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High Spider Fearfuls can Overcome their Fear in a Virtual Approach-Avoidance Conflict Task

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Abstract

Spider-fearful persons are more reluctant to approach spiders and, if possible, tend to avoid their feared animal. These behavioural tendencies play a major role in the maintenance of their phobia. The present study is the first to motivate spider fearfuls approaching spiders in an approach-avoidance conflict. This was accomplished by using a virtual reality paradigm in which the participants had the choice between a safe, low rewarding, stimulus and a conflict symbol that signaled the occurrence of a high reward (80% of the trials) or a spider (20% of the trials). The results indicate that the virtual spider was capable of eliciting a strong fear response and that spider fearfuls can overcome their avoidance tendency in favour of a goal-directed approach response. Though no direct relation was observed between approach behaviour and a reduction in fear, spider fearfuls did report less spider fear, tension and disgust after the task. These results are promising for development of new treatment options for specific phobias.

Keywords: Anxiety; Approach-avoidance conflicts; Spider fear; Virtual reality

Highlights

- Spider fearfuls avoid the feared animal
- Avoidance hinders processing of alternative information
- Approach-avoidance conflicts can help to conquer avoidance
- Indeed, spider fearfuls can overcome their fear
- A reduction in fear, tension and disgust was observed

Introduction

Fear and anxiety are normal protective reactions to (potentially) threatening or harmful stimuli. Detection of these stimuli activates cognitive, affective, physiological, and behavioural processes that foster survival. However, in case of a specific phobia, these processes are over-activated and no longer adaptive, hindering daily functioning. Persons with specific phobias are usually aware of their unreasonable fear and tend to avoid the feared object or situation excessively [1]. This avoidance behaviour can help to reduce anxious mood states of a patient by minimizing encounters of the dreaded object or situation. However, avoidance is considered as a major factor in the maintenance of phobias as it hinders habituation or adequate processing of fear-related stimuli [2,3].

Though avoiding spiders might seem beneficial for persons with spider phobia, they do often experience approach-avoidance conflicts. In other words, they experience opposite and competing motivations for approaching and avoiding stimuli or situations [4]. For example, a spider-fearful person might want to retrieve his bicycle out of the basement, a place where he has previously encountered a spider. Depending on the goal to get the bike, for example, to get in time for a job interview or to do some groceries, this conflict might be resolved by either approaching or avoiding the basement. Experimental research on spider fear has mainly focused on avoidance of the feared animal by, for example, using a behaviour avoidance test with real spiders [5-7], with virtual spiders [8], or by measuring avoidance of pictorial spider material [9]. Approach-avoidance conflicts in spider-fearful persons have received considerably less attention. The studies that did measure the incompatibility of approach and avoidance responses concerned computerised tasks. In these tasks, participants were instructed to "approach" certain picture frames and to "avoid" alternative frames by pulling or pushing a joystick, respectively. The approach response increased the size of the picture, whereas avoidance led to a decrease in size. Results of these studies indicated that, even though the picture content was task-irrelevant, spider-fearful persons were more prone to avoid than approach spider pictures [10,11]

The aforementioned studies indicate that spider-fearful persons are more reluctant to approach spiders and, if possible, tend to avoid them. However, in case the motivation to obtain a certain goal is high enough, individuals with spider phobia can overcome their fear (see for a model of approach-avoidance motivation) [12]. For example, their motivation to change enables them to face their fears in (exposure) therapy and fear-reduction does occur. Even more, motivation can be a significant predictor for treatment outcome in spider phobia [13]. However, to our knowledge, no experimental study has explicitly induced a motivational conflict in spider-fearful persons. As spider-fearful persons often do experience these conflicts, and sometimes are motivated to overcome their fear, it is highly important to further asses this topic. Especially, as motivation of approaching rather than avoiding spiders results in exposure, which in turn might reduce spider fear. Therefore, the first aim of the present study is to develop a paradigm that can motivate spider-fearful persons to approach spiders in approach-avoidance conflict situations. A highly suitable technique for developing such paradigm is virtual reality (VR). VR allows control over reinforcement schedules, the spiders and the environment and can induce behavioural and physiological fear responses that are equal to responses to real spiders [8].

The second aim of the present study is to assess whether approaching the spider during the approach-avoidance conflict will result in a diminishment of spider fear. As mentioned before, avoidance of spiders is an important factor in the maintenance of spider fear as it hinders extinction of the fear responses [14,15]. Inducing an approach-avoidance conflict might help to overcome avoidance responses and, thereby, help to extinguish spider fear.

