

Symbolic Online Exposure for Spider Fear: Habituation of Fear, Disgust and Physiological Arousal and Predictors of Symptom Improvement

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Abstract

Background and Objectives

This research compared the effects of real versus hyper-real images on anxiety, disgust, and physiological arousal during internet-delivered exposure in high spider-fearfuls. Hyper-real images were digitally altered to highlight fearful aspects. A further aim was to examine self-reported and behavioural therapeutic outcomes and exposure-related predictors of these outcomes.

Methods

Twenty-eight females were randomised to real ($n=14$) or hyper-real ($n=14$) treatment groups and nine participants were subsequently allocated to a wait-list control group. Treatment groups viewed an 8-stage exposure hierarchy of real or hyper-real spider images. Subjective anxiety and disgust ratings were taken during each stage (0, 60, 120, 180 seconds) with heart rate and skin conductance recorded throughout.

Results

Anxiety, disgust and physiological arousal habituated within each exposure stage, with no differential effect of real compared to hyper-real images. Both treatment groups but not controls demonstrated significant reductions in behavioural avoidance and self-reported phobic symptoms from pre-treatment to post-treatment with large effect sizes noted. The change in within-stage habituation of anxiety, disgust and heart rate, between the first and last stage, predicted improvement in behavioural avoidance at post-treatment. This suggests that generalisation of habituation to multiple images is an important predictor of improvement.

Limitations

While findings in relation to therapeutic outcome should be considered preliminary, clear relationships were found between exposure-related variables and outcome among those who undertook treatment.

Conclusions

Findings provide evidence in support of the efficacy of online image-based exposure and have implications for informing further research into the underlying mechanisms of image-based exposure treatment.

Key words: spider phobia; online exposure; habituation; heart rate; skin conductance;

emotional processing theory

1.1 Introduction

Specific phobia is the most common anxiety disorder with lifetime prevalence estimates ranging from 3-12% (Alonso et al., 2004; Kessler et al., 2005; Stinson et al., 2007). Specific phobia can be successfully treated with exposure-based interventions (Öst, 1997; Wolitzky-Taylor, Horowitz, Powers, & Telch, 2008), but many people do not seek treatment (Bebbington et al., 2000; Stinson et al., 2007). Barriers to treatment include unawareness of treatment options, fear of interaction with the phobic stimulus, and factors such as treatment availability, accessibility, labour intensiveness, stigma, and cost (Ritterband, Thorndike, Cox, Kovatchev, & Gonder-Frederick, 2009; Wolitzky-Taylor et al., 2008).

Computer-delivered and internet-based treatments have potential to provide cost-effective and convenient treatment to large numbers of people (Carlbring & Andersson, 2006; Ritterband et al., 2003). These treatment approaches include guided relaxation, instructional-based self-exposure (Marks, Kenwright, McDonough, Whittaker, & Mataix-Cols, 2004), vicarious exposure (Gilroy, Kirkby, Daniels, Menzies, & Montgomery, 2003), virtual reality (Krijn, Emmelkamp, Olafsson, & Biemond, 2004) and symbolic exposure via images and videos (Bornas et al., 2002; Matthews, Scanlan, & Kirkby, 2012; Vansteenwegen et al., 2007). A recent meta-analysis concluded that exposure-based interventions were more effective than placebo, or alternative psychotherapeutic interventions, and that *in vivo* exposure (involving direct contact with the phobic stimulus) was more effective than 'other' exposure-based interventions (e.g., imaginal, virtual reality) at post-treatment but not at follow-up (Wolitzky-Taylor et al., 2008). This latter finding was attributed to further improvements for 'other' exposure-based treatment rather than return of fear for *in vivo* treatment (Wolitzky-Taylor et al., 2008).

The mechanisms underlying exposure treatment remain a topic of debate in the literature. According to emotional processing theory (EPT) (Foa, Huppert, & Cahill, 2006; Foa & Kozak, 1986; Rachman, 1980), phobic fear is represented in memory by a 'fear structure' which is characterised by pathological associations between the feared stimulus, response representations, and threat-related cognitions (Foa & Kozak, 1986). These associations are maintained by behavioural and cognitive avoidance and cognitive biases at various stages of processing (Foa et al., 2006). For effective exposure treatment, it has been argued that the original 'fear structure' must be sufficiently activated (as indexed by physiological or self-report measures) and followed by reduction or habituation of response (Foa & Kozak, 1986). Secondly, new information is either incorporated into the original fear structure, a process known as corrective learning (Foa & Kozak, 1986), or new associations are formed which either inhibit or compete with the original associations (Foa et al., 2006; Foa & McNally, 1996). The theory that the latter context-dependent inhibitory learning takes place is supported by animal learning research (see Myers & Davis, 2007).

Within the context of EPT, initial fear activation (IFA), within-session habituation (WSH) and between-session habituation (BSH) have been identified as potential predictors of therapeutic improvement (see Craske et al., 2008; Foa & Kozak, 1986). IFA refers to the peak fear response during an exposure trial (minus baseline) and WSH is the difference between IFA and the end response during an exposure trial. BSH is the difference between the peak response in the first and last exposure trials and typically represents long-term learning across several sessions of exposure. The relationship between these variables and therapeutic outcome has often been examined in anxiety disorders other than specific phobia and has

generally yielded equivocal findings (for a review see Craske et al., 2008). However, there is some evidence that between rather than within session habituation may be a more reliable predictor of treatment outcome (Craske et al., 2008; Foa et al., 2006).

