Out of Sight, Out of Fear? Comparing the Effects of Masked Counterconditioning and Masked Exposure on Spider Fear

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Because of delays in data collection, fictitious data has been used for this bachelor thesis. The results and conclusions in this bachelor thesis are thus not based on real data of participants and therefore, should also not be used as such.

Abstract

Spider phobia is a prevalent and distressing condition, and although exposure therapy is effective, it is often avoided due to the distress it induces. Masked exposure has shown promise in reducing fear responses without conscious awareness or distress. However, it does not seem successful in altering the subjective evaluation towards spiders. Evaluative counterconditioning may further enhance outcomes by altering stimulus valence. This study examined whether masked counterconditioning is more effective than masked exposure and a control condition in increasing valence ratings of spiders among women with spider fear. A sample of 151 women with spider fear were assigned to one of three conditions and completed two short intervention blocks using a backward masking procedure. For the intervention conditions, participants were exposed to masked spider pictures that were followed by positive animal pictures (conditioning) or by a neutral letter array (exposure). The control condition was added to control for exposure to positive stimuli alone. Valence ratings of spider stimuli and subjective distress were assessed pre- and post-intervention. Results revealed no significant improvements in how participants rated the spider image across any of the conditions. However, importantly, neither intervention conditions led to an increase in subjective distress. These findings suggest that while masked procedures may not alter affective evaluations in the short term, they do offer the advantage of low distress, which could support their use as precursors to traditional exposure therapy. Future studies should investigate whether repeated sessions, improved stimulus selection, and double-blind procedures could enhance intervention effects.

Keywords: backward masking, evaluative counterconditioning, exposure, masking, spider phobia, subjective distress

Out of Sight, Out of Fear? Comparing the Effects of Masked Counterconditioning and Masked Exposure on Spider Fear

Spider phobia is a specific phobia that is common and occurs predominantly in women (APA, 2022; Arrindell, 2000; Stinson et al., 2007). Exposure therapy has been established as an effective therapy for specific phobias, including spider phobia (Norton & Price, 2007; Öst, 1989; Ougrin, 2011). This involves repeated exposure (EXP) of clients to the frightening stimulus, ultimately resulting in the extinction of the fearful reaction (Craske & Mystkowski, 2006). Sessions can be distressing because clients are confronted with what they fear most. Therefore, it frequently results in early cessation or rejection of therapy (Davis III et al., 2012; Issakidis & Andrews, 2004). Ultimately, a large proportion of clients with specific phobia do not seek help (Garcia-Palacios et al., 2007). This emphasizes the need to develop an intervention that resolves the phobia without creating excessive distress for the client.

Masked exposure (very brief exposure; VBE) has been proposed as a potential alternative to traditional exposure procedures (Siegel & Weinberger, 2009). In VBE, phobic stimuli are presented very briefly, typically under 30 milliseconds. After, they are immediately followed by a masking image, such as a neutral or scrambled visual stimulus, which should prevent conscious recognition of the phobic stimulus. As a result, the client is exposed to the phobic stimulus without being able to report it after the procedure. This method builds on the idea that emotional and threat-related information can be processed without conscious awareness (Dolan & Vuilleumier, 2003; Öhman, 1986). It has been shown that individuals with spider phobia who underwent VBE to masked spider images, showed stronger activation in brain regions associated with emotion regulation and fear extinction, such as the inferior frontal cortex and caudate nucleus (Siegel et al., 2020). This was compared to both non-phobic individuals and phobic individuals exposed to masked neutral stimuli (VBF). Participants in the VBE condition were also able to approach a live tarantula more closely right after the intervention took place. Another study found that the effects of VBE on approach behavior to a live tarantula had lasted one week after the intervention took place (Siegel & Weinberger, 2009). In this study, participants with spider phobia who underwent VBE approached the live tarantula more closely one week later, compared to those exposed to unmasked spider images. In addition to the effects found on approach behavior, another study demonstrated that participants with spider fear who underwent VBE showed no increase in subjective distress levels, similar to a control VBF condition (Siegel et al., 2018). This was compared to normal EXP procedures, which did cause an increase in subjective distress levels within the same participants with spider phobia. Altogether, VBE appears to be effective in reducing physiological and behavioral fear responses while not inducing more subjective distress for the client. However, a systematic review of multiple papers on masked exposure to phobic stimuli found that VBE does not seem to significantly alter the subjective evaluation of the phobic stimulus (Frumento et al., 2021). This is important, since subjective fear maintains avoidance behavior to the phobic stimulus, which could lead to renewal of the fear after the exposure therapy (Craske et al., 2014).

Evaluative counterconditioning (CC) is an alternative approach which is aimed at altering the affective value of a conditioned stimulus (CS) by systematically pairing it with a new, unconditioned stimulus (US). The US should elicit an emotional response which is opposed to the response caused by the CS. This creates a new CS-US association which inhibits the initial emotional response caused by the CS, in line with the inhibitory learning approach (Craske et al., 2014). In this way, pairing phobic stimuli to positive stimuli might create a positive association which then inhibits the negative association. Several studies have shown that CC is more effective than EXP in altering the subjective evaluation of certain stimuli (Baeyens et al., 1989; Eifert et al., 1988; van Dis et al., 2019). Furthermore, another study has shown that participants who underwent a CC intervention in combination with regular EXP, reported less distress in response to a conditioned threat cue after the CC intervention (Hendrix et al., 2021). This was compared to participants who underwent regular EXP without CC. These results show that CC can be effective in reducing the distress associated with the phobic stimulus. However, CC interventions for treating specific phobias are done in combination with a form of regular EXP to the phobic stimulus. As mentioned earlier, regular EXP can cause distress for the client and therefore, therapy can be avoided (Garcia-Palacios et al., 2007).

One possible way to maintain the benefits of counterconditioning while avoiding the distress associated with exposure, is to use masked counterconditioning (very brief counterconditioning; VBC). VBC builds on the idea that it could benefit from the same advantages as shown in VBE, such as lower subjective distress levels (Siegel et al., 2018), while upholding the added benefits of CC of altering the subjective evaluation of the CSs (Baeyens et al., 1989; Eifert et al., 1988; van Dis et al., 2019). In a recent study, the effectiveness of VBC was tested by pairing subliminally presented spider images with smiling faces (Masselman et al., 2024). Participants were female students with spider fear who were randomly assigned to one of four conditions: masked counterconditioning, masked mere exposure, non-masked counterconditioning, or a control condition. In the masked conditions, continuous flash suppression (CFS) was used as the masking technique. This technique works by presenting rapidly changing colorful patterns to the dominant eye and the phobic stimulus to the non-dominant eye. The patterns in the dominant eye should ensure that people are not able to report having seen the phobic stimulus (Tsuchiya & Koch, 2005). Participants' affective evaluation of spiders was measured before and after the intervention. Results showed that both VBC and VBE led to more positive evaluations of the spider, but there was not a significant added benefit of the counterconditioning. Furthermore, evaluations did not differ between the masked and non-masked CC condition (Masselman et al., 2024). However, a considerable number of participants reported seeing the spider images during the masked procedure. This raises concerns about the effectiveness of the masking technique used in the study.

These findings suggest that the observed effects of VBC may have been confounded by insufficient masking, thereby limiting the interpretability of the results. It is therefore essential to choose a reliable masking technique when testing whether masked procedures have any effects (Wiens, 2006). Recent studies on visual processing have shown that certain stimuli may break through conscious perception more easily during CFS. It has been argued, for example, that biologically salient threat-related stimuli may be partially processed even under the suppression with CFS (Sterzer et al., 2014). This raises doubts about the effectiveness of CFS in fully suppressing fear-relevant cues such as spiders. Since spiders are fear-related for people with spider phobia, this may explain why some participants in the study of Masselman et al. (2024) reported seeing the spiders. Another masking technique is the backward masking technique, which was previously used in the series of studies by Siegel and colleagues (2009, 2011, 2012, 2018, 2020). At the time, this technique had been successful in suppressing spiders, that is, people did not report seeing any spider pictures during the procedure. It works by very briefly presenting the phobic stimulus (e.g., a spider), followed immediately by a masking stimulus that interrupts processing of the original image (Breitmeyer & Ögmen, 2006). To date, no study has compared VBC and VBE using a reliable and successful masking technique, such as the backward masking technique. Additionally, subjective distress levels have also not been looked upon in earlier studies that looked at VBC.

