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Mechanisms and Effectiveness of Imagery Strategies in Reducing Disgust in Contamination-Related Obsessive–Compulsive Disorder: *Comparing Imagery Rescripting, Imagery Self-compassion and Mood-Focused Imagery*

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Abstract

Background Strong feelings of disgust and anxiety are maintaining factors in contamination-related obsessive–compulsive disorder (C-OCD). To this day there are not many studies that investigated strategies for changing pathological disgust. In a previous study, it was shown that imagery rescripting could successfully change disgust. However, whether imagery rescripting or more general imagery processing, helps to reduce pathological disgust, remains unclear. Therefore, the aim of the present study was to investigate how successful imagery rescripting is in comparison to imagery self-compassion and a passive positive imagery condition in reducing disgust.

Methods For this, the three strategies were compared to each other on 2 days (within-subject) in a laboratory experiment. The study included 24 subjects with diagnosed C-OCD, and 24 matched, healthy controls (between-subject).

Results The results show that all three strategies changed disgust, they do not differ from each other and that different traits appear to influence the strategies' success or failure. The theoretically derived underlying mechanisms of the strategies were found in an elaborate content analysis.

Conclusions The present study provides first indications that imagery in general can help to change pathological disgust experience.

Keywords Disgust · Imagery · Contamination · Obsessive–compulsive disorder · Compassion

Introduction

Disgust and fear are important maintaining factors in the contamination-related subtype of obsessive–compulsive disorders (C-OCD, Cisler et al., 2009), yet studies have shown that people with C-OCD have greater difficulty in changing disgust compared to fear reactions (Armstrong & Olatunji, 2017; McKay, 2006). Nevertheless, exposure therapy with response prevention is a very effective therapy for changing

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OCD symptoms (Öst et al., 2015), and a recent study has shown that disgust and fear habituated equally quickly when longer exposure sessions were conducted (Mathes et al., 2020). Although directly changing disgust should be a central aspect of a successful treatment of C-OCD (Knowles et al., 2018), there are only a few studies that have specifically investigated strategies which target disgust directly (Olatunji et al., 2017a, 2017b). In former studies, it was found that imagery rescripting (ImR) and cognitive reappraisal reduced disgust in people with C-OCD more effectively than a distraction-related control condition (Fink & Exner, 2019; Fink et al., 2018). The results provide motivation for further investigation of imagery strategies to change pathological disgust more successfully.

In these studies, ImR was applied with the aim of changing the affective meaning of aversive memories and intrusive mental images (Wild et al., 2008) by changing the content of a negative image into a positive image (Holmes et al., 2007).

The study by Fink et al. (2018) was criticized because it lacked an active and a passive imaginative control condition. If imagery is strongly associated with emotional reactivity, it may be that activating mental images is an adequate emotion regulation strategy. This reveals a gap in research, in that it is unclear whether ImR or simply imagery processing, is effective for reducing the disgust experienced. Therefore, in this study, the same (active) ImR condition was tested against an instruction to induce a positive mood state via imagery as a passive control (passive positive imagery condition). Hereby, people were instructed to think about their favorite hobby.

A strategy that might lie between passive imagination and active imagery would be a strategy in which the person is guided to work on more global aspects of the self (e.g., self-compassion). In view of the fact that the emotional experience of obsessive–compulsive disorder is accompanied by fear, disgust, restlessness and tension, Paul Gilbert's compassion-focused therapy (CFT) can offer a helpful approach. Care and greater compassion for ourselves are associated with less stress, less anxiety and less depression (MacBeth & Gumley, 2012), and promote resilience and more satisfied relationships (Neff & Germer, 2013). A growing number of experimental studies have shown that CFT leads to a significant improvement in well-being and complements classical behavioural therapy methods (Eichholz et al., 2020; Sommers-Spijkerman et al., 2018). Therefore, as third strategy, a imagery self-compassion strategy was included in this experiment. To test whether imagery is more likely to help broader disgust experience or specific OCD-related disgust experience, a healthy control group was assessed.

A further aim of the present study was to test, whether assumed mechanisms underlying CFT and ImR are reported to be helpful during emotion regulation. According to Neff's theory of self-compassion (Neff, 2003), the central mechanisms of successful CFT is Self-Kindness (understanding, warmth, kindness, friendliness, inner strength and appreciation), Common Humanity (empathy, compassion (for others), the feeling of connectedness and community), and Mindfulness (acceptance, mindfulness and non-judgmental observation, calmness and taking perspective). Many of the qualities comprised in these categories, such as kindness and empathy, are also described by Gilbert (2009) as being central to compassion focused therapy. On the other hand, according to Holmes et al. (2007), it can be assumed that central mechanisms of ImR are the modification of the content of a negative image into a positive image (activating the imagination and using it as a tool), and second, the creation of a new positive image to rewrite negative schematic beliefs (activating the experience of a positive image). It can be assumed that ImR can cause a change in the image's meaning, which in turn changes the associated emotions. Therefore, a qualitative content analysis was carried out to answer the question of whether assumed mechanisms of action underlying the CFT and ImR strategies were reported and perceived as subjectively helpful, in terms of disgust regulation.

The aim of the present study is to investigate to what extent non-pathological and pathological disgusting experiences can be reduced by different interventions using imagery. We expect that as ImR is the most active strategy, it will reduce disgust most directly and therefore more effectively, than the more indirect CFT condition (1.1). We also expect that the passive positive imagery condition will be the least effective strategy (1.2). We expect that the clinical sample will benefit more from all active strategies than the healthy controls (2). We expect that people who have a stronger tendency to apply self-compassion will benefit more from the CFT condition (3.1), while the habitual use of imagery should be a general, positive predictor for all interventions using imagery (3.2). Furthermore, we expect that, in the content analysis, the participants will report the mechanisms of action that provide the theoretical bases of the respective strategies (4).

Materials and Methods

Participants

Forty-eight subjects volunteered to participate in this study. All the participants were native German speakers. The healthy control group participants were screened by telephone before being invited to the first appointment, to ensure that they matched the inclusion criteria. The participants had to be aged between 18 and 65 years old and have no history of or be currently diagnosed with, neurological disorders, traumatic brain injury, tic disorder, psychotic or bipolar disorder, substance abuse, or dependence. All the healthy control participants were paid 9.50 €/h for participating in the experiment.

