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Refilling the half-empty glass – Investigating the potential role of the Interpretation Modification Paradigm for Depression (IMP-D)

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ABSTRACT

Background and objectives: Cognitive biases are known to cause and maintain depression. However, little research has been done on techniques targeting interpretation tendencies found in depression, despite the promising findings of anxiety studies. This paper presents two experiments, investigating the suitability of an Interpretation Modification Paradigm for Depression (IMP-D) in healthy individuals, which has already proven its effectiveness in anxiety (Beard & Amir, 2008). Different from other paradigms, the IMP-D aims at modifying an interpretation bias on response- and on a more implicit reaction time-level, making this task less susceptible to demand effects.
Methods: The Word–Sentence Association Paradigm for Depression (Hindash & Amir, 2011) was modified and administered in healthy volunteers (experiment I: $N = 81$; experiment II: $N = 105$). To enhance a positive interpretation bias, endorsing benign and rejecting negative interpretations of ambiguous scenarios was reinforced through feedback. This intervention was compared to the opposite training (both experiments) and a control training (experiment II only).
Results: Both experiments revealed a significant increase in bias towards benign interpretations on the level of overt decisions, while only in the first experiment a change was found on a reaction time level. These modifications are not reflected in group-differences in emotional vulnerability.
Limitations: Possible limitations regarding the reliability of inter-dependent response and reaction time measures are discussed.
Conclusions: The IMP-D is able to modify interpretation biases, but adaptations are required to maximize its beneficial effects.

Seeing a glass as half empty instead of half-full is one of the most popular examples of a negative interpretation of an ambiguous scenario. This bias towards negative interpretations is a characteristic cognitive marker often found in depression (e.g., Blackwell & Holmes, 2010; Hindash & Amir, 2011). This and other cognitive biases in the domain of memory and attention processing (e.g., Tran, Hertel, & Joormann, 2011; Vrijsen et al., 2014; Wells & Beevers, 2010) are not merely a symptom of depression, but appear to play a causal role in the onset and maintenance of depression (De Raedt & Koster, 2010). In the light of limited treatment options, techniques that are able to modify interpretation biases and the related depressive symptoms are therefore essential.

Recently two meta-analytical reviews have been published, investigating the possibility to modify cognitive biases for interpretation (CBM-I) in anxiety and depression (Hallion & Ruscio, 2011; Menne-Lothmann et al., 2014). Menne-Lothmann and colleagues thereby distinguished between three CBM-I techniques: 1) homograph paradigms, 2) ambiguous situation paradigms (AS), and 3) word–sentence association paradigms (WSAP). However, the WSAP has so far only been applied to anxious individuals (Amir, Bomyea, & Beard, 2010; Amir & Taylor, 2012; Beard & Amir, 2008). In the following paragraphs we introduce the homograph paradigm and the AS to highlight methodological differences to the

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WSAP, which we propose as an alternative technique to modify biases in depression.

In a homograph paradigm, single words comprising a benign and a negative meaning (e.g., stroke) are used to assess the strength of associations individuals have with their respective meaning (e.g., Grey & Mathews, 2000). However, as homographs are less frequent in other languages different from English, this paradigm is less suitable in other languages as Dutch or German.

In the AS, developed by Mathews and Mackintosh (2000), initially ambiguous scenarios are described of which the meaning can only be resolved by the last word. Several sentences provide participants with a detailed context to develop an interpretation. This paradigm has been used to alter interpretation biases in anxiety (Salemink, van den Hout, & Kindt, 2007; Yiend, Mackintosh, & Mathews, 2005) and depression (Micco, Henin, & Hirshfeld-Becker, 2014). Holmes, Mathews, Dalgleish, and Mackintosh (2006) further modified this technique, by presenting scenarios on audio recordings and asking participants to imagine the described scenarios. This mental imagery training has been shown to be able to reduce depressive symptoms compared to a control training (Blackwell & Holmes, 2010; Holmes, Lang, & Shah, 2009).