To fill in this critical gap, the current study investigated whether VBC is more effective than VBE in increasing valence ratings of spiders, reflecting reduced subjective fear of spiders. Additionally, it investigated whether subjective distress levels increased right after the masked exposure procedure. This was tested on a sample of female students with spider fear, given that spider phobia is more common among women (Arrindell, 2000). The backward masking technique was applied to investigate the effects of both VBC and VBE. A direct comparison was made between VBE and VBC including the use of a control condition. In both VBC and VBE, a spider is shown (33.4 ms), followed by a mask (117 ms). Next, participants in the VBC condition are shown an US and participants in the VBE condition are shown a letter sequence (both for 600 ms). The control condition is shown a blank screen instead of a spider (33.4 ms), followed by a mask (117 ms) and an US (600 ms). It was added to control for exposure to positive stimuli alone. VBC is expected to be more effective than VBE and the control condition in increasing valence ratings of spiders (hypothesis 1). Furthermore, VBE is expected to be more effective than the control condition in increasing valence ratings of spiders (hypothesis 2). In addition, participants' subjective distress level in VBC and VBE is expected to not increase more than in the control condition from immediately before to after the procedure (hypothesis 3).

Methods

Participants

A total of 152 female participants (*M* age = 19.86, *SD* = 1.79) were recruited via the University of Groningen SONA and Paid Participant Pool (PPP) systems. SONA is an online platform that consists of primarily first year psychology students who receive course credits for their participation, while the PPP system involves a broader demographic of students who instead receive monetary compensation. Students were eligible to participate if they gave prior consent via an online prescreening and obtained a score of 77.2 or higher on the Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995), similar to treatment seeking samples (e.g., De Jong & Peters, 2007). Participants were randomly assigned to one of three conditions: Control (CTL: *n* = 51), Very Brief Counterconditioning (VBC: *n* = 52), and Very Brief Exposure (VBE: *n* = 48). Prior to statistical analyses, data from one participant in the VBE condition were excluded due to missing data at T0 for all the affective ratings. Informed consent was obtained from all individuals, and the study received ethical approval from the University of Groningen Ethical Committee under the code PSY-2425-S-0008. The study was preregistered: https://aspredicted.org/9w9n-67gs.pdf.

Materials

Stimuli

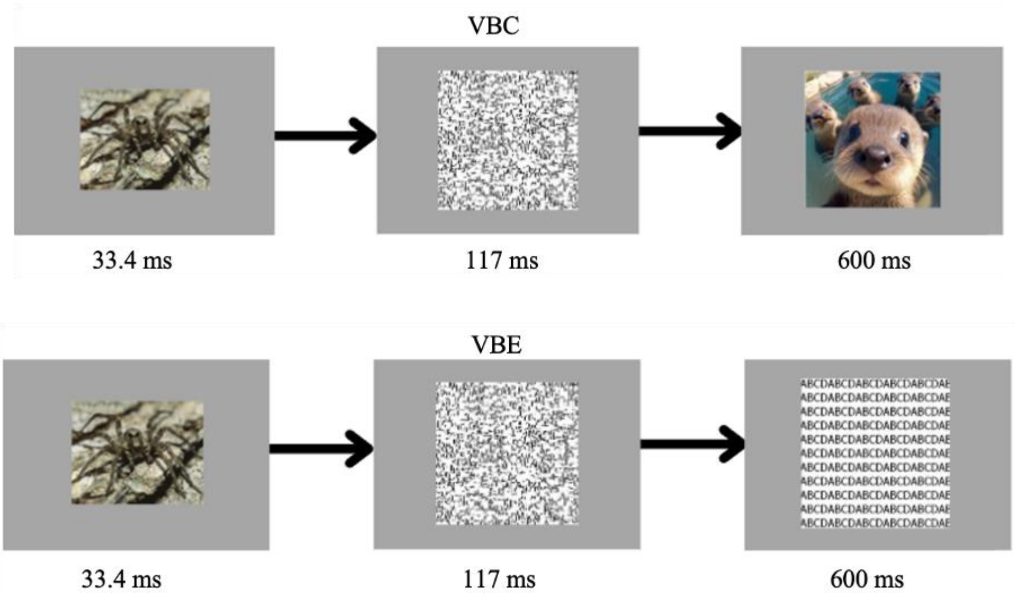
The conditioned stimuli (CSs) consisted of 25 frontal-view images of house spiders, taken from Siegel et al. (2012), which were presented in random order during the intervention in the VBC and VBE conditions. An additional spider image, sourced from Masselman et al. (2024), was used as a generalization spider in the questionnaires and was therefore not shown during the experiment blocks. This stimulus served to assess whether the effects of the manipulation would extend to a similar, yet distinct, feared stimulus. To increase stimulus variability and obscure the true focus of the study, ten filler stimuli were included in the affective ratings. These consisted of neutral or negatively valenced animals (e.g., a rat, a snake, or a fly). A scrambled image was used as a visual mask in all conditions. In the VBE condition, this was followed by a neutral array of letters, which served as a non-affective stimulus.

The unconditioned stimuli (USs) were 25 positively valenced animal images (e.g., a puppy or a duckling), which were systematically paired with the target spider images during the experimental blocks in the VBC condition. This was aimed at creating positive associations and reducing fear responses toward spiders. These same images were also presented in the CTL condition, but without preceding spider stimuli, serving as a control for exposure to positive stimuli alone. A stimulus validation study was conducted prior to the main experiment. Approximately 50 participants, recruited via thesis students' social networks, rated 50 positive animal images (sourced online) on a 0–100 valence scale using an anonymous, voluntary, and uncompensated online Qualtrics survey. The highest-rated images were selected as USs to ensure strong positive affective value.

Manipulation

The experiment was conducted using OpenSesame 3.3.6 (Mathôt et al., 2012). Each participant completed two blocks of 25 trials, with each block lasting approximately one minute. The task was presented on a neutral grey background. Participants were instructed to maintain focus on a centrally presented fixation cross throughout the task and were not informed about the nature, content, or sequence of the stimuli.

In each trial, a fixed three-part sequence was presented (see Figure 1): a 33.4 ms spider image (in the VBC and VBE conditions) or a neutral blank screen (CTL condition), followed by a 117 ms scrambled mask, and finally a 600 ms image. This final image was either a positively valenced animal (in the VBC and CTL conditions) or a neutral letter array (in the VBE condition). While the spider and animal images were randomized across trials, the neutral letter array in the VBE condition remained constant. Participants' subjective distress was assessed using the Subjective Units of Distress (SUD) scale, which was programmed directly into the task and presented immediately before and after each block.



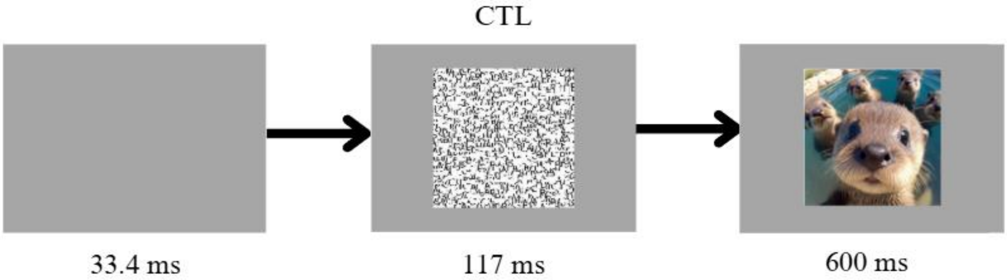


Figure 1. Example of a single intervention trial for the VBE, VBC, and CTL condition

Measures

Affective Ratings

Valence ratings were used to assess participants' subjective evaluation of the animal stimuli. The stimuli in the surveys were presented sequentially using Qualtrics, with a Visual Analogue Scale (VAS) displayed below each image (0 = *Very negative*, 100 = *Very positive*). Participants were shown an image of the spider CS, a generalization spider, followed by US animal and filler animal images. The spider CS and the generalization spider were presented first and in a fixed order (spider CS first, generalization spider after) to ensure their evaluation was not influenced by the other animal stimuli in the survey. The USs and filler animals followed after and were presented in a randomized order. Ratings for the USs were averaged. Out of the 25 spider images used in the experimental blocks, only one spider was rated as the spider CS in the surveys to avoid drawing attention to spider-related stimuli. Higher scores indicated more positive evaluations of the animals (*range*: 0-100).