Participants with the Washing Subtype of Obsessive–Compulsive Disorder

Twenty-four participants, who met the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013) criteria for current OCD, were included in this experiment. All the OCD participants reported predominant symptoms of fear of contamination, washing and cleaning in the *Yale-Brown Obsessive–Compulsive Scale* (Y-BOCS; Goodman et al., 1989) checklist, and thus met the criteria for the contamination-related subtype of OCD (C-OCD). The participants in the clinical population were recruited from the Schön-Klinik Bad Bramstedt ($n = 14$), the outpatient' clinic of the University

Table 1 Demographics and clinical characteristics by group

Demographic data	C-OCD ($n=24$)		HC ($n=24$)		Statistical analysis			
	Mean	S.D	Mean	S.D	t	df	P value	d
Age (years)	33.79	13.11	33.79	13.40	0	46	1	0
Gender [men: women (%men)]	20:4 (17%)		20:4 (17%)		$\chi^2 (1)=0$		1	0
Educational level [a]	1.833	1.239	1.833	1.239	0	45.9	1	0
Session difference (days)	7.818	4.393	8.250	9.023	−0.203	44	.840[b]	−.060
Clinical data								
Y-BOCS total (points)	23.417	7.058	–	–	–	–	–	
Disgust propensity (FEE)	97.875	21.559	75.292	22.718	3.532	46	<.001	1.020
Anxiety (STAI-T)	51.875	6.375	43.375	5.420	4.977	46	<.001	1.437
Depression (BDI-II)	22.042	15.298	7.167	6.657	4.368	46	<.001[b]	1.261
Self-compassion (SCS)	2.471	.814	3.226	.747	−3.315	45	.002	−.967
Imagination (SUIS)	60.750	14.845	56.667	9.703	1.128	46	.265	.326
Current co-morbidity [Y: N (% yes)]	15:9 (63%)		–					

C-OCD washing subtype of obsessive–compulsive disorder, *HC* healthy controls, *Y-BOCS* Yale-Brown obsessive–compulsive scale, *FEE* Fragebogen zur Erfassung der Ekelsensitivität (Disgust propensity), *STAI-T* state-trait anxiety inventory—trait version, *BDI-II* beck depression inventory II, *SCS* self-compassion scale, *SUIS* spontaneous use of imagery scale

[a]Educational level was recorded in four levels matching the German school system from 1 [highest secondary school level achieved (Abitur)] to 4 [=basic secondary school level achieved (Hauptschule)]

[b]Levene's test is significant ($P<.05$), suggesting a violation of the equal variance assumption

of Leipzig ($n=8$) and through advertisements online ($n=2$). Two participants only completed the first session, because they left their clinics afterwards. The diagnoses of OCD and potential co-morbid disorders, were assessed according to DSM-IV criteria, and based on a multimodal clinical consensus procedure including an SCID-based semi-structured clinical interview (SCID, Structured Clinical Interview for DSM-IV; German: Wittchen et al., 1997), questionnaires and behavioral observation by trained experts from the Schoen-Klinik hospital in Bad Bramstedt. The C-OCD group comprised 20 females (83%) and 4 males (17%), with an average age of 33.792 years ($SD=13.114$). Thirteen patients (43%) reported comorbid disorders, which matched the following DSM-5 Axis I diagnoses: current major depression disorder (MDD, $n=4$, 13.3%), MDD with partial remission ($n=7$, 23.3%) and dysthymia ($n=1$), as well as panic disorder ($n=1$). Ten participants were receiving outpatient treatment and 14 were receiving inpatient treatment at the time of assessment. 67% of the participants were receiving medical treatment ($n=16$), with 14 being on SSRI medication, one being on SNRI medication and one being on antidepressant medication. 63% participants had a comorbid disorder ($n=15$), with 12 participants being diagnosed with a comorbid depression and three participants with a comorbid panic disorder.

Healthy Controls

The healthy control group consisted of 24 participants, who were matched to the C-OCD group by age, gender and level of school education. The participants were recruited using a University of Leipzig internal database. The absence of any Axis I psychiatric disorder was ensured by accurately screening and interviewing the participants using the *Structural Clinical Interview for DSM. -IV* (SCID; German: Wittchen et al., 1997). The healthy control group consisted of 20 females (83%) and 4 males (17%) and the average age was 33.792 years ($SD=13.403$).

Comparison of the Two Groups

The two groups were not statistically different with respect to age, $t(45.978)=0$, $p=1$, $d=0$, highest level of school education, $t(46)=0$, $p=1$, $d=0$, days between the sessions, $t(44)=−0.203$, $P=−0.840$, $d=0.060$, or their habitual use of imagery (SUIS), $t(46)=1.128$; $p=0.265$, $d=0.326$. Both groups had exactly the same gender ratio [20 females:4 males (17%)]. On the other hand, the two groups did differ in any of the other demographic or clinical data, which are presented in Table 1.

Measures

Yale-Brown Obsessive–Compulsive Scale (Y-BOCS)

The severity of obsessive and compulsive symptoms was classified by clinician-rated assessment, using the German version (Hand & Büttner-Westphal, 1991) of the *Yale-Brown Obsessive–Compulsive Scale* (Y-BOCS; Goodman et al., 1989). In it, 10 items are rated on a 5-level scale to assess the severity of OCD symptoms, resulting in a score between 0 (no symptoms), and 40 (extreme symptoms). The scale has an excellent internal consistency ($\alpha = 0.91$).

Disgust Propensity (Fragebogen zur Erfassung der Ekelsensitivität, FEE)

The level of disgust propensity was assessed by applying the 37 item, scaled *Fragebogen zur Erfassung der Ekelsensitivität* (FEE; German: Schienle et al., 2002; Schienle et al., 2020; English: Questionnaire for the Assessment of Disgust Propensity, Goetz et al., 2013; Olatunji et al., 2011), which ranges from 0 (not disgusting) to 5 (very disgusting). The measure was used to assess five disgust categories: Death, bodily excretion, spoilage, hygiene and oral defence. The FEE has been reported to have an excellent internal consistency (Cronbach's $\alpha > 0.9$).

Beck Depression Scale-II (BDI-II)

The *Beck Depression Scale-II* (BDI-II; German: Beck et al., 1996; Hautzinger et al., 2006) was used to measure the severity of depressive symptoms. The BDI-II is a self-report scale which uses 21 items, rated from 0 to 3, to assess symptoms of depression. The German translation has a high internal consistency (Cronbach's $\alpha > 0.84$).

State-Trait Anxiety Inventory-Trait Version (STAI-T)

The *State-Trait Anxiety Inventory-Trait Version* (STAI-T; German: Laux et al., 1981) was applied to measure the level of negative affectivity. The STAI-T is a self-report scale, which uses 20 items, rated from 0 (never) to 4 (very), to assess anxiety-related symptoms. The German translation has a high internal consistency (Cronbach's $\alpha > 0.84$).

