More than just fear: Development and psychometric evaluation of the Spider Distress Scale to assess spider fear and spider-related disgust

Peters, J.; Visser, R.M; Kindt, M.

DOI
10.1016/j.janxdis.2022.102602

Publication date
2022

Document Version
Final published version

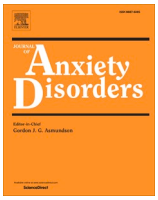
Published in
Journal of Anxiety Disorders

Journal of Anxiety Disorders 90 (2022) 102602

Contents lists available at ScienceDirect

Journal of Anxiety Disorders

journal homepage: www.elsevier.com/locate/janxdis



More than just fear: Development and psychometric evaluation of the Spider Distress Scale to assess spider fear and spider-related disgust

Jacqueline Peters *, Renee M. Visser, Merel Kindt

Department of Psychology, University of Amsterdam, Amsterdam, the Netherlands

ARTICLE INFO

Keywords:
Spider fear
Disgust
Specific phobias
Psychometrics
Factor analysis

ABSTRACT

Spider fear is an excellent model to experimentally study processes in the maintenance and treatment of long-lasting fears. A valid, reliable, and practical tool to assess spider-related distress dimensionally, and to differentiate between spider-related fear and disgust in a time-sensitive manner, may help to better understand individual differences in these two emotions and to tailor treatments accordingly. We developed a concise self-report questionnaire, the Spider Distress Scale (SDS), that combines the strengths of established spider fear questionnaires and addresses their shortcomings. We explored (study 1 and 2) and confirmed (study 3) a two-factor structure of the SDS in samples from the general population (n = 370; n = 360; n = 423), recruited online via Prolific Academic from the United Kingdom, the Netherlands, and the United States. The fear and disgust factors of the SDS are highly internally consistent and the SDS has excellent test-retest reliability. We found good convergent and discriminant validity, based on self-report measures and spider behavioural approach tasks, and the SDS successfully differentiated between individuals with and without spider fear (study 4, n = 75). Our series of studies suggests that fear and disgust are functionally related, but that disgust towards spiders can be differentially assessed when focussing on unique elements of disgust-related information.

1. Introduction

1.1. Spider fear: A model to study anxiety disorders

Spider fear is an excellent model to study the maintenance and treatment mechanisms of anxiety-related disorders in experimental settings. This is because spider fear and phobia are common in the general population (Costello, 1982; Oosterink et al., 2009) as well as student samples (Seim & Spates, 2010), and can be easily triggered and studied in the laboratory (e.g., Vansteenwegen et al., 2007). Moreover, it is a relatively 'clean' fear, typically focussed on a narrow range of fear-provoking situations, and not generally associated with comorbidity, allowing researchers to identify and isolate mechanisms of interest. While there are effective evidence-based treatments for anxiety disorders, such as exposure therapy (Arch & Craske, 2009; Carpenter et al., 2018; Norton & Price, 2007), a substantial proportion of individuals either does not complete the treatment (Arch & Craske, 2009), or experiences a return of fear (see Craske et al., 2014; Craske & Mystkowski, 2007). Research on spider fear can serve as a translational interface between laboratory models of fear in healthy individuals and clinical trials in patients with anxiety disorders to contribute to a better understanding of mechanisms of change and to optimise interventions for people who are suffering from long-lasting fears (e.g., Kindt et al., 2009; Mystkowski et al., 2006; Soeter & Kindt, 2012, 2015; Vansteenwegen et al., 2007).

Optimal leverage of spider fear as a translational model for long-lasting fears depends on the availability of a valid, reliable, and practical tool to assess spider-related distress. The currently established questionnaires for spider fear, the Spider Phobia Questionnaire (SPQ; Klorman et al., 1974) and the Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995), each have their strengths, but also shortcomings. Both measures have been valuable in research, because they are sensitive to therapeutic change, stable over time (but see Packer et al., 1987), show good internal consistency, and can differentiate between clinically fearful and non-clinical individuals, although the FSQ may be the preferable choice in non-clinical research due to its sensitivity in the non-phobic range (Muris & Merckelbach, 1996). The lower sensitivity of the SPQ in the non-phobic range is possibly due to its True/False format, which may also contribute to other shortcomings of this questionnaire, such as its low internal consistency in the non-phobic

* Correspondence to: Department of Psychology, University of Amsterdam, Nieuwe Achtergracht 129 B, REC G, Room 1.23, 1018 WS Amsterdam, the Netherlands.
E-mail address: j.peters@uva.nl (J. Peters).

https://doi.org/10.1016/j.janxdis.2022.102602
Received 29 July 2021; Received in revised form 20 May 2022; Accepted 2 July 2022
Available online 6 July 2022

range (α = .43, Muris & Merckelbach, 1996). Although a well-developed short form of the SPQ (SPQ-15; Olatunji & Woods, 2009) addresses some of the original scale's limitations, the SPQ-15′s True/False format may be prone to inflated treatment effects. The FSQ was developed to complement the SPQ by addressing fear of harm and improving its time-sensitivity (i.e., 7-point Likert scale and time-sensitive wording of items) but fails in measuring disgust and some items leave room for ambiguity. For instance, "Currently, I sometimes think about getting bitten by a spider" adds a time-sensitive element (i.e., currently), but in combination with 'sometimes' leads to confusion. Whereas the SPQ includes items that relate to disgust, it does not differentiate between fear and disgust. As discussed below, disgust may be an important factor in the maintenance and treatment resistance of specific phobias.

1.2. More than fear: Why a differential assessment of spider-related disgust is needed

While current interventions for phobias primarily focus on the reduction of fear, disgust also plays a central role in several anxiety disorders, and fear and disgust are closely related (Cisler et al., 2009; Davey, 2011; Olatunji et al., 2017). For instance, spider fearful individuals are more disgusted when encountering spiders or spider-related stimuli (e.g., pictures of spiders) compared to non-fearful individuals (Olatunji & Deacon, 2008; Sawchuk et al., 2002; Tolin et al., 1997). Although spider fear and disgust functionally overlap in that they both motivate avoidance behaviour (Cisler et al., 2009; Davey, 2011; Woody & Teachman, 2000), the driving mechanism for this clinically relevant behavioural tendency seems to differ. Whereas fear-motivated avoidance may originate from the goal to protect from perceived danger (e.g., the spider may bite me) (Davey, 2011; Woody & Teachman, 2000; but see de Jong & Muris, 2002), disgust-motivated avoidance is thought to originate from the aim of avoiding contaminants (Davey, 2011). Despite disgust's reputation as the 'disease-avoidance emotion' (Davey, 2011), the proximal goal of disgust-motivated avoidance likely reflects the urge to avoid unwanted physical contact with a disgust-evoking spider (de Jong & Muris, 2002). It has also been suggested that spider phobia reflects a fear of unwanted physical contact with a disgust-evoking spider (rather than fear of a fear-provoking spider) (de Jong & Muris, 2002; de Jong et al., 2000). Due to their relatedness, one might expect that fear and disgust decline concurrently over the course of exposure therapy. However, some findings (Woody et al., 2005) suggest that when both fear and disgust are entered in the equation, only disgust shows an independent relationship with spider avoidance behaviour, whereas feeling nervous (anxious) does not. This finding requires replication, but potentially creates an obstacle for successful exposure therapy. Although disgust often declines over the course of exposure in clinical analogue samples, it declines less than fear (Böhnlein et al., 2020; Olatunji, Wolitzky-Taylor et al., 2009; Smits et al., 2002). Even though the reasons for this treatment resistance are not fully understood, these observations are paralleled by laboratory studies showing that learnt disgust is (partially) resistant to unconditioned stimulus devaluation (Mertens et al., 2021) and extinction (Borg et al., 2016; Engelhard et al., 2014; Mason & Richardson, 2010), more so than learnt fear (Olatunji et al., 2007).

In short, a separate assessment of spider-related disgust may be an important step in mapping out the factors that predict successful treatment and/ or relapse. This may in turn contribute to further treatment development and individualised interventions.

1.3. Overarching aim of developing the Spider Distress Scale (SDS)

To address shortcomings of established spider fear questionnaires, and to allow for a more fine-grained mapping of the role of disgust, we aimed to develop a valid, reliable, and concise questionnaire that measures spider-related distress dimensionally and differentiates between spider-related fear and disgust in a time-sensitive manner. We developed the Spider Distress Scale (SDS) based on the following criteria as a first step to establish face validity: (1) the SDS taps into three levels of fear based on Lang's bioinformational model, i.e., the behavioural, verbal (cognitive and affective), and physiological level (Kozak & Miller, 1982; Lang, 1968; Lipp, 2007), albeit through self-report. (2) The SDS should also represent the core Diagnostic and statistical manual of mental disorders (DSM-5; American Psychiatric Association, 2013) symptoms of spider phobia,[1] as well as (3) hypervigilance (Mogg et al., 1987; Pflugshaupt et al., 2005), and (4) fear of harm. (5) The SDS covers spider-related disgust and differentiates it from other facets of spider-related distress (if exploratory factor analyses (EFAs) suggest a multi-factor solution). For developing the disgust items, we focussed on spider-related aspects that predominantly elicit feelings of disgust, such as drawing the individual's attention to the feeling provoked by physical contact with a dead/ harmless spider or objects that have been in contact with a spider (e.g., a sandwich that a spider had walked over).[2]

To develop the Spider Distress Scale, we created 46 fear- and disgust-related items based on the aforementioned theoretical criteria and previous work in the field. In a pilot study, 326 individuals responded to these 46 items in a randomized order with the aim to discard and revise items, primarily based on further review of the literature and participant feedback, leading to an 18-item version of our scale. Please see the Open Science Framework website of this series of studies for further details on the pilot study and an overview of all items (https://osf.io/4fsvy/). We then conducted an exploratory factor analysis (EFA) with the 18-item version in a sample of 370 individuals (study 1) to examine the factor structure, simplify it if needed, and to assess model fit and reliability. After minor revisions we explored the factor structure, model fit, and reliability of our current 17-item SDS in a sample of 360 individuals by running another EFA (study 2). We then conducted a confirmatory factor analysis (CFA) in an independent sample of 423 participants to confirm the two-factor structure and to assess test-retest reliability (study 3). Finally, we established concurrent, convergent, and discriminant validity in a lab-based study with 75 participants, which included two spider behavioural approach tasks (study 4).

