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Editorial

The Future of Virtual Reality Therapy for Phobias: Beyond Simple Exposures

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Inelegant as they may look to the outsider, the white boxy Samsung Gear VR goggles with a smartphone strapped to the front, have the power to change lives. In the last few years our research team at Stockholm University have used the device to treat nearly 100 spider phobic patients with virtual reality exposure therapy (VRET) using the Itsy application, developed alongside VR-startup Mimerse (Miloff et al., 2016). The real tears patients shed may be indication enough that the animated spiders and computer-generated world are helping them face their deepest fears. However, evidence shows large reductions in self-reported fear and avoidance around live spiders. In fact, the positive behavior change is very nearly as powerful as the gold-standard treatment for spider phobia that ends with handling a 3-centimeter spider with their hands (Miloff et al., 2019). The boundary for how we perceive real and artificial may not be as large as we think.

Today, the biggest tech companies are still pouring enormous resources into making virtual a reality. Facebook purchased Oculus, shipped the Rift, the mobile Go and now Quest, Google had the Daydream-standard and is now moving onto augmented-reality, Sony the Playstation VR and even Apple is said to be working on a device. Still, there is a feeling in this industry that it isn't really clear what virtual reality is good for. There are entertaining games available sure, mostly shooters and rhythm games. There is the extremely enjoyable feeling of awe to be dropped into a virtual world somewhere, flying in a fighter jet or swimming with divers. New ways of storytelling are certainly possible and are being created. However, there is the persistent feeling that something is missing. The technology is just too powerful for the limited experiences we've developed so far.

To understand what is possible, it may be best to look at the way our reality generating system functions and work backwards. Our eyes, ears, taste and touch are geared towards favoring certain information over others (Bayle et al., 2009; Erlich et al., 2013; Öhman & Mineka, 2001). Sudden movement in the corner of our eye evokes a fear response, as does the sound of a potentially violent individual above the din of a crowd, or the unexpected irritation of a wriggling bug on our skin. See a certain shape walk by and lust towards an attractive mate might cause butterflies in the stomach. The most common use of virtual reality in clinical treatments is for phobias and similar to face-to-face treatment is almost always seen through the lens of stimulus-emotion pairs and exposure therapy (Turner & Casey, 2014). With virtual reality, however, we might be able to explore not only working to modify basic emotions using simple stimuli but higher order functions of the mind using complex simulations as well.

For millions of years we sat on the savannah around open fires. The rustling and movement in tall grasses at the far edge of the camp may be just the wind but our minds see a leaping lion ready to disembowel us. Gifted with large brains capable of complex pattern recognition and learning, we've developed immense capabilities of prediction. For want of a better word, this is the power of imagination and at its most vivid. We see in our mind's eye a disaster before we experience it. We feel ourselves drowning before we ever get on the boat. We feel the wind on our face and the sensation of hitting the ground before we ever step onto the airplane. In the right frame of mind, we may have even pictured the previous two sentences in our imagination as we read them. Although this capacity is one of the ways we define ourselves as human, it's also responsible for great suffering, catastrophic fears, debilitating anxiety; its moderation actually one of the ways we define treatment success in specific phobia, i.e., no longer believing your catastrophic fears (Davis et al., 2012).

We are just at the beginning of exploring the many uses of VR and its practical application to clinical psychology. Tremendous progress has been made at importing what we know from traditional formats for psychological treatments (e.g., exposure therapy), but new and more innovative leaps in understanding and technique are possible. The capacity of imagination is something we take for granted and generalized solutions for dealing with its problematic aspects limited. Virtual reality offers a nearly limitless world in which to create, restricted only by development costs and again, the more useful aspects of our imagination. The industry driving development of the technology is searching for the killer app that could convince new users to jump in, and clinical applications that converge with the gaming industry and storytelling might offer such an opportunity. Whether such generalized solutions are possible is uncertain, however what is certain is that the future of clinical treatment and virtual reality is more than just simple exposures.

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Change Processes in Cognitive Therapy for Social Anxiety Disorder Delivered in Routine Clinical Practice

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Abstract

Background: Most studies examining processes of change in psychological therapy for social anxiety disorder (SAD) have analysed data from randomised controlled trials in research settings.
Method: To assess whether these findings are representative of routine clinical practice, we analysed audit data from two samples of patients who received Cognitive Therapy for SAD (total N = 271). Three process variables (self-focused attention, negative social cognitions, and depressed mood) were examined using multilevel structural equation models.
Results: Significant indirect effects were observed for all three variables in both samples, with negative social cognitions showing the strongest percent mediation effect. 'Reversed' relationships, where social anxiety predicted subsequent process variable scores, were also supported.
Conclusion: The findings suggest the processes of change in this treatment may be similar between research trials and routine care.

Keywords

social anxiety, cognitive therapy, change processes, structural equation model, mediation

Highlights

- The three process variables examined showed significant indirect effects on subsequent social anxiety.
- There was evidence of a bidirectional relationship between process and outcome.
- Results are consistent with the theoretical model underpinning the treatment.
- The change processes of this treatment in routine practice may be similar to those found in research trials.

There is good evidence for the efficacy of psychological therapies in the treatment of mental health problems. However, there is a less clear understanding of the exact processes through which they operate. Further research on mechanisms of clinical improvement has been highlighted as a significant need in clinical psychology (Emmelkamp et al., 2014; Holmes et al., 2018; Kazdin, 2007). If we can determine which process variables are involved in producing clinical improvement, it may be possible to adapt therapies to place more emphasis on these, and to implement techniques that target them earlier in therapy, so as to increase the efficacy and efficiency of treatment.

In Social Anxiety Disorder (SAD), there is a small but growing body of literature exploring process-outcome relationships in psychological therapy. The choice of process variables to be assessed is generally derived from theoretical accounts of SAD, such as the cognitive model of Clark and Wells (1995), and the cognitive-behavioural model of Rapee and Heimberg (see Hope, Heimberg, & Turk, 2006; Rapee & Heimberg, 1997). The Clark and Wells model specifies several anxiety-maintaining factors that are potential predictors of clinical change. These include negative social anxiety-related cognitions, avoidance and safety behaviours, and self-focused, evaluative attention. The Rapee and Heimberg model also highlights hypervigilance, avoidance and attentional bias towards perceived threat as potential mechanisms of anxiety maintenance. Besides anxiety-maintaining factors, other variables such as working alliance, or measures of the degree of compliance with clinical techniques, could be examined.

Five studies, mostly focusing on cognitive-behavioural interventions (Boden et al., 2012; Calamaras, Tully, Tone, Price, & Anderson, 2015; Goldin et al., 2014; Gregory, Wong, Marker, & Peters, 2018; Hoffart, Borge, Sexton, Clark, & Wampold, 2012), have shown evidence that changes in negative cognitions and threat appraisals were associated with improvements in social anxiety, while two studies (Mörtberg, Hoffart, Boecking, & Clark, 2015; Niles et al., 2014) did not find evidence of an association between changing negative cognitions and outcome. Evidence of changes in self-focused attention being associated with clinical improvement was found in the study by Mörtberg et al. (2015), and in both individual and group Cognitive Therapy (CT) in a study by Hedman et al. (2013). Two studies showed support for avoidance of social situations as

a predictor of outcome (Aderka, McLean, Huppert, Davidson, & Foa, 2013; Hedman et al., 2013), and the study of participants' use of exposure and thought records (Hawley, Rector, & Laposa, 2016) also supported a predictive relationship for these factors. In contrast, the two studies analysing working alliance either did not find a mediation relationship (Calamaras et al., 2015) or found that the alliance-outcome relationship was itself mediated by cognitive factors (Hoffart et al., 2012). The one study investigating physiological anxiety symptoms did not find evidence of a predictive association with outcome (Aderka et al., 2013), while the one study examining depression found a weak effect (Moscovitch, Hofmann, Suvak, & In-Albon, 2005).

Although it is promising that mediation and other predictive effects in treatments for SAD are starting to emerge, there is a lack of consistency across the studies to date regarding which process variables, and which treatments, are examined. It is rare for two studies to examine the same process variables within the same treatment. In addition, the participant samples analysed in the studies are almost all drawn from randomised controlled trials (RCTs), meaning there is a lack of research using data from routine clinical practice. Datasets from such settings typically include a larger number of therapists, some therapists who are less experienced, and fewer participant selection criteria relative to RCTs. In the same way that effectiveness studies in routine clinical settings complement efficacy studies, in that they can test whether findings from controlled research settings apply in routine practice (Gunter & Whittal, 2010; Kettlewell, 2004; Weisz, Ng, & Bearman, 2014), it can be argued that for a predictor to be considered reliable, it should operate similarly regardless of setting. It is therefore important to examine process-outcome effects within data from routine clinical practice.

The present study therefore aimed to explore change processes during Cognitive Therapy for Social Anxiety Disorder (CT-SAD) based on the Clark and Wells (1995) model delivered in routine clinical practice, using data from an audit of clinical outcomes from a specialist National Health Service (NHS) anxiety clinic in London. To be consistent with previous literature, negative social cognitions and self-focused attention were examined as process variables, and were measured in the same way as in previous studies (e.g. Hedman et al., 2013; Mörtberg et al., 2015). These variables have a strong theoretical basis given their key roles within the Clark and Wells (1995) model. In addition, depressed mood, which is not a component of the cognitive model of SAD, was investigated as an additional process variable to examine the specificity of any effects found using the other two theoretically-derived factors (see Preacher, 2015). There is, however, a plausible rationale for changes in depressed mood being associated with improvements in social anxiety, in that a reduction in depressed mood over time may be accompanied by greater hopefulness and optimism about treatment and the future, leading to subsequent improvement in social anxiety outcomes.

Method

Participants

Data were drawn from an audit of clinical outcomes of psychological therapy for SAD, which examined consecutive referrals to the Centre for Anxiety Disorders and Trauma, a UK NHS specialist clinic in London. The service receives referrals from general practitioners and community mental health teams. Assessments were completed between May 2001 and August 2010. All assessments were conducted by a trained clinician and included the Structured Clinical Interview for DSM-IV (SCID-IV; First, Spitzer, Gibbon, & Williams, 2002) to determine primary and comorbid diagnoses. The personality disorder screener questions of the SCID-II (First, Gibbon, Spitzer, Williams, & Benjamin, 1997) were also given, with further assessment undertaken as clinically indicated. All participants met DSM-IV criteria for SAD, with SAD being judged to be the main problem by the assessing clinician. Exclusion criteria were current psychosis, or dependence on alcohol or substances.

Across the audit period, 317 people were treated with CT-SAD. Three of these people were re-referred during the audit period and received a second course of treatment; only their first course of treatment was included in the analysis. Files of seven people who received treatment were not available for data entry. To be included in the present studies, participants were required to have attended at least five treatment sessions and completed the weekly questionnaires on at least five occasions. This ensured a sufficient number of measurement points per participant to permit analysis of process variables over time. As 23 participants attended fewer than five sessions, and 13 completed insufficient questionnaire data for analysis, the final sample size for the analysis of standard CT-SAD was 271.

These participants completed an average of 12.3 sessions (SD = 2.9). Six participants (2%) had more than 18 sessions and the greatest number of sessions attended was 26. Treatment extended over an average of 204.3 days (SD = 103.7). There were 69 participants who received their treatment as part of research trials running at the time.

Some of the outcome measures used by the clinic were changed in September 2008 when the clinic joined the Improving Access to Psychological Therapies (IAPT) programme (see Clark, 2018). Participants treated before (Sample 1; n = 185) and after (Sample 2; n = 86) this change in outcome measures were analysed separately. Demographic and clinical characteristics of both samples are shown in Table 1. The audit was approved by the local ethics committee.

Table 1

Demographic and Clinical Characteristics

Participant Variable	Sample 1 (*n* = 185)	Sample 2 (*n* = 86)	Total (*N* = 271)
% Female	48	52	49
Mean age (*SD*)	32.2 (8.6)	33.2 (9.5)	32.5 (8.9)
Marital status *n* (%)			
Married	19 (10.3)	22 (25.6)	41 (15.1)
Cohabiting	28 (15.1)	8 (9.3)	36 (13.3)
Widowed	1 (0.5)	0	1 (0.4)
Divorced	3 (1.6)	0	3 (1.1)
Separated	5 (2.7)	3 (3.5)	8 (3.0)
Single/Never married	120 (64.9)	45 (52.3)	165 (60.9)
Not given	9 (4.9)	8 (9.3)	17 (6.3)
Ethnicity *n* (%)			
Black	11 (5.9)	8 (9.3)	19 (7.0)
Caucasian	140 (75.7)	37 (43.0)	177 (65.3)
Indian	2 (1.1)	2 (2.3)	4 (1.5)
Pacific Asian	1 (0.5)	0	1 (0.4)
Other	6 (3.2)	0	6 (2.2)
Not given	25 (13.5)	39 (45.3)	64 (23.6)
Highest qualification *n* (%)			
Doctoral degree	7 (3.8)	2 (2.3)	9 (3.3)
Masters degree	18 (9.7)	11 (12.8)	29 (10.7)
Professional qualification	15 (8.1)	5 (5.8)	20 (7.4)
Bachelors degree	71 (38.4)	27 (31.4)	98 (36.2)
A Levels	31 (16.8)	12 (14.0)	43 (15.9)
GCSEs	23 (12.4)	9 (10.5)	32 (11.8)
None	12 (6.5)	3 (3.5)	15 (5.5)
Other	7 (3.8)	3 (3.5)	10 (3.7)
Not given	1 (0.5)	14 (16.3)	15 (5.5)
Employment status *n* (%)			
Unemployed	33 (17.8)	11 (12.8)	44 (16.2)
Full time	103 (55.7)	52 (60.5)	155 (57.2)
Part time	20 (10.8)	6 (7.0)	26 (9.6)
Self-employed	4 (2.2)	5 (5.8)	9 (3.3)
Sick leave	3 (1.6)	1 (1.2)	4 (1.5)
Retired	0	2 (2.3)	2 (0.7)
Student	17 (9.2)	2 (2.3)	19 (7.0)
Homemaker	2 (1.1)	1 (1.2)	3 (1.1)
Freelance	0	1 (1.2)	1 (0.4)

Participant Variable	Sample 1 (*n* = 185)	Sample 2 (*n* = 86)	Total (*N* = 271)
Compassionate leave	0	1 (1.2)	1(0.4)
Not given	3 (1.6)	4 (4.7)	7 (2.6)
Mean age of SAD onset in years (*SD*)	19.3 (8.4)	19.1 (7.1)	19.3 (8.0)
Mean duration of SAD in years at assessment (*SD*)	12.9 (9.5)	13.9 (10.8)	13.2 (9.9)
% Prescribed psychotropic medication	30	25	29

Treatment

All participants received individual CT-SAD as described in Clark et al. (2006). Manuals, videos of workshops, and other therapist support materials are available at https://oxcadatresources.com (Oxford Centre for Anxiety Disorders and Trauma, 2019). The standard structure of treatment used in RCTs comprises 14 weekly sessions, followed by up to three booster sessions at monthly intervals. For the present participants treated in routine clinical practice, this structure was followed in most cases, but for some, adjustments in the number and spacing of sessions were made due to clinical need. End of treatment outcomes were taken from the last attended session.

Therapists

Therapists were mental health professionals with a range of professional backgrounds including clinical psychology, counselling psychology, nursing and/or specialist CBT training. Some of the therapists were on training placements within the service (trainee clinical psychologists, trainee high intensity therapists, and specialist psychiatry registrars). A total of 22 therapists treated the participants in Sample 1, and 36 therapists for the participants in Sample 2. The number of participants seen by each therapist ranged from 1 to 24.

Session-By-Session Measures

Self-Focused Attention

This was measured using the mean score of the two self-focused attention items in the Social Phobia Weekly Summary Scale (SPWSS; Clark, 1995, available at https://oxcadatresources.com) where people provide a rating of their self-focused attention in general, and in situations they found difficult, over the past week. The full six-item scale also elicits ratings of avoidance, anticipatory worry, and post-event rumination over the previous week, along with an overall rating of social anxiety. All items are rated on 0-8 Likert scales, with total scores ranging between 0 and 48. The SPWSS has been shown to be sensitive to treatment effects and has good internal consistency (Clark et al., 2006; Clark et al., 2003). Cronbach's alpha in the present sample for the two self-focused attention items was .75 at baseline and .89 at end of treatment.

Negative Social Cognitions

The Social Cognitions Questionnaire (SCQ; Oxford Centre for Anxiety Disorders and Trauma, 2019; Wells, Stopa, & Clark, 1993) was used, which presents 22 negative social cognitions, each of which is rated for both the frequency with which it occurred in the last week when the respondent was anxious (rated from 1 = "thought never occurs" to 5 = "thought always occurs when I am nervous"), and the degree to which they believe the thought to be true when it occurs (rated from 0 = "I do not believe this thought", to 100 = "I am completely convinced this thought is true"). Mean scores are calculated for Frequency (range 1-5) and Belief (range 0-100) with higher scores indicating more negative social cognition. Cronbach's alpha in the present sample was .90 (baseline) and .96 (end of treatment) for the frequency subscale and .91 (baseline) and .97 (end of treatment) for the belief subscale. For the present studies the frequency and belief subscales were standardised and averaged to produce a single composite *z* score.

Depressed Mood

For Sample 1, depressed mood was measured using the Beck Depression Inventory (BDI; Beck & Steer, 1993). Cronbach's alpha in the present sample was .91 at baseline and .94 at end of treatment. For Sample 2, depressed mood was measured using the Patient Health Questionnaire – 9-item version (PHQ; Kroenke, Spitzer, & Williams, 2001). Cronbach's alpha in the present sample was .88 at baseline and .92 at end of treatment.

Social Anxiety

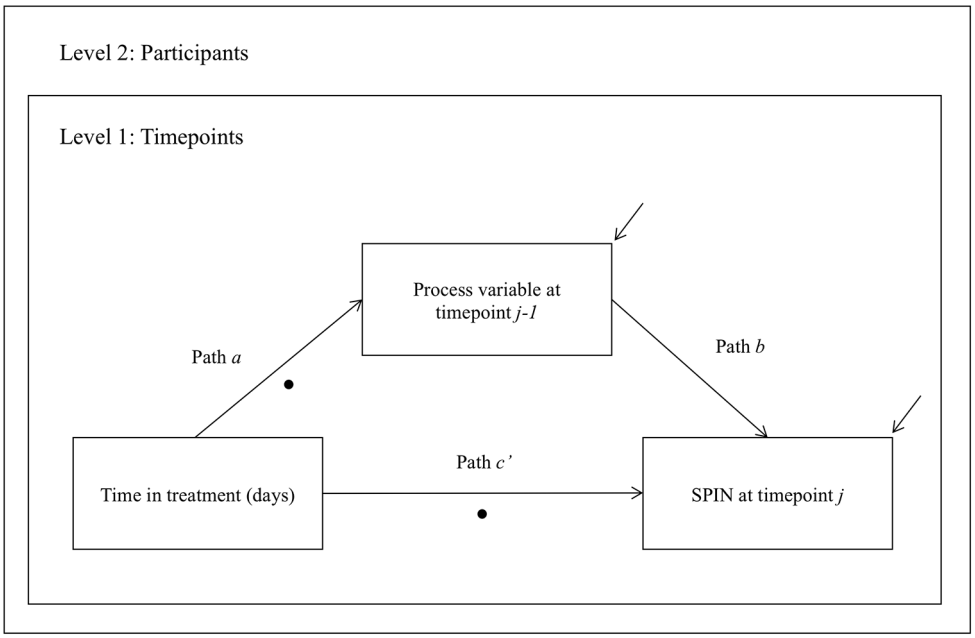
For Sample 1, social anxiety was measured using the Social Phobia Weekly Summary Scale (Clark et al., 2003; Oxford Centre for Anxiety Disorders and Trauma, 2019), minus the two attention items. A total social anxiety severity score was computed from the items: overall rating of social anxiety, avoidance, anticipatory worry, and post-event rumination. Cronbach's alpha for the baseline and end of treatment scores were .74 and .91 respectively. For Sample 2, social anxiety was measured using the Social Phobia Inventory (SPIN; Connor et al., 2000), a 17-item scale listing a range of SAD-related problems, incorporating fear, avoidance, and physical symptoms. Cronbach's alpha for the baseline and end of treatment scores were .90 and .93 respectively.

Analysis

A series of multilevel structural equation models (MSEM) were computed (see Preacher, Zhang, & Zyphur, 2011; Preacher, Zyphur, & Zhang, 2010) based on the analytic strategy of Mörtberg et al. (2015), with total scores at each session (Level 1) nested within participants (Level 2). Therapist was not included as a third level given the limited number of therapists[1], and the variability in the number of participants seen by each therapist. For two-level models, data simulations have shown that sample sizes of 50 and

Figure 1

Simplified Path Diagram of Multilevel Structural Equation Model (MSEM) to Test the Indirect Effect of Time on Scores on the Social Phobia Inventory (SPIN) Via One of Three Process Variables



Note. Filled circles indicate paths specified as random, and raised arrows indicate residuals.

above produce unbiased parameter estimates under a range of conditions (Hox, Maas, & Brinkhuis, 2010). The number of elapsed days in treatment was used as the independent variable, and severity of social anxiety as the dependent variable (see Figure 1). Three process variables were assessed: 1) self-focused attention, 2) negative social cognitions; and 3) depressed mood.

All variables were measured at Level 1 following the mediation procedure described by Bauer et al. (2006). To incorporate temporal precedence of the process variable (mediator), lagged scores were used, where social anxiety scores at any given assessment point (time *j*) were regressed on the scores on the process variable at the previous assessment point (time *j-1*). Social anxiety scores from the first week of therapy were therefore not included in the analysis due to the absence of prior scores on the process variable. Social

1) Maas and Hox (2005) suggest group sizes over 50 at the higher level of multilevel models are most appropriate to avoid biased estimates.

anxiety data from all other available sessions were included, as the model incorporated time gaps between assessment points. Models used robust maximum likelihood estimation (MLR). Path *a* (regression of the process variable on the independent variable) and path *c*' (regression of the dependent variable on the independent variable, in the presence of the process variable) were allowed to vary across participants and were therefore estimated as random, while path *b* (regression of the dependent variable on the process variable) was modelled as a fixed effect. This was done both to limit model complexity, and because the extent of between-subject variability in this relationship was not of primary interest in this study. To prevent the conflation of within- and between-subjects variance, independent and process variables were disaggregated into within- and between-level components via group mean centering. The participant (group) mean-centered scores, and the participant mean scores across all timepoints therefore represented the within and between components of these variables, respectively, and were entered into the model separately (see Hoffart, Borge, & Clark, 2016; Preacher et al., 2010). This approach therefore permits the examination of within-subjects effects, controlling for between-subjects effects.

To further examine the direction of the mediated effect, a series of models were computed which were identical to the models described above apart from the process and outcome variables, which were swapped. These therefore examined the 'reversed' relationship, using social anxiety at time *j-1* as the potential mediator, and self-focused attention, negative social cognitions, or depressed mood at time *j* as the dependent variable.

Percent mediation (P_M) of outcome by the process variable was calculated as an indicator of the strength of any indirect effects following the procedures described in Kenny et al. (2003) and Moscovitch et al. (2005); $P_M = 100 \times [((ab + c' + \sigma_{ab}) - c') / (ab + c' + \sigma_{ab})]$, where *a*, *b*, and *c*' represent the respective path coefficients, and σ_{ab} is the covariance between *a* and *b*. However, as path *b* was specified as fixed, and the covariance between a random and fixed path equals zero, the formula simplifies to $P_M = 100 \times (ab / ab + c')$, and the indirect effect to $a \times b$ (see Mörtberg et al., 2015).

Analyses were performed using MPlus version 7.0 (Muthén & Muthén, 1998-2015) and R version 3.4.3 (R Core Team, 2017) using the R package 'MplusAutomation' (Hallquist & Wiley, 2018). Inspection of the intraclass correlation coefficients for each model indicated sufficient between-subject variance to justify multilevel analysis (ICC = .43 – .68). Alongside *p*-values, confidence intervals of parameter estimates were reviewed to assess statistical significance.

Results

Baseline and end of treatment means and standard deviations for Samples 1 and 2 are shown in Table 2. Significant decreases were observed across treatment on all of the measures assessed.

Table 2

Baseline and End of Treatment Mean Scores for Samples 1 and 2

Measure	Baseline *M (SD)*	End of treatment *M (SD)*	Test statistic	Pre-post d_{Cohen} [95% CI]
Sample 1 (*n* = 185)				
SPWSS (4-item)	21.07 (5.04)	9.41 (7.18)	$t(183) = 22.23$, $p < .001$	1.88 [1.63, 2.12]
SFA	5.30 (1.48)	2.52 (1.75)	$t(176) = 18.59$, $p < .001$	1.72 [1.47, 1.96]
SCQ-c	1.38 (1.22)	-0.91 (1.36)	$t(182) = 22.77$, $p < .001$	1.77 [1.53, 2.01]
BDI	18.32 (11.03)	7.94 (10.07)	$t(184) = 14.68$, $p < .001$	0.98 [0.77, 1.20]
Sample 2 (*n* = 86)				
SPIN	41.52 (12.72)	21.71 (15.67)	$t(70) = 12.35$, $p < .001$	1.39 [1.04, 1.74]
SFA	4.82 (1.80)	2.92 (1.83)	$t(82) = 9.21$, $p < .001$	1.05 [0.73, 1.37]
SCQ-c	1.42 (1.29)	-0.74 (1.34)	$t(77) = 15.34$, $p < .001$	1.64 [1.29, 2.00]
PHQ	11.17 (6.85)	5.21 (6.17)	$t(83) = 9.59$, $p < .001$	0.91 [0.60, 1.23]

Note. Baseline (Pre) scores are taken from the initial assessment, or the Session 1 score in cases where no assessment score was available. End of treatment (Post) scores used the last available score. *t* statistics represent paired *t*-tests comparing baseline and end of treatment scores. SPWSS = Social Phobia Weekly Summary Scale; SFA = Self-Focused Attention; SCQ-c = Social Cognitions Questionnaire – composite *z* score; BDI = Beck Depression Inventory. SPIN = Social Phobia Inventory; PHQ = Patient Health Questionnaire. d_{Cohen} calculated using the pooled standard deviation as the denominator, calculated as SQRT(($SD^2_{initial}$ + SD^2_{post}) / 2) (Van Etten & Taylor, 1998). Confidence intervals for d_{Cohen} were calculated using the Hedges and Olkin formula (see Lee, 2016). Cohen (1988) suggested that broadly, effect sizes of 0.2, 0.5, and 0.8 indicated small, medium, and large effects, respectively.

Sample 1

Results of the MSEM models are shown in Table 3. Significant indirect effect estimates were observed for all three of the process variables assessed, indicating that self-focused attention, negative social cognitions, and depressed mood all mediated the effect of time on social anxiety. The significant and negative path *a* coefficients highlighted that as time in therapy increased, scores on the process variables decreased, with the significant, positive path *b* coefficients indicating that these lower scores predicted lower social anxiety at the following assessment. Inspection of the percent mediation values indicated that negative social cognitions showed the strongest indirect effect.

The reversed models, which swapped the social anxiety and process variables but retained the time-lag component, were also significant for the three process variables

assessed. These findings suggest that lower social anxiety scores were associated with subsequent reduced self-focused attention, reduced negative social cognitions, and improved mood at the following assessment. The percent mediation values for these models were similar across the three variables examined.

