Increased attentional control for emotional distractors moderates the use of

reflective pondering in times of life stress: A prospective study

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Abstract

According to the response-styles theory, rumination is a cognitive response to a stressor with repetitive and self-focused attention on a negative mood state. The attentional disengagement theory (Koster, De Lissnyder, Derakhshan, & De Raedt, 2011) highlights that attentional processes are critical underlying individual differences in ruminative thinking, such as reflective pondering and depressive brooding. Using a prospective design, the current study sought to determine whether attentional control for negative material was differently associated with brooding and reflection upon life stress. Spanning a period of three months, seventy-six never depressed undergraduate students completed a baseline measurement of attentional bias using an emotional modification of the exogenous cueing task (T1) and subsequently, six weeks after T1, completed internet questionnaires during their final examinations at 4 weekly fixed moments (T2-T5). The data were analyzed with a series of multilevel regression analyses. Results revealed that the relation between stress and the use of reflective pondering is stronger when participants allocate less attention to emotional information (negative and positive stimuli). On the other hand, attentional control did not moderate the relation between stress and depressive brooding. Based on the current research findings, it might be important to train attentional control to disengage from emotional distractors, which in turn may increase the use of more self-controlling thinking in response to stress.

Keywords: stress reactivity - reflective pondering - depressive brooding – attentional control – emotional distractors

Increased attentional control for emotional distractors moderates the use of reflective

pondering in times of life stress: A prospective study

It is well known that there are wide differences in the way people cope with stressful situations. Research shows that habitual thought processes strongly influence how individuals respond to life stress (for a review, see Watkins, 2008), with a main focus on the effects of ruminative thinking (Thompson et al., 2010). Rumination - defined as persistent self-focused thinking about negative moods and its causes and consequences (Nolen-Hoeksema & Morrow, 1993) - has been shown to be a remarkably good predictor of psychological distress and even of depressive symptoms (Nolen-Hoeksema, Wisco, Lyubomirsky, 2008).

According to the response-styles theory, rumination is a detrimental response to a stressor with repetitive and passive self-focused attention on a negative mood state (for a review, see Nolen-Hoeksema et al., 2008; Nolen-Hoeksema, 1991). Although rumination has been strongly linked to depression, there is some debate as to whether rumination should be considered as a purely maladaptive response to stress. Based on a factor analysis, research has drawn a clear distinction between two types of rumination: depressive brooding and reflective pondering (Treynor, Gonzalez, & Nolen-Hoeksema, 2003; Joormann, Dkane, Gotlib, 2006; Takano & Tanno, 2009). Depressive brooding, or brooding, is defined as a passive comparison of one"s current situation with some unachieved standards (e.g. "think about a recent situation, wishing it had gone better"; Treynor et al. 2003, p. 256) and appears to be a good predictor for prolonged negative mood (Nolen-Hoeksema et al., 2008). Reflective pondering, or reflection, is defined as an intentional inward focus to engage in cognitive problem-solving to alleviate one"s depressive symptoms (e.g. "analyze your personality to try to understand why you are depressed"; Treynor et al. 2003, p. 256). Although reflection is a response to life stress, it has been related to lower levels of

depressive feelings over time (Treynor et al., 2003). Moreover, Joormann et al. (2006) stated

that, specifically in non depressed individuals, reflection can be considered as „adaptive"

problem solving thinking that, as compared to brooding, dampens psychological distress.

The distinction between brooding and reflection has recently received increased

interest in research focusing on individual differences in how individuals cope with life

stress. In recent cognitive models, it has been postulated that rumination is strongly

influenced by cognitive processes at the level of attention, interpretation and memory

(Joormann & Gotlib, 2010; Koster, De Lissnyder, Derakhshan, & De Raedt, 2011). In a new

theoretical model, the attentional disengagement theory (Koster et al., 2011), ruminative

thinking styles are seen as cognitive products that are influenced by attentional control

processes. More specifically, it is argued that the ability to disengage attention from negative

material is crucial in predicting specific ruminative responses. That is, in order to engage in

adaptive coping, emotion regulation or mood repair (inclusive reflective pondering) it is

crucial to be able to disengage from negative information. If this ability is impaired,

individuals are more likely to experience prolonged rumination on negative affect (brooding).

For example, a life stressor such as an argument with one" s spouse will naturally elicit

negative thoughts. However, some individuals are able to call for attentional resources to

reduce the distraction from these ongoing negative thoughts about one self. This successful

disengagement from emotional distractions allows reflective pondering in order to (possibly)

solve the problem. Indeed, it has been found that this reflective pondering can increase self-

knowledge and facilitate psychological adjustment (e.g. Martin & Tesser, 1996; Mor &

Winquist, 2002). Conversely, individuals who are unable to control their attention are more

likely to engage in depressive brooding, a thinking style which is related to increased

depressive feelings (Koster et al., 2011). Thus, this theory predicts relations between attentional control (impairments) and both reflective pondering and depressive brooding.

The available research that has investigated information processes in relation to different forms of rumination have used cross-sectional and/or correlational designs. However, the testing of information processes underlying the entire process of stress reactivity calls for a *prospective design* to predict the activation of ruminative thinking during periods of life stress. This is because, when people are confronted with life stress, individual differences in information processes for emotional information may play a moderating role in the onset and course of well-defined ruminative response styles (e.g. Nolen-Hoeksema et al., 2008). To this end, the aim of the current study was to investigate the moderating impact of attentional control in the activation of reflective pondering and depressive brooding following a real-life stressor. To this end, we recruited a never depressed healthy sample specifically because current or past depressive episodes are associated with a markedly enhanced response to stress (for a review, see Scher, Ingram, & Segal, 2005). Moreover, the absence of depressive feelings increases the likelihood that we can distinguish between depressive brooding and reflective pondering (Joormann et al., 2006).

