



Belief updating in depression is not related to increased sensitivity to unexpectedly negative information



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ABSTRACT

Background: People with depression differ from healthy people in the extent to which they use novel positive information to adjust negative expectations. In this study, we examined whether the two groups also differ in updating positive expectations after receiving unexpectedly negative information.

Methods: Examining 76 people with depressive symptoms and 81 healthy controls, we used an adapted version of a previously validated paradigm. After the initial establishment of positive performance expectations, participants worked on the TEMINT performance test, whereupon half of the participants received standardized feedback that confirmed previous positive expectations while the other half received disconfirming negative feedback. Subsequently, participants' performance expectations were assessed again. Additionally, we assessed participants' appraisal of the feedback, particularly whether they tended to disregard it.

Results: Results indicated that healthy subjects had overall more positive expectations than people with depressive symptoms, but the two samples did not differ in updating their expectations: both groups changed their expectations in a negative direction after receiving negative feedback; similarly, there were no differences between the two samples after receiving confirmatory positive feedback. Both people with and without depressive symptoms were more likely to disregard the feedback received if the feedback was negative, and such a negative appraisal of the feedback was associated with smaller expectation update.

Conclusions: In combination with prior work, the current findings suggest that people with depressive symptoms do not over-sensitively react to unexpectedly negative information; rather, the main problem of depression seems to be the integration of novel positive information, as shown previously.

1. Introduction

Expectations¹ have been defined as cognitions that refer to the likelihood of future-events or experiences (Kirsch, 1985; Kube, D'Astolfo, Glombiewski, Doering, & Rief, 2017; Olson, Roese, & Zanna, 1996). Research has shown that expectations tremendously affect perception, emotion, and well-being (Barefoot et al., 2011; Diekhof et al., 2011; Greene, Botros, Beck, & Fei-Fei, 2015), as exemplified in major depression where dysfunctional expectations (i.e. overly negative expectations about future events) predict depressive symptoms and suicidal ideation (Czyz, Horwitz, & King, 2016; Horwitz, Berona, Czyz, Yeguez, & King, 2017; Kube, Siebers, et al., 2018). A relatively nascent area of research has begun to investigate how expectations are updated if novel experiences are made. According to the neuroscientific

literature on predictive processing, providing a Bayesian perspective on how the brain handles new incoming information (Clark, 2013; Hohwy, 2012; Huang & Rao, 2011), discrepancies between predicted and actual experiences (referred to as prediction errors) lead to an adjustment of future expectations (Barrett & Simmons, 2015; Friston & Kiebel, 2009; Kanai, Komura, Shipp, & Friston, 2015). In cognitive neuroscience, this principle of updating expectations after prediction errors is regarded as a basic learning mechanism. In recent years, Rief and colleagues have translated these findings from cognitive neuroscience into a clinical psychology framework (Kube, Schwarting, Rozenkrantz, Glombiewski, & Rief, in press; Rief & Glombiewski, 2017; Rief & Joormann, 2019). It has been proposed that mental disorders are characterized by difficulties in updating expectations after disconfirming experiences (Rief et al., 2015).

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¹ The terms 'expectation' and 'expectancy' are often used in an interchangeable way. However, 'expectation' is more frequently used as a specific, verbalized construct, whereas 'expectancies' may be present without full awareness (i.e., implicit expectancies). In this manuscript, we only use the term 'expectation'.

Consistent with this hypothesis, experimental studies have recently shown that people with social anxiety (Koban et al., 2017) and borderline personality disorder (Korn, La Rosée, Heekeren, & Roepke, 2016; Liebke et al., 2018) tend to maintain negative social expectations despite positive social feedback. Aside from these studies, the largest empirical support for a lack of expectation update comes from research on major depression. For instance, research into *interpretation biases* has shown that people with the major depressive disorder (MDD) tend to interpret ambiguous situations in a negative way (Everaert, Podina, & Koster, 2017), and sustain these negative interpretations despite novel information that would suggest a more positive interpretation (Everaert, Bronstein, Cannon, & Joormann, 2018; Likhaitzky, Smillie, & Allen, 2017). In one study, Everaert et al. (2018) presented short descriptions of emotionally relevant situations to the participants and asked them to choose one of four interpretations that, in their opinion, best explained the respective situation. Subsequently, participants received additional information on the scenario that questioned their initial interpretation and suggested an alternative interpretation. In half of the scenarios, the first information presented suggested a negative interpretation, which was later disconfirmed by new positive information; conversely, other scenarios suggested a positive interpretation, which was then negatively disconfirmed. The authors found that depressive symptoms were a negative predictor of revising initially negative interpretations after receiving novel positive information; by contrast, depressive symptoms were not predictive of difficulties in revising initially positive interpretations after novel negative information.

Consistent with this, research on *cognitive flexibility* has shown that MDD is associated with cognitive inflexibility, meaning that people with MDD have difficulty adapting their reactions to novel situations (Stange, Alloy, & Fresco, 2017). It has also been indicated that cognitive inflexibility predicts the onset of the first depressive episode (Stange et al., 2016) and suicidal ideation (Miranda, Gallagher, Bauchner, Vaysman, & Marroquín, 2012). Moreover, research on the *optimism bias* (Sharot, 2011) has shown that healthy people tend to process novel information rigorously in a positive way (Korn, Prehn, Park, Walter, & Heekeren, 2012; Sharot, Korn, & Dolan, 2011; Sharot, Riccardi, Raio, & Phelps, 2007), while this positivity bias was found to be absent in MDD (Garrett et al., 2014; Korn, Sharot, Walter, Heekeren, & Dolan, 2014). Consistent with the optimism bias, research on “depressive realism” suggests that people who are in good mental health show a range of mildly positive illusions related to themselves, such as unrealistic self-evaluations, exaggerated optimism, and inflated sense of control over their lives (Brookings & Serratelli, 2006; Taylor & Brown, 1988; Taylor, Kemeny, Reed, Bower, & Gruenewald, 2000); in contrast, mildly depressed or dysphoric people exhibit more realistic perception about their abilities and their control over the world (Alloy & Abramson, 1979; Carson, Hollon, & Shelton, 2010; Dobson, 1989; Dunning & Story, 1991).