Based on previous studies, it is expected that high levels of spider fear will coincide with high levels of self-reported fear and more avoidance/less approach behaviour of a virtual spider [8,16]. Furthermore, we expect that motivation can result in approach of the virtual spider. In case participants do overcome the conflict situation and approach the virtual spider, it is expected that this will result in a diminished spider-fear response due to (self)-exposure [6].

The results of the present study are important. Not only because they contribute to the sparse literature on motivation and approach-avoidance conflicts in spider-fearful persons, but also as they might provide insight in mechanisms that contribute to the diminishment of spider fear.

Method

Participants

Participants were recruited via a mass screening and through advertisements at the university billboards. A large group of first-year psychology students (n=174) received, among other questionnaires, a shortened version of the Spider Phobia Questionnaire (SPQ) to reduce the experimental load for the participants. Ten items were selected to get a general impression of their spider fear level, with a score range of 0 (no fear) to 10 (high fear). Persons with a high level of spider fear (score 5, top 20%) and a low level of spider fear (score=0, bottom 30%) were invited to participate. In the advertisements, we explicitly requested spider fearful participants, as this group was more difficult to recruit. A total of 44 persons, 37 females and 7 males, with a mean age of 20.41 years (SD=1.99 years) participated. Participation was rewarded with either course credit or a voucher of 7.50 €. The experiment was approved by the Ethical Committee Psychology at Maastricht University (approval code: ECP-118) and carried out in accordance with the International Ethical Guidelines and Declaration of Helsinki [17].

Materials

Virtual Reality (VR): The VR lab of the University of Maastricht is a room of 6 by 4 meters equipped with 16 speakers and cameras that are part of the highly accurate Phasespace tracking system (http://www.phasespace.com/). Participants can walk freely wearing a backpack with a laptop and a head mounted display (HMD, Nvis ST-50) that provides a 3D stereoscopic view. The virtual environment automatically adjusts to the head motions and the orientation of the participant. The task was programmed in Python (via Vizard, http://www.worldviz.com/), graphical content was made with Blender 3D (www.blender.org) and 3Ds Max (Motionbuilder, http://www.autodesk.com/).

Stimuli: Three different geometric symbols were used, each indicating a specific outcome schedule (counterbalanced; see Table 1 for an overview of the outcome schedules): a yellow circle (20 cm), an orange square (10 × 10 cm), and a blue triangle (base × height, 10 × 10 cm). A symbol (S) could predict either (1) the occurrence of a virtual tarantula (10 cm, 100%) and no coins (no reward, S0), (2), a continuous (100%) reinforcement schedule of 1 virtual coin (small reward, S1) and no spiders or (3) a combination of 5 coins on 80% of the trials (large reward, S5) or a spider (tarantula, about 10 cm) on the remaining 20% of the trials. Note that the combination of high reward (5 coins, 80%) and spider (20%), S5, was used to induce an approach-avoidance conflict and motivate approach behaviour; a safe alternative was to select S1 (always 1 coin, never a spider).

Symbol	One coin	Five coins	Spider
S0	0%	0%	100%
S1	100%	0%	0%
S5	0%	80%	20%
Note: Each cell presents the percentage of trials of the specific symbol outcome combination			

Table 1: Overview reinforcement schedules and symbols.

Questionnaires and measures: Spider Phobia Questionnaire (SPQ). The SPQ is a 31-item questionnaire composed of yes-no questions about three categories of spider fear: vigilance, preoccupation, and avoidance of spiders [18]. The score can range from 0 to 31, with higher scores representing more self-reported spider fear. The Dutch version, used for the present study, has an adequate test-retest stability (correlation of 0.94) and internal consistency with a Cronbach's alpha of 0.91 [19]. Cronbach's alpha in the present study was 0.92.

Fear of Spiders Questionnaire (FSQ): The FSQ is an 18-item self-report instrument that measures fear of spiders [20]. Scores range between 18 and 126, with higher scores reflecting higher levels of spider fear. The Dutch version, used for the present study, has an adequate test-retest reliability (correlation of 0.91) and an internal consistency ranging between 0.95 and 0.97 [19]. Cronbach's alpha in the present study was 0.97.