We set up a study in a group of non- (and never) depressed students using a prospective study design with five test moments. At time one (T1), we administered an emotional modification of the exogenous cueing task with angry, fearful, happy, and neutral faces as cues (ECT, Posner, 1980). This attentional paradigm was chosen in analogue of prior prospective research investigating dysphoria and stress responses (e.g., MacLeod & Hagan, 1992; Beevers & Carver, 2003; Fox, Cahill, Zougkou, 2010). In the ECT task, a target appears at one of two spatial locations, preceded by a cue at the same („valid trial") or opposite location („invalid trial"). This task provides a means of investigating attentional

biases for emotional information by calculating a Cue Validity index (CV)[1]. In the present study, cues were presented for either 200 ms (early attentional processing) or 1000 ms (later attentional processing). When the cue is presented for 200 ms, a faster response to valid compared to invalid trials for emotional versus neutral cues indicates that attention is more driven by the emotional stimuli (Fox, Russo, Bowles, & Dutton, 2001). There is a substantial body of work showing that very brief presentations of emotional facial expressions are associated with the capture of attention (for a review, see Brosch, Sander, Pourtois, & Scherer, 2008; but see also Koster, Verschuere, Burssens, Custers, & Crombez, 2007). When the cue is presented for a longer duration (> 1000 ms), this facilitative effect reverses because attention is drawn to new locations (the inhibition of return effect: IOR, Posner, 1980). However, if attention dwells on or is maintained by emotional cues, the inhibition of return effect will be reduced for the emotional cues (Fox, Russo, & Dutton, 2002). Based on previous studies in healthy volunteers where typically effects on emotional reactivity were related to early attentional processes (e.g., MacLeod & Hagan, 1992; Beevers & Carver, 2003; Fox et al., 2010), we expected effects only for the 200 ms cue presentation.

Subsequently, six weeks after T1, internet questionnaires were administered during final examinations at four fixed moments in time (weeks T2-T5 during final examinations), measuring real-life stress and the response, i.e. reflective pondering and depressive brooding. The two rumination variables are considered as independent constructs generated from the Ruminative Response Scale (Treynor et al., 2003). For undergraduate students, final examinations are considered as stressful events. How students handle these stressors and respond with different types of rumination might be moderated by attentional biases for

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[1]Using the ECT, more specific components of attention - attentional engagement and disengagement - can be examined. However, some methodological problems have been noted in the analyses of these components (Mogg, Holmes, Garner, & Bradley, 2008). Therefore, we chose to limit our analyses to the cue validity component as our main index of attentional bias.

emotional information. This association between attentional bias (T1) and levels of

rumination over the follow-ups in times of life stress (T2-T5) should be controlled for

baseline levels of trait rumination. This control for trait rumination in the multilevel models

will provide an indication of the temporal variation in the relation between stress and

differences in state rumination.

Overall, based on the attentional disengagement theory that specifies the role of

attentional control processes on ruminative thinking (Koster et al., 2011), two hypotheses

with regard to reflective pondering and depressive brooding were tested:

1.We predicted that the association between a stressor and reports of "reflective

pondering" (at T2-T5) would be larger when participants demonstrated a decreased

attentional bias (i.e. decreased CV) for angry faces at T1, hypothetically because a

decreased CV indicates attentional orienting away from emotional stimuli.

Disengagement from emotional information is important to engage in reflective

pondering.

2. We predicted that the association between a stressor and reports of "depressive

brooding" (at T2-T5) would be larger in participants with an increased attentional bias

(i.e. increased CV) for angry faces at T1. This is because attention to negative

emotional cues represents an inability to detract attention from negative cognitions

which might facilitate depressive brooding.

We expected an effect for emotionally negative information, specifically inter-

personal rejection (angry faces) (Koster et al., 2011). In addition, based on previous work

using a prospective design with a similar attentional task (MacLeod & Hagan, 1992; Beevers

& Carver, 2003; Fox et al., 2010), we expected an effect for shortly presented emotional cues

(200 msec.).

Methods

Participants

A total of 83 students at Ghent University (35 males and 48 females) with a mean age of 21.11 years (SD = 1.45) participated in this study. The absence of a history of a major depressive episode was confirmed using the structured Mini International Neuropsychiatric Interview (MINI - Sheehan et al., 1998; Dutch version: Van Vliet, Leroy, & Van Megen, 2000). At baseline, participants had a mean Beck Depression Inventory-II (BDI-II; see below) of 8.94 (SD = 8.66). After receiving a complete verbal description of the study, they all provided written informed consent (protocol approved by the local ethics committee of Ghent University). The students received a financial reward for their participation.

Materials

The instructions of the questionnaires administered at baseline were not changed (i.e. "how you are feeling in general"). The instructions of all the questionnaires, administered during the stressful period, were modified to examine a period of one week between two measurements (i.e. "how you were feeling over the last week"). The *Beck Depression Inventory II* (BDI-II; Beck, Steer, & Brown, 1996, Dutch translation by Van der Does, 2002) was administered to screen for depressive symptoms. The BDI-II consists of 21 multiple choice format items, measuring the presence and severity of cognitive, motivational, affective, and somatic symptoms of depression. The *Adverse Events Questionnaire* (AEQ) was used to measure adverse events in participants" lives. This instrument is designed specifically for a college population (for items, see Carver, 1998) and includes academic and relationship domains, occurrence of negative events in any other domain, and the accumulation of minor problems. Using a Likert-type scale from 0 to 3, participants specified

for each domain how frequently they encountered life stress and difficulties (i.e. 0 = No, 1 =

„Yes, this happened to me once" ; 2 = „Yes, this happened to me twice" ; 3 = „Yes, this

happened to me more than twice"). The *Ruminative Response Scale* (RRS) (Nolen-Hoeksema

& Morrow, 1991; Dutch translation by Raes & Hermans, 2007 RRS-NL; and also Schoofs,

Hermans, & Raes, 2010) was administered to measure rumination. Questions deal with

behaviour and cognitions that people are aware of when they feel depressed. This Dutch self-

report questionnaire consists of 26 questions to which participants respond using a 4-point

Likert scale (i.e. 1 = almost never, 2 = sometimes, 3 = often, 4 = most of the time). A factor

analysis of the RRS has identified two separate subscales that are differentially related to

psychological distress (Treynor et al., 2003; Joormann et al., 2006; Takano & Tanno, 2009).

Reflective pondering consists of five questions assessing the degree to which individuals

engage in cognitive self-regulation to reduce negative mood. More maladaptive ways of

rumination, i.e. depressive brooding, include five items assessing the extent to which

individuals passively focus on the reasons for their distress (Treynor et al., 2003). Past reports

indicated that all questionnaires had good psychometric qualities.

Attentional task

Attentional processing of emotional information was measured using an emotional

modification of the exogenous cueing task (ECT: Posner, 1980). The ECT was programmed

using Inquisit (Millisecond Software, 2003, Version 1.33) and was run on a personal

computer with a 17-inch colour screen (see Figure 2 for an outline of the ECT design).

Participants were instructed to respond as quickly and accurately as possible to two black

rectangles (3 mm/2 mm, with a vertical or a horizontal orientation) that could appear on the

left or right side of a fixation cross. They were informed that a cue (picture of a face)

preceded the presentation of the target and that this cue was not predictive for the target

location. It was emphasized attention should be directed towards a fixation cross during each trial. Depending on the orientation of the rectangles (vertical or horizontal), they were asked to press one of two assigned keys of a response box. The response labels were counterbalanced across subjects.