In a Word–Sentence Association Paradigm (WSAP; Beard & Amir, 2009) a negative word (e.g., "threatening") or a benign word (e.g., "funny") is presented, followed by an ambiguous sentence (e.g., "People laugh after something you said."). Participants indicate as fast as possible whether the word matches the sentence. Response choices and reaction times supply information about interpretation biases. In order to modify a pre-existing interpretation bias, Beard and Amir (2008) provided feedback on the performed reactions, reinforcing the acceptance of benign interpretations and the rejection of negative interpretations (i.e., "You are correct"), while punishing all other decisions (i.e., "You are incorrect"). This modification of the paradigm was sufficient to retrain initial interpretation tendencies in socially anxious individuals. Moreover these effects transferred to other modalities of information processing as attention (Amir et al., 2010), and reduced levels of social anxiety (Amir & Taylor, 2012; Beard & Amir, 2008).

Compared to AS paradigms (e.g., Mathews & Mackintosh, 2000), in the WSAP ambiguous stimuli are presented briefly as they consist of shorter sentences. This reduction of presentation time requires participants to rely on their associations to evaluate the scenarios. Compared to the mental imagery training (e.g., Blackwell & Holmes, 2010) the WSAP asks participants to actively perform an action, which has been suggested to be a critical component of a cognitive training targeting interpretation tendencies (Hoppitt, Mathews, Yiend, & Mackintosh, 2010). Moreover, next to measures of response choices, reaction times of the WSAP provide a more implicit assessment of this associative processing.

A modification of the WSAP has been used to assess interpretation biases in dysphoric individuals (WSAP-D; Hindash & Amir, 2011). Dysphoric participants tended to more often and more quickly endorse negative interpretations of ambiguous self-referential sentences compared to non-dysphoric individuals. However, no study has been published on the modification of these tendencies in the field of depression by means of this paradigm so far.

The aim of the current study was to investigate the efficacy of an Interpretation Modification Paradigm for Depression (IMP-D) by providing feedback on the WSAP-D, as in Beard and Amir (2008). In two experiments we investigated the efficacy of the IMP-D in modifying initial interpretation tendencies within an unselected sample. In addition we were interested in how far this modification of interpretation tendencies affects emotional vulnerability in response to a subsequent laboratory stressor. As this is the first study investigating the potential of modifying depressive interpretation tendencies by means of a modified WSAP, we decided to investigate this paradigm in an unselected sample as a proof-of-principle study first, before testing it in clinical samples. Hence, the aim of the first experiment was to investigate whether initial interpretation tendencies can be modified by means of the IMP-D. Therefore, we compared two training conditions, one reinforcing healthy interpretation tendencies and the other reinforcing maladaptive interpretation tendencies. These two training conditions were contrasted, as the strengthening of a healthy bias in an unselected sample might result only in small changes, which are difficult to detect. The second experiment aimed at investigating whether we can strengthen an adaptive interpretation bias. Both training conditions from the first study were compared to a neutral control condition, wherein no interpretation tendencies were strengthened at all.

1. Experiment I

A group of unselected participants received either a positivity training (PT), involving reinforcement of the rejection of negative interpretations and the acceptance of benign interpretations, or a negativity training (NT), in which the opposite pattern was reinforced. Participants were expected to more often and more quickly execute the reinforced response pattern after the training. The PT group was further expected to show attenuated levels of emotional vulnerability in response to a subsequent stress task, compared to the NT group.

1.1. Method

1.1.1. Participants

81 Dutch and German speaking students participated in return for course credits or a payment of €10. All participants were randomly assigned to the PT group ($n = 40$) or the NT group ($n = 41$). Groups did not differ on age, gender, nationality or any trait questionnaires (see Table 1).

1.1.2. Materials

1.1.2.1. Zung self-rating depression scale (SDS). The SDS was administered to investigate differences in depressive symptoms (Zung, 1965, 1973). Scores range from 20 to 80, with higher scores reflecting more depressive symptoms.

Table 1
Descriptive statistics of both groups in experiment I.

Name	PT	NT	Range	t ($df = 79$)	χ^2	p
	Mean (*SD*)	Mean (SD)				
N	40	41				
Gender	25 female 15 male	19 female 22 male			2.13	.144
Nationality	21 Dutch 19 German	24 Dutch 17 German			.3	.585
Age	22.6 (2.35)	23.49 (6.45)		.82		.416
SDS	36.23 (6.96)	35.49 (9.01)	23–55	.41		.682
STAI	37.18 (9.17)	37.8 (12.15)	20–69	.26		.793
NEO-FFI	6.3 (3.16)	6.71 (4.03)	0–16	.51		.615
PA	33.8 (5.29)	34.37 (6.26)	18–47	.44		.662
NA	18.6 (7.33)	19 (7.7)	10–42	.24		.811
Mood Scales	35.87 (6.52)	36.17 (8.47)	12–48	.18		.861

Note. PT: positivity training; NT: negativity training; SDS: Zung Self-Rating Depression Scale; STAI: Trait measure of the Spielberger State Trait Anxiety Inventory; NEO-FFI: neuroticism scale of the NEO; PA: positive affect scale of the Positive Affect Negative Affect Schedule; NA: negative affect scale of the Positive Affect Negative Affect Schedule; Mood Scales before the training.