Mental Behavioral Approach Test (BAT)

Participants completed a mental behavioral approach test (BAT) to assess their mental willingness to approach the CS spider. Participants were shown the spider CS and were asked to imagine that the spider was placed in a glass jar on a table before them. They were instructed to indicate to which step of the BAT they would be willing to proceed. Steps ranged from minimal (0) to maximal engagement (8), with minimal engagement being ‘‘none of the above’’, and maximal engagement being ‘‘let the spider walk over my hands’’. The steps were based on standardized BAT steps used in prior research (de Jong et al., 2000), and are included in Appendix A. Higher scores indicated a stronger (mental) approach to the spider.

After completing the mental BAT, participants’ subjective fear and disgust were assessed. They were instructed to imagine having to execute the final step of the mental BAT. First, they were presented with the spider CS and were asked “Imagine that this spider walks over your hands. How fearful would you be?”. Afterwards, they were asked “Imagine that this spider walks over your hands. How disgusted would you be?”. Scores for both variables were rated on a VAS ranging from 0 (*not at all*), to 100 (*extremely*), with higher scores indicating greater levels of fear and disgust.

Subjective Distress

Participants’ level of subjective distress was assessed using the Subjective Unit of Distress (SUD) scale. At the top of the experimental manipulation page participants were asked “How do you feel right now?”. Scores were rated on a VAS and ranged between 0 (*no fear whatsoever*) to 100 (*an extremely high, unbearable amount of fear*), with higher scores indicating a greater level of subjective distress.

Spider Fear

Spider-specific fear was measured using the 18-item FSQ (Szymanski & O’Donohue, 1995). The items assessed avoidance behaviors, fear, and cognitive preoccupation with spiders (e.g., “If I came across a spider now, I would get help from someone else to remove it” or “If I came across a spider now, I would leave the room”). Responses were rated on a 7-point Likert scale ranging from 1 (*not at all*) to 7 (*very much*). Total FSQ scores were calculated by summing all items. Scores ranged from 18 to 126, with higher scores indicating a greater degree of spider fear. Participants also completed the FSQ during the prescreening, allowing for a baseline FSQ score. The internal consistency of the FSQ was high in the current sample with a Cronbach's alpha of .95 for both the baseline FSQ and the FSQ measured at T2.

Contingency Awareness and Confidence

The participants' contingency awareness in the VBC condition was assessed via a VAS in which participants reported their estimation of the CS-US contingency. Specifically, participants were asked to estimate the proportion of non-spider animal images that were preceded by a spider image, with responses ranging from 0% (*none*) to 100% (*all*). Higher percentages reflected a greater level of perceived contingency awareness. Participants were also asked to indicate how confident they were in their contingency estimation, using a separate VAS ranging from 0% (*not at all confident*) to 100% (*extremely confident*). Higher percentages indicated greater confidence in the participants' own contingency estimation.

Other Awareness and Manipulation Checks

A complete set of funneled awareness questions, designed to assess participants' attention to the task, stimulus awareness, contingency awareness and perceived study purpose, is provided in Appendix A. To clarify the intended reference stimulus in each question, the wording of these questions included slight variations across conditions.

Procedure

This study was advertised as an investigation into how viewing animals that one likes or dislikes affects emotional responses. On arrival at the laboratory, participants were given a printed information letter, and asked to give written informed consent. Participants were informed that participation was voluntary and that they could withdraw at any time without negative consequences. The experiment took place in a quiet, dimly lit testing room to minimize distractions. All participants were seated in front of a computer screen (1920 x 1080 IIYAMA ProLite G2773HS, refresh rate = 100 Hz) and asked to position their head in a chin rest to maintain a standardized viewing distance during the experimental tasks. The procedure consisted of three survey time points (T0, T1, T2) and two short experimental blocks. Prior to the start of the procedure, participants were randomly assigned to one of the three experimental conditions in a between-subject design. Participants began with the first questionnaire (T0), in which they evaluated the spider CS, followed by the generalization spider and subsequently the 25 USs and 10 filler animals. Next and directly prior to the first experimental block (T0), participants' SUD was measured. Subsequently, participants completed the first experimental block of 25 trials in alignment with the allocated condition. Thereafter (T1a), the SUD of the participants was re-assessed. The second questionnaire (T1) was then conducted, with participants rating all previously assessed animals in a comparable manner to the first survey. Furthermore, the participants completed the questions that measured the mental BAT, subjective fear and subjective disgust. Baseline assessments at T0 for these measurements were omitted to avoid drawing attention to the spider-related stimuli. After this, participants' SUD was reassessed prior to the start of the second experimental block (T1b). The following second experimental block employed the same condition-specific manipulation as the earlier block. Immediately following the second block and before the start of the final survey, the SUD was assessed again (T2). The final survey (T2) included the same measurements as the second, along with the FSQ and a funneled awareness interview. In the final stage of the questionnaire, participants reported their age. Following the submission of the final survey, participants were asked about their overall experience and were given the opportunity to share any discomfort or distress they may have encountered during the procedure. The participants were then compensated with course credits or monetary compensation. To minimize the risk of information spreading that could influence the ongoing data collection, a full debriefing was postponed until after the study concluded.

Statistical analyses

A repeated measures (RM) analysis of variance (ANOVA) was conducted to examine whether participants in the VBC condition showed a greater increase in valence ratings towards the spider CS than participants in the VBE and CTL condition, and to assess if participants in the VBE condition showed a greater increase in valence ratings towards the spider CS compared to the CTL condition. In this analysis, the valence ratings of the spider (CS) served as the dependent variable. The within-subject factor was Time, comparing pre-manipulation (T0) to post-Block 2 (T2) ratings. T1 is not included in the analysis, because the greatest result is expected after two manipulation blocks at T2. Condition (VBC, VBE and CTL) served as a between-subjects factor. To test whether participants' subjective distress levels did not increase from immediately before to after the entire procedure for the VBC and VBE conditions, another two RM ANOVAs were conducted. Since participants had to fill out a questionnaire between T1a and T1b where SUD ratings were not measured, the analysis of the SUD was split up into two RM ANOVAs. Here, the SUD ratings served as the dependent variable. Time and Condition remained the within- and between-subject factors. To explore within-condition changes in CS valence over time, paired-sample t tests were conducted post hoc for each condition. Pairwise comparisons were conducted to explore between-condition differences per time point. These tests evaluated whether the change in CS valence from pre- to post manipulation was statistically significant within and between each condition. For all analyses, a significance level of $\alpha = .05$ was used.

Power calculation

An a priori power analysis for the RM ANOVA was conducted using G*Power 3.1 (Faul et al., 2009), which indicated that a sample of 159 participants would provide a power of .80 to detect a medium effect ($f = .25$) at an alpha level of .05. The final sample consisted of 151 participants.

Results

Participants

For an overview of the descriptive variables of the participants, see Table 1. The spider CS was generally rated as quite negative ($M = 17.40$, $SD = 17.06$). USs were generally rated as quite positive ($M = 70.27$, $SD = 12.08$).

Table 1

Means and standard deviations per condition for the descriptive variables

		VBC (n = 52)	VBE (n = 48)	CTL (n = 51)
		M (*SD*)	M (*SD*)	M (*SD*)
Descriptive variables	Age	19.69 (1.76)	19.73 (1.47)	20.20 (2.08)
	FSQ pre	97.52 (16.50)	94.96 (17.84)	96.51 (16.50)

Note. FSQ pre = Fear of Spider Questionnaire measured in the prescreening (range 18 – 126, higher scores indicating greater spider fear).