The experience of disgust is particularly important in the development and maintenance of spider phobia (Cisler, Olatunji, & Lohr, 2009; Olatunji, Cisler, McKay, & Phillips, 2010). For example, during exposure, self-reported disgust was found to be a better predictor of avoidance than self-reported fear (Woody, McLean, & Klassen, 2005) and high disgust sensitivity is associated with heightened resistance to extinction, suggesting that it may contribute to relapse following treatment (Mason & Richardson, 2010). There is evidence that self-reported disgust habituates or reduces over time during *in vivo* exposure (Smits, Telch, & Randall, 2002) and during exposure to videos of spiders (Edwards & Salkovskis, 2006; Olatunji et al., 2009), and also evidence that habituation of disgust occurs at a slower rate than fear (Cisler et al., 2009; Olatunji et al., 2009). However, there has been little research examining the relationship between the activation and habituation of disgust and therapeutic outcome, with one study showing that both fear and disgust explain unique variance in symptom improvement following exposure-based treatment (Olatunji, Huijding, de Jong, & Smits, 2011).

Treatments based on exposure to images and videos have been shown to produce activation and habituation of anxiety (as measured by self-report, behavioural and physiological measures) in studies of dental phobia, spider phobia, and fear of flying (Coldwell et al., 1998; Nelissen, Muris, & Merckelbach, 1995; Vansteenwegen et al., 2007; Veltman et al., 2004). A computer platform for the delivery of image-based exposure (Feardrop) has recently been developed for the treatment of spider fear (Matthews, Scanlan, & Kirkby, 2010; Matthews et

al., 2012; Matthews, Wong, Scanlan, & Kirkby, 2011). In this program, participants view spider images (moving or stationary) and rate their anxiety at several time points. A hierarchy of stages is completed with progression based on the level of subjective anxiety at the end of the previous stage. Research in both the laboratory and online environment has shown that high spider fearful participants show habituation across stages and generalisation between stages of the program. Furthermore, in a preceding study comprising laboratory-based then home-based exposure tasks, (Matthews et al., 2011), participants showed significant reductions in self-reported spider phobia symptoms at 30-day follow-up, suggesting that the exposure treatment reduced phobic fear.

The aim of the present study was to conduct a laboratory evaluation of the program, using self-report, behavioural, and physiological outcome measures. Given the importance of disgust in spider phobia, self-reported disgust was also measured during exposure. Participants were allocated to receive exposure to either real or hyper-real images. Hyper-real images were real images altered to portray extra features such as enlarged fangs. The hyper-real condition was included in an attempt to increase initial fear and disgust activation in order to test hypotheses derived from EPT. For example, early conceptualisations of EPT would predict that greater activation of fear would result in better therapeutic outcome (Foa & Kozak, 1986). However, more recently it has been argued that while adequate fear activation is necessary, over activation may actually impede emotional processing due to its impact on attentional processing (Foa et al., 2006).

It was hypothesised that both treatment groups (hyper-real and real) would experience a reduction in self-reported anxiety and disgust, and physiological arousal (heart rate and skin

conductance) within each stage of the program (within-stage habituation). An interaction was also predicted such that exposure to hyper-real compared to real images would result in higher self-reported anxiety and disgust and greater physiological arousal. It was also hypothesised that there would be a reduction in spider phobia symptoms (self-reported and behavioural) from pre-treatment to one-week and one-month post-treatment for the two treatment groups, but not for the wait-list control group. Within the context of EPT, a further aim was to examine the relationship between treatment outcome and both self-reported and physiological measures of fear activation and habituation (within-stage and between-stage) during exposure.

2.1. Method

2.1.1 Participants

Thirty-seven females (Mean age =26.5, $SD=8.9$ years) volunteered to participate. Fourteen participants were recruited by screening undergraduate Psychology students ($n=177$) with the Spider Phobia Questionnaire (SPQ) (Watts & Sharrock, 1984), receiving course credit for participation. The remainder were recruited from the local community via media and flyer distribution and received no reimbursement.

Eligibility criteria was high spider fear, defined as a score of 55 or above on the Fear of Spiders Questionnaire (FSQ) (Szymanski & O'Donohue, 1995). Exclusion criteria included current pregnancy, previous spider phobia treatment, past or current self-reported psychiatric disorder (other than anxiety or affective), heart condition or serious medical condition, current prescription medications (except contraceptive pill), and non-corrected visual impairment. All participants had completed at least ten years of formal education ($M=11.7$, $SD=0.7$).

The first twenty-eight participants were randomly allocated to real ($n=14$) or hyper-real ($n=14$) treatment groups. Due to practical considerations, once sufficient participants had been recruited to the experimental groups, a further nine participants (recruited through the same procedures) were allocated to a wait-list comparison group. There was no significant difference between groups in terms of mean age, self-reported phobic symptoms (FSQ), behavioural avoidance (BAT), disgust propensity/sensitivity (DPSS-R) or trait anxiety (STAI-Y) at pre-treatment (Table 1) ($p>.05$). A large majority of the real (86%), hyper-real (86%), and control (100%) groups met DSM-IV criteria for specific phobia on the Composite International Diagnostic Interview (CIDI) (World Health Organisation, 1999), administered via interview.

Table 1

Mean (SD) age and scores on baseline measures for each treatment group.