In line with this previous work, we recently found that people with MDD maintain negative performance-related expectations despite positive disconfirming feedback. In contrast, healthy people adjusted their performance expectations in the same situation consistent with the unexpected positive feedback (Kube, Rief, Gollwitzer, Gärtner, & Glombiewski, 2019). As one mechanism that may account for this phenomenon of biased learning, researchers have introduced the concept of “cognitive immunization”: this concept refers to cognitive strategies aimed at devaluing disconfirmatory evidence, thus making people become immune to novel information that disproves their prior expectations (Rief et al., 2015). For example, the expectation of failure in performance-related situations might be maintained despite disconfirming positive performance feedback by thoughts such as, “this was especially easy”; “anyone could have done this”. In subsequent experiments, we demonstrated that modulating the use of cognitive immunization strategies after unexpectedly positive feedback led to significant differences in expectation update in people with MDD

(Kube, Glombiewski, Gall, et al., 2019; Kube, Rief, et al., 2019). Specifically, we found that promoting the use of cognitive immunization strategies prevented people from updating their negative expectations in line with the positive feedback; in contrast, inhibiting the use of cognitive immunization strategies facilitated the modification of negative expectations in line with the positive feedback. These findings suggest that cognitive immunization is crucially involved in updating (negative) expectations.

Notwithstanding the frequently documented differences in updating negative beliefs after receiving “good news”, relatively little research has been undertaken to investigate belief updating in response to “bad news” in healthy vs. depressed people. The few previous studies addressing this research question provided inconsistent results: while Garrett et al. (2014) found that people with MDD updated their beliefs in line with bad news more than healthy controls, Korn et al. (2014) found no significant differences between the two groups in terms of integrating unexpectedly negative information into their beliefs. Similar to Korn et al. (2014), Everaert et al. (2018) found that depressive symptom severity was not related to difficulty in revising initially positive interpretations after novel negative information. Although it may not be suitable to reconcile these apparently discrepant findings, research on belief updating in response to bad news can also draw on the literature on affective information processing, in which depression has been linked to deficits in inhibiting negative information and increased attention to negative emotional stimuli (Goeleven, De Raedt, Baert, & Koster, 2006; Gollan, Pane, McCloskey, & Coccaro, 2008; Joormann, Talbot, & Gotlib, 2007).

1.1. Aims and hypotheses

While there is sound evidence that people with and without MDD differ in the extent to which they adjust negative expectations after novel positive information, previous research provided mixed findings as to whether they also differ in processing unexpectedly negative information (Everaert et al., 2018; Garrett et al., 2014; Korn et al., 2014). We believe that it is important for the understanding of depression and its treatment whether people with MDD not only have difficulty adjusting negative expectations after novel positive information, but also whether they, unlike people without MDD, react over-sensitively to unexpected negative information. If depression was related to increased sensitivity to unexpected negative information, this would speak to the need of psychological interventions aimed at modifying such a negativity bias. The aim of this study was therefore to examine possible differences between people with and without depressive symptoms in terms of updating positive expectations after receiving disconfirming negative information.

To form hypotheses on this research question, it may be useful to consider a recent study by Garrett, González-Garzón, Foulkes, Levita, and Sharot (2018). In this study, the authors found that the optimistic bias, which normally guides belief updating in healthy people (as opposed to people with depression), vanishes in response to perceived threat, both in a laboratory setting with manipulated perceived threat and in firefighters on duty. The authors interpreted their results in such a way that healthy people are characterized by the flexibility to integrate unexpected negative information into their beliefs when required by the situational circumstances, but maintaining the positivity bias otherwise, which may be considered adaptive from an evolutionary point of view (Garrett et al., 2018). With reference to the literature on cognitive inflexibility in depression (Miranda et al., 2012; Stange et al., 2016, 2017), we assumed that the flexibility in integrating bad news as indicated by Garrett et al. (2018) is absent in depression. In particular, we hypothesized that people with depressive symptoms would change their expectations in a negative direction after receiving unexpected negative information in relation to their expectations, whereas people without depressive symptoms maintain positive expectations in the face of bad news, given that there is no perceived threat. Relatedly, with

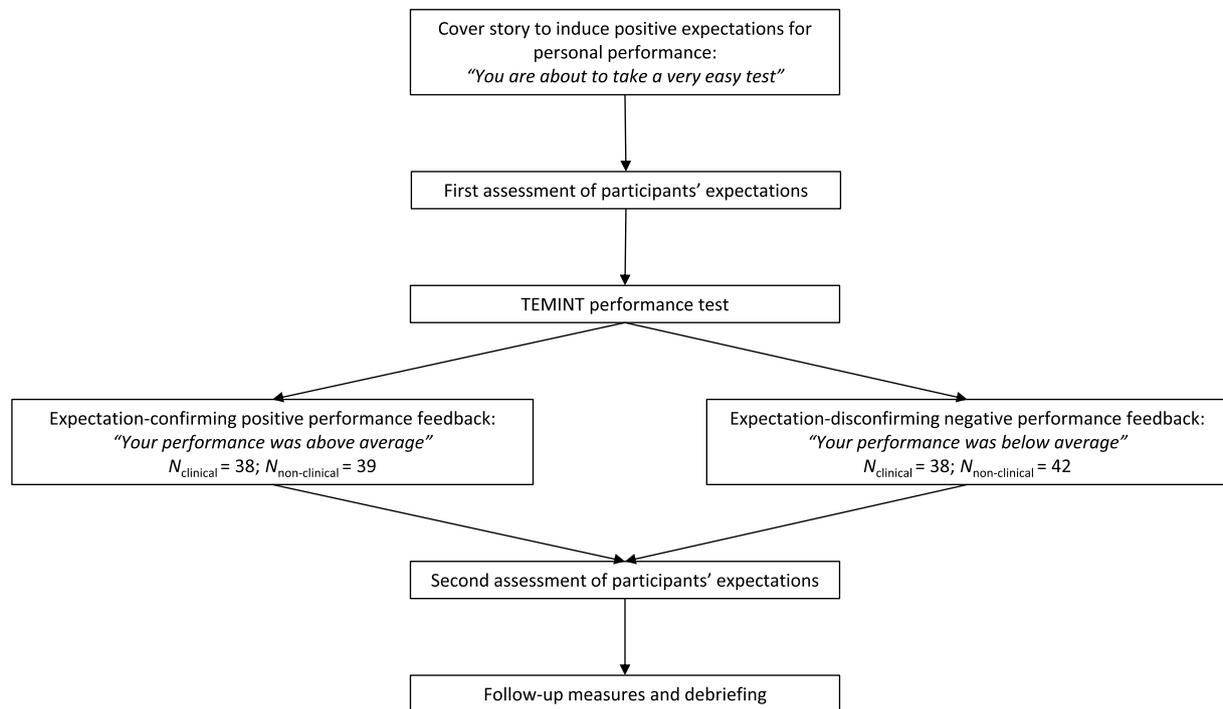


Fig. 1. Design of the present study. After the establishment of positive expectations, participants worked on the performance test TEMINT. Participants received feedback on their performance that either confirmed their initial positive expectations or negatively disconfirmed them. Afterwards, participants' expectations were assessed again.

reference to the previous work on cognitive immunization (Kube, Rief, et al., 2019), we hypothesized that non-depressed people would use more cognitive immunization strategies than people with depressive symptoms to devalue unexpectedly negative feedback. Specifically, we expected that people without depressive symptoms, after receiving unexpectedly negative feedback, would endorse statements suggesting that the feedback received is unreliable and/or not relevant to them more than people with depressive symptoms, thus maintaining positive expectations. No such differences between people with and without depressive symptoms in updating their expectations and the engagement in cognitive immunization strategies were expected for confirmatory positive feedback.