2. Study 1: Exploring the factor structure of an 18-item SDS

2.1. Methods

2.1.1. Participants

A total of 375 participants were recruited via Prolific Academic (prolific.co). This allowed us to exclude up to 25 % while maintaining our target sample of at least 300. To be eligible, participants had to be 18–65 years old, fluent in English, and their current country of residence as well as nationality had to be the United Kingdom, the United States of America, or the Netherlands at the time of pre-screening. Further, participants had to have a Prolific approval rate of at least 99 %, could not be part of other crowdsourcing platforms, had to participate using their

[1] The DSM-5 describes spider phobia as a phenomenon where spider fear is excessive, unreasonable, and out of proportion to the actual danger. It interferes with an individual's daily life, and spider encounters are either tolerated with extreme distress or avoided. The SDS does not cover the duration criterion (6 months), because we want to detect time-sensitive changes. The SDS also does not include the criterion that the disturbance is not better explained by the symptoms of another mental health disorder, as a formal diagnosis is not the aim of the new scale.

[2] Unlike fear, disgust elicited by objects that have been in contact with spiders involves beliefs about threat of contamination (Cisler et al., 2009; Woody & Teachman, 2000). This does not imply that an individual with spider fear will feel disgusted when encountering a spider because they are afraid of contaminants. Here, contamination beliefs refer to the appraisal that once an object has been in contact with a spider, it remains "dirty" and able to elicit disgust even after the spider has left, and should therefore be avoided (i.e., "once in contact, always in contact", Rozin & Fallon, 1987).

desktop or laptop (i.e., mobile phones and tablets were not allowed), and had to have filled out pre-screening questions about their sex and student status. We excluded four participants for failing our attention check, zero participants for 'jibberish' responses on an open-ended text question, and one participant for having the Czech nationality.

Our final sample consisted of 370 participants (59 % female), with an age range of 18–65 ($M = 35.81$, $SD = 12.04$). Most of our sample was from the United Kingdom (79.19 %), followed by the United States (18.65 %), and the Netherlands (2.16 %). About one fifth of our sample (21.08 %) were students. All participants were reimbursed £ 0.63. Data collection took place in November 2020.

2.1.2. Procedure

The study was visible to participants on Prolific who met our eligibility criteria, determined by self-reported responses on Prolific's pre-screening questionnaire. This online study took about five minutes to complete, and informed consent was obtained prior to participation. We did not record personal information other than participants' Prolific IDs and their demographic data. All reported studies were approved by the Ethics Review Board of the Faculty of Social and Behavioural Sciences at the University of Amsterdam.

2.1.3. Materials

18-item Spider Distress Scale (SDS). The version of the SDS used in study 1 consisted of 18 items, which were assessed on a 7-point Likert scale, ranging from 0 (*Completely Disagree)* to 6 (*Completely Agree)*. Thirteen of these items were designed to target spider fear, fear of harm, avoidance, and hypervigilance, whereas five items were designed to target spider-related disgust.

Attention Check. An attention check, for which a specific response was required, was placed between item 10 and 11 of the SDS.

Suggestions for Improvement. After participants filled out the SDS, they were asked whether they had suggestions for improvements. If they did not have any, then they were asked to say what they liked about the questionnaire. This open-ended question was used for participant feedback and to screen for nonsensible responses to exclude inattentive participants.

Exploratory Questions. After participants completed the SDS, they were asked several spider-related questions, such as whether they feel more fear if they were within a touching distance of a house spider or a tarantula.

2.2. Study 1: Results

Anonymised data and R code for exploratory and confirmatory factor analyses (study 1–3) can be found at the Open Science Framework web page for this series of studies (https://osf.io/4fsvy/).

2.2.1. Data screening

First, the data ($N = 370$) were screened for univariate and multivariate normality (MVN). We allowed substantial deviation from univariate normality because we theoretically expected that some items would test for particularly high or low fear. Based on criteria outlined by Curran et al. (1996), only item 8 *("I try to avoid going to forests, parks, or other green areas because I may encounter spiders there.")* was identified as potentially problematic (skew = 2.66, kurtosis = 7.89), but remained in the data set for further examination, due to its theoretically meaningful measurement of clinical avoidance. We identified seven participants as extreme multivariate outliers based on Mahalanobis' D-squared that exceeded the critical value of 42.31, reflecting an alpha level of .001. As all data are likely plausible, we did not remove outliers from our main analyses, but ran additional EFAs excluding MVN outliers to check for the robustness of our factor structure. Second, we checked whether our data are suitable for factor analysis. We did not find singularity, i.e., no perfect (Spearman's rank) correlations ($r_s = 1$) between any two SDS items. We used the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy to assess whether the correlation matrix is factorable. All items' KMO values were greater than .9, and hence 'marvellous' for factorability (Kaiser & Rice, 1974). Lastly, there were no missing data in the SDS due to our forced response format. For demographics, there were no missing data for nationality, sex, and student status, but 0.81 % were missing for current country of residence.

2.2.2. Exploratory factor analysis (EFA)

We conducted EFAs to determine the underlying structure of the SDS, using the *psych* (Revelle, 2020) package in R. First, we determined the number of factors based on (1) theory, (2) parallel analysis (Horn, 1965), and a (3) scree plot (Cattell, 1966), as suggested by Buchanan et al. (2014). We used minimum residual estimation with direct oblimin rotation, which is an oblique rotation method, because we did not expect our factors to be uncorrelated (Preacher & MacCallum, 2003). We chose a minimum residual estimation method because it is not as susceptible to (multivariate) normality violations as other estimation methods, such as maximum likelihood (Zygmont & Smith, 2014). We used polychoric correlations, because our data are ordinal and polychoric correlations were found to be more accurate for non-normal data (Gaskin & Happell, 2014). Based on theory, we expected two factors: One factor to capture aspects that are unique to spider-related disgust, and one factor that captures all other aspects relevant to spider fear. Parallel analysis suggested three factors, and the scree plot indicated two factors before the point of inflexion (Field, 2009). As two of our three criteria indicated two factors, we decided for a two-factor model.

To achieve simple structure, we used the criterion that loadings must be greater than 0.4, because then an item shares at least 16 % of variance with the factor, which means it is likely meaningful to be interpreted (Stevens, 2009). In our first EFA, all 18 items loaded above 0.4 on two factors, but item 14 (*"Spiders are disgusting")* cross-loaded with 0.47 and 0.41 on the first and second factor respectively. Therefore, we removed this item. Then we re-ran the EFA with the 17 remaining items, which achieved simple structure in that no item cross-loaded and all items loaded above 0.4 (see Table 1). Importantly, the two-factor structure reflected the expected structure when developing the questionnaire with all items that were developed to distinguish spider-related disgust from fear loading on the second factor (SDS-D), and all other items loading on a larger, first fear factor (SDS-F). The SDS-F ($M = 32.52$, $SD = 20.82$) explained 51 % of the total variance and the SDS-D ($M = 13.42$, $SD = 6.91$) explained an additional 16 %, leading to a total explained variance of 67 %.

This two-factor model had an acceptable fit based on the Tucker-Lewis Index (TLI) at .91, but a marginally poor fit based on the Root Mean Square Error of Approximation (RMSEA) at .10 CI [.09–.11] where values above .10 indicate poor fit (MacCallum et al., 1996). Both the SDS-F (McDonald's $\omega = .96$, Cronbach's $\alpha = .95$) and the SDS-D (McDonald's $\omega = .89$, Cronbach's $\alpha = .87$), as well as the SDS as a whole (McDonald's $\omega = .97$, Cronbach's $\alpha = .96$), were highly reliable regarding internal consistency. The pattern of our results neither changed when excluding multivariate outliers ($n = 7$), nor across varying estimation methods (i.e., maximum likelihood and generalized weighted least squares).