	Real ($n=14$)	Hyper-real ($n=14$)	Wait-list control ($n=9$)
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Age (years)	23.71 (4.51)	26.79 (9.12)	27.44 (9.45)
FSQ score	105.64 (13.32)	100.00 (18.30)	95.44 (16.19)
BAT score	9.78 (5.38)	11.50 (5.80)	11.11 (5.01)
DPSS-R Propensity	16.50 (6.71)	15.57 (4.07)	15.67 (5.17)
DPSS-R Sensitivity	11.21 (6.00)	12.00 (6.13)	10.33 (5.98)
STAI-Y score	45.57 (10.35)	40.57 (7.84)	41.11 (12.82)

2.1.2 Materials

Composite international diagnostic interview (CIDI) – Specific phobia module (World Health Organisation, 1999). The Specific phobia module of the CIDI is a structured interview with questions related to fear of objects and situations, with algorithms used to establish the presence of a DSM-IV diagnosis for specific phobia (spiders).

Fear of Spiders Questionnaire (FSQ) (Muris & Merckelbach, 1996; Szymanski & O'Donohue, 1995). The FSQ measures phobic symptoms, with 18 items (e.g., 'Spiders are one of my worst fears') rated on a scale from 1 ('definitely not') to 7 ('absolutely'), and scores ranging from 18 to 126. The FSQ has good split-half reliability ($r=0.89$), internal consistency (Cronbach's alpha 0.92–0.97), and test-retest reliability ($r=0.91$), distinguishes phobics from non-phobics, and is sensitive to therapeutic change.

The Behavioural Avoidance Test (BAT) (adapted from Gilroy et al., 2003). The BAT measures phobic avoidance using a hierarchy of 11 tasks involving a 4-6 cm Huntsman spider (*Delena cancerides*), a large harmless spider native to Australia. The tasks ranged from opening the door and entering a room containing the spider in a sealed container (Step 1), to handling the spider using both hands and replacing in the container (Step 11). Two points are given for completed steps and one point for attempted steps, with scores ranging from 0 to 22. The test is discontinued after refusal or partial attempt to complete a step.

The Disgust Propensity and Sensitivity Scale-Revised (DPSS-R) (van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006). The DPSS-R is a 16-item scale designed to assess frequency of disgust experiences (Disgust Propensity) and emotional impact of disgust experiences

(Disgust Sensitivity). Each item (e.g., 'I avoid disgusting things') is rated on a scale from 1 ('never') to 5 ('always').

State-trait anxiety inventory Form Y (STAI-Y) (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The STAI-Y is a 20-item scale assessing characteristics of trait anxiety. Responses range from 1 to 4 with higher scores indicating greater trait anxiety. The STAI has good internal consistency (.86-.95) and adequate test-retest reliability (.65-.75).

Subjective Units of Distress Scale (SUDS) (Hope & Heimberg, 1993) and *Subjective units of Disgust scale (SUGS)*. The SUDS is a visual analogue scale in which current anxiety is rated on a scale from 0 (no anxiety) to 100 (extreme anxiety). An analogous disgust scale (SUGS) was used to measure current experience of disgust ranging from 0 (no disgust) to 100 (extreme disgust)(Olatunji et al., 2009).

Physiological recording. Physiological measures were sampled continuously at 1000 Hz using a MacLab/8 data system and Chart 4.2.3 software (ADInstruments). Following skin preparation, ECG electrodes (Ag/AgCl) were attached to the lower right and left rib cage, with a ground affixed below the right clavicle. Skin conductance level (SCL) was recorded from the middle phalanges of the first and third fingers of the non-dominant hand. Data were analysed offline using LabChart 7 software (ADInstruments). ECG data were band-pass filtered (0.7-50Hz) and converted to heart rate (HR) using an integrated R-wave detection algorithm.

Exposure hierarchies. Each hierarchy contained eight spider images. In a pilot study, 13 huntsman spider images were each digitally manipulated to produce a paired hyper-real image. Manipulations included extra or more prominent anatomical features, added details, or extra spiders. In a pilot study, volunteers ($n=70$) rated the 'scariness' of the 26 spider images from 0

(‘not at all’) to 10 (‘very severely’). Pairs were identified in which the hyper-real image was rated as significantly scarier ($p < .05$) than the corresponding real image. For these pairs, a mean scariness rating was calculated by averaging the ratings for each real/hyper-real pair. Six pairs were selected to construct a hierarchy progressing from least to most scary, forming Stages 2-7. Specific hyper-real manipulations relative to the real image were: three extra spiders (Stage 2), six extra legs (Stage 3), one extra spider (Stage 4), two extra heads (Stage 5), fangs with dripping blood (Stage 6), and ten extra spiders (Stage 7). In both hierarchies, an identical real image was used at Stage 1 (single small spider on wall) and a different identical image was used at Stage 8 (single large spider on chair). This allowed direct comparisons between the two treatment groups prior to and after exposure to real or hyper-real hierarchies (Stages 2-7).

2.1.3 Procedure

This study was approved by the University of Tasmania Human Research Ethics Committee. Following telephone screening, participants attended a laboratory session where they gave written informed consent, and completed the CIDI, FSQ, BAT, DPSS-R and STAI-Y. Following set-up for physiological recording, participants in the two treatment groups were asked to complete the eight-stage online exposure task.