2. Methods

The study was approved by the local ethics committee (reference number 2018–37k) and was conducted in accordance with ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. All participants gave written informed consent and were treated in accordance with the ethical guidelines of the German Psychological Society. The study was registered at ClinicalTrials.gov: NCT03780881.

2.1. Participants

The sample size was determined via a-priori power analysis. Garrett et al. (2014) and Korn et al. (2014) found large differences between healthy and depressed people in expectation update after desirable vs. undesirable information, while we found medium effects in our own previous work (Kube, Rief, et al., 2019). Since we aimed to use our own previously developed paradigm, we expected a small to medium rather than a large effect size regarding possible differences between healthy people and people with MDD in updating performance-related expectations. Thus, the power analysis (expected $\eta_p^2 = .05$; power = .80; $\alpha = 0.05$; numerator $df = 1$) indicated a required sample size of at least 152 participants. We recruited $N = 171$ participants; this surplus would

allow us to exclude participant data if necessary due to experimental or statistical issues without substantially losing power. As an incentive for participation, participants had the chance to win gift vouchers for a popular book shop.

Clinical sample. The clinical sample ($n = 78$) was recruited at a German inpatient acute psychosomatic hospital. In this hospital, all patients received non-manualized cognitive behavioral therapy. Inclusion criteria were: current diagnosis of MDD according to ICD-10 or BDI-II sum score ≥ 20 (indicating at least moderate depressive symptoms); at least 18 years old; and sufficient German language skills. Exclusion criterion of the clinical sample was: participation in previous studies of our research group on changes in expectations. Participants were diagnosed by trained clinical psychologists and psychotherapists working at the psychosomatic hospital. Participants were diagnosed according to the hospital's routine diagnostic procedure using semi-structured clinical interviews based on the SCID interview (First, 2014; Wittchen, Zaudig, & Fydrich, 1997).

Non-clinical sample. The non-clinical sample ($n = 93$) was recruited via e-mail lists and postings in the surroundings of the universities of Marburg and Landau. Inclusion criteria for the non-clinical sample were: at least 18 years old; and sufficient German language knowledge. Exclusion criteria were: diagnosis of current mental disorder; life time diagnosis of MDD (both assessed via self-report); BDI ≥ 20 (indicating at least moderate symptoms of depression); currently receiving psychotherapeutic treatment; and participation in previous studies of our research group on expectation update.

2.2. Procedure

The present study was based on a paradigm developed and validated in previous work (Kube, Rief, Gollwitzer, & Glombiewski, 2018). The experimental sessions of the present study were conducted by three psychology master students (two females, one male) and a female psychology bachelor student. Data collection lasted from November 2018 to March 2019. All measures were completed in German language online via the survey platform Unipark®. Fig. 1 illustrates the study

procedure.

Induction of positive expectations. At the beginning of the experimental session, participants were informed that they were about to take very easy, unknown test. The goal of this instruction was to induce neutral to positive performance expectations among all participants before working on the test. The relevant section of the instruction read: “Up to now, you should not be familiar with the tasks from the test. The tasks were designed by the developers to be very easy and to be solved correctly by nearly all people”.

Performance test. Participants completed the Test of EMotional INTelligence (TEMINT) (Schmidt-Atzert & Buehner, 2002). This test was used in all previous studies using this paradigm (Kube, Glombiewski, Gall, et al., 2019; Kube, Rief, et al., 2019; Kube, Rief, et al., 2018), and was selected primarily because in this test it is quite difficult for participants to evaluate their own performance, which is important for the performance feedback received to appear credible. Another advantage of using this test is that people with and without depressive symptoms do not differ in their actual performance, as shown previously (Kube, Rief, et al., 2019). When working on the TEMINT, participants are presented a total of 12 brief descriptions of situations with one acting person who experienced the situation (e.g. “I had a dispute with a colleague”), and their task is to empathize with the acting person and to evaluate to what degree the acting person experienced different emotions in the given situation. The TEMINT sum score reflects the overall deviations from the actual ratings of the persons mentioned in the situations; low sum scores indicate good performance. The TEMINT has shown good psychometric properties in previous studies (Blickle, Momm, Liu, Witzki, & Steinmayr, 2011; Schmidt-Atzert & Buehner, 2002). Internal consistency of the TEMINT in the present study was $\alpha = 0.85$.

Experimental conditions. After each of three blocks of the TEMINT, participants received standardized performance feedback that either confirmed or disconfirmed their previous expectations. In the expectation confirmation condition, participants received positive feedback stating that they solved most of the tasks correctly, and that their performance on this test was above average compared to other participants. This feedback was supposed to confirm their initial positive expectations for their performance. Participants from the expectation disconfirmation condition, on the other hand, received negative feedback suggesting that they solved only about half of the tasks correctly and that their performance was thus below average in comparison to other participants. The goal of this feedback was to disconfirm participants’ initial positive expectations negatively. Participants from both conditions received feedback after each of the three blocks as well as after completing the entire test. Participants from the clinical and the healthy sample were randomly assigned to one of the two conditions, resulting in a total of four experimental groups (clinical sample – confirming positive feedback; clinical sample – disconfirming negative feedback; healthy sample – confirming positive feedback; healthy sample – disconfirming negative feedback).

To decrease the obviousness of the manipulation, the experimental procedure was embedded into a cover story. As part of the cover story, participants were informed at the very beginning of the experimental session that they would have to work on a well-established performance test whose applicability for clinical diagnostic use it to be evaluated. This cover story was used in several previous studies and has been found credible by the majority of participants (Kube, Glombiewski, Gall, et al., 2019; Kube, Rief, et al., 2019; Kube, Rief, et al., 2018).

Follow-up measures and debriefing. After completing the TEMINT, several follow-up questionnaires were administered to assess sociodemographic variables and depressive symptoms. Finally, participants were debriefed with respect to the true purpose of the study.