2.3. Study 1: Discussion

Study 1 showed that the SDS measures spider distress in a reliable manner and meaningfully differentiates unique elements of spider-related disgust from fear, supporting its content validity. We removed item 14 ("Spiders are disgusting"), because it cross-loaded on both factors despite its explicit disgust-related wording. Although counterintuitive, this finding is not surprising as it emphasizes the functional overlap of spider fear and disgust in that they both motivate an avoidance response (Cisler et al., 2009; Davey, 2011; Woody & Teachman, 2000). When confronted with a spider, both emotions evoke the desire to withdraw and feeling one may strengthen the other. This could

Table 1
Study 1: Factor Loadings, Item Means (M), and Standard Deviations (SD) of the Spider Distress Scale.

	Item	SDS-F	SDS-D	h2	*M*	*SD*
1	I am afraid of all types of spiders	**0.81**	0.05	0.72	2.88	2.02
2	If I were in a room with a spider, it would be difficult for me to ignore it.	**0.73**	0.13	0.69	3.76	2.06
3	I feel very distressed whenever I see a spider.	**0.92**	0.00	0.85	2.82	2.01
4	If there were a spider in my bedroom, I would ask someone else to remove it.	**0.81**	0.02	0.69	2.61	2.32
5	Looking at pictures of spiders makes me feel uncomfortable.	**0.80**	0.03	0.68	2.61	2.07
6	Whenever I enter a room, I scan it for spiders.	**0.77**	-0.03	0.56	1.27	1.70
7	If I were asked to touch a tarantula, there is no way that I could do it.	**0.50**	0.22	0.47	3.43	2.08
8	I try to avoid going to forests, parks, or other green areas because I may encounter spiders there.	**0.51**	0.03	0.29	0.59	1.09
9	I feel fear whenever I see a spider	**0.93**	-0.02	0.85	2.36	2.02
10	I am afraid of spiders even if they are not venomous.	**0.96**	-0.05	0.86	2.89	2.18
11	Whenever a spider is nearby, I am afraid that it will jump on me.	**0.81**	0.07	0.74	2.62	2.11
12	If I saw a spider now, my heart would beat faster.	**0.96**	-0.09	0.80	2.90	2.12
13	Whenever a spider is within my reach, I worry that it will try to bite me.	**0.64**	0.13	0.54	1.77	1.86
15	I feel sick when I imagine eating a sandwich that a harmless spider had walked over.	0.06	**0.83**	0.76	3.03	2.10
16	I would want to wash my hands after touching a spider.	-0.12	**0.89**	0.65	4.03	1.98
17	The sticky texture of spider webs is sickening.	0.13	**0.66**	0.58	2.86	1.98
18	If I were asked to touch a dead spider with my bare hands, I would feel disgusted.	0.28	**0.65**	0.23	3.50	2.12

Note. Applied rotation method is oblimin. We used minimum residuals as the estimation method with polychoric correlations. Factor loadings > 0.4 are listed in boldface type. SDS-F: Fear factor. SDS-D: Spider-related disgust factor. h2: Communality. N = 370. Item 14 ("Spiders are disgusting.") is not listed as it cross-loaded on both factors and was removed before re-running EFA with the 17 remaining items.

potentially result in difficulties describing to what extent one is feeling fear or disgust (Davey, 2011; Woody & Teachman, 2000). Please see the General Discussion for an evaluation of the implications of removing cross-loading items in the context of spider distress.

Even though the TLI indicated an acceptable model fit after removing item 14, the RMSEA fell short of an acceptable fit, which may be partly due to the severely skewed item 8 *("I try to avoid going to forests, parks, or other green areas because I may encounter spiders there"),* which also loaded lower than most other items on its factor (i.e., 0.51). Most participants completely disagreed with this item, which seems sensible as it assesses clinically significant avoidance behaviour. Measuring avoidance behaviour is theoretically meaningful as it is a key aspect of maladaptive fear (Krypotos et al., 2015; LeDoux et al., 2017). As no other item on the SDS measures (expected) avoidance behaviour directly without also measuring another aspect of fear, such as hypervigilance, we were reluctant to remove this item. Additionally, this item loaded greater than 0.4 on the fear factor. Hence, we revised this item to capture expected avoidance behaviour dimensionally by phrasing it less extreme: *"There are certain places that I try to avoid because I may encounter spiders there"*.

Several participants thought that it was not always clear to which type of spider the questionnaire was referring to, with one participant pointing out that the spider they are most scared of is not black while describing a normal, large house spider. We revised our questionnaire instructions by replacing "black" with "large" to allow participants to apply the instructions to the type of house spider that they may encounter in their surroundings: "*Whenever the spider type is not specified in a given statement, we refer to a large house spider with a thick body"*.

3. Study 2: Exploring the factor structure of the current 17-item SDS

Please see study 1 for justifications of our methods and procedure. Unless otherwise specified, the eligibility criteria and methods are identical to study 1.

3.1. Methods

3.1.1. Participants

A total of 376 participants were recruited through Prolific Academic. We excluded one participant for not completing the questionnaire, 14 for failing our attention check, zero for responding with jibberish answers to an open-ended question, and one participant for indicating that their current country of residence is Israel. Hence, our final sample consisted of 360 participants (63.89 % female), with an age range of 18–65 (M = 36.53, SD = 11.90). The majority of our sample was from the United Kingdom (90 %), whereas 5 % were from the Netherlands and the United States each. Nearly one fifth of our sample (18.33 %) were students. Data collection took place in December 2020. If participants had already participated in study 1, they were not eligible for study 2.

3.1.2. Materials and procedure

See study 1 for all other materials and procedures.

Spider Distress Scale (SDS). The SDS consists of 17 items, which were assessed on a 7-point Likert scale, ranging from 0 (*Completely Disagree)* to 6 (*Completely Agree)*. Thirteen of these items were designed to target spider fear, fear of harm, avoidance, and hypervigilance, whereas four items were designed to target spider-related disgust. See appendix A for all items and questionnaire instructions.

3.2. Study 2: Results

3.2.1. Data screening

There were no substantial deviations from univariate normality in our data (skew > 2, kurtosis > 7), but several items appeared non-normal upon inspecting histograms. We identified six MVN outliers based on Mahalanobis' D-squared that exceeded the critical value of 40.79, reflecting an alpha level of .001. We ran all our main analyses including MVN outliers and checked for the robustness of the factor structure when excluding outliers.

Our data seemed suitable for factor analysis. There was no singularity and all items' KMO values were greater than .9, indicating excellent factorability (Kaiser & Rice, 1974). There were no missing data in the SDS due to our forced response format. For demographics, there were no missing data for nationality, sex, and student status, but 0.83 % were missing for current country of residence.

3.2.2. Exploratory factor analysis (EFA)

As in study 1, EFAs were conducted using a minimum residual estimation method with direct oblimin rotation and polychoric correlations. Based on theory and results from study 1, we expected a two-factor structure. In line with this, parallel analysis and the scree plot indicated two factors, hence we conducted our EFAs using a two-factor model. In our first EFA, all 17 items loaded above 0.4 and no item cross-loaded, indicating simple structure (see **Table 2**). The identified two-factor structure reflected the expected structure when developing

Table 2
Study 2: Factor Loadings, Item Means (M), and Standard Deviations (SD) of the Spider Distress Scale.

	Item	SDS-F	SDS-D	h2	*M*	*SD*
1	I am afraid of all types of spiders	**0.88**	-0.02	0.76	2.75	2.00
2	If I were in a room with a spider, it would be difficult for me to ignore it.	**0.80**	0.06	0.71	3.44	2.07
3	I feel very distressed whenever I see a spider.	**0.92**	0.00	0.85	2.52	1.99
4	If there were a spider in my bedroom, I would ask someone else to remove it.	**0.89**	-0.07	0.70	2.51	2.33
5	Looking at pictures of spiders makes me feel uncomfortable.	**0.81**	0.04	0.70	2.61	2.16
6	Whenever I enter a room, I scan it for spiders.	**0.77**	0.02	0.62	1.02	1.59
7	If I were asked to touch a tarantula, there is no way that I could do it.	**0.56**	0.17	0.48	3.39	2.00
8	There are certain places that I try to avoid because I may encounter spiders there.	**0.79**	0.04	0.67	1.99	1.98
9	I feel fear whenever I see a spider	**0.93**	0.00	0.87	2.43	2.02
10	I am afraid of spiders even if they are not venomous.	**0.98**	-0.04	0.90	2.69	2.21
11	Whenever a spider is nearby, I am afraid that it will jump on me.	**0.86**	0.03	0.76	2.49	2.07
12	If I saw a spider now, my heart would beat faster.	**0.88**	0.01	0.79	2.80	2.11
13	Whenever a spider is within my reach, I worry that it will try to bite me.	**0.75**	0.02	0.58	1.59	1.69
14	I feel sick when I imagine eating a sandwich that a harmless spider had walked over.	0.18	**0.68**	0.66	2.58	2.01
15	I would want to wash my hands after touching a spider.	-0.13	**0.87**	0.61	3.83	1.87
16	The sticky texture of spider webs is sickening.	0.17	**0.61**	0.54	2.79	1.85
17	If I were asked to touch a dead spider with my bare hands, I would feel disgusted.	0.32	**0.55**	0.66	3.45	2.03

Note. Applied rotation method is oblimin. We used minimum residuals as the estimation method with polychoric correlations. Factor loadings > 0.4 are listed in boldface type. SDS-F: Fear factor. SDS-D: Spider-related disgust factor. h2: Communality. N = 360.

the questionnaire (SDS-F and SDS-D) in that items developed to reflect spider-related disgust loaded on the SDS-D and all other items loaded on the SDS-F. The SDS-F (M = 32.23, SD = 21.92) explained 57 % of the total variance and the SDS-D (M = 12.65, SD = 6.33) explained an additional 13 %, reflecting 70 % total explained variance.