Subjective Units of Distress Scales (SUD): The SUDs used for the present study comprised an oral report to the experimenter of the amount of fear, tension, and disgust at various points during the study. The scores could range from 0, indicating no fear, tension or disgust at all, to 100 indicating extreme fear, tension or disgust.

Stimulus Questionnaire (SQ): The SQ was explicitly designed for the current experiment and was composed of three parts. The first part consisted of a blank version of Table 1 to assess contingency awareness. The second part examined the valence and perceived safety of each symbol via 100 mm visual analogue scales (VASs). In part three, the reinforcement value of the coins, valence of the spider, difficulty of the task, and amount of effort were assessed via VASs.

Presence Questionnaire (PQ): The PQ was adopted from a list that was used during a virtual reality spider exposure study [7]. The PQ consisted of five questions, one question concerning experienced nausea, three concerning the VR environment (e.g., How real did the environment seem to you?) and one question concerned the spider (i.e., How real did the virtual spider seem to you?). Participants rated their answers using 100 mm VASs. The three environmental questions were averaged, leaving the PQ with three scores (nausea, environment, and spider).

Virtual Reality Behavioural Avoidance Test (VR-BAT): The behavioural avoidance test (BAT) is a generally used objective measure to assess spider fear [8]. Participants are asked to walk as close as they can to a caged spider. At the closest distance the level of fear, tension, and disgust are measured. This level can range from 0 (no fear at all) to 100 (panic-level of fear) using subjective units of discomfort scales (SUDs). Likewise, a virtual reality spider scenario avoidance test (VR-BAT) can be used for spider fear assessment [8].

Procedure

After entering the room, the participant received written information about the general experimental procedure and was asked to sign an informed consent. Next, the full version of the SPQ and FSQ were presented. Subsequently, the participant was equipped with the laptop and HMD. The experiment consisted of four phases: (1) a baseline measure, (2) the first approach test (VR-BAT#1), (3) the approach-avoidance task (AAT), and (4) a second approach test (VR-BAT#2).

Baseline: The baseline task was introduced to familiarise participants with moving around in a virtual environment, in this case a virtual room. In this room, a white table was placed containing a note with a code. The participant entered the room through a door and was asked to walk around and to read the code on the table aloud. On request of the participant the next phase was started.

VR-BAT#1: The same room as during the baseline was used. The starting point was identical as during the baseline phase, however this time the table did not contain a note, but a glass cage with a (virtual) crawling tarantula. The participant was asked to approach the virtual spider as close as possible and to orally report their level of fear, tension, and disgust (SUDs) to the experimenter. Additionally, the distance to the spider and duration to the final approach distance were measured.

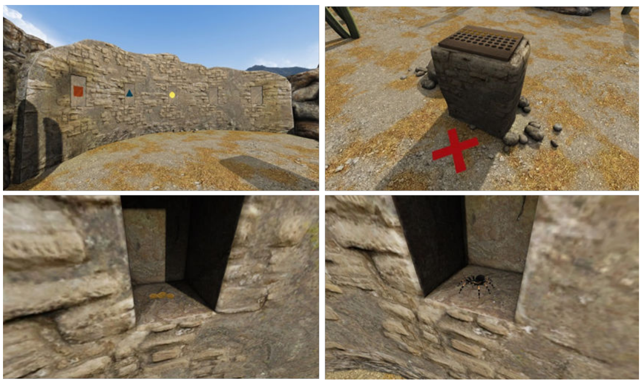

Figure 1: Screenshot from the approach-avoidance task. The left top panel depicts the ruins with the five cavities. The right top panel depicts the shrine and the wooden cupboard in which the coins are collected. The red X depicts the starting point of each trial. The left lower panel depicts a cavity with high reward (five coins). The right lower panel depicts a cavity with the tarantula.

Approach-avoidance task: Next, the approach-avoidance task, AAT, was presented (Figure 1). A virtual desert with a shrine and ruins was displayed. Starting point of each trial was marked by a red X on the ground in front of the shrine. The ruins contained five closed cavities; three cavities were marked by one of the three symbols (order varied across trials). On the other two cavities, no symbol was presented. The goal for the participant was to gather 50 coins as quick as possible. Participants were told to pay attention to the symbols as these symbols could help them to find coins. In case the participant approached one of the five cavities, the door would automatically open and the contents of the cavity were displayed. To start a new trial the participant had to return to the X-mark in front of the shrine. The coins earned were placed on the shrine in a wooden cupboard holding 50 holes. Two dummy trials were introduced to practice the experimental procedure (no symbols, no outcomes). Note that the first two visits to S5 always resulted in 5 coins to ensure that each participant experienced the large reward to motivate approach behaviour. After reaching the goal of earning 50 (or more) coins was reached, the AAT automatically ended. Both approach time and stimulus selection were recorded.

