQ; Trapnell and Campbell 1999). The RRQ consists of two subscales focusing on self-rumination and self-reflection. Each of the two subscales contains 12 items that were rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). In this study, the Japanese version of the scale (Takano and Tanno 2008) was used; this version exhibited good internal consistency ($\alpha = 0.83$ for self-rumination; $\alpha = 0.85$ for self-reflection).

Baseline depressive symptoms

In order to control for baseline depressive symptoms, we administered the Beck Depression Inventory (BDI; Beck et al. 1979). Although the BDI consists of 21 items, we removed one item (suicidal thoughts) for ethical reasons that some naive participants may have been influenced by questions of whether or not they had suicidal ideations. Thus, 20 items were used to determine an initial depressive symptoms score.[2] Each item was rated on a 4-point scale (from 0 to 3). In the present study, the Japanese version of the scale (Hayashi 1988) was used with an alpha coefficient of 0.84. One participant had two missing values on the BDI, which were replaced with the within-person mean of responses to the other BDI items.

Statistical analysis

Due to the nested structure of the data, we used multilevel modeling to test our hypotheses; within-person variables (i.e., daily depressed mood, problem-solving behavior, and the stress level of the problem) were nested within between-person variables (i.e., self-rumination and self-reflection). Analyses were conducted using the SAS statistical package's (version 9) MIXED procedure and restricted maximum likelihood estimations.

At Level 1 (the within-person level), depressed mood was modeled as a function of problem-solving behavior, stress level, and their two-way interaction, which led to the following Level 1 model:

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[1] In regard to the Beck Depression Inventory, our aggregated measure of depressed mood showed a correlation size ($r = 0.28$) almost compatible to that of the single subscale of depressed mood ($r = 0.34$). These results do not suggest that the aggregated measure captures depressive symptoms better than the single depressed-mood measure, but we decided to report the results of the aggregated measure for the theoretical and conceptual validity as described in the main text.

[2] In the early survey period, 12 participants responded to the original 21-item BDI including "suicidal thoughts." We calculated BDI scores for the 12 participants by summing 20 items excluding "suicidal thoughts." Hence, two groups responded to the original or modified BDI, but there was no significant between-group difference in BDI scores.

$$Depressed\ mood_{ij} = \beta_{0j} + \beta_{1j}PSB_{ij} + \beta_{2j}Stress_{ij}$$
$$+ \beta_{3j}(PSB_{ij} \times Stress_{ij}) + r_{ij}$$

where $Depressed\ mood_{ij}$ is the depressed mood score on day i for participant j. Problem-solving behavior was expressed as PSB_{ij}, which was a dummy code indicating 1 for problem-solving behavior and 0 for no problem-solving behavior that day. Because the severity of the problem being addressed would influence the effectiveness of participants' problem-solving efforts (e.g., highly stressful problems would be difficult to manage), the interaction between problem solving and the stress level of the target problem ($Stress_{ij}$) was also included in the equation. The residual was denoted by r_{ij}.

To test our main hypotheses, according to which the two subtypes of self-consciousness should moderate the effects of problem-solving behaviors (and stress level of the problem) on depressed mood, we added self-rumination and self-reflection as between-person level variables. The moderating effects of self-reflection and self-rumination were tested in separate models, and thus, the Level 2 (i.e., person-level) equation for self-reflection was described as follows:

$$\beta_{0j} = \beta_{00} + \beta_{01}Ref_j + \beta_{02}Gender_j + \beta_{03}BDI_j + u_{0j}$$
$$\beta_{1j} = \beta_{10} + \beta_{11}Ref_j + u_{1j}$$
$$\beta_{2j} = \beta_{20} + \beta_{21}Ref_j + u_{2j}$$
$$\beta_{3j} = \beta_{30} + \beta_{31}Ref_j + u_{3j}$$