1.1.2.2. Spielberger state-trait anxiety inventory (STAI-T). The trait scale of the STAI has been applied to examine differences in trait anxiety (Laux, Glanzmann, Schaffner, & Spielberger, 1981; Spielberger, Gorsuch, & Lushene, 1970). Scores range from 20 to 80, with higher scores representing higher trait anxiety.

1.1.2.3. NEO-FFI. The neuroticism subscale of the NEO-FFI was administered in order to assess individual trait differences in emotional vulnerability. Sum scores of this scale range from 0 to 48, while higher scores represent higher levels of neuroticism (Borkenau & Ostendorf, 1993; Hoekstra, Ormel, & de Fruyt, 1996).

1.1.2.4. Positive affect negative affect schedule (PANAS). To assess individual levels of affect the PANAS (Watson, Clark, & Tellegen, 1988) was used. On two subscales the level of positive affect and negative affect can be indicated, with total scores ranging between 5 and 50 for each scale.

1.1.2.5. Mood scales. To assess changes of mood during the experiment we repeatedly applied a mood scale. This scale consisted of 5 items to be rated on a 10-point Likert scale with two emotional descriptions at the anchor of each item, which is tensed/relaxed, sad/cheerful, anxious/save, frustrated/content, and unhappy/happy. The scores on all items are summed to a total between 5 and 50, with higher scores reflecting more positive mood states.

1.1.2.6. Interpretation modification paradigm for depression (IMP-D). The WSAP-D was modified as in Beard and Amir (2008). The material used by Hindash and Amir (2011), kindly provided by the authors, was translated into Dutch and German. During the pre- and post-assessment, 32 ambiguous sentences (e.g., "Your supervisor is surprised by your work") were presented and equally often combined with either a benign word (e.g., "competent") or a negative word (e.g., "incompetent"). During the training, 58 sentence-word combinations were presented, in addition to 10 filler sentence-word combinations. All sentences were presented twice during the training, once combined with the benign and once with the negative word, resulting in 136 trials.

During each assessment trial, participants first saw a black fixation cross on a white screen, replaced by a sentence after 500 ms. After 2500 ms a benign or negative word appeared in the center of the screen. The participants' task was to indicate as fast as possible whether sentence and word were related by pressing a button on the keyboard. Both, reaction times and decisions were recorded.

For training purposes, feedback was given after every response. Participants in the PT group received reinforcing feedback (i.e., "correct") on trials where they accepted combinations with a benign word and where they rejected combinations with a negative word. All other reactions were punished (i.e., "incorrect"). Participants in the NT group received the opposite feedback, reinforcing the acceptance of negative and the rejection of benign interpretations.

Filler trials were added in order to prevent participants from exclusively reacting to the valence of the word without reading the previously presented sentence. These trials required the untrained response, e.g., participants in the PT group received unambiguous filler-sentences (e.g., "You are stuck in a traffic jam") combined with a negative word (e.g., "accident") that had to be accepted, or combined with a benign word (e.g., "sunshine") that had to be rejected. Before pre-assessment, 10 practice trials were presented, which were similar to the training trials in that feedback was given on the performance. The task lasted about 20 min.

1.1.2.7. Stressful memory task. In order to measure training effects on emotional vulnerability, a challenging memory task was administered. The sentences of the post-assessment trials were combined with the same words as during the post-assessment in 50 percent of the trials, and with new words in the remaining trials, resulting in 64 trials. Word-valence was counterbalanced across old and new combinations. Trials started with a black fixation-cross for 500 ms, replaced by the sentence-word combination. Subjects had 1500 ms to indicate whether the word–sentence combination was novel or repeated. In case of no response within 1500 ms, participants were instructed to react faster.

1.1.2.8. Mood induction. In order to restore participants' mood at the end of the experiment, a positive mood induction was administered after the memory task. Participants viewed a movie clip from the Jungle Book, lasting about 5 min.