The two-factor model had an excellent fit based on the TLI at .97, and a fair fit based on the RMSEA at .065 CI [.055–.075]. Both, the SDS-F (McDonald's ω = .97, Cronbach's α = .96) and the SDS-D (McDonald's ω = .86, Cronbach's α = .83) as well as the SDS as a whole (McDonald's ω = .97, Cronbach's α = .96) were highly reliable with regards to internal consistency. The pattern of our results remained the same when excluding multivariate outliers (n = 6), and across estimation methods.

3.3. Study 2: Discussion

Our exploratory factor analysis in study 2 indicated that the suggested two-factor model fits the 17-item SDS well, and that this scale differentiates spider fear from unique aspects of spider-related disgust. Participant feedback was positive (e.g., "The questions were clear, concise, and not repetitive") and less than a handful of participants suggested that the spider type, size, or attributes were unclear in the current version of the SDS. Hence, we concluded that no further revisions were necessary.

4. Study 3: Confirming the two-factor structure

To confirm the two-factor structure of the SDS and to establish test-retest reliability, we conducted another study with an independent sample.

4.1. Methods

4.1.1. Participants

A total of 430 participants were recruited through Prolific Academic, aiming at 400 included individuals. We excluded seven participants for failing our attention check and zero for providing jibberish answers on our open-ended question. Hence, our final sample size consisted of 423 participants (59.81 % female), with an age range of 18–65 (M = 37.69, SD = 13.09). Most of our sample was from the United Kingdom (93.14 %), whereas 4.25 % were from the Netherlands and 2.60 % from the United States. About one fifth of our sample (19.62 %) were students. Participants were only eligible if they had not participated in study 1 or 2.

4.1.2. Procedure and materials

See study 1 for the detailed procedure and materials, and study 2 for the 17-item version of the SDS. The main data collection took place April 13–15th 2021. Additionally, participants were invited to fill out the SDS again about three weeks after participating (May 4–11th) to assess test-retest reliability among the included participants.

4.2. Results

4.2.1. Data screening

There were no substantial deviations from univariate normality in our data, but several items appeared non-normal upon expecting histograms. Nine MVN outliers were identified based on a Mahalanobis' D-squared that exceeded the critical value of 40.79, reflecting an alpha level of .001. These data were not removed from the main analyses, but we conducted an additional CFA without multivariate outliers to check for the robustness of our findings. There were no missing data in the SDS due to the forced response format. No data were missing with regards to nationality, sex, and age, but 2.84 % were missing for the current country of residence.

4.2.2. Confirmatory factor analysis

We used the *lavaan* (Rosseel, 2012) package in *R* to perform our analyses. To examine the factor structure of the SDS, we specified a two-factor model with 13 and four items, reflecting our previously established SDS-F and SDS-D factors. Diagonally weighted least squares (DWLS) was used for the CFAs as this is the preferred method for ordinal data over traditional maximum likelihood estimation (Li, 2016). See **Table 3** for all factor loadings of the two-factor model as specified above.

We used the following fit indices to assess model fit: RMSEA, standardized root mean residual (SRMR; Bentler, 1990), TLI, and the comparative fit index (CFI; Bentler, 1990).[3] For RMSEA and SRMR it is the aim to obtain low values (< .10 for moderate fit, < .06 for good fit), whereas for TLI and CFI high values (> .90 good; > .95 excellent) are desirable (Hu & Bentler, 1999). The TLI of .99, CFI of .99, and SRMR of .03 indicated an excellent fit of the specified two-factor model, whereas the RMSEA at .081 CI [.073–.089] indicated moderate fit. The pattern of these results remained stable without multivariate (n = 9) outliers, and when using maximum likelihood as an estimation method, although the fit based on the TLI of .93 and the CFI of .94 were in the acceptable, instead of the excellent range.

[3] We report χ^2, but we do not use it to assess model fit, because it is biased by large sample size (MacCallum et al., 1996)

Table 3
Standardized Factor Loadings Based on Confirmatory Factor Analysis (CFA) With a Two-Factor Model and Diagonally Weighted Least Squares (DWLS), Item Means (M), and Standard Deviations (SD).

		SDS-F	SDS-D	*M*	*SD*
1	I am afraid of all types of spiders	0.87		2.78	2.02
2	If I were in a room with a spider, it would be difficult for me to ignore it.	0.89		3.59	2.12
3	I feel very distressed whenever I see a spider.	0.94		2.56	2.06
4	If there were a spider in my bedroom, I would ask someone else to remove it.	0.87		2.46	2.35
5	Looking at pictures of spiders makes me feel uncomfortable.	0.86		2.51	2.07
6	Whenever I enter a room, I scan it for spiders.	0.83		1.02	1.58
7	If I were asked to touch a tarantula, there is no way that I could do it.	0.73		3.47	2.13
8	There are certain places that I try to avoid because I may encounter spiders there.	0.79		1.90	2.02
9	I feel fear whenever I see a spider	0.97		2.46	2.06
10	I am afraid of spiders even if they are not venomous.	0.96		2.74	2.20
11	Whenever a spider is nearby, I am afraid that it will jump on me.	0.86		2.42	2.02
12	If I saw a spider now, my heart would beat faster.	0.92		2.80	2.07
13	Whenever a spider is within my reach, I worry that it will try to bite me.	0.82		1.64	1.78
14	I feel sick when I imagine eating a sandwich that a harmless spider had walked over.		0.76	2.46	2.02
15	I would want to wash my hands after touching a spider.		0.69	3.71	2.06
16	The sticky texture of spider webs is sickening.		0.75	2.57	1.99
17	If I were asked to touch a dead spider with my bare hands, I would feel disgusted.		0.94	3.34	2.14

Note. SDS-F: Fear factor. SDS-D: Spider-related disgust factor. N = 423.

The SDS-F (McDonald's ω = .97, Cronbach's α = .96) and the SDS-D (McDonald's ω = .86, Cronbach's α = .83) as well as the SDS as a whole (McDonald's ω = .97, Cronbach's α = .96) were highly reliable with regards to internal consistency (Table 4).

4.2.3. Test-retest reliability

The SDS-F (r = .95), SDS-D (r = .87) as well as the total score (r = .95) were highly stable over the course of three weeks. 396 out of the 423 invited participants filled out the SDS again three weeks later. Of these, one response was incomplete, and one participant failed an attention check, leading to 394 participants (complete pairs) to assess stability, reflecting 93.14 % of the original sample. Mean scores for the SDS (M_{time1} = 44.36, SD_{time1} = 27.18; M_{time2} = 44.87, SD_{time2} = 28.01), the SDS-F (M_{time1} = 32.31, SD_{time1} = 21.98; M_{time2} = 32.12, SD_{time2} = 22.64), and the SDS-D (M_{time1} = 12.05, SD_{time1} = 6.67; M_{time2} = 12.75, SD_{time2} = 6.76) remained highly similar across three weeks for the 394 participants.

4.3. Study 3: Discussion

We confirmed that a two-factor model has a good fit overall. Whereas most of our fit indices indicated excellent fit, the RMSEA indicated moderate fit in this study (Browne & Cudeck, 1992; MacCallum et al., 1996). Even though the fit indices, which we used to evaluate our model fit in this series of studies are positively evaluated and recommended, it is not uncommon for them to not fully align. This can be caused by the arbitrary cut-offs that we used to evaluate model fit (Browne & Cudeck, 1992; MacCallum et al., 1996), by the fact that RMSEA and CFI/TLI evaluate model fit from a different perspective, and because adequate interpretations of these indices are not yet well understood (Lai & Green, 2016). The test-retest reliability of the SDS (r = .95) over the course of three weeks was excellent, and comparable to those previously reported for the FSQ (r = .91) and SPQ (r = .94) (Muris & Merckelbach, 1996).

Table 4
Summary of Means (M), Standard Deviations (SD), Range, and Reliability Coefficients for the Spider Distress Scale (SDS) and its two Factors.

	M (SD) Sum score	*M (SD)* Item average	Range	McDonald's ω	Cronbach's α
SDS-Total	44.42 (27.34)	2.61 (1.61)	0–102 (0–6)	.97	.96
SDS-F	32.34 (22.14)	2.49 (1.70)	0–78 (0–6)	.97	.96
SDS-D	12.08 (6.66)	3.10 (1.67)	0–24 (0–6)	.86	.83

Note. SDS-Total consists of 17 items. The fear factor (SDS-F) consists of 13 items and the spider disgust factor (SDS-D) of four items. McDonald's ω is based on polychoric correlations, which is suitable for ordinal data, whereas Cronbach's α is traditionally used to assess internal consistency. N = 423.

5. Study 4: Concurrent, convergent, and discriminant validity

To further asses the validity of the SDS, we assessed its associations with several related measures and two spider behavioural approach tasks (BATs). We also assessed whether it could discriminate between individuals with and without spider fear.