Before the target appeared, a picture of an angry, happy, fearful, or neutral face was presented. The location of the picture cued the spatial location of the target in 50% of the trials (valid *cue)* and incorrectly cued the location of the target in the other 50% of the trials (invalid *cue).* This valid/invalid ratio was based on previous work (Koster, De Raedt, Franck, Goeleven, & Crombez, 2005) to ensure that attentional effects were specifically related to the exogenous cues. Within trials, pictures of neutral or valenced (happy, fearful, and angry) faces appeared with equal frequency on the left and right sides of the screen. Each trial started with a fixation cross that stayed in the middle of the screen for the remainder of the trial presentation. Five hundred ms after presentation of the fixation cross, a picture of a neutral or valenced face was presented for 200 or 1000 ms (block wise). Next, after a blank screen (50 ms), the target appeared for 1500 ms or until the subject responded. Several ECT index scores for CV [3 (CV angry, CV fearful, CV happy) x 2 (200 ms, 1000 ms)] were calculated using the following formulae: (1) Cue validity index (CVi) = RT invalid cue – RT valid cue; (2) CV = CVi for emotional – CVi for neutral. As a result, a positive score on this latter score indicates enhanced attention for emotional stimuli in comparison with neutral control stimuli (e.g. higher CV indicates an enhanced attentional bias). This latter index will be used as a moderating variable in the analyses (level 2 predictor).

Participants first completed 20 practice trials, followed by two experiment blocks (200 ms and 1000 ms, counterbalanced order) each containing 104 test trials. The order of trial types (emotion - validity - target type) was random. Stimuli were taken from the „Karolinska

Directed Emotional Faces" (KDEF) database (Lundqvist, Flykt, & Öhman, 1998). Prior to

selection, all pictures were adjusted to exclude interference of background stimuli (hair and

clothing) so that only the face of the person was presented. In addition, all coloured pictures

were adjusted to the same size (326 x 326 pixels). We chose to include angry (in the context

of interpersonal rejection), fearful (in the context of perceived threat specific to

examinations), and happy (in the context of positive information) faces as emotional pictures.

Pictures were selected based on a validation study of the KDEF picture set: 20 pictures of

neutral faces [> 75 % of the raters categorized them as neutral; moderate average intensity

rating ($M = 4.32$)] and 60 of angry, fearful, and happy faces (20 each) [categorized by > 80%

of the raters; high average intensity rating ($M = 6.5$)] (Goeleven, De Raedt, Leyman, &

Verschuere, 2008).

Procedure

During an initial laboratory session (T1), participants completed the following

baseline questionnaires: BDI-II, RRS, and the AEQ. Thereafter, an ECT task with fearful,

angry, neutral, and happy faces was presented to participants. At a follow-up approximately 6

weeks later (T2-T5), all participants were preparing for and performing final examinations.

During that period, participants completed the same questionnaires as at baseline

measurement in four consecutive weeks. Internet questionnaires were sent every week on

Wednesday, and participants" responses were automatically emailed to a lab address after

completion of an online questionnaire. Participants were instructed to complete the

questionnaires on the same day or the day after receipt.

Statistical analyses

The data comprised a multilevel (or hierarchically nested) data structure with life stress reports over 4 test moments (level 1) nested within individual scores of attentional control (level 2) in order to predict rumination. We controlled for baseline levels of rumination (trait rumination) in order to estimate any temporal variation in the relationship between stress and rumination. In other words, taking into account the baseline ruminative response, we investigated whether attentional bias to emotional faces at Time 1 moderated the relationship between stressors and ruminative thinking at T2-T5. The data were analyzed with multilevel regression analyses using the HLM program (Raudenbush, Bryk, & Congdon, 2004; Version 6.01). The Level-1 predictor (i.e. AEQ) was group-mean centered; Level-2 predictors (i.e. CV) were standardized and grand-mean centered to allow for comparisons across Level 2 units and for a clearer interpretation of coefficients. A full maximum likelihood estimation was used for all models. Effect sizes r were calculated according to the formula $r = r_D \sqrt{(1 + r_I/2)}$, where $r_D = \sqrt{(t^2 / t^2 + n-2)}$ and r_I = intraclass correlation (see Kenny, Kashy, & Cook, 2006). Estimates of effect size are reported: estimates of .1 are considered small, .3 medium, and .5 large (see Cohen, 1988). The significance level was set at an alpha level of .05.

<center>**Results**</center>

Descriptives

Mean scores, standard deviation, and Cronbach‟s alphas of self-report measures at all test moments are listed in Table 1. Higher scores are indicative of higher rumination, more stressors, and more depressive symptoms respectively. Of a total of 83 subjects, 7 subjects (8.3%) did not return their questionnaires at 3 out of 4 test moments and were consequently

excluded from the analyses. Of the remaining 76 participants, 7 did not return their

questionnaires at one test moment, and their data were all listed as missing. Before analyzing

the response latencies of the ECT, trials with errors, and latencies, more than 2.5 standard

deviations beyond each participant" s mean for each data category were omitted (M=4.6%,

SD=3.5). A data analysis of correct responses was performed on the remaining ECT data.

Mean response times for the ECT are listed in Table 2. No correlations between each of the 6

ECT variables and baseline measures of rumination, depressive symptoms, and stress were

observed (rs<.20; ps>.09). We observed no absolute differences between reports of stress

across time, ps<.1.

Multi-level modeling

The dependent variables were respectively the reflective pondering and brooding

scores (separate set of analysis). The Level 1 predictors (AEQ at four consecutive time

points) and the level 2 predictors (6 ECT variables measured at baseline) were entered in a

multilevel model to investigate the moderating effect of attentional bias upon the relationship

between AEQ and ruminative thinking. Each of these multilevel models (at T2-T5) was

controlled for baseline measures of reflection or brooding (at T1). Table 3 lists a full

correlation matrix of all the measures included in the analysis.