Self-compassion Scale (SCS)

The *Self-Compassion Scale* (SCS; Hupfeld & Ruffieux, 2011) was applied to measure the habitual use of self-compassion. The answers are given on a 5-point Likert scale, ranging from 0 (occasionally) to 4 (most of the time). The SCS has been reported to have a high internal consistency (Cronbach's $\alpha > 0.81$).

Spontaneous Use of Imagery Scale (SUIS)

The *Spontaneous Use of Imagery Scale* (SUIS; German: Görgen et al., 2016; Reisberg et al., 2003) was used to assess the habitual use of imagery. The answers were given using a 5-point Likert scale, ranging from 1 (always) to 5 (never). The German revision by Görgen et al. (2016), differs from the original SUIS by having additional items, results in a 17-item measurement, which has been reported to have a high internal consistency (Cronbach's $\alpha > 0.85$). Participants scored mean values between 1.6 and 4.9 on this questionnaire. Accordingly, there was no person who never experiences imagination in everyday life."

Experimental Design

The influence of imagery rescripting and imagery self-compassion on disgust reduction was tested in a mixed subject design. While the differences between the C-OCD sample and the matched control sample, were analyzed by a between-subject design, the actual experiment was performed using a within-subject design, whereby each participant performed each of the three experimental conditions, on both days, in a randomized order. Therefore, two data points for each experimental condition were recorded for each participant. The study was approved by the local ethics committee of the University of Leipzig (2019.03.05_eb_3) and therefore the research was conducted in accordance with the 1964 Helsinki Declaration. We have reported how we determined our sample size, all data exclusion (if any), all manipulations, and all measures in the study.

Stimuli and Material

Fourteen pictures were selected from the validated *Disgust-RelaTed-Images database* (DIRTI, Haberkamp et al., 2017).[1] The pictures were associated with fourteen questions about disgust-related situations, which participants answered before the actual experiment began. This was supposed to ensure that only pictures that were individually regarded as really disgusting, were presented. The questions were related to typical contamination-related disgust categories, like spoilage (e.g. "You will find mold on the chocolate pudding.") and hygiene (e.g. "A toilet is full of urine."). The complete set of images and questions are listed in Appendix 1. There were 7 questions and pictures for each of the

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[1] The Disgust-RelaTed-Images database and technical manuals (Haberkamp et al., 2017) can be obtained on request from the original authors. The DIRTI numbers for the disgust pictures used in this experiment are: 1011, 1119, 1253, 1013, 1120, 1258, 1015, 1134, 1262, 1034, 1138, 1139, 1038, 1271.
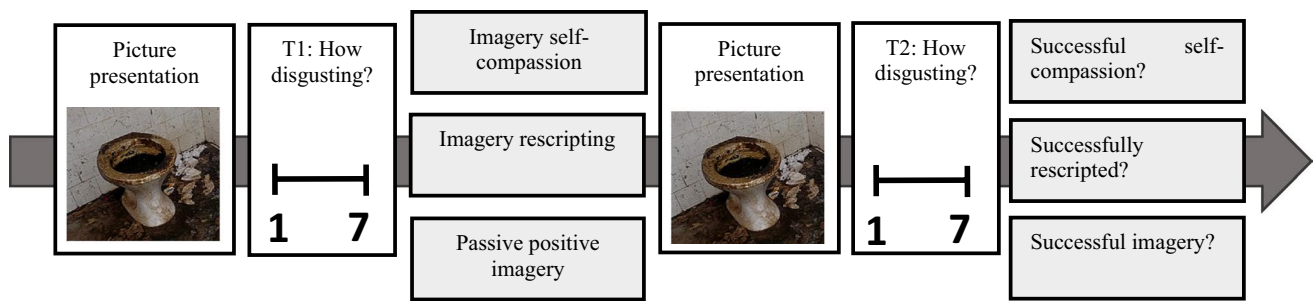
Fig. 1 Illustration of one block of the experimental procedure

two disgust categories. All the pictures were 16 cm wide and 12 cm high and were presented on a white, 30.5 cm wide and 13.5 cm high, screen. The participants were seated in front of the screen, about 50 cm from it, and responded by using a keyboard. The MATLAB © based PsychToolbox (Brainard, 1997; Kleiner et al., 2007; The MathWorks Inc., 2019) was used to run the experiment on a ThinkPad Laptop with a 14" TFT monitor.

Procedure

As in the study carried out by Fink et al. (2018), the experiment started with 14 written questions, which were used to select the six pictures to be presented in the experiment (see Section "Procedure"). On the first day, the participants were first informed of the details of the study and the test subjects' written consent to participation was obtained (informed consent was given). The participants then had to fill out the questionnaires listed above. So that the disgusting images caused an aversive experience for the test person, they were individually selected by means of an a priori survey of different disgust categories (see Section "Stimuli and Material"). Thereafter, the participants were instructed to look at the screen, on which the individually selected disgusting picture was presented for 10 s. The participants were then asked to indicate how much the picture disgusted them on a 7-point Likert scale (0 = not at all, 6 = very disgusted). One of the three experimental conditions was then performed (imagery self-compassion, imagery rescripting, passive positive imagery condition, see section "Experimental Condition: Imagery Rescripting", "Experimental Condition: Imagery Self-Compassion", "Experimental Condition: Passive Positive Imagery Condition"), followed, on both days, by the two other intervention conditions, for which audible instructions were given over headphones, in a randomized order. The target picture was shown again for 10 s after each experimental condition, and the participants were asked to indicate, again on a 7-point Likert scale, how disgusted by the picture they now were. Finally, all the participants were asked to write down what they had actually done during the intervention

on a white sheet of paper (e.g. I thought of something else), to determine whether the change in their disgust experience was due to the intended manipulation or another internal process. A new disgust picture was selected and shown for each session. Each participant performed all the three experimental conditions two times, over 2 days. The experimental conditions were performed in a randomized order, and none were repeated on the same day. The same picture was presented before (t1) and after (t2) the experimental condition in each experimental block. Therefore, each participant saw a total of six pictures. The two-session design was used to control for reliability and sequence effects through within-person repetition. The period of at least 1 week between sessions was chosen to reduce memory effects of the interventions. The number of days roughly aligns with the study by Fink et al. (2018). The course of the experiment is shown as an example in Fig. 1.

Experimental Condition: Imagery Rescripting

In the imagery rescripting (ImR) condition, the subjects were instructed to transform an aversive inner image (e.g. a disgusting image) into a neutral or positive inner image (Schmucker & Köster, 2015). The same intervention had already been used in the studies by Fink et al. (2018) and Fink and Exner (2019). In these earlier studies, it was shown that imagery rescripting was superior to a distracting task for reducing the experience of disgust. The duration of the procedure was 6:30 min in total. A transcript of the instructions is attached in Appendix 2.