2.3. Measures

Changes in expectations. After reading the instructions,

participants rated their initial expectations for their performance. After completing the test, participants rated their expectations again. While both task-specific and generalized expectations were each assessed with single item measures in previous studies (Kube, Glombiewski, Gall, et al., 2019; Kube, Rief, et al., 2019; Kube, Rief, et al., 2018), we added two additional items for this study – one additional item for the measure of task-specific expectations and one additional item for generalized expectations, respectively – in order to allow a better psychometric assessment of participants’ expectations. The additional item for task-specific expectations was, “Solving the tasks from the test will be difficult for me” (before working on the test), and “I will find it difficult to solve tasks similar to those from the test in the future” (after feedback). The additional item for generalized expectations read, “Solving unknown tasks in general will be difficult for me” (before working on the test), and “In general I will find it difficult to solve unknown tasks in the future”. Notably, although the precise wording of the pre- and post-test items may appear somewhat different in the English translation presented here, the original German statements are fairly similar and differ only slightly in the order of the words, so that changes from pre to post in these items can be reasonably interpreted. The slight change in the wording from pre to post, though, was due to the fact that we had some concerns about the possibility of raising doubts about the cover story among participants when asked twice with the same wording about their expectations, as participants were led to believe that the study was not about changes in their expectations but about the evaluation of the test procedure. All items are rated on a seven-point Likert scale ranging from (1) “I totally disagree” to (7) “I totally agree”. Thus the total score for task-specific and generalized expectations ranges from 2 to 14. Internal consistency of the task-specific expectations scale was $\alpha = 0.66$ before the test and $\alpha = 0.72$ after feedback. Internal consistency of the generalized performance expectations scale was $\alpha = 0.78$ both before and after feedback. As in previous studies (Kube, Glombiewski, Gall, et al., 2019; Kube, Rief, et al., 2019), pre to post changes in generalized performance expectations were pre-defined as the primary outcome, and the adjustment of task-specific expectations was considered the secondary outcome.

Cognitive immunization. To examine the extent to which participants cognitively reappraise or discard the performance feedback, we used the Cognitive Immunization after Performance Feedback (CIPF) scale. In a previous study using a clinical sample, this scale has shown good psychometric properties and was associated with the degree of changes in performance expectations after feedback (Kube, Glombiewski, Gall, et al., 2019). The original scale comprises four items, two of them assessing the extent to which participants question the credibility of the feedback, and two items assessing the relevance of the result yielded by the test. For this study, we added another two items to assess whether participants appraise their performance feedback as an exception rather than a typical result “The result in this test was rather an exception for me”; “The test result is representative of my performance in other situations” (inverted). We added these two items in order to cover additional ways of devaluing unexpected performance feedback through cognitive immunization. Thus, the CIPF scale used in this study comprised a total of six items with the subscales *credibility*, *relevance*, and *exception*. Each item was rated on Likert scale ranging from (1) “I totally disagree” to (7) “I totally agree”, so the total score of the CIPF scale can range from 6 to 42, with higher values reflecting a greater engagement in cognitive immunization strategies. Internal consistency of the six-item CIPF scale was $\alpha = 0.77$.

Depressive symptoms. Depressive symptoms were assessed using the second edition of the Beck Depression Inventory (BDI- II); (Beck, Steer, Ball, & Ranieri, 1996), which includes 21 items assessing depressive symptoms on a 4-point scale ranging from 0 to 3. The sum score ranges between 0 and 63, and lower values indicate fewer depressive symptoms. In our sample, the internal consistency of the BDI-II was $\alpha = 0.95$.

Socio-demographics. Socio-demographic variables, including age,

Table 1
Sociodemographic and clinical characteristics of the two samples.

Variable	Clinical sample (n = 76)	Non-clinical sample (n = 81)	Differences between samples	
Age in years, <i>M</i> (<i>SD</i>)	41.30 (14.79)	28.00 (13.08)	$F(1, 155) = 35.735; p < .001$	
Sex, <i>N</i> (%)				
male	31 (40.8)	25 (30.9)	$\chi^2 = 1.683, p = .243$	
female	45 (59.2)	56 (69.1)		
Educational level, <i>N</i> (%)				
Secondary education	32 (42.1)	3 (3.7)	$\chi^2 = 47.114, p < .001$	
School leaving examination	23 (30.3)	59 (72.8)		
University degree	21 (27.6)	19 (23.5)		
Employment status, <i>N</i> (%)				
Full-time working	30 (39.5)	8 (9.9)	$\chi^2 = 61.156, p < .001$	
Part-time working	10 (13.2)	5 (6.2)		
Unemployed	9 (11.8)	1 (1.2)		
Pensioners	3 (3.9)	2 (2.5)		
Disabled	7 (9.2)	0		
Homemaker	2 (2.6)	0		
In training	15 (19.7)	65 (80.2)		
BDI-II, <i>M</i> (<i>SD</i>)	28.71 (12.12)	6.38 (4.38)		$F(1, 155) = 241.332; p < .001$
Dispositional optimism LOT-R, <i>M</i> (<i>SD</i>)	16.35 (5.02)	24.28 (3.26)		$F(1, 155) = 139.343; p < .001$
Psychological inflexibility, <i>M</i> (<i>SD</i>)	34.05 (9.23)	16.60 (6.13)	$F(1, 155) = 196.968; p < .001$	
Self-concept FSKN, <i>M</i> (<i>SD</i>)				
Overall performance	32.16 (11.31)	49.58 (6.99)	$F(1, 155) = 136.672; p < .001$	
General self-esteem	33.17 (14.01)	52.38 (6.58)	$F(1, 155) = 123.400; p < .001$	
Control attitudes FKK, <i>M</i> (<i>SD</i>)	111.99 (18.01)	144.00 (15.21)	$F(1, 155) = 66.351; p < .001$	

Note. *M* = Mean, *SD* = Standard deviation, *N* = Number, BDI-II = Beck's Depression Inventory II, LOT-R = Life Orientation Test Revised, FSKN = Frankfurt Self-Concept Scales.

sex, education, and employment status, were assessed using a brief self-report questionnaire.

Other measures. To control for potential confounding variables, we measured participants' self-concept using the "overall performance" (internal consistency in the present sample: $\alpha = 0.95$) and "general self-esteem" (internal consistency in the present sample: $\alpha = 0.96$) subscales from the Frankfurt Self-Concept Scale FSKN; (Deusinger, 1986); dispositional optimism using the Life Orientation Test Revised (LOT-R) (Glaesmer, Hoyer, Klotsche, & Herzberg, 2008) (internal consistency in the present sample: $\alpha = 0.88$); control attitudes with the Questionnaire on Competence and Control Attitudes (Krampen, 1991) (internal consistency in the present sample: $\alpha = 0.91$); and psychological flexibility using the German version of the Acceptance and Action Questionnaire (ACQ-II) by Hoyer and Gloster (2013) (internal consistency in the present sample: $\alpha = 0.96$). In addition, duration of treatment at the hospital was controlled.