Table 3

Model Results for Sample 1: Unstandardised Path Coefficients, Random Slope Variances, and Indirect Effect Estimates

	Self-focused attention				Negative social cognitions				Depressed mood			
Parameter	**Estimate**	***SE***	***p***	**P_M**	**Estimate**	***SE***	***p***	**P_M**	**Estimate**	***SE***	***p***	**P_M**
a	-0.013	0.001	< .001		-0.011	0.001	< .001		-0.035	0.003	< .001	
b	0.821	0.100	< .001		1.922	0.162	< .001		0.162	0.034	< .001	
c'	-0.039	0.002	< .001		-0.029	0.002	< .001		-0.044	0.003	< .001	
Var_a	< 0.001	< 0.001	< .001		< 0.001	< 0.001	< .001		0.001	< 0.001	< .001	
$Var_{c'}$	0.001	< 0.001	< .001		< 0.001	< 0.001	< .001		0.001	< 0.001	< .001	
Indirect effect *ab*	-0.010	0.001	< .001	21	-0.021	0.002	< .001	42	-0.006	0.001	< .001	11
Models reversing process variable and outcome												
a	-0.053	0.003	< .001		-0.053	0.03	< .001		-0.053	0.003	< .001	
b	0.096	0.008	< .001		0.073	0.005	< .001		0.159	0.030	< .001	
c'	-0.006	0.001	< .001		-0.005	< 0.001	< .001		-0.022	0.003	< .001	
Var_a	0.001	< 0.001	< .001		0.001	< 0.001	< .001		0.001	< 0.001	< .001	
$Var_{c'}$	(see notes)				(see notes)				0.001	< 0.001	< .001	
Indirect effect *ab*	-0.005	0.001	< .001	46	-0.004	< 0.001	< .001	43	-0.008	0.002	< .001	28

Note. n = 185. Path *a* represents the effect of time on the process variable. Path *b* represents the effect of the process variable on social anxiety score at the subsequent assessment (with time held constant). Path *c'* represents the effect of time on social anxiety score controlling for the effect of the process variable. Path *ab* represents the indirect, or mediated, effect. The 'reversed' models swap the process and outcome variables. *SE* = standard error, P_M = percent mediation (i.e. the percentage of the total effect of time on outcome score that is accounted for by the mediated path *ab*), Var = variance. Due to lack of model convergence when the *c'* path was specified as random, the reversed models for self-focused attention and negative social cognitions were run using a fixed *c'* path therefore no variance is given.

Sample 2

Results of the MSEM models for Sample 2 are shown in Table 4. These models also showed significant indirect effect estimates for all three of the process variables assessed (self-focused attention, negative social cognitions, and depressed mood), indicating that these variables mediated the effect of time on social anxiety as measured by the SPIN. The percent mediation values again indicated that negative social cognitions showed the strongest effect, though the strength of the indirect effect for self-focused attention was weaker in Sample 2 compared to Sample 1. The reversed models were significant for the three process variables assessed, with similar percent mediation values across the three

variables, as was observed in Sample 1. Overall, the consistency of model results between the two samples was high, suggesting the Sample 1 findings were replicated in Sample 2.

Table 4

Model Results for Sample 2: Unstandardised Path Coefficients, Random Slope Variances, and Indirect Effect Estimates

	Self-focused attention				Negative social cognitions				Depressed mood			
Parameter	**Estimate**	***SE***	***p***	**P_M**	**Estimate**	***SE***	***p***	**P_M**	**Estimate**	***SE***	***p***	**P_M**
a	-0.016	0.001	< .001		-0.016	0.001	< .001		-0.036	0.005	< .001	
b	0.796	0.250	.001		3.199	0.448	< .001		0.428	0.123	< .001	
c'	-0.128	0.011	< .001		-0.092	0.010	< .001		-0.127	0.011	< .001	
Var_a	< 0.001	< 0.001	< .001		< 0.001	< 0.001	< .001		0.001	< 0.001	< .001	
$Var_{c'}$	0.007	0.001	< .001		0.005	0.001	< .001		0.007	0.001	< .001	
Indirect effect *ab*	-0.013	0.004	.003	9	-0.050	0.008	< .001	35	-0.015	0.005	.002	11
Models reversing process variable and outcome												
a	-0.158	0.012	< .001		-0.158	0.012	< .001		-0.159	0.012	< .001	
b	0.030	0.007	< .001		0.040	0.005	< .001		0.078	0.021	< .001	
c'	-0.010	0.002	< .001		-0.007	0.001	< .001		-0.021	0.005	< .001	
Var_a	0.010	0.002	< .001		0.010	0.002	< .001		0.010	0.002	< .001	
$Var_{c'}$	< 0.001	< 0.001	< .001		(see notes)				0.001	< 0.001	.001	
Indirect effect *ab*	-0.005	0.001	< .001	32	-0.006	0.001	< .001	47	-0.012	0.004	.001	37

Note. $n = 86$. Path *a* represents the effect of time on the process variable. Path *b* represents the effect of the process variable on social anxiety score at the subsequent assessment (with time held constant). Path *c'* represents the effect of time on social anxiety score controlling for the effect of the process variable. Path *ab* represents the indirect, or mediated, effect. The 'reversed' models swap the process and outcome variables. *SE* = standard error, P_M = percent mediation (i.e. the percentage of the total effect of time on outcome score that is accounted for by the mediated path *ab*), Var = variance. Due to lack of model convergence when the *c'* path was specified as random, the reversed model for negative social cognitions was run using a fixed *c'* path therefore no variance is given.

Discussion

This study aimed to examine whether self-focused attention, negative social cognitions, and depressed mood were associated with clinical improvement in CT-SAD delivered in a routine clinic setting. Negative social cognitions were supported as a mediator of clinical improvement in Samples 1 and 2, showing the strongest percent mediation values of the three process variables assessed. The results therefore support the Clark and Wells (1995) model that underpins the treatment, and suggest that one of the reasons why people experience less social anxiety as they progress through treatment is that they are experiencing fewer and less-convincing negative thoughts about social situations. These findings are in line with a number of other studies investigating cognitions as a possible

process variable driving improvements in social anxiety (Boden et al., 2012; Calamaras et al., 2015; Goldin et al., 2014; Gregory et al., 2018; Hoffart et al., 2012).

Self-focused attention was supported as a mediator of clinical improvement in both Samples 1 and 2, suggesting that successfully shifting towards a more external focus of attention is one reason for the reduction in social anxiety as time in therapy increases. These findings are consistent with the three existing studies of self-focused attention (Hedman et al., 2013; Hoffart et al., 2016; Mörtberg et al., 2015), all of which used the same treatment protocol and found process-outcome effects within RCT datasets using analytic approaches similar to the present study. However, the results from both of the present samples indicated a weaker effect for self-focused attention compared to cognitions. This may indicate a distinction between the RCT context and routine practice, for example in how the self-focus aspects of treatment were implemented. The clinical methods to address self-focused attention were further refined during the audit period, so it is likely that not all participants completed an 'attention training' session or had this consistently emphasised during treatment. In contrast, participants in the Hoffart et al. (2016), Hedman et al. (2013), and Mörtberg et al. (2015) studies all completed a specific attention training session, and were supported to practise externally focused attention throughout therapy. It is possible that the lesser emphasis on targeting self-focused attention in the present samples, especially in comparison to targeting cognitions, may help to explain the differences observed in the strength of these effects.

Depressed mood showed significant mediation across Samples 1 and 2, though the percent mediation values indicated a weaker relationship compared to negative social cognitions. The weaker and less consistent effects observed for this variable, which is not part of the theoretical model underpinning CT-SAD, therefore lend some support to the specificity of the effects found for the theoretically-derived process variables.

It is notable that for both Samples 1 and 2, significant 'reversed' effects were observed across the three process variables, with similar or greater percent mediation values than in the forward models. This may indicate a cyclical relationship between process and outcome, where changes in negative cognitions and self-focused attention lead to subsequent reductions in social anxiety, and in addition, reductions in social anxiety have a beneficial effect in reducing negative social beliefs and perhaps reducing the perceived need to monitor and focus on yourself in social situations.

Strengths and Limitations

From a methodological perspective, the use of an additional process variable that is not part of the theoretical model being tested, and statistical methods such as MSEM to account for repeated-measures data and the between- and within-person variance were strengths of the present work and should be considered for future studies in this area. Reversed models are also not implemented consistently and are therefore recommended. While the division of the data into two samples was necessary given the different

outcome measures used, it provided a helpful opportunity to assess whether the Sample 1 results would replicate, and the similarity of the results between samples affords increased confidence in the findings. The self-focused attention models may be limited by the use of a two-item mean score to measure this construct. While this measure has been used previously (Hoffart et al., 2016; Mörtberg et al., 2015) future research could usefully develop more nuanced tools to monitor change in this variable over time. It remains possible that other process variables not assessed in the present studies could show strong associations with outcome; for example the use of safety behaviours would be hypothesised as a mediator based on the Clark and Wells (1995) model, but could not be examined here given this was not measured weekly. It is noted also that the present models only examine consecutive timepoints (usually weekly measures), so do not assess process-outcome effects on broader levels, for example delayed or cumulative effects of changes in process variables.

Conclusion

Overall, the present study found that in routine clinical practice, three process variables (negative social cognitions, self-focused attention, and depressed mood) were associated with subsequent social anxiety outcomes in CT-SAD, with negative social cognitions showing the strongest and most consistent effect. The findings are therefore in line with the Clark and Wells (1995) model that underpins the treatment, and are consistent with RCT-based research findings examining cognitive-behavioural therapies for SAD. Further work examining associations between process variables and clinical outcomes within datasets from routine clinical practice is recommended.

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Author Contributions: GRT and DMC developed the data analysis concept. DMC and AE designed the data collection protocol and with NG, JW, and EWP supervised treatment and data collection. RD collated, entered, and cleaned the data. GRT performed the analyses and drafted the paper, under supervision from AE and DMC who provided critical revisions. All authors reviewed and approved the final version of the paper for submission.

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Pre-Sleep Arousal and Fear of Sleep in Trauma-Related Sleep Disturbances: A Cluster-Analytic Approach

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Abstract

Background: Trauma-related sleep disturbances constitute critical symptoms of posttraumatic stress disorder (PTSD), but sleep symptoms often reside even after successful trauma-focused psychotherapy. Therefore, currently unattended factors – like fear of sleep (FoS) – might play a crucial role in the development and maintenance of residual sleep disturbances. However, it is unclear whether trauma-exposed individuals exhibit different symptomatic profiles of sleep disturbances that could inform individualized therapeutic approaches and eventually enhance treatment efficacy.

Method: In a large online study, a two-step cluster analysis and a hierarchical cluster analysis using Ward's method were performed to explore subgroups among trauma-exposed individuals (N = 471) in terms of FoS, different aspects of trauma-related sleep disturbances (e.g., insomnia symptoms, nightmares, arousal), and PTSD symptoms. These variables were compared between resulting clusters using ANOVAs and Scheffé's post-hoc tests.

Results: The hierarchical cluster analysis supported 3- and 4-cluster solutions. The 3-cluster solution consisted of one "healthy" (n = 199), one "subclinical" (n = 223), and one "clinical" (n = 49) cluster, with overall low, medium, and high symptomatology on all used variables. In the 4-cluster solution, the clinical cluster was further divided into two subgroups (n = 38, n = 11), where one cluster was specifically characterized by elevated somatic pre-sleep arousal and high levels of FoS.

Conclusions: A subgroup of trauma-exposed individuals with PTSD and sleep disturbances suffers from increased pre-sleep arousal and FoS, which has been suggested as one possible explanation for residual sleep disturbances. In these patients, FoS might be a relevant treatment target.

Keywords

trauma-related sleep disturbances, pre-sleep arousal, insomnia, nightmares, fear of sleep, posttraumatic stress disorder, cluster analysis

Highlights

- Fear of sleep is one additional, important aspect of trauma-related sleep disturbances.
- Trauma-exposed individuals can be clustered based on their sleep- and PTSD-related symptomatology.
- One subgroup was specifically characterized by increased fear of sleep and somatic pre-sleep arousal.
- Fear of sleep might be a relevant treatment target and might provide more specialized treatments with greater response rates.
- Somatic pre-sleep arousal might reflect the physiological component of fear of sleep.

During the last decade, the body of research on sleep disturbances in trauma- and stressor-related disorders, particularly posttraumatic stress disorder (PTSD), has rapidly grown. Sleep disturbances following traumatic experiences are mostly conceptualized as symptoms of insomnia (e.g., difficulties falling or staying asleep) and recurrent nightmares (Pace-Schott & Bottary, 2018), which were previously seen as secondary symptoms of PTSD (Spoormaker & Montgomery, 2008). This might be due to the fact that these types of sleep disturbances are represented in the formal diagnosis of PTSD (American Psychiatric Association, 2013). However, recent research has consistently shown that sleep disturbances are more than a mere epiphenomenon, as they appear to constitute a crucial factor in the development and maintenance of PTSD (Cox, Tuck, & Olatunji, 2017; Germain, McKeon, & Campbell, 2017; Sinha, 2016; Spoormaker & Montgomery, 2008). Furthermore, although evidence-based treatment for PTSD (Lee et al., 2016; Schnurr, 2017) often leads to significant reductions in symptoms of insomnia as well as nightmares, in contrast to other PTSD symptoms, sleep disturbances do not usually fully remit (Belleville, Guay, & Marchand, 2011; Galovski, Monson, Bruce, & Resick, 2009; Gutner, Casement, Stavitsky Gilbert, & Resick, 2013; Lommen et al., 2016; Woodward et al., 2017). Sleep-focused treatments, like *Cognitive Behavioral Therapy for Insomnia* (CBT-I) or forms of trauma-related nightmare treatments (e.g., *Imagery Rehearsal Therapy*, IRT; or *Exposure, Relaxation, and Rescripting Therapy*, ERRT), lead to stronger reductions in sleep disturbances and nightmares respectively (Casement & Swanson, 2012; Ho, Chan, & Tang, 2016), and additionally moderately reduce PTSD symptoms (Davis et al., 2011; Davis & Wright, 2007; Pruiksma, Cranston, Rhudy, Micol, & Davis, 2018). However, most studies show that even after sleep-focused treatments, sleep disturbances remain in the clinical range, especially in more severe PTSD samples (Nappi, Drummond, Thorp, & McQuaid, 2010; Swanson, Favorite, Horin, & Arnedt, 2009; Ulmer, Edinger, & Calhoun, 2011). This leads to the assumption that other factors, which are currently unattended, seem to play a role in the development and maintenance of trauma-related sleep disturbances.

One such factor is fear of sleep (FoS), which includes dysfunctional beliefs about one's perceived safety during sleep, fear of nightmares, and maladaptive behaviors. FoS seems to develop due to two main reasons: First, traumatic experiences together with daytime PTSD-symptoms (e.g., intrusive re-experiencing) induce a feeling of loss of control, which can trigger strong feelings of helplessness and reduced trust in other people and in the world (Ehlers, Hackmann, & Michael, 2004). Yet sleep is a state where a reduced ability to monitor the environment and giving up control is inevitable (Dahl, 1996). Therefore, it is plausible that trauma survivors with PTSD might be particularly fearful of this state because they feel extremely vulnerable during sleep. Second, due to a fear of re-experiencing the traumatic event during sleep, nightmares might additionally enhance FoS (Davis, 2009; Krakow, Tandberg, Scriggins, & Barey, 1995; Neylan et al., 1998). Also, related sleep-interfering maladaptive behaviors, such as sleeping with lights on, the use of heavy blankets, exaggerated safety checking before sleeping, or delaying bedtime in order to deal with nightmares or being vulnerable during sleep, can be considered part of FoS (Pruiksma et al., 2014). As FoS is not targeted during trauma- or sleep-focused psychotherapy (Pigeon & Gallegos, 2015), it has recently been suggested as an underlying mechanism of residual sleep disturbances (Pruiksma et al., 2014).

Several empirical findings support correlational links between FoS and increased symptoms of insomnia and nightmares, as well as overall PTSD symptomatology (Huntley, Hall Brown, Kobayashi, & Mellman, 2014; Kanady et al., 2018; Neylan et al., 1998; Pruiksma, Cranston, Jaffe, & Davis, 2011). However, other factors can also influence the maintenance of trauma-related sleep disturbances. For example, traumatic experiences generally lead to a state of heightened cognitive and somatic arousal – particularly during the pre-sleep period – that might consequently induce sleep disturbances (Sinha, 2016). Furthermore, the severity of trauma-related insomnia symptoms and nightmares *per se* might be one important factor for the persistence of sleep disturbances. Finally, both difficulty maintaining sleep and nightmares have also been associated with more interrupted, and therefore fragmented, rapid eye movement (REM) sleep, which can interfere with treatment response via impaired extinction learning (Pace-Schott, Germain, & Milad, 2015; Riemann et al., 2012).

Overall, there is a need to investigate these various aspects of trauma-related sleep disturbances in order to provide additional promising treatment targets. FoS might be a particularly relevant factor influencing the maintenance of trauma-related sleep disturbances because other factors (e.g., feeling of safety during the day, sleep disturbances, and nightmares in general) are already targeted during trauma- or sleep-focused therapy (Pigeon & Gallegos, 2015). However, the role of FoS in individuals with trauma-related sleep disturbances is currently unknown. Therefore, we have investigated FoS together with symptoms of insomnia, nightmares, pre-sleep arousal, and REM sleep fragmentation in the context of traumatic experiences in a general population sample that included both healthy individuals and individuals with clinically relevant PTSD symptoms. Through

the use of a cluster-analytic approach, this study aims to explore symptomatic profiles of trauma-exposed individuals on FoS, insomnia symptoms, nightmares, pre-sleep arousal, and REM sleep fragmentation, as well as PTSD symptomatology. Classifying this heterogeneous group of individuals with traumatic experiences into better-defined subgroups could help to provide more specialized treatments with greater response rates, especially with regard to trauma-related sleep disturbances.

Method

Sample and Procedures

Overall, 754 individuals (62% female, mean age = 48.69 years; *SD* = 14.00; range 18–92) from the German nationwide online panel PsyWeb (*N* = 12.317 in 2017; https://www.uni-muenster.de/PsyWeb) participated in the study. PsyWeb is a panel that provides information about psychological topics of common interest and offers possibilities to take part in anonymous psychological tests and studies for registered members from the general population (i.e., panel members). Panel members were contacted via e-mail by the panel organization and were invited to take part in an online survey study investigating influencing factors on sleep and sleep problems. We specifically invited all panel members, independent of existing sleep problems or previous traumatic experiences. Study participants did not receive any monetary compensation but were offered automated feedback regarding their sleep quality and depression scores after completion of the survey. Participants were included if they were 18 years or older and proficient in the German language, but were excluded from all analysis if they did not give written informed consent.

It is worth noting that the data collected in this study was also used to validate the German version of the Fear of Sleep Inventory-Short Form (FOSI-SF; Drexl, Kunze, & Werner, 2019). Both projects were preregistered specifying their different research foci and analytic approaches (Kunze, Drexl, Metodiev, & Werner, 2017; Werner, Metodiev, Drexl, & Kunze, 2017).

Measures

The survey included several measures assessing FoS, insomnia symptoms, nightmares, traumatic experiences, PTSD symptoms, and other aspects of trauma-related sleep disturbances, like arousal and a proxy for fragmented REM sleep, with higher scores indicating increased symptomatology. Traumatic experiences and PTSD symptoms were measured by the German version of the *Life Events Checklist* (LEC-5, including the extended criterion A assessment), followed by the *PTSD Checklist for DSM-5* (PCL; range 0-80; Krüger-Gottschalk et al., 2017) if any traumatic experience was indicated by the participant. In the present sample, internal consistency for the PCL was excellent (Cronbach's α = .95).

Insomnia severity was measured via the German version of the *Insomnia Severity Index* (ISI; range 0-28; Gerber et al., 2016). It assesses difficulties with initiating or maintaining sleep as well as early morning awakenings and related worries, and there is good internal consistency in our sample (α = .84) and a clinical cut-off at 15 for moderate insomnia. Furthermore, nightmares were assessed using the German version of the *Nightmare Distress Questionnaire* (NDQ; range 13-65; Böckermann, Gieselmann, & Pietrowsky, 2014) with excellent internal consistency in the present sample (α = .91). Additionally, FoS was measured via the German version of the *FOSI-SF* (Drexl et al., 2019). The FOSI-SF contains 13 items (range 0–52) on the fear of being particularly vulnerable during sleep, fear of experiencing nightmares, fear of darkness, and related behaviors, such as sleeping with lights on. The FOSI-SF showed good internal consistency in this sample (α = .86). Further measures linked to trauma-related sleep disturbances included the German versions of the *Pre-Sleep Arousal Scale* (PSAS; range 15-75; Gieselmann, de Jong-Meyer, & Pietrowsky, 2012; somatic arousal [8 items]: α = .80; cognitive arousal [7 items]: α = .92) as well as *Nocturnal Mentations* as a proxy for REM sleep fragmentation (NMS; range 3-27; Wassing et al., 2016); however internal consistency was questionable for this 3-item scale (α = .63). Depression and anxiety were assessed for exploratory purposes using the German versions of the depression module of the Patient Health Questionnaire (PHQ-9; range 0-27; Löwe, Spitzer, Zipfel, & Herzog, 2002) and the General Anxiety Disorder Screener (GAD-7; range 0–21; Löwe et al., 2008).

Statistical Analyses

Only participants with at least one potentially traumatic experience (according to DSM-5) – and therefore valid values for PTSD symptom severity (PCL) – were further included in the analyses. Potentially traumatic experiences were defined on the basis of the LEC-5 and the extended criterion A assessment if one of the traumatic events was personally experienced or witnessed (Weathers et al., 2013). However, if the indicated index traumatic event for the PCL did not include any of the following criterion A characteristics, the participant was assigned to the no-trauma group and excluded from further analyses. The criterion A characteristics were: Danger of life, serious injury, sexual violence, or – in the case of the death of a close family member – accident or violence. After exclusion, the remaining sample consisted of 471 trauma-exposed individuals (see Table 1 for demographic variables of the sample).

All analyses were carried out using the Statistical Package for the Social Sciences (IBM SPSS Statistics, Version 24). Cluster analysis is a data-driven approach seeking to identify specific subgroups of individuals within a larger sample on the basis of shared characteristics. Specifically, cluster analyses aim to group individuals that are similar to each other on specified variables into distinct groups. In the present study, cluster analyses were used to explore different symptomatic profiles of trauma-exposed individuals. In order to identify subgroups within our sample, we first performed a non-hierarchical

two-step cluster analysis. This type of cluster analysis is advantageous, as it automatically uses standardized variables and chooses the optimal number of clusters based on Schwarz's Bayesian Criterion (BIC) and the ratio of distance measures (Schendera, 2010); in this case the Euclidian distance measure was used. The resulting cluster quality was automatically rated based on the silhouette measure for cohesion and separation. For PTSD symptomatology we used the PCL score without items referring to sleep ("PCL-", i.e., PCL without items 2 and 20) to decrease overlap with other measures assessing sleep-relevant variables.

Table 1

Demographic Variables of the Trauma-Exposed Subsample (n = 471)

Variable		
Age	***M***	***SD***
	49.02	13.25
Female	***n***	**%**
	306	64.97
Marital status	***n***	**%**
Single	101	21.44
In relationship	95	20.17
Married	201	42.68
Divorced or widowed	74	15.71
Education	***n***	**%**
Middle school degree	55	11.68
High school degree	98	20.81
University degree	268	56.90
Vocational education	45	9.55
Other	5	1.06
Occupation	***n***	**%**
Student	33	7.00
Employed	319	67.73
Unemployed	13	2.76
Retired	86	18.26
Other	20	4.25
Past psychotherapeutic treatment	***n***	**%**
	225	47.77

As non-hierarchical cluster analyses only detect main clusters, we also conducted a hierarchical cluster analysis, using Ward's method (Ward, 1963). This method, which has been broadly used in the social sciences (Clatworthy, Buick, Hankins, Weinman,

& Horne, 2005), seeks to minimize the total within-cluster variance (leading to more homogeneous subgroups) and tends to create approximately equally sized, non-overlapping clusters (Schendera, 2010). Using this agglomerative approach, each individual initially represents its own cluster and clusters then progressively merge with others (as a function of their relative distance, i.e., the squared Euclidian distance) until one cluster including all cases is formed. The ideal number of clusters was determined by inspection of the resulting dendrogram and agglomeration coefficients, where a large increase between two consecutive cluster solutions indicates an unfavorable combination of two heterogeneous clusters and should therefore be abandoned. If the dendrogram and agglomeration coefficients supported more than one cluster solution, they were all treated as final solutions and further examined. Differences in clustering variables between the resulting clusters of the final cluster solution were then explored via subsequent analyses of variance (ANOVAs) followed by post-hoc analyses. Differences in secondary and demographic variables were investigated for exploratory purposes.

Results

Psychometric Variables

The psychometric characteristics of the sample with regard to variables used in the cluster analyses are given in Table 2. PTSD symptomatology is reported both overall (PCL) and without items referring to sleep disturbances (PCL-), as the latter was used for cluster analyses.

Table 2

Psychometric Characteristics of the Trauma-Exposed Subsample

Variable	*M*	*SD*	*Range*
PTSD symptoms (PCL)	14.60	14.71	0–71
PTSD symptoms without sleep disturbances (PCL-)	13.23	13.57	0–63
Insomnia symptoms (ISI)	8.63	5.39	0–26
Nightmare distress (NDQ)	23.10	8.99	13–54
Fear of sleep (FOSI-SF)	2.07	4.39	0–35
Pre-sleep arousal (PSAS)	27.56	9.70	15–62
Somatic pre-sleep arousal (PSAS, somatic subscale)	12.56	4.51	8–32
Cognitive pre-sleep arousal (PSAS, cognitive subscale)	15.01	6.30	7–33
REM sleep fragmentation (nocturnal mentations)	10.86	5.91	3–27

Note. PCL = Posttraumatic Checklist; PCL- = PCL score without items 2 and 20; ISI = Insomnia Severity Index; NDQ = Nightmare Distress Questionnaire; FOSI-SF = Fear of Sleep Inventory-Short Form; PSAS = Pre-Sleep Arousal Scale.

Two-Step Cluster Analysis

The lowest BIC (2067.80) and the largest ratio of distance (1.39) both supported a 2-cluster solution, which was automatically chosen. Cluster quality was rated as good, based on the silhouette measure for cohesion and separation. Cluster 1 was characterized by low values of all variables ("healthy cluster"; n = 418), and cluster 2 was characterized by high values of all variables ("clinical cluster"; n = 53) (see Table 3). Subsequent t-tests revealed significant differences between the two clusters on all grouping variables, ps ≤ .001.

Table 3

Mean Scores of Clustering Variables in Clusters Obtained by Two-Step Cluster Analysis

	Healthy cluster n = 418		Clinical cluster n = 53	
Variable	***M***	***SD***	***M***	***SD***
PCL	11.35	11.01	40.25	15.09
PCL-	10.28	10.28	36.45	14.07
ISI	7.69	4.78	15.98	4.09
NDQ	21.18	6.92	38.28	9.10
FOSI	1.06	2.00	10.09	8.27
PSAS-S	11.70	3.53	19.32	5.65
PSAS-C	13.70	5.16	25.28	4.95
NMS	10.22	5.72	15.85	4.93

Note. PCL is reported for descriptive purposes, PCL- was used as clustering variable. PCL = Posttraumatic Checklist; PCL- = PCL score without items 2 and 20; ISI = Insomnia Severity Index; NDQ = Nightmare Distress Questionnaire; FOSI-SF = Fear of Sleep Inventory-Short Form; PSAS-S = Pre-Sleep Arousal Scale somatic subscale; PSAS-C = Pre-Sleep Arousal Scale cognitive subscale; NMS = Nocturnal Mentations.