Experimental Condition: Imagery Self-Compassion

In the imagery self-compassion condition, the subjects were instructed in acting techniques from compassion focused therapy (Gilbert, 2013). Here, the subject had to imagine acting as a compassionate version of themselves, as if they were portraying a distinct theatrical role. This compassionate person was characterized by wisdom, sensitivity, tolerance, warmth, kindness and helpfulness. At the end, the

subject was re-introduced to this "compassionate self" and linked this inner self to the feeling of inner peace. The duration of the procedure was 6:49 min in total. A transcript of the instructions is attached in Appendix 3.

Experimental Condition: Passive Positive Imagery Condition

A passive positive imagery condition was performed in the present study, in which the subjects were guided to imagine their favorite hobby. The duration of the procedure was 6:26 min in total. A transcript of the instructions is attached in Appendix 4.

Statistical Analysis

Quantitative Analysis

The software R (R Core Team, 2021), was used for the statistical analysis. Several t-tests were conducted to test for group differences. The statistical investigations were tested at the $\alpha = 0.05$ (two-tailed) level of significance. We calculated a necessary sample size of 44, using g×power (V. 3.1; Faul et al., 2007), and assuming the medium effect size from Fink et al. (2018) of cohen's $f = 0.2$ for the main effect strategy, with two groups and six measurements (strategies and time), a power of 0.95, and an α of 0.05. All data is published under https://osf.io/qvm83.

An ANOVA with the factors *group, time* and *imagery strategy* were calculated for the main results and for the dependent variable *disgust experience*. One ANOVAs with the factors *day* and *block* was calculated for the dependent variables, *disgust experience*. For hypothesis 3 and 4 linear models and further ANOVAs were calculated to the dependent variable *difference in disgust experience between t1 and t2*. The effect sizes were calculated using the R package "rstatix" (Version 0.4.0; Kassambara, 2019). Whereby, the generalized eta-squares (η^2) are reported. A Shapiro Wilk Test for Normality was conducted, and the normality assumption was violated for both dependent variables. However, due to sample size and the multiple measures for each participant, it is possible to assume an approximate asymptotic normal distribution for each of these variables (Field, 2013). A Levene's test for homogeneity of variance was conducted for the dependent variables across the imagery strategies. The R package "car" (Version 3.0-3; Fox & Weisberg, 2019) was used for the Levene test. This test was not significant ($P > 0.05$), so homogeneity of the residual variances for the two groups is assumed.

Qualitative Analysis

The written description and the actual use and success of the instructed emotion-regulation strategies were analyzed using a qualitative content analysis. For coding, iteratively and theoretical based qualitative categories for both the ImR condition and the imagery CFT, were created by using an empirically and theoretically guided category formation (Appendix 5, Mayring, 2010). The passive positive imagery condition was not included in the content analysis because the research question was focused on the possible therapeutic approaches. Two raters, who were instructed and trained in rating the written descriptions according to the protocol, marked the category column which best represented the participant' description of their experience during the task. It was possible to rate two or more categories per comment, since in some cases, different qualities were described. An almost excellent agreement between the two raters was calculated by using the two-way random effect model and "single rater" unit ($\kappa = 0.9$, $P < 0.001$).

Results

Testing for Baseline Effects

To test for baseline effects, a 3×2 ANOVA with the dependent variable *initial disgust experience* (t1) revealed no baseline differences for *imagery strategy*, but a significant baseline difference for *group*, $F(1, 126) = 21.831$, $P < 0.001$, $\eta^2 = 0.15$. A further investigation on the *initial disgust experience* (t1), revealed that being in the healthy control group was associated with a smaller disgust experience at t1, $M = 4.319$, $SD = 0.81$, compared to being in the clinical group, $M = 5.219$, $SD = 0.611$, $t(42.77) = -4.344$, $P < 0.001$, $d = 1.254$. These results show that individuals did not rate images differently at baseline between the experimental conditions (within-person), though there were between-subject differences between the two groups for the initial disgust experience.

Hypothesis 1 and 2: The Impact of Emotion Regulation on Disgust Reduction Across Groups and Imagery Strategies

For disgust experience, which was operationalized with the *subjectively reported disgust experience on the 7-point Likert-scale*, a 3×2×2 ANOVA with the within-subject factors *time* (t1, t2), and *imagery strategy* (imagery rescripting, imagery compassion, passive positive imagery) and the between-subject factor *group* (healthy controls, clinical group), revealed that there were significant main effects for *time*, $F(1, 46) = 34.702.$, $P < 0.001$, $\eta^2 = 0.09$, and for *group*,
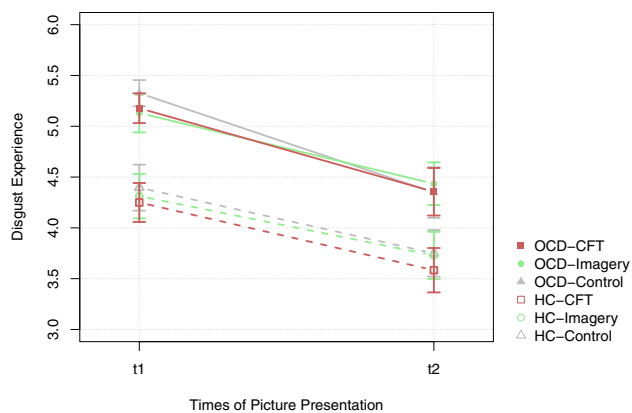
Fig. 2 Means and standard deviations of the disgust experience between t1 and t2 across the three experimental conditions for the two groups (*COCD* contamination-based obsessive–compulsive disorder). Disgust ratings were given on a scale between 0 and 6

$F(1, 46) = 12.243., P = 0.001, \eta^2 = 0.12$, but not for *imagery strategy* and no interaction became significant (Fig. 2). Further investigation into the main effect of *time* on *disgust experience,* revealed that disgust experience on *t1*, $M = 4.771, SD = 1.061$, was significant higher compared to $t2, M = 4.056, SD = 1.349, t(47) = 5.94, P < 0.001, d = 0.694$. More specifically, all three imagery strategies reduced disgust in a medium effect size range: imagery rescripting ($d = 0.528$), imagery self-compassion (CFT, $d = 0.561$), and the passive positive imagery condition ($d = 0.6$). Further investigation into the effect of *group* on *disgust experience* using planned contrasts*,* revealed that being in the healthy control group was associated with a significant smaller overall disgust experience, $M = 4.003, SD = 0.846$, than being in the clinical group, $M = 4.818, SD = 0.772, t(54.62) = 3.489, P = 0.001, d = 1.007$. The main effects on time and group stayed significant when controlling for individual traits in ANCOVAs. However, these results are not reported in more detail due to the insufficient power and would need to be examined in more detail in subsequent studies.