Primary analysis

Affective ratings

For an overview on all outcome variables, see Table 2. Visual inspection has found a violation of the assumption of normality of the residuals (Graph 1, Appendix B; Graph 2, Appendix B). This was not considered as problematic due to the large sample size of $n > 30$ per condition, in line with the central limit theorem (Field, 2018). A few outliers ($n = 8$) were indicated for the Spider CS variable for T0 and T2, but were kept in the final analysis (Graph 3, Appendix B; Graph 4, Appendix B). Outliers were based on standardized residuals ≥ 3 (Johnson & Wichern, 2007). Mauchly's Test of Sphericity was not relevant, since only one depended variable was used instead of more (Field, 2018). The Box's Test of Equality of Covariance Matrices (Box's M test) was not significant (Box's M = 2.49, $F(6, 529143.35) = 0.41$, $p = .88$), indicating that the assumption of equality of covariance matrices was not violated. Levene's Test of Equality of Error Variances (Levene's test) showed no significant differences in variance between the conditions at T0, $F(2, 148) = 0.62$, $p = .54$, and at T2, $F(2, 148) = 0.25$, p = .78. This suggests that the assumption of homogeneous variances was also not violated.

Valence ratings

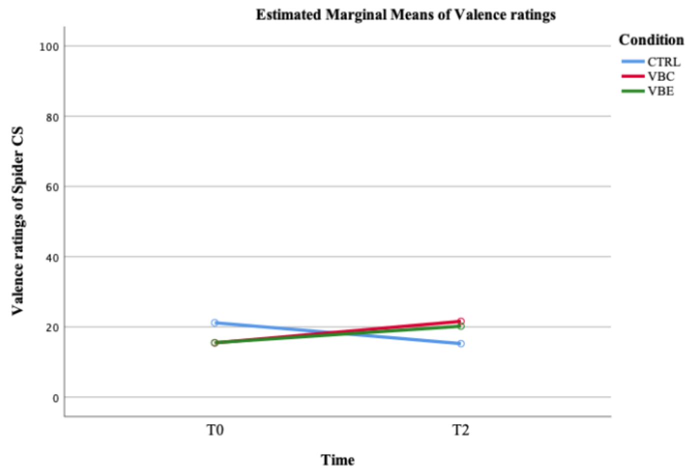
To examine the effects of the VBC, VBE, and CTL on valence ratings of spiders, a 3 (Condition) x 2 (Time) RM ANOVA was conducted on the VAS scores of the Spider CS. There was no significant main effect of Time, $F(1, 148) = 0.62$, $p = .43$, $\eta_p^2 = .004$. This indicates that valence ratings did not significantly change overall. Furthermore, there was no significant main effect of Condition, $F(2, 148) = 0.04$, $p = .97$, $\eta_p^2 < .001$, meaning that ratings did not differ significantly across conditions. However, there was a significant interaction effect between Time and Condition, $F(2, 148) = 3.46$, $p = .034$, $\eta_p^2 = .045$. This indicates that over time, valence ratings did significantly differ across conditions. For a visualization of the results, see Graph 1, which shows a divergent pattern between the intervention conditions (VBC and VBE) and CTL. This pattern likely accounts for the interaction effect that was found.

Post hoc paired sample t-tests were conducted to test for within-condition differences. The assumption of normality for the difference scores (T2 – T0) was met (Graph 5, Appendix B). The tests showed no significant difference between pre- and post-intervention for all conditions (CTL: ($t(50) = 1.65$, $p = .11$; VBE: $t(47) = -1.20$, $p = .24$; VBC: $t(51) = -1.91$, $p = .062$). Pairwise comparisons were conducted to test for between-condition differences at each time point and showed no significant differences (all comparisons $p > .05$). Thus, despite a significant interaction, no significant within- or between-condition differences were observed in post hoc analyses.

Since inspection of the data revealed eight outliers, a follow-up analysis was conducted excluding the outliers ($n = 143$). The follow-up showed the same pattern for the main- and interaction effect (Main of Time: $F(1, 140) = 0.07$, $p = .79$, $\eta_p^2 < .001$; Main of Condition: $F(2, 140) = 1.02$, $p = .36$, $\eta_p^2 = .014$; Interaction: $F(2, 140) = 6.99$, $p = .001$, $\eta_p^2 = .091$). For this reason, outliers were kept in the final analysis.

Graph 1

Average valence ratings of the spider CS by condition and time



Subjective distress ratings

To examine changes in subjective distress, two 3 (Condition) x 2 (Time) RM ANOVAs were conducted. Visual inspection showed a violation of normality of the residuals (Graph 6, Appendix B; Graph 7, Appendix B; Graph 10, Appendix B; Graph 11, Appendix B). This was not considered problematic, because of the large sample size per condition (Field, 2018). There were no outliers found (Graph 8, Appendix B; Graph 9, Appendix B; Graph 12, Appendix B; Graph 13, Appendix B). For both analyses, Mauchly's Test of Sphericity was not relevant, since only one depended variable was used instead of more (Field, 2018). The Box's M test was significant for both analyses (Analysis 1: Box's M: 111.53, $F(6, 529143.35) = 18.23$, $p < .001$; Analysis 2: Box's M: 113. 12, $F(6, 529143.35) = 18.48$, $p < .001$). This violation of the assumption of equality of covariance matrices was not considered problematic, due to the involvement of only one within-subjects factor and the usage of univariate F-tests rather than multivariate tests (Field, 2018). Additionally, multivariate tests (e.g., Pillai's Trace) showed the same results as the univariate test, confirming this. The homogeneity of variance assumption was also violated for both analyses, as shown by the significant Levene's tests (T0: *F*(2, 148) = 36.87, $p < .001$; T1a: *F*(2, 148) = 29.85, $p < .001$; T1b: *F*(2, 148) = 38.42, $p < .001$; T2: *F*(2, 148) = 31.08, $p < .001$). To address this violation, Welch's ANOVA was used to test the main effect of Condition, followed by Games-Howell and paired sample t tests. Both are more robust under unequal variances (Field, 2018).

T0 – T1a. There was no significant main effect of Time (*F*(1, 148 = 0.01, $p = .95$, $\eta_p^2 < .001$), and no significant interaction effect (*F*(2, 148) = 0.13, $p = .88$, $\eta_p^2 = .002$). This indicates there was not a significant difference between SUD scores reported at T0 and T1a, both independently of Condition and across all conditions. Welch's ANOVA showed significant differences between conditions at T0 (Welch's *F*(2, 77.73) = 484.39, $p < .001$), and at T1a (Welch's *F*(2, 77.84) = 438.77, $p < .001$). This indicates that before and after the intervention, there were significant group differences in SUD scores between the conditions. For a visualization of the results, see Graph 2, which shows the between-condition differences.

Post hoc Games-Howell tests revealed that at T0 and at T1a, both VBC and VBE conditions showed significantly higher SUD scores compared to CTL ($p < .001$ for all comparisons). However, there was no significant difference between VBC and VBE for both time points (T0: $p = .94$; T1a: $p = .99$). Paired sample t-tests were conducted to test for within-condition differences. The assumption of normality for the difference scores (SUD T1a – SUD T0) was met (Graph 14, Appendix B). In line with the non-significant interaction effect, there were no significant differences found for all three conditions (CTL: *t*(50) = -0.79, $p = .43$; VBC: *t*(51): 0.06, $p = .96$; VBE: *t*(47) = 0.31, $p = .76$).