Hierarchical Cluster Analysis

The dendrogram of the hierarchical cluster analysis using Ward's method and squared Euclidian distances showed possible solutions of two, three, and four clusters (see Figure S1, Supplementary Material). There was a smaller increase in agglomeration coefficients between the 4- and 3-cluster solutions (155.73) and a larger increase between the 3- and 2-cluster solutions (525.09), indicating a stronger increase in the heterogeneity within clusters between the latter solutions (see Table S1, Supplementary Material). Therefore, the 2-cluster solution was abandoned and the 3- and 4-cluster solutions were further described.

The 3-cluster solution revealed two bigger clusters and one smaller cluster (Cluster 1: n = 199; Cluster 2: n = 223; Cluster 3: n = 49). One-way ANOVAs and Scheffé's post-hoc comparisons indicated that all clusters differed significantly from each other regarding all

variables (see Table 4 for descriptive values and inferential statistics). Specifically, Cluster 1 was characterized by low levels, Cluster 2 by medium levels, and Cluster 3 by high levels of all variables. Based on these results, and taking the clinical cut-offs for insomnia (ISI ≥ 15) and PTSD symptoms (PCL ≥ 33) into consideration, these clusters were named "healthy cluster", "subclinical cluster", and "clinical cluster" (see Table 4). In line with the two-step cluster analysis, the clinical clusters of both analytic approaches are comparable with respect to cluster size (n = 53 vs. n = 49) and mean scores of all variables.

Table 4

Descriptive Values and Inferential Statistics of the 3-Cluster Solution

	Healthy cluster n = 199		Subclinical cluster n = 223		Clinical cluster n = 49		Statistics	
Variable	***M***	***SD***	***M***	***SD***	***M***	***SD***	***F*(2, 468)**	**η^2**
PCL	5.36_a	5.15	16.98_b	12.31	41.29_c	14.16	256.36***	.52
PCL-	4.84_a	4.81	15.39_b	11.58	37.45_c	13.27	239.18***	.51
ISI	4.78_a	2.92	10.39_b	4.63	16.22_c	3.92	210.29***	.47
NDQ	16.92_a	3.32	25.27_b	7.30	38.35_c	9.09	260.68***	.53
FOSI	0.20_a	0.57	2.24_b	3.01	8.92_c	9.11	115.86***	.33
PSAS-S	10.06_a	2.14	13.09_b	3.87	20.27_c	4.84	183.94***	.44
PSAS-C	10.61_a	2.71	16.45_b	5.25	26.29_c	3.42	303.46***	.56
NMS	7.23_a	4.00	12.90_b	5.62	16.29_c	5.07	102.60***	.31

Note. PCL is reported for descriptive purposes, PCL- was used as clustering variable. Omnibus tests and η^2 of one-way ANOVAs are reported (independent variable: cluster, dependent variables: clustering variables). Different subscripts indicate significant differences in Scheffé's post-hoc comparisons (p < .001). PCL = Posttraumatic Checklist; PCL- = PCL score without items 2 and 20; ISI = Insomnia Severity Index; NDQ = Nightmare Distress Questionnaire; FOSI-SF = Fear of Sleep Inventory-Short Form; PSAS-S = Pre-Sleep Arousal Scale somatic subscale; PSAS-C = Pre-Sleep Arousal Scale cognitive subscale; NMS = Nocturnal Mentations.
***p < .001.

Regarding the 4-cluster solution, the clinical cluster was further divided into two clusters (Cluster 3: n = 38; Cluster 4: n = 11). One-way ANOVAs and Scheffé's post-hoc comparisons were again used to explore differences between the identified clusters regarding all clustering variables as well as some additional exploratory and demographic variables (see Table 5 for descriptive values and inferential statistics). In line with the 3-cluster solution, Scheffé's post-hoc comparisons demonstrated that both clinical clusters were characterized by significantly higher levels of all variables compared to the subclinical cluster and the healthy cluster; only nocturnal mentations did not differ significantly between one of the clinical clusters (Cluster 4) and the healthy cluster (Cluster 1), M_{Diff} = 0.92, p = .948 (see Table 5). However, comparing both clinical clusters, Cluster 4

additionally showed significantly increased levels of somatic pre-sleep arousal, M_{Diff} = 3.41, p = .033, as well as much higher levels of FoS than Cluster 3, M_{Diff} = 18.16, $p \leq .001$ (see also Figure 1 for cluster group mean z-scores). Moreover, the amount of variance in FoS that can be explained by clustergroup membership (η^2) was much higher in the 4-cluster solution (η^2 = .64) than in the 3-Cluster solution (η^2 = .33), while the amount of explained variance of all other variables did not differ between solutions. Therefore, Cluster 4 was named "clinical cluster with FoS", while the third cluster remained a more general "clinical cluster".

Table 5

Descriptive Values and Inferential Statistics of the 4-Cluster Solution

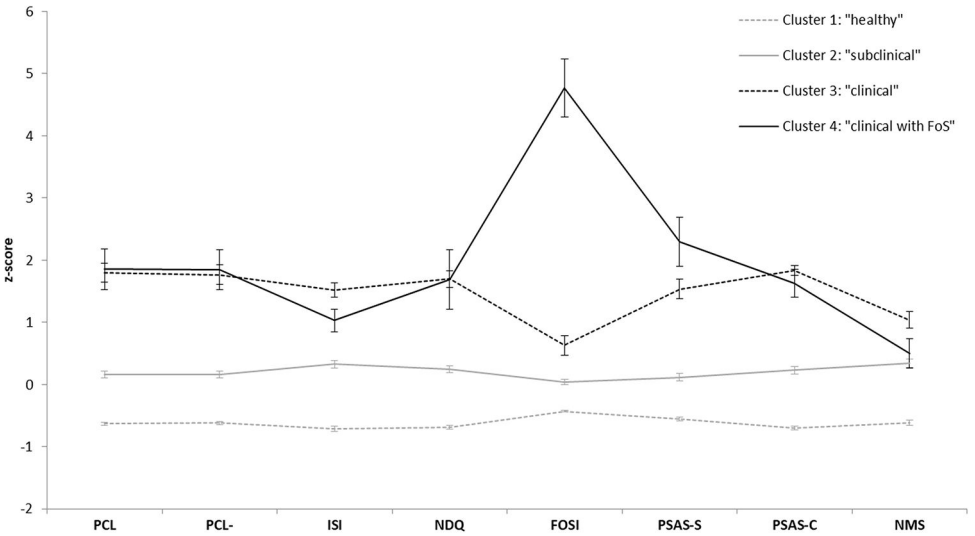
	Healthy cluster n = 199		Subclinical cluster n = 223		Clinical cluster n = 38		Clinical cluster with FoS n = 11		Statistics	
Variable	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***F*(3, 467)**	**η^2**
PCL	5.36_{a}	5.15	16.98_{b}	12.31	41.11_{c}	13.84	41.91_{c}	15.90	170.58***	.52
PCL-	4.84_{a}	4.81	15.39_{b}	11.58	37.21_{c}	13.06	38.27_{c}	14.60	159.19***	.51
ISI	4.78_{a}	2.92	10.39_{b}	4.63	16.82_{c}	3.94	14.18_{c}	3.25	142.35***	.48
NDQ	16.92_{a}	3.32	25.27_{b}	7.30	38.37_{c}	7.26	38.27_{c}	14.20	173.42***	.53
FOSI	0.20_{a}	0.57	2.24_{b}	3.01	4.84_{c}	4.37	23.00_{d}	6.81	278.75***	.64
PSAS-S	10.06_{a}	2.14	13.09_{b}	3.87	19.5_{c}	4.29	22.91_{d}	5.89	127.60***	.45
PSAS-C	10.61_{a}	2.71	16.45_{b}	5.24	26.58_{c}	2.97	25.27_{c}	4.67	202.52***	.57
NMS	7.23_{a}	4.00	12.90_{b}	5.62	17.00_{c}	5.04	$13.82_{a, c}$	4.58	69.96***	.31
PHQ-9	12.66_{a}	2.82	18.05_{b}	4.83	25.11_{c}	4.79	27.45_{c}	5.05	150.43***	.49
GAD-7	10.08_{a}	2.27	13.93_{b}	3.82	20.61_{c}	3.51	20.09_{c}	3.78	148.64***	.49
Age	51.27_{a}	13.42	$48.09_{a,b}$	12.82	44.08_{b}	12.55	$44.18_{a,b}$	14.52	4.64*	.03

Note. PCL scores are reported for descriptive purposes, PCL- was used as clustering variable. Omnibus tests and η^2 of one-way ANOVAs are reported (independent variable: cluster, dependent variables: clustering variables and secondary variables). Different subscripts indicate significant differences in Scheffé's post-hoc comparisons ($p < .05$). PCL = Posttraumatic Checklist; PCL- = PCL score without items 2 and 20; ISI = Insomnia Severity Index; NDQ = Nightmare Distress Questionnaire; FOSI-SF = Fear of Sleep Inventory-Short Form; PSAS-S = Pre-Sleep Arousal Scale somatic subscale; PSAS-C = Pre-Sleep Arousal Scale cognitive subscale; NMS = Nocturnal Mentations; PHQ-9 = Patient Health Questionnaire, Depression Module; GAD-7 = General Anxiety Disorder Screener.

*$p < .05$. **$p < .01$ ***$p < .001$.

Figure 1

Profile of z-Scores (With Standard Error Bars) for Clustering Variables by Cluster Group



Note. PCL scores are reported for descriptive purposes only and were not included in the analysis. PCL = Posttraumatic Checklist; PCL- = PCL score without items 2 and 20; ISI = Insomnia Severity Index; NDQ = Nightmare Distress Questionnaire; FOSI-SF = Fear of Sleep Inventory-Short Form; PSAS-S = Pre-Sleep Arousal Scale somatic subscale; PSAS-C = PSAS cognitive subscale; NMS = Nocturnal Mentations.

Additionally, one-way ANOVAs and Scheffé's post-hoc comparisons were used to explore differences between the final four clusters regarding secondary and demographic variables that were not used as clustering variables (see Table 5 for descriptive values and inferential statistics). Both clinical clusters were characterized by significantly higher levels of depression and anxiety compared to the subclinical cluster and the healthy cluster. However, comparing both clinical clusters, no differences in the levels of depression and anxiety were found. Considering age, only a difference between the healthy and the clinical cluster was found indicating higher age in the healthy cluster. Furthermore, there was a significant association between cluster group membership and gender, $\chi^2(3) = 23.67$, $p < .001$. Overall, clusters with higher symptom severity were associated with female gender (healthy cluster: 53.8% women; subclinical cluster: 70.7% women; clinical cluster: 84.2% women; clinical cluster with FoS: 90.9% women).

Discussion

The present study investigated FoS together with other factors that might be important for the maintenance of trauma-related sleep disturbances in trauma-exposed individuals (i.e., symptoms of insomnia, nightmares, pre-sleep arousal, REM fragmentation, and PTSD symptoms) by using a data-driven, cluster-analytic approach. Identifying different symptomatic profiles in individuals with trauma-related sleep disturbances might help to provide more individualized treatment targets. The main analyses supported a 3-cluster as well as a 4-cluster solution: The 3-cluster solution revealed one healthy, subclinical, and clinical cluster with respective low, medium, and high scores for all variables. In the 4-cluster solution, the clinical cluster was further split into two smaller clusters. Both clusters again demonstrated significantly higher levels of all variables compared to the healthy and subclinical clusters. Additionally, one of the two clinical clusters was characterized by elevated levels of somatic pre-sleep arousal and considerably higher levels of FoS compared to the other clinical cluster. The results suggest that a subgroup of individuals suffering from PTSD is characterized by increased somatic pre-sleep arousal and FoS, which might be relevant treatment targets, particularly for these individuals.

In general, trauma-exposed individuals differ dramatically with regard to their levels of psychopathology. Empirical findings indicate that, on average, around 10% of trauma-exposed individuals demonstrate residual stress-related symptoms and subsequently develop PTSD (Hidalgo & Davidson, 2000). In line with these observations, both cluster methods in this study revealed clinical clusters whose size accounted for around 10% of the trauma-exposed sample. In the two-step cluster analysis, the clinical sample consisted of 53 (11.25%) individuals who showed PTSD and insomnia symptoms above the proposed clinical cut-offs (Bovin et al., 2016; Gerber et al., 2016). In the hierarchical cluster analysis using Ward´s method, the clinical sample consisted of 49 (10.40%) individuals, again with PTSD and insomnia symptoms above the clinical cut-off (3-cluster solution). These findings support the representativeness of our online sample with regard to PTSD symptomatology. Furthermore, 47% of the trauma-exposed sample formed a subclinical cluster with significantly higher levels on all variables (i.e., FoS, insomnia symptoms, nightmares, pre-sleep arousal, REM sleep fragmentation, and PTSD symptoms) compared to the healthy cluster. In further support of the dimensionality of the constructs measured in the present study, this cluster indicated levels of subthreshold insomnia symptoms (Gerber et al., 2016) as well as medium levels on all other variables.

In the 4-cluster solution, the clinical cluster of the 3-cluster solution was further split into two clusters. While one of these two clusters was very similar to the clinical cluster in the 3-cluster solution (i.e., clinical cluster), the fourth cluster additionally showed significantly higher levels of somatic pre-sleep arousal as well as absolute levels of FoS that were nearly 5 times higher than in the clinical cluster (i.e., clinical cluster with FoS). This cluster accounted for 22% of the clinical sample and 2% of the overall sample. However, the average scores of FoS in this cluster are slightly higher than those

observed in other studies with diagnosed PTSD patients, whereas the average FoS score in the other clinical cluster is significantly lower (see Figure 1). This might indicate that, although the percentage of individuals with clinically-relevant PTSD symptoms is in line with the prevalence of PTSD in the general population, the overall symptom severity, and especially FoS, is less pronounced in this online sample, with only a subgroup demonstrating FoS values that are rather comparable to those observed in diagnosed clinical samples (Kanady et al., 2018; Pruiksma et al., 2014; Short, Allan, Stentz, Portero, & Schmidt, 2018). Although a clinical cut-off for the FOSI-SF is currently lacking, a detailed assessment of various aspects of sleep disturbances, like FoS (including whether the traumatic event took place in a sleep-related context and maladaptive sleep-interfering behaviors), could inform practitioners whether or not sleep and/or FoS should also be targeted in treatment.

Furthermore, preliminary findings on the temporal links between FoS and sleep disturbances have shown that increased FoS during a baseline period predicted worse daily sleep quality during the following week in PTSD patients (Short et al., 2018). In our sample, individuals in the clinical cluster with FoS indicated that they experience FoS once or twice per week (mean FOSI-SF = 1.77), whereas individuals in the clinical cluster indicated that they never experience FoS (mean FOSI-SF = 0.37; scale 0 = not at all, 1 = a few times per month, 2 = once or twice per week, 3 = several times per week, 4 = every night). It is worth noting that in the FoS subgroup, participants overwhelmingly indicated that they experienced the fear of loss of control and being vulnerable during sleep as often as several times per week or nearly every night. Although losing control and feeling vulnerable are cognitive dysfunctional beliefs, they are also a form of anticipatory anxiety that goes along with enhanced arousal (Davis, 2009). Accordingly, our results show that pre-sleep somatic arousal, conceptualized as various physical sensations during the pre-sleep period (e.g., palpitations, breathlessness, sweating, or muscle tension), was also significantly enhanced in the FoS subgroup (see Figure 1). Somatic pre-sleep arousal might reflect the physiological component that accompanies cognitive dysfunctional beliefs about safety during sleep. In contrast, cognitive arousal was conceptualized as more general rumination behaviors and worries about sleep disturbances as well as non-sleep-related problems and a feeling of mental activation in this study. Cognitive arousal might therefore be more characteristic of individuals suffering only from insomnia, but not in the context of PTSD, where the feeling of safety is more important than the effect of non-restorative sleep (Pigeon & Gallegos, 2015). Overall, enhanced FoS might increase sleep disturbances due to increased somatic pre-sleep arousal on the one hand, and, on the other hand, through increased engagement in sleep-interfering maladaptive behaviors. Completing this vicious cycle, there is considerable evidence supporting a perpetuating role of sleep disturbances for daytime PTSD symptomatology (Short, Allan, & Schmidt, 2017).

Trauma-focused treatments aim to differentiate between past experiences and the present situation in order to restructure dysfunctional posttraumatic cognitions with regard to safety and control (König, Resik, Karl, & Rosner, 2012). However, dysfunctional beliefs about safety during sleep are not part of standardized treatments. Consequently, anticipatory anxiety together with somatic pre-sleep arousal and subsequent maladaptive behaviors might contribute to prolonged trauma-related sleep disturbances, even after remission of other PTSD symptoms (Belleville et al., 2011). These are only theoretical considerations and research investigating the sensitivity of FoS across trauma-focused treatment is yet to be conducted. Though current sleep-focused treatments do not explicitly target FoS, promising findings have been reported recently. For example, studies using trauma-related nightmare treatments (e.g., ERRT) have reported reductions in FoS from pre- to post-treatment as well as during the follow-up assessments, together with reductions in overall sleep disturbances and PTSD symptom severity (Davis et al., 2011; Davis & Wright, 2007; Pruiksma et al., 2018). It is assumed that these treatments target mastery ("I can deal with/manage the nightmares"), which might increase a more general sense of control (Germain et al., 2004). Thus, it seems plausible that trauma-related nightmare treatments, such as ERRT, might also affect FoS. Other approaches, like CBT-I, have also shown moderate reductions in FoS after 8 weekly sessions with 29 individuals with PTSD and clinical insomnia (vs. 16 waitlist controls), although beliefs about the safety of the bed or bedroom were intentionally not targeted (Kanady et al., 2018). Given that reduced dysfunctional beliefs about sleep have been linked to better sleep in insomnia (Morin, Blais, & Savard, 2002), specifically changing dysfunctional beliefs about one's safety during sleep and the corresponding maladaptive behaviors (i.e., FoS) might reduce trauma-related sleep disturbances. Therefore, directly targeting FoS in addition to trauma-focused and/ or sleep-focused treatment in individuals with high levels of FoS might increase treatment response, especially with regard to trauma-related sleep disturbances.

Limitations

Some limitations must be considered when interpreting the current findings. First, although the LEC-5 and specific items regarding the index traumatic experience were used to identify trauma-exposed individuals according to PTSD criterion A as defined in the DSM-5 (Weathers et al., 2013), traumatic experiences and PTSD symptomatology were based solely on online self-report measures. Second, this is the first study to classify individuals on the basis of FoS, insomnia symptoms, nightmares, arousal, a self-report proxy for REM sleep fragmentation, and PTSD symptoms. Although meaningful cluster solutions were found, we were not able to validate cluster stability and meaningfulness of cluster membership with an external criterion. Therefore, it is essential to replicate and extend the present findings in diagnosed PTSD samples. For this purpose, we are currently collecting data in PTSD patients before trauma-focused treatment with

a twofold aim: 1) to investigate whether the results of the current study also hold for clinically diagnosed PTSD samples and 2) to validate the meaningfulness of the identified subgroups by using treatment outcome as an external criterion. Third, somatic pre-sleep arousal and sleep difficulties were only measured via self-report. Especially in sleep research the use of self-reported versus objectively measured sleep is an often discussed topic. However, the subjective "sleep quality" experience seems to cover aspects that cannot be exhaustively captured via objective indices yet (see Krystal & Edinger, 2008, for a discussion on this topic). The diagnosis of insomnia disorder is currently only based on subjective complaints (e.g., Harvey & Spielman, 2011), therefore focusing on subjective indices in clinical studies is a common approach. Fourth, the 3-item measure of nocturnal mentations, which was used as a self-report proxy for REM sleep fragmentation, showed low internal consistency and was the only variable that did not consistently differentiate between the healthy, subclinical, and clinical clusters. To increase the validity of this self-report proxy, future research should include physiological measures of arousal and REM sleep fragmentation. Finally, medication and substance use as well as other sleep disturbances that might occur in PTSD (e.g., sleep apnea, parasomnias, and disruptive nocturnal behaviors) were not assessed.

Conclusion

In sum, the data-driven, cluster-analytic approach used in this study clearly supports FoS as an important characteristic and possible additional treatment target of trauma-related sleep disturbances in individuals with PTSD. Current standard trauma-focused and/ or sleep-focused treatments seem to only moderately reduce trauma-related sleep disturbances, and residual sleep symptoms often remain. The present data support the proposition that FoS might offer an important construct involved in the development and maintenance of sleep disturbances after exposure to a traumatic event, at least in a subgroup of individuals suffering from PTSD. However, research about FoS is still in its infancy and additional studies are needed to investigate whether directly targeting FoS during treatment – particularly in PTSD subgroups with high FoS scores – might enhance treatment efficacy.

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Supplementary Materials

The supplementary materials include the dendrogram of the hierarchical cluster analysis as well as the corresponding agglomeration schedule (for access see Index of Supplementary Materials below):

Index of Supplementary Materials

Werner, G. G., Danböck, S. K., Metodiev, S., & Kunze, A. E. (2020). *Supplementary materials to "Pre-sleep arousal and fear of sleep in trauma-related sleep disturbances: A cluster-analytic approach"*. PsychOpen. https://doi.org/10.23668/psycharchives.3089

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Research Articles

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The Effect of Television and Print News Stories on the Nocebo Responding Following a Generic Medication Switch

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Abstract

Background: Following a nationwide switch to a generic antidepressant, a series of negative media stories publicised the experiences of some patients having side effects following the switch. This occurred first in print media and five months later it occurred again in television news. In this study we examined the effect of television news stories compared to print stories on adverse drug reaction reporting. We also examined the change in reporting rate of specific side effects mentioned in the TV news bulletins.

Method: Using an interrupted time series analysis of data from a national adverse reactions database, we compared the number of adverse reaction reports after the print and television coverage and the changes in reporting rate of side effects mentioned and not mentioned in TV news stories.

Results: We found a significant increase in adverse reaction reports following TV news items that discussed patients' reports of side effects following the medication switch (interruption effect = 73.25, p = .046). The reporting rate of symptoms mentioned in the TV news bulletins also increased, in particular suicidal thoughts (interruption effect = 23.60, p = .031). The effect of TV stories on adverse reaction reports was 211% greater than the print articles.

Conclusions: Television stories have a much stronger effect than print media on nocebo responding and specific symptoms mentioned in the bulletins have a direct influence on the type of side effects subsequently reported. Media guidelines should be developed to reduce the negative public health effects of media coverage following medication switches.

Keywords

nocebo effect, television media, print media, side effects, medication switch, generic medicine

Highlights

- This study shows that television news items have a considerably greater effect on the rate of adverse reaction reporting than print media.
- The specific side effects mentioned in the television coverage, especially suicidal thoughts, showed an increase in reporting.
- This study provides further evidence that media coverage of side effects can induce a nocebo effect and have negative effects on public health.

Negative media stories about medication can increase public anxiety and lead to a reduction in the use of the drug highlighted in the news story. Studies have shown that media coverage of the negative effects of statin medication is linked to the early discontinuation of the drug by patients in the United Kingdom (Matthews et al., 2016), Australia (Schaffer, Buckley, Dobbins, Banks, & Pearson, 2015) and France (Saib et al., 2013) and led to a subsequent increase in the rates of heart attacks and cardiac deaths in Denmark (Nielsen & Nordestgaard, 2016). While drops in rates of antidepressant dispensing have also been reported in the United States after widespread media coverage linking antidepressant medication to a possible increase in the risk of suicidal behaviour in young people (Yu et al., 2014).

Negative news coverage can also lead to an increase in the rate of adverse reactions reported to medication due to the nocebo effect (Petrie & Rief, 2019). This typically occurs following publicity about a particular drug's side effects, which increases the reporting of the specific side effects mentioned in the story, due to common symptoms being misattributed to the effect of the medicine (Tan et al., 2014). An increase in the rate of adverse drug reaction reports was shown in New Zealand following television news stories reporting that patients were experiencing problems after the appearance of a common thyroid replacement medication had changed due to a shift in manufacturing plant (Faasse et al., 2009; Faasse et al., 2012). A large increase in the adverse drug reactions reports to statins was also documented following a Dutch television programme on the benefits and risks of statins (Van Hunsel et al., 2009).

It seems likely that television may have a stronger effect on the nocebo response than print media, although this has not been formally investigated. Despite the increased role of the internet and a drop in the number of young people watching, television still reaches a larger audience than other forms of news media (Gollust et al., 2019). Television news is also seen as having an important role in surveillance, by informing the public what health risks to be vigilant of and concerned about (Brosius & Kepplinger, 1990). Television news stories about health risks also typically make more use of individual case studies and individual narratives as a key part of the story, which can play an important role in social modelling of side effects (Faasse & Petrie, 2016), as well as causing an overestimation of the likelihood of a health problem occurring (Gollust et al., 2019).

A recent nationwide switch from a branded to generic antidepressant medicine in New Zealand in 2017 provided us with the opportunity to investigate the impact of newspaper stories on the nocebo effect. In this previous study we examined how newspaper stories published in February and April 2018 influenced side effect reporting up to July 2018 (MacKrill et al., 2019). We found the number of side effects, particularly those mentioned in the stories, and complaints of reduced dug efficacy increased immediately after the newspaper stories before returning to baseline levels. However, later in the year after our paper was submitted, the medicine switch received more media attention, this time from television news. Four TV news stories were broadcast from September 2 to November 30 and discussed patients' negative reactions following the generic venlafaxine switch. The television news coverage of the same generic switch allowed us to quantify the relative impact of newspaper and television media on the nocebo response. Based on previous research we hypothesised that television news would have a larger impact. We also investigated the hypothesis that the specific side effects mentioned in the television news reports would increase adverse reaction reports to the national Centre for Adverse Reactions Monitoring (CARM), compared to previously equivalently reported side effects not mentioned in the television bulletins.

Method

Media Coverage

Newspaper Articles

In February and April 2018, two of New Zealand's largest print media outlets published three newspaper and online articles discussing a small group of patients' adverse reactions to the new generic version of the antidepressant venlafaxine (see Table 1). The previous year, 45,000 patients prescribed either the branded originator or a generic version of venlafaxine were switched to another generic, Enlafax. This compulsory nationwide switch had been initiated by Pharmac – the New Zealand government's pharmaceutical agency. The articles described patients' concerns that Enlafax was less effective and was causing side effects such as suicidal thoughts, nausea and headaches (see MacKrill et al., 2019 for further details of the newspaper reports).