The Level 1 intercept (β_{0j}) and slopes (β_{1j}, β_{2j}, and β_{3j}) were assumed to vary across participants, including the effects of self-reflection (Ref_j) and person-level random effects[3] (u_{0j}, u_{1j}, u_{2j}, or u_{3j}). We also included gender ($Gender_j$; 0 = men, and 1 = women) and baseline depressive symptoms (BDI_j) as controls at the Level 1 intercept (β_{0j}).[4] The most important parameter for our hypothesis testing was β_{31}, which reflects the three-way interaction effect between self-reflection, problem-solving behavior, and stress level. When testing for the effect of self-rumination, we replaced self-reflection with self-rumination in these equations. Prior to the main analysis, the Level 1 dependent variable (i.e., stress level), except for dichotomous variables (i.e., gender and problem-solving

behavior), was person-mean centered, and Level 2 predictors were grand-mean centered to ease interpretation.

Results

Across 39 participants, 264 diary reports were collected (compliance rate = 96.7 %). Descriptive statistics and correlations between the study variables are provided in Table 1. Consistent with previous research (e.g., Trapnell and Campbell 1999), our data indicated a significant correlation between self-rumination and depression ($r = 0.41$, $p = 0.010$) but not for self-reflection and depression ($r = 0.11$, $p = 0.493$). For the day-level variables, problem-solving behavior itself did not have a significant association with daily depressed mood ($r = -0.10$, $p = 0.541$), although stress exhibited a moderate correlation with daily depressed mood ($r = 0.46$, $p = 0.003$). The frequency of problem-solving behavior correlated with neither self-reflection ($r = 0.15$, $p = 0.361$) nor self-rumination ($r = 0.07$, $p = 0.687$).

Prior to main analyses, we classified reported problems into three domains (achievement/academic, interpersonal, and somatic) and tested the relationship between the problem domain and its level of stress. Consequently, 173 problems were in the achievement domain (mean stress level was 2.4, $SD = 1.1$), 63 interpersonal (mean stress level was 3.2, $SD = 1.4$), and 28 somatic (mean stress level was 2.6, $SD = 1.6$). To clarify the effects of these domains, we first tested the effect of domain on stress level. Before the analysis, we made two dummy-coded variables (x_1 and x_2) indicating the problem's domain with x_1 indicating achievement domain (1 = achievement, 0 = not) and x_2 indicating interpersonal domain (1 = interpersonal, 0 = not); if both x_1 and x_2 are 0, it means the problem is in the somatic domain. We conducted the multilevel model in which x_1 and x_2 predict stress level (both dummy-coded variables and stress are analyzed as daily level variables). As a result, only the dummy-coded interpersonal variable (x_2) had a marginally significant and positive effect on stress level ($B = 0.57$, $t = 1.86$, $p = 0.065$), suggesting interpersonal problems are slightly more stressful than those in other domains. Next, we conducted another multilevel model in which stress, domain, and interaction between stress and domain predicts depressed mood (stress was person-mean centered prior to analysis). This analysis showed that only stress had a significant main effect on depressed mood ($B = 3.00$, $t = 2.51$, $p = 0.013$). Together, the difference of the domain may be explained by the difference of stress level when predicting depressed mood. Thus, we conducted the following analyses without discrimination of the domain.

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[3] Because u_{3j} did not converge to a positive value when conducting the analysis about self-reflection, we re-estimated the model, fixing u_{3j} to be zero.

[4] To test whether the BDI has any interactions with problem-solving behavior, stress, or self-focus, we also added the BDI score and its interaction with self-reflection to the equation as independent variables for the Level 1 intercept and slopes. Furthermore, we estimated an analogous model replacing self-reflection with self-rumination. Consequently, all interactions including the BDI were significant in neither the self-reflection nor the self-rumination model.