1.1.3. Procedure

All participants were tested individually in a testing room. After providing informed consent, participants were seated in front of the computer screen, where they were asked to first answer all questionnaires before starting with the IMP-D procedure. Immediately after the training, they were asked to fill in the mood scales for the second time before working on the stressful memory task and filling in the mood scales for the final time. After the positive mood induction participants were paid. The whole experiment lasted about 1 h. After finishing data collection participants were debriefed via email.

1.1.4. Design and analyses

Percentages of accepting benign and negative interpretations were calculated separately for each participant at both assessment points, with higher percentages of accepting a given combination being equivalent to lower percentages of rejecting the same combination. A 2 (group: PT, NT) × 2 (valence: benign, negative) × 2 (time: pre-assessment, post-assessment) mixed repeated measures analysis of covariance (ANCOVA) was conducted on the percentage of acceptations to investigate effects of the intervention. SDS served as covariate for all analyses.

For reaction times (RT), the first and the last percentile of all RT during the assessment trials were deleted. A median score for accepting and rejecting negative and benign word–sentence combinations of each assessment point was calculated. The resulting medians were log transformed. These scores were subjected to a 2 (group: PT, NT) × 2 (valence: benign, negative) × 2 (time: pre-assessment, post-assessment) × 2 (decision: accept, reject) repeated measures ANCOVA.

Training effects on stress reactivity were investigated by a 2 (group: PT, NT) × 2 (time: pre-stressor, post-stressor) repeated measures ANCOVA on log transformed mood scores, comparing group difference in mood changes before to after the stress task.

1.2. Results

1.2.1. Interpretation training

1.2.1.1. Decisions. No pre-training differences between groups were found. The critical 2 (group: PT, NT) × 2 (time: pre-assessment, post-assessment) × 2 (valence: benign, negative) repeated measures ANCOVA revealed a significant 3-way interaction ($F(1,78) = 8.49$, $p = .005$, $\eta^2 = .098$). To further investigate this interaction effect, two separate repeated measures ANCOVAs were conducted for both levels of valence.

On accepted negative interpretations, there was a time by group interaction ($F(1,78) = 8.57$, $p = .004$, $\eta^2 = .099$) mainly driven by a reduction of accepted negative interpretations in the PT group ($t(39) = 6.62$, $p < .001$). This was not found in the NT group ($t(40) = .93$, $p = .358$). SDS was significant as well ($F(1,78) = 12.56$,

$p = .001$, $\eta^2 = .139$). The analysis was repeated for accepted benign interpretations. This analysis yielded no time by group interaction effect ($F(1,78) = 2.44$, $p = .122$), but only a significant main effect of group ($F(1,78) = 6.38$, $p = .014$, $\eta^2 = .076$), indicating an overall higher level of acceptations of benign interpretations. SDS revealed to be marginally significant ($F(1,78) = 3.15$, $p = .08$, $\eta^2 = .039$). See Table 2 for mean percentages of acceptations.

To investigate the relation of depression and the training effect we correlated a change score for the acceptance of negative interpretations (i.e., pre minus post scores) with SDS, separately for both groups. Only in the NT group depression was marginally related to a change in acceptance rates ($r(41) = -.27$, $p = .083$), showing that higher scores on SDS were related to a stronger increase in acceptance of negative interpretations. This relation was not found in the PT group ($p > .1$), indicating that individuals with low and high levels of depression were trained equally well.

1.2.1.2. Reaction times. No pre-training differences between groups were found. The critical 2 (group: PT, NT) × 2 (time: pre-assessment, post-assessment) × 2 (valence: benign, negative) × 2 (decision: accept, reject) repeated measures ANCOVA revealed a marginally significant 4-way interaction ($F(1,62) = 3.48$, $p = .067$, $\eta^2 = .053$), which we tested per level of valence and decision.

1.2.1.2.1. Negative interpretations. A 2 (group: NT, PT) × 2 (time: pre-assessment, post-assessment) repeated measures ANCOVA on the RT of accepting negative interpretations revealed no significant 2-way interaction effect ($F(1,67) = .77$, $p = .382$). The same analysis on RT for rejecting negative interpretations revealed a significant interaction ($F(1,78) = 9.02$, $p = .004$, $\eta^2 = .104$). This interaction was mainly due to faster rejections of negative interpretations in the PT group ($t(39) = 5.21$, $p < .001$), while the RT in the NT group remained stable ($t(40) = .27$, $p = .792$). SDS was marginally significant ($F(1,78) = 3.86$, $p = .053$, $\eta^2 = .047$).

