



# The Effects of Attentional Deployment on Reinterpretation in Depressed Adolescents: Evidence from an Eye-Tracking Study

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## Abstract

**Background** Individuals with major depression have difficulties employing cognitive reappraisal. Most prior studies have not accounted for attentional deployment, which seems to be involved in this process.

**Methods** We investigated the cognitive reappraisal tactic reinterpretation in 20 depressed and 28 healthy youths and assessed regulation success in response to negative pictures via self-report. To investigate attentional deployment during reinterpretation, we applied eye-tracking and manipulated gaze focus by instructing participants to direct their attention towards/away from emotional picture aspects.

**Results** Depressed adolescents, compared with healthy youths, had a diminished regulation success when their gaze was focused on emotional aspects. Both depressed and healthy adolescents spent less time fixating on emotional facets of negative pictures when using reinterpretation as compared with simply attending to the pictures.

**Conclusions** Results from this study suggest that adolescents with major depression have emotion regulation deficits when being confronted with negative emotional facets, while showing intact overt attentional processes. The findings provide important starting points for future research investigating the role of other factors which might impact on emotion regulation processes in this patient group, such as cognitive control deficits.

**Keywords** Major depression · Adolescence · Cognitive reappraisal · Reinterpretation · Attentional deployment

## Introduction

Emotional responses fulfill an important role in managing stressors in daily life. For instance, sadness may encourage an individual to establish social support (Keltner & Gross, 1999). The intense and prolonged experience of negative emotions, however, can be detrimental and is associated with psychopathology, including depressive symptoms (Joormann & Stanton, 2016; Silk et al., 2003). Thus, the ability to regulate negative emotions is crucial for maintaining psychological health and well-being (Gross, 2013). Emotion regulation can be defined as “processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions” (Gross, 1998, p. 275).

During childhood, emotion regulation processes take the form of an external regulation by a caregiver, self-soothing behavior, and changes in overt attention (Eisenberg et al., 2010). With increasing age, attempts to self-regulate become more effortful and goal-directed (Eisenberg et al., 2010; Thompson et al., 2008). This process is accompanied by gains in executive functions like inhibition, planning, and focusing attention (Eisenberg et al., 2010). During youth, executive functions further markedly develop and are paralleled by additional increases in (social) cognitive capabilities, such as perspective taking and abstract thinking (Ahmed et al., 2015). Adolescence represents a sensitive developmental period for the effects of experiences and is characterized by elevated levels of stressful events and a heightened emotional responsiveness to these stressors (Dahl & Gunnar, 2009; Paus et al., 2008; Pfeifer et al., 2011). Moreover, an imbalance in the maturation of prefrontal versus limbic brain structures is associated with not yet fully developed abilities of youths to regulate emotions effectively (Ahmed et al., 2015). These aspects contribute to the increased vulnerability to develop psychiatric disorders, including major

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depression (MD), with prevalence rates up to 14% during adolescence (Andersen & Teicher, 2008; Substance Abuse & Mental Health Services Administration, 2019). It has also been suggested that affective styles may be implicated in the choice of emotion regulation strategies. Affective styles refer to individual differences in tendencies for emotion regulation, including, e.g., the extent to which emotions are being concealed after they occur. Besides certain maladaptive affective styles (e.g., concealing), it has been posited that negative affect, as well as an inflexibility of applying emotion regulation strategies in accordance with situational demands may represent important factors contributing to MD (Hofmann et al., 2012). Memory and interpretation biases along with a diminished preference for experiencing positive emotions may contribute to difficulties in regulating emotions in patients with MD (Joorman & Vanderlind 2014; Vanderlind et al., 2020).

The concept of emotion regulation subsumes a range of strategies, one of them being cognitive reappraisal. Cognitive reappraisal includes altering the meaning of a situation to influence the emotional reaction to it, which can be realized via different tactics (Gross, 1998; Ochsner et al., 2012). One cognitive reappraisal tactic comprises the reinterpretation of the emotion-eliciting situation, which entails forming alternative meanings for a given situation (Ochsner et al., 2012). For example, when parents argue, their child could imagine that they have different opinions on a topic but will find a solution together. Another tactic implies distancing oneself cognitively from the situation, e.g., by mentally adopting the position of an uninvolved observer (Ochsner et al., 2012; but see Dunn et al., 2009 for a challenging view). For instance, the child could regulate its emotions to the parental conflict by thinking that it is not involved in it. While distancing and reinterpretation can both be subsumed under cognitive reappraisal (Ochsner et al., 2012), it needs to be mentioned that this conceptualization has also been challenged (Dunn et al., 2009). It has been argued that the essential characteristic of cognitive reappraisal is altering the meaning of a situation and not detachment (Dunn et al., 2009). In addition, reinterpretation more closely resembles techniques employed in cognitive-behavioral therapy (CBT) and therefore has more face-validity when it comes to clinical contexts/psychotherapeutic approaches. Both tactics (reinterpretation and distancing), however, are considered to be effective in dampening negative emotions to aversive situations and therefore are commonly defined as adaptive (Webb et al., 2012, but see Aldao, 2013; Bonanno & Burton, 2013 for critique of this uniform view). In line, associations have been found between the habitual use of cognitive reappraisal and positive outcomes, such as the experience of more positive affect and improved interpersonal relationships (Cutuli, 2014; Gross, 2013; Webb

et al., 2012). In addition, the habitual use of cognitive reappraisal was found to negatively correlate with psychopathology, including depressive symptoms and MD (Aldao et al., 2010; Garnefski & Kraaij, 2006; Garnefski et al., 2002; Martin & Dahlen, 2005; Schäfer et al., 2016). In this context, it needs to be mentioned that not only intrapersonal emotion regulation strategies (e.g., cognitive reappraisal), but also interpersonal strategies (e.g., seeking social support) play an important role in regulating emotions during everyday life and impairments in the latter may also be implicated in psychopathology, such as MD (Hofmann, 2014).

It is interesting to note that experimental studies in which depressed and healthy participants were explicitly instructed to apply cognitive reappraisal in response to aversive material often showed contrary results compared with studies examining the habitual use of cognitive reappraisal. These experimental studies usually compared (a) conditions in which participants were instructed to employ an emotion regulation strategy, including cognitive reappraisal, to down-regulate negative emotions to aversive images (i.e., the “regulate condition”) with (b) conditions in which participants were asked to naturally attend to the presented images without trying to alter their emotional reactions to them (i.e., the “attend condition”). Several of these studies demonstrated that depressed individuals are equally capable as healthy individuals to down-regulate their emotions by means of cognitive reappraisal (Dillon & Pizzagalli, 2013; LeWinn et al., 2018; Murphy et al., 2016, but see Greening et al., 2014).

From these studies, it is unclear whether differences in emotion regulation success might be explained by difficulties of individuals with MD to down-regulate negative emotions via cognitive reappraisal or whether other factors, such as attention deployment might play a role. Attentional deployment is an emotion regulation strategy that comprises shifting one’s overt attention (e.g., gaze) or one’s internal focus (e.g., thoughts) towards or away from certain facets of a situation (e.g., emotional or non-emotional aspects; Gross, 1998; Webb et al., 2012). Cognitive reappraisal and attentional deployment can both be conceptualized as emotion regulation strategies that rely on cognitive control mechanisms. These strategies, however, also differ in terms of their goals, effectiveness in different situations, as well as neural systems involved (Ochsner & Gross, 2005). Although it has been argued that they lie on a continuum, these strategies may also overlap, e.g., on a cognitive and neural level (Ochsner & Gross, 2005; Sheppes et al., 2014). Furthermore, it has been argued that cognitive reappraisal may include attentional deployment at an early stage of emotion regulation (Sheppes et al., 2014). To date, it is an unexplored question whether or not depressed and healthy individuals might direct their attention away from or to emotionally-laden

aspects of aversive situations during cognitive reappraisal and whether this aspect might influence emotion regulation success and group differences.