An additional 2×3 ANOVA with the within-subject variables *day* (1 or 2) and *block* (1 or 2 or 3)*,* had revealed a significant main effect of *day*, $F(1, 43) = 23.459., P < 0.001, \eta^2 = 0.06$, and *block*, $F(2, 86) = 8.929., P < 0.001, \eta^2 = 0.04$, on the *subjectively reported disgust experience*, but the interaction became not significant. Further investigation into the main effect of *day* on *disgust experience,* revealed that disgust experience on *day 1*, $M = 4.733, SD = 0.095$, was higher compared to *day 2*, $M = 4.04, SD = 1.08$. Further investigation into the main effect of *block* on *disgust experience,* revealed that disgust experience during block *1*, $M = 4.01, SD = 1.15$, was smaller compared to *block 2*, $M = 4.568, SD = 1.035$, and *block 3*, $M = 4.667, SD = 1.066$.

Hypothesis 3: Regression Effects of Individual Trials on Disgust Reduction and First Disgust Experience

The *habitual use of imagery* ($b = -0.018, P = 0.004$) and *disgust propensity* ($b = 0.008, P = 0.01$) were significant predictors of the *difference in disgust experience between t1 and t2* in a linear regression model. A *higher habitual use of imagery* trait was associated with more disgust reduction between t1 and t2, and also that higher *disgust propensity* was associated with less disgust reduction between t1 and t2. All other traits were not significant predictors. The overall model fit was $R^2 = 0.087$.

When *initial disgust experience* (t1) was predicted in a linear regression model, *disgust propensity* ($b = 0.015, P < 0.001$) and *negative affectivity* ($b = 0.037, P = 0.028$) were significant predictors. Therefore, higher *disgust propensity,* as well as higher *negative affectivity,* were associated with a stronger *initial disgust experience* (t1). All other traits were not significant predictors. The overall model fit was $R^2 = 0.108$.

Hypothesis 4: Qualitative Results

In order to present the results referring to the dichotomous variable (e.g. in the CFT condition, "Were you able to build up a compassionate self?" yes/no), *qualitative response*, *group* and *imagery strategy* were tested in the context of a 3×2×2 ANOVA with mixed measures on the dependent variable *disgust reduction between t1 and t2*. Here, a significant main effect was found for *qualitative response* with respect to *disgust reduction between t1 and t2*, $F(1, 275) = 6.759, P = 0.009, \eta^2 = 0.04$. According to this, the participants who themselves stated that they had successfully completed the task, $M = -0.834, SD = 1.186$, reduced their disgust experience between t1 and t2 more strongly across all conditions and groups, than those who stated that they had not successfully completed the task, $M = -0.375, SD = 0.787$. However, when considering the frequencies with which the subjects rated the interventions as successful or unsuccessful, a 3×2 ANOVA with mixed measures shows a significant main effect for *imagery strategy*, $F(2,92) = 3.014, P = 0.009$, with more successful ratings in the passive positive imagery condition ($n = 78$) and the ImR condition ($n = 76$), than in the CFT condition ($n = 63$). In addition there is a significant main effect for *group*, $F(1,56) = 5.593, P = 0.022$, as there were more successful responses in the healthy group ($n = 122$) compared to the clinical group ($n = 95$). Overall, an average of 42.5 statements about helpful aspects of the CFT strategy and 38.5 statements about difficulties with the same strategy, were encoded. For ImR, it was possible to encode an overall average of 62.5 statements on helpful aspects and 14.5 statements on those that caused difficulties. Participants did

Table 2 Results of the qualitative content analysis

Strategy	Category (*definition*)	Mentioned
Compassion-self (CFT)		
Helpful	Self-kindness (*understanding, warmth, kindness, friendliness, inner strength and appreciation*)	62.4% (n = 26.5)
	Mindfulness (*acceptance, mindfulness and non-judgmental observation, calmness and taking perspective*)	27.1% (n = 11.5)
	Common Humanity (*empathy, compassion (for others), the feeling of connectedness and community*)	10.95% (n = 4.5)
Difficult	External structure of the exercise	24.68% (n = 9.5)
	No access to self-compassion	22.08% (n = 8.5)
	Lack of imagination	20.78% (n = 8)
	Internal resistance	20.78% (n = 8)
	Lack of concentration	11.96% (n = 4.5)
Imagery rescripting (ImR)		
Helpful	Activating the experience of a positive image (*the positive re-evaluation of the image, the creating of a positive image, to focus on positive features or even the idea of pleasant smells*)	56.6% (n = 35.5)
	Activating the imagination and using it as a tool (*possible actions that were tried out within the imagination, such as dissolving the image, exchanging objects or transforming them*)	37.6% (n = 23.5)
	Protective cover (*aspect of security and protection against threats*)	5.6% (n = 3.5)
Difficult	External structure of the exercise	44.44% (n = 8)
	Difficulties in disengaging from the disgusting stimulus	44.44% (n = 8)
	Lack of imagination	11.11% (n = 2)

not give enough information about why the passive positive imagery condition was helpful or difficult to implement and these where therefore not analyzed. Participants reported aspects in all of our a priori theoretically derived categories, albeit with varying frequency. How often each category was mentioned is shown in Table 2.

Discussion

The aim of the present study was to investigate whether there are differences in the mechanisms and effectiveness of different imagery strategies (imagery rescripting, imagery self-compassion, passive positive imagery condition) for reducing disgust in the context of contamination-related obsessive–compulsive disorder (C-OCD). With regard to the lack of disgust reduction in the "Fish counting"-control condition of Fink et al. (2018), who used the same experimental design, the results show that all three interventions were equally helpful for reducing strong feelings of disgust, which means we have to reject our hypothesis 1. Further, the results show that people with C-OCD have a stronger initial disgust experience and that they can also reduce the disgusting experience to the same extent than the healthy control sample, which is contrary to our hypothesis 2. In line with hypothesis 3, higher habitual use of imagery is a positive predictor of greater disgust reduction, while stronger trait disgust propensity tends to make disgust reduction more difficult. People who tend to have a stronger anxiety or disgust

propensity trait also experience more initial disgust. Also, in line with hypothesis 4, the results of the elaborate content analysis show that the theoretically derived mechanisms were reported by the subjects and had an impact on the success or failure of the strategies.