T1b – T2. A significant main effect of Time was found (*F*(1, 148) = 8.14, $p = .005$, $\eta_p^2 = .052$). This indicates that participants reported less distress at T2 than at T1b. The interaction effect was not significant (*F*(2, 148) = 0.74, $p = .48$, $\eta_p^2 = .010$), suggesting that the main effect

Table 2

Mean and standard deviations per condition for the outcome variables

	VBC (*n* = 52)			VBE (*n* = 48)			CTL (*n* = 51)		
	T0	T1	T2	T0	T1	T2	T0	T1	T2
	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)	M (*SD*)
Spider CS	15.44 (15.64)	20.48 (20.16)	21.58 (17.62)	15.50 (17.85)	21.42 (16.90)	20.19 (17.74)	21.81 (17.38)	23.98 (19.83)	15.24 (19.27)
Spider 2	15.15 (15.68)	17.58 (17.85)	17.58 (17.85)	16.35 (16.00)	20.90 (18.66)	20.90 (18.66)	20.06 (17.21)	21.69 (17.70)	21.69 (17.70)
USs	70.91 (12.53)	68.07 (13.52)	68.07 (13.52)	69.87 (12.45)	67.87 (12.71)	67.87 (12.71)	70.02 (11.48)	68.48 (12.01)	68.48 (12.01)
Subjective fear	________	68.31 (22.73)	66.31 (22.73)	________	63.40 (29.20)	61.48 (29.02)	________	65.14 (23.74)	63.18 (23.63)
Mental BAT	________	3.69 (2.59)	3.29 (2.51)	________	3.88 (2.56)	4.50 (2.28)	________	4.16 (2.34)	3.96 (2.05)
SUD	68.96 (16.24)	A: 68.77 (16.99) B: 70.44 (17.85)	65.31 (19.87)	70.10 (18.23)	A: 68.92 (18.04) B: 66.81 (18.23)	64.54 (20.04)	10.10 (5.87)	A: 11.12 (6.03) B: 11.57 (5.39)	9.33 (6.67)
FSQ post	________	____________	72.92 (23.58)	________	____________	69.52 (25.33)	________	____________	70.84 (23.84)

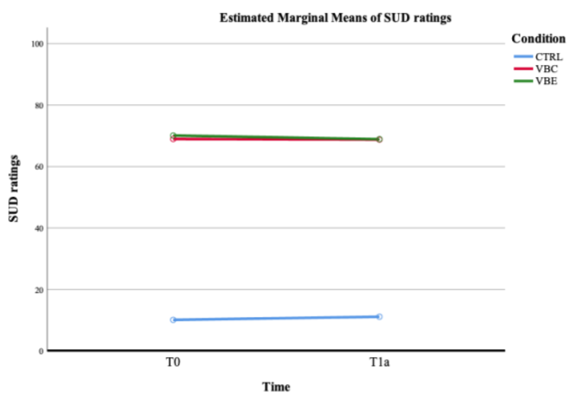
Note. Spider CS, Spider 2 (= generalization spider, not included in the manipulation), and USs (= mean valence of the 25 USs) rated on a VAS scale (*range*: 0 – 100, higher scores indicating more positive evaluations); Subjective fear = asked after the BAT, "Imagine that this spider walks over your hands, how fearful would you be?" (*range*: 0 – 100); Mental BAT (*range*: 0 – 8, higher scores indicating more engagement to the spider CS); SUD = Subjective Units of Distress (*range*: 0 – 100, higher scores indicating greater subjective distress); FSQ post = Fear of Spider Questionnaire measured at T2 (*range:* 18 – 126, higher scores indicating greater spider fear.

of Time occurred similarly across conditions. Welch's ANOVA showed significant differences between conditions at T1b (Welch's $F(2, 75.17) = 424.44$, $p < .001$) and at T2 (Welch's $F(2, 77.24) = 316.02$, $p < .001$). This indicates that before and after the intervention, there were significant group differences in SUD scores between the conditions. For a visualization of the results, see Graph 3, which shows the between-condition differences.

Post hoc Games-Howell tests revealed that VBC and VBE had significantly higher SUD scores than CTL ($p < .001$ for all comparisons). Both time points had no significant differences between VBC and VBE (T1b: $p = .58$; T2: $p = .98$). Paired sample t-tests were conducted to test for within-condition differences. The assumption of normality for the difference scores (SUD T2 – SUD T1b) was not met (Graph 15, Appendix B), but not problematic due to the large sample size (Field, 2018). No significant difference was observed in the VBE condition ($t(47) = 1.00$, $p = .32$). However, VBC and CTL did show significant differences in SUD scores (VBC: $t(51) = 2.18$, $p = .034$; CTL: $t(50) = 2.54$, $p = .014$). This indicates that participants in both conditions reported less distress at T2 than T1b. Although there were no differences across conditions at a statistically significant level, exploratory analyses do indicate that the main effect of Time might have been primarily driven by the VBC and CTL condition.

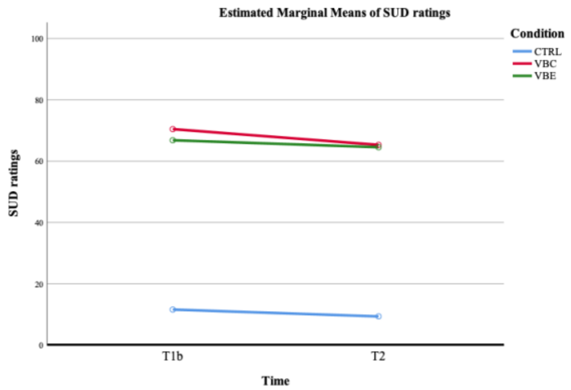
Graph 2

Average SUD ratings by condition and time (T0 – T1a)



Graph 3

Average SUD ratings by condition and time (T1b – T2)



Discussion

The present study tested whether very brief counterconditioning (VBC) is more effective than very brief exposure (VBE) and a control condition (CTL) in increasing valence ratings of spiders among women with spider fear. Additionally, the study examined whether subjective distress levels increased during either masked procedure. The results showed that spider valence ratings did not become more positive after VBC than after VBE or CTL (≠ hypothesis 1). Ratings also did not become more positive after VBE than after CTL (≠ hypothesis. Overall, there were no significant within- or between-condition differences in spider valence ratings, however, there was a significant interaction effect found. Finally, results showed that there was no evidence that VBC or VBE increased subjective distress (SUD) levels compared to CTL (= H3).

The current findings provide only limited support for previous research on VBE and VBC. While the series of studies by Siegel et al. (2009, 2011, 2012, 2018, 2020) continuously showed significant effects of VBE regarding altering fear-related behavior towards spiders, the present study did not observe any significant effects following VBE. Findings in the present study are more in line with findings from Frumento et al. (2021), who concluded that masked exposure techniques do not consistently alter the subjective valence of phobic stimuli.

Similarly, studies on evaluative counterconditioning (e.g., Baeyens et al., 1989; van Dis et al., 2019) have shown that pairing aversive stimuli with positive unconditioned stimuli (USs) leads to more positive evaluations of the conditioned stimulus (CS). However, this effect did not emerge in the VBC condition, despite using positively rated animal images as USs. These discrepancies may suggest that the effects of VBE and VBC on subjective evaluation may be less robust due to the masking or when only assessed via brief, single-session interventions. Another explanation might be that the used USs may not have evoked strong enough positive affective responses to create a new, more positive association with the CS. Finally, the present study does support earlier findings regarding SUD levels following a masked exposure procedure (Siegel et al., 2018).

One notable feature in the results was the presence of a significant Time x Condition interaction for valence ratings of spiders, without corresponding within- or between-condition differences. Specifically, Graph 1 suggests that while the intervention conditions (VBC and VBE) showed a slight increase in scores from pre- to post-intervention, and the CTL condition showed a slight decrease, none of these changes reached significance. These trends were in the expected direction, but too weak to produce any within-condition effects. However, the divergence in direction likely accounts for the observed interaction effect, suggesting it was driven by small, opposing shifts rather than by strong intervention effects. A follow-up question that arises is why CTL appeared to rate the spider slightly more negatively over time, despite not being exposed to any spider images during the experimental blocks. Although this trend was not statistically significant, one possible explanation is that their exposure to only positive animal images may have created an affective contrast, making the spider appear more negative by comparison. This idea is consistent with contrast effects in evaluative processing, where the presence of highly positive stimuli can shift the perception of neutral or negative stimuli in the opposite direction (Green et al., 2020).