The role of attentional deployment during cognitive reappraisal can be investigated by examining eye gaze patterns by means of eye-tracking. Some previous studies in healthy adults following this approach allowed participants to look freely at images to investigate the relationship between cognitive reappraisal and attentional deployment. Results from these studies showed that participants who were instructed to use cognitive reappraisal in response to the depicted situations tended to spend less time fixating/made less fixations on emotional aspects of negative images in comparison with “attend conditions” (Manera et al., 2014; van Reekum et al., 2007). Further evidence for the role of attentional processes in cognitive reappraisal comes from two studies examining the course of gaze patterns over time (Bebko et al., 2011; Strauss et al., 2016). Results showed that when instructed to use cognitive reappraisal in reaction to negative situations, participants at first allocated their gaze to an emotional picture aspect, which was followed by a redirection of gaze to non-emotional portions of the picture. It was suggested that initially focusing attention on an emotional/arousing portion of an aversive picture represents an automatic bottom-up process. This is thought to be quickly followed by a deliberate top-down process, during which the meaning of the emotional aspect is appraised (Strauss et al., 2016). Directing one’s gaze to non-emotional portions of the picture supposedly counteracts the influence of the appraisal initially formed by fixating on the aversive aspect (Bebko et al., 2011; Strauss et al., 2016). This allows the construction of alternative appraisals drawing on memory processes (Strauss et al., 2016).

While studies following this free-viewing approach provide valuable insight and indicate that attentional deployment may be crucially associated with cognitive reappraisal, this approach cannot clarify the question whether attentional deployment plays a causal role in applying this emotion regulation strategy effectively. Building on studies in healthy adults (Bebko et al., 2011; Urry, 2010), we recently examined the role of attentional deployment in the cognitive reappraisal tactic distancing in youths with MD and typically developing (TD) adolescents (Greimel et al., 2020a). To disentangle the effects of cognitive reappraisal and attentional deployment, we experimentally manipulated gaze focus by directing gaze to highlighted emotional and non-emotional aspects of negative pictures. Results from our study demonstrated that, irrespective of gaze focus, both adolescents with MD and TD youths were able to down-regulate negative affect by means of distancing. However, compared with healthy adolescents, we observed a relatively lower emotion regulation success in MD adolescents when their gaze was allocated to emotional areas of aversive pictures. These

findings indicate that attentional deployment differently impacts on the ability to down-regulate negative affect in adolescents with MD vs. TD adolescents.

It is likely that focusing gaze on emotional picture aspects interferes with reappraisal in adolescents with MD and it is conceivable that difficulties in disengaging from negative information might, at least in part, contribute to diminished regulation success (e.g., Armstrong & Olatunji, 2012). To date, it is unknown whether the results from our previous study can be extended to the cognitive reappraisal tactic reinterpretation. Examining the role of attentional deployment in cognitive reappraisal in depressed individuals can help to better understand emotion regulation deficits in MD which have been proposed to be an important vulnerability factor for the emergence and maintenance of the disorder (Ahmed et al., 2015). Targeting an adolescent sample seems especially fruitful as the developmental period of youth not only confers heightened risk of developing MD, but also offers the opportunity for favorable outcomes in the context of positive interventions (Ahmed et al., 2015; Fergus & Zimmerman, 2005; Fuhrmann et al., 2015). In line, as emotion regulation strategies are amenable to change, they may represent an important starting point for prevention and treatment of youth MD (Ahmed et al., 2015; Berking et al., 2008, 2013).

Building on our previous study (Greimel et al., 2020a), the aim of the present study was to examine the role of attentional deployment in the reinterpretation tactic by directing gaze experimentally to circumscribed emotional and non-emotional areas of negative pictures. Adding to our prior study, we took a detailed view on gaze patterns as measured by eye-tracking during the emotion regulation process. Manipulating gaze focus experimentally as well as investigating gaze patterns simultaneously allows to establish whether attentional deployment, and more specifically whether attentional disengagement (i.e., directing attention away from emotional aspects of negative pictures), plays a causal role in cognitive reappraisal. Based on our previous work, we hypothesized that MD adolescents as compared with healthy peers would show a diminished emotion regulation success when their gaze was directed to emotional areas of negative pictures (Greimel et al., 2020a), but intact emotion regulation success when their gaze was directed to non-emotional areas. Our hypotheses with regard to gaze patterns were based on previous studies in healthy adults (Bebko et al., 2011; Manera et al., 2014; Strauss et al., 2016; van Reekum et al., 2007). When instructed to reinterpret negative pictures in the emotional gaze focus condition, we hypothesized TD youths to initially shift their gaze away from emotional picture aspects. We further expected that this shift would be followed by a gradual re-orientation of gaze back to emotional picture facets. In adolescents with MD, we did not expect to find a shift in gaze from emotional aspects

of aversive pictures during the reinterpretation tactic. This hypothesis was based on previous research in adults showing that depressed individuals have difficulties shifting attention away from emotional cues (i.e., attentional disengagement; Armstrong & Olatunji, 2012; Joormann & Stanton, 2016; Koster et al., 2011).

## Method

### Participants

The final sample consists of 20 adolescents with MD and 28 TD adolescents aged 13 to 18 years. In total, 66 participants were assessed for the present study. Of those, 15 participants (5 MD, 10 TD) were excluded because they did not fulfill our criteria for valid trials (see “Data analysis–Manipulation check” sections). Three TD adolescents were not included because of heightened, subclinical depressive symptoms (BDI-II score  $\geq 9$ ).

Adolescents with MD were recruited from a child and adolescent psychiatric clinic. The sample includes in- and outpatients, with a majority receiving psychotherapy (most commonly cognitive behavioral therapy) during the time of participating in the study. TD controls were recruited via flyers and from a pool of interested families who could be contacted for studies within the department. Inclusion criteria for both groups were an IQ  $> 80$ , as measured with the German version of the WISC-IV or the CFT-20 (Petermann & Petermann, 2011; Weiß, 2006). None of the participants of the present study took part in our previous study on the role of attentional deployment in the cognitive reappraisal tactic distancing (Greimel et al., 2020a). In the patient group, a current diagnosis of MD, as well as comorbid psychiatric disorders based on ICD-10 (World Health Organization, 1992), were assessed via a well-established, standardized, semi-structured German diagnostic interview (Diagnostic Interview for Mental Disorders for Children and Adolescents, Kinder-DIPS; Schneider et al., 2008) with test–retest-reliabilities of Cohen

’s  $\kappa = .85–.94$  for all psychiatric diagnoses (Adornetto et al., 2008). All interviews were conducted by advanced psychology students who were instructed and closely supervised by experienced psychologists and clinicians (CP, LF, EG). The supervisors had earned an official certificate after having completed an extensive Kinder-DIPS training by an author of the Kinder-DIPS (Schneider et al., 2008). Patients with a comorbid schizophrenic, pervasive developmental, bipolar, borderline personality or posttraumatic stress disorder were excluded. Patients with other comorbid disorders (e.g., anxiety disorders) were included when MD was the primary diagnosis. For further information on comorbid diagnoses in the MD group we refer to the Supplement.

To be included in the TD group, participants had to be free of any past or current psychiatric illnesses based on the Kinder-DIPS. TD children of parents with a lifetime history of any affective disorder were excluded from the study. None of the MD or TD participants suffered from neurological disorders.