1.2.1.2.2. Benign interpretations. The 2 (group: NT, PT) × 2 (time: pre-assessment, post-assessment) repeated measures ANCOVA on accepting benign interpretations revealed a significant 2-way interaction ($F(1,78) = 5.36$, $p = .023$, $\eta^2 = .064$), which was again mostly caused by the PT group showing faster acceptations of benign interpretations after the training ($t(39) = 2.59$, $p = .013$). The NT group did not show faster responses when comparing pre and post measures ($t(40) = .886$, $p = .381$). There was no 2-way interaction on rejecting benign interpretations ($F(1,70) = .17$, $p = .682$). Only a marginal significant main effect of time was found, indicating a reduction of response time ($F(1,70) = 3.16$, $p = .08$, $\eta^2 = .043$).

We conducted a correlation analyses to investigate the relation between the depression rating and the change in reaction times on rejecting negative interpretations and on accepting benign interpretations. These analyses revealed no significant correlation ($p > .1$) for either of the groups, indicating that the training functions equally well for individuals scoring low and high on the depression rating.

Table 2
Mean percentage of acceptance rates (SD) for benign and negative interpretations in experiment I.

	PT		NT	
	Benign	Negative	Benign	Negative
Pre	72.19 (13.05)	37.81 (17.16)	68.6 (17.26)	39.02 (17.39)
Post	80.47 (13.29)	21.09 (18.71)	70.58 (18.02)	35.37 (20.9)

Note. PT = positivity training group; NT = negativity training group.

1.2.2. Mood changes

1.2.2.1. Direct effects. To investigate whether the training affected mood, we conducted a 2 (group: PT, NT) × 2 (time: before training, after training) repeated measures ANCOVA on log transformed mood ratings, which revealed a marginal significant time effect ($F(1,78) = 2.87$, $p = .094$, $\eta^2 = .035$) indicating a decrease in mood during the training (see Table 3 for untransformed means). The interaction effect remained non-significant ($F(1,78) = 2.57$, $p = .113$).

1.2.2.2. Emotional vulnerability. The 2 × 2 repeated measures ANCOVA comparing mood scores before to after the stress inducing memory task yielded no significant interaction effect ($F(1,78) = .02$, $p = .895$). After controlling for variation of depressed level, the time effect turned out to be not significant either ($F(1,78) = .03$, $p = .86$). Only SDS was significant ($F(1,78) = 31.52$, $p < .001$, $\eta^2 = .288$) and revealed to be positively correlated with stress reactivity ($r(81) = .391$, $p < .001$), showing that higher levels of depression were related to a stronger increase in stress.

1.3. Discussion

The aim of this first experiment was to investigate, whether the IMP-D is able to alter depressive interpretation tendencies. The PT group showed changes in accordance with their training condition, accepting fewer negative interpretations after the training compared to before the training, and becoming faster in rejecting negative interpretations as well as in accepting benign interpretations. In contrast to our expectations, individuals in the NT group showed similar training effects as participants in the PT group, indicated by an increase in acceptations of benign word–sentence combinations and by faster responses on rejecting negative interpretations.

Participants' mood decreased as a result of either training, perhaps due to the monotonicity of the task. Beyond that, training condition had no effect on emotional vulnerability in response to a laboratory stressor task. However, lower depression scores were related to attenuated stress reactivity, demonstrating the stress resilience of healthy individuals. Self-esteem might also have been an important factor. Whereas low self-esteem is known to be a risk factor for developing depression, high self-esteem might have attenuated the impact of the stressor (Orth, Robins, & Meier, 2009; Rector & Roger, 1997). It also might be possible that a training effect is visible in recovery from stress (Sanchez, Vazquez, Marker, LeMoult, & Joormann, 2013). To investigate this, we assessed mood after the positive mood induction subsequent to the challenging stress task in experiment II.

2. Experiment II

The second experiment aimed at replicating the findings from the first experiment and in addition to study effects relative to a neutral control condition. This is required to investigate whether the PT improves interpretation tendencies. To investigate effects on recovery from stress, we additionally assessed mood after the

Table 3
Mean mood ratings (SD) of both groups for all three assessment time points in experiment I.