Table 1 Descriptive statistics and correlations between person-level and daily-level variables

	Mean	SD	1	2	3	4	5	6
Person-level variables								
1. BDI	10.6	7.4	–					
2. Self-reflection	37.9	8.3	0.11	–				
3. Self-rumination	42.5	7.0	0.41**	0.19	–			
Daily-level variables								
4. Depressed mood	5.0	10.3	0.28	−0.10	0.43**	–	−0.11	0.41***
5. PSB	0.6	0.5	−0.01	0.15	0.07	−0.10	–	−0.04
6. Stress	2.6	1.3	0.31	0.09	0.18	0.46**	−0.10	–

Correlations below the diagonal represent the person-level (N = 39). Daily-level variables were aggregated across the 7 days. Correlations above the diagonal represent the day-level (N = 264). Gender is coded 0 = male, 1 = female

BDI beck depression inventory, *PSB* problem-solving behavior

** $p < 0.01$; *** p < 0.001

Self-reflection and depressed mood after problem-solving behavior

First, we tested the hypothesis regarding self-reflection wherein we posited that individuals with higher levels of self-reflection would show lower levels of depressed moods following problem-solving behaviors; we believed that this would be evident even if the problems were highly stressful (Table 2). We used the above-mentioned multilevel model in which daily depressed mood was predicted by self-reflection, problem-solving behavior, and problem stress level and their interactions. The results showed a significant main effect of daily problem stress level ($B = 2.75$, $t = 3.68$, $p < 0.001$), suggesting that, on days when more stressful problems were reported, participants were more likely to experience increased depressed moods. Although none of the two-way interaction effects were significant, the three-way interaction significantly predicted depressed mood ($B = −0.27$, $t = −2.21$, $p = 0.029$). In order to explore the form of this interaction, conditional effects of problem-solving behaviors on depressed mood for higher and lower levels (1 *SD* above and below the mean) of the two moderators (i.e., self-reflection and problem stress level) were calculated using our equation (Aiken and West 1991; Preacher et al. 2006; Fig. 2). The simple slope for higher levels of self-reflection and stress was significant ($B = −6.91$, $z = −2.63$, $p = 0.008$), but this was not seen in the case of lower self-reflection and higher stress ($B = 3.00$, $z = 1.19$, $p = 0.236$). The simple slopes were not significant for higher self-reflection and lower stress and for lower self-reflection and lower stress ($B = −1.23$, $z = −0.44$, $p = 0.660$; $B = −2.85$, $z = −1.19$, $p = 0.235$). These results support our hypothesis, suggesting that individuals with higher levels of self-reflection were likely to report low depressed moods on the days in which they reported problem-solving behaviors for highly stressful problems.

Self-rumination and depressed mood after problem-solving behavior

Next, we tested the hypothesis regarding self-rumination, wherein we posited that individuals with high levels of self-rumination would exhibit high levels of depressed mood despite engaging in problem-solving behaviors to rectify a stressful problem; those with low self-rumination levels, however, would be able to successfully regulate their depressed moods if they engaged in problem solving (Table 3). We employed our multilevel model and replaced self-reflection with self-rumination. Our results showed significant main effects of stress ($B = 2.74$, $t = 3.82$, $p < 0.001$) and self-rumination ($B = 0.41$, $t = 2.21$, $p = 0.032$) in predicting depressed moods, suggesting that individuals with higher levels of self-rumination tended to report higher levels of depressed mood over the diary assessment period. Although we found neither two-way nor three-way interactions among self-rumination, problem-solving behavior, and stress level, the two-way interaction between self-rumination and stress level was marginally significant ($B = 0.19$, $t = 1.98$, $p = 0.066$). In order to explore the form of this interaction, conditional effects of stress level on depressed mood for higher and lower levels (1 *SD* above and below the mean) of the moderators (i.e., self-rumination) were calculated using our equation (Fig. 3). The simple slope was significant for higher levels of self-rumination ($B = 4.06$, $z = 3.87$, $p < 0.001$), but not lower levels ($B = 1.42$, $z = 1.58$, $p = 0.114$). Although the non-significant higher-order interaction effect does not support our hypothesis that self-rumination prevents the emotion regulation function of problem-solving behavior,