To assess depressive symptoms, all participants completed the Beck Depression Inventory-II (BDI-II; Hautzinger et al., 2006). As would be expected, adolescents with MD had significantly higher BDI-II scores than their TD peers (see Table 1). Three MD participants received antidepressant medication. Since their inclusion did not change the pattern of the main results, findings are reported for the full sample. The MD and TD group were comparable with regard to age, IQ, and sex distribution (see Table 1).

Participants received vouchers as compensation for their participation. The study was approved by the local ethics committee and was performed in accordance with the latest version of the Declaration of Helsinki and in compliance with national legislation. All participants and at least one of their parents/legal custodians were informed in detail about the experimental procedures and the aims of the study. All participants provided written informed assent and at least one of their parents/legal custodians provided written informed consent.

**Table 1** Demographic and clinical characteristics of the study sample

	MD group ( $n=20$ )	TD group ( $n=28$ )	$p$
Age (M, SD)	15.89 (1.63)	16.61 (1.41)	.108
Sex (f/m)	14/6	20/8	.915
IQ (M, SD)	107.65 (10.84)	109.46 (12.62)	.606
BDI-II score (M, SD)	27.90 (9.38)	2.68 (2.07)	<.001
FEEL-KJ—adaptive ER scale (M, SD)	37.95 (11.58)	56.07 (9.47)	<.001
FEEL-KJ—maladaptive ER scale (M, SD)	69.05 (8.07)	44.00 (9.93)	<.001

Abbreviations: MD major depression, TD typically developing, BDI-II Beck depression inventory-II, ER emotion regulation

## Material

### Questionnaires

To relate experimental results to habitual emotion regulation characteristics the FEEL-KJ was administered. This is a 90-item self-report questionnaire for youths and measures the habitual use of emotion regulation strategies in response to sadness, anger, and anxiety (Grob & Smolenski, 2005). The questionnaire assesses 15 different emotion regulation strategies (“primary emotion regulation strategy scales”) and differentiates globally between adaptive and maladaptive ER strategies (“adaptive emotion regulation scale”/ “maladaptive emotion regulation scale”; Cronbach’s  $\alpha = .82/.93$ ; Grob & Smolenski, 2005). In the current study, we used the maladaptive and adaptive emotion regulation scales due to superior psychometric properties as compared with the primary emotion regulation scales. As expected, adolescents with MD, as compared with TD youths, had higher values for maladaptive ER strategies and lower values for adaptive emotion regulation strategies (all  $ps < .05$ ; see Table 1).

As response bias may affect self-report affect ratings, which were assessed in the experimental paradigm, we evaluated social desirability with the Social Desirability Scale-17 (SDS-17; Stöber, 1999, 2001; Cronbach’s  $\alpha = .72-.75$ ). The two groups did not differ with regard to socially desirable answer tendencies ( $p > .05$ ).

### Stimuli

Participants were presented negative, positive, and neutral color photographs (1280 × 960 pixels) from the International Affective Picture System (IAPS; Lang et al., 2008). We refer to our previous study (Greimel et al., 2020a) for an overview of the pictures used and a detailed description of the picture selection. In total, 40 negative and arousing, 20 positive, and 20 neutral pictures were selected. Of those 40 negative pictures, 20 pictures were assigned to the “reinterpret” condition, and 20 pictures were assigned to the “attend” condition. Valence and arousal ratings of negative pictures did not differ between these conditions ( $ps \geq .233$ ). To direct gaze experimentally to an emotional and non-emotional aspect of the negative pictures, respectively, a circumscribed square within the pictures was highlighted: half of the pictures in the “reinterpret” and “attend” condition, respectively, were made transparent (60% transparency), except a square (400 × 400 pixels) indicating an emotional or a non-emotional area of the respective picture (for a similar approach see Urry, 2010).

Positive and neutral pictures were only presented in an “attend” condition to prevent a negative mood induction in response to the negative pictures, as well as a habituation to these pictures (Greimel et al., 2020a). Following the

approach used for the negative pictures, the same square was depicted to direct gaze to emotional/non-emotional (on positive pictures, 10 pictures each) and central/peripheral (on neutral pictures, 10 pictures each) areas.

The definition of emotional and non-emotional areas of negative and positive pictures as well as central/peripheral areas of neutral pictures was based on the selection of three independent raters. When raters differed concerning their selection of areas, consensus was reached in a discussion. An independent validation study including 12 TD adolescents (50% girls, age range 12 to 17 years) demonstrated that emotional areas of negative/positive pictures were rated as more emotional (negative and positive, respectively) and arousing than the selected non-emotional areas (all  $ps < .05$ ). Additionally, central areas did not differ from peripheral areas of neutral pictures concerning arousal and valence ratings (both  $ps > .05$ ).

### Eye-Tracking Apparatus

The experiment was programmed with “Experiment Builder” (SR Research) and ran on a PC connected with the eye-tracker. An EyeLink 1000 Plus SR Research eye-tracker recorded monocular eye-movements during the experimental session while participants’ heads were placed on a chin-and-forehead rest. A 9-point calibration was performed before each picture block and drift corrections were conducted prior to each experimental trial (see “Experimental Procedure” section). The pictures (resolution 1280 × 960 pixels) were presented on a 19-inch screen with a distance of 55 cm from the participant. The percentage of time spent fixating on the square (i.e., % dwell time) was used to measure gaze behavior.

## Procedure

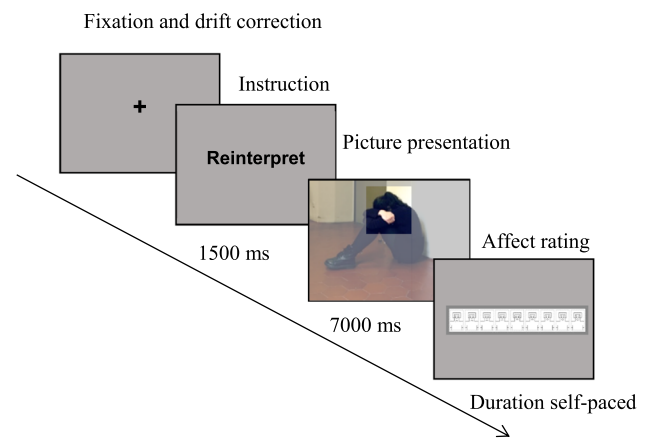
### Reinterpretation Training

Prior to the experiment, participants were acquainted with the experimental procedure and trained in applying the instructions to “reinterpret” and to “attend” using a standardized protocol including oral instructions by an experimenter during an approximately 12-min training session. The experimenter was told to adhere to this protocol and to present the instructions as written in the protocol. The protocol was implemented to ensure a high degree of standardization and equivalence of training between the two groups. Participants were told that the cognitive reappraisal tactic “reinterpretation” involves changing the meaning of the situation depicted in the pictures by providing a more positive interpretation of the situation. More specifically, participants were asked to imagine that the situation can be improved

or that the situation is not as negative as seen at first sight (see e.g., Denny & Ochsner, 2014; McRae et al., 2012). Participants were also explained the “attend” condition, in which they were instructed to view the respective pictures naturally without trying to alter their emotional response towards the pictures (see e.g., Denny & Ochsner, 2014). They were told that the pictures were preceded by a cue indicating the respective instruction (“reinterpret” or “attend”). Additionally, participants were informed that areas of the pictures would be highlighted by a square and that they should direct their gaze to the square when following the respective instruction. They were also acquainted with the 9-point self-assessment manikin (SAM) for valence, which was used to measure affective responses (Bradley & Lang, 1994; for the portrait version see Lang, 1980; Suk, 2006). Participants practiced the instructions with the experimenter, i.e., the experimenter provided an exemplary reinterpretation of one situation depicted on a practice picture. Subsequently, two negative pictures were presented, and participants were asked to verbalize the reinterpretation tactic. This was done to ensure that the participants understood the instructions and were able to implement them in the subsequent experimental procedure. Participants were instructed to only use the reinterpretation tactic and not to employ any other emotion regulation strategy, including distancing. In addition, two practice pictures were shown with the instruction to “attend” to them. Likewise, participants were asked to verbalize what they did during picture viewing (i.e., responding naturally to them). If necessary, more examples were given to train the two instructions. Based on the verbalizations of the participants, the experimenter judged whether the participants understood the instructions. Upon completion of the training and prior to the experiment, participants were asked to repeat what they were instructed to do during attend and interpret trials. Within the training session, pictures varied in gaze focus, i.e., pictures with emotional and non-emotional foci, respectively, were shown.