2.4. Statistical analyses

We conducted data screening according to the suggestions of Tabachnick and Fidell (2014) and tested the assumptions of analyses of variance (ANOVA) and multivariate analyses of variance (MANOVA). Univariate outliers were inspected via standardized values of measured variables and their histograms (Kline, 2005). According to Cohen, Cohen, West, and Aiken (2003) and Stevens (2002), we additionally looked for multivariate outliers via Mahalanobis distance and Cook's distance. Following the recommendations by Stevens (2002), participants were excluded as outliers in the event of deviations > 3 standard deviations from the mean to ensure that the analyses reflect most of the data and are not influenced by highly influential or errant data points.

We conducted a multivariate analysis of variance (MANOVA) to examine possible baseline differences between the two experimental conditions (expectation confirmation vs. disconfirmation) and the two samples (clinical vs. non-clinical) in initial expectations, TEMINT performance, depressive symptoms, age, dispositional optimism, psychological inflexibility, control attitudes, and self-concept. Performing χ^2 tests, we examined whether the distribution of sex, education level, or employment status significantly differed across conditions and samples. Next, we conducted a 2 (Time: before feedback vs. after feedback) \times 2

(Condition: expectation confirmation vs. disconfirmation) \times 2 (Sample: clinical vs. non-clinical) mixed ANOVA, with the generalized performance expectations as the dependent variable. To examine group differences in expectation change, the analysis of most interest is the three-way interaction between the factors Time, Condition, and Sample. Possible differences between conditions and samples in cognitive immunization were examined in a 2 (Condition: expectation confirmation vs. disconfirmation) \times 2 (Sample: clinical vs. non-clinical) factorial ANOVA with the CIPF total scores as the dependent variable. Analyses of covariance (ANCOVAs) were performed to control for self-concept, dispositional optimism, control attitudes, psychological flexibility, sociodemographic variables, and TEMINT performance. Type-1 error levels were set at 5% (two-tailed). All analyses were conducted using IBM SPSS Statistics Version 25.

3. Results

3.1. Sample characteristics

Clinical sample. One participant was identified as a statistical outlier (standard values > 3) on the dependent variable and was therefore excluded. Another person had to be excluded because of serious doubts concerning the cover story and the correct suspicion of the actual purpose of the study. Four participants did not meet the criteria of MDD, but had BDI-II sum scores of 21; 39; 46; and 48, indicating moderate to severe depressive symptoms. Due to their high BDI scores, these participants were not excluded. Thus, subsequent analyses are based on data from 76 participants (100% Caucasian) from the clinical sample (with $n = 38$ in each experimental condition). The mean BDI-II score was 28.71 ($SD = 12.12$), indicating moderate to severe symptoms of depression (Beck et al., 1996). Regarding the specific diagnoses, 72.2% were diagnosed with a recurrent depressive disorder, 26.4% with a major depressive episode, and one person (1.4%) with a "double depression" (dysthymia plus current major depressive episode). A majority (57.9%) had at least one comorbid mental disorder, of which eating disorders (27.9%), somatoform disorders (21.1%), and anxiety disorders (18.0%) were the most common comorbid disorders. Socio-demographic and further clinical characteristics of the clinical sample can be found in Table 1.

Non-clinical sample. All sociodemographic and clinical characteristics of the non-clinical sample are presented in Table 1. From the non-clinical sample, three participants had to be excluded due to a BDI-II sum score ≥ 20 , indicating at least moderate depressive symptoms. As for the clinical sample, we also excluded participants from final analyses if they expressed serious doubts concerning the cover story and guessed the real purpose of the study. In the non-clinical sample, this was the case for eleven persons (four from the confirming positive condition and seven from the disconfirming negative condition). We excluded these participants from further analyses to reduce the potential of demand effects. Thus, the final analyses are based on data from 81 participants (80 Caucasians, one Asian person) from the non-clinical sample (with $n = 39$ in the expectation-confirming positive condition and $n = 42$ in the disconfirming negative condition).

In the supplementary material, we report a sensitivity analysis for the main results including all 171 participants. As can be seen there, the pattern of results is not significantly influenced by whether or not the respective fourteen persons were excluded or left in the analysis.

3.2. Manipulation check

As intended, participants reported overall neutral to positive values for their initial task-specific ($M = 10.85$; $SD = 2.39$) and generalized expectations ($M = 10.11$; $SD = 2.37$) after receiving the information that the upcoming test was very easy. In a previous study, it was shown that this instruction also led to significantly higher expectations than an instruction suggesting that the test was very difficult (Kube, Rief, et al., 2018).

3.3. Baseline differences between conditions and samples

Conditions. A MANOVA indicated that participants from the experimental conditions (confirming positive vs. disconfirming negative feedback) did not differ on initial task-specific expectations, $F(1, 155) = 1.651, p = .201, \eta_p^2 = .011$; initial generalized expectations, $F(1, 155) = 1.064, p = .304, \eta_p^2 = .007$; age, $F(1, 155) = 0.638, p = .426, \eta_p^2 = .004$; and BDI sum score, $F(1, 155) = 0.029, p = .866, \eta_p^2 < .001$. The two conditions did also not differ in terms of dispositional optimism, psychological inflexibility, self-concept, and control attitudes (all p -values $> .38$). The two conditions did differ, however, in their TEMINT performance, $F(1, 155) = 5.169, p = .024, \eta_p^2 = .032$, with participants from the confirming positive condition ($M = 30.06, SD = 8.18$) showing a better performance than participants from the disconfirming negative condition ($M = 33.03, SD = 8.20$). The distribution of male and female participants was not significantly different across the groups, $\chi^2 = 1.334, p = .317$, nor was the distribution of educational level, $\chi^2 = 6.828, p = .234$, and employment status,

$\chi^2 = 8.629, p = .196$.

Samples. A MANOVA indicated that participants from the non-clinical sample had more positive initial task-specific, $F(1, 155) = 8.368, p = .004, \eta_p^2 = .051$; and generalized expectations, $F(1, 155) = 11.721, p = .001, \eta_p^2 = .070$, compared to participants from the clinical sample. The MANOVA indicated that participants from the non-clinical sample had significantly lower BDI-II sum scores than participants from the clinical sample, $F(1, 155) = 241.332, p < .001, \eta_p^2 = .609$. Further, participants from the non-clinical sample were significantly younger than participants with depressive symptoms, $F(1, 155) = 35.735, p < .001, \eta_p^2 = .187$. Participants from the non-clinical sample had also higher educational degrees, $\chi^2 = 47.114, p < .001$, and were more likely to be in training instead of full-time or part-time working as opposed to participants from the clinical sample, $\chi^2 = 61.156, p < .001$. As can be seen in Table 1, the two samples did not differ in their distribution of sexes, but differed in accordance with their mental health status on additional psychological measures, i.e., dispositional optimism, psychological inflexibility, self-concept and control attitudes. Importantly, there were no differences between the two samples in their TEMINT performance, $F(1, 155) = 2.580, p = .110, \eta_p^2 = .016$.