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Table 1

New Zealand Print and Television Media Coverage of the Venlafaxine Brand Change

Date	News outlet	Item title	URL
Print media			
February 28 2018	New Zealand Herald	Patients say generic Pharmac-funded version of antidepressant venlafaxine left them depressed, anxious	https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12002918
February 28 2018	Stuff.co.nz	Anti-depressant swap: Sufferers claim generic drug is harming their condition	https://www.stuff.co.nz/national/health/101628317/antidepressant-swap-sufferers-claim-generic-drug-is-harming-their-condition
April 27 2018	Stuff.co.nz	Fight over Pharmac's switch to generic anti-depressant brand continues	https://www.stuff.co.nz/national/health/99388645/fight-over-pharmacs-switch-to-generic-antidepressant-brand-continues
Television media			
September 2 2018	One News	Growing number of patients questioning Pharmac's decision to fund a different brand of anti-depressant	https://www.tvnz.co.nz/one-news/new-zealand/growing-number-patients-questioning-pharmacs-decision-fund-different-brand-anti-depressant
September 26 2018	One News	Patients reporting life-threatening side effects from new antidepressant	https://www.tvnz.co.nz/one-news/new-zealand/patients-reporting-life-threatening-side-effects-new-antidepressant
October 20 2018	One News	Mental health specialists question new antidepressant's effectiveness	https://www.tvnz.co.nz/one-news/new-zealand/mental-health-specialists-question-new-antidepressants-effectiveness?auto=5851184169001
November 30 2018	One News	Patients claim discrimination after Medsafe warns about joint supplement but not antidepressant	https://www.tvnz.co.nz/one-news/new-zealand/patients-claim-discrimination-after-medsafe-warns-joint-supplement-but-not-antidepressant?auto=5973439901001

Television News Items

Five months after the print coverage, the venlafaxine brand change featured in a series of primetime news items on One News, New Zealand's largest television news broadcaster. The first item aired on September 2 and discussed the increasing number of patients questioning Pharmac's decision to fund a generic version of venlafaxine. Three patients were interviewed and stated that Enlafax had serious side effects, including increased suicidal ideation. While it is estimated that 2.4 of 4.8 million New Zealanders watch television each day (ThinkTV, 2018), RatingPoint, a television viewership database by analytics company Nielsen, shows that One News had an estimated audience of 679,500 viewers on September 2.

Later that month on September 26, another news item stated that more than 200 people had reported adverse reactions from the new generic some of which were considered life threatening. The side effects specifically mentioned were thoughts of self-harm and suicide, nightmares and feeling depressed. A General Practitioner was interviewed for the item and stated that the side effects were linked to Enlafax and called for patients' previous medication to remain available as an alternative to the generic. This news bulletin received slightly fewer views at 577,100.

On October 20, One News broadcast a third item on the venlafaxine brand change. This media report included interviews with patients as well as two mental health specialists who questioned the effectiveness of the generic Enlafax. Patients reported feeling disorientated, having a foggy brain and experiencing brain zaps. In a statement, Pharmac and Medsafe (New Zealand's medicine's safety authority) stood by the decision to change the funded brand of venlafaxine, emphasising that the medications are pharmaceutically identical. This item received 395,000 views, the lowest of the four items.

The last media report on November 30 discussed patients' claims of discrimination, as the New Zealand government's Ministry of Health had released two public health warnings about an over-the-counter supplement but had not issued a warning about venlafaxine, despite patient complaints. This item received 540,600 views and no side effects were mentioned. All four One News items were aired early in the nightly news bulletin between 6pm to 6:15pm. In 2018, One News had the highest ratings of all programmes in New Zealand and was the most watched news programme (Nielsen, 2018).

Outcome Measures

Number of Adverse Reaction Reports

The primary variable of interest to this study was the number of adverse reaction reports submitted to CARM each month. Both healthcare professionals and patients can submit a report describing a suspected adverse reaction from a medicine or vaccine directly to CARM. Adverse reaction data was collected from October 2017 to March 2019 which

covered a four-month period before the print articles (February 28 – April 27) to four months after the TV bulletins (September 2 – November 30).

Total Side Effects and Decreased Therapeutic Response

The total number of side effects reported each month was calculated by summing each patient's side effect reports excluding decreased therapeutic response, which was calculated separately.

Specific Side Effects

We calculated the reporting rate for suicidal thoughts, foggy brain and brain zaps that were mentioned in the television news items. The CARM side effects categories of suicidal ideation, suicidal tendency, suicidal attempt, thoughts of self-harm, and intentional self-injury were summed and recoded as suicidal thoughts. Both foggy brain and brain zaps mentioned in the television items do not have specific terms in the CARM database. We used reports of fuzzy head and electrical shock sensations as the closest coded categories. We compared the side effects that were mentioned in the television coverage with three control side effects that were not mentioned in television bulletins but were reported at similar rates prior to the media coverage. These control side effects were dizziness, drug withdrawal syndrome and irritability.

Statistical Analyses

Three analyses were conducted to investigate the study hypotheses. An interrupted time series analysis was conducted to determine whether the television news items were associated with an increase in CARM reports, total side effects, reports of decreased therapeutic response, and the specific side effects of suicidal thoughts, foggy brain, brain zaps, dizziness, drug withdrawal syndrome and irritability. An automated integrated moving average model (ARIMA [1,0,1]) was used. To indicate the presence of the television media in the model, an independent binary variable was created with the months September to December 2018 coded 1 and the five baseline pre-media months coded 0. This analysis produces an estimated interruption effect (the change in rate between the months coded 0 and 1) and indicates whether this is a significant change.

In addition to this analysis, the number of adverse reaction reports was modelled using general linear modelling (GLIMMIX) assuming a Poisson distribution to test for differences in the total number of reports in discrete time periods: 5 pre-media baseline months, 3 months during the print media stories, the next 3 months (a pre-TV, no media period), 4 months during which television media reports appeared, and an additional post-TV 3 months. These time periods were pragmatically determined: initiated by the start of each type of media report and ending when reports had returned to the pre-media reporting baseline. Tukey's HSD test was used to protect the overall 5% significance level after pairwise post hoc comparison of time periods.

To examine the effect of print versus television media on adverse reporting, a Poisson Events Test was conducted comparing total number of reports between pairs of months, specifically the peak month of reporting during the print media period and the peak during the TV media period. Percentage change was used to describe the effect of the print and television media on number of CARM reports. Analyses were conducted in SAS (v9.4 SAS Institute Inc., Cary, NC) and alpha level of .05 was considered significant for all analyses.

Results

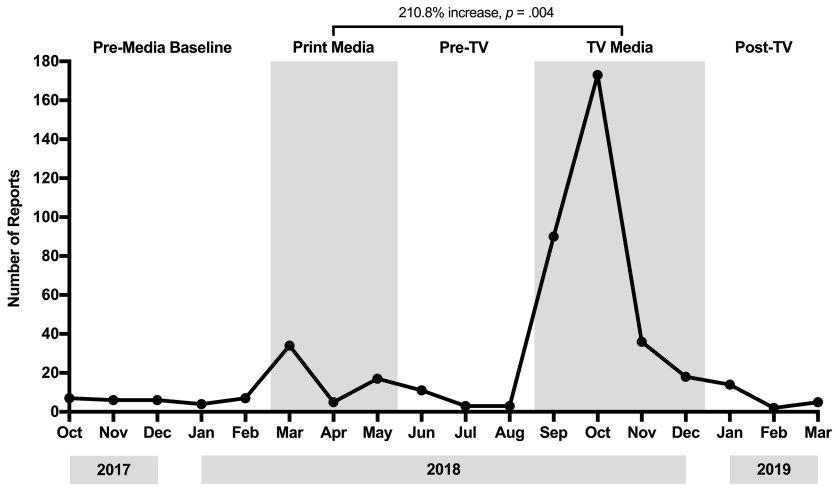
Number of Adverse Reaction Reports

From August 2018 to March 2019 there were 341 adverse reaction reports to CARM, with 317 of these occurring during the four-month period when the television items aired. The average age of reporters was 44.3 years old and 79.1% were female. These demographic proportions are similar to the total population of people taking venlafaxine in New Zealand, the median age range being 40-49 years and 64.5% identifying as female (MacKrill & Petrie, 2018).

The first aim of this study was to examine the impact of the television coverage on adverse event reporting and compare this with what was observed following the print media. There were significant differences between time periods in the number of adverse reaction reports (GLIMMIX $p < .001$). In the five months before any print or television media (October 2017 to February 2018), there was an average of 6.00 (SD = 1.23) adverse reaction reports to CARM per month. However, in the four months where the television coverage occurred, CARM reports significantly increased to an average of 79.25 (SD = 60.26) reports per month (interruption effect [IE] = 73.25, $p = .046$). Comparing the average effect of print versus television media, CARM reports following the television coverage were 210.8% greater than those that followed the print (mean number of reports = 25.50, SD = 12.02), which was a significant difference (GLIMMIX $p = .004$) as shown in Figure 1. A Poisson Events Test showed that the peak month of adverse reaction reporting during the television coverage was 408.8% greater than the peak during the print media period ($p < .001$).

Figure 1

The Effect of Television Compared to Print Media Stories on Total Number of Adverse Reaction Reports to the Centre for Adverse Reactions Monitoring Following a Switch to Generic Venlafaxine



Note. The number of adverse reaction reports during pre-media baseline was not significantly different to the reporting rate pre (GLIMMIX p = .220) or post (GLIMMIX p = .120) the television coverage.

Total Number of Side Effects and Decreased Therapeutic Response Reports

Individual CARM reports submitted from August 2018 to March 2019 listed an average of 2.88 side effects attributed to Enlafax. The rate of side effect reporting significantly changed from baseline to post-television. The total number of side effects reported to CARM significantly increased from an average of 7.00 reports (*SD* = 4.18) per month before any media coverage to 235.75 (*SD* = 184.77) following the television items (IE = 228.75, p = .042). Reports of 'decreased therapeutic response' increased from 4.00 (*SD* = 2.12) before the media to 52.25 (*SD* = 39.35) after the television, however this was not a statistically significant change (p = .064).

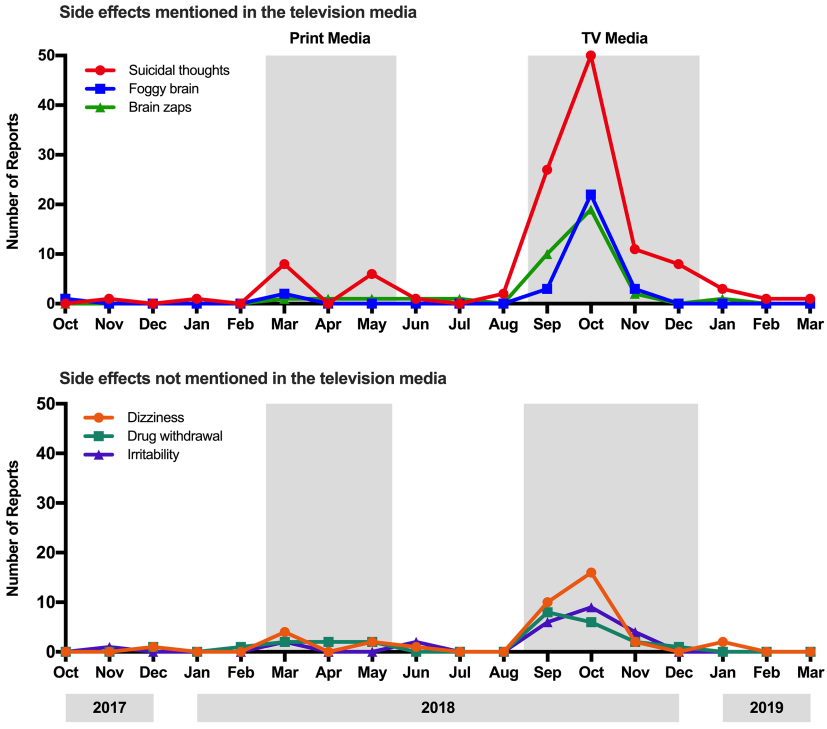
Specific Side Effects Reports

We investigated the change in reporting of rate of three side effects that were mentioned in the television coverage (Figure 2). The generalised mixed model and interrupted time series analyses both showed a significant increase in reports of suicidal thoughts from an average of 0.40 (*SD* = 0.55) in the five months before any media coverage to 24.00 (*SD* = 16.66) following the television (GLIMMIX p = .029; IE = 23.60, p = .031). The reporting rate of foggy brain did not show a statistically significant increase in the number of

reports in each time period (GLIMMIX p = .160; IE = 8.13, p = .160), however there was an increasing trend with reports going from 0.20 (*SD* = 0.40) before the media coverage to 8.33 (*SD* = 9.74) after the television item aired in October. While there were no reports of brain zaps during the pre-media period, the rate increased to an average of 7.00 (*SD* = 8.52) but this was not significantly different to baseline (GLIMMIX p = .150; IE = 7.00, p = .098).

Figure 2

Number of Reports of Side Effects Mentioned in the Television News Reports on the Venlafaxine Switch Compared to Side Effects That Were not Mentioned



Finally, we examined whether there was a change in the reporting rate of three side effects that were not mentioned in the media (Figure 2). Reports of dizziness increased from an average of 0.20 (*SD* = 0.40) over the five baseline months to 7.00 (*SD* = 6.40) following the television coverage, which has a statistically significant interruption effect (IE = 6.80, p = .024), however, the general linear model was not statistically significant (GLIMMIX p = .110). The reporting rate of drug withdrawal syndrome did not significantly change from 0.40 (*SD* = 0.49) to 4.25 (*SD* = 2.86) after the television media (GLIMMIX

p = .470; IE = 3.85, p = .180). Similarly, reports of irritability did not significantly change from 0.20 (*SD* = 0.40) to 4.75 (*SD* = 3.27) (GLIMMIX p = .011; IE = 4.55, p = .240).

Discussion

Main Findings

This study found a significant increase in the number of adverse reaction reports following a switch to a generic formulation of venlafaxine, which corresponded to the broadcast of four television news items that discussed this medication change. In line with our hypothesis, we found the effect of TV stories on adverse reaction reports to CARM was significantly higher than print media, causing an approximately 200% greater rise in adverse reaction reports than the publication of the print articles earlier that year. Television news also had a 400% greater peak in reported adverse reports compared to print media, indicating a much stronger nocebo response. There was also partial support for the hypothesis that the specific symptoms mentioned in the TV coverage would be reflected in subsequent side effect reporting. There was an increase in the reporting of side effects mentioned in the television items, especially suicidal thoughts, and although this was generally larger than the symptoms that were not mentioned, it could be that TV coverage causes a greater awareness of side effects in general, rather than being restricted to those specifically mentioned in the bulletins.

Looking at the reasons why TV has a much stronger effect than print media, it seems unlikely that this is due to the use of expert opinion or difference in the amount of coverage (3 print versus 4 TV stories). A more likely explanation is that television contains a stronger and more impactful modelling element by including real patient stories and experiences that can be easily identified with by viewers (Faasse, Grey, Jordan, Garland, & Petrie, 2015; Faasse & Petrie, 2016).

Comparison With Other Studies

The results are consistent with data in the medical area showing intense negative media coverage on statins was followed by an increase in patients stopping the drug (Matthews et al., 2016; Schaffer et al., 2015). The results also align with previous work on TV news stories. For example, the Thyroxine drug scare produced an increase in both symptom reporting and the specific symptoms mentioned in bulletins, increasing adverse reaction reports by 1,866% following the first television news story (Faasse et al., 2012). The current study showed an even larger increase in adverse reaction reports after the first television news bulletin of 4,283%. More widely, the data are consistent with the powerful social modelling effects of TV in the context of suicidal behaviour (Hawton & Williams, 2002), mass shootings (Meindl & Ivy, 2017) and the transmission of acute stress following terrorist attacks (Holman et al., 2014). The unique contribution of this paper is

to quantify the relative impact of television compared to print media and to demonstrate how much more impact TV has in the context of a health scare.

It may be that the nature of the population taking venlafaxine could have influenced the strength of the nocebo response. The indications for the drug are for depressive and anxiety disorders and the nocebo effect has been shown to occur more frequently in patients being treated for psychological conditions (Weissenfeld et al., 2010). Individuals taking venlafaxine may have been more reactive to negative stories, increasing their overall concerns about the medication. It is likely that the increased nocebo response apparent following media coverage arose from an overall increase in anxiety, increased expectations of side effects and greater personal monitoring of the side effects specifically mentioned in these bulletins (Crichton et al., 2014; Faasse & Petrie, 2016; Petrie, Moss-Morris, Grey, & Shaw, 2004; Petrie & Rief, 2019). Of particular concern in such situations is the media transmission of suicidal thoughts, which seem to be easily converted into increased rates of suicidal ideation following both print and television media stories and possibly greater rates of suicidal behaviour, although this has yet to be determined in this situation.

Strengths and Limitations

The study is limited by reliance on reporting to the national centre and is likely to be a low estimate of the true rate of nocebo response following the media stories as many patients would not have reported symptoms to CARM or to a health professional. It is also likely that many doctors may not have taken the time to file a report. Previous studies estimate that reports to a national database are less than 10% of adverse drug reactions (McGettigan et al., 1997). As the reports to CARM are de-identified we are unable to examine other personal characteristics that may be associated with increased or decreased nocebo responding. However, people who are older, female and with lower medicine efficacy beliefs have been shown to report more side effects following a generic medicine switch (MacKrill & Petrie, 2018). It should be also noted that the current study only had access to adverse reaction reports per month. This makes it more difficult to separate out media effects from background noise compared to a finer grain of measurement such as weekly reports.

In conclusion, we believe this is the first study to compare the effect of both print and television media on medication adverse event reporting. We found television news stories have around a 200% stronger effect on nocebo responding than print media and cause an immediate increase in overall adverse reaction responding as well as influencing the type of symptoms reported following the coverage. Television news coverage can easily increase overall anxiety about a medication and cause individuals to focus on their symptoms as possible side effects. The transmission of symptoms of suicidal ideation is of special concern as there is good evidence of a strong modelling effect on suicidal behaviour from media stories (Hawton & Williams, 2002). We believe the data indicate

that media guidelines should be developed to reduce the possible harm from stories that focus on dramatic negative effects reported by individual patients to include information from a wider range of professionals and agencies as well as including information about the nocebo response.

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Biased Perception of Physiological Arousal in Child Social Anxiety Disorder Before and After Cognitive Behavioral Treatment

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Abstract

Background: A biased perception of physiological hyperreactivity to social-evaluative situations is crucial for the maintenance of social anxiety disorder (SAD). Alterations in interoceptive accuracy (IAc) when confronted with social stressors may play a role for SAD in children. We expected a biased perception of hyperarousal in children with SAD before treatment and, consequently, a reduced bias after successful cognitive behavioral therapy (CBT).

Method: In two centers, 64 children with the diagnosis of SAD and 55 healthy control (HC) children (both 9 to 13 years) participated in the Trier Social Stress Test for Children (TSST-C), which was repeated after children with SAD were assigned to either a 12-week group CBT (n = 31) or a waitlist condition (n = 33). Perception of and worry about physiological arousal and autonomic variables (heart rate, skin conductance) were assessed. After each TSST-C, all children further completed a heartbeat perception task to assess IAc.

Results: Before treatment, children with SAD reported both a stronger perception of and more worry about their heart rate and skin conductance than HC children, while the objective reactivity of heart rate did not differ. Additionally, children with SAD reported heightened perception of and increased worry about trembling throughout the TSST-C compared to HC children, but reported increased worry about blushing only after the stress phase of the TSST-C compared to HC children. Children with and without SAD did not differ in IAc. Contrary to our hypothesis, after treatment, children in the CBT group reported heightened perception of physiological arousal and increased worry on some parameters after the baseline phase of the TSST-C, whereas actual IAc remained unaffected. IAc before and after treatment were significantly related.

Conclusions: Increased self-reported perception of physiological arousal may play a role in childhood SAD and could be an important target in CBT. However, further studies should examine if this is an epiphenomenon, a temporarily occurring and necessary condition for change, or indeed an unwanted adverse intervention effect.

Keywords

bodily arousal, social phobia, CBT, therapy, interoceptive awareness, heartbeat perception

Highlights

- Biased perception of physiological arousal may play a role in child social anxiety disorder (SAD).
- Faced with standardized social stress, biased perception of heart rate but not skin conductance.
- No change in biased perception due to cognitive-behavioral treatment.
- Further research regarding the nature of biased perception (e.g. epiphenomenon) necessary.

Social anxiety disorder (SAD) is a highly prevalent disorder (Burstein et al., 2011) that leads to great impairment in the well-being and everyday life of affected children (Rao et al., 2007). Cognitive models of SAD (e.g., Clark & Wells, 1995) point to the importance of an increased focus on cognitions, feelings, and behaviors. In addition, a person with SAD is also alarmed by physiological reactions in social situations. In line with cognitive models, the subjective awareness of physiological and emotional arousal is interpreted negatively, which leads to an overall negative self-perception followed by elevated fear of and avoidance of social situations.

A (physiological) anxiety reaction was required in the Diagnostic and Statistical Manual for Mental Disorders (4th ed., text rev.; DSM-IV-TR; American Psychiatric Association [APA], 2000). This has been revised in the latest version, allowing to display any sign of fear, not necessarily physiologically (DSM-5, APA, 2013). This change reflects that the objective physiological reaction is not yet fully understood: Several studies have shown tonic hyperarousal in children with SAD (Asbrand, Blechert, Nitschke, Tuschen-Caffier, & Schmitz, 2017; Krämer et al., 2012; Miers, Blöte, Sumter, Kallen, & Westenberg, 2011; Schmitz, Tuschen-Caffier, Wilhelm, & Blechert, 2013). However, research has failed to find heightened physiological reactivity to disorder-typical stress (for an overview see Siess, Blechert, & Schmitz, 2014). Still, both children and adults with SAD have reported increased perception of physiological arousal (Gerlach, Mourlane, & Rist, 2004; Schmitz, Blechert, Krämer, Asbrand, & Tuschen-Caffier, 2012). Therefore, it has been hypothesized that cognitive factors (e.g., attention allocation and evaluation) are also relevant for physiological factors. That is, people with SAD are more prone to shift their attention towards physiological arousal and evaluate this arousal as more threatening (Clark &

Wells, 1995; Siess et al., 2014). Attentional biases have previously been examined mostly for external cues, such as angry versus happy faces, with measures of reaction times or with eye tracking (for an overview in adults see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). Similar to studies of adults, a meta-analysis of anxious compared to nonanxious children (Dudeney, Sharpe, & Hunt, 2015) showed a significant attentional bias to threat. While these findings on external attentional biases are in line with Rapee and Heimberg's (1997) theoretical model of SAD, the importance of other biases, also suggested by current cognitive models (e.g., Clark & Wells, 1995; Rapee & Heimberg, 1997) have received less attention, specifically internal perceptional biases. The processing of internal perceptional information is likely dependent upon their (believed) visibility for others:

Certain internal symptoms (e.g. increased heart rate, nausea) are relevant for the experience of anxiety in general but are not overly visible (cognition: "My heart is racing, this must mean that I am anxious"). However, other physiological symptoms are clearly visible (e.g. blushing, sweating, trembling) and are, therefore, extremely relevant for the fear of being judged (cognition: "I am blushing, others can see how anxious I am"). As such, these physiological symptoms are relevant for the experience of SAD specifically. One previous study in children aged 10 to 12 years with high versus low social anxiety (Schmitz et al., 2012) manipulated heart rate visibility by applying a heart rate feedback tone while children told a story in a "private" condition (head phones) and a "public" condition (with adult observers present). Children with high social anxiety perceived their heart rate as higher than low socially anxious children when they listened to their (supposedly own) heart rate both in private and in public with adult observers present. Further, the public condition led to more worry about the heart rate visibility only in children with high social anxiety. This study demonstrated that both perception of and worry about visibility of physiological arousal (i.e. evaluation) is elevated in socially anxious children. As this study examined a subclinical sample, it is necessary to assess children with SAD to assure the stability of this phenomenon in clinically affected children. Additionally, as the study used a set-up specific to perception of and worry about heart rate, it should be tested if this finding is stable in a well-established social stress test, the Trier Social Stress Test for Children (TSST-C; Buske-Kirschbaum et al., 1997) and using more than one physiological parameter (Siess et al., 2014).

To reveal the underlying processes of biased perception in children with SAD, it is required to assess different facets of interoception: First, 'interoceptive accuracy' (IAc) represents the correspondence between actual and perceived physical signals (e.g., heartbeats). Second, the subjective tendency to be focused on physical signals is considered 'interoceptive sensibility' (IS) (Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015). Third, 'interoceptive evaluation' (IE) reflects subjective affective valence of physical sensations such as worry about visibility (Pollatos & Herbert, 2018). While the attentional biases refer more closely to IS and IE, IAc should be additionally considered. The heartbeat

counting task (HCT) has been established as most common approach to assess cardiac IAc in adults and in school children with and without anxiety symptoms (Eley, Gregory, Clark, & Ehlers, 2007; Eley, Stirling, Ehlers, Gregory, & Clark, 2004; Georgiou et al., 2015; Koch & Pollatos, 2014; Schandry, 1981; Schmitz et al., 2012). For example, Antony et al. (1995) assessed IAc based on HCT and heart rate (HR) in adult patients with panic disorder and SAD compared to healthy controls (HC). Groups did not differ in IAc at rest or after exercise. However, self-reported anxiety was positively related to IAc. In a child community sample (Eley et al., 2004), children between 8 and 11 years completed the HCT. After a distinction into good and poor heartbeat perceivers based on IAc scores, good perceivers reported significantly higher panic and/or somatic symptoms and were more sensitive to anxiety. Similarly, higher levels of panic and/or somatic symptoms were positively related to IAc. Both findings suggest that a proper perception of physical sensations (IAc) enhances their interpretation as potentially threatening (IE) in SAD. Furthermore, Schmitz et al. (2012) did not find differences in IAc based on the HCT between children with high and low social anxiety, which implies that IAc and IE may dissociate under specific circumstances. The authors assume that socially anxious children overestimate their HR under stress (i.e. over-reporting of cardiac sensations) but are able to perceive their heartbeat correctly in the recovery period after stress (Mauss, Wilhelm, & Gross, 2004; Pollatos, Traut-Mattausch, Schroeder, & Schandry, 2007). In summary, the role of IAc, IS and IE (including over-reporting of cardiac sensations) in fully manifested SAD remains unclear.

If biased perception (IS) and evaluation (IE) of physiological symptoms and/or IAc are central factors in childhood SAD, a longitudinal assessment measuring stability and changeability by treatment is a plausible next step (e.g., Siess et al., 2014). Once again, previous research focused on treatment effects on other biases, for example, interpretation biases (Leigh & Clark, 2018). However, theoretical models placed the misperception of physiological symptoms as central for SAD (e.g., Clark & Wells, 1995), which leads to the assumption that cognitive behavioral therapy (CBT) might change this perception bias. Interestingly though, most treatments of SAD do not explicitly focus on a biased perception of physiological symptoms but rather on general cognitions in and after social situations and on behavior in children (e.g., Beidel & Turner, 2007). However, as pointed out above, the importance of including specific treatment components targeting physiological reactions cannot be fully supported by empirical evidence, as findings on physiological hyperarousal are inconsistent (Siess et al., 2014).

The Current Study

On objective measures (heart rate, electrodermal activity [EDA]), we expected children with SAD to show only tonic hyperarousal and no increased reactivity to social stress compared to children in a healthy control (HC) group (Asbrand et al., 2017; Schmitz et al., 2013). On subjective measures, we expected all children to report perception (i.e. IS)

of and worry (i.e. IE) about physiological variables (heart rate, perspiration, blushing, trembling)[1] that increases from baseline to stress and then decreases to recovery. This effect, that is, heightened perceived reactivity, has been hypothesized to be stronger in children with SAD compared to HC children (Schmitz et al., 2012). In line with previous findings, we expect a positive correlation between physiological activation (e.g., heart rate) and IAc. After children with SAD were assigned to a treatment (group CBT) or waitlist control (WLC) group, we expected only small differences in objective measures (heart rate, EDA) on a second TSST-C. We expected differences in subjective measures, i.e. children in the CBT group reporting less perception of and worry about physiological variables compared to children in the WLC group and compared to results of the TSST-C before treatment.