## Experimental Procedure

The experimental time course is illustrated in Fig. 1. In total, 80 pictures with differing valences, instructions and foci were presented (see Table 2): (1) 20 negative pictures with the instruction to “reinterpret”, (2) 20 negative pictures with the instruction to “attend”, (3) 20 positive pictures with the instruction to “attend”, (4) 20 neutral pictures with the instruction to “attend”. Half of the negative (10 trials with the instruction to “reinterpret” and 10 trials with the instruction to “attend”) and positive pictures (i.e., 10 trials) had an emotional focus; the other half had a non-emotional focus. Likewise, 10 neutral pictures with a central focus and 10 pictures with a peripheral focus were presented. Pictures were presented in a block-wise pseudo-randomized order.



**Fig. 1** Experimental time course. Exemplary illustration of a trial (negative picture—emotional gaze focus condition). The picture shown is exemplary and not part of the IAPS picture database used in the study

The pictures were divided into 8 blocks (each containing 10 pictures) to avoid complex task demands and potential task switching effects. Blocks were presented in a pseudo-randomized order, with the restriction that both during the first half (block 1–4) and second half (block 5–8) of the experiment, each one block with (a) negative attend, (b) negative reinterpret, (c) positive attend, (d) and neutral attend trials was included. Within each block, the respective negative, positive, and neutral pictures were randomly allocated to a trial. After the first block, participants were given a short rest of approximately two minutes.

After the presentation of each picture, participants had to rate their emotional response to the picture on a 9-point SAM scale ranging from 1 (“strongly negative”) to 9 (“strongly positive”). At the end of the experimental session, participants answered a questionnaire in which they had to rate the difficulty of following the two instructions (“reinterpret”/“attend”: “As how difficult did you perceive following the instruction “reinterpret”/“attend”?”). Moreover, it was checked via open questions whether participants followed the instructions as explained. All participants included in the final sample understood and followed the task instructions correctly.

## Data Analysis

### Manipulation Check

We only included data from individual trials/participants, which met our definition criteria of gaze accuracy. Inclusion thresholds for gaze accuracy were therefore defined and measured as the percentage of dwell time spent fixating on the highlighted square during each trial, which had to exceed

**Table 2** Descriptive data (M, SD) of the self-reported affective responses to the pictures

	MD group ( <i>n</i> = 20)	TD group ( <i>n</i> = 28)	<i>p</i>
<i>Emotional/central focus</i>			
Negative attend	3.81 (1.00)	3.50 (0.71)	.205
Negative reinterpret	5.21 (0.95)	5.58 (0.78)	.152
Positive attend	5.94 (1.00)	7.15 (0.62)	< .001
Neutral attend	5.10 (0.51)	5.43 (0.31)	< .01
<i>Non-emotional/peripheral focus</i>			
Negative attend	4.59 (0.87)	4.73 (0.66)	.527
Negative reinterpret	5.34 (0.58)	5.60 (0.78)	.219
Positive attend	5.50 (0.67)	6.14 (0.74)	< .01
Neutral attend	5.12 (0.52)	5.29 (0.44)	.233

Note: Higher numbers indicate a more positive affect rating

Abbreviations: *MD* major depression, *TD* typically developing

50% on the trial- and participant-level (see Greimel et al., 2020a, for the same approach). In more detail, we excluded individual trials in which  $\leq 50\%$  of the total dwell time was spent fixating on the highlighted squares. Likewise, on the participant-level, we excluded participants from the analyses who spent  $\leq 50\%$  of the trials of each condition fixating on the highlighted squares (see Greimel et al., 2020a, for a similar approach also see Kleinberg & Verschuere, 2015). This procedure resulted in the exclusion of 15 participants (*MD* = 5, *TD* = 10). Thus, these participants were not included in the final sample consisting of *n* = 20 adolescents with *MD* and *n* = 28 *TD* adolescents as described in the “Participants” section. After exclusion of individual trials, *MD* and *TD* participants had on average  $\geq 9.76$  valid trials per experimental condition, which were subsequently included in the data analyses.

### Effects of Cognitive Reappraisal and Attentional Deployment on Affect Ratings

First, we investigated whether employing the reinterpretation tactic (vs. attending to negative pictures) would result in more positive affect ratings, as measured by the SAM-rating scale, in both depressed and healthy adolescents. For this aim, we conducted repeated-measures ANOVAs with instruction and gaze focus condition as within-subjects factors separately for the two groups (*MD*, *TD*). Significant interactions between gaze focus and instruction were followed-up by paired *t*-tests separately for the two groups and gaze focus conditions.

### Effects of Attentional Deployment on Affect Ratings During Negative Attend Trials

We exploratively investigated whether during negative attend trials, directing gaze focus towards non-emotional aspects of negative pictures itself already results in a

decrease of negative emotional responses, as indicated by the SAM-rating scale (i.e., the mere effect of attentional deployment during negative attend trials). To address this, we ran a mixed-model ANOVA with gaze focus condition as within-subjects factor and group as between-subjects factor.

### Emotion Regulation Success

In a next step, we calculated a measure for emotion regulation success by subtracting SAM-ratings in the “reinterpretation” from those in the “attend” condition separately for the gaze focus conditions (see Bebko et al., 2014). A subsequent mixed-model ANOVA was calculated with gaze focus condition as within-subjects factor and group as between-subjects factor.

### Perceived Difficulty of Following Task Instructions

Group differences concerning the perceived difficulty of employing the instructions “reinterpret” and “attend” were computed using *t*-tests.

### Relationships Between Emotion Regulation Success and Questionnaire Data

To exclude the possibility that emotion regulation success was related to the tendency to give socially desirable answers, we examined whether emotion regulation success in the two gaze focus conditions correlated with social desirability, as measured with the SDS-17, separately for the two groups.

Next, we investigated the association between emotion regulation success in the two gaze focus conditions and the habitual use of emotion regulation strategies, as measured with the maladaptive and adaptive emotion regulation scales of the FEEL-KJ, separately for the two groups.

Moreover, we investigated whether emotion regulation success was linked to the perceived difficulty of following the instructions to “reinterpret” and “attend” by calculating correlations between these measures separately for the MD and TD group and gaze focus conditions.

In adolescents with MD, we additionally explored whether the severity of the depressive symptomatology, as assessed with the BDI-II, correlated with emotion regulation success in the two gaze focus conditions.