First, the results show that all three imagery strategies are equally effective for reducing disgust. This is contrary to our expectation, that the disgusting image would be changed most directly in the ImR condition and therefore, that this strategy would have the greatest effect, while the passive positive imagery condition was expected to have the most indirect and therefore weakest, effect. Still, the overall disgust reduction is similar to, or more pronounced than, the effect of imagery rescripting (ImR) in previous studies. In the study by Fink et al. (2018), it was shown that cognitive appraisal ($d = 0.255$) and ImR ($d = 0.202$) reduced disgust with small effects, which were stronger than the effect size for a control condition in which the subjects were instructed to count fish in a video aquarium ($d = 0.096$). In the study by Fink and Exner (2019), which only had a healthy sample, there was a small effect for the disgust reduction in the same control condition ($d = 0.163$), but a medium effect for the ImR condition ($d = 0.415$). In the present study, all three imagery strategies reduced disgust in a medium effect size range: ImR ($d = 0.528$), imagery self-compassion (CFT, $d = 0.561$), and the passive positive imagery condition ($d = 0.6$). In the context of the short intervention, these are first indications that general imagery processing is a basic factor that can help change disgust experience.

The results of the content analysis are in accordance with our predictions and show that participants reported the assumed mechanisms in the CFT condition (a positive self-image when activating self-kindness and mindfulness) and in the ImR condition (self-efficacy and self-control in experiencing the rescripted positive image and imagination as a "tool"). The finding that subjects found the very core of underlying theories of the two strategies helpful, supports (a) the theory that self-compassion can be understood as a strategy for preventing the individual from identifying excessively with thoughts and feelings and thus becoming trapped and carried away by negative reactions and (b) that ImR can cause a change in the image's meaning, which in turn changes the associated emotions. However, we were surprised by the equally effective passive positive imagery condition. Here there is evidence from the findings that this condition was even more often self-assessed as being a successful strategy. It can be assumed that this is a non-specific distraction effect, which has a powerful, short-term effect in handling aversive emotions (Salkovskis, 1999). On the other hand, it is a further proof that activating mental images is an adequate emotion regulation strategy.

We had expected that how well the strategies fit would depend on the different traits' characteristics but the results do not show this. However, different traits did have strategy-unspecific effects: Higher levels of trait *disgust propensity* and negative affectivity, led to a higher initial disgust experience at t1. This is understandable in view of the many findings on the high correlation between disgust and fear in maintaining C-OCD (Cisler et al., 2009). In general, the results show that a higher tendency to habitually use imagery is helpful in the application of imagery strategies to reduce disgust. In the study by Fink et al. (2018), the opposite effect was found, but since the effect is strategy-unspecific in the present study, this may still be the case. The higher habitual use of imagery might have been particularly helpful for the passive positive imagery condition and the CFT condition, because the mental image did not have to be actively changed in these conditions (Holmes et al., 2007). A higher *disgust propensity* trait, on the other hand, actually hinders changing disgust with imagery strategies, which is in accordance with the former assumptions. Although there are no effects concerning specific strategies, the results show that the ability to imagine is an important indicator for the successful use of imagery. This should be given special attention when implementing imagery strategies in therapeutic practice and, preliminary exercises should be conducted where there is doubt. Other variables that could be considered predictors of imagery success were elaborated by Kunze et al. (2019). In particular, mastery (or self-efficacy) seems to be a vestigial predictor that should also be considered more closely in future studies in the context of disgust.

There is a significant group difference in the present study: Patients with C-OCD experienced more initial and general disgust experience, but did benefit in the same way from imagery strategies than the matched, healthy controls. This is contrary to the findings of Fink et al. (2018) and could be interpreted in a way, that imagery generally reduces all levels of disgust. This is particularly interesting, because the qualitative findings show that more healthy subjects rated their implementation of the interventions as successful, than those with C-OCD. Further, the results also show that those who assessed the implementation as successful, benefited more from the interventions than those who assessed them as unsuccessful. Thus, it could also be that those patients whose self-perception is that they have benefited from the strategy, can reduce disgust much strongly and in a more enduring way, than their healthy counterparts. This would need to be investigated in future studies.

Methodological Considerations and Limitations of the Experiment

We are aware of some limitations to our study. The first limitation is the gender ratio of 83% women. A more equal gender ratio might control for disgust-specific gender effects, taking into account the idea that women tend to be more sensitive to disgust (Schienle et al., 2005). Nonetheless, exactly the same results were found by recalculating all the results and excluding the four male subjects in each group; therefore, our results have to be seen as applying primarily to women. A second limitation is that the content analysis on subjectively perceived strategies could not be applied to the passive positive imagery condition. This was because the participants did not give enough information about why the strategy was helpful or difficult to implement. In a future study, the questions should be asked in such a way that participants are more motivated to answer these questions. Third, a fundamental problem is that the 7-min interventions and 10-s picture presentations reduced the ecological validity and promoted distraction effects. In the long run, it will be important to perform longer, and more elaborate, interventions regarding idiosyncratic disgust, preferably in a face-to-face setting. Due to the current study design enduring effects of imagery could not be investigated. To test this in future studies, short interventions would have to be presented more frequently or the effect would have to be recorded in the short term (e.g., on the next day) (see the studies on imagery rescripting by Kunze et al., 2017; Siegesleitner et al., 2019). A fourth limitation could be that habituation effects could not be tested directly, because a non-imagery condition was not included. However, previous studies (Fink & Exner, 2019; Fink et al., 2018) have shown the effectiveness of imagery rescripting compared to a habituation control condition. A methodological consideration is

that by stringing the three blocks together, the experience of disgust was magnified, which is evident in the main effect block. Emotional sensitization by repetition of disgust experience in well known in other studies (Fink-Lamotte et al., 2020). While these processes should not have influenced the main hypotheses here due to randomization and the focus on within-block change, it is nonetheless important to keep a closer eye on this in future studies.

Conclusion and Implication for Future Research

The aim of this study was to investigate how effectively and by what mechanisms, three different imagery strategies reduced disgust in the context of C-OCD. Particularly in comparison with the results of Fink et al. (2018)—including a habituation control condition and an imagery rescripting condition—the results show that all three strategies were equally capable of reducing disgust on all levels of disgust experiencing. This provides further evidence of the benefits of imagery strategies in altering pathological disgust. The results also show that the success of imagery strategies is related to the subject's ability to use imagination. Special attention should be paid to this when implementing imagery strategies in a therapeutic setting and, in case of doubt, preliminary exercises should be performed (also in future studies). In the elaborate content analysis it was shown, that participants who reported the theoretically assumed mechanisms of the strategies and considered the intervention itself to have been a success, were better at reducing disgust. Even though it seems that "many roads lead to Rome" in the context of changing disgust through imagery, the difference between more active and more passive imagery strategies should be further investigated in future studies.