5.1. Methods

5.1.1. Participants

Participants were recruited via the University of Amsterdam's laboratory recruitment system, which is accessible to both students and the general population. Eligibility criteria were being comfortable to participate in English, being at least 18 years old, and not having taken part in any research or therapy involving living spiders. 75 participants (81.33 % female), with an age range of 18–38 (M = 21.12, SD = 3.08) completed this study, which exceeded the minimal required sample size of 59 to assess correlations between the SDS and related measures with an effect size of $|\rho|$ = 0.45 at an alpha error probability of 0.05 with 95 % power. Participants were reimbursed with either 20 EUR or two psychology study credits for completion.

5.1.2. Procedure

Participants filled out an intake questionnaire to confirm their eligibility. Then they were scheduled for their in-person session by phone, during which we also conducted a structured clinical interview for DSM-5 specific phobias (SCID-5), modified to screen for spider phobia. Participants then came to an in-person session, during which they provided written informed consent, filled in several questionnaires, and participated in two BATs in counterbalanced order, separated by 7-min breaks to avoid spill-over effects.

5.1.3. Materials

Questionnaires. In addition to the SDS, we used the SPQ (Klorman et al., 1974) and the FSQ (Szymanski & O'Donohue, 1995) to assess self-reported spider fear. For related measures, we used the Disgust Propensity and Sensitivity Scale – Revised (DPSS-R; Fergus & Valentiner, 2009; van Overveld et al., 2006) and the State-Trait Anxiety Inventory – Trait, Form Y, English back-translation of the Dutch version

(STAI-T; Spielberger et al., 1983). The DPSS-R is a 12-item self-report measure that assesses (and distinguishes) disgust propensity (i.e., how readily someone responds with disgust) and sensitivity (i.e., how aversive someone considers experiencing disgust) on a 5-point Likert scale with good internal consistency (Fergus & Valentiner, 2009).

Spider Behavioural Approach Tasks (BATs). We conducted a tarantula BAT (TBAT; adult female *Grammostola porteri*, ~10 cm) and a house spider BAT (HBAT; *Eratigena atrica*, ~ 3 cm) to assess participants' spider avoidance behaviour, modified from Soeter and Kindt (2015). The TBAT consisted of eight steps, ranging from standing in front of the terrarium (1), touching the tarantula (5), to placing one's hand on the terrarium's floor with the eyes closed while the spider is being sprayed with water (8). The HBAT consisted of nine steps, ranging from sitting on a chair in front of a closed jar with the spider (1) to letting the spider walk over one's hand (9). Participants were given low demand instructions indicating that they could stop the BAT at any time. The task was ended if participants did not complete a step within three minutes.

5.2. Study 4: Results

There were no outliers on the SDS total score (M = 46.77, SD = 22.89), the SDS-F (M = 33.85, SD = 18.29), or the SDS-D (M = 12.92, SD = 6.34). Hence, all 75 participants were included in the analyses. Spearman's rank correlations of the SDS and its sub-scales with related measures can be found in Table 5. There was a ceiling effect with regards to stepwise completion of BATs, with 76 % and 72 % of participants completing all steps in the TBAT and HBAT respectively.

A Mann-Whitney U test showed that the SDS could differentiate individuals without spider fear (M = 27.76, SD = 16.23) from those with (sub-clinical) spider fear[4] (M = 61.71, SD = 14.84) as determined by the SCID-5, U ($N_{\text{absent phobia}}$ = 33, $N_{\text{sub-clinical}}$ = 42) = 101.5, p = < .001. These group differences were also significant for the SDS-F, U = 66.00, p < .001, and the SDS-D, U = 342.00, p < .001.

5.3. Study 4: Discussion

The SDS and its fear sub-scale correlated very strongly with the SPQ and FSQ, supporting its convergent validity. Similarly, the SDS-D correlated strongly, but slightly less, with these measures, as expected. Importantly, the SPQ, FSQ, and SDS showed comparable patterns of correlations with all other related measures, suggesting that the SDS is neither inferior nor superior to established measures with regards to convergent and discriminant validity. We used two BATs to determine the relationship of the SDS with avoidance behaviour towards living spiders, instead of merely relying on self-report measures. The SDS and its fear sub-score correlated moderately negatively with spider approach behaviour. Negative associations were expected because a high stepwise completion on the BATs indicates less avoidance behaviour. Spider-related disgust (SDS-D) correlated weakly to moderately negatively with approach behaviour. The associations between spider fear and avoidance behaviour are comparable to or higher than associations of the SPQ and FSQ with spider avoidance behaviour at baseline in individuals with and without spider phobia (Muris & Merckelbach, 1996). Most of our participants, who were recruited from the general population, completed all steps in the BATs. Hence, the direction of associations is meaningful, but the relationship between self-reported spider fear and avoidance behaviour may have been stronger had there not been a ceiling effect regarding spider avoidance behaviour. We expected a positive association of disgust propensity with the SDS that is stronger than the association between disgust sensitivity and the SDS (van Overveld et al., 2006), which was confirmed.[5] Lastly, in line with our expectations of a weak (Olatunji & Williams, 2007) or non-significant (e.g., Davey, 1991; Muris et al., 1998) association, trait anxiety correlated weakly with spider distress, underlining the SDS' divergent validity.

The SDS successfully differentiated individuals without spider fear from those with spider fear, supporting its initial concurrent validity. However, only one of the 42 spider fearful participants was identified as clinically fearful. As participants knew that they were to engage in two spider-related tasks, it is possible that there was a selection bias when recruiting for this study. Nonetheless, the mean SDS score was very similar to our online samples for which participants knew that they would not be forced to view pictures of spiders, suggesting no strong selection bias.

6. General discussion

By covering all relevant aspects of spider fear, addressing the shortcomings of established measures, and identifying unique elements of disgust, we developed the SDS, a two-factor questionnaire that measures spider fear and differentially assesses unique aspects of spider-related disgust. EFAs suggested a two-factor structure with good model fit (study 1 and 2), which was confirmed with moderate to excellent fit in study 3. The SDS total score and both sub-scores showed excellent internal consistencies across studies and were highly stable over the course of three weeks (study 3). The SDS correlated in the expected directions with related self-report measures as well as with spider avoidance behaviour and could discriminate between individuals with and without spider fear, supporting its concurrent validity (study 4).

Spider fear and disgust overlap functionally and cannot always be easily differentiated (Cisler et al., 2009), which raises the question whether a two-factor solution is appropriate to conceptualize spider-related distress. Some researchers suggested that spider fear or distress may be best measured as a one-factor construct (e.g., SPQ-15; Olatunji & Woods, 2009). However, in the current series of studies, all SDS items loaded meaningfully on two factors that differentiate unique elements of spider-related disgust from other aspects of spider distress, whereas none of the three criteria that we used to determine the number of underlying factors, namely (1) theory, (2) parallel analysis (Horn, 1965), and a (3) scree plot (Cattell, 1966), suggested a one-factor solution. A multi-factor solution is in line with findings suggesting that disgust is more resistant to extinction or exposure than fear (Böhnlein et al., 2020; Olatunji, Forsyth et al., 2007; Olatunji, Wolitzky-Taylor et al., 2009; Smits et al., 2002). Thus, a tool to differentially assess spider-related disgust may help to better monitor treatment effects, understand treatment mechanisms, and to individualize and advance interventions accordingly. For instance, reappraisal (e.g., Fink et al., 2018; Olatunji et al., 2017; Olatunji & Berg, 2017; Schubert et al., 2020; Wong et al., 2021) and counterconditioning (e.g., Engelhard et al., 2014; but see de Jong et al., 2000) may be promising in the treatment of disgust, but more research is needed.

If a multi-factor solution best fits the underlying construct, then questionnaire items that load on more than one factor are typically removed as part of questionnaire development. From a data analytic

[4] 41 participants were categorized with sub-clinical spider fear based on the SCID-5, whereas only one participant fell into the clinical spider phobia category (i.e., all SCID criteria were fully met, including that the fear interferes with an individual's daily life or causes clinically significant distress). These participants were pooled into one (sub-clinical) spider fear group.

[5] Whereas the expected pattern of association of self-reported spider fear with disgust propensity and sensitivity was confirmed, the magnitude of the association between the DPSS and self-reported spider fear (SDS, FSQ, and SPQ) is higher in the current study series (study 4 and pilot study) than in previous work (van Overveld et al., 2006). Of note, we used the revised 12- (study 4) and 16-item (pilot study) versions of the DPSS, whereas van Overveld and colleagues (2006) used the 32-item DPSS, which could possibly contribute to differences in magnitude. Future research could further investigate the strength of the relationship between spider fear and disgust propensity/sensitivity, which is beyond the scope of the current paper.

Table 5
Spearman's Rank Correlations of the Spider Distress Scale (SDS) and its Sub-Scores with Related Measures.