### Investigation of Gaze Behavior

**Gaze Behavior During the Whole 7-Second Picture Presentation Duration** We first investigated whether the two groups differed from each other regarding the time spent fixating on emotional and non-emotional aspects of the negative pictures in the “reinterpret” and “attend” condition. These analyses focused on the percentage of dwell time spent fixating on the highlighted squares within negative pictures for the emotional and non-emotional gaze-focus condition, respectively. We therefore conducted a mixed-model ANOVA with gaze focus condition and instruction as within-subjects factors, and group as between-subjects factor.

**Gaze Behavior Over Time** In a next step, we examined gaze behavior over time when prompted to focus the gaze on highlighted squares within negative pictures. To accomplish this, we divided the whole seven-second picture presentation duration into seven epochs with a duration of one second each (for a similar approach see Strauss et al., 2016). We then calculated mixed-model ANOVAs with epoch (second 1–7) and gaze focus condition as within-subjects factors and group as between-subjects factor. These ANOVAs were calculated separately for the two instruction conditions to restrict analyses to three-way interactions and to simplify interpretations.

SPSS was used to conduct the statistical analyses. The level of significance was set to  $\alpha < .05$ . The effect sizes for the ANOVAs are reported in  $\eta_p^2$  ( $\eta_p^2$ : .01 = small effect; .06 = medium effect; .16 = large effect) (Ellis, 2010). The effect sizes for the *t*-tests are indicated as Cohen’s *d* (*d*: .20 = small effect; .50 = medium effect; .80 = large effect) (Ellis, 2010). 95% confidence intervals (CI) are indicated for the main analyses (investigation of emotion regulation success). The Greenhouse–Geisser’s procedure was used to correct the degrees of freedom when sphericity was violated in an ANOVA.

### Power Analysis

We conducted a power analysis to determine the sample size needed to test our hypotheses. Based on our previous study (Greimel et al., 2020a) and a conservative assumption, we

expected a medium effect size ( $\eta_p^2 = .06$ ) for the interaction between gaze focus condition and group. Using a repeated-measures ANOVA,  $N = 34$  participants are needed to detect this effect, assuming an alpha error of .05 and a power of .80. The sample included in the present study was thus sufficiently large to detect the interaction effect.

## Results

### Manipulation Check

Supplementary Table S3 depicts the percentages of dwell time spent fixating on circumscribed squares in the different gaze focus conditions per instruction and group. Participants spent at least 81% of the time fixating on highlighted picture facets, which confirms the validity of the experimental manipulation. The overall split-half reliability for the percentage of dwell time spent on negative pictures (Spearman-Brown-corrected) was .945, ranging from .440 and .796 for the different foci/conditions. For more details see supplementary Table S2.

### Effects of Cognitive Reappraisal and Attentional Deployment on Affect Ratings

Descriptive statistics of the affect ratings as measured with the SAM-rating scale for both groups, instructions and gaze focus conditions can be found in Table 2.

In both groups, we found a significant main effect of gaze focus condition (MD:  $F(1, 19) = 18.83, p < .001, \eta_p^2 = .498$ ; TD:  $F(1, 27) = 78.60, p < .001, \eta_p^2 = .744$ ), with more negative affect ratings in the emotional than in the non-emotional gaze focus condition. The main effect of instruction was also significant ( $F(1, 19) = 25.64, p < .001, \eta_p^2 = .574$ ; TD:  $F(1, 27) = 93.97, p < .001, \eta_p^2 = .777$ ). Participants reported more positive affect ratings when reappraising as compared with attending the negative pictures. The gaze focus  $\times$  condition interaction was significant ( $F(1, 19) = 8.71, p = .008, \eta_p^2 = .314$ ; TD:  $F(1, 27) = 46.96, p < .001, \eta_p^2 = .635$ ). As shown by follow-up paired *t*-tests, in both groups and gaze focus conditions, applying the reinterpretation tactic resulted in less negative affective responses than attending to negative pictures (all  $ps < .001$ ; MD: emotional:  $t(19) = 5.09, d = 1.43$ , non-emotional:  $t(19) = 3.84, d = 1.02$ ; TD: emotional:  $t(27) = 10.24, d = 2.78$ , non-emotional:  $t(27) = 6.05, d = 1.21$ ).

### Effects of Attentional Deployment on Affect Ratings During Negative Attend Trials

We found a main effect of gaze focus condition ( $F(1, 46) = 88.22, p < .001, \eta_p^2 = .657$ ), with participants



reporting less negative affective responses in the non-emotional ( $M=4.66$ ,  $SD = 0.75$ ) than in the emotional ( $M=3.63$ ,  $SD = 0.85$ ) gaze focus condition. No significant main effect of group was revealed ( $F(1,46)=0.18$ ,  $p = .671$ ,  $\eta_p^2 = .004$ ). There was a significant interaction between gaze focus condition and group ( $F(1,46)=4.63$ ,  $p = .037$ ,  $\eta_p^2 = .091$ ). However, no significant differences in affective ratings between depressed and TD adolescents were found in the emotional and non-emotional gaze focus condition, respectively ( $ps > .205$ ; emotional:  $d=0.38$ ; non-emotional:  $d=0.17$ ). To get more insight into the gaze focus  $\times$  group-interaction, we calculated the difference between affective reactions in the emotional and non-emotional gaze focus condition. The subsequent independent samples  $t$ -test comparing these difference scores revealed a smaller difference score in the MD, as compared with the TD group ( $t(46)=2.15$ ;  $p = .037$ ;  $d = -0.63$ ), suggesting that the effect of attentional deployment in the attend condition was attenuated in MD adolescents.

### Emotion Regulation Success

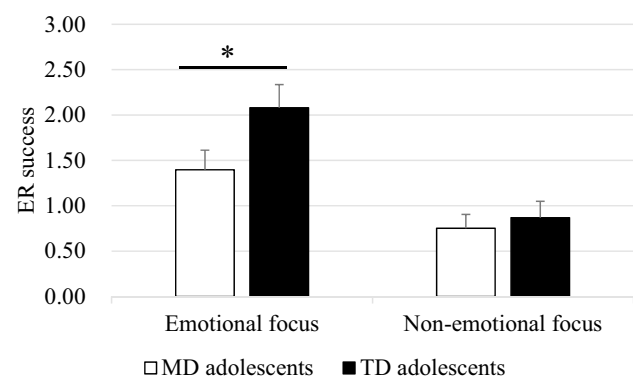
The results of the mixed-model ANOVA indicated a main effect of gaze focus condition ( $F(1,46)=44.28$ ,  $p < .001$ , 95% CI [0.65, 1.21],  $\eta_p^2 = .490$ ), with a greater emotion regulation success in the emotional ( $M=1.80$ ,  $SD = 1.18$ ) as compared with the non-emotional ( $M=0.82$ ,  $SD = 0.80$ ) gaze focus condition. No significant main effect of group was found ( $F(1,46)=2.48$ ,  $p = .122$ , 95% CI [-0.11, 0.91],  $\eta_p^2 = .051$ ). However, we found a significant gaze focus condition  $\times$  group-interaction ( $F(1,46)=4.14$ ,  $p = .048$ ,  $\eta_p^2 = .082$ ). Follow-up  $t$ -tests revealed that MD adolescents showed a smaller emotion regulation success than TD adolescents when gaze was directed to emotional aspects of negative pictures ( $p = .046$ , 95% CI [0.01, 1.36],  $d = -0.59$ ; see Fig. 2). The emotion regulation success was comparable between groups in the non-emotional gaze focus condition ( $p = .626$ , 95% CI [-0.36, 0.59],  $d = -0.14$ ).