Reflective pondering. The baseline model indicated that there was a significant

amount of unexplained variance in participants" reflection scores as a significant chi-square

associated with the variance component, $\chi^2(72)=800.70$, p<.001, was found. An inspection of

the baseline model with no predictors indicated that 76% of the variance in ratings of

reflective pondering was due to variation between subjects (intraclass correlation) and 24% to

variation within subjects, warranting a multi-level analysis. We fully describe the results from

the model with CV index for angry faces presented at 200 msec (level 2 predictor), being our

hypothesized moderating variable. First, a positive relation between the level 1 predictor (AEQ) and reflection scores was observed, *t(263)=2.47, p<.05.* Second, no relation between the negative attentional bias and reflective pondering, *t(68)=1.65, p>.05,* was observed. Furthermore, it was investigated how the Level-1 association between AEQ and reflective pondering varied as a function of the Level-2 predictor negative attentional bias (referred to as a cross-level interaction). It was found that baseline negative attentional bias (200msec) moderated the association between AEQ and reflective pondering. In particular, real-life stress was associated with reflective pondering more strongly when baseline ECT measurements showed a decreased CV specifically for angry faces [β=-.37, *SE=.16, t(263)=-*2.35, effect size *r=.25, p* = .02]. We refer to figure 3 for an illustration of these results.

Interestingly, CV for happy and fearful faces also seem to have an influence on the relation between AEQ and reflection (the same direction but at a trend level): happy faces [β=-.27, *SE=.15, t(263)=-1.76,* effect size *r=.18, p=.08]* and for fearful faces [β=-.28, *SE=.16, t(263)=-1.75,* effect size *r=.18, p=.08]* at 200 ms. The main and interaction effects of these multi level models are listed in table 4. To test for the unique predictive value of each predictor at level 2, we entered the three predictors into the same model. This analysis demonstrated that none of the predictors demonstrated a main effect or uniquely moderated the relation between stress and reflective pondering, *ps>.12.*

As expected, these cross level interactions did not emerge for 1000 ms cue presentation [angry faces: *t(263)=-.17, p>.80;* fearful and happy faces: *ts<.1, ps>.90],* indicating no moderation effect on the relation between stress and reflective pondering.

Depressive brooding. The baseline model indicated that there was a significant amount of unexplained variance in participants" reflection scores as a significant chi-square associated with the variance component, $\chi^2(72)=736.97, p<.001,$ was found. Initial analyses

indicated that 83% of the variance in brooding was due to variation between participants (intraclass correlation) and 17% to variation within participants, indicating the importance of a nested data structure and a multi-level analysis. We fully describe the results from the model with CV index for angry faces presented at 200 msec (level 2 predictor), being our hypothesized moderating variable. First, no relation between the level 1 predictor (AEQ) and brooding scores was observed, $t(263)=1.23, p>.20$. Second, no relation between negative attentional bias and depressive brooding was observed, $t(68)=.14, p>.50$. No significant cross-level interaction was found between baseline negative attentional bias (200msec) and AEQ, $t(263)=-.41, p>.50$. Also no cross-level interaction was observed with fearful, $t(263)=-1.64, p>.05$; and happy faces: $t(263)=-1.16, p>.05]$. The main and interaction effects of these multi level models are listed in table 3.

As expected, attentional bias indexes for cues presented at 1000 ms cue presentation yielded no significant results in the moderation between stress and depressive brooding: [angry faces: $\beta =.12, t(263)=.86, p>.05$, fearful faces: $\beta=.03, SE=.17, t(263)=.15, p>.05$; and happy faces: $\beta =.17, SE=.12, t(263)=1.19, p>.05]$.

Discussion

In this study, we investigated whether attention for emotionally negative information moderates the relationship between real-life stress and rumination. Based on the attentional disengagement theory (Koster et al., 2011), differential predictions for reflective pondering and depressive brooding were tested. These hypotheses were tested in a prospective design in which the relation between stressful events and rumination was examined as predicted by attentional bias measured six weeks earlier. The present data show that (1) a specific early

attentional bias for angry faces moderated the relation between stress and reflective

pondering; (2) there was no moderation of attentional bias between stress and depressive

brooding. These results are discussed below.

The present data demonstrate that the Cue Validity (CV) index for angry faces at T1

(baseline measurements six weeks before T2-T5) moderates the relationship between the

occurrence of a stressor and the activation of reflective pondering at T2-T5. This moderation

analysis was conducted during a period of final examinations, a period that is generally

considered as stressful for undergraduate students. In particular, our findings demonstrate that

the relation between stress and reflective pondering is stronger when participants allocate less

attention to emotionally negative distractors (i.e. angry faces). Because this multilevel model

was controlled for a measure of trait reflection at baseline (during a period of low stress), it

provides an indication of the relation between stress on the temporal variations in reflection.

It is important to mention that, although the strongest effect was observed for angry

faces, the attentional bias for fearful and happy faces also moderated (in the same direction,

but at a trend level, $p = .08$) the relation between the amount of stress and the usage of

reflective pondering. Moreover, the model demonstrated that the unique variability of

attentional control for angry, fearful and sad faces was not significantly different from each

other. These data indicate that for a more adaptive response to life stress, it is not only

important to ignore distraction from emotionally negative information, but also attentional

control over other emotional distractors seems to play a role. Using a similar attentional

paradigm, Beevers, Wells, Ellis, and McGeary (2009) demonstrated that participants that are

genetically vulnerable for depression had difficulties to disengage their attention from sad,

fearful and happy stimuli, suggesting an increased sensitivity for emotional distractors in

general. All together, it seems that an adequate regulation of emotional material in general is

important in order to generate adaptive reactions in times of stress. For this, only early

attentive processing of emotional information (short cue presentation times) moderated the

link between stress and reflective pondering. This is in line with prior research findings in

healthy volunteers with (e.g., MacLeod & Hagan, 1992; Beevers & Carver, 2003; Fox et al.,

2010).

Interestingly, attentional bias did not moderate the relationship between distress and

depressive brooding. Depressive brooding is considered a maladaptive form of self-focused

attention to negative mood. This result is somewhat surprising as cross-sectional and/or

correlational research has demonstrated quite strong relations between information

processing bias at the level of attention and depressive brooding, even when depression levels

were statistically controlled for (Joormann et al., 2006). A possible explanation for the

absence of this association may be that in cross-sectional research, individuals are typically

preselected on depression scores and therefore include individuals with quite high depression

as well as depressive brooding scores. In contrast, in our study, individuals with heightened

depression scores or former depressive episodes were not included. Another possible

explanation is that brooding might be more related to the control over internal stimuli but not

to the control over external stimuli. Indeed, the ECT assesses attentional biases for external

stimuli (externally presented emotional faces), whereas brooding might result from an

inability to control attentional stimuli with respect to internal stimuli (e.g. mental events,

cognitions, updating working memory) (De Lissnyder, Koster, Derakshan, & De Raedt,

2010). Using a similar design in healthy volunteers (not pre-selected on depression scores),

we observed that attentional control for internal emotionally negative stimuli moderated the

relation between life stress and increased use of depressive brooding (De Lissnyder et al., in

press). In this latter study, no effects for reflective pondering were observed. Future research

should test whether reflective pondering and depressive brooding might uniquely be associated with attentional control for respectively externally and internally presented stimuli. Finally, it could be that the nature of the stressor (a performance based stressor) more strongly elicited reflective pondering rather than depressive brooding, with the latter perhaps being more easily triggered by interpersonal stress.