Table 2 Estimation of multilevel model predicting depressed mood

	B	SE	t value
Intercept	4.98	(1.69)	2.95**
Daily-level variable			
Problem-solving behavior	−2.00	(1.26)	−1.58
Stress	2.75	(0.75)	3.68***
Person-level variables			
Gender	1.94	(2.16)	0.90
BDI	0.24	(0.14)	1.69
Self-reflection	0.03	(0.15)	0.21
Two-way interaction			
Self-reflection × problem-solving behavior	−0.25	(0.16)	−1.58
Self-reflection × stress	0.12	(0.09)	1.32
Stress × problem-solving behavior	0.03	(1.00)	0.03
Three-way interaction			
Self-reflection × problem-solving behavior × stress	−0.27	(0.12)	−2.21*
Random effcts			z value
Intercept variance	31.12	(10.53)	2.96**
Problem-solving behavior variance	14.67	(11.36)	1.29
Stress variance	2.26	(2.11)	1.07
Residual variance	54.17	(5.80)	9.34***

Analyses include 264 days across participants ($N = 39$)

BDI Beck depression inventory; PSB problem-solving behavior
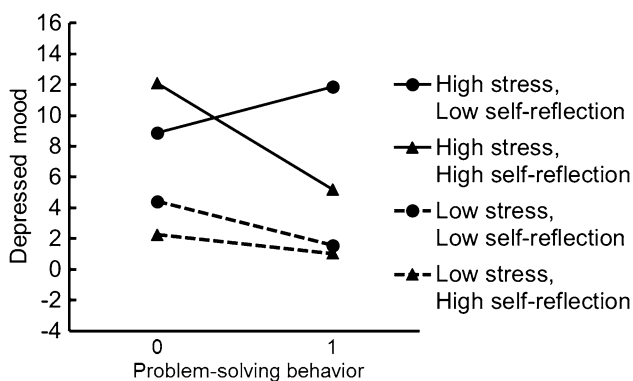
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Fig. 2 Conditional effects of problem-solving behavior on depressed mood as a function of self-reflection and problem stress level

the pattern of the interaction between self-rumination and stress suggests that individuals with higher levels of self-rumination tend to exhibit higher levels of depressed mood upon experiencing a high-intensity stressor.

Finally, we tested the possibility that self-reflection and self-rumination interact with each other in predicting depressed mood. To test this, we simultaneously added self-reflection, self-rumination, and their interactions into a multilevel model as Level 2 predictors. Consequently, the estimated model included additional 3-way interactions (i.e., self-reflection × self-rumination × problem-solving behavior and self-reflection × self-rumination × stress) and a 4-way interaction (self-reflection × self-rumination × problem-solving behavior × stress). The results showed that neither 3-way nor 4-way interactions related to self-reflection and self-rumination were significant ($ps > 0.165$). This result suggests that self-reflection and self-rumination independently associate with depressed mood.

Discussion

Using a diary assessment of problem solving and moods, the present study investigated the moderating effects of the two subtypes of private self-consciousness on the relationships between problem-solving behavior and depressed mood. The results showed that self-reflection interacted with problem-solving behavior and problem stress level, predicting daily depressed moods. The form of this interaction suggests that individuals with higher levels of self-reflection reported lower depressed mood when they tried to solve a highly stressful problem; in other words, only highly self-reflective people experience the benefit of problem-solving behavior when the stress level is high. This finding supports our prediction that self-reflection plays an adaptive role in problem solving. Although self-rumination showed no significant interaction with problem-solving behavior, the interaction between self-rumination and stress level was marginally significant. This result suggests that self-ruminative people are modestly vulnerable to stress, consistent with previous research (Nolen-Hoeksema and Morrow 1991; Takano et al. 2011).