### Perceived Difficulty of Following Task Instructions

Adolescents with MD perceived the instruction to reinterpret as more difficult than TD adolescents ( $t(46) = -2.29$ ,  $p = .027$ ,  $d = 0.68$ ; MD:  $M = 3.25$ ,  $SD = 0.79$ ; TD:  $M = 2.71$ ,  $SD = 0.81$ ). No differences between MD and TD adolescents were found with regard to the perceived difficulty of following the “attend” instruction ( $t(46) = -1.65$ ,  $p > .05$ ).

### Relationships Between Emotion Regulation Success and Questionnaire Data

In the TD group, a negative correlation was found between the perceived difficulty of following the instruction to



**Fig. 2** Interaction between group and gaze focus condition on ER success (M, SE). Abbreviations: ER emotion regulation, MD major depression, TD typically developing. Note: ER success was calculated by subtracting self-reported ratings in the “attend” from the “reinterpret” condition. Higher values indicate higher ER success. The asterisk indicates significance ( $t$ -test;  $p < .05$ )

reinterpret and emotion regulation success in the emotional gaze focus condition ( $p = .049$ ,  $r = -.376$ ). All other correlations were non-significant (see Supplement for details).

### Investigation of Gaze Behavior

#### Gaze Behavior During the Whole 7-Second Picture Presentation Duration

The mixed-model ANOVA indicated a significant main effect of gaze focus condition ( $F(1,46)=161.91$ ,  $p < .001$ ,  $\eta_p^2 = .779$ ). Participants spent more time fixating on the highlighted emotional ( $M=91.60\%$ ,  $SD = 4.65\%$ ) than the highlighted non-emotional picture areas ( $M = 84.00\%$ ,  $SD = 7.79\%$ ). The main effect of group was marginally significant ( $F(1,46)=3.15$ ,  $p = .082$ ,  $\eta_p^2 = .064$ ). MD youths spent slightly more time fixating on highlighted areas of negative pictures as compared with TD youths (MD:  $M = 89.25\%$ ,  $SD = 4.88\%$ ; TD:  $M = 86.33\%$ ,  $SD = 6.81\%$ ). The gaze focus  $\times$  group-interaction was marginally significant ( $F(1,46)=3.59$ ,  $p = .065$ ,  $\eta_p^2 = .072$ ). The exploratory post-hoc  $t$ -test to follow-up this trend revealed that adolescents with MD showed marginally higher dwell times than TD youths only in the non-emotional gaze focus condition ( $p = .064$ ,  $d = 0.55$ ), whereas dwell times were comparable between groups in the emotional gaze focus condition ( $p = .160$ ,  $d = 0.41$ ). All other interactions involving the factor group were non-significant ( $Fs \leq 2.21$ ,  $ps \geq .144$ ,  $\eta_p^2 \geq .017$ ). We found a significant interaction between gaze focus condition and instruction ( $F(1,46)=4.96$ ,  $p = .031$ ,  $\eta_p^2 = .097$ ). Post-hoc analyses for the emotional gaze focus condition revealed lower dwell times in the “reinterpret”, as compared with the “attend” condition ( $p = .013$ ,  $d = 0.22$ ). The dwell times did not differ between instructions in the

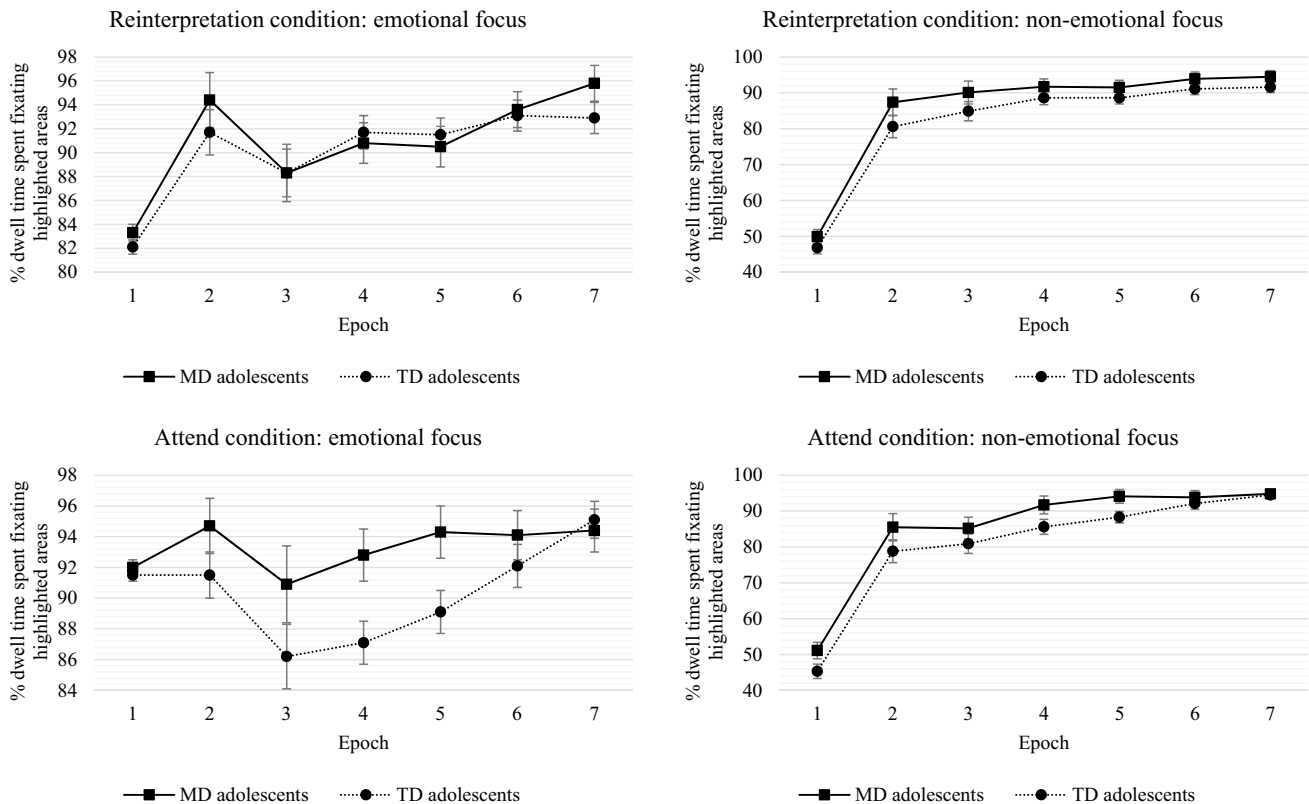
non-emotional gaze focus condition ( $p = .372, d = -0.08$ ). No main effect of instruction ( $F(1,46) = 0.64, p = .429, \eta_p^2 = .014$ ) was found.

**Gaze Behavior Over Time**

The  $2(\text{group}) \times 2(\text{gaze focus}) \times 7(\text{epoch})$  mixed-model ANOVA for the “reinterpret” instruction revealed a significant main effect of epoch ( $F(6,144.82) = 134.73, p < .001, \eta_p^2 = .745$ ), which resulted from increases in dwell times over time. We refer to the Supplement to get a deeper insight into results on eye gaze patterns over time. No significant main effect of group was found ( $F(1,46) = 1.64, p = .207, \eta_p^2 = .034$ ). There was a main effect of gaze focus condition ( $F(1,46) = 95.35, p < .001, \eta_p^2 = .675$ ), with higher dwell times in the highlighted square in the emotional ( $M = 90.60\%, SD = 7.32\%$ ), as compared with the non-emotional gaze focus condition ( $M = 83.70\%, SD = 10.33\%$ ). There was a significant interaction between group and gaze focus condition ( $F(1,46) = 4.62, p = .037, \eta_p^2 = .091$ ). Post-hoc independent  $t$ -tests revealed that dwell times were comparable between groups in both the emotional and non-emotional gaze focus condition (both  $ps \geq .109$ , emotional:  $d = 0.11$ , non-emotional:  $d = 0.33$ ). To further investigate the interaction, we calculated the difference scores between

the percentages of dwell time spent on emotional vs. non-emotional picture aspects during reinterpretation for each group. The post-hoc independent  $t$ -test indicated a lower difference score in MD than in TD adolescents ( $t(46) = 2.09, p = .042, d = -0.61$ ). The other interactions involving group were non-significant ( $Fs \leq 0.59, ps \geq .736$ ). Moreover, we found a significant interaction between epoch and gaze focus condition ( $F(4.30, 197.84) = 74.72, p < .001, \eta_p^2 = .619$ ). Post-hoc dependent  $t$ -test revealed that this interaction was qualified by differential increases and decreases in dwell times between the epochs for the two gaze focus conditions, which are illustrated in Fig. 3 (also see Supplement “Data analysis”).