To open each stage participants clicked on a small thumbnail preview of the spider image. Then, to begin each stage, participants followed a circle with their computer mouse and the image faded in. If the circle was not followed, the image disappeared, ensuring individual control over exposure. During each 180-second exposure stage, SUDS then SUGS ratings were completed at four intervals (0, 60, 120 and 180 seconds). At the end of each stage, participants viewed their graphed SUDS ratings. If their final SUDS rating was below 25 (out of 100), the next

stage was unlocked. If not, they were asked to repeat the stage. A majority of participants ($n=28$) did not repeat any stages (32%) or repeated just one stage (46%). Smaller proportions repeated three (11%), four (7%) or five (4%) stages. Three participants (all from the hyper-real group) withdrew during exposure and did not complete all eight stages.

All groups attended sessions at approximately one-week (range 6-9 days) and one-month (range 21-50 days) post-treatment to complete the FSQ and the BAT. At the conclusion of the study, the wait-list group were invited to complete the online exposure treatment (real images), with all nine commencing treatment and two of these choosing not to complete all exposure stages.

2.1.4 Design and Data Analysis

Habituation and outcome analyses were conducted using mixed model ANOVA ($p < .05$) with Greenhouse-Geisser corrections where appropriate and effect sizes reported as partial eta squared (η_p^2). Given the large number of analyses performed to assess habituation of response during treatment, an alpha level of .01 was chosen for all analyses to reduce potential inflation of Type 1 errors. Habituation of SUDS and SUGS ratings was analysed using an 8(Stage: 1, 2, 3, 4, 5, 6, 7, 8) x 2(Group: real, hyper-real) x 3(Rating point: pre-exposure, 60-seconds, 120-seconds, final rating) mixed design. Due to differences in the number of attempts at each stage, and given that overall habituation was of most interest, the final post exposure rating was the final rating for that stage (regardless of the number of attempts). Mean HR (beats per minute) and Mean SCL (μS) for each 10-second epoch of each 1-minute segment were analysed using an 8(Stage: 1-8) x 6(Epoch: 1, 2, 3, 4, 5, 6) x 3(Segment: 1, 2, 3) x 2(Group: real, hyper-real) mixed

design. For SCL, all six epochs within each minute were baselined to the 10-second pre-exposure epoch.

The time points used to calculate initial activation for each measure were based on these preliminary analyses and determined as the time point in which activation was greatest overall for the group. While this does not necessarily capture the initial activation for each individual it allows for assessment of effects over a uniform time period for all participants. To directly test whether there was differential activation and habituation for the real and hyper-real image groups an 8(Stage: 1, 2, 3, 4, 5, 6, 7,8) x 2(Group: real, hyper-real) ANOVA was conducted for both initial activation and within-stage habituation for each of the measures (SUDS, SUGS, HR, SCL).

Changes in outcome measures (FSQ and BAT scores) were analysed using a 3(Time: pre-treatment, 1-week post-treatment, 1-month post-treatment) x 3[Group: real, hyper-real, wait-list] mixed design. Between and within groups effect sizes (d) were calculated and magnitude was determined as negligible (<0.1), small (0.1-0.3), medium (0.3-0.5) and large (>0.8) according to Cohen's criteria (Cohen, 1988). The relationships between exposure-related variables and FSQ and BAT change scores (pre-treatment minus one-month post-treatment) were examined using univariate linear regression. Significant interactions were analysed with 1-way ANOVAs with an alpha level of .01 chosen to correct for multiple comparisons.

Linear regression analyses were conducted to examine the relationship between treatment outcome and exposure-related variables. Initial activation and within stage habituation were determined according to the procedures described above. Between stage

habituation was calculated as Stage 1 WstH minus Stage 8 WstH for all measures, with positive scores indicating greater WStH at Stage 1 than 8.

For outcome measures, there were missing data due to non-attendance at 1-week ($n=2$) and 1-month ($n=2$) post-treatment. For physiological data, some ECG data ($n=4$) and SCL data ($n=1$) were excluded due to excessive artefact. Due to sample sizes, no attempt was made to impute missing data.

3.1 Results

3.1.1 Treatment analyses

Self-reported anxiety (SUDS) ratings. Analysis of SUDS ratings revealed a significant effect of Rating point, $F(3,69)=25.36$, $p<.001$, $\eta_p^2=.524$, such that SUDS ratings increased from pre-exposure ($M=19.7$, $SEM=2.7$) to 60-second post-exposure ($M=31.1$, $SEM=2.8$, $p<.001$), decreased significantly from 60 to 120 seconds ($M=22.43$, $SEM=2.12$, $p<.001$) and decreased from 120-seconds to the final rating ($M=13.2$, $SEM=1.06$, $p<.001$). Thus the 60-second post exposure SUDS rating point was used as the initial fear activation (IFA) time point in further analyses and WStH of fear was determined as IFA minus the final SUDS rating (regardless of the number of attempts). Further analysis revealed non-significant effects of Group ($ps<.01$) and non-significant Group x Stage interactions for both IFA, $F(7, 161)=1.72$, $p=.154$, $\eta_p^2=.069$, and WStH, $F(7, 161)=1.39$, $p=.242$, $\eta_p^2=.047$, indicating that there was no differential effect of treatment group across the exposure stages.