Appendix 1: Picture selection questionnaire and picture numbers

The following table refers by using examples, to two dimensions of the disgust-evoking stimuli that were used in the study. Subjects were first presented with the questionnaire items in the third column. The disgust-related pictures were selected on the basis of these results.

scale	#	Questionnaire item for preselection	Picture	Valence M (SD)	Arousal M (SD)
Spoilage	1	There is mouldy food in front of you *(Vor Ihnen liegt verschimmeltes Essen)*	1011	2.78 (1.32)	3.47 (2.66)
	2	The trash can is full of urine and tissues *(Der Mülleimer ist voller Urin und Taschentücher)*	1119	2.57 (1.32)	3.58 (2.59)
	3	A preserving jar is full of mould after being opened. *(Ein Einmachglas ist nach dem Öffnen voller Schimmel.)*	1013	2.69 (1.22)	3.28 (2.46)
	4	A friend's apartment is cluttered. *(Die Wohnung eines Bekannten ist zugemüllt)*	1258	2.58 (1.32)	3.56 (2.66)
	5	You find mould on the chocolate pudding *(Auf dem Schokoladenpudding finden Sie Schimmel)*	1015	2.84 (1.18)	*3.22 (2.53)*
	6	The food in a fast food box is mouldy *(In einer Fastfoodbox ist das Essen verschimmelt)*	1034	2.91 (1.26)	3.21 (2.42)
	7	Spoiled food is covered with a layer of mould. *(Verdorbene Essen ist von einer Schicht Schimmel belegt.)*	1038	2.85 (1.27)	3.14 (2.48)

scale	#	Questionnaire item for preselection	Picture	Valence M (SD)	Arousal M (SD)
Hygiene	8	Strangers' fingernails are full of dirt. *(Die Fingernagel einer fremden Person sind voller Dreck.)*	1253	3.23 (1.32)	3.10 (2.39)
	9	Right in front of you, someone has thrown up on the pavement. *(Direkt vor Ihnen hat sich jemand auf der Straße erbrochen.)*	1120	2.72 (1.40)	3.62 (2.66)
	10	You must use a port-a-potty, which is full of urine. *(Sie müssen auf ein Dixieklo, das voll mit Urin ist.)*	1134	2.21 (1.31)	4.05 (2.80)
	11	There's a lot of hair in the shower strainer. *(Im Duschsieb befinden sich viele Haare.)*	1262	3.36 (1.28)	2.81 (2.23)
	12	A public toilet that you visit is full of excrement and toilet paper. *(Eine öffentliche Toilette, die Sie besuchen, ist voll mit Kot und Klopapier.)*	1138	2.07 (1.24)	4.30 (2.83)
	13	A toilet is full of urine. *(Eine Toilette ist voll Urin.)*	1139	2.71 (1.30)	3.46 (2.65)
	14	A toilet is full of toilet paper, excrement, and urine. *(Eine Toilette ist voller Toilettenpapier, Kot und Urin.)*	1271	2.20 (1.30)	4.09 (2.79)

Appendix 2: Imagery rescripting procedure

Instructions	Function	Time
Envision the picture before your inner eye To do so, you can either close your eyes or look at the screen Imagine in as much detail as possible, what you can see, hear, feel and smell	Introduction, activation of experiencing	0:00–0:31
Imagine how you enter the picture and how the object presented becomes real Your body is surrounded by a protective cover. Nothing can penetrate the cover to threaten you Imagine your protective cover in as much detail as possible. What color is it? How big is it?	Activation of imagery and trial of imagery as a tool. Protective cover as protection against threat; increases feelings of control	0:31–1:25
Please move yourself, inside the picture, towards the object presented Use your imagination to change the size of the presented object First, make the object very tiny Then make it huge Return it to its normal size	Activation of imagery and working with imagery as a tool	1:25–2:03
Please notice exactly what the object looks like, how it sounds and how it smells	Activation of experiencing and feeling of disgust	2:03–2:28
If you are disgusted, try to tolerate this feeling	Activation of experiencing and feeling of disgust	2:28–2:40
Please try to change the object so that it is no longer disgusting In your imagination, you can be a wizard. You can change everything! You decide, what happens in your imagination You can include new elements and you can erase elements in your imagination You can change the environment, or you can change the object into something completely different There are no limits. Let your imagination go wild!	Imagery Rescripting; testing different options in handling imagery rescripting; increase feelings of control concerning mental experiences	2:40–4:09

Instructions	Function	Time
Develop your own positive image of the object! What do you observe in your changed image? Move through your image. Are you satisfied with the changes? You can change the scenery as much as you need until you feel good and safe in your image	Set a criterion to finish imagery rescripting (positive, satisfaction, safety and well-being); activation of experiencing the positive image	4:09–5:06
Imagine exactly what you see, hear, feel and smell when you look at your new image	activation of experiencing the positive image	5:06–5:26
Consider a title or name for your self-created, positive image!	Set a memory-link for fast recall	5:26–5:41
Please return your attention to the room. Feel the seat and the position of your arms and legs If you want, you can now move and open your eyes	Return into the present	5:41–6:30

Appendix 3: Imagery self-Compassion procedure

Instructions	Function	Time
Picture the image in your mind You can either close your eyes or look at the screen Paint yourself as exactly as possible, from what they see, hear, feel and smell	Introduction, Activate experience	0:00–0:24
Now imagine yourself entering this picture and what is depicted becomes real Your body is surrounded by a protective cover Imagine that nothing can penetrate this protective cover and threaten you Take a good look at your protective cover What is it made of; what colour is it; how big is this cover?	Activate imagination and try it out as a "tool"; protective cover against possible threat; stronger sense of control	0:25–1:15

Instructions	Function	Time
Now imagine you are an actor in training As an actor, you have been able to evoke certain positive feelings, thoughts and motives in yourself—in order to achieve exactly these characters from the inside out Focus on how the character thinks and looks at the world The character we are now developing is a compassionate person who is especially characterized by compassion for himself and for other people	Activate imagination and try it out as a "tool"	1:16–2:12
Concentrate on your task as an actor, to portray a "compassionate person" Imagine how they are calm and talk about wisdom and grounding serenity How you sense and have the ability to tolerate difficulties and face challenges. Feel the warmth and goodness and the understanding that you bring to yourself Take an unprejudiced attitude towards yourself and the things around you Feel the deep desire to relieve suffering, to make changes and to help others and to support themselves and other people in growing and living	Development and activation of a compassionate person	2:13–3:47
Try to put a compassionate expression on your face, such as a light smile, or any other expression that suits you Imagine how you expand as you become more powerful, mature, wise, and have more confident authority Feel the warmth in your body and linger in this moment for a moment	Activating experience for a positive self-image (positive, satisfactory, security, well-being)	3:48–4:44