	PT	NT
Before Training	35.88 (6.52)	36.17 (8.47)
Before Stress Task	35.7 (5.93)	33.9 (8.51)
After Stress Task	34.25 (6.27)	32.34 (9.35)

Note. PT = positivity training group; NT = negativity training group.

Table 4
Descriptive statistics of all three groups in experiment II.

Name	PT	NT	Control	Range	F (2,102)	χ^2	p
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)				
N	36	35	34				
Gender	23 female	22 female	20 female			.21	.8
	13 male	13 male	14 male				
Nationality	15 Dutch	20 Dutch	12 Dutch			3.54	.17
	21 German	15 German	22 German				
Age	20.42 (1.99)	20.14 (2.24)	19.74 (1.85)		.99		.375
SDS	36.67 (6.87)	38.6 (7.4)	35.68 (6.14)	26–55	1.64		.199
STAI	39.78 (9.47)	43.17 (10.8)	37.15 (8.51)	23–67	3.39		.038
RSES	22.14 (4.84)	19.89 (4.53)	23.21 (4.1)	8–30	4.84		.01
PA	33.44 (6.63)	31.89 (6.73)	34.82 (6.19)	17–48	1.75		.179
NA	19.69 (7.29)	20.83 (5.91)	18.56 (5.83)	10–37	1.09		.341
Mood Scales	34.97 (8.17)	32.49 (8.18)	35.91 (5.96)	16–50	1.92		.152

Note. PT: positivity training; NT: negativity training; Control: control group; SDS: Zung Self-Rating Depression Scale; STAI: Trait measure of the Spielberger State Trait Anxiety Inventory; RSES: Rosenberg Self-esteem Scale; PA: positive affect scale of the Positive Affect Negative Affect Schedule; NA: negative affect scale of the Positive Affect Negative Affect Schedule; Mood Scales before the training.
This table represents the final sample after excluding five participants due to high error rates on the IMP-D.

positive mood induction phase following the challenging stress task.

2.1. Methods

Only differences between the two experiments will be described.

2.1.1. Participants

In this experiment 128 Dutch and German speaking students participated for course credits. Due to a computer error, the first 18 participants had to be excluded. All participants were randomly assigned to one of the three conditions (PT: $n = 36$; NT: $n = 37$; control: $n = 37$). Groups did not differ in age, gender, nationality and trait questionnaires, except for the STAI and Rosenberg Self-Esteem Scale (see Table 4).

2.1.2. Materials

2.1.2.1. Rosenberg self-esteem scale (RSES). To control for individual differences in self-esteem, the RSES was administered (Ferring & Filipp, 1996; Franck, Raedt, Barbez, & Rosseel, 2008). On 10 items participants indicated on a 4-point Likert scale ranging from 0 (*strongly disagree*) to 3 (*strongly agree*) to what degree every item represents a proper description of themselves. These scores are summed up to total score ranging between 0 and 30 with higher scores representing higher levels of self-esteem.

2.1.2.2. IMP-D. The structure of the IMP-D was identical to the first experiment. A control training was added, in which participants received a continued assessment task, consisting of the same training trials as the PT and NT, but without feedback.

2.1.2.3. Stressful memory task. The only difference to the first experiment was an extension of the response window to 2500 ms.[1]

[1] Results of the memory task in experiment I indicate a ceiling effect regarding the response latencies to identify previous combinations. To be able to detect a potential transference effect from the IMP-D to a memory bias, we prolonged the time limit of the stressful memory task.

Table 5
Mean percentage of acceptance rates (SD) for benign and negative interpretations in experiment II.

	Pre		Post	
	Benign	Negative	Benign	Negative
PT	67.01 (13.58)	38.72 (18.41)	72.4 (15.84)	22.57 (14.12)
NT	70 (14.44)	37.14 (17.74)	70.71 (15.52)	36.43 (21.73)
Control	69.97 (12.13)	34.56 (20.13)	72.79 (12.67)	31.25 (17.41)

Note. PT = positivity training group; NT = negativity training group; Control = control group.

2.1.3. Procedure

The order of the tasks was replicated, with the only exception that at after the positive mood induction, mood scales were presented again.

2.1.4. Design and analyses

Data preparation followed the same steps as in experiment I, with the exception that the mood ratings did not have to be log transformed. Furthermore, five participants have been removed based on their outlying scores (values greater than 3 times the interquartile range; Field, 2009) on RT measures and measures of decisions (see Table 4 for characteristics of the final sample).