Self-reported disgust (SUGS) ratings. Analysis of SUGS ratings revealed a significant effect of Rating point, $F(2,69)=22.66$, $p<.001$, $\eta_p^2=.496$, such that SUGS ratings increased from pre-exposure ($M=21.1$, $SEM=3.7$) to 60-seconds post-exposure ($M=37.5$, $SEM=4.2$, $p<.001$),

decreased significantly from 60 to 120 seconds ($M=28.62$, $SEM=3.78$, $p<.001$) and decreased from the 60-seconds to the final rating ($M=22.1$, $SEM=3.9$, $p<.001$). Thus the 60-second post exposure rating point was used as the initial disgust activation (IDA) time point in further analyses and WStH of disgust was determined as IDA minus the final rating point (regardless of number of attempts). Analysis of IDA and WStH of disgust revealed non-significant effects of Group ($p>.01$) and non-significant Group x Stage interactions for both IDA, $F(7, 161)=1.39$, $p=.213$, $\eta_p^2=.057$, and WStH of disgust, $F(7, 161)=1.77$, $p=.134$, $\eta_p^2=.072$, indicating that there was no differential effect of treatment group across the exposure stages.

Skin Conductance Level (SCL). For analysis of all 10-second epochs, a significant Segment x Epoch interaction was found (Figure 2), $F(10,220)=4.17$, $p=.009$, $\eta_p^2=.159$, such that peak activation occurred during the first three epochs of the first minute and during the first epoch of the subsequent two minutes for each stage. Thus the greatest average SCL out of the first three epochs in the first minute was used as the initial activation point. WStH in the first minute of exposure was determined as initial activation minus the average activation in the final epoch. Further analysis revealed non-significant effects of Group ($p>.01$) and non-significant Group x Stage interactions for both initial activation, $F(7, 154)=.512$, $p=.644$, $\eta_p^2=.023$, and WStH, $F(7, 154)=1.56$, $p=.206$, $\eta_p^2=.066$, indicating that there was no differential effect of treatment group across the exposure stages.

Heart Rate. Analysis of all epochs revealed a significant effect of Epoch, $F(5,95)=11.32$, $p<.001$, $\eta_p^2=.373$, such that heart rate was significantly greater in the first 10 seconds of exposure ($M=78.8$, $SEM=2.75$, $95\%CI$ 73.1-84.6) compared to all subsequent epochs ($p<.001$). For comparability with SCL, the greatest average HR out of the first three epochs of exposure

was used to determine the initial activation point. WStH in the first minute of exposure was determined as initial activation minus the average activation in the final epoch. Further analysis revealed non-significant effects of Group ($p < .01$) and non-significant Group x Stage interactions for both initial activation, $F(7, 133) = .416, p = .677, \eta_p^2 = .021$, and WStH, $F(7, 133) = 0.723, p = .528, \eta_p^2 = .037$, indicating that there was no differential effect of treatment group across the exposure stages.

3.1.3 Outcome Analyses

Fear of Spiders Questionnaire (FSQ). There was a significant Time x Group interaction (Table 2), $F(4, 62) = 3.31, p = .024, \eta_p^2 = .18$. For the real image group, $F(2, 26) = 12.96, p = .01, \eta_p^2 = .50$, FSQ scores were significantly lower at 1-week ($p = .003$) and 1-month ($p = .002$) post-treatment relative to pre-treatment, with large effect sizes noted. There was a trend for a decrease in scores between 1-week and 1-month post-treatment ($p = .058$), with a small effect size. For the hyper-real image group, $F(2, 20) = 4.13, p = .042, \eta_p^2 = .29$, there was a significant reduction in FSQ scores at 1-month post-treatment relative to pre-treatment with a large effect size ($p = .007$), a non-significant but large magnitude effect between pre-treatment and 1-week post-treatment ($p = .137$), and a non-significant effect with a small effect size between 1-week and 1-month post-treatment ($p = .378$). The effect of Time was non-significant for the wait-list control group, $F(2, 16) = 0.827, p = .449, \eta_p^2 = .094$, with negligible effect sizes for the difference at 1-week and 1-month post-treatment relative to pre-treatment. While there were no statistically significant differences between group differences at any time point ($p > .05$), the magnitude of the difference between the control group was negligible at pre-treatment and large at post-treatment for the hyper-real image group. For the real group, there were large differences

compared to the control group in opposite directions, indicating that the real image group had greater scores at pre-treatment and lower scores at 1-month post-treatment.

Table 2.

Mean FSQ scores (and effect sizes) across time for each group

	Control	Real	Hyper-real	Between group effect sizes		
	(n=9)	(n=14)	(n=11)	<i>d</i>		
FSQ scores	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>R vs C</i>	<i>H vs C</i>	<i>R vs H</i>
Pre-treatment	95.4 (16.2)	105.6 (13.3)	97.1 (19.2)	0.704	0.092	0.527
1-week post-treatment	95.3 (17.9)	80.7 (29.5)	85.5 (21.6)	0.568	0.489	0.182
1-month post-treatment	91.4 (26.1)	72.4 (33.9)	80.4 (13.4)	0.612	0.551	0.297
Within group effect sizes	<i>d</i>	<i>d</i>	<i>d</i>			
Pre- vs 1-week	0.006	1.088**	0.569			
Pre- vs 1-month	0.184	1.289**	1.009**			
1-week vs 1-month	0.172	0.261^	0.284			

Note: * $p < .05$, ** $p < .01$, *** $p < .001$, ^ $p < .10$; d =Cohen's d effect size; R=real, H=hyper-real, C=Control