The  $2(\text{group}) \times 2(\text{gaze focus condition}) \times 7(\text{epoch})$  mixed-model ANOVA for the “attend” instruction indicated a main effect of group ( $F(1,46) = 4.58, p = .038, \eta_p^2 = .090$ ), with higher dwell times in the MD ( $M = 89.26\%, SD = 6.90\%$ ) than in the TD group ( $M = 85.59\%, SD = 10.02\%$ ). The main effect of gaze focus condition was also significant ( $F(1,46) = 148.23, p < .001, \eta_p^2 = .763$ ), with higher dwell times in the emotional ( $M = 91.61\%, SD = 7.28\%$ ), as compared with the non-emotional gaze focus condition ( $M = 82.62\%, SD = 10.87\%$ ). Moreover, the ANOVA revealed a main effect of epoch ( $F(6,147.74) = 83.31, p < .001, \eta_p^2 = .644$ ), which resulted from increases in dwell



**Fig. 3** % dwell time spent fixating highlighted aspects in the experimental conditions

times over time (see Supplement). All interactions involving the factor group were found to be non-significant ( $F_s \geq 0.62$ ,  $p_s \geq .193$ ). We found a significant interaction between epoch and gaze focus condition ( $F(6,4.40) = 130.72$ ,  $p < .001$ ,  $\eta_p^2 = .740$ ). Post-hoc dependent  $t$ -test revealed that this interaction was qualified by differential increases and decreases in dwell times between the epochs, which are illustrated in Fig. 3 (also see Supplement “Data analysis”).

## Discussion

To our knowledge, this is the first study which investigated the role of attentional deployment during cognitive reappraisal in youths with MD and healthy adolescents employing the reinterpretation tactic. We experimentally manipulated gaze focus by highlighting emotional and non-emotional aspects of negative pictures and examined affective responses by self-report, as well as gaze behavior by means of eye-tracking. Recently, our group investigated the role of attentional deployment in the cognitive reappraisal tactic distancing in adolescents with MD and TD adolescents (Greimel et al., 2020a). This study provided evidence for a relatively diminished ER success in adolescents with MD when their gaze was focused on emotional aspects of aversive pictures. Extending this finding to the emotion regulation tactic reinterpretation, the present study also revealed a reduced emotion regulation success in adolescents with MD as compared with TD adolescents in the emotional gaze focus condition. When instructed to use the reinterpretation tactic in this condition, both MD and TD adolescents initially directed their gaze away from emotional picture aspects after having shortly fixated on the emotional facet. This attentional shift was followed by a gradual re-orientation of gaze to emotional aspects of negative pictures.

### Group Differences in Emotion Regulation Success in the Emotional Gaze Focus Condition

As expected, we found that adolescents with MD, as compared with healthy youths, showed a reduced emotion regulation success when their gaze was focused on emotional aspects of negative pictures. Interestingly, gaze behavior was comparable between groups when reinterpreting negative pictures in the emotional gaze focus condition. It is therefore unlikely that these emotion regulation deficits might be explained by difficulties of adolescents with MD in drawing visual attention away from emotional picture facets. Rather, youths with MD might have problems shifting their internal focus away from negative contents. In line, it seems likely that adolescents with MD have impairments in processes interfering with the downregulation of negative affect in the emotional gaze focus condition. These impairments may

include difficulties in cognitive control mechanisms and ensuing ruminative thoughts, as well as difficulties with applying reinterpretations (Joormann & Siemer, 2011; Joormann & Stanton, 2016).

Emotion regulation via the reinterpretation tactic requires several steps. After appraising a specific situation as being aversive, the decision needs to be made to employ the reinterpretation tactic to counteract possible negative emotions elicited by the situation. Effectively reinterpreting a situation requires cognitive control abilities, which inhibit the initial appraisal of the situation. Furthermore, memory capacities are needed to reinterpret the situation (Joormann & Stanton, 2016; Ochsner & Gross, 2005).

In youths with MD, focusing attention on emotional aspects of negative pictures might lead to an automatic retrieval of negative thoughts, which might lead to a negative assessment of the picture content. Due to difficulties in cognitive control and a presumable inability to fall back upon more favorable thoughts and memories, emerging negative affective responses cannot be inhibited and counteracted by more positive alternative interpretations (Joormann & Siemer, 2011; Joormann & Stanton, 2016). As a result, ruminative thoughts might occur and initial negative appraisals and interpretations of the situation likely persist, which will further contribute to negative affect (Joormann & Siemer, 2011; Joormann & Stanton, 2016). Our results support the notion that depressed adolescents might have difficulties employing cognitive reappraisal, which may not be explained by deviant gaze behavior. It is more likely that processes, such as cognitive control deficits as well as ruminative tendencies contribute to cognitive reappraisal difficulties. It would therefore be important to also target these deficits in interventions in conjunction with the training of cognitive reappraisal abilities.

In this context, it should be noted that we did not study correlations between habitual tendencies to ruminate and emotion regulation success. In future studies investigating the momentary use of cognitive reappraisal, it would be worthwhile to also include measures of situation-contingent rumination (see Sanchez et al., 2016 for a similar approach; Sanchez-Lopez et al., 2019). In addition, focusing one’s gaze on emotional aspects of negative pictures presumably made it even more difficult for participants to down-regulate negative emotions via the reinterpretation tactic because a focus on emotional picture facets likely interferes with formulating alternative appraisals. It is likely that this effect is stronger in depressed adolescents due to their deficits in cognitive control mechanisms (Kaiser et al., 2015; Siegle et al., 2002).

Providing a reinterpretation is a demanding task, especially for depressed individuals (Joormann & Vanderlind, 2014). Indeed, as has been confirmed in the present study, adolescents with MD perceived formulating reinterpretations as more difficult than did healthy controls. In TD

youths, we found a negative relationship between the perceived difficulty of using the reinterpretation tactic and emotion regulation success in the emotional gaze focus condition. In adolescents with MD no such link was revealed. This suggests that healthy adolescents are better capable to relate the perceived difficulty of employing cognitive reappraisal to their emotion regulation success.

### Gaze Behavior During Reinterpretation in the Emotional Gaze Focus Condition

We did not find any significant group differences in the course of gaze patterns over time. In this context, it needs to be mentioned that MD and TD adolescents spent most of the time fixating on the emotional picture aspects (i.e., the highlighted areas) and thus complied with the instruction. To get insight into spontaneous gaze patterns during reinterpretation, it would therefore be important to examine gaze patterns in free-viewing cognitive reappraisal paradigms in future studies. Moreover, although our sample was sufficiently large to test our main hypothesis regarding diminished regulation success in the emotional gaze conditions in participants with MD, statistical power for the three-way interactions focused on gaze behavior over time might have been too low. Thus, future studies with a main focus on gaze behavior should include more patients with major depression and controls to be able to draw more comprehensive conclusions.