Method

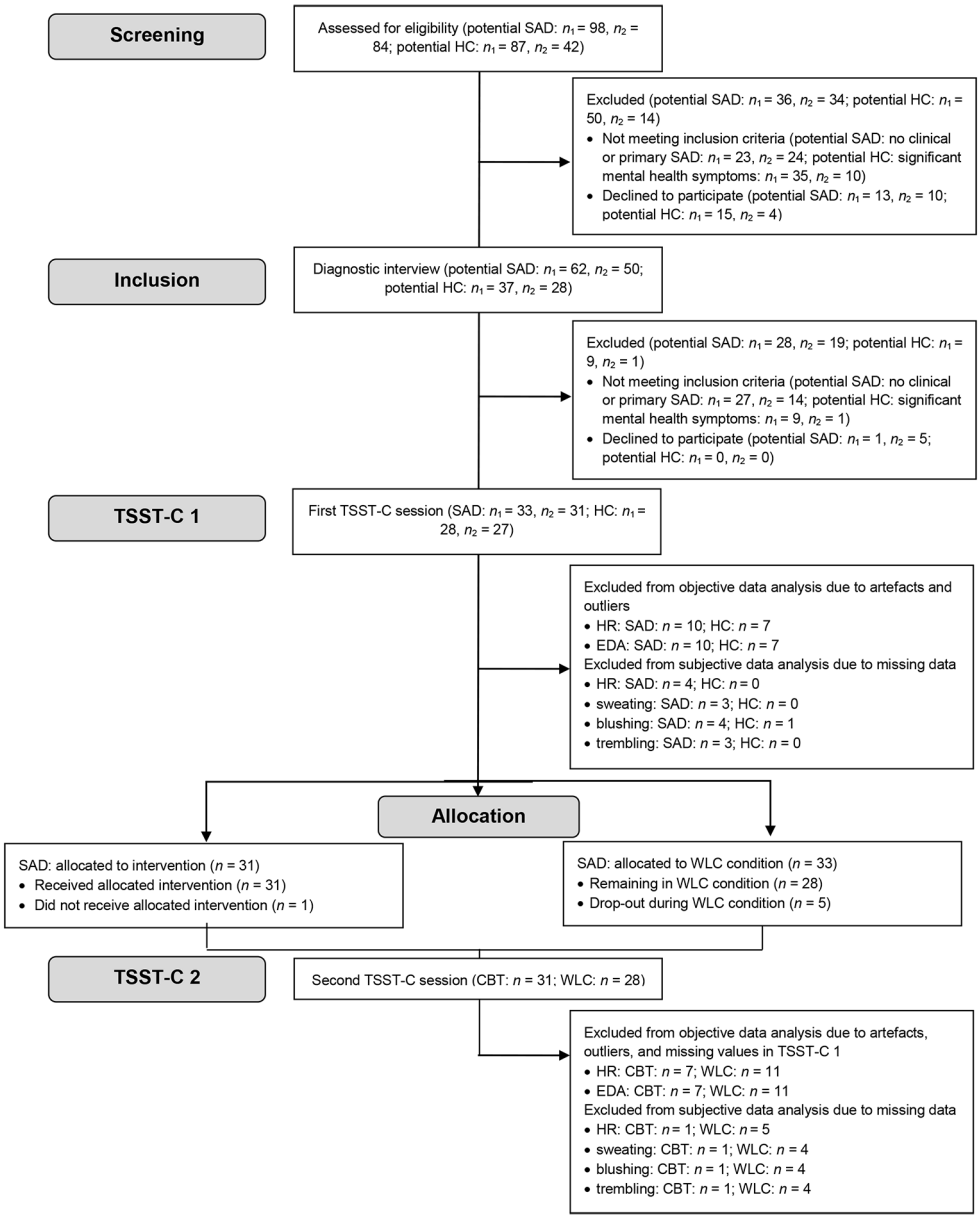
Trial Design

The study was designed as a randomized controlled trial (block randomization, in which half of the participants were allocated by drawing from a hat to an experimental condition receiving immediate treatment and half to a WLC condition receiving treatment about 16 weeks later; for an overview see Figure 1). Randomization for each research center was conducted in a concealed fashion by the other center, based on subject codes, as soon as there were enough participants for one experimental and one WLC allocation. Eligibility criteria were registered with the German Research Foundation (TU 78/5-2, HE 3342/4-2) prior to recruitment and not changed during the study. This study was part of a larger project. The overall project consisted of experimental studies related to research questions of visual attention allocation or psychophysiological processes under (social) stress and it also aimed to measure treatment success by including several outcome variables (state anxiety, negative cognitions, physiological arousal, perception of and worry about physiological symptoms, perception of academic performance, negative post-event processing, parental cognitions, parental fear of negative child evaluation, and related treatment outcome predictions). Due to the extent of the project and limitations on length and foci in articles, not all treatment related results could be reported in a single manuscript. Further results are reported elsewhere (treatment outcome, Asbrand, Heinrichs, Schmidtendorf, Nitschke, & Tuschen-Caffier, 2020; changes in post-event processing based on treatment, Asbrand, Schmitz, et al., 2019; stability of the cortisol response despite treatment, Asbrand, Heinrichs, Nitschke, Wolf, Schmidtendorf,

1) Heart rate and perspiration were chosen to be assessed objectively as well. While the project further included other physiological variables (e.g. cortisol; Asbrand, Heinrichs, Nitschke, Wolf, Schmidtendorf, & Tuschen-Caffier, 2019), these do not have a subjective counterpart which can be assessed by self-report. Due to technical limitations, we could not assess blushing and trembling as objective parameters.

Figure 1

Flowchart of Study Participants



Note. n_1 = Center 1, n_2 = Center 2; CBT = cognitive behavioral therapy; EDA = electrodermal activity; HC = healthy control; HR = heart rate; SAD = social anxiety disorder; TSST-C = Trier Social Stress Test for Children; WLC = waitlist control.

& Tuschen-Caffier, 2019) or are being prepared for submission (social performance, detailed psychophysiological activity pre and post treatment).

To ensure maximal transparency, all articles include cross-references to other reports on measures used to investigate potential treatment-related effects. The current study reports primary outcome variables relating to perception of (IS) and worry about physiological symptoms heart rate and EDA (IE). The inclusion of subjective perception of and worry about blushing and trembling as well as cardiac IAc was included post-hoc. The sample size for the current study, based on a medium to large effect (Schmitz et al., 2012) and power of (1 - β) = .80, was set at n = 90 (each group n = 45). As the study was part of a larger research project (see footnote) requiring a larger sample size of n = 110, all children were included to increase power. Because the data are being used in a large project, this Method section has been reported before in a similar fashion (Asbrand, Heinrichs, et al., 2019; Asbrand, Schmitz, et al., 2019).

Participants

We informed parents of anxious children (9 to 13 years) through advertisements in schools, medical facilities, and newspapers in two midsized German cities from January 2012 to November 2013 until the targeted sample size had been reached (for an overview see Figure 1). No harms were reported. Parents received €35, and children €25 in vouchers in compensation for participation in the laboratory study. Ethical approval for this study was granted by an independent ethics committee (ethics committee of the German Society for Psychology). All participating children and their caregivers consented to participation in both oral and written form.

Inclusion criterion for children consisted of SAD as a primary diagnosis in the SAD group and no current or lifetime diagnosis of a mental disorder in the HC group. Exclusion criteria entailed health problems or medication which could have interfered with psychophysiological assessment (e.g., asthma, cardiac arrhythmia, and methylphenidate). As can be seen in Table 1, the groups did not differ in age, type of school, or any of the disorder-specific measures. Social Phobia and Anxiety Inventory for Children (SPAI-C) scores exceeded suggested cut-offs for clinically relevant SAD.

Table 1

Participant Characteristics of the Experimental Groups (Social Anxiety Disorder vs. Healthy Controls)

	Group		
Characteristic	**SAD**	**Healthy controls**	**Statistics**
n[a]	64	55	
Mean age (*SD*), in years	11.3 (1.4)	11.3 (1.4)	$t(117) = 0.06$, n.s.
Female	63.6%	60.0%	$\chi^2(1) = 0.17$, n.s.
Mean SPAI-C (*SD*)	23.3 (9.03)	4.2 (5.4)	$t(117) = -13.71^{***}$

Characteristic	Group		Statistics
	SAD	Healthy controls	
Net income (per month)			$\chi^2(8) = 11.42$, n.s.
n.a.	0%	1.3%	
< €1,000	0%	5.9%	
€1,001–1,500	1.9%	7.4%	
€1,501–2,000	11.1%	8.8%	
€2,001–3,000	35.2%	32.4%	
€3,001–4,000	14.8%	16.2%	
€4,001–5,000	14.8%	20.6%	
> €5,000	22.2%	7.4%	
Mean (*SD*) state anxiety during TSST-C (before treatment)	6.6 (2.8)	4.5 (2.9)	$t(117) = 4.05^{***}$

Note. Table adapted from Asbrand, Schmitz, et al. (2019). Reprinted with permission. SPAI-C = Social Phobia and Anxiety Inventory for Children; TSST-C = Trier Social Stress Test for Children; n.a. = not available.
[a]Sample sizes differ as not all questionnaires were completed correctly.
$^{***}p \leq .001$, n.s. = not significant.

Further, in the SAD group, children in the two conditions (CBT vs. WLC) did not differ in sociodemographic and psychopathological variables (see Table 2).

Table 2

Participant Characteristics of Children With Social Anxiety Disorder Allocated to the Treatment Versus Waitlist Group

Characteristic	Group		Statistics
	Treatment (CBT)	Waitlist control	
n[a]	31	33	
Mean age (*SD*), in years	11.5 (1.4)	11.2 (1.3)	$t(62) = 0.78$, n.s.
Female	51.6%	67.6%	$\chi^2(2) = 1.88$, n.s.
Mean SPAI-C (*SD*)	11.8 (7.3)	12.1 (7.1)	$t(62) = 0.18$, n.s.
Net income (per month)			$\chi^2(7) = 6.65$, n.s.
n.a.	3.2%	0.0%	
< €1,000	6.5%	5.6%	
€1,001–1,500	9.7%	5.6%	
€1,501–2,000	6.5%	8.3%	
€2,001–3,000	41.9%	23.7%	
€3,001–4,000	16.1%	16.7%	
€4,001–5,000	9.7%	30.6%	
> €5,000	6.5%	8.3%	
Mean (*SD*) state anxiety during TSST-C (before treatment)	6.7 (2.9)	6.6 (2.8)	$t(62) = 0.10$, n.s.

Note. Table adapted from Asbrand, Schmitz, et al. (2019). Reprinted with permission. CBT = Cognitive behavioral therapy; n.a. = not available; SPAI-C = Social Phobia and Anxiety Inventory for Children; TSST-C = Trier Social Stress Test for Children.
[a]Sample sizes differ as not all questionnaires were completed correctly.
$^{***}p \leq .001$. n.s. = not significant.

Procedure

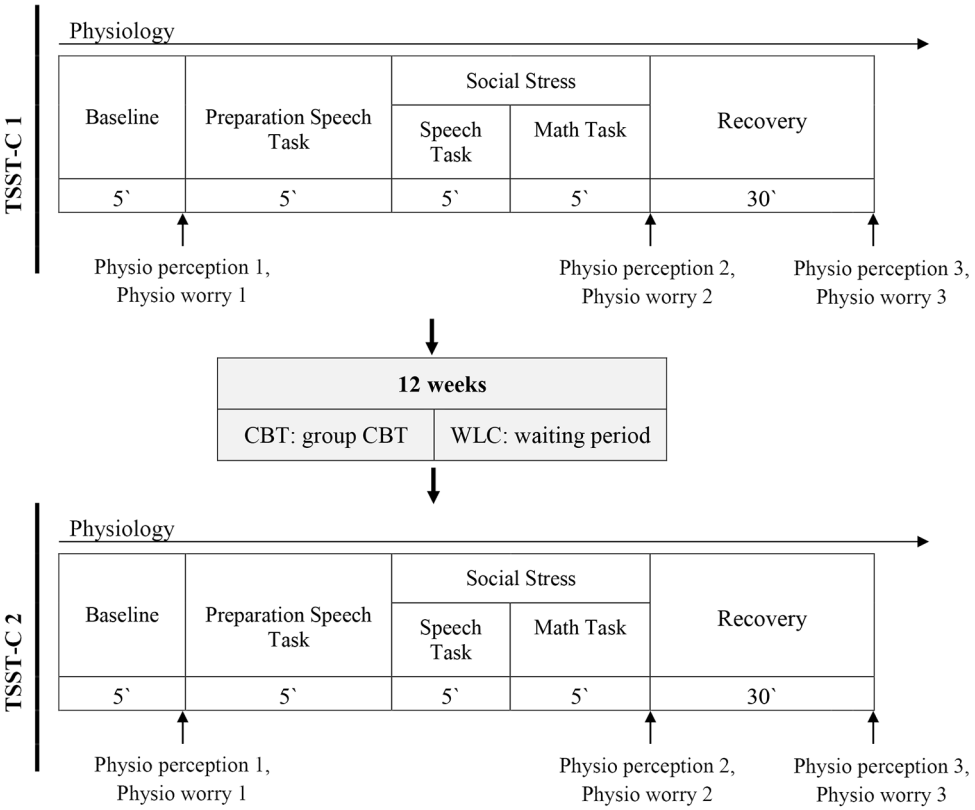
The study took place at two German universities. All analyses first considered site differences, which were non-existent. Following a short telephone screening for anxiety symptoms, eligible children and their parents attended a diagnostic session (see flowchart in Figure 1). Both the child and a parent separately participated in the Kinder-DIPS, a structured interview that codes for mental disorders in children and adolescents (Schneider, Unnewehr, & Margraf, 2008). Diagnoses of SAD and comorbid disorders (*DSM-IV-TR*, APA, 2000) were then reached through combining both interviews, supervised by an experienced clinical psychologist. Diagnoses were assigned under supervision of the same licensed clinical psychologists per site throughout the project (one psychologist at the first, two psychologists at the second center). The Kinder-DIPS is a validated interview for the most frequent mental disorders in children and adolescents (Schneider et al., 2008). The Kinder-DIPS is conducted by trained interviewers and the diagnosis is usually based on both child and parent reports. The authors have reported adequate interrater reliability (87% for anxiety disorders), good retest reliability (Schneider et al., 2008), and successful validation with disorder-specific questionnaires. Additionally, children and parents reported sociodemographic data, anxiety symptoms, and general psychopathology in online questionnaires. According to the diagnostic assessment, 65 children fulfilled the inclusion criterion of a primary diagnosis of SAD; 55 children were included in the HC group.

After the diagnostic interviews children participated in the first laboratory session, the TSST-C (Buske-Kirschbaum et al., 1997), which consists of a speech and a math task (see Figure 2). In the speech task, children narrate a story in front of two observers after listening to the beginning of the story. In the following mental arithmetic task, children were asked to serially subtract the number 7 from 758 (9- to 11-year-olds) or the number 13 from 1,023 (12- to 13-year-olds) as fast and as accurately as possible again in front of two observers. Both observers were instructed and trained to give neutral verbal and nonverbal feedback. The TSST-C elicits high social-evaluative stress in children (cf. Allen et al., 2017). Throughout the session, heart rate and skin conductance level were assessed. Further, perception of (IS) and worry about physiological symptoms (IE) were assessed after baseline, stress, and recovery (see Figure 2). After a recovery period, children performed the HCT to assess IAc (see below). As the current project focused on the climax of social stress, only this time of measurement was included in the analyses. Assessments of perception and worry were based on a previous study (Schmitz et al., 2012): Children were asked to rate their perceived level of physiological intensity during the task (e.g., "How strongly did you feel your heartbeat during the task?") and their worry about their physiological symptoms ("How much did you worry that others could notice how fast your heart was beating?" on a scale of 0 (*not at all*) to 10 (*extremely*). After participating in a 12-week CBT program (CBT group) or waiting without treatment (WLC group), all children performed a parallel version of the first testing session. Based on the original

TSST-C (Buske-Kirschbaum et al., 1997), the speech task was changed to a different story that was judged to be similarly interesting and difficult in a preevaluation. The math task was changed to a different start number (+10). The TSST-C reliably induces social anxiety in all children, even more so in children with SAD compared to healthy control children, $p < .001$.

Figure 2

Overall Procedure Including the Trier Social Stress Test for Children (TSST-C) Before (TSST-C 1) and After (TSST-C 2) Treatment or Waiting



Note. Physio perception 1–3 refers to measurements of participants' perceived level of physiological intensity and physio worry 1–3 to worry about their physiological symptoms.

Treatment

Treatment consisted of an exposure-based CBT treatment that was evaluated simultaneously (Asbrand, Heinrichs, Schmidtendorf, Nitschke, & Tuschen-Caffier, 2020). It targets dysfunctional cognitions, possible social deficits, and social avoidance with a strong

focus on exposure. Each session consisted of 100 min (including a 10-min break) in groups of five to seven children. Standard CBT components were implemented in 12 sessions (psychoeducation, cognitive restructuring, social skills training, exposure, and relapse prevention). Children were instructed to use their newly developed skills outside of treatment to ensure a transfer into everyday life.

Psychometric Measure

The SPAI-C (Beidel, Turner, Hamlin, & Morris, 2000) assesses behavioral characteristics specific to SAD (26 items; e.g., "I am anxious when I meet new boys or girls"). Children respond to each item using a 3-point Likert-type scale ranging from "never or hardly ever" to "almost always or always." Validity and reliability were confirmed in the original sample (Beidel et al., 2000) and a German sample (Melfsen, Walitza, & Warnke, 2011). Internal consistency and test–retest reliability after 4 weeks in the German sample was excellent (Cronbach's $\alpha = .92$; $r_{tt} = .84$).

Psychophysiological Measures

Electrodermal and cardiovascular measures including heart rate were assessed at 400 Hz using the Varioport system (Becker Meditec, Karlsruhe, Germany). Data inspection and artefact rejection were conducted offline using ANSLAB (Blechert, Peyk, Liedlgruber, & Wilhelm, 2016). For the electrocardiogram, the cardiac interbeat interval (IBI), calculated as the interval in milliseconds between successive R waves, was extracted. For illustrative purposes the IBI was converted to heart rate (in beats per minute) for tables and figures but all statistical analyses were based on IBI values (Quigley & Berntson, 1996). EDA, reflecting electrodermal sympathetic activity (Boucsein, 2012), was assessed by placing two electrodes on the middle phalanx of the middle and ring fingers of the left hand using 11-mm inner diameter Ag/AgCl electrodes filled with isotonic electrode paste (TD-245, Med Associates, Inc., St. Albans, Vermont). As a parameter of EDA, skin conductance level was used.

Interoceptive Accuracy (IAc)

We assessed IAc using the HCT. After a short training of about 10s, children were asked to silently count their heartbeats during three instructed intervals (25, 35, 45s in a fixed order), to indicate 'zero' if they had not perceived any, and not take their pulse or to use any other strategies such as holding their breath (Eley et al., 2004). Subjective reports of perceived heartbeats were checked for plausibility. For the first testing session, perceived heart beats ranged between 10 and 86 (25s interval), 10 and 90 (35s interval), and 13 and 600 (45s interval). Based on the extreme value at the third interval, one child was excluded from further analyses as it is possible that the child did not understand the instructions correctly, leaving a range between 13 and 120 (45s interval). For the second

testing session, perceived heart beats ranged between 7 and 70 (25s interval), 1 and 85 (35s interval), and 6 and 105 (45s interval).

To ensure comparability to an earlier study (Koch & Pollatos, 2014), IAc was calculated using the formula:

$$\mathrm{IAc_{HCT}} = \frac{1}{3}\sum_{k=1}^{3}\left(1 - \frac{\left|\text{no. of recorded heartbeats}_k - \text{no. of perceived heatbeats}_k\right|}{\text{no. of recorded heartbeats}_k}\right)$$

Higher scores indicate higher IAc, with a maximum score of '1' reflecting perfect IAc. As physical symptom reporting is related to the tendency to report false alarms in a somatosensory signal detection task (Brown et al., 2012), we calculated a simple IAc score to distinguish over- from underreporting using the formula (Rost, Van Ryckeghem, Schulz, Crombez, & Vögele, 2017):

$$\mathrm{IAc_{simple}} = \frac{1}{3}\sum_{k=1}^{3}\left(\frac{\text{no. of perceived heartbeats}_k - \text{no. of recorded heartbeats}_k}{\text{no. of recorded heartbeats}_k}\right)$$

A positive score reflects over-reporting and a negative score reflects underreporting of heartbeats.

Statistical Analysis

First, for objective measures, statistical outliers 2.5 SD above or below the mean were excluded. Outliers were calculated separately for groups and time. To examine biases before treatment, we conducted analyses of variance (ANOVAs) with repeated measures on phase (baseline, stress, recovery), using group (SAD, HC) as between-subjects factor. For objective physiology, EDA and heart rate were used as dependent variables in separate ANOVAs. For subjective perception, rating (perception, worry) was further added as a factor. We included first the heart rate and perspiration scales and then the blushing and trembling scales as dependent variables in separate ANOVAs. Including objective physiology as a covariate did not lead to any significances, *p*s > .05, and is therefore not further reported. To consider that objective physiology and subjective perception (IS) and worry (IE) might depend on each other, multiple correlation analyses were conducted for both EDA and heart rate including subjective and objective measures. IAc scores ($\mathrm{IAc_{HCT}}$ and $\mathrm{IAc_{simple}}$) from the first laboratory session were compared using an independent sample *t* test with *group* (SAD, HC) as independent variable.

For treatment effects, we once again conducted ANOVAs with repeated measures on session (pre, post) and phase (baseline, stress, recovery), using group (CBT, WLC) as between-subjects factor. For objective physiology, EDA and heart rate were used as dependent variables in separate ANOVAs. For subjective perception, perception and worry of all physiology questionnaires (heart rate, perspiration, blushing, trembling) were

analyzed as dependent variables in separate ANOVAs. Once again, multiple correlation analyses were conducted for both EDA and heart rate including subjective and objective measures. For the analysis of treatment effects on IAc scores, an ANOVA with repeated measures on *time* (pre, post) was used based on *treatment* (CBT, WLC) as independent variable. Further, a moderation analysis was conducted testing treatment as potential moderator (CBT, WLC) between IAc pre (IAc_1) and post treatment (IAc_2) using the PROCESS macro for SPSS (Hayes, 2013). Further exploratory analyses are reported in the Supplementary Materials.

Significant main effects and interactions for all ANOVAs were further analyzed with post hoc *t* tests for independent groups for the group comparisons and with *t* tests for dependent groups for the time comparisons (phase, session) if relevant for the hypotheses. Cohen's *d* effect sizes are reported for the post hoc tests.

Results

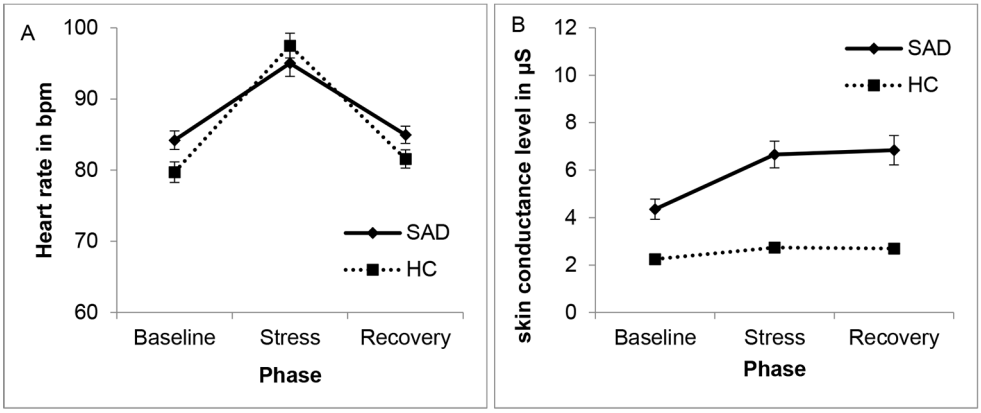
Before Treatment: Objective Physiology Comparison of Children With and Without SAD

We found higher heart rate (HR) during the stress as compared to the baseline and post phases, Wilk's $\lambda = .351$, $F(2,94) = 87.07$, $p < .001$, $\eta_p^2 = .649$, but HR did not differ between groups, $F(1,95) = 0.87$, $p = .354$. There was a significant interaction of Phase × Group, Wilk's $\lambda = .870$, $F(2,94) = 87.07$, $p < .001$, $\eta_p^2 = .130$. Post hoc tests showed a significantly higher HR in children in the SAD group during the baseline phase, $t(95) = -2.30$, $p = .023$, $d = 0.47$, but no further group differences, $ts < 1.33$, $ps > .187$ (see Figure 3A). In the SAD group, HR increased significantly from baseline to stress, $t(53) = 7.12$, $p < .001$, $d = 0.41$, and decreased from stress to recovery, $t(53) = -7.27$, $p < .001$, $d = 0.40$. Similarly, in the HC group, HR increased significantly from baseline to stress, $t(42) = 11.31$, $p < .001$, $d = 0.67$, and decreased from stress to recovery, $t(53) = -10.40$, $p < .001$, $d = 0.61$. The significant interaction between group and phase and the higher effect sizes for post-hoc tests in the HC than the SAD group suggest a steeper increase and decrease in the HC group compared to the SAD group.

EDA significantly increased over time, Wilk's $\lambda = .586$, $F(2,91) = 32.17$, $p < .001$, $\eta_p^2 = .414$, and differed between groups, $F(1,92) = 35.12$, $p < .001$, $\eta_p^2 = .276$. Furthermore, we observed a significant Phase × Group interaction, Wilk's $\lambda = .750$, $F(2,91) = 15.14$, $p < .001$, $\eta_p^2 = .250$. Post hoc tests showed that in the SAD group, EDA increased significantly from baseline to stress, $t(49) = 7.17$, $p < .001$, $d = 0.31$, but did not decrease from stress to recovery, $t(49) = 1.30$, $p = .199$, $d = 0.02$. Similarly, in the HC group, EDA increased significantly from baseline to stress, $t(43) = 4.45$, $p < .001$, $d = 0.23$, but did not decrease from stress to recovery, $t(43) = 1.02$, $p = .311$, $d = 0.02$ (see Figure 3B). Again,

Figure 3

Group Comparisons of (A) Heart Rate (in Beats per Minute, BPM) and (B) Electrodermal Activity During the First Trier Social Stress Test for Children for Children With Social Anxiety Disorder (SAD) and Healthy Control (HC) Children



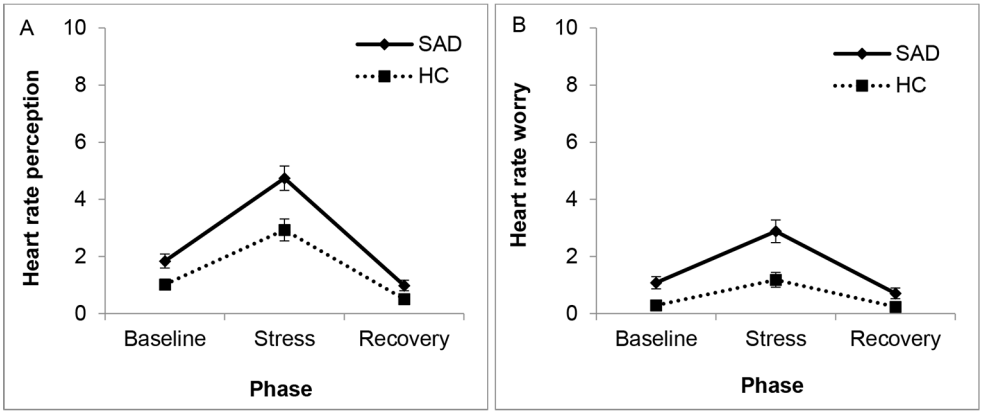
the significant interaction and the higher effect sizes imply a steeper increase in the HC group compared to the SAD group.