Behavioural Avoidance Test (BAT). There was a significant Time x Group interaction for BAT scores (Table 3), $F(4,62)=9.99$, $MSE=3.65$, $p < .001$, $\eta_p^2=.39$. For the real image group, $F(2, 26)=50.86$, $p < .001$, $\eta_p^2=.80$, BAT scores increased significantly from pre-treatment to 1-week post-treatment ($p=.003$) and 1-month post-treatment ($p=.002$) with large effects sizes noted. There was a trend for a further decrease from 1-week than 1-month post-treatment which

approached statistical significance ($p=.012$) with a small effect size noted. For the hyper-real group, $F(2,20)=14.80$, $p=.001$, $\eta_p^2=.60$, there were also large magnitude effect sizes with significantly greater BAT scores at 1-week ($p=.009$) and 1-month post-treatment ($p=.001$) compared to pre-treatment. There was a non-significant increase in scores between 1-week and 1-month post-treatment ($p=.104$), with a negligible effect size noted. The effect of Time was non-significant for the wait-list group, $F(2,16)=0.821$, $p=.416$, $\eta_p^2=.093$, with negligible effect sizes noted between each time-point. The main effect of Group was non-significant at pre-treatment, $F(2,31)=0.633$, $p=.538$, with small effect sizes for the differences between the control and treatment groups. In contrast, at one-week post-treatment, a non-significant effect of Group was found, $F(2,31)=1.73$, $p=.194$, with large effect sizes noted for the differences between the control group and both the real and hyper-real groups. At one-month post-treatment, the main effect of Group approached significance, $F(2,31)=2.85$, $p=.073$, such that the control group tended to have lower scores than the real ($p=.036$) and hyper-real ($p=.05$) groups, with large effect sizes noted.

Table 3.

Mean BAT scores (and effect sizes) across time for each group

	Control (n=9)	Real (n=14)	Hyper-real (n=11)	Between group effect sizes <i>d</i>		
BAT scores	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>R vs C</i>	<i>H vs C</i>	<i>R vs H</i>
Pre-treatment	11.1 (5.0)	9.8 (5.4)	12.3 (6.0)	0.248	0.215	0.441
1-week post-treatment	11.2 (5.6)	14.9 (5.9)	15.5 (4.8)	0.639	0.832 [^]	0.110
1-month post-treatment	11.8 (4.5)	16.3 (5.2)	16.2 (4.5)	0.910*	0.989*	0.205
Within group effect sizes	<i>d</i>	<i>d</i>	<i>d</i>			
Pre- vs 1-week	0.019	0.902**	0.589**			
Pre- vs 1-month	0.147 [^]	1.226**	0.735**			
1-week vs 1-month	0.118	0.252*	0.151			

Note: * $p < .05$, ** $p < .01$, *** $p < .001$, [^] $p < .10$; d =Cohen's d effect size; R=real, H=hyper-real, C=Control

Clinical significance of improvement. For FSQ scores, clinical significance (Jacobson & Truax, 1991) was defined as a reliable change index (RCI) and an FSQ score less than 68 at one-week post-treatment (based on pre-treatment, $M=100.2$, $SD=16.3$). Although limited by sample size, there was a trend for differences in proportions at 1-week post-treatment, $\chi^2=5.85$, $p=.054$. The proportion of the real image group (43%) who demonstrated clinically significant improvement was significantly greater than the control group (0%), $\chi^2=5.22$, $p=.022$, with no differences between the hyper-real group (18%) and the real group ($p=.189$) or control group ($p=.105$). There were no normative data available to calculate clinical significance for the BAT.

3.1.4 Prediction of outcome from exposure-related variables.

Given the lack of differences between the two treatment groups in terms of habituation, regression analyses were conducted for both treatment groups collectively (see Table 4). Furthermore, given that longer-term improvement in symptoms is of most clinical relevance, one-month rather than 1-week follow-up data was examined. There were non-significant relationships between FSQ change scores at one-month post-treatment and all of the exposure-related variables, aside from SCL for which there were small ($R^2=.222$) and moderate ($R^2=.390$) effects noted for change in initial activation and change in WStH from Stages 1 to 8. Several exposure-related variables predicted BAT change scores at one-month post-treatment (see Table 4). For SUDS and SUGS ratings, a greater change in initial activation (60-seconds) between Stages 1 and 8 was a significant predictor of BAT change scores at 1-month post-treatment, with small ($R^2=.261$) and moderate ($R^2=.470$) effect sizes respectively. Similarly, a greater difference in WStH (60-seconds minus final rating) between Stages 1 and 8 was a significant predictor of BAT change scores at one-month post-treatment for multiple measures, with small effects found for SUDS ratings ($R^2=.161$) and heart rate ($R^2=.177$) and a moderate effect found for SUGS ratings ($R^2=.423$).

Table 4

Prediction of change in BAT and FSQ scores (pre-treatment minus 1-month post-treatment) from exposure-related variables among those who completed all exposure stages (n=23).