The enhanced emotion regulation for self-reflective individuals supports the theoretical suggestion that certain

Table 3 Estimation of multilevel model predicting depressed mood

	B	SE	t value
Intercept	6.12	(1.62)	3.77**
Daily-level variable			
Problem-solving behavior	−2.05	(1.28)	−1.60
Stress	2.74	(0.72)	3.82***
Person-level variables			
Gender	0.19	(2.14)	0.09
BDI	0.10	(0.15)	0.67
Self-rumination	0.41	(0.18)	2.21*
Two-way interaction			
Self-rumination × problem-solving behavior	−0.08	(0.18)	−0.45
Self-rumination × stress	0.19	(0.09)	1.98
Stress × problem-solving behavior	0.26	(0.99)	0.26
Three-way interaction			
Self-rumination × problem-solving behavior × stress	−0.19	(0.12)	−1.50
Random effects			z value
Intercept variance	23.96	(9.24)	2.59**
Problem-solving behavior variance	18.21	(11.96)	1.52
Stress variance	1.30	(2.78)	0.47
Stress × problem-solving behavior variance	0.19	(3.70)	0.05
Residual variance	55.82	(6.04)	9.24***

Analyses include 264 days across participants (N = 39)

BDI Beck depression inventory, *PSB* problem-solving behavior

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$
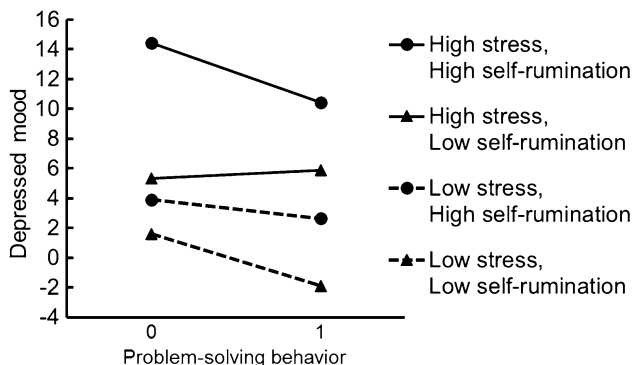
Fig. 3 Conditional effects of problem-solving behavior on depressed mood as a function of self-rumination and stress level of the problem

types of self-focus have beneficial outcomes, including reduced negative affect, increased positive affect, and decreases in anxiety and depression (Martin and Tesser 1996; Watkins 2008). Such benefits of self-focused attention are considered to appear when self-focus facilitates the self-regulatory cycle aimed at the achievement of personal goals and a reduction in self-discrepancy (Carver and Scheier 1982, 1990; Pyszczynski and Greenberg 1987). As proposed by proponents of control theory (e.g., Carver and Scheier 1990), self-regulatory goals and behaviors would be hierarchically organized from superordinate goals (e.g., idealized self-image) to subordinate goals (e.g., be kind)

and actual behaviors (e.g., shovel snow off walks). Theorists have argued that the proper translation of the superordinate goals into the subordinate goals and specific action plans would lead to adaptive outcomes in difficult or stressful situations (Watkins 2008), because the enhanced rate of goal progress is closely associated with increases in both confidence and positive feelings and decreases in doubt and negative affect. Since self-reflection is motivated by curiosity about the self and is associated with clear self-knowledge (Şimşek et al. 2013; Trapnell and Campbell 1999), it can help to translate superordinate goals into the concrete actions that are most suitable to one's ability and circumstances. Thus, self-reflection could contribute to a well-organized hierarchy in the self-regulatory cycle, resulting in greater problem-solving success. This speculation is consistent with recent research showing a significant association between a curious personality type (i.e., openness to experience) and higher trait problem-solving ability (D'Zurilla et al. 2011).

As another possible explanation, self-reflection contributes to emotion-regulation through positive appraisal. Previous research suggested the association between self-reflection and positive reappraisal (Jones et al. 2009). Therefore, individuals with high self-reflection possibly make positive appraisal, which is known to facilitate negative emotion regulation (Garnefski and Kraaij 2006), on the results of problem-solving behavior, even if the results are

not, in fact, good. To elaborate the mechanism underlying the adaptive effect of self-reflection on problem-solving behavior, future research needs objective measures (e.g., proofreading test score; Lyubomirsky et al. 2003) to differentiate the objective effectiveness of problem-solving behavior from participant's subjective appraisal.