In this context it is also noteworthy that the stress level in the "stress phases" (T2, T3, etc.) seems lower (although not significantly,) as compared to the stress level at baseline (T1). Indeed, the mean reported levels of stress were not elevated from T1 to T5, which could suggest that the exam stress as studied here did not act as a highly significant stressor. However, the AEQ was used to assess the number of events perceived as stressful that a person encountered during the last week, which asks for well defined stressful events. Although the exams are generally considered to be quite stressful, it might be that students don" t experience many different well defined, isolated stress events during their exams, but rather consider it as one general stressor. Nevertheless, in the present study, the absolute number of stressful events (the mean over all participants) is of less interest compared to the relation between these stress levels and reports of brooding and reflection. Moreover, we observed a positive relation between reports of stress (by the AEQ) and reports of reflective pondering (first step of our HLM analysis in reflection). However, in future studies it might be better to use questionnaires that measure the levels of (dis)tress instead of the number of well defined stressful events.

The current research findings speak to a number of applied issues. The current findings in healthy volunteers suggest that an attention for emotional information appears to influence the magnitude of reflective pondering upon stress. Reflection has been found to predict emotional well-being over time, and this thinking pattern might indicate some kind of

"adaptive" response to stress in non-depressed healthy individuals. In other words, the ability

the overcome distraction from emotional material in the environment appears to play a

significant role in the activation of reflective pondering in times of life stress. In the example

of the discussion with one‟ s spouse, problem solving thinking will be augmented when that

person is able to focus on what is goal relevant (solve the discussion) and not be captured by

his/her emotions. Therefore, it would be important to practice attentional control to disengage

from emotional distractors which, based on the current research findings, may increase the

use of more self-controlling thinking in response to stress. For instance, it has been shown

that training programs aimed at modifying attentional control to reduce vigilance for social

threat result in lower self-reported stress during a period of final examinations (Dandeneau,

Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007).

It is important to mention that high and low attentional bias for angry faces seems to

differ mainly in the association between low stress and reflective pondering (see figure 3 for

this cross level interaction). Nevertheless, the cross level slope for low attentional bias was

significantly different between low and high measures of stress, whereas the slope for high

attentional bias was not. Reflective thinking in people with higher bias was not reactive on

stress. This indicates that only those participants who demonstrated low attentional bias at

baseline engaged less in reflective thinking under low stress (when reflective thinking might

be considered not to be necessary) but more under high stress. This interpretation is in line

with the disengagement theory of Koster et al. (2011), where attentional control for negative

information is seen as the process underlying the cognitive product of rumination during

stressful events.

There are some limitations to the current study. A first drawback is the decreased generalizability of our results, because only healthy, never depressed students were included. This selection resulted in a restriction of range in the depressive brooding scores and might explain the absent findings in brooding upon stress. Future research should therefore include a longitudinal study using a larger sample in order to replicate and specify these results for different types of ruminative thinking. A second limitation of the current study is that, although this is in line with most of the other studies using this attentional paradigm, the reliability of the attentional bias index is low. The choice of this task is nonetheless in analogue with many other prospective studies looking at stress, dysphoria and rumination (e.g., MacLeod & Hagan, 1992; Beevers & Carver, 2003; Fox et al., 2010). Moreover, our results partially confirm our a-priori predictions, which attests to the validity of our attention task. As a final limitation, we used only one measurement of attentional bias and so it is questionable whether the bias remained stable over time. For the current prospective study, this is however important because the attentional bias serves a predictor at the level of the individuals and is considered to remain stable over times of life stress. However, there is no data in the current study design to back-up this claim. Research findings of other studies from our lab however suggest that the attentional bias index remains stable over time (after one hour, but also after one week) (De Raedt et al., 2010; Vanderhasselt, Baeken, Hendrickx, De Raedt, 2011). Still, we advise future prospective studies to measure attentional control for emotional information again at the end of the study to detect possible changes.

Notwithstanding these limitations, our results show that, in a group of healthy, never depressed students, attentional control to disengage from emotional information moderates the relationship between stress and reflective pondering. These findings provide key

information for researchers investigating the underlying working mechanisms of stress

reactivity.

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References

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck depression inventory* (2nd ed.). San Antonio, TX: The Psychological Corporation.

Beevers, C. G., & Carver, C. S. (2003). Attentional bias and mood persistence as prospective predictors of dysphoria. *Cognitive Therapy and Research, 27(6),* 619-637.

Beevers, C. G., Wells, T. T., Ellis, A. J., & McGeary, J. E. (2009). Association of the Serotonin Transporter Gene Promoter Region (5-HTTLPR) Polymorphism With Biased Attention for Emotional Stimuli. *Journal of Abnormal Psychology, 118(3),* 670-681. doi: 10.1037/a0016198

Brosch, T., Sander, D., Pourtois, G., & Scherer, K. R. (2008). Beyond fear - Rapid spatial orienting toward positive emotional stimuli. *Psychological Science, 19(4),* 362-370.

Carver, C.S. (1998). Generalization, adverse events, and development of depressive symptoms. *Journal of Personality, 66,* 607-619.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (Rev. ed.). Hillsdale, NJ: Erlbaum.

Dandeneau, S. D., Baldwin, M. W., Baccus, J. R., Sakellaropoulo, M., & Pruessner, J. C. (2007). Cutting stress off at the pass: Reducing vigilance and responsiveness to social threat by manipulating attention. *Journal of Personality and Social Psychology, 93,* 651-666. doi: 10.1037/0022-3514.93.4.651

De Lissnyder, E., Koster, E. H. W., Derakshan, N., & De Raedt, R. (2010). The association

between depressive symptoms and executive control impairments in response to

emotional and non-emotional information. *Cognition & Emotion, 24(2),* 264-280.

De Lissnyder, E., Koster, E.H.W., Goubert, L., Vanderhasselt, M.A., & De Raedt, R. (in

press). Cognitive control moderates the association between stress and rumination.

Journal of Behavior Therapy and Experimental Psychiatry.