3.4. Main analyses

Changes in generalized expectations. The Time by Condition by Sample three-factorial ANOVA with generalized expectations as the dependent variable indicated no significant main effect of Time, $F(1, 153) = 2.682, p = .104, \eta_p^2 = .017$. The main effect of Condition was not significant either, $F(1, 153) = 1.757, p = .187, \eta_p^2 = .011$. The main effect of Sample was significant, $F(1, 153) = 17.547, p < .001, \eta_p^2 = .103$, indicating that people without depressive symptoms ($M = 10.63, SD = 1.98$) had overall more positive expectations than people with depressive symptoms ($M = 9.22, SD = 2.89$). The Time by Condition interaction was significant, $F(1, 153) = 18.104, p < .001, \eta_p^2 = .106$; after receiving unexpectedly negative feedback, participants significantly changed their expectations in a negative direction, $t(79) = 3.784, p < .001, d = 0.448$, reflecting a medium effect; when receiving confirming positive feedback, participants changed their expectation in a slightly more positive direction, $t(76) = -2.097, p = .039, d = 0.196$, reflecting a small effect. The Time by Sample interaction was not significant, $F(1, 153) = 0.781, p = .378, \eta_p^2 = .005$, nor was the Condition by Sample interaction, $F(1, 153) = 0.015, p = .902, \eta_p^2 < .001$. The analysis of most interest, that is, the three way interaction between the factors Time, Condition, and Sample, was not significant, $F(1, 153) = 0.200, p = .656, \eta_p^2 = .001$. The results of this main analysis of the study are illustrated in Fig. 2. The descriptive values for the expectation ratings are presented in Table 2.

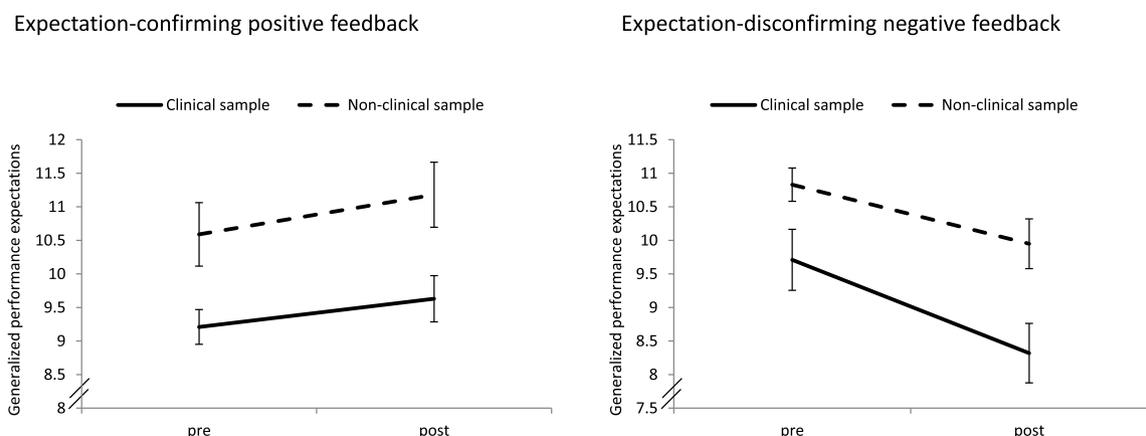


Fig. 2. Changes in generalized performance expectations. Overall, participants from the non-clinical sample had more positive expectations than people with depressive symptoms, but the two samples did not differ in updating their expectations after confirming positive vs. disconfirming negative feedback.

Table 2
Expectation and cognitive immunization ratings.

Variable	Clinical sample		Non-clinical sample	
	Positive feedback (n = 38)	Negative feedback (n = 38)	Positive feedback (n = 39)	Negative feedback (n = 42)
Generalized expectations, <i>M</i> (<i>SD</i>)				
Pre	9.21 (2.91)	9.71 (2.81)	10.59 (1.62)	10.83 (1.61)
Post	9.63 (2.98)	8.31 (2.73)	11.18 (2.15)	9.95 (2.40)
Task-specific expectations, <i>M</i> (<i>SD</i>)				
Pre	9.97 (3.00)	10.61 (2.68)	11.21 (1.92)	11.52 (1.57)
Post	11.87 (2.11)	7.47 (2.92)	12.10 (2.01)	8.45 (2.38)
CIPF scale, <i>M</i> (<i>SD</i>)				
Total score	22.45 (7.31)	30.34 (6.74)	23.02 (6.67)	31.90 (3.86)
Subscale exception	6.39 (3.04)	9.87 (2.48)	6.36 (2.18)	11.19 (1.71)
Subscale credibility	8.95 (3.79)	10.76 (3.16)	8.87 (3.51)	11.54 (2.05)
Subscale relevance	7.11 (3.09)	9.71 (3.23)	7.79 (3.11)	9.17 (2.52)

Note. M = Mean, SD = Standard deviation, CIPF = Cognitive Immunization after Performance Feedback.

Changes in task-specific expectations. The Time by Condition by Sample three-factorial ANOVA with task-specific expectations as the dependent variable indicated a significant main effect of Time, $F(1, 153) = 13.598, p < .001, \eta_p^2 = .082$, with overall less positive expectations after feedback ($M = 9.95, SD = 3.11$) than before feedback ($M = 10.85, SD = 2.39$). The main effect of Condition was significant, $F(1, 153) = 35.533, p < .001, \eta_p^2 = .188$, with overall more positive expectations in the confirming positive condition ($M = 11.29, SD = 2.31$) compared to disconfirming negative feedback ($M = 9.54, SD = 2.44$). The main effect of Sample was significant, too, $F(1, 153) = 7.983, p = .005, \eta_p^2 = .050$, indicating that participants from the non-clinical sample ($M = 10.79, SD = 2.30$) had more positive expectations than participants from the clinical sample ($M = 9.98, SD = 3.10$). The Time by Condition interaction was significant, $F(1, 153) = 94.574, p < .001, \eta_p^2 = .382$; after receiving confirming positive feedback, participants changed their expectations in a more positive direction, $t(76) = -4.227, p < .001, d = 0.595$, reflecting a medium effect; by contrast, after receiving disconfirming negative feedback, participants changed their expectations in a negative direction, $t(79) = 9.527, p < .001, d = 1.261$, reflecting a large effect. The Time by Sample interaction was not significant, $F(1, 153) = 1.027, p = .313, \eta_p^2 = .007$, nor was the Condition by Sample interaction, $F(1, 153) = 0.132, p = .717, \eta_p^2 = .001$. As for generalized expectations, the

Time by Condition by Sample interaction was not significant, $F(1, 153) = 1.307, p = .255, \eta_p^2 = .008$. The descriptive values of the ratings for task-specific expectations are presented in Table 2.