Another striking finding was the large between-condition differences in SUD scores that were found at all time points. Notably, the baseline differences remained there regardless of the within-condition effects found between T1b and T2, as suggested by Graph 2 and 3. The differences were found between VBC/VBE and CTL, where CTL had significantly lower SUD scores than the intervention conditions. It is unlikely that this baseline difference is due to between-condition differences in spider fear, since there are no significant baseline differences in valence ratings of the spider (as shown by the non-significant pairwise comparisons) and similar prescreening scores on the Fear of Spider Questionnaire (FSQ). Another possible reason for this discrepancy may point to subtle experimenter effects, as experimenters were aware of the condition assignments. Prior research highlights how even minor behavioral cues or expectations from researchers can influence participants' subjective experiences (Rosenthal, 1966). This emphasizes the need for double-blind procedures in future studies to control for possible experimenter effects, especially when measuring self-reported distress.

Despite the absence of effects on valence ratings of spiders, the finding that neither VBC nor VBE increased SUD levels is of clinical importance. As mentioned earlier, this supports earlier work by Siegel et al. (2018), who showed that masked exposure can reduce fear responses without increasing physiological arousal or subjective distress. This feature may make masked interventions especially appealing to clients who are unwilling or unable to (further) engage in traditional exposure therapy due to high (anticipated) distress, like shown in earlier research (e.g., Davis III et al., 2012; Garcia-Palacios et al., 2007; Issakidis & Andrews, 2004; Siegel et al., 2018). Although the present study did not find direct effects of masked interventions like VBC or VBE on valence ratings of spiders, such interventions may still serve as helpful precursors to more intensive exposure-based treatments. By providing a less threatening and distressing form of initial exposure, masked interventions may help reduce early treatment avoidance and promote gradual engagement with feared stimuli. Future research could explore whether incorporating masked procedures into the early phases of exposure-based treatments helps buffer distress responses, lower treatment avoidance and improve overall treatment engagement.

This study has limitations. First, although SUD ratings were measured multiple times, they were assessed only immediately before and after each intervention block. As a result, it was not possible to draw conclusions about what happened during the intervention block. There might have been more fine-grained fluctuations in subjective distress throughout the intervention itself, such as those captured by continuous physiological measures like skin conductance (as used by Siegel et al., 2018). Second, the intervention consisted of only two short blocks. This might have caused a lack in power to detect stronger effects of the intervention. Longer or repeated sessions may be necessary to produce stronger effects and detect, if any, long-term effects of the intervention on fear-related behavior and valence ratings of spiders.

Conclusion

The goal of the current study was to compare the effects of masked counterconditioning and masked exposure on valence ratings of spiders, and to assess whether these interventions influence subjective distress levels. It did not find support for the hypothesis that masked counterconditioning leads to stronger increases in evaluations of phobic stimuli than masked exposure or a control condition. However, both masked interventions did not increase subjective distress, supporting their potential as low-intensity tools in clinical contexts. Masked procedures could be used early in exposure-based treatment to reduce avoidance and ease clients into more intensive exposure. Future research should investigate how to optimize these techniques, for instance through improved stimulus selection, double-blind designs, or increased intervention dosage to strengthen the impact.

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Appendix A

Mental Behavioral Approach Test

The steps used in the mental Behavioral Approach Test (BAT) are as follows:

0 = none of the above

1 = walk towards the spider as near as I can

2 = touch the jar

3 = open the jar

4 = take the jar in my hands

5 = touch the spider with a pencil

6 = hold the jar upside-down to put the spider in a washing bowl

7 = touch the spider with a finger

8 = let the spider walk over my hands

Funneled questionnaire

This questionnaire was administered at the end of the study to assess participants' awareness of the stimuli, task contingencies, and their engagement during the experiment.

Motivation Check

Did you fill out the questions seriously?

Demand Awareness

What is the purpose of this study, according to you?

Stimulus Awareness

When you were watching the computer screen, what do you remember happening?

Flash Perception Check (Condition-dependent)

In between the X and the black-and-white pattern presented on the screen, did you see something?

- If you were in the VBE condition:

☐ No ☐ A flash ☐ Something else

- If you were not in the VBE condition:

We don't mean the animal pictures that were presented after the black-and-white pattern.

☐ No ☐ A flash ☐ Something else

Flash Content Guess

Something was flashed on the screen between the X and black-and-white pattern. If you had to guess what the flash was, what would you say it was?

Flash Frequency Estimate

How many times did you see this?

Contingency Awareness

Is there anything else that you noticed with regard to order of these pictures?

☐ No ☐ Yes

Contingency Awareness - Detail

If Yes: What did you notice?

Incidental Spider Awareness

During the task you were exposed to pictures of spiders and bugs. How many spiders did you see?

Contingency Estimation

How many of the other animals were preceded by a spider picture do you think? Please indicate the percentage.

Confidence Rating

Please indicate how confident you are in your estimation:

Attention Check

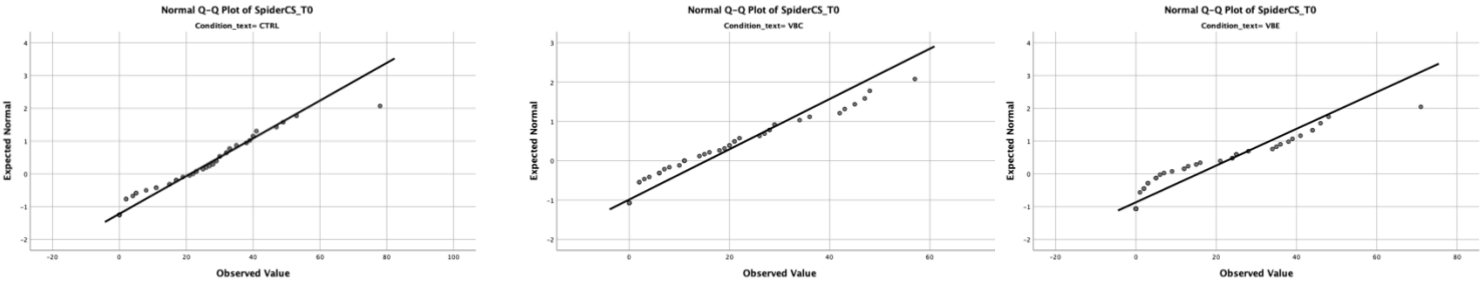
Did you pay attention to the screen during the entire computer task? If you didn't (e.g., looked away purposefully), please select 'no' below.