Instructions	Function	Time
Now go through these qualities again slowly and imagine that they had grown in you a little bit, as if you could really feel them: Wisdom, sensitivity, serenity, tolerance, warmth, kindness, helping You can imagine your "compassionate self" again and think of a feeling of inner peace and a supporting voice	Intensify experience for a positive self-image	4:45–5:41
Now give your self-created, positive figure a name. You can now recall the imagined person again and again to support you in your fears and resistance	Set memory anchor for quick recall	5:42–6:07
Now slowly return your attention to the room. Feel the seat and the position of your arms and legs. You can move and open your eyes. Keep your compassionate character and his name in mind. You can slip into this role again and again	return to the present	6:08–6:49

Appendix 4: Imagery control condition procedure

Instructions	Function	Time
Picture the image in your mind You can either close your eyes or look at the screen Paint yourself as exactly as possible, from what they see, hear, feel and smell	Introduction, Activate experience	0:00–0:31

Instructions	Function	Time
Now imagine yourself entering this picture and what isdepicted becomes real Your body is surrounded by a protective cover Imagine that nothing can penetrate this protective cover and threaten you Take a good look at your protective cover What is it made of; what colour is it; how big is this cover?	Activate imagination and try it out as a "tool"; protective cover against possible threat; stronger sense of control	0:32–1:40
Now imagine yourself pursuing your favourite hobby. Remember, it doesn't matter what you choose. Let all positive feelings, thoughts and motives come up and concentrate on them	Activate imagination and try it out as a "tool"	1:41–2:29
Now choose the hobby that is most good to you. Say in your mind what you have chosen	Activation of your favourite hobby	2:30–2:55
Now direct your full concentration to your favourite hobby. Imagine your favourite hobby exactly. What does it consist of; what activity or activities do you pursue? Imagine exactly what you see, hear, feel and smell there now	Activating experience of the positive hobby	2:56–4:09
Now perceive your physical sensations Perceive which thoughts come to you Perceive how you feel Stay in the moment for a moment and enjoy the pleasure and contentment that spreads within you	Intensify experience for a positive hobby	4:10–5:16
Now go through these properties again, slowly	Set memory anchor for quick recall	5:17–5:38
Now slowly return your attention to the room. Feel the seat and the position of your arms and legs. You can move and open your eyes. Keep the positive image in mind	return to the present	5:39–6:26

Appendix 5: Content analysis—code book

Categories "helpful" CFT	Freq	Categories "helpful" ImR	Freq	Categories "difficult" ImR	Freq	Categories "difficult" CFT	Freq	Categories "helpful" CFT II	Freq
Sicherheit, Geborgenheit, Schutz, Vertrauen / Safety, security, protection, trust	11	Positive Umgestaltung / positive Neubewertung / Positive reorganisation/ positive reappraisal	37	zu starke Konfrontation / Too much confrontation	9	kein Zugang (zu mitfühlender Stimme) / No access (to sympathetic voice)	11	Zufriedenheit, Wohlgefühl / Satisfaction, well-being	5
Wärme / Warmth	10	Guter Geruch / Pleasant smell	11	fehlende Vorstellungskraft/Phantasie / Lack of imagination/fantasy	2	Mitgefühl nur für andere / Compassion only for others	10	Menschliche Verbundenheit/Gemeinschaft/Zusammenhalt / Human connectedness/community/ cohesion	4
beruhigend/Ruhe / Calming/peaceful	9	Verwandlung, Zeit zurückdrehen, "gezaubert" / Transformation, turning back time, "magic"	6	unzureichende Anleitung fehlende Struktur / Insufficient guidance /lack of structure	2	nicht konkret genug, unzureichende Anleitung, fehlende Erfahrung / Not concrete enough, insufficient guidance, lack of experience	5	Lächeln, Freundlichkeit, friedlich / Smile, kindness, peaceful	4
(innere) Stärke, Bestärkung / (Inner) strength, reinforcement	9	Positives Bild / Positive image	5	Schwierig das mentale Bild aufrecht zu halten / Difficult to maintain the mental image	1	fehlende Vorstellungskraft, Imagination schwer / lack of imagination, difficult	5	Akzeptanz, Achtsamkeit, wertfreie Betrachtung / Acceptance, mindfulness, value-free consideration	4
Verständnis, Güte, Milde / Understanding, kindness, mildness	7	Auflösung des Bildes / Resolution of the image	4			fehlende Konzentration, innere Unruhe / Lack of concentration, inner restlessness	4	Mitleid, Trost / Sympathy, comfort	4
Ausgeglichenheit, Im Einklang mit sich selbst, Gelassenheit / Balance, In harmony with oneself, Serenity	6	Schutzhülle, Sicherheit / Protective cover, safety	4					Gefühl gebraucht zu werden / Helfen / Feeling needed/ Helping	3
Angenehmes Gefühl / Pleasant feeling	5	Konzentration auf Positives, Neugierde / Focus on the positive, curiosity	3					Wertschätzung, Erinnerung an ideales Selbst / Appreciation, reminder of ideal self	3

Categories "helpful" CFT	Freq	Categories "helpful" ImR	Freq	Categories "difficult" ImR	Freq	Categories "difficult" CFT	Freq	Categories "helpful" CFT II	Freq
Entspannung / Relaxation	5	Austausch von Objekten / Replacement of objects	2			kein Bedürfnis / No need	3	Motivation, Optimismus / Motivation, Optimism	2
Empathie, Mitgefühl (für sich und andere) / Empathy, compassion (for self and others)	5	positive Erinnerungen, Ablenkung / Positive memories, distraction	2			zu starke Konfrontation, zu wenig Ablenkung, zu schwer / Too much exposure, too little distraction	5	Schwerelosigkeit, verändertes Körpergefühl / Weightlessness, changed body awareness	2
								Neutralität / Neutrality	2
								Rolle annehmen, neue Perspektive, Abstand / Assume role, new perspective, distance	2

Declarations

Conflict of interest Jakob Fink-Lamotte, Pauline Platter, Christian Stierle, and Cornelia Exner declare that they have no conflict of interest.

Informed Consent The participants were first informed of the details of the study and the test subjects' written consent to participation was obtained.

Human and Animal Rights The study was approved by the local ethics committee of the University of Leipzig (2019.03.05_eb_3) and therefore the research was conducted in accordance with the 1964 Helsinki Declaration.

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