Analyses of covariance. To control for differences between the samples in age, educational level, and employment status, we performed three separate ANCOVAs considering these factors as covariates. Considering these factors did not significantly change the pattern of results; that is, their inclusion did not change the significance of any of the main or interaction effects, and effect sizes in the ANCOVAs were similar to those in the ANOVAs reported above. Similarly, the pattern of results did not significantly change when considering measures of self-concept, dispositional optimism, control attitudes, and psychological inflexibility as covariates. As we found that the two experimental conditions differed in their TEMINT performance, we also performed an additional ANCOVA controlling for the effects of actual test performance. As for the other covariates, including the TEMINT sum scores as a covariate did not significantly change the pattern of results. Lastly, we examined within the clinical sample whether the type of diagnosis or the presence of comorbidities influenced the results. Again, the results of the main analyses were not affected by these clinical factors.

3.5. Results for cognitive immunization

The Condition by Sample two-factorial ANOVA with the CIPF sum scores as the dependent variable indicated a significant main effect of condition, $F(1, 153) = 70.773, p < .001, \eta_p^2 = .316$; overall, the engagement in cognitive immunization strategies was greater after receiving disconfirming negative feedback ($M = 31.16, SD = 5.44$) than after confirming positive feedback ($M = 22.74, SD = 6.95$). The main effect of Sample was not significant, $F(1, 153) = 1.153, p = .285, \eta_p^2 = .007$, nor was the Condition by Sample interaction, $F(1, 153) = 0.244; p = .622; \eta_p^2 = .002$. The descriptive values for the cognitive immunization ratings including the three subscales of the CIPF are presented in Table 2. The CIPF total score was significantly correlated with pre to post changes in task-specific ($r = -0.406, p < .001$) and generalized expectations ($r = -0.243, p = .002$), indicating that the more participants engaged in cognitive immunization strategies, the less likely were they to update their expectation in a positive direction. The results of this correlation analysis are illustrated in Fig. 3.

4. Discussion

While previous research has shown that people with and without depressive symptoms differ in the extent to which they adjust negative expectations after novel positive experiences, little is known about whether the two groups also differ in updating expectations after

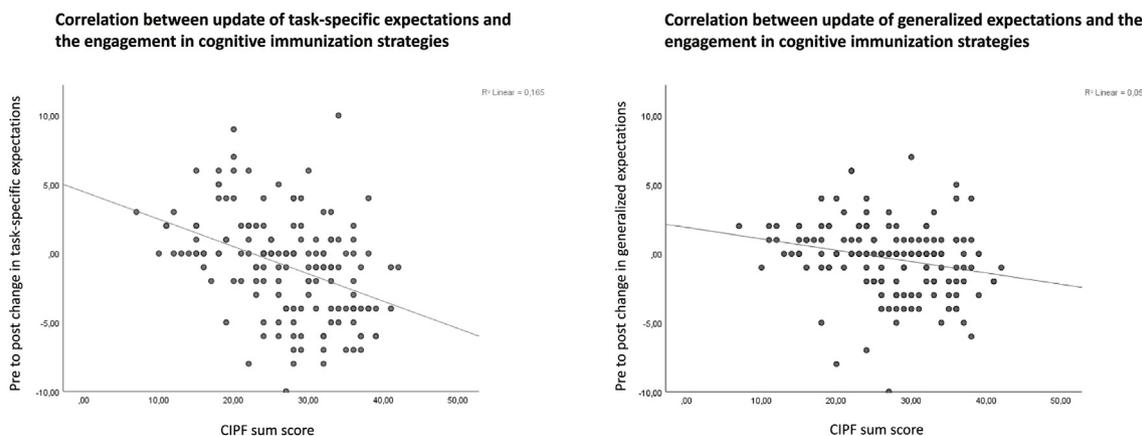


Fig. 3. Correlations between update in expectations and the engagement in cognitive immunization strategies. The engagement in cognitive immunization strategies – assessed with the Cognitive Immunization after Performance Feedback (CIPF) scale – significantly correlated with change in task-specific ($r = -0.406, p < .001$) and generalized expectations ($r = -0.243, p = .002$).

unexpectedly negative experiences. The present study addressed this issue by examining intra-individual changes in neutral to positive performance expectations after receiving feedback that either confirmed previous expectations or negatively disconfirmed them. The results indicate that participants from the non-clinical sample had overall more positive expectations than participants from the clinical sample, but there were no differences between the two groups in updating their expectations. In both samples, there was a slight change of generalized performance expectations in an even more positive direction after receiving confirmatory positive performance feedback, reflecting a small effect. Conversely, when receiving unexpectedly negative feedback, both samples changed their performance expectations in a negative direction, with large effect sizes. The same pattern of results, albeit with larger effect sizes, was found for task-specific expectations. Thus, the study did not provide evidence for the main hypothesis that people with depressive symptoms would react more sensitively to unexpectedly negative information compared to people without depressive symptoms.

These findings contrast with the results provided by Garrett et al. (2014), who found that people with depression updated their expectations to a greater extent after receiving negative disconfirmatory information than healthy people. By contrast, the current results are consistent with Korn et al. (2014), who found significant differences in belief updating between healthy and depressed people only with respect to the integration of desirable information, but not of undesirable information. Similar to Korn et al. (2014), Everaert et al. (2018) found depressive symptoms to be predictive of difficulty in revising negative interpretations after novel positive information, but not of revising positive interpretations after disconfirmatory negative information. Thus, in accordance with Korn et al. (2014) and Everaert et al. (2018), but in contradiction to Garrett et al. (2014), we did not find significant differences between people with and without depressive symptoms in updating neutral to positive expectations after unexpectedly negative information, while we did find such differences in updating negative expectations after novel positive information in previous work (Kube, Rief, et al., 2019).