De Raedt, R., Leyman, L., Baeken, C., Van Schuerbeek, P., Luypaert, R., Vanderhasselt,

M.A., & Dannlowski, U. (2010). Neurocognitive Effects of Hf-rTMS over the

Dorsolateral Prefrontal Cortex on the Attentional Processing of Emotional

Information in healthy women: An Event-Related fMRI Study. *Biological

Psychology, 85,* 487–495.

Fox, E., Russo, R., Bowles, R.J., & Dutton, K. (2001). Do threatening stimuli draw or hold

visual attention in sub-clinical anxiety? *Journal of Experimental Psychology:

General, 130,* 681-700.

Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for delayed

disengagement from emotional faces. *Cognition & Emotion, 16(3),* 355-379.

Fox, E., Cahill, S., & Zougkou, K. (2010). Preconscious Processing Biases Predict Emotional

Reactivity to Stress. *Biological Psychiatry, 67(4),* 371-377. doi:

10.1016/j.biopsych.2009.11.0.18

Goeleven, E., De Raedt, R., Leyman, L., & Verschuere, B. (2008). The Karolinska Directed

Emotional Faces: A validation study. *Cognition & Emotion, 22(6),* 1094 - 1118.

Inquisit 1.33 [Computer software]. (2003). Seattle, WA: Millisecond Software.

Joormann, J., Dkane, M., & Gotlib, I. H. (2006). Adaptive and maladaptive components of rumination? Diagnostic specificity and relation to depressive biases. *Behavior Therapy, 37,* 269-280.

Joormann, J., & Gotlib, I. H. (2010). Emotion regulation in depression: Relation to cognitive inhibition. *Cognition & Emotion, 24,* 281-298.

Kenny, D.A., Kashy, D.A., & Cook, W.L. (2006). *Dyadic data analysis.* NY: The Guilford Press.

Koster, E.H.W., De Lissnyder, E., Derakshan, N. & De Raedt, R. (2011). Understanding depressive rumination from a cognitive science perspective: The impaired disengagement hypothesis. *Clinical Psychology Review. 31,* 138–145.

Koster, E.H.W., Verschuere, B., Burssens, B., Custers, R., & Crombez, G. (2007). Attention for emotional faces under restricted awareness revisited: Do emotional faces automatically draw attention? *Emotion, 7,* 285-295.

Koster, E.H.W., De Raedt, R., Goeleven, E., Frank, E., & Crombez, G. (2005). Dysphoria impairs attentional disengagement from negative information. *Emotion, 5,* 446-455.

Lundqvist, D., Flykt, A., & Öhman, A. (1998). *The Karolinska Directed Emotional Faces (KDEF).* Stockholm: Department of Neurosciences Karolinska Hospital.

Macleod, C., & Hagan, R. (1992). INDIVIDUAL-DIFFERENCES IN THE SELECTIVE PROCESSING OF THREATENING INFORMATION, AND EMOTIONAL RESPONSES TO A STRESSFUL LIFE EVENT. *Behaviour Research and Therapy, 30(2),* 151-161.

Martin, L. L., & Tesser, A. (1996). *Introduction.* Mahwah: Lawrence Erlbaum Assoc Publ.

Mauss, I.B., Bunge, S.A., & Gross, J.J. (2007). Automatic emotion regulation. *Social and Personality Psychology Compass, 1,* 146-167.

Mogg, K., Holmes, A., Garner, M., & Bradley, B. P. (2008). Effects of threat cues on attentional shifting, disengagement and response slowing in anxious individuals. *Behaviour Research and Therapy, 46(5),* 656-667.

Mor, N., & Winquist, J. (2002). Self-focused attention and negative affect: A meta-analysis. *Psychological Bulletin, 128(4),* 638-662.

Nolen-Hoeksema, N. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology,100,* 569-582.

Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective study of depression and posttraumatic stress symptoms after a natural disaster: the 1989 Loma Prieta earthquake. *Journal of Personality and Social Psychology, 61,* 115-121.

Nolen-Hoeksema, S., & Morrow, J. (1993). Effects of rumination and distraction on naturally-occurring depressed mood. *Cognition & Emotion, 7(6),* 561-570.

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking Rumination. *Perspectives on Psychological Science, 3(5),* 400-424.

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology, 32,* 3-25.

Raudenbush, S.W., Bryk, A.S., & Congdon, R. (2004). *HLM 6: hierarchical linear and nonlinear modeling.* Lincolnwood (IL): Scientific Software International.

Raes, F., & Hermans, D. (2007). The revised version of the Dutch Ruminative Response

Scale. Unpublished instrument.

Scher, C., Ingram, R., & Segal, Z. (2005). Cognitive reactivity and vulnerability: empirical

evaluation of construct activation and cognitive diatheses in unipolar depression.

Clinical Psychology Review, 25, 487-510.

Schoofs, H., Hermans, D., & Raes, F. (2010). Brooding and reflection as subtypes of

rumination: Evidence from confirmatory factor analysis in nonclinical samples using

the Dutch Ruminative Response Scale. *Journal of Psychopathology and Behavioral

Assessment. 32(4),* 609-617.

Sheehan, D.V., Lecrubier, Y., Sheehan, K.H., et al. (1998). The Mini-International

Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured

diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical

Psychiatry, 59* (Suppl 20), 22-33; quiz 34-57.

Takano, K., & Tanno, Y. (2009). Self-rumination, self-reflection, and depression: self-

rumination counteracts the adaptive effect of self-reflection. *Behavior Research and

Therapy, 33,260-264.*

Thompson, R. J., Mata, J., Jaeggi, S. M., Buschkuehl, M., Jonides, J., & Gotlib, I. H. (2010).

Maladaptive coping, adaptive coping, and depressive symptoms: Variations across

age and depressive state. *Behaviour Research and Therapy, 48(6),* 459-466. doi:

10.1016/j.brat.2010.01.007

Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination reconsidered: a

psychometric analysis. *Cognitive Therapy and Research, 27,* 247-259.

Van der Does, A. J. W. (2002). *De Nederlandse versie van de Beck depression inventory -*

    Tweede Editie. [The Dutch version of the Beck depression inventory - Second

    edition]. Lisse: Swets & Zeitlinger B.V.

van Vliet, I.M, Leroy, H, & van Megen, H.J.G.M. (2000). Mini Internationaal

    Neuropsychiatrisch Interview (2000) Nederlandse versie 5.0.0.-R. Vertalen

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological*

    Bulletin, 134(2), 163-206.