☐ Yes ☐ No

Appendix B

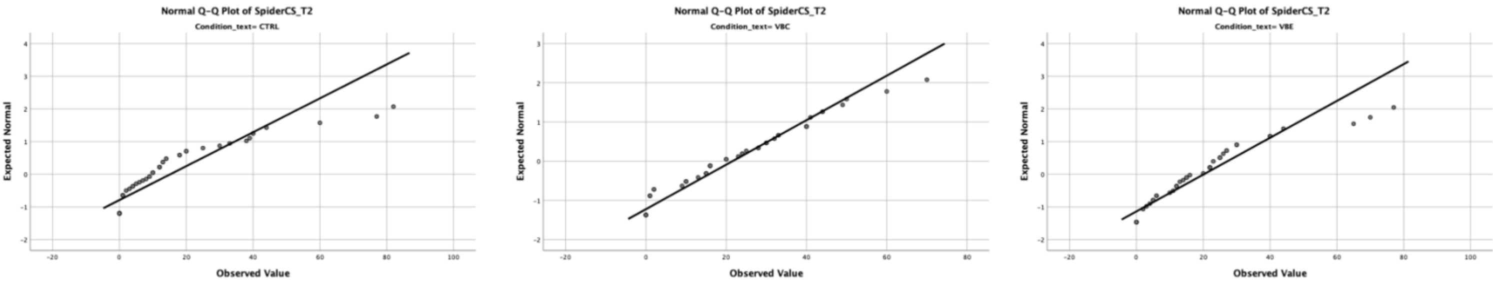
Graph 1

Q-Q plots for spider CS at T0 per condition



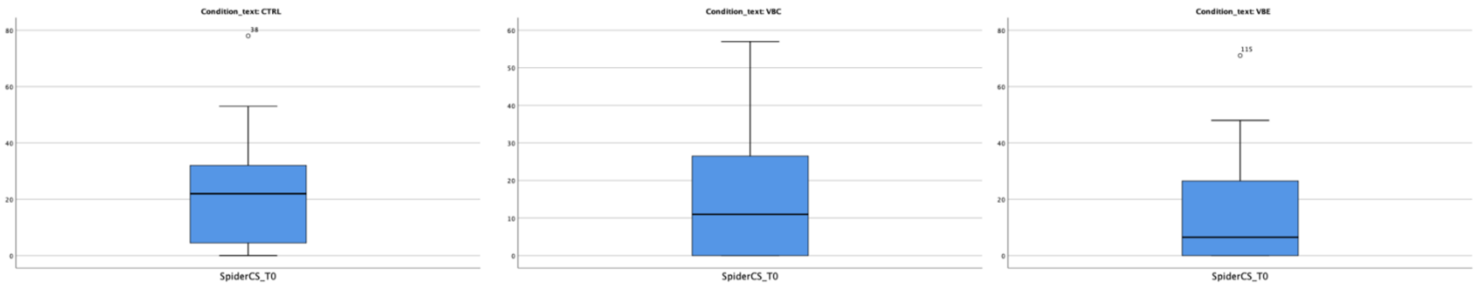
Graph 2

Q-Q plots for spider CS at T2 per condition



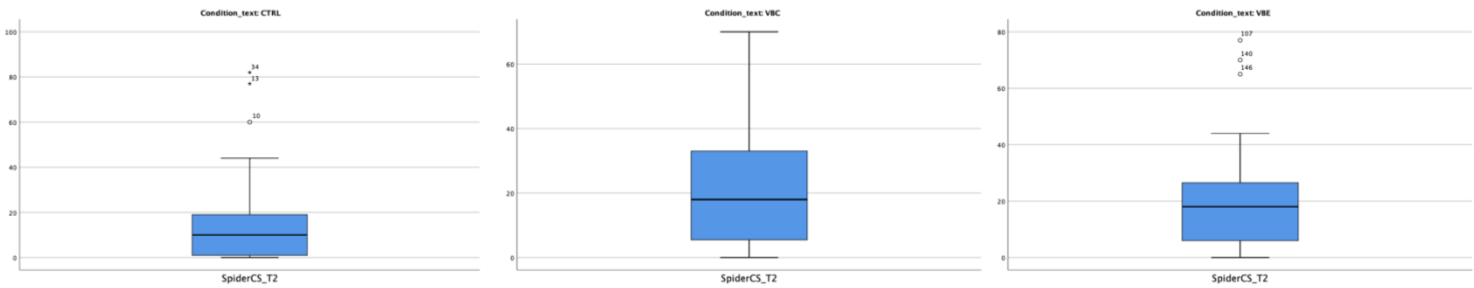
Graph 3

Box plots for spider CS at T0 per condition



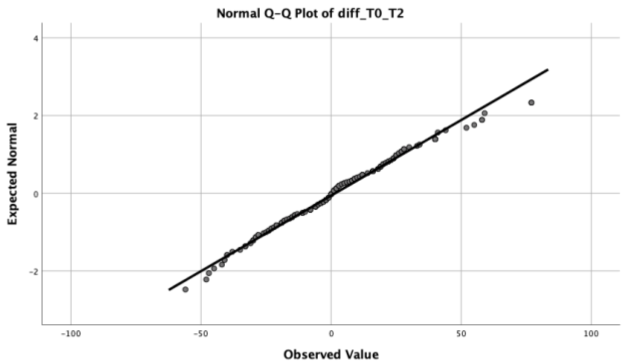
Graph 4

Box plots for spider CS at T2 per condition



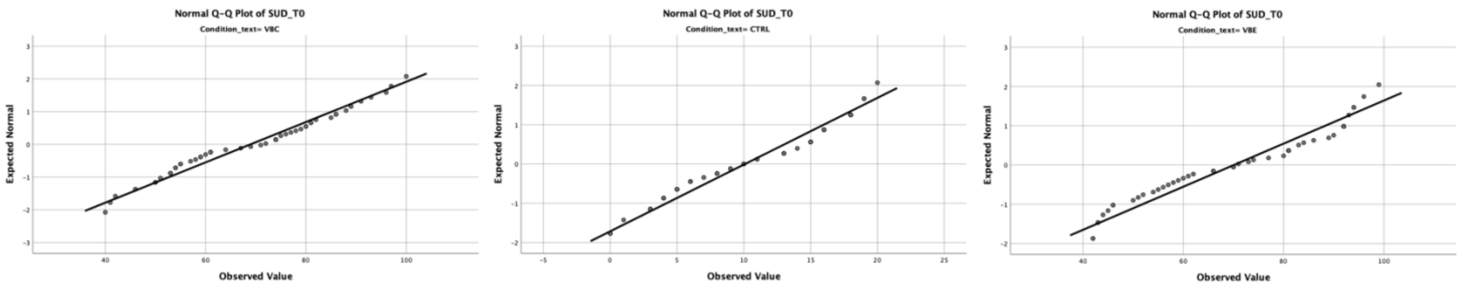
Graph 5

Q-Q plot for difference score between spider CS T2 – spider CS T0



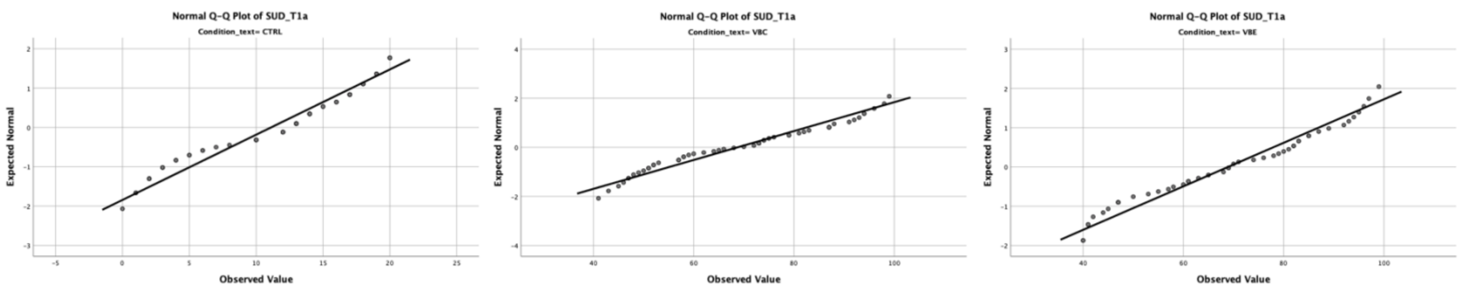
Graph 6

Q-Q plots for SUD at T0 per condition



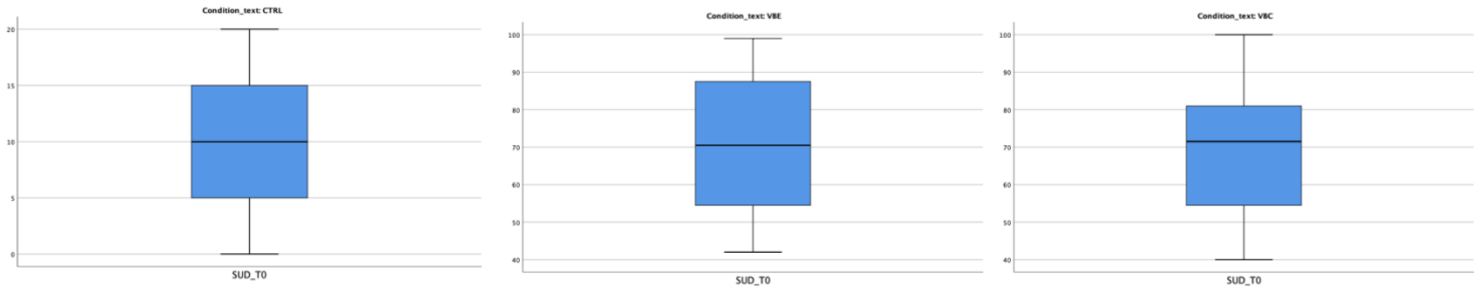
Graph 7