We showed that both MD and TD adolescents spent less time fixating on the emotional aspects of negative pictures during the reinterpretation compared with the attend condition. Interestingly, when reinterpreting, the attentional shift away from the emotional picture content towards non-emotional aspects of negative pictures occurred relatively early during the reinterpretation process (after second 2 of the picture presentation). It is important to note that after an initial shift in gaze away from the emotional picture aspect, the participants gradually re-oriented their gaze towards the emotional facet of the picture. These findings can be brought in line with prior studies which investigated gaze behavior during free-viewing cognitive reappraisal paradigms in healthy adults (Bebko et al., 2011; Manera et al., 2014; Strauss et al., 2016; van Reekum et al., 2007). As has been previously suggested, appraising the valence of a situation first requires focusing one's gaze on the respective emotional aspect. Shifting one's gaze away from an emotional picture aspect then enables the inhibition of an initial negative appraisal. This is thought to ultimately aid the process of forming an alternative interpretation of the situation (Bebko et al., 2011; Gross, 2015; Strauss et al., 2016). The re-orientation towards emotional picture aspects supposedly provides the context for formulating a specific alternative interpretation of the situation (Gross, 2015). In adolescents

with MD, despite apparent intact capabilities of shifting the gaze away from emotional picture aspects, a reduced emotion regulation success might be due to deficits in shifting the internal focus away from the negative content. It should be discussed that we also found a similar gaze shift when participants attended to the emotional picture facets naturally. Thus, it might be the case that the described pattern is not specific for the reinterpretation tactic but might also represent a spontaneous strategy used when being confronted with negative situations. More comprehensive conclusions should be drawn from future free-viewing cognitive reappraisal paradigms.

### Group Differences in Emotion Regulation Success in the Non-emotional Gaze Focus Condition

As expected, results from the current study showed no differences between adolescents with MD and healthy youths in emotion regulation success in the non-emotional gaze focus condition. This finding suggests that MD adolescents are equally capable as TD adolescents to employ the reinterpretation tactic when focusing on non-emotional portions of negative pictures. It seems that the distraction from emotional picture aspects in youths with MD likely facilitates formulating reinterpretations. It is likely that negative appraisals and ensuing ruminative thoughts are attenuated in the non-emotional gaze focus condition and therefore do not interfere with the use of the reinterpretation tactic (Joormann & Stanton, 2016). In this context, it is interesting to note that emotion regulation success in both groups was higher in the emotional than the non-emotional gaze focus condition. One explanation for this finding is that directing one's gaze towards non-emotional aspects of negative pictures already contributes to a less negative perception of negative picture facets. Accordingly, cognitive reappraisal contributes less to regulation success, as compared with the emotional gaze focus condition (also see Greimel et al., 2020a). It needs to be pointed out that focusing one's gaze on non-emotional picture aspects does not preclude perceiving the valence of the pictures as a whole. In line, it is likely that the picture valence is subliminally processed, even when gaze is focused on a circumscribed non-emotional picture aspect (Killgore & Yurgelun-Todd, 2004; Liddell et al., 2004).

### Strengths and Limitations

One particular strength of our study is the experimental manipulation of gaze focus by directing gaze to emotional vs. non-emotional picture aspects. This paradigm allows drawing conclusions regarding the causal role of attentional deployment in the reinterpretation tactic. Furthermore, the use of eye-tracking provided additional insights into the role of gaze behavior in reinterpretation and enabled a more

refined analysis of attentional processes in the context of emotion regulation. Constraining gaze to circumscribed picture aspects, however, is limited as it does not allow to examine naturally occurring gaze patterns during cognitive reappraisal. We used self-report to examine affective responses, which might be affected by response biases. However, tendencies to give socially desirable answers did not correlate with emotion regulation success. Notwithstanding this issue, it would be fruitful to also include more objective measures to examine emotion regulation success, such as the reduction of the Late Positive Potential (Hajcak et al., 2010). One limitation of the study is the restricted number of trials, which might also limit the reliability of the task particularly given that the IAPS stimuli comprised complex socio-emotional scenes. Although the average number of trials included per experimental condition was close to 10 and similar to previous studies (Bebko et al., 2014; Greimel et al., 2020a), it would be important in future studies to extend the number of trials to be able to draw stronger conclusions and to increase reliability. Finally, although our study was adequately powered to test our hypothesis on the effect of attentional deployment on regulation success in TD versus MD participants, larger sample sizes are needed to examine the role of gaze behavior more comprehensively during this process.

## Conclusions

To our knowledge, this study is the first to investigate the role of attentional deployment during the cognitive reappraisal tactic reinterpretation in adolescents with MD and TD youths. We could replicate and extend our previous findings in youths with MD (Greimel et al., 2020a) by showing that despite comparable gaze behavior, adolescents with MD exhibited a reduced emotion regulation success during reinterpretation when their gaze was focused on emotional aspects of negative pictures. Results from the current study provide important starting points for future research investigating the role of other factors which likely influence the reduced emotion regulation success of MD adolescents, for instance rumination and cognitive control deficits. In addition, this study offers important indications for clinical applications. For instance, it is conceivable that the training of adaptive emotion regulation strategies, including cognitive reappraisal, may have favorable effects on the use of cognitive reappraisal in daily life. As such, the training of adaptive emotion regulation strategies might have the potential to ameliorate depressive symptoms, for example in the context of cognitive-behavioral interventions (Greimel et al., 2020b). In the same vein, it would be interesting in future studies to examine whether and to what extent cognitive behavior therapy might improve reappraisal abilities in

youths with MD as suggested by a study in adults with MD (Forkmann et al., 2014). Furthermore, in the context of prevention efforts, it would be fruitful to teach adolescents who experience many stressors to cope effectively with them by means of cognitive reappraisal. Taken together, results from the present and our previous study (Greimel et al., 2020a) emphasize the critical role of attentional deployment in cognitive reappraisal and its differential impact on reappraisal capabilities of MD vs. TD adolescents.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s10608-022-10303-2>.

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**Author Contributions** CEP contributed to the study design, project administration, participant recruitment and data collection, analyzed and interpreted the data and wrote the manuscript draft. PTS contributed to project administration, recruited the participants, collected the data and contributed to writing the manuscript draft. LF contributed to the study design, project administration, participant recruitment, data collection and interpretation of the data. GSK contributed to the study design, provided resources for the project administration and supported the recruitment of participants. EG designed the study, acquired funding, administered the project, and supervised the recruitment of participants, the data collection, analysis and interpretation of the data, as well as manuscript preparation. All authors read and commented the draft of the paper and approved the final version of the manuscript.

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**Data Availability** Since patients could be identified by publishing our raw data, ethical principles of patient confidentiality protection would be breached. However, aggregated data can be made available upon request.

## Declarations

**Conflict of Interest** Charlotte Elisabeth Piechaczek, Pia-Theresa Schröder, Lisa Feldmann, Gerd Schulte-Körne and Ellen Greimel declare that they have no conflict of interest.

**Ethical Approval** This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Medical Faculty of the LMU University Hospital Munich.

**Consent to Participate** All participants and at least one of their parents/legal custodians were informed in detail about the experimental procedures and the aims of the study. All participants provided written informed assent and at least one of their parents/legal custodians provided written informed consent.

**Consent for Publication** Not applicable.

**Research Involving Animal Rights** No animal studies were carried out by the authors for this article.

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