Table 1

Mean scores (and standard deviation) with Cronbach's alpha (α) of all self-report questionnaires at T1 – T5 (N = 76)

	T1	T2	T3	T4	T5	
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	α
RRS/ Total scores	52.76 (13.94)	52.55 (17.13)	50.63 (15.80)	50.39 (16.33)	49.61 (16.79)	.85
RRS/ Depressive Brooding	10.41 (3.16)	10.53 (4.03)	10.20 (4.00)	10.40 (4.04)	10.39 (4.10)	.84
RRS/ Reflective Pondering	9.51 (3.21)	8.90 (3.59)	8.37 (3.20)	8.15 (3.19)	8.34 (3.19)	.88
BDI-II	8.94 (8.66)	10.93 (9.45)	10.17 (7.79)	9.90 (8.72)	8.90 (10.57)	.88
AEQ	1.59 (.73)	1.55 (.74)	1.18 (.60)	1.40 (.63)	1.31 (.48)	.87

Note: BDI-II: Beck Depression Inventory; RRS: Ruminative Response Scale; AEQ: Adverse

Events Questionnaire.

Table 2:

Mean response times (and standard deviations) (in ms) for the ECT with conditions 200 ms and 1000 ms cue presentation time (N = 76)

	200 msec				1000 msec			
	Valid Trial	Invalid Trial	Validity-Index [ab]	Cue Validity	Valid Trial	Invalid Trial	Validity-Index [a]	Cue Validity [b]
Neutral	496	496	1		503	508	5	
	(64)	(67)	(38)		(79)	(76)	(40)	
Angry	504	503	-1	-2	504	510	6	1
	(70)	(71)	(42)	(51)	(78)	(77)	(45)	(57)
Fearful	503	500	-3	-3	511	511	0	-5
	(69)	(62)	(37)	(49)	(74)	(79)	(42)	(49)
Happy	496	500	3	3	506	514	8	3
	(69)	(59)	(38)	(54)	(76)	(72)	(44)	(60)

a) Validity index (VI) = RT invalid cue – RT valid cue; b) CV = VI for emotional – VI neutral.

Table 3: Full correlation matrix (listing the Pearson‟s *r)* of the key variables at the various time points

	CVang200	CVang1000	Ref_T2	Bro_T2	AEQ_T2	Ref_T3	Bro_T3	AEQ_T3	Ref_T4	Bro_T4	AEQ_T4	Ref_T5	Bro_T5	AEQ_T5
CVang200	1.00	-.12	.09	.09	.06	.17	.05	-.03	.23	.14	.08	.07	.11	-.18
CVang1000		1.00	-.10	.04	.21	-.06	.07	.12	-.15	-.03	-.06	-.06	-.04	.13
Ref_T2			1.00	.50**	.28*	.73**	.40**	.44**	.66**	.45**	.47**	.65**	.50**	.08
Bro_T2				1.00	.28*	.47**	.80**	.39**	.44**	.82**	.27*	.48**	.77**	.07
AEQ_T2					1.00	.01	.29*	.18	.02	.31*	.32**	.05	.30*	.22
Ref_T3						1.00	.48**	.46**	.89**	.46**	.21	.77**	.40**	-.14
Bro_T3							1.00	.42**	.51**	.91**	.24	.51**	.83**	.23
AEQ_T3								1.00	.58**	.41**	.33**	.57**	.38**	.20
Ref_T4									1.00	.50**	.22	.83**	.50**	-.07
Bro_T4										1.00	.32**	.50**	.87**	.17
AEQ_T4											1.00	.20	.25*	.43**
Ref_T5												1.00	.57**	.10
Bro_T5													1.00	.23

note *p<.05, **p<.01, Note: CVang200*: Cue Validity index for cues demonstrating an angry expression presented at 200 msec;* CVang1000: *Cue*

Validity index for cues demonstrating an angry expression presented at 1000 msec; Ref: reflective pondering; Bro : depressive brooding, AEQ:

Adverse Events Questionnaire.

Table 4:

Multilevelmodels assessing the association between stress and individual differences in rumination and the moderating effects of attentional bias for fearful and happy faces, presented at 200 msec.

	Reflective pondering							
	fearful faces				**happy faces**			
	Coefficient	*SE*	*t*	*p value*	*Coefficient*	*SE*	*t*	*p value*
Intercept (γ_{00})	8.47	.31	27.50	.0001	8.47	.30	28.04	.0001
Baseline reflective pondering (γ_{01})	.46	.10	4.77	.0001	.46	.09	4.90	.0001
Attentional bias (γ_{02})	.33	.31	1.08	.29	.63	.31	2.01	.05
Stress (AEQ) (γ_{10})	.35	.16	2.22	.03	.35	.15	2.23	.03
AEQ x Attentional bias (γ_{11})	-.28	.16	-1.75	.08	-.27	.15	-1.76	.08

	Depressive brooding							
	fearful faces				**happy faces**			
	Coefficient	*SE*	*t*	*p value*	*Coefficient*	*SE*	*t*	*p value*
Intercept (γ_{00})	10.42	.28	36.23	.0001	10.42	.29	36.48	.0001
Baseline depressive brooding (γ_{01})	.92	.07	12.09	.0001	.92	.07	13.12	.0001
Attentional bias (γ_{02})	-.14	.34	-.42	.68	.26	.26	.97	.36
Stress (AEQ) (γ_{10})	.21	.18	1.22	.23	.22	.18	1.24	.22
AEQ x Attentional bias (γ_{11})	-.32	.20	-1.64	.10	-.26	.23	-1.16	.25

Note. Regression equation: $Y_{ij} = \beta_{0j} + \beta_{1j}(AEQ) + r_{ij}$, with $\beta_{0j} = \gamma_{00} + \gamma_{01}$(trait reflective pondering or trait depressive brooding) + γ_{02}(Attentional bias) + u_{0j}, $\beta_{1j} = \gamma_{10} + \gamma_{11}$(Attentional bias).
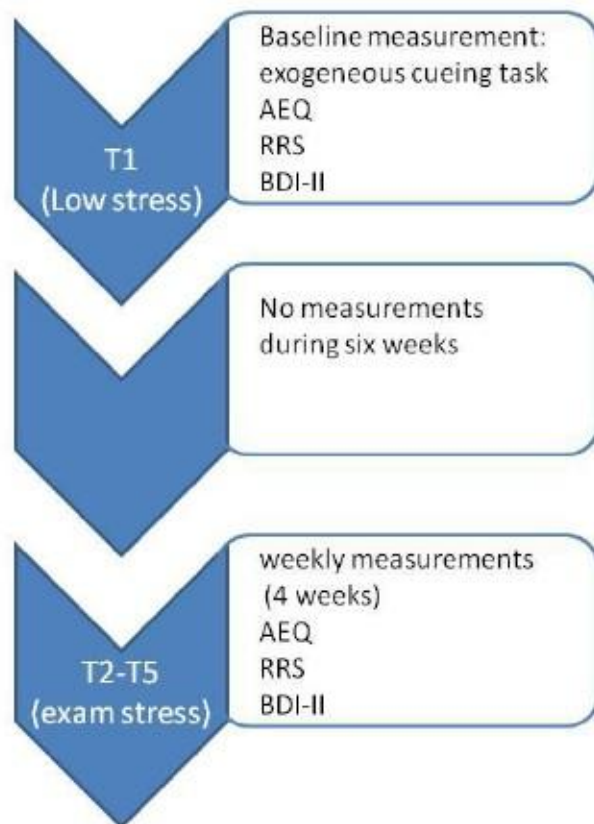
Figure captions