These apparently inconsistent findings might, to some extent, be accounted for by considering several sources of heterogeneity in the respective studies. One source of heterogeneity refers to the content of the beliefs examined. While both Garrett et al. (2014) and Korn et al. (2014) examined beliefs about the likelihood of experiencing certain life events, Everaert et al. (2018) examined interpretations of emotionally relevant situations, and we investigated changes in expectations for one's performance. Second, our study differs from previous work in so far as in the present study, participants' initial expectations were presumably influenced by the cover story, which suggested that the test they were about to take was very easy. In contrast, in the studies by Garrett et al. (2014) and Korn et al. (2014), the initial expectations of the participants were assessed free from any experimental manipulation. Their initial expectations may therefore, contrary to the present study (and, notably, also the study by Everaert et al. where the presentation of the scenario also suggested a certain interpretation), have reflected their "real" beliefs. Thus, it is conceivable that differences between clinical and non-clinical samples with respect to the integration of unexpectedly negative information are more likely to be found if the participants' initial beliefs are assessed free from any experimental manipulations. This interpretation, however, is somewhat countered by the fact that even Garrett et al. (2014) and Korn et al. (2014), using the same experimental design, provided discrepant results on expectation updating after bad news for healthy vs. depressed people (while consistently reporting differences between the groups in updating their expectations in response to good news).

The current results can also be linked to research on the optimism bias and cognitive flexibility. Recently, Garrett et al. (2018) found that the optimistic bias, which is normally characteristic of belief updating in healthy people, vanishes if they are under perceived threat, and

suggested that this speaks to a flexibility in adapting belief updating to the situational circumstances. With reference to previous work linking depression to cognitive inflexibility (Miranda et al., 2012; Stange et al., 2016, 2017), we hypothesized that depression would be characterized by a lack of such a flexibility. However, similar to Everaert et al. (2018), our findings suggest that this inflexibility applies only to using novel positive information to update previous negative beliefs (Kube, Rief, et al., 2019), but not to the adjustment of positive beliefs after disconfirmatory negative information.

With regard to cognitive immunization, the results indicate that the use of cognitive immunization strategies was higher in the disconfirming negative feedback condition than in the positive feedback condition, presumably because unexpectedly negative feedback leads to defiance and reactance which makes it likely to reject the feedback. However, contrary to our hypothesis, there was no significant interaction between feedback and sample. Previous work found that promoting or inhibiting the use of cognitive immunization strategies after unexpectedly positive information significantly affected the update of negative expectations in people with depression (Kube, Glombiewski, Gall, et al., 2019; Kube, Rief, et al., 2019). Therefore, it may be valuable to examine in future research whether modulating the use of cognitive immunization strategies after unexpectedly negative feedback also differentially affects the update of positive expectation in people with depression vs. healthy controls.

4.1. Theoretical and clinical implications

Combined with previous work, the present findings have some implications for theoretical models of depression. Consistent with theoretical models of cognitive dysfunctions in MDD (Beck, Rush, Shaw, & Emery, 1979; Everaert, Koster, & Derakshan, 2012; Rief & Joermann, 2019), a considerable amount of evidence has linked depression to difficulties in updating negative beliefs after novel positive information (Everaert et al., 2018; Kube, Rief, et al., 2019; Likhaitzky et al., 2017). In contrast, except for the study by Garrett et al. (2014), no such difficulties were found for updating positive expectations after disconfirming negative information in prior work (Everaert et al., 2018; Korn et al., 2014) as well as in the present study. Synthesizing these findings, we suggest that belief updating in depression is not related to increased sensitivity to unexpectedly negative information. Rather, the main problem of MDD seems to be that people with depression, unlike healthy people, have difficulty using new positive experiences to update their negative expectations. In other words, research points to an asymmetry in differences between healthy and depressed people in updating beliefs: While they differ greatly in the extent to which they use unexpectedly positive information to alter negative beliefs, this difference is much less pronounced (or even non-existent) when updating positive beliefs after disconfirmatory negative information. This consideration is consistent with a recent longitudinal study showing that the strongest predictor of the course of depressive symptoms in at-risk adolescents was not overly negative future expectations but lack of positive future expectations (Horwitz et al., 2017). It is also supported by the *impaired disengagement hypothesis*, suggesting that persistent negative thoughts in depression are primarily related to difficulty in disengaging from negative self-referent information and lack of considering novel positive information (Koster, De Lissnyder, Derakshan, & De Raedt, 2011).

With regard to the treatment of depression, the current findings imply that cognitive-behavioral interventions may not primarily focus on modifying the processing of unexpectedly negative information. Rather, therapists may consider ways to help people with depression use positive information effectively to alter their negative expectations. Therapeutic strategies aimed at facilitating the modification of negative expectations in depression through the inhibition of cognitive immunization against positive information have recently been discussed elsewhere (Kube, Glombiewski, Gall, et al., 2019; Kube, Glombiewski,

& Rief, 2019).

4.2. Limitations

A significant limitation is that the two samples differed in socio-demographic variables (i.e. age, education level, and employment status). Although ANCOVAs controlling for these factors did not find any influence of them on the main results, these differences nonetheless compromise the comparability of the two samples. Another limitation is that we focused only on performance-related expectations, which are indeed important to people with MDD, but only cover a small part of areas where people with MDD have dysfunctional expectations (Backenstrass et al., 2006; Kube et al., 2017; Miranda & Mennin, 2007). Furthermore, it is unclear how stable the changes in expectations are over time, since the second assessment of expectation took place immediately after feedback. For example, it is conceivable that the negative changes in expectations after the receipt of negative feedback, as indicated in this study, are reversed after some time. Another limitation is that potential effects of medication use in the inpatient sample were not controlled. A further general limitation is that the study was based solely on self-report measures and, for example, no observer-rated, indirect, or neurophysiological measures were used. Thus, some potential of demand effects remains. Moreover, although not intended, an interesting additional finding of the present study was that participants from the negative feedback condition achieved worse results in the TEMINT performance test than participants from positive feedback condition. It seems reasonable that motivational aspects account for these performance differences, in the sense that participants who repeatedly received negative feedback were less motivated to continue to work on the test ambitiously, and thus performed worse. In order to take this issue into account, analyses were controlled for TEMINT sum scores.

5. Concluding remarks

The present study aimed to complement prior work that indicated differences between healthy and depressed people in updating negative expectations after novel positive information. In this study, we examined whether these differences are mirrored when positive expectations are negatively disconfirmed. Contrary to our main hypothesis, we found no differences between people with depressive symptoms and people without depressive symptoms in updating positive expectations, nor did they differ in their appraisal of the feedback received. Combined with prior work, these findings suggest that a clinically relevant phenomenon in depression is the maintenance of negative expectations despite novel positive experiences; in contrast, when integrating unexpectedly negative information, there seem to be less psychopathological abnormalities in people with depression compared to people who are in good mental health.

Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.brat.2019.103509>.

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