To test for training effects on *Decision* level a 3 (group: PT, NT, control) × 2 (time: pre-assessment, post-assessment) × 2 (valence: benign, negative) repeated measures ANCOVA was conducted. Changes in log transformed median RT were analyzed by means of a 3 (group: PT, NT, control) × 2 (time: pre-assessment, post-assessment) × 2 (valence: benign, negative) × 2 (decision: accept, reject) repeated measures ANCOVA. Finally, a 3 (group: PT, NT, control) × 2 (time: pre-stressor, post-stressor) repeated measures ANCOVA was conducted on the mood scales to investigate differences in stress responsiveness between the groups. This analysis was repeated with the mood scales before and after the positive mood induction to test for differential recovery during the positive mood induction. SDS, STAI and RSES served as covariates. As the NT differed significantly from the remaining groups, all planned analyses were repeated without this group.

2.2. Results

2.2.1. IMP-D

2.2.1.1. Decision. No pre-training group-differences were found. The 3 (group: PT, NT, control) × 2 (time: pre-assessment, post-assessment) × 2 (valence: benign, negative) repeated measures ANCOVA revealed a significant 3-way interaction ($F(2,99) = 5.52$, $p = .005$, $\eta^2 = .1$). To understand this interaction, we conducted two separate repeated measures ANCOVA for both levels of valence.

The 3 (group: PT, NT, control) × 2 (time: pre-assessment, post-assessment) repeated measures ANCOVA on the percentage of accepted negative interpretations revealed a significant interaction ($F(2,101) = 5.26$, $p = .007$, $\eta^2 = .096$), which was mostly driven by a decrease in percentage of acceptations within the PT group ($t(35) = 5.27$, $p < .001$), while the scores remained stable in the other groups (NT: ($t(34) = .18$, $p = .86$; control: ($t(33) = .96$, $p = .345$). The remaining effects remained non-significant ($p > .05$).

The same 3 × 2 repeated measures ANCOVA on the percentage of accepted benign interpretations revealed no significant interaction effect ($F(2,99) = .62$, $p = .539$), or main effect of condition or time ($p > .1$) (see Table 5 for mean percentages of acceptance rates). As in the first study, a change in percentage of acceptations was correlated with SDS, however, this correlation was not significant in either group ($p > .1$).

2.2.1.2. Reaction times. No significant group differences were found on the RT level. The planned 3 (group: PT, NT, control) × 2 (time: pre-assessment, post-assessment) × 2 (valence: benign, negative) × 2 (decision: accept, reject) repeated measures ANCOVA revealed no effect of the training as indicated by the non-significant 4-way interaction ($F(2,91) = 1.82$, $p = .167$).

2.2.2. Mood changes

2.2.2.1. Direct effects. Changes in mood as a result of the training were evaluated via a 3 (group: PT, NT, control) × 2 (time: pre-assessment, post-assessment) repeated measures ANCOVA, on the mood scales before and after the IMP-D, revealing an overall drop in mood during the training ($F(1,100) = 4.33$, $p = .04$, $\eta^2 = .041$). All other effects were not significant ($p > .05$).

2.2.2.2. Emotional vulnerability. The 3 (group: PT, NT, control) × 2 (time: pre-stressor, post-stressor) repeated measures ANCOVA, revealed no significant interaction effect ($F(2,100) = 1.23$, $p = .298$). The main effect of time did not reveal a significant effect either ($F(1,100) = .58$, $p = .448$), indicating the failure to generally induce heightened levels of stress.

2.2.2.3. Stress recovery. The 3 × 2 repeated measures ANCOVA analysis revealed no significant time × group interaction effect either ($F(2,93) = 1.28$, $p = .283$), or any other main effect ($p > .05$).[2]

2.3. Discussion

Results from the first experiment were replicated: the training strengthened tendencies to reject negative interpretations. Again, this change was only present in the PT group. The NT group remained stable, as did the control group. However, the second experiment did not succeed in strengthening initial tendencies regarding the acceptance of benign interpretations, or in modifying initial tendencies on reaction time.

As in the first study, the IMP-D did not differentially affect mood, neither during the training nor in response to the stress task. Note that the stress task in the second experiment did not induce stress at all, probably due to the decreased time pressure. The absence of a stress induction might further have impeded the detection of a group difference in mood recovery after the positive mood induction either, even though mood increased across all groups over this phase.