	BAT score change		FSQ score change	
	B (SE)	R ²	B (SE)	R ²
SUDs ratings (n=23)				
Summed IFA (All Stages)	<0.001 (0.01)	-.048	0.025 (0.05)	-.037
Change in IFA (Stage 1 minus 8)	0.08 (0.03)**	.261	0.335 (0.31)	.008
Summed WStH (All Stages)	0.002 (0.007)	-.044	0.03 (0.07)	-.039
Change in WStH (Stage 1 minus 8)	0.08 (0.04)*	.161	0.22 (0.36)	-.028
SUGs ratings (n=23)				
Summed IDA (All Stages)	-0.007 (0.004)	.070	-0.001 (0.04)	-.048
Change in IDA (Stage 1 minus 8)	0.07 (0.02)***	.470	0.05 (0.22)	-.045
Summed WStH (All Stages)	0.01 (0.01)	-.007	0.03 (0.10)	-.044
Change in WStH (Stage 1 minus 8)	0.08 (0.02)***	.423	-0.13 (0.26)	-.036
Heart rate (0-60-seconds) (n=20)				
Summed IHA (All stages)	0.007 (0.007)	.004	-0.06 (0.065)	-.009
Change in IHA (Stage 1 minus 8)	0.107 (0.053) [^]	.138	-0.514 (0.559)	-.008
Summed WStH (All Stages)	0.002 (0.02)	-.055	-0.04 (0.196)	-.053
Change in WStH (Stage 1 minus 8)	0.104 (0.046)*	.177	-0.415 (0.494)	-.016
SCL (0-60-seconds) (n=22)				
Summed ISA (All stages)	-0.130 (0.056)*	.171	-0.757 (0.597)	.028
Change in ISA (Stage 1 minus 8)	0.293 (0.274)	.007	6.29 (2.378)*	.222
Summed WStH (All Stages)	0.066 (0.055)	.020	-0.798 (0.53)	.057
Change in WStH (Stage 1 minus 8)	0.241 (0.175)	.041	-5.213 (1.37)**	.390

Note: * $p < .05$, ** $p < .01$, *** $p < .001$, [^] $p < .10$; adjusted R² is reported

4.1 Discussion

The aim was to evaluate the effects of real and hyper-real images on habituation during image-based exposure among spider fearfuls, and to examine the effect of image-based exposure on improvement in phobic symptoms. A further aim was to examine the treatment-related correlates of improvements in phobic symptoms. There was no evidence for a differential effect of real versus hyper-real images in terms of anxiety or disgust ratings, or physiological arousal (heart rate and skin conductance measures). However, both groups showed within-stage habituation of self-reported anxiety and disgust and physiological arousal. There were significant improvements in both self-reported (FSQ score) and behavioural (BAT score) measures of phobic symptoms at 1-week and 1-month post-treatment with large effect sizes for both treatment groups. In comparison there were non-significant effects for the wait-list control group with negligible effect sizes noted. This provides supportive evidence for the effectiveness of online image-based exposure. In addition, exposure-related variables were found to predict treatment outcome. For example, the change in WStH of self-reported anxiety, self-reported disgust, and heart rate between the first and last stages were significant predictors of improvement in behavioural avoidance at one-month post-treatment.

Habituation of subjective anxiety and disgust occurred during each exposure stage for both treatment groups, with increased SUDS/SUGS ratings from pre-exposure (0-seconds) to first post-exposure rating point (60-seconds), followed by a decline from 60 to 120 and from 120 to the final rating point. This is consistent with previous research using this online exposure program (Matthews et al., 2010, 2011, 2012), and other research examining habituation of self-reported anxiety (Coldwell et al., 1998; Nelissen et al., 1995; Vansteenwegen et al., 2007;

Veltman et al., 2004) and disgust (Edwards & Salkovskis, 2006; Olatunji et al., 2009) during exposure to spider images. Habituation was also observed for physiological measures of arousal. Overall heart rate was significantly higher during the first 10 seconds of exposure and SCL was higher in the first 30 seconds relative to subsequent epochs. This is consistent with previous research demonstrating elevation and habituation of physiological activity during both image-based (Klorman, 1974; Vansteenwegen et al., 2007) and in vivo (Foa & Kozak, 1986; Johnstone & Page, 2004) exposure.

There was no evidence for a differential effect of the treatment conditions on self-reported anxiety/disgust or physiological measures of arousal. Thus the digital manipulation of hyper-real images did not produce the expected increase in anxiety or disgust ratings, even though they were rated as significantly 'scarier' than their real image pair in a pilot study ($n=70$). Given that the pilot group were a general sample with a range of phobic symptoms, it is possible that the subjective scariness of spider images was qualitatively different among the current high fear sample. Alternatively, given that 'scariness' rather than anxiety (SUDS) ratings were used in the pilot study, it is possible that scariness ratings do not adequately predict anxiety. However, given that three participants from the hyper-real group declined to continue, it is possible that this exposure hierarchy was less acceptable for some participants.

Both treatment groups showed significant reductions with large effect sizes for both self-reported phobic symptoms (FSQ scores) and behavioural avoidance of real spiders (indexed by greater BAT scores) at post-treatment, compared to non-significant differences of negligible effect size for the control group. Furthermore, there was evidence for moderate-large effect sizes between the control and treatment groups at post-treatment compared to negligible or

opposite direction effect sizes at pre-treatment. While these data require replication with larger sample sizes they provide evidence in support of the effectiveness of online image-based exposure and suggest that the treatment groups showed improvement beyond that which might be expected from exposure to a real spider stimulus when completing the BAT at each of the three time points. The improvement in BAT scores for the treatment groups also suggests generalisation of treatment effects to a real life situation. Furthermore, a significantly greater proportion of the real image group achieved clinically significant improvement in self-reported symptoms (43%) compared to the control group (0%). While these findings should be considered preliminary due to non-randomised allocation of the control group, the control group did not differ from treatment groups in terms of pre-treatment phobic symptoms and the results are consistent with other research examining the effectiveness of image-based exposure (Muller, Kull, Wilhelm, & Michael, 2011). These improvements were in response to a brief intervention (~24 minutes), and the effective delivery of a higher 'dose' of symbolic exposure would be of particular interest in future research.