VR-BAT#2: During the last phase the VR-BAT was repeated (see above, VR-BAT#1), SUDs were collected and the SQ was filled out.

Results

Missing values and statistical analyses

The data of one participant (low-fearful group: female, 21 years) were discarded due to technical equipment problems. One person never selected S1, resulting in a missing value for S1 approach time. For the symbols, the proportion of each selected symbol was calculated (trials of specific symbol divided by total number of trials). The mean scores of the high-fearful group on the SPQ and FSQ were 16.91 (SD=3.85) and 64.14 (SD=18.23), respectively. For the low-fearful group the mean SPQ score was 4.67 (SD=2.97) and the mean FSQ score 8.48 (SD=6.17). Note that using a median split of the SPQ and FSQ scores resulted in the same (preselected) high- and low-fearful groups.

	VR-BAT#1		VR-BAT#2	
Group	**Low-fearful**	**High-fearful**	**Low-fearful**	**High-fearful**
Meters	0.15 (0.12)	0.52 (0.29)	0.11 (0.12)	0.24 (0.25)
Seconds	59.50 (10.17)	70.45 (11.47)	40.38 (8.77)	49.70 (11.90)
Fear	5.67 (7.73)	52.05 (22.40)	2.52 (5.03)	42.95 (26.44)
Tension	12.43 (15.34)	61.91 (21.02)	6.10 (9.49)	48.64 (25.74)
Disgust	14.29 (17.20)	68.41 (21.29)	8.48 (10.14)	56.36 (24.26)

Table 2: Mean VR-BAT#1 and VR-BAT#2 results (+SDs) for the high- and low-fearful group.

The questionnaire and VAS data were analysed parametrically. Bonferroni Holm corrections were made in case of multiple or pairwise comparisons. If sphericity assumptions were violated, Greenhouse-Geisser corrections were made. The rejection criterion was set at $p<0.05$.

VR-BAT#1

Table 2 displays the data of VR-BAT#1. An ANOVA was carried out with the measures on the first VR-BAT (distance in meters, time in seconds, SUDS: anxiety, tension, and disgust) as dependent variables and high- and low-fearful group as factor.

This analyses revealed group differences on all VR-BAT#1 measures, Fs(1, 41)>10.93, ps<0.005, $\eta\rho^2>0.21$. Compared to low spider-fearful group, the high-fearful group kept a larger distance to the spider, they approached the spider slower, and reported more anxiety, tension and disgust.

Approach-Avoidance Task (AAT)

Symbol selection: The data of the AAT can be found in Table 3. A General Linear Model (GLM) repeated measures was carried out with proportion of each symbol (S0, S1, and S5) as within-subjects factor and group (high- and low-fearful) as between-subjects factor.

This analysis revealed a significant main effect of symbol, F(2, 82)=197.60, p<0.001, $\eta\rho^2=0.83$, but no significant main effect of group or symbol x group interaction, Fs<1.24, ps>0.28, $\eta\rho^2<0.030$. Pairwise comparisons revealed the following selection order: S5>S1>S0, all ps<0.001.

	Low spider fear		High spider fear	
Symbol	**Proportion**	**Seconds**	**Proportion**	**Seconds**
S0	0.13 (0.058)	2.19 (1.19)	0.13 (0.062)	2.40 (0.67)
S1	0.18 (0.11)	1.89 (0.54)	0.22 (0.13)	2.36 (0.66)
S5	0.69 (0.14)	1.83 (0.55)	0.64 (0.15)	2.20 (0.54)

Table 3: Mean (SD) Symbol Selection and Approach Time for High- and Low Spider Fearfuls (median split FSQ) during the Approach-Avoidance Task

Approach time: A similar GLM repeated measures was run for the approach time (see Table 3). This analysis revealed a significant effect of symbol, F(2, 80)=4.05, p<0.05, $\eta\rho^2=0.092$, and a marginally significant effect of group, F(1, 40)=3.30, p=0.077, $\eta\rho^2=0.076$. No significant interaction effect was observed, F<1. Pairwise comparisons revealed that S5 was approached faster than S0, p<0.05. No other differences were observed, ps>0.11.