3. General discussion

The aim of this study was to test the Interpretation Modification Paradigm for Depression (IMP-D), an instrument developed to modify depressogenic interpretation tendencies. In two experiments we showed that the IMP-D enhances a healthy bias favoring benign interpretations, by modifying interpretation tendencies on decisions (i.e., that is how often a negative or benign interpretation is rejected or accepted) as well as on RT. These results support the testing of the IMP-D as training technique in an emotionally vulnerable or depressive sample.

However, the IMP-D did not influence all bias measures. Whereas in the first experiment, participants displayed changes in interpretation tendencies as assessed by means of latencies and decisions, the second experiment only revealed a reduction in accepting negative interpretations in the PT group. This variation in results might be explained by the change in study design. Whereas in the first experiment we contrasted two extreme training conditions, we compared these conditions to a third, neutral condition in the second experiment. As this control condition was expected to deviate less from the two interventions, it became more difficult to detect subtle differences.

The aim of a CBM technique such as the IMP-D is to beneficially affect depression, either by reducing symptoms or, as during a single session intervention, to attenuate emotional vulnerability in response to a stressor. Both experiments revealed no effects on stress reactivity during a challenging memory task, which can partly be explained by the limited induction of stress. These results are however in line with the findings of Menne-Lothmann et al. (2014), demonstrating no beneficial effects of CBM-I on subsequent stressors. As suggested by the authors, to investigate effects on emotional vulnerability a stressor needs to be applied that provokes ambiguity rather than general distress as in the current study.

An alternative explanation for the absence of statistical group differences might be ascribed to the feedback of the IMP-D. The explicit feedback might have made participants aware of the training contingencies. As the feedback in the NT group probably was in strong contrast to the natural interpretation tendencies of these healthy individuals, it might have provoked reactance (Fulcher & Hammerl, 2005; Murphy & Zajonc, 1993), rather than a shift in interpretation bias. Reactance would reinforce a healthy interpretation bias and hence explain the changes found in the NT group that are comparable to the PT group.

These results further shed light on discussions concerning awareness of training contingencies. By providing feedback on every single decision, the purpose of such a training procedure might have been obvious to participants. Grafton, Mackintosh, Vujic, and MacLeod (2014) demonstrated that participants who are informed about the training contingency showed an improvement in bias while emotional vulnerability to a subsequent stressor remained unaffected. Hence, it might be interesting to alter the training procedure by reinforcing healthy interpretation patterns more implicitly.

Several limitations need to be mentioned. An inherent characteristic to the design is the interdependency of measures of RT and response choices. The IMP-D reinforces of one kind of interpretation (e.g., accept benign interpretations) while punishing the opposite reaction (e.g., reject benign interpretations). Hence, the more effective the training is in reducing the unwanted reaction pattern, the fewer data points are available to calculate a representative median reaction time. This affects a reliable estimation of an interpretation bias on RT level. Increasing the number of trials without excessively prolonging the session might help to improve this estimation.

It remains speculative how this training affects the evaluation of an initially ambiguous scenario. Due to the task features, characterized by repetitively performing a decision within a very short period, it is conceivable that the IMP-D targets associative learning and as a result facilitates the access to benign interpretations when encountering an ambiguous situation. Increasing the number of training sessions might hereby be an important step to strengthen these associations and amplify beneficial effects. Moreover, participants might need to be confronted with ambiguous situations in their daily life to experience meaningful changes in their mood states. Finally, we cannot directly draw conclusions about the effectiveness of the IMP-D in clinical samples. Based on the recent meta-analysis (Menne-Lothmann et al., 2014) we might expect that clinical samples benefit more from this intervention compared to the

[2] As the NT group initially differed from the other two groups on trait measures of anxiety and self-esteem, all planned analyses on changes of response choices, reaction times and mood changes were repeated without the NT group. The results remained unchanged.

current sample. This however needs to be tested in future research.

In conclusion, this study is the first to show that the IMP-D is able to positively influence initial interpretation tendencies in an unselected sample, by repetitively practicing the acceptance of benign interpretations of ambiguous sentences and the rejection of negative interpretations. Such a modification of interpretation tendencies typically found in depressed individuals is a prerequisite to reduce emotional vulnerability and affect depression (Clarke, Notebaert, & MacLeod, 2014). Hence, future studies of this paradigm in an adapted form are justified to deploy the therapeutic potential of the IMP-D.

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