Arguably the most interesting findings in the present study are the relationships observed between exposure-related variables and treatment outcome. According to emotional processing theory, treatment outcomes should be proportional to measures of fear activation (IFA) and habituation of fear within (WSH) and between (BSH) exposure sessions (Foa et al., 2006; Foa & Kozak, 1986). The innovative design of this online exposure treatment allowed for a similar conceptualisation of these variables within a single session of multiple exposure events. For example, while initial activation is defined (often retrospectively) as the peak response across the entire exposure session, the present design allowed for assessment of

activation within each discrete exposure stage. As such, each exposure stage was conceptualised as a single brief session and within stage habituation (WStH) was calculated as the peak minus the final rating for each stage. This also allowed summed initial activation and summed WStH to be calculated across the 8-stage treatment. In the present study, self-reported and physiological measures of summed IFA and WStH were generally not significant predictors of outcome. While not reported in the present study, exploratory analyses showed that this was also the case when IFA and WSH were calculated across the entire session, rather than for each discrete exposure stage. These findings are consistent with the lack of evidence for a relationship between outcome and IFA or WSH within the anxiety disorder literature, although much of this research relates to disorders other than specific phobia (Craske et al., 2008). However, it is also possible that the present measure of initial fear and disgust activation (60-seconds post-exposure) did not adequately capture the true peak in activation. This is particularly likely given that the physiological measures of arousal peaked within the first 30 seconds of exposure. Further research is required to identify the most appropriate time point to measure self-reported initial activation during online exposure, but current research suggests that the 60-second time point was most appropriate within the context of the current online treatment paradigm (Matthews et al., 2010; Matthews et al., 2012).

In contrast, several exposure-related measures were found to be significant correlates of improvement in behavioural avoidance (but not self-reported symptoms) at one-month post-treatment, accounting for a small to moderate proportion of the variance. In particular, for both anxiety and disgust ratings, a greater reduction in IFA and WStH between Stages 1 and 8 predicted a greater change in BAT scores at post-treatment (with greater change scores

indexing less behavioural avoidance and therefore improvement). Similarly, a greater reduction in WStH of heart rate between Stages 1 and 8 also predicted a greater change in BAT scores at post-treatment. The fact that this relationship was observed across multiple measures (i.e., fear, disgust, and heart rate) is particularly noteworthy and adds to the reliability of the results. In contrast, the change in initial activation and WStH of SCL was associated with improvement in self-reported phobic symptoms rather than behavioural avoidance. This finding should be considered preliminary but may relate to the differences between SCL and the other measures reported.

Within the context of emotional processing theory, change in fear activation and habituation between the first and last stages is similar to the concept of BSH (Foa et al., 2006; Foa & Kozak, 1986). For example, the difference between the peak response of the first and last exposure trial (albeit across different sessions) has previously been conceptualised as a measure of BSH, with some studies reporting significant relationships between BSH and outcome measures (Craske et al., 2008). Although the change in initial activation from the first to the last stage necessarily confounds initial activation with WSH, as mentioned above, there were no relationships found when overall WSH was considered, so the present result is more likely to be related to the reduction in initial activation.

The change in activation and habituation between the first and last stages might be seen as a measure of the generalisation of habituation to new images or contexts. This seems plausible given that this most often predicted improvement on the BAT, an *in vivo* situation. From an inhibitory learning perspective (Craske et al., 2008), this generalisation of habituation between stages may be related to the strength of new inhibitory associations and/or their

resilience over time and context. For example, previous research has shown that fear extinction in multiple contexts results in less renewal of fear relative to extinction a single context (Shiban, Pauli, & Muhlberger, 2013; Vansteenwegen et al., 2007).

Interestingly, the between-stage reduction in initial activation and habituation of disgust accounted for the most variation in improved behavioural avoidance (accounting for 47% and 42% of the variance respectively). This is consistent with previous research in which disgust has been identified as an important component in the maintenance and treatment of spider phobia (Olatunji et al., 2011). Previous research has shown that habituation of disgust occurs at a slower rate than fear (Cisler et al., 2009; Olatunji et al., 2009). In the present study, the SUDS and SUGS ratings were not presented in randomised order. As such, it was not possible to accurately assess the relative rate of habituation for anxiety and disgust, as the disgust ratings may not be truly independent from self-reported anxiety. This limitation should be taken into consideration when considering the present findings and further research would be required to examine this further.

The present results have some limitations in terms of statistical power. For example, statistical power and non-randomised allocation of the control group were a specific limitation in relation to the outcome analyses. However, this was mitigated somewhat by examination of effect sizes which indicated clear psychological significance of the findings. Furthermore, although the waitlist control group was recruited subsequent to the treatment groups, all controls met diagnostic criteria for specific phobia and did not differ from the treatment groups at pre-treatment. The results are also limited in terms of their generalisability to males and to

clinically diagnosed phobic populations. However, it is important to note that a majority of participants in this high spider fear group met diagnostic criteria for specific phobia (DSM-IV).

The findings of the present study provide further evidence in support of the efficacy of online image-based exposure. In general, spider images produced within-session habituation of self-reported anxiety, disgust, and physiological arousal. Online exposure to images also produced significant improvements in self-reported spider phobia symptoms and behavioural avoidance with large effect sizes that were maintained over a one-month period. Changes in habituation (anxiety, disgust and heart rate) between the first and last exposure stages predicted improvement in behavioural avoidance at one-month post-treatment. Thus generalisation of habituation to multiple stages may be an important indicator of outcome during online exposure to feared images. Together these findings have implications for informing future research into the underlying mechanisms of effective image-based exposure.

Conflict of interest

There are no conflicts of interest to be declared.

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