Contrary to our hypothesis, the three-way interaction between self-rumination, problem-solving behavior, and problem stress level was not significant. This null interaction effect indicates that the emotional influences of problem-solving behaviors would not be different between either self-rumination levels or daily problem stress levels. However, self-rumination had a significant main effect and marginally significant interaction with the stress level in predicting depressed mood. These results suggest that individuals inclined towards self-rumination tend to experience higher levels of depressed mood over the 1-week sampling period, and they may further exacerbate these moods after encountering high-intensity stressors. The interaction between depressive rumination and stressful experiences has been consistently reported in previous studies, suggesting that ruminative self-focus amplifies stress-induced negative moods because such individuals are prone to focusing on unresolved goals and self-discrepancies (Kraaij et al. 2003; Skitch and Abela 2008). While this mood-exacerbation effect was argued to be caused by disturbed problem-solving processes resulting from negative ruminative thinking (Lyubomirsky and Nolen-Hoeksema 1995; Lyubomirsky et al. 1999), this moderating role of self-rumination was not supported in our data. This is possibly because our assessment of problem-solving behavior focused on participants' immediate actions in response to daily stressors that were taken before the day was over. If we had tracked the course of emotion regulation processes after the initial problem-solving actions, the deleterious influences of self-rumination may have become more evident. This lag is likely since self-rumination may interrupt problem-solving behavior such that highly ruminative people cannot manage to finish problem solving before the day is over. Indeed, an empirical study showed that induced rumination increased the time for solving the task, suggesting that ruminative thinking disrupts the concentration by its cognitive load (Lyubomirsky et al. 2003). Such delay effect of self-rumination on problem solving can be associated with the senses of frustration, self-doubt, and depressed feelings (Carver and Scheier 1990).

Another possible reason for the non-significant interaction between self-rumination and problem-solving behavior is that dichotomous assessment of problem-solving behavior was not sufficiently sensitive to how people were ruminating. As introduced above, previous researchers have suggested that harmful effects of depressive rumination on problem solving stem from the depletion of cognitive resources by ruminative or interfering thoughts (Lyubomirsky et al. 2003). There is a possibility that problem-solving behaviors reported in the present study ranged from ones requiring more cognitive resources (e.g., planning for the complex problem) to ones requiring fewer resources (e.g., routine work). Thus, if we assessed the cognitive load of problem-solving behavior, we may have observed the interaction between self-rumination and highly effortful problem-solving behavior.

In addition, the non-significant correlation between self-rumination and the frequency of reported problem-solving behavior appear to be inconsistent with previous research revealing that individuals with depressive rumination lack the motivation for problem solving (Lyubomirsky et al. 1999; Ward et al. 2003). As discussed above, ruminative individuals may be unable to finish problem solving within 1 day. A possible explanation is that ruminative people tended to continue working on one problem over several days, and we counted such longer problem-solving behavior repeatedly due to our once-a-day assessment methodology. If we had assessed all problems of the day and participants' reactions, we would have found that individuals with high self-rumination can handle only few problems within a day. Similarly, even if the individuals with high self-reflection actively tried to solve their problems, once-a-day assessment was not enough to capture all their problem-solving behaviors. We measured only one problem-solving behavior for the most stressful problem per day. While our results showed that self-reflection was not associated with frequency of problem-solving behavior for the most bothersome issue of the day, highly self-reflective people may actively try to solve moderately or slightly stressful problems.

Limitation

Our findings should be cautiously interpreted in light of several important limitations. First, we did not specify whether the everyday problem-solving behaviors led to actual goal achievement. Goal success is an important parameter that influences mood states, as indicated in an experience sampling study that suggested that the combination of low goal success and high goal importance was associated with increased negative moods (Moberly and Watkins 2010). Despite even mental simulation aimed at resolving personal problems alleviating negative emotions triggered by stressful events and enhancing positive emotions (Rivkin and Taylor 1999), research has yet to confirm that the reflective form of self-focus facilitates the problem-solving process.