Variable		SDS	SDS-F	SDS-D	SPQ	FSQ	TBAT	HBAT	DPSS-P	DPSS-S	STAI-T
SDS	r_s	—									
	p-value	—									
SDS-F	r_s	.973	—								
	p-value	< .001	—								
SDS-D	r_s	.779	.625	—							
	p-value	< .001	< .001	—							
SPQ	r_s	.916	.900	.704	—						
	p-value	< .001	< .001	< .001	—						
FSQ	r_s	.907	.908	.651	.867	—					
	p-value	< .001	< .001	< .001	< .001	—					
TBAT	r_s	-.389	-.407	-.244	-.407	-.419	—				
	p-value	< .001	< .001	.035	< .001	< .001	—				
HBAT	r_s	-.486	-.509	-.300	-.532	-.532	.775	—			
	p-value	< .001	< .001	.009	< .001	< .001	< .001	—			
DPSS-P	r_s	.520	.503	.453	.529	.515	-.293	-.275	—		
	p-value	< .001	< .001	< .001	< .001	< .001	.011	.017	—		
DPSS-S	r_s	.376	.403	.241	.319	.417	-.013	-.017	.468	—	
	p-value	< .001	< .001	.037	.005	< .001	.915	.886	< .001	—	
STAI-T	r_s	.259	.262	.226	.205	.276	-.025	.000	.258	.405	—
	p-value	.025	.023	.051	.078	.016	.833	.996	.026	< .001	—

Note. Spider Distress Scale (SDS), SDS-Fear (SDS-F), SDS-Disgust (SDS-D), Spider Phobia Questionnaire (SPQ), Fear of Spiders Questionnaire (FSQ), Number of steps completed on the Tarantula Behavioural Approach Task (TBAT) and the House spider Behavioural Approach Task (HBAT), Disgust Propensity and Sensitivity Scale (DPSS), DPSS-Propensity (DPSS-P), DPSS-Sensitivity (DPSS-S), State-Trait Anxiety Inventory- Trait (STAI-T). N = 75.

perspective, EFA explores how many latent variables underlie the observed set of variables (i.e., questionnaire items) and reduces the item pool (Tabachnik & Fidell, 2007). As such, removing cross-loading items shortens the questionnaire and thereby makes it more practical to use in research and clinical practice. Further, removing cross-loading items that ambiguously stand in-between factors simplifies the interpretability of the factors (Tabachnik & Fidell, 2007). From a theoretical perspective, the question arises whether removing a cross-loading item that clearly relates to spider distress results in an assessment instrument that does not fully cover the construct. For instance, we removed the cross-loading item "Spiders are disgusting" from the SDS (see study 1). This item likely cross-loaded because it taps on the functional overlap of fear and disgust. Specifically, the thought of a disgusting spider may prompt avoidance behaviour, which is also prompted by fear (Cisler et al., 2009). Avoidance behaviour and spider disgust are also assessed by the remaining SDS items, making this removed item theoretically redundant. In sum, removing cross-loading items should improve and not compromise a questionnaire, both from a data analytic and theoretical point of view, under the assumption that its remaining items cover all relevant aspects of the target construct.

Lastly, we will discuss several strengths and limitations. First, the SDS does not include any reverse-coded items that could potentially reduce response bias. This is because reversed wording of items has been criticized for confusing participants and is associated with more mistakes (van Sonderen et al., 2013). Further, reverse-coded items tend to load on a separate factor due to their wording and hence induce secondary sources of variance (Olatunji & Woods, 2009; Suárez-Alvarez et al., 2018; Zhang et al., 2016). Second, we recruited most of our samples (study 1–3) via the online recruitment platform Prolific Academic, whereas research on spider fear is often conducted with student samples (e.g., Vansteenwegen et al., 2007). Even though there have been concerns regarding the data quality of participants who were recruited online (Chandler et al., 2014), online samples were found to be more attentive than student samples (Hauser & Schwarz, 2016) and participants on Prolific tend to be relatively naïve and diverse (Adams et al., 2020; Peer et al., 2017), possibly indicating a more representative sample than if we had relied on student data alone. Third, we recruited participants from the United States, the United Kingdom, and the Netherlands. This might limit the generalizability of the SDS cross-culturally because the concept of a house spider and therefore the meaning of adaptive avoidance behaviour likely differs across countries. We decided that a narrow sample of participants living in three countries where English proficiency is high and where (most) house spiders are non-venomous to humans is favourable for the initial development and validation of the SDS compared to recruiting participants from many different countries, possibly introducing unknown confounders. Of course, we recommend that future research assesses the validity of the SDS cross-culturally. Fourth, the SDS could reliably differentiate between individuals with and without spider fear as determined with the SCID-5, supporting its initial concurrent validity. Nonetheless, future research is advised to further evaluate the validity of the SDS by monitoring its sensitivity to treatment effects over the course of therapy. Related, it may also be of interest to investigate whether differentially targeting disgust and fear during treatment will result in a disparate response on the sub-scales of the SDS.

7. Conclusion

Spider fear serves as a translational model to experimentally study treatment processes for long-lasting fears. A valid and practical spider fear questionnaire is crucial to better understand the maintenance and treatment of spider phobia, and to thereby advance interventions for anxiety disorders. In the current series of studies, we developed and validated the Spider Distress Scale, a reliable and concise 17-item questionnaire to assess spider-related distress and to differentiate unique aspects of spider-related disgust from fear, while combining the strengths of currently established measures. The SDS can also be used as a tool to paint a more fine-grained picture of spider phobia by differentially assessing spider-related disgust, which may help to set appropriate treatment targets.

Funding

This work was supported by an European Research Council Advanced Grant (74326) awarded to M.K and R.M.V receives support from the Dutch Research Council (NWO Veni 016.Veni.195.246).

Data Availability

Anonymised data and R code for exploratory and confirmatory factor analyses (study 1–3) can be found at the Open Science Framework web page for this study series (https://osf.io/4fsvy/).

Acknowledgements

The authors would like to thank Dr Arjen Noordhof for brainstorming about the concept of spider-related distress with regards to appropriate analyses methods, and Dr Raoul Grasman as well as Dr Julia Haaf for their statistical advice. Lastly, we would like to thank Anne van Wonderen (BSc) and Thomas I. Schoevaart (BSc) for data collection for study 4, and Elif Nur Poyraz (MSc) and the Amsterdam Emotional Memory lab for their feedback on the content and phrasing of the questionnaire items.

Declaration of Interests

None.

Appendix A. The Spider Distress Scale (study 2 – 4)

Questionnaire Instructions:

Below are several statements about spiders. Please read each statement carefully and indicate how much you agree with each statement. Whenever the spider type is not specified in a given statement, we refer to a large house spider with a thick body.

Item Descriptions
1. I am afraid of all types of spiders
2. If I were in a room with a spider, it would be difficult for me to ignore it.
3. I feel very distressed whenever I see a spider.
4. If there were a spider in my bedroom, I would ask someone else to remove it.
5. Looking at pictures of spiders makes me feel uncomfortable.
6. Whenever I enter a room, I scan it for spiders.
7. If I were asked to touch a tarantula, there is no way that I could do it.
8. There are certain places that I try to avoid because I may encounter spiders there.
9. I feel fear whenever I see a spider
10. I am afraid of spiders even if they are not venomous.
11. Whenever a spider is nearby, I am afraid that it will jump on me.
12. If I saw a spider now, my heart would beat faster.
13. Whenever a spider is within my reach, I worry that it will try to bite me.
14. I feel sick when I imagine eating a sandwich that a harmless spider had walked over.
15. I would want to wash my hands after touching a spider.
16. The sticky texture of spider webs is sickening.
17. If I were asked to touch a dead spider with my bare hands, I would feel disgusted.

Note. Responses are given on a 7-point Likert scale, ranging from 0 (Completely Disagree) to 6 (Completely Agree). The SDS total score ranges from 0 to 102. The SDS has a two-factor structure with items 1–13 loading on the fear factor (SDS-F, range = 0–78), and item 14–17 loading on the spider-related disgust factor (SDS-D, range 0–24).

References

Adams, T. L., Li, Y., & Liu, H. (2020). A replication of beyond the Turk: Alternative platforms for crowdsourcing behavioral research-sometimes preferable to student groups. *AIS Transactions on Replication Research, 6*, 1.

American Psychiatric Association, (2013). Diagnostic and statistical manual of mental disorders, fifth ed. https://doi.org/10.1176/appi.books.9780890425596.