Before Treatment: Subjective Physiology Perception Comparison of Children With and Without SAD

For subjective perception of heart rate (IS), we found significant main effects of phase, Wilk's $\lambda = .468$, $F(4,111) = 31.49$, $p < .001$, $\eta_p^2 = .532$, and group, Wilk's $\lambda = .861$, $F(2,113) = 9.10$, $p < .001$, $\eta_p^2 = .139$, with a trend for a significant interaction of Phase × Group, Wilk's $\lambda = .929$, $F(4,111) = 2.11$, $p = .084$, $\eta_p^2 = .071$. Groups differed in both perception of and worry about heart rate in all phases (see Figure 4; $ps < .05$). The increase from baseline to stress and the decrease from stress to recovery was significant in both groups, $ps < .001$. Similar effects were found for subjective perception of perspiration, blushing, and trembling (see Supplementary Materials).

Figure 4

Subjective Perception of (A) and Worry (B) About Heart Rate After All Phases of the First Trier Social Stress Test for Children



Note. For other parameters, see Supplementary Materials.

Before Treatment: Relations Between Objective and Subjective Physiology

A multiple correlation analysis between objective heartrate and subjective perception of and worry about heart rate did not reveal any significant correlation, *p*s > .084. Similarly, no effects were found for EDA and subjective perception, *p*s > .105.

For the first laboratory session, neither the IAc_{HCT} scores, $t(96) = -1.29$, $p = .200$, $d = 0.26$, nor the IAc_{simple} scores differed significantly between groups, $t(98) = -1.48$, $p = .142$, $d = 0.30$.

After Treatment: Objective Physiology Comparison of Children With SAD After Treatment Versus Waiting

Comparable to the first measurement occasion, HR was higher during stress than during baseline and post phases, Wilk's $\lambda = .355$, $F(2,37) = 33.55$, $p < .001$, $\eta_p^2 = .645$. All other effects remained nonsignificant, *F*s < 2.77, *p*s < .103.

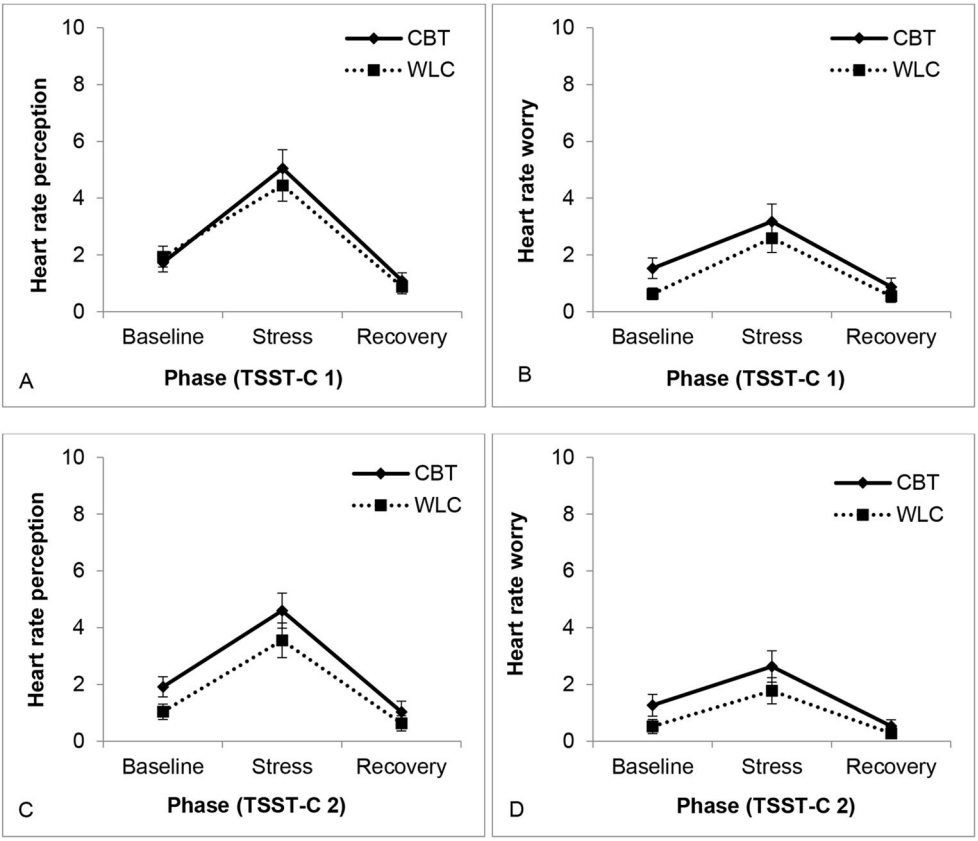
Again, EDA was higher during stress than during baseline and post phases, Wilk's $\lambda = .388$, $F(2,37) = 29.15$, $p < .001$, $\eta_p^2 = .612$. All other effects remained nonsignificant, *F*s < 3.91, *p*s < .057.

After Treatment: Subjective Physiology Perception Comparison of Children With SAD After Treatment Versus Waiting

For subjective perception of heart rate after treatment, the ANOVA showed a significant main effect of phase, Wilk's $\lambda = .364$, $F(4,48) = 20.94$, $p < .001$, $\eta_p^2 = .636$, and a trend for a significant effect of session, Wilk's $\lambda = .891$, $F(2,50) = 3.07$, $p = .055$, $\eta_p^2 = .109$. All other Fs < 2.27, ps > .113 (see Figure 5).

Figure 5

Subjective Perception of and Worry About Heart Rate After All Phases of the First (A, B) and Second (C, D) Trier Social Stress Test for Children (TSST-C), Comparing the Cognitive Behavioral Therapy (CBT) and Waitlist Control (WLC) Groups



Note. For other parameters, see Supplementary Materials.

An analysis of the main effect of session for heart rate in both groups, using t tests for paired samples, showed an overall decrease in the perception, $t(56) = 2.03$, $p = .047$, d

= 0.28, and worry after the stress phase, $t(56) = 2.22$, $p = .030$, $d = 0.30$. All other ts < 1.33, ps > .191. So, heart rate perception and worry decreased in all children from TSST-C 1 to TSST-C 2. Similar effects were found for subjective perception of trembling (see Supplementary Materials).

After Treatment: Relations Between Objective and Subjective Physiology

A multiple correlation analysis at TSST-C 2 between objective HR and subjective perception (IS) of and worry (IE) of HR did not reveal any significant correlation, ps > .077. Similarly, no effects were found for EDA and subjective perception, ps > .229.

Regular IAc_{HCT} did not change from pre- to post-measurement (main effect 'session), independent of treatment group (interaction treatment × session, Fs < 1.92, ps > .174). Likewise, for IAc_{simple}, no significant effects appeared for treatment, session or session × treatment, Fs < 2.19, ps > .146.

Additionally, the moderation analysis showed an overall significant relation, $R^2 = .382$, $F(3,35) = 7.2$, $p < .001$. There was a significant relation between IAc_1 and IAc_2, while treatment was no significant moderator (Table 3).

Table 3

Prediction of IAc at Second Laboratory Session

Predictor	*b*	*SE B*	*t*	*p*
Constant	-0.12 [-0.75, 0.51]	0.31	-0.38	.703
IAc_1 (standardized)	0.92 [0.03, 1.18]	0.44	2.09	.044
Treatment (CBT, WLC; standardized)	0.27 [-0.19, 0.74]	0.23	1.20	.237
IAc_1 × Treatment (CBT, WLC)	-0.25 [-0.90, 0.40]	0.32	-0.79	.437

Note. IAc_1 = Interoceptive accuracy laboratory session 1, IAc_2 = Interoceptive accurarcy laboratory session 2.

Discussion

The study aimed to assess alterations in perception of (IS) and worry about (IE) physiological symptoms as well as IAc in childhood SAD. It further strived to examine possible changes after CBT. Supporting our hypotheses at TSST-C 1, children with SAD showed higher heart rate than children in the HC group during the baseline phase, and a lower reactivity to stress. Further, EDA was heightened throughout the testing session. These findings may indicate an autonomic hyperarousal and blunted stress reactivity in the SAD group. Moreover, children in the SAD group reported heightened perception (IS) of and increased worry (IE) about heart rate, perspiration, and trembling throughout the TSST-C. There seems to be no biased perception for EDA. However, the pattern for the

objective and subjective side in heart rate differed: Objectively, children in the HC group showed a steep increase and decrease throughout the TSST-C 1. Subjectively however, HC children's perception and worry remained below that of SAD children. As blushing and trembling were not controlled on objective parameters, this effect can only be confirmed for heart rate and perspiration. Further, contrary to findings in adults (Domschke, Stevens, Pfleiderer, & Gerlach, 2010), no differences in IAc were found between children with SAD and HC children.

Findings after treatment were not in line with our hypotheses: Objective physiological parameters (heart rate, EDA) did not change. Interestingly, children in the CBT group reported heightened perception of and increased worry about perspiration, and trembling after the baseline phase at TSST-C 2 compared to children in the WLC group. Additionally, both before and after treatment subjective and objective parameters did not correlate. Further, as no differences appeared between children with SAD receiving treatment vs. waiting, no effects of treatment on IAc can be assumed.

Before Treatment: Findings on Children With SAD Compared to an HC Group

Objectively in line with earlier studies (cf., Asbrand et al., 2017), a tonic hyperarousal was shown in children with SAD concerning EDA. However, in contrast to earlier studies (Schmitz et al., 2012), this was mirrored by subjective perception. Part of the earlier findings in high socially anxious children (Schmitz et al., 2012) still seems to be also found in our sample: Concerning HR, children with SAD perceived an increase in their physiological reaction that was not mirrored by the pattern of physiological reactivity. Further, they worried more than children in the HC group that this physiological arousal might be observable. Considering the point of (non)visibility of heart rate, children with SAD might have more unrealistic worries that internal signals might be observable. As our paradigm was slightly altered to Schmitz et al. (TSST-C instead of a speech task with public vs. private sound of heart rate), our findings are not replication in a narrow sense but show a robust effect in an established social stress test. However, mean scores on symptom perception intensity as well as worry were rather low (< 5 on a scale of 0 to 10). The pattern of results demonstrates that worry is linked to several physiological symptoms (but not all). Further, it may be that some physiological sensations are more likely linked to SAD (e.g., blushing; Bögels, Rijsemus, & De Jong, 2002). These symptoms are more consistently associated with worry, reflecting a more general tendency to worry about SAD-related physiological symptoms instead of symptom-specific links between perception of and worry about these symptoms. This might be related to visibility of physiological symptoms. Finally, a lack of correlation between IAc, IS and IE provides an interesting insight: It would be expected that a higher physiological arousal leads to the perception of – and possibly worry about – these symptoms. However, our results point to the independence of both sides. This might stem from the fact that children

struggle more with IAc (Koch & Pollatos, 2014). The current study suggests that SAD children do not show altered IAc, but report higher subjective heart rates (IS) and higher worries about cardiac perceptions (IE). SAD in childhood may be reflected, therefore, by a selective increase in the subjective tendency to be focused on heart rate increases and a negative evaluation of these percepts, whereas the actual perception is unaffected.

After Treatment: Findings on a Treatment (CBT) Versus a WLC Group

Children in the CBT group reported higher perception of and more worry about perspiration as well as more worry about trembling after the baseline phase of TSST-C 2. In other words, children in the CBT group reported heightened perception of physiological arousal and increased worry on some parameters after the baseline phase. Previous findings from this sample could show that CBT was in general successful in reducing the severity of SAD as measured by a blind interview after treatment (cf., Asbrand et al., 2020). Further, some SAD-relevant rumination processes such as post-event processing changed for the better as negative thoughts after a social situation decreased significantly after treatment (Asbrand, Schmitz, et al., 2019). Still, cortisol levels did not change based on treatment; however, cortisol levels in the WLC group increased in the second TSST-C (Asbrand, Heinrichs, et al., 2019). Overall, it would have been plausible that physiological awareness and biased perception also change with treatment. However, instead of decreasing, children in the CBT group reported higher perception and worry about several physiological parameters before entering the social stress situation. It might be that children in the CBT group were sensitized to similar tasks as they had experienced exposure sessions beforehand. Psychoeducation conveys a concept of anxiety that includes cognitions, behavior, and physiological reactions. Often, this is the first time children are confronted with such a concept. It might direct their attention to these factors and, as such, support sensitization. Further, our treatment was rather short (12 sessions), and recent research has argued that longer treatment is necessary in SAD (e.g., Hudson et al., 2015). As the main treatment component, exposure, had to be properly prepared (habituation rationale, first exposure in social skills sessions), only a few sessions remained to experience in-vivo exposure. Thus, it is possible that treatment was already successful in reducing overall symptoms (Asbrand, Heinrichs, et al., 2020), but children were still in the process of handling high state anxiety. Additionally, our treatment did not specifically target physiological symptoms and their interpretation. This treatment component is more common in treatment of panic disorders (e.g., Clark et al., 1999; Öst & Westling, 1995) but should be considered for SAD treatment as well, given our results. However, interpretation of these findings of elevated perception and worry in the CBT group should be evaluated cautiously as they were found only after the baseline phase of the TSST-C and not after the stress phase. In addition, even if the

pattern of results allows for interpretation of sensitization, the overall scores remain low at posttreatment (mean scores < 4 on a scale of 0 to 10).

Finally, while comparison of single intervals of the HCT has shown high correlations between these (e.g., Koch & Pollatos, 2014), our study is the first to show stability over a longer period of time providing first evidence for IAc as a trait marker in children. However, as we do not find differences in IAc between children with and without SAD in our study, IAc may not play a key role for SAD in children. Possibly, a subsample of children with SAD suffering from panic-like symptoms (cf. Domschke, Stevens, Pfleiderer, & Gerlach, 2010) in social situations might show both different IAc scores and changes in IAc based on treatment. Future studies are warranted to investigate, which role other occasion- or situation-specific factors, as well as error variance (Wittkamp et al., 2018), contribute to IAc in in children.

Limitations and Conclusions

While the study has several strengths, such as a clinical sample and inclusion of treatment, several limitations apply. First, we assessed a variety of dependent variables based on concerns to target physiological arousal broadly (Siess et al., 2014). Possibly, a lack of effects might stem from lack of power. However, the current sample was relatively large and could detect differences in treatment groups, even though they showed to be contrary to expectations. Second, we did not assess all variables both subjectively and objectively but provide subjective data only for blushing and trembling. Future studies might target these variables to examine the objective basis for subjective perception. Previous studies from adults, however, point to similar results for blushing, as this depends mainly on social anxiety instead of objective blood flow (Drummond & Su, 2012). Third, we refrained from using an experimental setup (cf., Gerlach et al., 2004; Schmitz et al., 2012), instead opting for a standardized social stress task. Thus, taking note of these earlier findings (Gerlach et al., 2004; Schmitz et al., 2012) on the importance of the perception of and worry about physiological arousal in social anxiety, we did not manipulate visibility of physiological arousal but chose to measure subjective and objective arousal in parallel during social stress. Finally, we did not include a correlation analysis between a change in social anxiety symptoms and changes in perceptions of physiology as this would not have been based on a solid theoretical background. However, future studies could include this perspective to analyze a possible co-occurrence of change in anxiety and perception of physiology.

In conclusion, our results indicate that SAD children show a selective enhancement of subjective cardiac interoception, as proposed by cognitive models of SAD (Clark & Wells, 1995), whereas behavioral indices of cardiac interoception and the perception of EDA changes remain unaffected. CBT did not change this perception. Thus, further inclusion of treatment components targeting this bias as currently proposed mainly by

adult research (Hofmann & Otto, 2017; Naim, Kivity, Bar-Haim, & Huppert, 2018; Wong et al., 2017) should be considered.

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Supplementary Materials

The supplementary materials include additional exploratory analyses on subjective perception of perspiration, blushing and trembling before and after treatment (for access see Index of Supplementary Materials below):

Index of Supplementary Materials

Asbrand, J., Schulz, A., Heinrichs, N., & Tuschen-Caffier, B. (2020). *Supplementary materials to "Biased perception of physiological arousal in child social anxiety disorder before and after cognitive behavioral treatment"* [Additional exploratory analyses]. PsychOpen. https://doi.org/10.23668/psycharchives.3086

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There Are no Short-Term Longitudinal Associations Among Interoceptive Accuracy, External Body Orientation, and Body Image Dissatisfaction

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Abstract

Background: Objectification theory assumes that individuals with low level of interoceptive accuracy may develop an external orientation for information concerning their body. Past research has found associations between interoceptive accuracy and body image concerns. We aimed to explore temporal relationships between the tendency to monitor one's body from a third-party perspective, body image dissatisfaction, and interoceptive accuracy.
Method: In a short longitudinal research, 38 Hungarian and 59 Norwegian university students completed the Schandry heartbeat tracking task and filled out baseline and follow-up questionnaires assessing private body consciousness, body surveillance, and body image dissatisfaction 8 weeks apart.
Results: Interoceptive accuracy and indicators of external body orientation did not predict body image dissatisfaction after controlling for gender, nationality, and body image dissatisfaction at baseline. Similarly, body surveillance was not predicted by baseline levels of interoceptive accuracy and body image dissatisfaction.
Conclusion: Contrary to the tenets of objectification theory, body image dissatisfaction and body surveillance are not predicted by interoceptive accuracy over a short period of time among young individuals.

Keywords

interoceptive accuracy, body image, self objectification, body surveillance, public body consciousness, body image dissatisfaction

Highlights

- Past research suggests that an individual's ability to detect their own internal signals may have important implications for body monitoring and body image.
- We did not find the expected temporal associations among interoceptive accuracy and body image-related variables.
- Culture and gender were predictors of body image dissatisfaction, an important consideration when designing interventions targeting body image concerns.

Interoception, the perception of sensations originating from within the body, is related to many aspects of daily functioning, including subjective emotional experience, decision making, and our sense of self (Craig, 2002; Damasio, 1999; Tsakiris, 2017). In the insular cortex, interoceptive and exteroceptive information converge, are processed and integrated, and provide us with a sense of the physiological status of our entire body, or a feeling of *embodiment* (Craig, 2015; Herbert & Pollatos, 2012; Tsakiris, 2017). Interoceptive accuracy (IAc) is the dimension of interoception that specifically describes accurately detecting one's own bodily signals (Ceunen, Van Diest, & Vlaeyen, 2013; Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015). It is typically measured via behavioral test, as opposed to self-report. Individuals with low levels of IAc seem to have more difficulties maintaining a healthy body image and may be more likely to experience body dissatisfaction and eating disorders (Badoud & Tsakiris, 2017; Cash & Deagle, 1997; Herbert & Pollatos, 2012; Pollatos et al., 2008), although this is not always the case (Pollatos & Georgiou, 2016).

Body image as a concept refers to the mental representation of one's own body, but is multifaceted in that it includes perceptual, affective, and cognitive components (Badoud & Tsakiris, 2017; Cash & Pruzinsky, 1990, 2002; Gaudio & Quattrocchi, 2012; Tiggemann & Lynch, 2001). Past research has approached body image concerns from several different perspectives (i.e., body image dissatisfaction, internalized thin ideals); thus, body image has been widely used as an umbrella term for several related constructs (Badoud & Tsakiris, 2017). In light of an absence of a clear definition, Badoud and Tsakiris (2017, p. 7) have defined body image very simply as "the conscious, predominantly visual, mental representation of one's own body and of our perceptual, cognitive and affective attitudes towards it". It is considered the product of a complex aggregation of bottom up and top down information - signals originating from within and outside of the body (Craig, 2015; Eshkevari, Rieger, Longo, Haggard, & Treasure, 2012; Suzuki, Garfinkel, Critchley, & Seth, 2013). It is proposed that the balance between processing of interoceptive and exteroceptive cues is central to the stability and health of our body image (Badoud & Tsakiris, 2017; Tsakiris, 2017). Predictive coding models suggest that individuals who do not perceive interoceptive signals accurately may learn to rely more on external cues when assessing the body's status due to the imprecision of predictions (i.e., top-down

representations) based on prior inaccuracies (Ainley, Apps, Fotopoulou, & Tsakiris, 2016). In line with this idea, Tsakiris and colleagues (2011) found that individuals with low IAc were more likely to assume ownership of a false body part, highlighting the level of disembodiment and body image distortion that can occur when accurate perception of internal signals is dampened. Objectification Theory (Fredrickson & Roberts, 1997) indicates that when the psychological experience of the body (i.e., embodiment) is predominantly informed by external sources of information, there will be greater exposure to negative cultural cues (i.e., unattainable beauty ideals, objectifying media imagery). This, in turn, contributes to discrepancies between the idealized body image and perceived actual appearance of the body, through further internalization of ideals and making salient any existing discrepancies (McKinley & Hyde, 1996). Furthermore, discrepancies between the perceived self and an internalised ideal self (i.e., evaluation), plus a high level of importance placed on matching that ideal (i.e., investment) can produce body image dissatisfaction (Cash, 2012; Cash & Pruzinsky, 2002). Concerning healthy young individuals, women with attenuated IAc exhibit higher levels of body image dissatisfaction (Emanuelsen, Drew, & Köteles, 2015). Similarly, Duschek and colleagues (2015) found that individuals with greater IAc had a more positive body image.

Self objectification is the acculturated tendency to view one's own body as an object, to evaluate it based on appearance rather than functionality, and to experience oneself from a third-party perspective (Ainley & Tsakiris, 2013; Calogero, Tantleff-Dunn, & Thompson, 2010; Fredrickson & Roberts, 1997). Habitual self-monitoring, an integral aspect of self objectification, is referred to in the literature as body surveillance (Calogero et al., 2010; Grippo & Hill, 2008; McKinley & Hyde, 1996). Body surveillance is accepted as the behavioural manifestation of self objectification, and as such it is measured independently from other facets of the original self objectification construct (i.e., body shame and control beliefs), but also used synonymously (Moradi & Huang, 2008; Tiggemann, 2013). It is important to note that body surveillance and IAc (or other aspects of interoception) are different constructs; the former includes an external perspective and evaluation, whereas the latter refers to internal body related sensations. Research has indicated a relationship between body surveillance and negative body image or distortion in both clinical (i.e., eating disorders, depression) and non-clinical samples (Calogero, Davis, & Thompson, 2005; Dakanalis, Timko, Clerici, Riva, & Carrà, 2017; Fitzsimmons-Craft et al., 2012; Moradi & Huang, 2008; Peat & Muehlenkamp, 2011; Tiggemann & Kuring, 2004). Self objectification is proposed to predict body image problems, and body surveillance has mediated the relationship between internalised thin ideals and body image dissatisfaction in previous research (Fitzsimmons-Craft et al., 2012; Fredrickson & Roberts, 1997; Knauss, Paxton, & Alsaker, 2008; Myers & Crowther, 2007; Tiggemann & Williams, 2012). More recently, Fitzsimmons-Craft and colleagues (2015) found that a higher level of body surveillance was moderately associated with increased body dissatisfaction. Other

research suggests that less external body orientation is important for maintaining a positive body image (Avalos & Tylka, 2006; Homan & Tylka, 2014).

We suggest that Objectification Theory (Fredrickson & Roberts, 1997) may provide insight into previous findings that individuals with diminished IAc express higher body image dissatisfaction; while those with improved IAc demonstrate a more positive body image (Duschek et al., 2015; Emanuelsen et al., 2015). We believe that diminished accuracy in perceiving one's internal signals may lead a person to rely on external sources of information concerning the bodily self, or vice versa.

Miller and colleagues (1981, p. 404) define public body consciousness, another concept of external orientation concerning one's appearance, as "a chronic tendency to focus on and be concerned with the external appearance of the body". Individuals who are high in public body consciousness typically view themselves from an outsider's perspective, monitoring their appearance and behaviour to facilitate social interaction (Ainley & Tsakiris, 2013; Miller et al., 1981). Although distinct constructs, one could argue that public body consciousness is closely related to body surveillance, insofar as both constructs concern viewing oneself as a social object, an external orientation for information concerning one's body, and a preoccupation with appearance (Miner-Rubino, Twenge, & Fredrickson, 2002). Body surveillance, however, primarily differs from public body consciousness in that the individual takes on the perspective of the observer, as opposed to merely being aware of it (Miller et al., 1981; Miner-Rubino et al., 2002). In this way, it is likely a more disembodied experience than the awareness of self from a public perspective (Miner-Rubino et al., 2002).

Our aim was to investigate how internal orientation (i.e., interoception) and external orientation (i.e., public body consciousness and body surveillance) influence body image dissatisfaction. Research investigating similar associations (Ainley & Tsakiris, 2013; Duschek et al., 2015; Emanuelsen et al., 2015) has not included these constructs in one empirical study. Additionally, as this previous work investigated cross-sectional data, spontaneous fluctuation cannot be excluded; thus, we have used a short-term longitudinal study to explore their relation.

Based on the aforementioned theoretical considerations and empirical findings, low level of IAc and the proclivity to assess one's body from an outsider's perspective should predict a negative body image. In the present research, we expected that IAc, body surveillance and public body consciousness at baseline (t1) would predict body image dissatisfaction 8 weeks later (t2) (Hypothesis 1). We also considered the possibility that low IAc and high levels of body image dissatisfaction may increase the tendency to view oneself from a third party perspective. Therefore, alternately, we expected that IAc and body image dissatisfaction at t1 would predict body surveillance at t2 (Hypothesis 2).

Material and Method

Participants

Assuming $\alpha = .05$, $1\text{-}\beta = .80$, and a medium effect size (.15; in the lack of empirical data, this estimation was based on theoretical considerations), the minimum sample size for a multiple linear regression analysis with 6 predictor variables is 97 (Faul, Erdfelder, Lang, & Buchner, 2007). Participants in this research were Norwegian (n = 59, 74.6% female, 24.8 ± 5.09 yrs) and Hungarian (n = 38, 65.8% female, 21.3 ± 1.60 yrs) students enrolled at a University in Hungary. Norwegian students were enrolled in an English language international program. The research was approved by the Research Ethics Committee of the institution. Participation was voluntary, and all participants signed an informed consent form before the measurements. The English versions of the questionnaires were administered for the Norwegian students and the Hungarian version for the Hungarian participants.

Measures

The Body Surveillance Subscale of Objectified Body Consciousness Scale

The scale was developed by McKinley and Hyde (1996) to assess negative body experience from a social constructionist point of view. The questionnaire measures the experience of the body as an object to be viewed by others and the beliefs underlying this experience. For the purpose of this research, we have chosen to use only the 8 item body surveillance subscale, which uses a 7 point Likert-scale. Higher values indicate higher surveillance tendency. Cronbach's alpha in the present study was .75 at t1, and .70 at t2.

The Public Body Consciousness Scale

The scale was developed by Miller and colleagues (1981) as part of the Body Consciousness Questionnaire, and it consists of 5 items rated on a 5 point Likert-scale. Higher scores indicate more importance placed on individual appearance. Cronbach's alpha for the public body consciousness subscale in the present study was .71 at t1.