Q-Q plots for SUD at T1a per condition



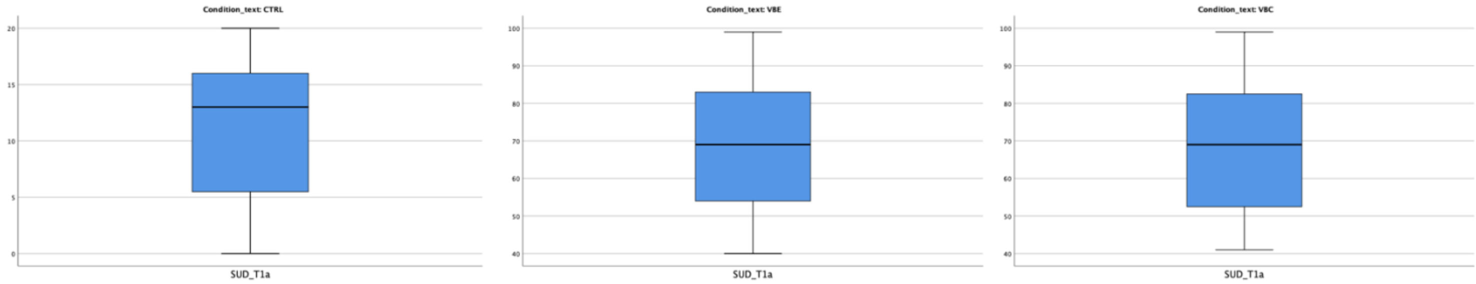
Graph 8

Box plots for SUD at T0 per condition



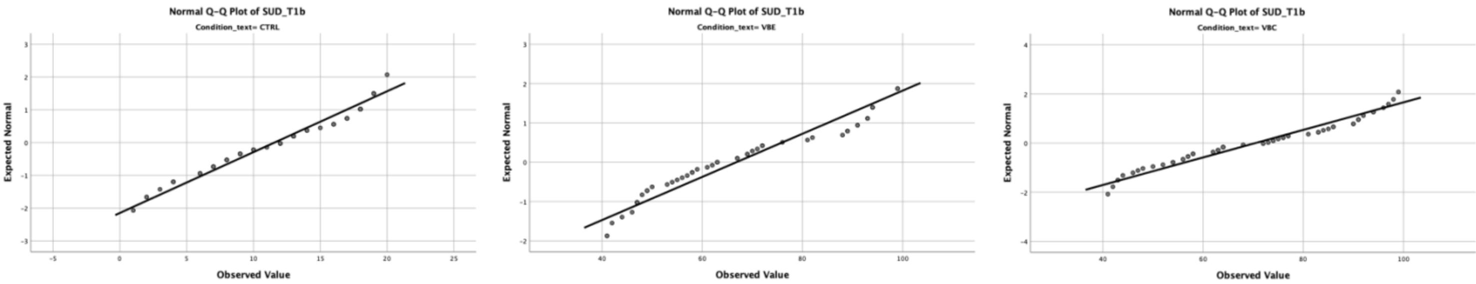
Graph 9

Box plots for SUD at T1a per condition



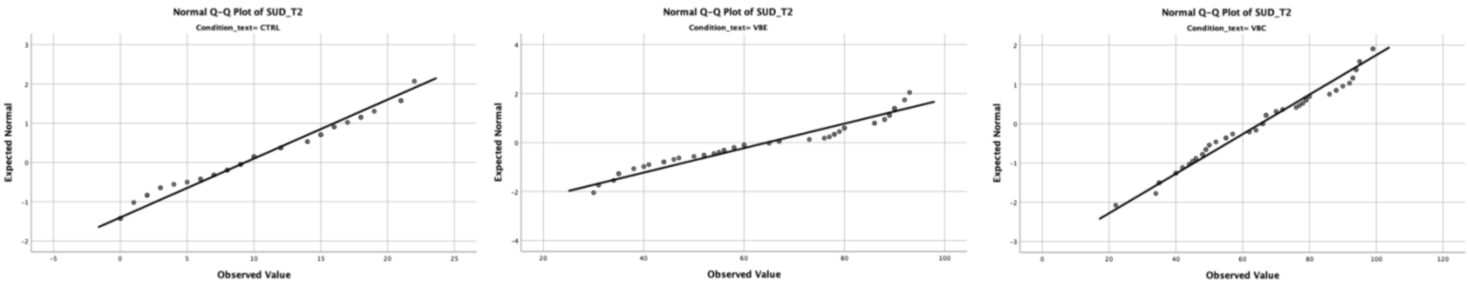
Graph 10

Q-Q plots for SUD at T1b per condition



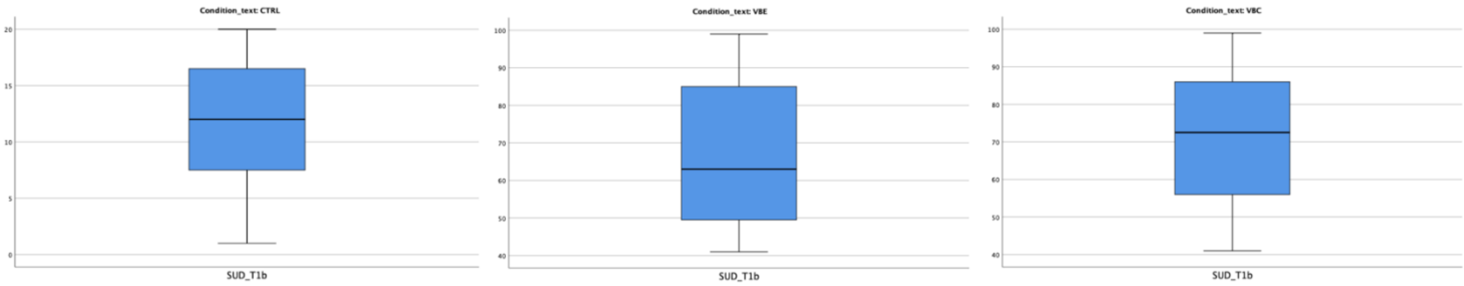
Graph 11

Q-Q plots for SUD at T2 per condition



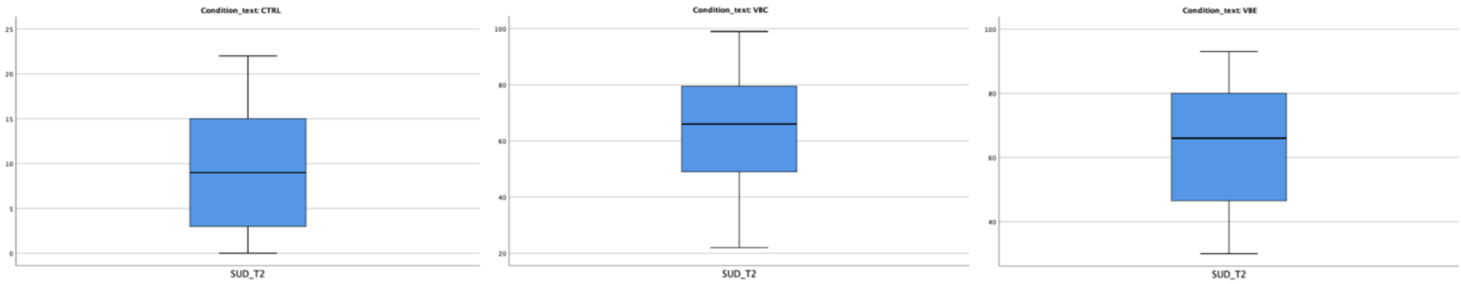
Graph 12

Box plots for SUD at T1b



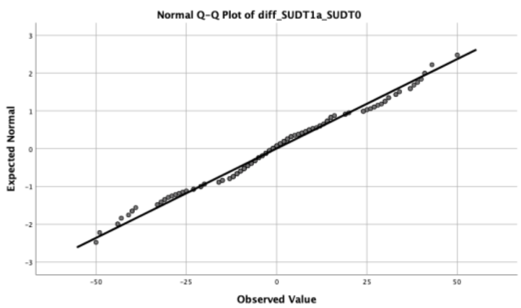
Graph 13

Box plots for SUD at T2



Graph 14

Q-Q plot for difference score between SUD T1a – SUD T0



Graph 15

Q-Q plot for difference score between SUD T2 – SUD T1b