Arch, J. J., & Craske, M. G. (2009). First-line treatment: A critical appraisal of cognitive behavioral therapy developments and alternatives. *Psychiatric Clinics of North America, 32*(3), 525–547. https://doi.org/10.1016/j.psc.2009.05.001

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2). https://doi.org/10.1037/0033-2909.107.2.238

Böhnlein, J., Altegoer, L., Muck, N. K., Roesmann, K., Redlich, R., Dannlowski, U., & Leehr, E. J. (2020). Factors influencing the success of exposure therapy for specific phobia: A systematic review. *Neuroscience and Biobehavioral Reviews, 108*, 796–820. https://doi.org/10.1016/j.neubiorev.2019.12.009

Borg, C., Bosman, R. C., Engelhard, I., Olatunji, B. O., & de Jong, P. J. (2016). Is disgust sensitive to classical conditioning as indexed by facial electromyography and behavioural responses. *Cognition and Emotion, 30*(4), 669–686. https://doi.org/10.1080/02699931.2015.1022512

Browne, M. W., & Cudeck, R. (1992). Alternative ways of assessing model fit. *Sociological Methods & Research, 21*(2). https://doi.org/10.1177/0049124192021002005

Buchanan, E. M., Valentine, K. D., & Schulenberg, S. E. (2014). Exploratory and confirmatory factor analysis: Developing the purpose in Life Test–Short Form. *SAGE Research Methods Cases*. https://doi.org/10.4135/9781446272305013517794

Carpenter, J. K., Andrews, L. A., Witcraft, S. M., Powers, M. B., Smits, J. A. J., & Hofmann, S. G. (2018). Cognitive behavioral therapy for anxiety and related disorders: A meta-analysis of randomized placebo-controlled trials. *Depression and Anxiety, 35*(6), 502–514. https://doi.org/10.1002/da.22728

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1*(2), 245–276. https://doi.org/10.1207/s15327906mbr0102_10

Chandler, J., Mueller, P., & Paolacci, G. (2014). Nonnaïveté among Amazon Mechanical Turk workers: Consequences and solutions for behavioral researchers. *Behavior Research Methods, 46*(1), 112–130. https://doi.org/10.3758/s13428-013-0365-7

Cisler, J. M., Olatunji, B. O., & Lohr, J. M. (2009). Disgust, fear, and the anxiety disorders: A critical review. *Clinical Psychology Review, 29*(1), 34–46. https://doi.org/10.1016/j.cpr.2008.09.007

Costello, C. G. (1982). Fears and phobias in women: A community study. *Journal of Abnormal Psychology, 91*(4), 280–286. https://doi.org/10.1037/0021-843X.91.4.280

Craske, M. G., & Mystkowski, J. L. (2007). Exposure therapy and extinction: Clinical studies. In M. G. Craske, D. Hermans, & D. Vansteenwegen (Eds.), *Fear and learning: From basic processes to clinical implications* (pp. 217–233). American Psychological Association. https://doi.org/10.1037/11474-011.

Craske, M. G., Treanor, M., Conway, C. C., Zbozinek, T., & Vervliet, B. (2014). Maximizing exposure therapy: An inhibitory learning approach. *Behaviour Research and Therapy, 58*, 10–23. https://doi.org/10.1016/j.brat.2014.04.006

Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods, 1*(1), 16–29. https://doi.org/10.1037/1082-989X.1.1.16

Davey, G. C. L. (1991). Characteristics of individuals with fear of spiders. *Anxiety Research, 4*(4), 299–314. https://doi.org/10.1080/08917779208248798

Davey, G. C. L. (2011). Disgust: The disease-avoidance emotion and its dysfunctions. *Philosophical Transactions of the Royal Society B: Biological Sciences, 366*(1583), 3453–3465. https://doi.org/10.1098/rstb.2011.0039

Engelhard, I. M., Leer, A., Lange, E., & Olatunji, B. O. (2014). Shaking that icky feeling: Effects of extinction and counterconditioning on disgust-related evaluative learning. *Behavior Therapy, 45*(5), 708–719. https://doi.org/10.1016/j.beth.2014.04.003

Fergus, T. A., & Valentiner, D. P. (2009). The Disgust Propensity and Sensitivity Scale-revised: An examination of a reduced-item version. *Journal of Anxiety Disorders, 23*(5), 703–710. https://doi.org/10.1016/j.janxdis.2009.02.009

Field, A. P. (2009). *Discovering Statistics using SPSS: And sex and drugs and rock 'n' roll* (third ed.). SAGE Publications,.

Fink, J., Pflugradt, E., Stierle, C., & Exner, C. (2018). Changing disgust through imagery rescripting and cognitive reappraisal in contamination-based obsessive-compulsive disorder. *Journal of Anxiety Disorders, 54*, 36–48. https://doi.org/10.1016/j.janxdis.2018.01.002

Gaskin, C. J., & Happell, B. (2014). On exploratory factor analysis: A review of recent evidence, an assessment of current practice, and recommendations for future use.