Separate ANOVAs revealed that the approach time for the symbols followed by reward, S1 and S5, was faster in the low-fearful group, Fs(1, 41)>4.33, ps<0.05, $\eta\rho^2>0.095$, compared to the high-fearful group. No group differences were observed for S0, F< 1.

VR-BAT#2

The VR-BAT#2 results are listed in Table 2. Linear stepwise regressions were carried out in order to examine if task performance during the AAT could predict VR-BAT#2 performance. In these analyses, the proportion of each symbol (S0, S1, and S5) and the approach time to each symbol were entered as predictors and the measures on the second VR-BAT (distance, time, SUD: anxiety, tension, and disgust) served as dependent variables.

A significant model emerged for all analyses, Fs>4.73, ps<0.036, with exception of the SUD tension score, Fs>3.65, ps>0.063. An overview of the significant predictors and the explained variation can be found in Table 4. These data indicate that only the approach time to symbol S5 is a valid predictor for VR-BAT#2 performance. Slower approach of S5 during the AAT was related to a larger distance, slower approach time to the virtual spider and higher levels of self-reported fear and disgust during VR-BAT#2. However, the amount of explained variance is low (less than 17%).

Change in VR-BAT performance

GLM repeated measures were carried out to assess changes in VR-BAT performance (distance, duration, SUD: fear, tension, and disgust) with VR-BAT moment as within-subjects factor (before and after AAT) and group as between-subjects factor. These analyses revealed that at VR-BAT#2 participants approached the spider closer, F(1, 41)=8.33, p<0.01, $\eta\rho^2=0.17$, but that in general spider fearfuls kept a larger distance, F(1, 41)=32.49, p<0.001, $\eta\rho^2=0.44$. No interaction was observed, F(1, 41)=1.29, p=0.26, $\eta\rho^2=0.031$. A similar pattern was observed for approach time with faster approach during VR-BAT#2 compared to VR-BAT#1, F(1, 41)=183.09, p<0.001, $\eta\rho^2=0.82$, and an overall slower approach time for the fearful group, F(1, 41)=12.17, p<0.005, $\eta\rho^2=0.23$, but no time × group interaction, F<1. Importantly, separate GLMs revealed that this decrease in distance and approach time was visible in both the low- and high-fearful group, Fs>4.83, ps<0.05, $\eta\rho^2>0.18$.

Variable	Mean (SD)	Pred.	Adjusted R2	B	SE B	Β	r	p
Meters	0.28 (0.26)	S5AT	0.140	-0.088	0.139	0.402	0.402	0.008
Seconds	45.15 (11.39)	S5AT	0.173	8.288	6.003	0.416	0.416	0.006
Fear	23.21 (27.93)	S5AT	0.144	18.713	7.202	0.380	0.380	0.013
Tension	27.86 (28.93)	--	--	--	--	--	--	--
Disgust	32.98 (30.49)	S5AT	0.084	17.378	7.984	.325	.325	.035
Note. S5AT: Approach time to symbol S5								

Table 4: Significant predictors from the AAT for the variables measured during VR-BAT#2

For the SUD scores a decrease in fear, F(1, 41)=7.88, p<0.01, $\eta\rho^2=0.16$, tension, F(1, 41)=19.74, p<0.001, $\eta\rho^2=0.33$, and disgust, F(1. 41)=24.14, p<0.001, $\eta\rho^2=0.37$, was observed. In all analyses the high-fearful group displayed higher scores, Fs(1, 41)>73.02, ps<0.001, $\eta\rho^2>0.64$, than the low-fearful group. No significant interactions emerged, Fs< 2.99, ps>0.093, $\eta\rho^2<0.067$. Separate GLMs for each group indicated that the decrease in fear, tension and disgust was visible in both high- and low-fearfuls, Fs>4.69, ps<0.05, $\eta\rho^2$>0.18.

Stimulus Questionnaire (SQ): stimulus ratings and contingencies

Table 5 gives an overview of the mean ratings of the stimuli used during the AAT. Two GLM repeated measures with stimulus ratings of the symbols (pleasantness or safety) as within-subjects factor and groups as between-subjects factor were carried out. These analyses revealed a main effect of symbol, Fs(2, 82)>18.39, ps<0.001, $\eta\rho^2$>.31, and a main effect of group, Fs(1, 41)>5.62, ps<0.03, $\eta\rho^2$>0.12. No interaction effects were observed, Fs<1.09, ps>0.34.