The Body Image Ideals Questionnaire

The questionnaire was developed by Cash and Szymanski (1995) to provide a reliable assessment of participants' evaluation of their own physical appearance, and asks two questions with regard to each of 11 physical characteristics, including muscle tone, hair texture, complexion and various physical abilities (e.g., coordination, strength). Responses are indicated on a 4 point Likert-type scale. The first question asks participants to what extent they feel that they match their physical ideals; the second question asks how important it is to the participant that their actual attributes match their ideals. Higher

scores on the scale indicate a greater overall level of body image dissatisfaction. In the current study, the internal consistency of the questionnaire was .65 at t1, and .69 at t2.

The Mental Heartbeat Tracking Method

Interoceptive accuracy was assessed using the mental tracking method (Schandry, 1981), a widely used paradigm. In healthy individuals, there is a correspondence between the performance on the Schandry-task and the mean amplitude of heartbeat evoked potential (Pollatos & Schandry, 2004), an EEG potential associated with the heartbeat, which is also higher during the Schandry-task than during periods of rest (Schulz et al., 2015). During the task, participants were asked to count their perceived heartbeats silently. They were not allowed to monitor their pulse (e.g., palpating the wrist or neck artery) or use any other physical techniques that might help them to count more accurately. They were further instructed to count uncertain sensations but to refrain from guessing. Upon hearing a "start" cue, participants began to silently count their own heartbeats until a "stop" cue was given, at which point they reported the number of heartbeats counted to an experimenter. At the same time, the experimenter counted and recorded the participants' heartbeats using a Polar watch (model RS-400) with a chest strap. This procedure was administered for one 15 second warm-up trial followed by three subsequent intervals (30, 40, and 100 seconds) presented in random order, with a 10 second break in between. Following the initial trial, participants were asked to indicate how they arrived at the reported number of heartbeats. Subjects who reported guessing or counting seconds were encouraged to count only the perceived heartbeats for the remaining three trials. The experimenter explained that accuracy is regarded as neither positive nor negative. Subjects were not aware of the length of the intervals and no feedback about performance was given. IAc is the mean score of the formula: 1 – [(| recorded heartbeats – counted heartbeats|)/recorded heartbeats] calculated for each of the three time trials. Cronbach's alpha coefficient for the index was .924.

Procedure

Participants filled out an on-line test battery one day prior to a scheduled meeting with the experimenter (t1). At the meeting, participants were seated in a quiet room. After a brief introduction to the mental tracking method, participants were asked to relax, breath normally, and focus on the beating of their heart. Participants completed the on-line self report battery a second time 8 weeks later (t2). This period of time appears long enough to capture short-term fluctuations and fits within a typical 12-week university semester, while avoiding the inclusion of the stressful first and final 2 weeks of the semester.

This research was part of a larger study, thus participants took part in other measurements as well. Concerning the variables used in the present paper, only baseline interoceptive accuracy values were included in another research (Ferentzi, Drew, Tihanyi, & Köteles, 2018).

Statistical Analysis

Statistical analysis was conducted using the JASP v0.8.5.1 software (JASP Team, 2019). Based on the results of normality analysis (Shapiro-Wilk tests), parametric statistical methods were used throughout the analysis. Differences between groups with respect to age and sex were checked using Student *t*-test and chi-square test, respectively. Concerning the assessed psychological variables, the two national groups were compared using Student *t*-test. Cross-sectional associations among variables at t1 were checked using Pearson correlation. Longitudinal associations (Hypothesis 1 and 2) were investigated using multiple linear regression analysis. In Step 1 the baseline value of the respective criterion variable was entered; in Step 2, group affiliation (Hungarian = 1; Norwegian = 2), gender (male = 1; female = 2), t1 values of interoceptive accuracy, body surveillance, and (only for body image dissatisfaction) public body consciousness were stepped in.

Results

Descriptive statistics, group level comparisons, and baseline correlations are presented in Table 1 and Table 2, respectively. A statistically significant difference between groups in age, $t(95) = -4.104$, $p < .001$, $d = -0.854$, but not in sex ratio, $\chi^2(1) = 0.869$, $p = .351$, was found. The two groups showed significant differences with respect to body surveillance and public body consciousness at t1, and body image dissatisfaction at t2. Concerning baseline measures, a significant negative medium level association between body surveillance and IAc was found in the Hungarian group. In the Norwegian group, body surveillance was moderately associated with body image dissatisfaction and weakly with public body consciousness, and public body consciousness was negatively associated with IAc (for details, see Table 2).

Table 1

Descriptive Statistics (Mean ± Standard Deviation) of the Assessed Variables Split by Group, and Results of Student t-Tests Comparing the Two Groups

Variable	Hungarians *n = 38*	Norwegians *n = 59*	*t*(95)	*p*	Cohen's *d*
Body surveillance at t1	36.04 ± 5.174	33.05 ± 7.454	2.159	.033	0.449
Body surveillance at t2	33.68 ± 5.132	32.03 ± 6.465	1.322	.189	0.275
Body image dissatisfaction at t1	1.58 ± 1.327	1.41 ± .883	0.757	.451	0.157
Body image dissatisfaction at t2	1.96 ± 1.292	1.33 ± .797	3.015	.003	0.627
Public body consciousness at t1	24.16 ± 2.937	21.00 ± 3.634	4.492	< .001	0.934
IAc at t1	.46 ± .249	.52 ± .269	-1.087	.280	-0.226

Note. IAc = Interoceptive accuracy; t1 = Baseline; t2 = 8 weeks later.

Table 2

Pearson's Correlations Among Variables at Baseline

Variable	1	2	3	4
1. Body image dissatisfaction	-	.14	-.07	.11
2. Body surveillance	.44**	–	.18	-.40*
3. Public body consciousness	.11	.32*	–	-.18
4. IAc	-.11	-.11	-.33*	–

Note. Upper triangle = Hungarians (n = 38); Lower triangle = Norwegians (n = 59); IAc = interoceptive accuracy. *p < .05. **p < .01.

In the multiple linear regression analysis predicting body image dissatisfaction at t2 (Hypothesis 1), baseline BIQ score explained 23.1% of the total variance (p < .001) in Step 1. In Step 2, the regression equation explained 32.6% of the total variance (p < .001). Predictors of body image dissatisfaction at t2 were baseline body image dissatisfaction, group, and gender (p < .1), but not IAc, body surveillance, and public body consciousness (for details, see Table 3). Group association was negative, while gender had a positive association; thus, all other factors being equal, Hungarian nationality and female gender predicted higher levels of body image dissatisfaction at t2.

Table 3

Results of the Multiple Linear Regression With Body Image Dissatisfaction at t2 as the Dependent Variable

Step	*B*	SE_B	β	95% CI (*LL*, *UL*)	*p*	Zero-order correlation	Partial correlation
Step 1: R^2 = .231, p < .001							
Body image dissatisfaction at t1	0.474	0.089	0.481	0.298, 0.650	< .001	.481	.481
Step 2: R^2 = .326, p < .001							
Body image dissatisfaction at t1	0.439	0.091	0.446	0.259, 0.619	< .001	.481	.455
Group	-0.622	0.210	-0.288	-1.038, -0.205	0.004	-.296	-.298
Gender	0.371	0.214	0.159	-0.055, 0.797	0.087	.202	.179
IAc at t1	-0.147	0.382	-0.036	-0.905, 0.611	0.701	-.100	-.041
Body surveillance at t1	-0.005	0.015	-0.035	-0.036, 0.025	0.725	.191	-.037
Public body consciousness at t1	-0.006	0.029	-0.019	-0.064, 0.053	0.851	.140	-.020

Note. IAc = Interoceptive accuracy; t1 = Baseline; t2 = 8 weeks later.

The regression equation predicting body surveillance at t2 (Hypothesis 2) explained 49.7% of total variance in Step 1, and 51.7% in Step 2. The only significant predictor was baseline body surveillance score (for details, see Table 4).

Table 4

Results of the Multiple Linear Regression With Body Surveillance at t2 as Dependent Variable

Step	*B*	SE_B	β	95% CI (*LL*, *UL*)	*p*	Zero-order correlation	Partial correlation
Step 1: R^2 = .497, p < .001							
Body surveillance at t1	0.624	0.064	0.705	0.496, 0.752	< .001	.705	.705
Step 2: R^2 = .517, p < .001							
Body surveillance at t1	0.640	0.071	0.724	0.499, 0.781	< .001	.705	.687
Group	-0.069	0.927	-0.006	-1.911, 1.773	.941	-.134	-0.008
Gender	1.571	1.021	0.119	-0.458, 3.600	.128	.206	.159
IAc at t1	2.468	1.770	0.108	-1.049, 5.985	.167	-.073	.145
Body image dissatisfaction at t1	-0.327	0.431	-0.059	-1.184, 0.529	.450	.179	-.079

Note. IAc = Interoceptive accuracy; T1 = Baseline; T2 = 8 weeks later.

Discussion

This study investigated the temporal relationships among the external orientation toward the body, body image, and interoceptive accuracy (heartbeat tracking ability) assessing a general student sample of young Hungarians and Norwegians. Dissatisfaction with body image 8 weeks later was predicted by baseline dissatisfaction, Hungarian nationality, and female gender, but not by interoceptive accuracy or external body orientation. Body surveillance was predicted only by baseline body surveillance but not by gender, nationality, interoceptive accuracy, or dissatisfaction with body image.

Based on past research, we expected that interoceptive accuracy (IAc) and constructs representing an external body orientation (public body consciousness and body surveillance) would predict body image dissatisfaction (Ainley & Tsakiris, 2013; Emanuelsen et al., 2015; Fitzsimmons-Craft et al., 2012; Fredrickson & Roberts, 1997). Whereas these hypotheses were not supported by our data, nationality and gender were predictors of change. Nationality related findings are difficult to explain as (1) the size of the two samples was not equal and (2) there was a significant difference between the two groups with respect to age. Generally, Hungarian adolescents experience higher levels of body concerns when compared to other European nationalities (Papp, Urbán, Czeglédi, Babusa, & Túry, 2013); this tendency, along with their younger age, might have made the temporal fluctuations of body image dissatisfaction more marked.

The result that female gender predicted (although only at a trend level) greater change in body image dissatisfaction was not surprising, as empirical evidence shows that females generally experience higher levels of body image dissatisfaction (Grabe, Ward, & Hyde, 2008; Grogan, 2016; Tiggemann, 2004). In past studies, both Norwegian and Hungarian adolescent females have shown higher levels of body image dissatisfaction than their male counterparts (Meland, Haugland, & Breidablik, 2007; Papp et al.,

2013). Even at very young ages, girls are more likely to exhibit body concerns, and be more dissatisfied with their bodies (Grogan, 2016), perpetuated by the internalised ideals promoted by modern western culture and media (Grabe et al., 2008; Myers & Crowther, 2007).

Although a previous cross-sectional study revealed a medium level reverse correlation between IAc and self objectification (Ainley & Tsakiris, 2013), this was replicated only in the Hungarian sample in the present study. Moreover, results of our second regression model indicate that IAc does not explain variance in changes of body surveillance. According to our results, the only predictor of self objectification at t2 was the baseline self objectification score; the strong association between the two ($\beta = 0.705$) indicates high temporal stability. Therefore, temporal associations with IAc are difficult to detect if the effect size of IAc is low and additional factors are controlled for. Temporal stability of body image dissatisfaction was lower ($\beta = 0.481$); still, low to medium level associations between body image dissatisfaction and IAc reported in cross-sectional studies (Duschek et al., 2015; Emanuelsen et al., 2015) might have been too weak to detect in the current study. Moreover, the instruction used in the Schandry-task was more strict than usual with respect to allowing estimation. This might have resulted in lower IAc scores with less variance than in other studies and possibly influenced participants' response tendencies (for more detail, see the limitations section). Overall, the lack of predictive associations among self-objectification, body image dissatisfaction, and IAc indicates that the ability to accurately sense our bodily signals is not among the significant factors that influence how we monitor and envision our body's appearance. For example, self-reported (i.e., conscious) aspects of interoception (e.g., interoceptive sensibility and body awareness) might play a more important role in these processes. Additionally, as Tiggemann (2004) has pointed out, body surveillance and body image dissatisfaction do not necessarily go hand-in-hand, especially considering the multi-faceted complexity of the body image dissatisfaction construct and individual differences in the internalised-ideal used as a comparator between the perceived body and ideal body.

The current study is not without limitations. First, an 8 week time frame might not be sufficient to reveal on complex time-related associations among multiple variables. Second, internal consistency for the Body Image Ideals Questionnaire and public body consciousness scores were acceptable but low when compared to previous research (Ainley & Tsakiris, 2013; Dakanalis et al., 2017; Miller et al., 1981). Third, although widely accepted, the mental tracking paradigm (Schandry, 1981) has received some criticism for the potential that participant responses could be influenced by previous knowledge about their own heart rate, or expectations concerning their ability to detect their heart rate accurately (Ring, Brener, Knapp, & Mailloux, 2015). Instruction given to participants can also bias the measurement (Desmedt, Luminet, & Corneille, 2018). For example, participants with the tendency to please others may produce lower overall IAc scores when given strict instructions that do not allow guessing, but produce inflated IAc

scores when given permissive instructions that do allow for guessing. Individuals with a desire to please others could also be likely to aspire to social norms and experience body image dissatisfaction, which may provide some explanation for why we did not find an expected relationship between increased body image dissatisfaction and lower IAc at baseline. Finally, although Norwegian students in the present research have a high level of proficiency and study in English on a daily basis, the questionnaires were neither translated into Norwegian nor validated for use with a Norwegian population. There may be subtle variations in responses due to second language understanding.

In summary, culture and gender differences should be considered when designing interventions for improving body image, as subgroups of the population may show disparate patterns of association among related constructs.

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No1LikesU! – A Pilot Study on an Ecologically Valid and Highly Standardised Experimental Paradigm to Investigate Social Rejection Expectations and Their Modification

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Abstract

Background: Dysfunctional expectations have been suggested as core features in the development and maintenance of mental disorders. Thus, preventing development and promoting modification of dysfunctional expectations through intervention might improve clinical treatment. While there are well-established experimental procedures to investigate the acquisition and modification of dysfunctional performance expectations in major depression, paradigms for investigating other important types of dysfunctional expectations (e.g. social rejection expectations) are currently lacking. We introduce an innovative associative learning paradigm, which can be used to investigate the development, maintenance, and modification of social rejection expectations.
Method: A pilot sample of 28 healthy participants experienced manipulated social feedback after answering personal questions in supposed webcam conferences. While participants repeatedly received social rejection feedback in a first phase, differential feedback was given in a second phase (social rejection vs. social appreciation). In a third phase, explicit social feedback was omitted.
Results: Participants developed social rejection expectations in the first phase. For the second phase, we found an interaction effect of experimental condition; i.e. participants adjusted their expectations according to the differential social feedback. In the third phase, learned social expectations remained stable in accordance to the social feedback in the second phase.
Conclusion: Results indicate that the paradigm can be used to investigate the development, maintenance, and modification of social rejection expectations in healthy participants. This offers broad applications to explore the differential acquisition and modification of social rejection

expectations in healthy vs. clinical samples. Further, the paradigm might be used to investigate therapeutic strategies to facilitate expectation change.

Keywords

ViolEx-Model, expectation violation, expectation persistence, expectation modification, dysfunctional expectations, social rejection, No1LikesU!

Highlights

- This paradigm can be used to induce and modify social rejection expectations.
- This allows to investigate differences in expectation acquisition, maintenance, and modification between clinical vs. healthy samples.
- Further, this paradigm enables research on interventions promoting expectation modification.

Recent developments in clinical psychology propose dysfunctional expectations (i.e. future-directed 'if-X-then-Y'-predictions, Rief et al., 2015, p. 380) as an important factor in the development of mental disorders and as a promising target in clinical treatment (e.g. Greenberg, Constantino, & Bruce, 2006; Rief & Glombiewski, 2017; Rief et al., 2015).

Dysfunctional expectations have been shown to play a crucial role in mental health as they negatively impact future behaviour (e.g. excessive avoidance, Krypotos, 2015), aggravate subjective suffering (e.g. pain perception, Jepma, Koban, van Doorn, Jones, & Wager, 2018), and elicit potentially maladaptive anticipatory reactions (e.g. negative mood, Davidson, Marshall, Tomarken, & Henriques, 2000).

Further, dysfunctional expectations have been shown to impede important clinical outcomes (e.g. treatment success, Constantino, Vîslă, Coyne, & Boswell, 2018). As George A. Kelly put it early in his theory of personal constructs: 'A person's processes are psychologically channelised by the ways in which he anticipates events' (Kelly, 1977, pp. 358-359). Thus, preventing acquisition and promoting modification of dysfunctional expectations through intervention might improve clinical treatment (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; Rief & Glombiewski, 2016; Rief & Joormann, 2019).

However, acquisition, maintenance, and modification of dysfunctional expectations is still little understood (Rief & Joormann, 2019). While there are promising theoretical approaches (Kube, Rief, & Glombiewski, 2017; Kube, Schwarting, Rozenkrantz, Glombiewski, & Rief, 2020) and well established experimental procedures concerning this issue with regard to dysfunctional performance expectations in major depression (Kube, Rief, Gollwitzer, & Glombiewski, 2018), experimental paradigms are lacking when it comes to other types of dysfunctional expectations (see Liebke et al., 2018, for a laudable exception).

Since especially (dysfunctional) expectations of social rejection (e.g. 'When I open myself to others, they will refuse me!") have serious implications for mental health (e.g.

Bianchi, Schonfeld, & Laurent, 2015; Gao, Assink, Cipriani, & Lin, 2017) and the course of various mental disorders (e.g. Bungert et al., 2015; De Panfilis, Riva, Preti, Cabrino, & Marchesi, 2015; Kimbrel, 2008; Slavich, O'Donovan, Epel, & Kemeny, 2010), ecologically valid experimental procedures are strongly needed for further investigation.

The aim of the current study was to develop an experimental social rejection expectation paradigm (No1LikesU!), which can be used to investigate the acquisition, maintenance and modification of social rejection expectations within a highly standardised and ecologically valid procedure. In contrast to existing paradigms on social exclusion (for an overview, see Riva & Eck, 2016), No1LikesU! was especially designed to mimic key processes proposed by a recently published theoretical model on expectation development, maintenance, and modification – the so called 'ViolEx-Model' by Rief and colleagues (2015).

This model proposes that when entering concrete situations, individuals form situation-specific predictions about these situations (drawn from more generalised expectations) which become either (a) confirmed or (b) disconfirmed by experience. While repeated expectation confirmations should stabilise or reinforce the original situation-specific prediction (or respectively, the underlying generalised expectation), repeated expectation 'violations' should entail its modification (Gollwitzer, Thorwart, & Meissner, 2018; Rief et al., 2015).

Following the predications of the model, we hypothesise that (1) repeatedly exposing healthy individuals to situation-specific experiences of social rejection will increase levels of social rejection expectations over time. Consistent with the ViolEx-Model, we further hypothesise that (2) repeatedly exposing healthy individuals with increased levels of social rejection expectations to situation-specific experiences of social rejection ('Stabilisation') vs. appreciation ('Modification') will lead to differential changes (i.e. to an increase vs. stabilisation) in social rejection expectation levels over time.

Method

No1LikesU! is an ecologically valid and highly standardised associative learning paradigm created to model the development, maintenance, and modification of social rejection expectations. Like the O-Cam paradigm (Godwin et al., 2014; Goodacre & Zadro, 2010), it relies on a cover story leading participants to believe that they are going to interact with real human beings via webcam. Participants in No1LikesU! are told that they are going to participate in a study investigating 'how people socialise with and affect each other in virtual environments'. Participants pass multiple supposed 'webcam-conferences' (actually, realistic looking video stimuli) on a computer in which they answer personal questions to different 'listeners' (actually, pre-recorded and instructed confederates). Afterwards, they receive written social feedback on their self-presentation

(actually, manipulated feedback that induces experiences of social rejection vs. social appreciation).

The local ethics committee (reference number 2018-36k) approved the study. All participants gave written informed consent before they started the experiment. This study was part of a parent study, which additionally investigates interventions for promoting the modification of dysfunctional expectations. In the present work, we focus on the effects of the paradigm on the development, maintenance, and modification of social rejection expectations in healthy participants.

Participants

We recruited participants via e-mail lists, flyers, and the research participation system of our university. Inclusion criteria were: (a) A minimum age of 18 years, (b) sufficient German language skills, (c) no severe visual impairment, (d) no serious physical illness, (e) no current psychological stress, (f) not in psychotherapeutic treatment, and (g) a sum score in Beck's Depression Inventory II (BDI-II; Kühner, Bürger, Keller, & Hautzinger, 2007) ≤ 13, indicating no to minimal depressive symptoms.

Until now, a pilot sample of 31 healthy participants could be included in the study, which provides sufficient power to investigate our hypotheses (Huta, 2014). As mentioned above, recruitment based on a priori power analyses continues as we test No1likesU! within an ongoing study addressing further research questions we do not fully report here (preregistered at 'Aspredicted': https://aspredicted.org/g544c.pdf). Since recruitment is currently faltering for the parent study, we would like to publish our pilot results on the paradigm contrary to preregistration in order to make them accessible to the research community. Three participants had to be excluded due to technical problems with the experimental software. The final pilot dataset consisted of 28 healthy participants (82.10% female, M_{age} = 23.39 years, SD = 6.51, range of age = 19–51 years). Table 1 shows the demographic data of the sample.

Participants received credit points as compensation for their participation. Alternatively, they got the chance to win gift vouchers for different online shops.

Procedure

Testing sessions started with participants reading the study information and signing informed consent (see Figure 1 for an overview of the study design). Afterwards, they completed paper-pencil pre-questionnaires.

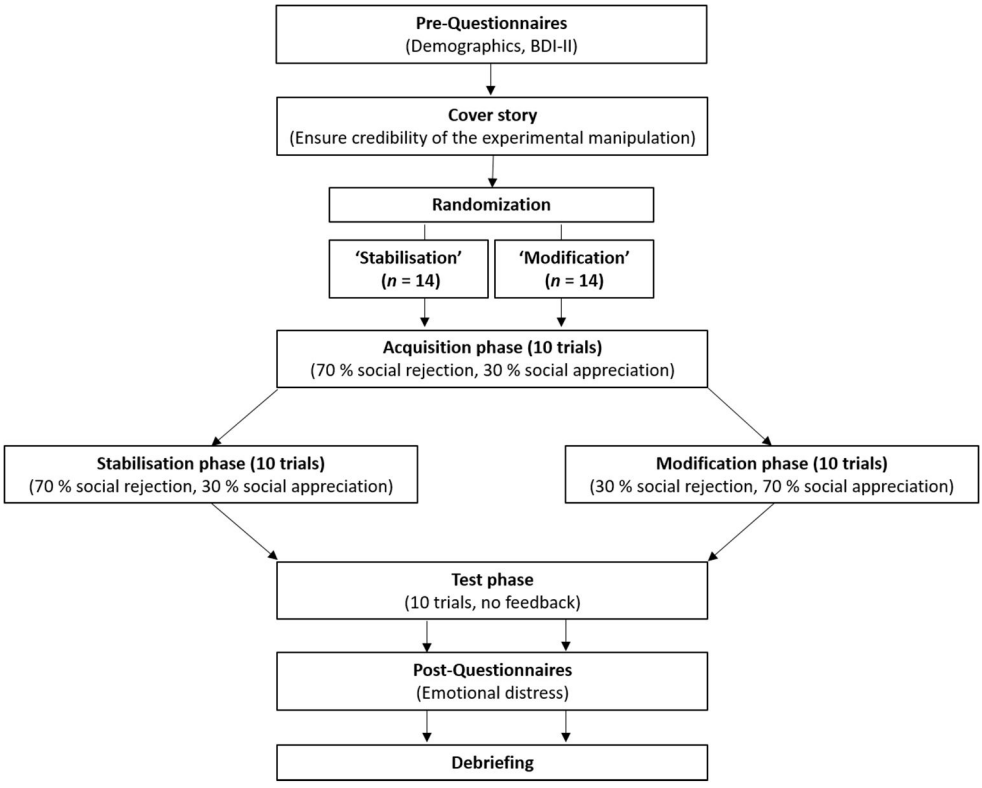
Research assistants checked age as well as BDI-II cut-off scores. Participants who failed the inclusion criteria received partial compensation and were fully debriefed. Participants who met the inclusion criteria received study information incorporating the cover story. To allay concerns about the authenticity of the webcam conference, participants were told that their listeners (who were announced as 'students from an experimental intern-

ship at the university') were instructed 'not to talk' during conferences for 'methodological reasons'. Afterwards, research assistants started the paradigm on the computer and left the experimental room. The participants were fully randomised into two independent experimental conditions (group 'Stabilisation' vs. group 'Modification') and followed instructions presented on the computer screen, which guided through the paradigm.

To model key processes of the 'ViolEx-Model', No1LikesU! encompasses multiple trials (30) which are divided into three different experimental phases (acquisition phase, stabilisation vs. modification phase, test phase, see Figure 1).

Figure 1

Study Design



These phases are structurally based on fear conditioning paradigms (Lissek et al., 2005; Lonsdorf et al., 2017). During the acquisition and stabilisation phase, participants repeatedly form associations between introducing themselves to strangers (conditioned stimulus, CS) and being socially rejected (unconditioned stimulus, US) resulting into

situation-specific social rejection expectations (conditioned response, CR). During modification, opposing associations (CS-US' [being socially appreciated]) are formed resulting into expectations of social appreciation. In order to enhance stability of expectations and ecological validity, No1LikesU! provides partial reinforcement (70%) within these phases. To explore the stability of the social expectations learned within the experimental paradigm, No1LikesU! ends with a test phase which did not provide written social feedback (retention test).

After completing the paradigm, research assistants entered the experimental room and provided paper-pencil post-questionnaires to check for suspiciousness about the cover story and emotional distress due to participation. Participants were then fully debriefed about the true purposes of the study and the deceptions within the experimental manipulation. Testing sessions lasted between 1.0 and 1.5 hours.

Measures

Note that we applied additional questionnaires to address further research questions in the parent study, which we do not describe here.

Situation-Specific Social Expectations

We assed situation-specific social expectations using a one-item 7-point bipolar Likert scale (social expectation rating: 'Please indicate to what extent you expect your next listener to be interested or disinterested in you!') ranging from -3 (maximal disinterest) to +3 (maximal interest) before each trial. Thus, lower values indicate higher social rejection expectations.

Situation-Specific Social Experience

To examine how participants actually perceived a passed webcam conference, we used a one-item 7-point bipolar Likert scale (social experience rating: 'Please indicate to what extent you experienced interest or disinterest from your last listener!') ranging from -3 (maximal disinterest) to +3 (maximal interest) after each trial. Thus, lower values indicate higher social rejection experiences.

Pre-Questionnaires

Depressive Symptoms — We assessed depressive symptoms using the Beck Depression Inventory II (BDI-II; Kühner et al., 2007 prior to running No1LikesU!). Participants responded to the 21 items on a 4-point scale ranging from 0 to 3. The sum score of the 21 items ranges between 0 and 63, whereby higher values indicate more depressive symptoms.

Socio-Demographics — We used a brief self-report questionnaire in order to assess demographic variables like sex, age, nationality, relationship status, educational level, employment status, and living situation.

Post-Questionnaires

Emotional Distress Due to Participation — We assessed emotional distress due to participation by asking whether participants felt impaired due to the experimental procedures ('Do you feel impaired due to our investigation?'). Further, we applied a one-item 5-point bipolar Likert scale ('Please indicate to what extent you feel positive or negative in this moment!') ranging from -2 (very negative) to +2 (very positive) to assess emotional distress. Higher values indicate lower emotional distress due to participation.