Figure 1: Schematic outline of the prospective research design. Note: BDI-ii: Beck

Depression Inventory; RRS: Ruminative Response Scale; AEQ: Adverse Events

Questionnaire.

Figure 2: The exogenous cueing task (ECT): Stimulus presentation for valid and invalid trials

with 200 and 1000 msec cue presentation time of a valenced or neutral face.

Figure 3: Regression lines for reflective pondering by life stress (AEQ), for high (75th

percentile) and low (25th percentile) attentional bias for angry faces presented at 200 msec.

CV = Cue Validity index= A higher CV indicates an enhanced attentional bias (e.g., more

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Figure 1: Schematic outline of the prospective research design. Note: BDI-ii: Beck

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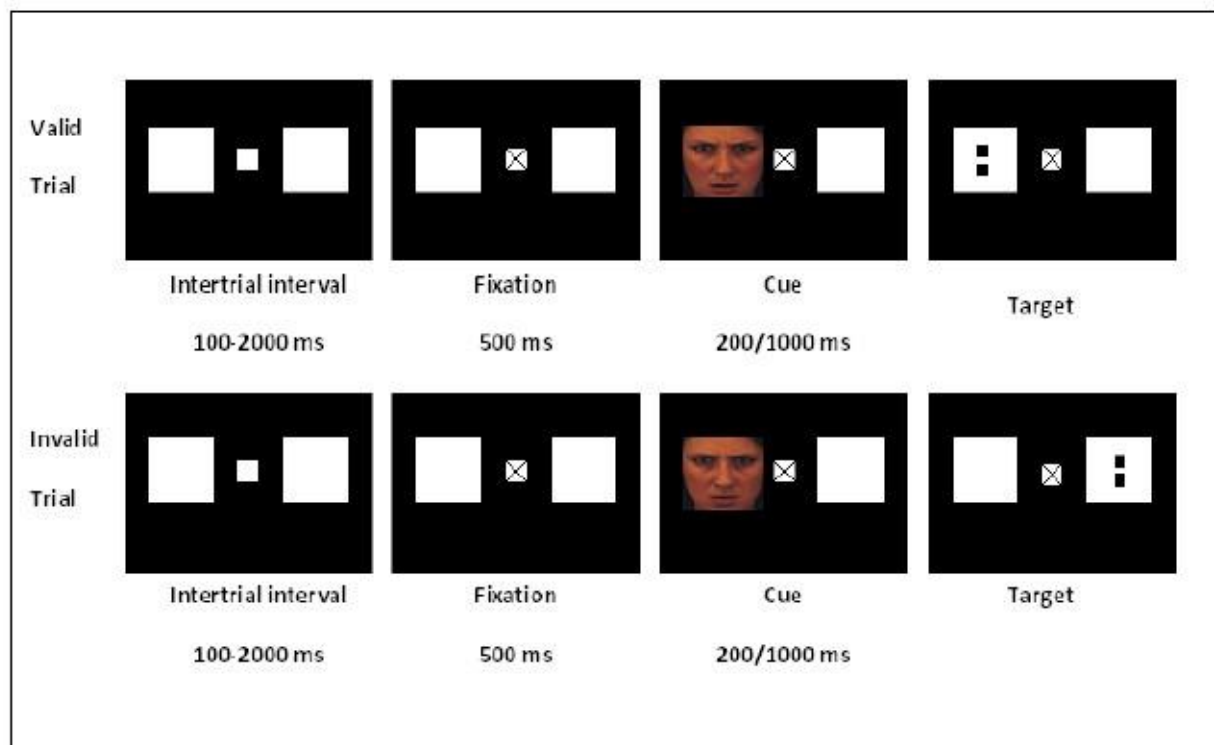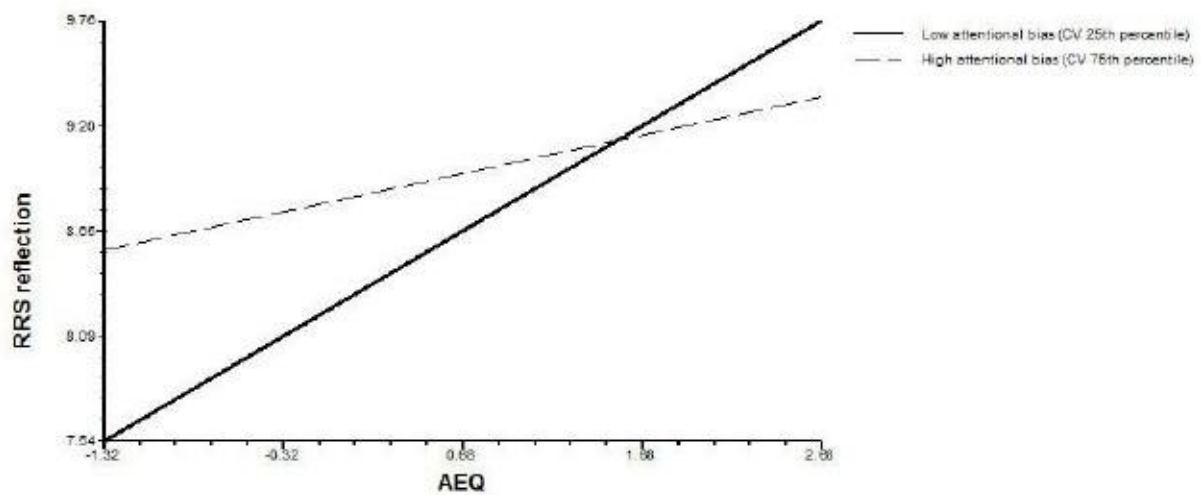
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