Symbol	Low spider fear	High spider fear
S0 Pleasant	45.81 (29.62)	24.82 (30.85)
Safe	46.67 (33.30)	23.95 (31.43)
S1 Pleasant	65.90 (29.67)	61.73 (30.52)
Safe	80.48 (24.29)	70.05 (31.99)
S5 Pleasant	73.95 (22.20)	59.91 (25.55)
Safe	64.71 (26.01)	57.86 (24.60)
Spider		
Scary	13.38 (17.99)	62.45 (27.84)
Fear	6.81 (9.21)	61.64 (27.56)
Disgust	26.57 (30.55)	73.41 (24.81)

Table 5: Mean Ratings (SD) of the Stimuli used during the Approach-Avoidance Task for High- and low spider fearfulls.

Pleasantness could be ordered as follows: S5=S1>S0 (p=0.63 and ps<0.001, respectively); safety as S1>S5>S0 (ps<0.02). Overall the persons in the high-fearful group gave lower pleasantness and safety ratings than the persons in the low-fearful group.

An ANOVA indicated that the high-fearful group rated the virtual spider as more scary, F(1, 41)=46.63, p<0.001, $\eta\rho^2$=0.53, fear-evoking, F(1,41)=75.06, p<0.001, $\eta\rho^2$=0.65, and disgusting F(1,41)=30.59, p<0.001, $\eta\rho^2$=0.43, compared to the low-fearful group.

Concerning the task experience (difficulty, effort and reinforcement), only an effect of difficulty was observed, F(1,41)=8.72, p<0.01, $\eta\rho^2$=0.18. No other group differences were detected, Fs(1,41)<1.36, ps>0.24, $\eta\rho^2$<0.032. Overall the spider fearfuls found the task more difficult than the non-fearfuls.

Finally, no differences concerning the contingencies reported were observed, Fs(1, 42)<1.84, ps>0.18, $\eta\rho^2$<0.043.

Presence Questionnaire

The amount of experienced nausea through the VR experience was low (low fearful: M=17.05, SD=24.83; high fearful: M=27.73, SD=26.81) and did not differ between the groups, F(1, 41)=1.81, p=0.18, $\eta\rho^2$=0.043. Regarding the spider, the high-fearful group experienced the spider to be more realistic (M=53.23, SD=25.54) compared to the low-fearful group (M=35.19, SD=21.35), F(1,41)=6.28, p<0.05, $\eta\rho^2$=0.13. For the environment presence, no difference was observed between the two groups (low fearful: M=46.53, SD=22.57; high fearful: M=53.88, SD=16.16).

Discussion

A specific phobia is characterised as an unreasonable fear and avoidance of a specific object or situation. Although research on avoidance behaviour is crucial for the understanding of the aetiology and maintenance of phobias, it only recently regained attention [21]. In the present paper, we are particular interested if spider fearfuls can be motivated to overcome approach-avoidance conflicts (i.e., achieving a goal versus avoiding the spider).

As outlined previously, the aim of the current experiment was twofold. Our first aim was to develop a paradigm that can motivate spider-fearful persons to approach spiders in an approach-avoidance conflict situation. This approach-avoidance conflict was induced by using a virtual reality paradigm in which participants were presented with the choice between three symbols each representing a specific reinforcement schedule: (1) 100% a tarantula (S0, zero coins); (2) 100% one coin (safe symbol with a low reward, S1); or (3) 80% 5 coins (high reward) and 20% a spider (S5, conflict symbol).

Highly important, the virtual spider was able to elicit strong fear responses in the spider-fearful participants: high spider fearfuls, compared to low spider fearfuls, showed significantly larger approach distances, longer approach durations, and reported more fear, tension, and disgust on the first virtual Behaviour Approach Test (VR-BAT#1). Hence, the virtual spider was a truly aversive and fearful stimulus and triggered similar behavioural responses in spider-fearful persons as observed when encountering a real spider [15,16], which is crucial to install a conflict between approach and avoidance behaviour.