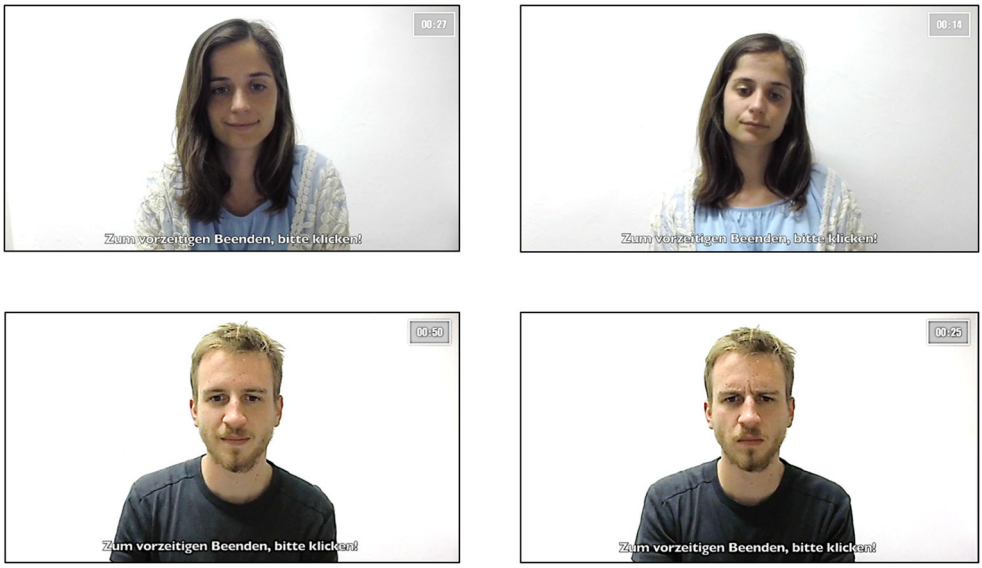
Suspiciousness — In order to assess the credibility of the cover story, the video stimuli and the experimental manipulation, we asked participants whether 1) they knew any of their 'webcam partners', 2) what they believed was the aim and purpose of the study, and 3) how they experienced the experimental procedure. Responses were rated on a 3-point Likert scale ranging from 0 ("not suspicious at all") to 2 ("doubted the authenticity of the webcam conferences").

Apparatus and Stimuli

Participants were seated in front of a computer with an external microphone and a webcam connected to the computer. The paradigm, including instructions, video stimuli, and social feedback, was presented on the computer screen. Participants used a mouse to interact with the computer. Video stimuli were pre-recorded with 30 volunteers (15 male, 15 female, age: 25 – 35). Volunteers were instructed to express nonverbal cues of either social rejection or social appreciation (see Figure 2). We produced two sequences of each volunteer resulting into 30 sequences of social rejection and 30 sequences of social appreciation (50 seconds each). The nonverbal feedback during each trial was matched with the written feedback. The personal and self-related questions were adapted from various dating websites in order to promote positive self-disclosure (see Appendix A in the Supplementary Materials). The video stimuli as well as the personal questions were presented fully randomised during experimental procedure in accordance with the partial reinforcement. For each participant, video stimuli and personal questions were never repeated twice.

Figure 2

Video Stimuli (Left: Social Appreciation, Right: Social Rejection)

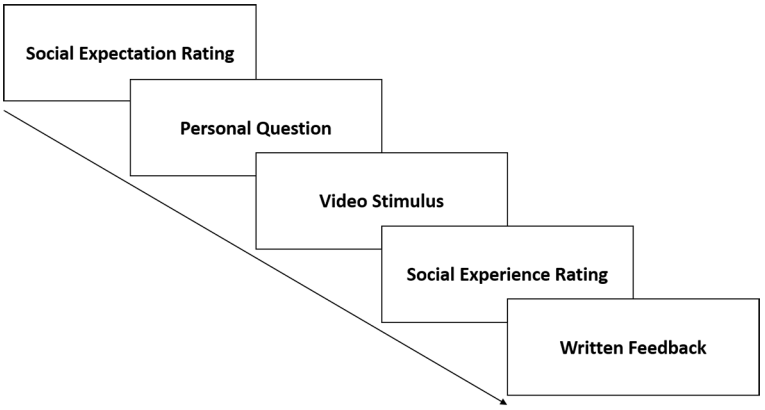


Trial Sequence

Figure 3 gives an overview of the trial sequence. Each trial started with a situation-specific social expectation rating. Afterwards, participants received a personal, self-related question (e.g. 'What are your hobbies?') on the screen ostensibly asked by the 'next listener' in order to pre-set the content of the next conference. Following preparation time depicted by a countdown (20 seconds), participants received a short connection-signal on the screen (5 seconds) before the supposed 'webcam conference' started by showing a pre-recorded video stimulus. To ensure the authenticity of the conferences, participants were instructed to actively end conferences when they finished their self-presentation. After each conference, participants gave a situation-specific social experience rating before receiving written social feedback (e.g. 'Your last listener found you rather uninteresting and would not like to get in touch with you again.'). This trial sequence was repeated (10 times) within each of the three experimental phases. However, written feedback was omitted in the last phase.

Figure 3

Trial Sequence



Statistical Analyses

Before conducting the analyses, we checked for outliers to exclude influential data points. For each expectation rating, we calculated the Mahalanobis distance which we checked against a χ^2-cut-off of $\alpha = .001$. We found no influential data points.

All analyses were computed using *R Studio* (R Studio Team, 2015) for R (R Development Core Team, 2008). We used *lme4* (Bates, Mächler, Bolker, & Walker, 2015), *nlme* (Kuznetsova, Brockhoff, & Christensen, 2017), *blme* (Chung, Rabe-Hesketh, Dorie, Gelman, & Liu, 2013), and *lmerTest* (Kuznetsova et al., 2017) to perform a hierarchical mixed effects analysis of the relationship between social expectations, measuring time and experimental condition. Since the times at which expectations were measured are separable into the three phases, we defined a contrast matrix for Time, which accounted for the nested data structure. We used the contrast matrix for Time as a Level-1-fixed effect, and group as a Level-3-fixed effect (including the interaction term). As random effect, we implemented intercepts for participants (Level 2). We checked homoscedasticity and normality via the residual plots, which always showed expected patterns. We obtained *p*-values by likelihood ratio tests, testing the model with the additional level effect against the model without the additional level effect.

Subsequently, we analysed the phases individually to estimate effect sizes for each phase effect. We used linear models to investigate the relationship between social expectations and group affiliation. We entered Group as fixed effect. We inspected the residual plot to check homoscedasticity and normality. Again, all plots showed patterns as expected. For all analyses, we applied sum contrasts to calculate intercepts and slopes.

Results

Sample Characteristics

Participants were predominantly young (M_{age} = 23.39, *SD* = 6.51), female (82.14%) and well-educated (100% general qualification for university entrance). The mean BDI-II sum score was 4.54 (*SD* = 3.26), indicating that no participant exceeded the clinical threshold of depressive symptoms (Kühner et al., 2007). Table 1 gives an overview of the sample characteristics. There were no significant differences between the experimental conditions in any of the assessed variables.

Table 1

Sample Characteristics

Variable	Stabilisation (*n* = 14)	Modification (*n* = 14)	Difference between experimental conditions
Age in years, *M (SD)*	21.79 (3.02)	25.00 (8.57)	t (26) = 1.32, p = .20
Sex, *N* (%)			χ^2 = 2.19, p = .14
Male	4 (28.57)	1 (7.14)	
Female	10 (71.43)	13 (92.86)	
Nationality, *N* (%)			χ^2 = 0.37, p = .54
German	13 (92.86)	12 (85.71)	
Other	1 (7.14)	2 (14.29)	
Romantic relationship, *N* (%)			χ^2 = 1.29, p = .26
Yes	5 (35.71)	8 (57.14)	
No	9 (64.29)	6 (42.86)	
Living situation, *N* (%)[a]			χ^2 = 0.01, p = .94
Living alone	2 (14.29)	2 (15.38)	
Living with others	12 (85.71)	11 (84.62)	
Educational level, *N* (%)			χ^2 = 1.71, p = .19
University degree	2 (14.29)	5 (35.71)	
No university degree	12 (85.71)	9 (64.29)	
Employment status, *N* (%)			χ^2 = 1.47, p = .23
Employed	6 (42.86)	3 (21.43)	
Not employed	8 (57.14)	11 (78.57)	
BDI-II sum-score, *M (SD)*	4.86 (3.44)	4.21 (3.17)	t (26) = - 0.52, p = .61
MSER before first trial, *M (SD)*	3.86 (1.29)	4.21 (1.12	t (26) = 0.78, p = .44
Emotional distress after participation, *M (SD)*	3.21 (0.70)	3.57 (0.65)	t (26) = 1.40, p = .17

Note. BDI-II = Beck Depression Inventory II; MSER = Mean social expectation rating.
[a]One missing data point.

Manipulation Check for the Nonverbal Social Feedback

We investigated whether the nonverbal social feedback (rejection vs. appreciation) displayed in the videos affected the situation-specific social experience ratings of the supposed webcam conferences. Participants provided these ratings after each conference and before receiving written social feedback.

First, we performed a mixed ANOVA using a linear model of the mean social experience ratings as a function of Group (between factor) and Time (within factor) using Greenhouse-Geisser correction. We found a significant interaction of Group and Time ($F(1, 33) = 5.09$, $p = .023$) as well as a significant main effect for Group ($F(1, 26) = 4.68$, $p = .040$), and Time ($F(1, 33) = 6.80$, $p = .009$).

Next, we performed post-hoc analyses and pairwise comparisons to further analyse the significant interaction effect.

The Bonferroni adjusted p-values suggest that the main effect of Group was significant during modification vs. stabilisation phase ($F(1, 26) = 11.33$, $p = .006$) but not during acquisition phase ($F(1, 26) = 2.46$, $p = .387$), and test phase ($F(1, 26) = 0.64$, $p = 1.000$). Pairwise comparisons showed that the mean social experience rating between group 'Stabilisation' and group 'Modification' differed only during modification vs. stabilisation phase ($p = .002$) when differential nonverbal social feedback was applied (70% social rejection feedback in group 'Stabilisation' vs. 70% social appreciation feedback in group 'Modification'). As expected, group 'Modification' ($M = 3.53$, $SD = 0.64$) showed higher social experience ratings than group 'Stabilisation' ($M = 2.77$, $SD = 0.55$), indicating more perceived social appreciation.

Regarding the main effect of Time, the Bonferroni adjusted p-values suggested significant differences for group 'Modification'($F(1, 16) = 8.26$, $p = .014$), but not for group 'Stabilisation' ($F(1,16) = 4.56$, $p = .080$). Pairwise comparisons revealed differences in mean social experience rating within group 'Modification' between Acquisition Phase ($M = 3.07$, $SD = 0.72$) and Modification vs. Stabilisation Phase ($M = 3.53$, $SD = 0.64$) as well as between modification vs. stabilisation phase and Test Phase ($M = 3.27$, $SD = 0.58$) with modification phase having the highest social experience ratings reflecting the highest nonverbal social appreciation feedback of 70%. We found no significant differences in social experience ratings between acquisition and test phase. These results indicate that the participants experienced the nonverbal social feedback as intended.

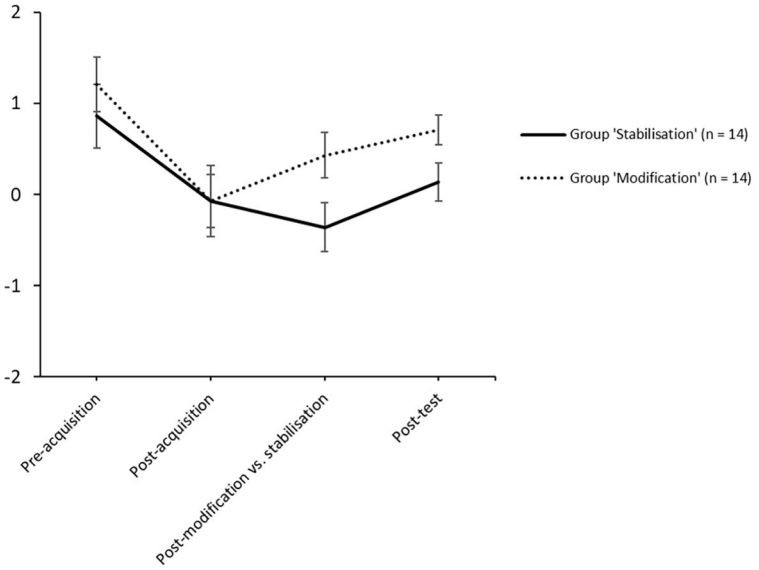
Main Analyses

First, we included all experimental phases in one statistical model and investigated changes in social expectation ratings across the course of the experiment. Therefore, we performed a multilevel mixed effect multinomial linear regression on the social expectation ratings as a function of Group and Time (i.e. the contrast matrix of individual social expectation ratings nested in each phase). Time therefore consists of three variables each representing an experimental phase (acquisition phase, modification vs. stabilisation phase, test phase). Unless otherwise stated, we used the standard bound optimisation by quadratic approximation (BOBYQA) optimisation for the models. We calculated the linear regression of the social expectation ratings as a function of Time (Level 1). We then subsequently added the next-level effects until arriving at the full model including Time (Level 1), random intercept for participant (Level 2), and Group with interaction

term for Time (Level 3). We compared mixed-effects models using likelihood ratio tests. Here, we will describe the results of the Level-3-model, the results for the Level-1- and Level-2-models can be found in the Supplementary Material. Figure 4 shows the course of the mean social expectation ratings across all phases of the experiment.

Figure 4

Mean Social Expectation Rating Across All Experimental Phases as a Function of Experimental Condition



Note. Error bars indicate ± 1 *SE*.

The Level-3-model revealed no significant Group x Acquisition Phase interaction (β = -.00, t = -0.05, p = .585) but a trend for the Group x Test Phase interaction (β = -.02, t = -1.96, p = .050) as well as a significant interaction for Group x Modification vs. Stabilisation Phase (β = .02, t = 2.12, p = .034) in accordance with our hypotheses. Also, we found a main effect for Group (β = .15, t = 2.00, p = .046), Acquisition Phase (β = -.06, t = -3.61, p < .001), and Test Phase (β = .04, t = 2.40, p = .016), but not for Modification vs. Stabilisation Phase (β = -.00, t = -0.5, p = .572). In other words, there were no significant group differences in social expectation ratings during acquisition phase but during stabilisation vs. modification phase and test phase (retention test), whereby participants in group 'Stabilisation' showed higher social rejection ratings than participants in group 'Modification'. Also, social rejection ratings significantly increased during acquisition phase and slightly decreased during test phase for both groups. The non-significant main

effect for Stabilisation vs. Modification Phase can be explained with the opposing effect of the groups on social expectation ratings due to the inverted reinforcement rates.

Table 2 shows the model comparisons for the hierarchical linear regression. The models were sequentially tested against the previous models.

Table 2

Analysis of Variance for the Hierarchical Linear Regression Models

Model	AIC	χ^2	χ_{df}	p
Level 2 (random effect for participant)	2249.7	–	–	–
Level 3 (fixed effect for group)	2243.8	13.87	4	.007

Note. AIC = Akaike information criterion.

Individual Phases

Next, we used MANOVA tests to investigate the effect of Group on the social expectation ratings for each phase individually to investigate the effect sizes of the changes.

Hypothesis 1: Main Effect of Acquisition Phase

We constructed a linear model of the social expectation ratings (as outcome matrix for ratings 1 to 10) as a function of Group and Baseline Social Expectation Rating (with interaction term) to exclude differential learning for the groups and to account for inter-individual influences of baseline ratings on expectation rating during acquisition. We calculated a Type-II-MANOVA using Pillai's test statistic for the linear model. As expected, we found no significant interaction between Group and Baseline Social Expectation Rating, $F(1,15) = 1.41$, $p = .264$, and no significant main effect for Group, $F(1,15) = 0.85$, $p = .593$, but a main effect of the Baseline Social Expectation Rating, $F(1,15) = 3.53$, $p = .013$. Overall, the linear model accounted for 21% of variance ($R^2 = .21$), which constitutes a medium effect (Ellis, 2010).

Hypothesis 2: Main Effect of Group in Stabilisation vs. Modification Phase

Following the significant interaction of Group x Stabilisation vs. Modification Phase in the main analyses, we constructed a linear model of the social expectation ratings (as outcome matrix for ratings 11 to 20) predicted by experimental condition to further investigate the main effect of Group. The Type-II-MANOVA revealed a marginally significant main effect for Group ($F(1,17) = 2.38$, $p = .055$). The model explained 19% of the variance ($R^2 = .19$) constituting a medium effect (Ellis, 2010).

Exploratory Analysis: Stability of the Social Expectation Ratings

To test whether the social expectation ratings would remain consistent during test phase, we analysed a linear model of the social expectation ratings (outcome matrix for ratings 21 to 30) as a function of Group. As expected, the Type-II-MANOVA did not reveal a significant main effect for Group, $F(1,17) = 0.88$, $p = .568$. For test phase, the linear model accounted for 7% of the variance ($R^2 = .07$) which constitutes a small effect (Ellis, 2010).

Suspiciousness of the Cover Story

Additionally, we analysed suspiciousness of the cover story. Seven participants reported doubts about the authenticity of the webcam conferences, six reported that they felt something 'was off' while 15 participants found nothing wrong with the webcam conferences. Further, three participants knew some of their 'webcam partners'. However, a sensitivity analysis excluding all suspicious participants did not reveal significant differences in the result patterns. Therefore, we based our results on the whole sample.

Discussion

While social rejection expectations play a crucial role in mental health, experimental research on the processes of how these expectations develop, maintain, and change is currently lacking. Our study addresses this gap by providing an ecologically valid and highly standardised experimental paradigm to investigate the acquisition, maintenance, and modification of situation-specific social rejection expectations in healthy samples. Results indicate, that this paradigm can be used to successfully induce (Hypothesis 1) as well as differentially change (Hypothesis 2) situation-specific social rejection expectations in healthy participants as a function of social feedback (social rejection vs. social appreciation). Altogether these results are consistent with the predictions drawn from the 'VIolEx-Model', which assumes modification of expectations after experiencing disconfirming results (e.g. positive social feedback after negative social feedback) as well as stabilisation of expectations after experiencing confirming results (e.g. Rief et al., 2015). Further, our results are in line with previous research on expectation development, maintenance, and modification in healthy participants. For example, Liebke et al. (2018) showed that healthy participants increase (respectively reduce) expectations of social acceptance as a function of social feedback (acceptance vs. rejection). Kube, Rief, Gollwitzer, and Glombiewski (2018) as well as Kube, Kirchner, Rief, Gärtner, and Glombiewski (2019) provided similar results concerning the modification of performance-related expectations as a function of performance-related feedback. Kube, Rief, Gollwitzer, and Glombiewski (2018) showed that healthy participants modify dysfunctional task-specific performance expectations in face of positive performance feedback. Consistently, Kube, Kirchner, Rief, Gärtner, and Glombiewski (2019) found that healthy as well as depressed participants

update dysfunctional task-specific performance expectations in accordance to positive vs. negative feedback.

Moreover, our results resemble basic result patterns found in fear conditioning paradigms concerning the acquisition and modification of fear (Lissek et al., 2005): Repeatedly pairing self-presentation with social rejection led to higher social rejection expectation (i.e. higher 'contingency awareness', Lonsdorf et al., 2017, pp. 268-269) while social rejection expectations decreased in turn when social rejection feedback was omitted. However, comparability is limited here, since social expectations formed in the real world might interfere with social expectations formed within No1LikesU! (which is different from most typical fear conditioning procedures). Concerning our test phase, results indicate no 'return' or 'renewal' of social rejection expectations which is normally a common phenomenon in classical fear conditioning ('return of fear', Lonsdorf et al., 2017, p. 260). The stability of the associations learned within stabilisation vs. modification phase might be due to partial reinforcement during this phase as occasional reinforcement seem to attenuate return of fear in human fear conditioning (Craske et al., 2014; Culver, Stevens, Fanselow, & Craske, 2018).

Limitations

Despite incorporating naturalistic stimuli, No1LikesU! does not provide dynamic social interactions. While the pre-scripted video stimuli ensure standardised experimental manipulation, these stimuli do not adapt to individual expressions of participants, threatening its external validity. Moreover, the paradigm only focuses on one specific social situation, i.e. self-disclosure in front of a stranger. Thus, investigating the generalisation of social rejection expectations to other social situations might be difficult within this paradigm. Additionally, a substantial amount of our participants seemed to be suspicious about the 'webcam conferences' and the social feedback we provided within No1LikesU!. While this issue could be solved at the expense of standardisation (for example by using real time interactions with confederates), problems with suspiciousness should not be overestimated within the actual procedure. Firstly, post-hoc questionnaires about the 'aims and purposes' of a study demand for suspiciousness by construction and therefore potentially overestimate actual suspiciousness of individuals during participation. Secondly, research on social exclusion shows that experiences of social exclusion stay impactful even if participants know that social feedback is simulated (e.g. Zadro, Williams, & Richardson, 2004). Further, we measured situation-specific social expectation only via self-report on a one-item scale. While expectations are usually assessed via self-report, more advanced self-report measures as well as multimodal indicators of social rejection expectation (e.g. avoidance behaviour) would improve validity of social rejection expectation assessment.

Further, while we incorporated general suggestions on fear conditioning paradigms, there are no clear instructions on how to set certain parameters in associative learning

procedures (e.g. reinforcement rate or trial number). Thus, changing these parameters might also influence the effects of the paradigm.

Also, while we focused on contingency learning of outcome expectations, we did not include valence ratings for social rejection and social appreciation. Meta-analyses clearly show negative valence for social rejection (Gao et al., 2017), however, individual valence ratings might influence contingency learning. Outcome valence and outcome expectations might be coded differently in human brains (von Borries et al., 2013). While many brain areas associated with contingency learning seem independent of valence, some brain areas are suggested to be more strongly activated when processing positively evaluated stimuli (Bischoff-Grethe et al., 2009).

Finally, while we incorporated the concept of 'expectation violation' (Rief et al., 2015) in our paradigm, it could be argued that we did not provide real extinction training in our study as typically applied in fear conditioning (Lonsdorf et al., 2017). Since social rejection feedback was not only omitted but replaced by social appreciation feedback, we rather provided a 'counterconditioning' (de Jong, Vorage, & van den Hout, 2000) approach in group 'Modification'.

Future Directions

No1LikesU! provides options for broad applications to investigate the acquisition, maintenance, and modification of social rejection expectations within a highly standardised and ecologically valid experimental procedure. It is adaptable to various research attempts. Future research should use No1LikesU! to identify differences in the development, maintenance, and modification of social rejection expectations between healthy and clinical samples (with special regards to patients with borderline personality disorder, social anxiety or depression). To test whether clinical samples show to be differentially more sensitive to social rejection experiences during acquisition than healthy controls and show to be less responsive to social appreciation experiences during modification, has important implications for etiological considerations and clinical treatment. On the one hand, this could call for the development of expectation-focused etiological models (with special emphasise on dysfunctional social rejection expectations as connecting link) like Kube, Siebers, et al. (2018) as well as Rief and Joormann (2019) proposed for major depression. On the other hand, these results would stress the need for carefully designed expectation-focused psychological interventions specifically targeting dysfunctional social rejection expectations through contradictory experiences like Kube, Glombiewski, and Rief (2019) elaborated for people with depressive symptoms. Further, this would extend former findings on the 'ViolEx-Model' and clarify whether expectations of social rejection should be especially targeted in clinical practice. In order to develop proper interventions, researchers should apply No1LikesU! to investigate whether different interventions on informational processing (e.g. verbalisation, functional attention management) improve the modification of social rejection expectations in

face of expectation violations. Here, it would also be of interest to investigate behavioural changes in participants (healthy participants as well as clinical samples) following social appreciation vs. social rejection feedback. This could provide further insight in behavioural expressions of social rejection expectations, which might also consolidate or even reinforce social rejection expectations.

From an ethical point of view, screening for and treatment of emotional distress produced by the paradigm should be enhanced when investigating clinical samples but also healthy controls. Researchers should provide extended debriefing and emotional aftercare by trained psychotherapists in order to prevent clinical subjects from transferring negative social experiences from the paradigm to their real life. Further, they should integrate phases of repeated positive social experiences at the end of their experiments by default in order to compensate for negative social experiences.

Conclusion

No1LikesU! is an ecologically valid and highly standardised experimental paradigm to investigate the development, maintenance, and modification of social rejection expectations. Participants pass multiple short 'webcam-conferences' (video stimuli) in which they answer personal questions to different 'listeners' (confederates). Afterwards, they receive manipulated social feedback on their self-presentation. Our results suggest that researcher can use No1LikesU! to induce and alter social rejection expectations in healthy participants. Future research should focus on differences in the acquisition, maintenance, and modification of social rejection expectations between healthy and clinical samples. Additionally, incorporating interventions on expectation violation processing might improve the modification of social rejection expectations with implications for clinical treatment.

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Supplementary Materials

The supplementary material contains an overview of the 30 questions used in the No1LikesU! paradigm (Appendix A). Questions were adapted from various dating websites to promote positive self-disclosure. Appendix B provides the results of the Level-1- and Level-2-mixed effects models

within the multilevel mixed effect multinomial linear regression (for access, see Index of Supplementary Materials below):

Index of Supplementary Materials

D'Astolfo, L., Kirchner, L., & Rief, W. (2020). *Supplementary materials to "No1LikesU! – A pilot study on an ecologically valid and highly standardised experimental paradigm to investigate social rejection expectations and their modification"*. PsychOpen. https://doi.org/10.23668/psycharchives.3082

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Letter to the Editor, Commentary

A Response to Marvin Goldfried's Article on the Immaturity of the Psy-Professions

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Marvin Goldfried's article (Goldfried, 2020) critiqued the lack of consensus within the psy-professions, articulating reasons for this, but without mentioning *power* or *interest*. I believe the preoccupation with new theories described by Goldfried arises from our inability to discard unworkable ideas, despite ample empirical or conceptual grounds for doing so, because of the workings of power.

If *technology* is the ability to understand and manipulate the non-human material world, *social power* is the ability to influence the behaviour of other humans. Social power varies according to the identities of the parties involved, while technology does not. Disciplines concerned with humans affect and are affected by social power, immediately creating uncertainty. People do not passively accept the effects of new knowledge, but seek to achieve outcomes favourable to their interests by taking control over that knowledge ("History is written by the victors"). Research findings are not determined solely by empirical data, but also through the exercise of ideological power. Social dynamics affect what is asked, what answers are acceptable, how data is interpreted and how much attention is paid to conclusions.

Our profession's immaturity is not for want of empirical data. Questions that may have been answerable decades ago persist because the answers have been unacceptable to powerful interests. Would we really expect the psychometric industry (enmeshed with clinical psychology because of the power it affords the profession) to accept that there is no evidence to support the existence of *g* or temporally and contextually stable personality? Would the legal systems in our societies suddenly shift from punishment to pragmatism, as proposed by Skinner (1973) almost half a century ago, simply because of empirical data refuting free will? Is the persistence of psychiatric diagnosis due to its utility or to the power of the psychiatric profession? How many expert witnesses in legal

cases point out to judges that data obtained through self-report psychometrics is in no way objective?

This is not to suggest that change cannot happen, but that social power is as least as important as "truth" in determining how knowledge develops. Attempts to increase the maturity of our discipline have to take account of power and interest.

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