International Journal of Nursing Studies, 51(3), 511–521. https://doi.org/10.1016/j.ijnurstu.2013.10.005
Hauser, D. J., & Schwarz, N. (2016). Attentive Turkers: MTurk participants perform better on online attention checks than do subject pool participants. *Behavior Research Methods, 48*(1), 400–407. https://doi.org/10.3758/s13428-015-0578-z
Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika, 30*(2), 179–185. https://doi.org/10.1007/BF02289447
Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118
de Jong, P. J., & Muris, P. (2002). Spider phobia: Interaction of disgust and perceived likelihood of involuntary physical contact. *Journal of Anxiety Disorders, 16*(1), 51–65.
de Jong, P. J., Vorage, I., & van den Hout, M. A. (2000). Counterconditioning in the treatment of spider phobia: Effects on disgust, fear and valence. *Behaviour Research and Therapy, 38*(11), 1055–1069.
Kaiser, H. F., & Rice, J. (1974). Little Jiffy, Mark Iv. *Educational and Psychological Measurement, 34*(1), 111–117. https://doi.org/10.1177/001316447403400115
Kindt, M., Soeter, M., & Vervliet, B. (2009). Beyond extinction: Erasing human fear responses and preventing the return of fear. *Nature Neuroscience, 12*(3), 256–258. https://doi.org/10.1038/nn.2271
Klorman, R., Weerts, T. C., Hastings, J. E., Melamed, B. G., & Lang, P. J. (1974). Psychometric description of some specific-fear questionnaires. *Behavior Therapy, 5*(3), 401–409. https://doi.org/10.1016/S0005-7894(74)80008-0
Kozak, M. J., & Miller, G. A. (1982). Hypothetical constructs versus intervening variables: A re-appraisal of the three-systems model of anxiety assessment. *Behavioral Assessment, 4*, 3.
Krypotos, A. M., Effting, M., Kindt, M., & Beckers, T. (2015). Avoidance learning: A review of theoretical models and recent developments. *Frontiers in Behavioral Neuroscience, 9*. https://doi.org/10.3389/fnbeh.2015.00189
Lai, K., & Green, S. B. (2016). The problem with having two watches: Assessment of fit when RMSEA and CFI disagree. *Multivariate Behavioral Research, 51*(2–3), 220–239. https://doi.org/10.1080/00273171.2015.1134306
Lang, P. J. (1968). Fear reduction and fear behavior: Problems in treating a construct. In J. M. Shlien (Ed.), *Research in Psychotherapy* (pp. 90–102). American Psychiatric Association. https://doi.org/10.1037/10546-004.
LeDoux, J. E., Moscarello, J., Sears, R., & Campese, V. (2017). The birth, death and resurrection of avoidance: A reconceptualization of a troubled paradigm. *Molecular Psychiatry, 22*(1), 24–36. https://doi.org/10.1038/mp.2016.166
Li, C. H. (2016). Confirmatory factor analysis with ordinal data: Comparing robust maximum likelihood and diagonally weighted least squares. *Behavior Research Methods, 48*(3), 936–949. https://doi.org/10.3758/s13428-015-0619-7
Lipp, O.V., 2007. Human fear learning: Contemporary procedures and measurement. In M.G. Craske, D. Hermans, & D. Vansteenwegen (Eds.), Fear and learning: From basic processes to clinical implications (pp. 37–51). https://doi.org/10.1037/11474–002.
MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods, 1*(2), 130–149. https://doi.org/10.1037/1082-989X.1.2.130
Mason, E. C., & Richardson, R. (2010). Looking beyond fear: The extinction of other emotions implicated in anxiety disorders. *Journal of Anxiety Disorders, 24*(1), 63–70. https://doi.org/10.1016/j.janxdis.2009.08.007
Mertens, G., van Dis, E. A. M., Krypotos, A.-M., & Engelhard, I. M. (2021). Does an unconditioned stimulus memory devaluation procedure decrease disgust memories and conditioned disgust? Results of two laboratory studies. *Journal of Anxiety Disorders, 82*, Article 102447. https://doi.org/10.1016/j.janxdis.2021.102447
Mogg, K., Mathews, A., & Weinman, J. (1987). Memory bias in clinical anxiety. *Journal of Abnormal Psychology, 96*(2), 94–98. https://doi.org/10.1037/0021-843X.96.2.94
Muris, P., Mayer, B., & Merckelbach, H. (1998). Trait anxiety as a predictor of behaviour therapy outcome in spider phobia. *Behavioural and Cognitive Psychotherapy, 26*(1). https://doi.org/10.1017/S1352465898000095
Muris, P., & Merckelbach, H. (1996). A comparison of two spider fear questionnaires. *Journal of Behavior Therapy and Experimental Psychiatry, 27*(3), 87–91. https://doi.org/10.1016/S0005-7916(96)00022-5
Mystkowski, J. L., Craske, M. G., Echiverri, A. M., & Labus, J. S. (2006). Mental reinstatement of context and return of fear in spider-fearful participants. *Behavior Therapy, 37*(1), 49–60. https://doi.org/10.1016/j.beth.2005.04.001
Norton, P. J., & Price, E. C. (2007). A meta-analytic review of adult cognitive-behavioral treatment outcome across the anxiety disorders. *Journal of Nervous and Mental Disease, 195*(6), 521–531. https://doi.org/10.1097/01.nmd.0000253843.70149.9a
Olatunji, B. O., Armstrong, T., & Elwood, L. (2017). Is disgust proneness associated with anxiety and related disorders? A qualitative review and meta-analysis of group comparison and correlational studies. *Perspectives on Psychological Science, 12*(4), 613–648. https://doi.org/10.1177/1745691616688879
Olatunji, B. O., Berg, H., Cox, R. C., & Billingsley, A. (2017). The effects of cognitive reappraisal on conditioned disgust in contamination-based OCD: An analogue study. *Journal of Anxiety Disorders, 51*, 86–93. https://doi.org/10.1016/j.janxdis.2017.06.005
Olatunji, B. O., Berg, H. E., & Zhao, Z. (2017). Emotion regulation of fear and disgust: differential effects of reappraisal and suppression. *Cognition and Emotion, 31*(2), 403–410. https://doi.org/10.1080/02699931.2015.1110117
Olatunji, B. O., & Deacon, B. (2008). Specificity of disgust sensitivity in the prediction of fear and disgust responding to a brief spider exposure. *Journal of Anxiety Disorders, 22*(2), 328–336. https://doi.org/10.1016/j.janxdis.2007.03.007
Olatunji, B. O., Forsyth, J. P., & Cherian, A. (2007). Evaluative differential conditioning of disgust: A sticky form of relational learning that is resistant to extinction. *Journal of Anxiety Disorders, 21*(6), 328–336. https://doi.org/10.1016/j.janxdis.2006.11.004
Olatunji, B. O., Williams, N. L., Lohr, J. M., Connolly, K. M., Cisler, J., & Meunier, S. A. (2007). Structural differentiation of disgust from trait anxiety in the prediction of specific anxiety disorder symptoms. *Behaviour Research and Therapy, 45*(12), 3002–3017. https://doi.org/10.1016/j.brat.2007.08.011
Olatunji, B. O., Wolitzky-Taylor, K. B., Willems, J., Lohr, J. M., & Armstrong, T. (2009). Differential habituation of fear and disgust during repeated exposure to threat-relevant stimuli in contamination-based OCD: An analogue study. *Journal of Anxiety Disorders, 23*(1), 118–123. https://doi.org/10.1016/j.janxdis.2008.04.006
Olatunji, B. O., Woods, C. M., de Jong, P. J., Teachman, B. A., Sawchuk, C. N., & David, B. (2009). Development and initial validation of an abbreviated spider phobia questionnaire using item response theory. *Behavior Therapy, 40*(2), 114–130. https://doi.org/10.1016/j.beth.2008.04.002
Oosterink, F. M. D., de Jongh, A., & Hoogstraten, J. (2009). Prevalence of dental fear and phobia relative to other fear and phobia subtypes. *European Journal of Oral Sciences, 117*(2), 135–143. https://doi.org/10.1111/j.1600-0722.2008.00602.x
Packer, J. S., Bond, N. W., & Siddle, D. A. T. (1987). Animal fears in the antipodes: normative data from an Australian sample. *Scandinavian Journal of Psychology, 28*(2), 150–156. https://doi.org/10.1111/j.1467-9450.1987.tb00749.x
Peer, E., Brandimarte, L., Samat, S., & Acquisti, A. (2017). Beyond the Turk: Alternative platforms for crowdsourcing behavioral research. *Journal of Experimental Social Psychology, 70*, 153–163. https://doi.org/10.1016/j.jesp.2017.01.006
Pflugshaupt, T., Mosimann, U. P., von Wartburg, R., Schmitt, W., Nyffeler, T., & Müri, R. M. (2005). Hypervigilance-avoidance pattern in spider phobia. *Journal of Anxiety Disorders, 19*(1), 105–116. https://doi.org/10.1016/j.janxdis.2003.12.002
Preacher, K. J., & MacCallum, R. C. (2003). Repairing Tom Swift's electric factor analysis machine. *Understanding Statistics: Statistical Issues in Psychology, Education, and the Social Sciences, 2*(1), 13–43. https://doi.org/10.1207/s15328031us0201_02
Revelle, W., 2020. *psych: Procedures for personality and psychological research*. Northwestern University, Evanston, Illinois. R package. ⟨https://CRAN.R-Project.Org/Package=psych⟩.
Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2), 1–36. https://doi.org/10.18637/jss.v048.i02
Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*(1), 23–41. https://doi.org/10.1037/0033-295X.94.1.23
Sawchuk, C. N., Meunier, S. A., Lohr, J. M., & Westendorf, D. H. (2002). Fear, disgust, and information processing in specific phobia: The application of signal detection theory. *Journal of Anxiety Disorders, 16*(5), 495–510. https://doi.org/10.1016/s0887-6185(02)00168-8
Schubert, E., Agathos, J. A., Brydevall, M., Feuerriegel, D., Koval, P., Morawetz, C., & Bode, S. (2020). Neural patterns during anticipation predict emotion regulation success for reappraisal. *Cognitive, Affective and Behavioral Neuroscience, 20*(4), 888–990. https://doi.org/10.3758/s13415-020-00808-2
Seim, R. W., & Spates, C. R. (2010). The prevalence and comorbidity of specific phobias in college students and their interest in receiving treatment. *Journal of College Student Psychotherapy, 24*(1), 49–58. https://doi.org/10.1080/87568220903400302
Smits, J. A. J., Telch, M. J., & Randall, P. K. (2002). An examination of the decline in fear and disgust during exposure-based treatment. *Behaviour Research and Therapy, 40*(11), 1243–1253. https://doi.org/10.1016/S0005-7967(01)00094-8
Soeter, M., & Kindt, M. (2012). Stimulation of the noradrenergic system during memory formation impairs extinction learning but not the disruption of reconsolidation. *Neuropsychopharmacology, 37*(5), 1204–1215. https://doi.org/10.1038/n.307
Soeter, M., & Kindt, M. (2015). An abrupt transformation of phobic behavior after a post-retrieval amnesic agent. *Biological Psychiatry, 78*(12), 880–886. https://doi.org/10.1016/j.biopsych.2015.04.006
Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, A. G. (1983). *Manual for the State–Trait Anxiety Inventory*. Consulting Psychologists Press.
Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (fifth ed.). Routledge,.
Suárez-Alvarez, J., Pedrosa, I., Lozano, L. M., García-Cueto, E., Cuesta, M., & Muñiz, J. (2018). Using reversed items in Likert scales: A questionable practice. *Psicothema, 30*(2), 149–158. https://doi.org/10.7334/psicothema2018.33
Szymanski, J., & O'Donohue, W. (1995). Fear of spiders questionnaire. *Journal of Behavior Therapy and Experimental Psychiatry, 26*(1), 31–34. https://doi.org/10.1016/0005-7916(94)00072-T
Tabachnik, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (fifth ed.). Allyn & Bacon/Pearson Education,.
Tolin, D. F., Lohr, J. M., Sawchuk, C. N., & Lee, T. C. (1997). Disgust and disgust sensitivity in blood-injection-injury and spider phobia. *Behaviour Research and Therapy, 35*(10). https://doi.org/10.1016/S0005-7967(97)00048-X
van Overveld, W. J. M., de Jong, P. J., Peters, M. L., Cavanagh, K., & Davey, G. C. L. (2006). Disgust propensity and disgust sensitivity: Separate constructs that are differentially related to specific fears. *Personality and Individual Differences, 41*(7), 1241–1252. https://doi.org/10.1016/j.paid.2006.04.021
van Sonderen, E., Sanderman, R., & Coyne, J. C. (2013). Ineffectiveness of reverse wording of questionnaire Items: Let's learn from cows in the rain. *PLoS ONE, 8*(7). https://doi.org/10.1371/journal.pone.0068967
Vansteenwegen, D., Vervliet, B., Iberico, C., Baeyens, F., van den Bergh, O., & Hermans, D. (2007). The repeated confrontation with videotapes of spiders in multiple contexts attenuates renewal of fear in spider-anxious students. *Behaviour Research and Therapy, 45*(6), 1169–1179. https://doi.org/10.1016/j.brat.2006.08.023
Wong, S. F., Krause, S., Marishel, D., & Grisham, J. R. (2021). Reappraisal of disgust: Self-report and behavioural assessment of individuals with moderate to high contamination fears. *Journal of Anxiety Disorders, 78*. https://doi.org/10.1016/j.janxdis.2020.102346

Woody, S. R., McLean, C., & Klassen, T. (2005). Disgust as a motivator of avoidance of spiders. *Journal of Anxiety Disorders, 19*(4), 461–475. https://doi.org/10.1016/j.janxdis.2004.04.002

Woody, S. R., & Teachman, B. A. (2000). Intersection of disgust and fear: Normative and pathological views. *Clinical Psychology: Science and Practice, 7*(3), 291–311. https://doi.org/10.1093/clipsy.7.3.291

Zhang, X., Noor, R., & Savalei, V. (2016). Examining the effect of reverse worded items on the factor structure of the need for cognition scale. *PLoS ONE, 11*(6). https://doi.org/10.1371/journal.pone.0157795

Zygmont, C., & Smith, M. R. (2014). Robust factor analysis in the presence of normality violations, missing data, and outliers: Empirical questions and possible solutions. *The Quantitative Methods for Psychology, 10*(1), 40–55. https://doi.org/10.20982/tqmp.10.1.p040