The data of the Approach-Avoidance Task (AAT) indicated that both the high- and low-fearful group preferred the S5 symbol (conflict, high reward and spider) over the S1 symbol (safety, low reward). This indicates that spider-fearful persons can be motivated to approach spiders even if they risk encountering a (virtual) spider. These results are in line with the general conception that fearful individuals can overcome avoidance behaviour, if the fearful object is clearly juxtaposed with behavioural reinforcements and effort reduction, even when the object is obviously distressing (i.e., counterconditioning) [22].

Looking at the approach time, we do see differences between the high- and low-fearful persons. That is, persons with higher levels of spider fear were more reluctant to approach S1 and S5 than persons with lower levels of spider fear. This was not due to a general slower approach time as no differences were observed for S0. These results are in line with previous research, in which spider-fearful persons are slower in approaching spider-related material [11].

From a theoretical point of view, this lack of a difference in symbol selection comes as no surprise. According to a traditional decision behaviour approach, the tendencies to approach or avoid a goal vary directly with the strength of the drive upon which they are based. In case of a conflict, the stronger response tendency will occur [23]. In the present study, participants received a large reward for approach behaviour. This reward might have influenced the drive or motivation of the spider fearfuls, resulting in approach of S5 although, at a slower pace.

The second aim of the current study was to assess whether approaching the spider during the approach-avoidance conflict results in a diminishment of spider fear. Substantial research has already shown that virtual reality exposure therapy is highly effective in treating spider phobia. In our experiment both low- and high-fearful participants were significantly faster in approaching the spider, dared to approach the spider closer, and reported less fear, tension, and disgust after the AAT at VR-BAT2. As such the experimental set-up, including the AAT, was successful.

The only predictor for VR-BAT2 performance was the approach time of symbol S5. Slower approach time of the ambiguous symbol coincided with slower approach time to the virtual spider at VR-BAT2, a larger distance and more self-reported fear and disgust. This comes as no surprise as high-fearfuls more slowly approached S5 (and S1) than low-fearfuls, indicating at least some reluctance for a possible encounter with the virtual spider.

The lack of a specific self-inflicted exposure effect on spider fear can be explained in several ways. First, one can wonder if the S5 symbol indeed induced a conflict as more than 90% of the participants preferred S5 over S1 (and S0). Nevertheless, spider fearfuls did show more reluctance (slower approach time) to approach this symbol than non fearfuls. It might be the case that the discrepancy between 1 and 5 coins is too large, resulting in a disproportionate approach drive or motivation of S5. For a future study we would recommend to decrease the reinforcement gap between the safe and conflict symbol or to increase the proportion of non-reinforced S5 visits.

A second explanation is that the amount of exposure in the current study was probably too low to reduce spider fear. On average the participant had 5 encounters with the virtual spider (M=5.33, SD=1.26) with only a limited amount of exposure time (a couple of seconds per trial). Increasing the amount of exposure to the spider, for example by increasing the number of trials or changing the S5 ratio, might have a larger impact on spider fear and the spider fear measures. An additional option could be to reward self-exposure by letting the spider disappear in the cavity after a certain amount of exposure time and reward this self-exposure with one or more coins. Furthermore, we would advise to add autonomic measures, such as heart rate or skin conductance, to detect (changes in) physiological stress responses. These measures can provide information about the stress levels during the task, indicating the amount of stress or conflict experienced during the choices made.

A last topic that deserves attention is the clinical relevance of the present study. Though we did not include a clinical population, our participants did display high levels of spider fear [24]. Most importantly, the results indicate that conflict induction can result in goal-directed approach behaviour in spider-fearful individuals even if a “safe” response option is available. These results add to literature on optimisation of fear reduction [25,26]. A next logical step would be to see whether such indirect way of spider exposure can help to overcome spider fear in a clinical population.

Though the results of the present study are not entirely in line with our hypotheses, they do remain important. Not only because they contribute to the sparse literature on approach-avoidance conflicts in spider-fearful persons, they also provide insight in mechanisms that contribute to the diminishment of spider fear. In sum, the present study indicates that spider-fearful persons are more reluctant to approach the feared animal, but can be motivated to overcome an avoidance response in a conflict situation. Additionally, the general experimental set-up does result in a decrease in spider fear, tension and disgust in spider-fearful persons. Future research is warranted to investigate approach-avoidance tendencies in anxiety disorders further. More specifically, more research is necessary with respect to approach-avoidance conflicts, since this is a highly relevant but understudied topic in anxiety disorders/behaviour.

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