In addition, we could not capture the main effect of problem-solving behavior on depressed mood. These non-significant effects may be caused by the retrospective nature of the DCI. One possibility is that the end-of-day methodology is too retrospective such that participants could not accurately indicate whether they did problem-solving behavior. Furthermore, if they engaged in problem-solving behavior earlier in the day, its effect may have attenuated before the end of the day. To fully disentangle such temporal relationships, we have to estimate lagged effects using an autoregressive model. Nevertheless, since the DCI can provide much fewer measurement times per person than the experiences sampling method (ESM), it is difficult to robustly estimate the autoregressive model. We have used a diary method because other methodology, such as ESM, per se interrupts problem-solving behavior. However, future research needs to employ alternative methodology such as the day reconstruction method (Kahneman et al. 2004) to assess temporal effects.

Moreover, to discuss the relationship between depressed mood and problem stress level, other valuables remain to be considered; namely, the tendency to report negative feelings. Such a tendency may cause a spurious correlation between stress level and depressed mood. To be sure, it is preferable to use physiological indices such as heart rate for assessing stress responses. Nevertheless, we controlled the BDI scores that reflect negative cognitive biases. Therefore, personal tendency to report negative feelings was controlled to a certain degree.

Our sample size is relatively small, which reduced statistical power. One possibility is that less statistical power leads to non-significant results such as interaction between person-level variables (i.e., self-reflection and self-rumination). Moreover, the present sample is entirely made up of Japanese students. This may constrain the generalizability of our findings. Theorists have pointed out that the self-other relationships in Japan differ from those in Western or American cultures (Markus and Kitayama 1991). In Eastern or Asian cultures, people have interdependent construal of self in which an individual recognizes self as a participant in a larger social unit, and s/he is motivated to find a way to fit in with relevant others, while Western or American people have an independent construal of the self in which an individual has a conception of self as an autonomous, independent person (Markus and Kitayama 1991). Furthermore, interdependent self-construal is positively associated with social anxiety, while independent self-construal has negative association with that (Okazaki 1997). Thus, the association between self-focus and emotion in Japan may differ from that in other countries so that we should be careful when applying our results to other cultures. As another sampling issue, our sample was only graduate or undergraduate students. In particular, negative mood in college students is typically not particularly serious, nor does it last very long. In fact, the reported daily depressed mood (M = 5.0, SD = 10.3 with a possible range from −20 to 40) and the reported problem stress level (M = 2.6, SD = 1.3 with a possible range from 1 to 7) were not high. To generalize our findings to other populations, future research needs to be conducted with different participants such as people in other development stages or depressed patients.

Conclusion

Our data suggest that the reflective form of self-focus may contribute to daily problem solving in terms of the enhanced emotion regulation function associated with decreased levels of depressed mood resulting from highly stressful challenges. These results are consistent with the previous findings, suggesting that certain types of self-focused thinking help improve social problem solving (Watkins and Moulds 2005), facilitate adaptive emotional analysis (Ayduk and Kross 2010), and make individuals more resilient to stressful events (Watkins et al. 2008). These studies have shown that analyzing negative feelings from a distant perspective (i.e., self-distancing) leads to positive reconstructions of negative experiences and reductions in negative affect (Kross et al. 2012). Furthermore, concrete forms of self-focused thinking enable individuals to construct sequential problem-solving processes more effectively than abstract and ruminative form of self-focus, and such concrete thinking results in lower levels of negative affect (Watkins 2008; Takano and Tanno 2010). Integrating these findings on the beneficial functions of self-reflection, future research needs to clarify the mode, contents, and motivations of self-focused thinking that facilitate problem solving and enhance emotion regulation. Such attempts to reveal the adaptive components of self-reflection could directly contribute to developing more effective interventions and preventative treatments of mood disturbances and depressive disorders.

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