Fear and Avoidance: A 3 Day Investigation on the Impact of a Fear-Related Verbal-Rehearsal Task on a Behavior-Behavior Relation

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Abstract

Recent research suggests that fear and avoidance responding based on derived transformation of functions may be considered functionally independent. The current study examined the impact of a Fear-Related Verbal-Rehearsal task on performance on two Implicit Relational Assessment Procedures (IRAPs), actual approach behavior towards a live spider (a BAT), and the relationship between the IRAPs and the BAT. The study was conducted over 3 separate days. Day 1 involved exposure to a series of questionnaires, the Fear-Related Verbal-Rehearsal task and homework. Day 2 involved a second exposure to the Fear-Related Verbal-Rehearsal task and exposure to the IRAPs and BAT. The final day involved a second exposure to the IRAPs and BAT. Participants were randomly assigned to one of three conditions (i.e., control, accept- or reduce-fear). Broadly similar findings were obtained for performance on the IRAPs as were reported by Leech, Barnes-Holmes and McEnteggart, 2017. No significant differences between the conditions emerged on the self-report measures, the IRAPs, or the BAT. However, correlations between performances on the IRAPs and the BAT were concentrated almost exclusively in the control and reduce-fear conditions rather than the accept-fear condition. The replication of results reported here, provide further evidence of the functional independence of approach and avoidance responding. Furthermore, the differential pattern of correlations observed provide further evidence that the Fear-Related Verbal-Rehearsal task impacted upon a behavior-behavior relation that may be directly relevant to the concept of defusion in the ACT literature. In addition, the differential arbitrarily applicable relational responding effects (DAARRE) model offers an alternative explanation for the results reported.

Keywords: fear, avoidance, IRAP, DAARRE,

Introduction

Behavioral researchers have been investigating the derived stimulus relations paradigm for over 30 years. In particular, researchers have been interested in the emergence of untrained stimulus functions among members of an equivalence class. This involves reinforcing relational responding to arbitrary stimuli within an equivalence class by establishing a response towards one of the stimuli in that class, and then testing for the emergence of that response in the other stimuli of the class. The emergence or acquisition of an untrained stimulus function among members of an equivalence class is known as the derived transformation of functions and researchers have focused on this phenomenon to account for fear acquisition in the absence of direct stimulus pairings. The derived transformation of functions is readily observed in experiments employing fear conditioning procedures. This procedure involves establishing a fear response towards one member of an equivalence class, usually via electric shock, and testing for the emergence of that fear response towards other members of that class (See Dougher, Augustson, Markham, Greenway, & Wulfert, 1994, for a seminal study). Derived transformation of functions effects have also been demonstrated in the study of fear extinction (Dougher et al., 1994) and avoidance responding (Augustson & Dougher, 1997). Recent research suggests that fear and avoidance responding based on derived transformation of functions may be considered functionally independent. Luciano and colleagues reported a series of studies that demonstrated derived fear responses may be extinguished when derived avoidance responding is maintained (Luciano et al., 2013), and that it is also possible for avoidance responding to reduce whilst derived fear responding is maintained (Luciano et al., 2014).

At the same time, behaviour-analytic researchers have been exploring the functional independence of fear and avoidance using a different paradigm to that employed in the previously mentioned derived transformation of function studies. These researchers have

employed a method known as the implicit relational assessment procedure (IRAP), which is a computer-based task that requires participants to respond quickly and accurately to sets of stimuli that may be considered consistent or inconsistent with an individual's previous learning history. Participants are presented with trials containing label and target stimuli presented at the top and centre of the screen, respectively. The task for the participant is to select between two response options at the bottom of the screen regarding the relation between the label and target stimuli. The general prediction is that relational responding should be quicker and more accurate on history-consistent trials compared to history-inconsistent trials.

The first published IRAP study investigating fear and avoidance presented images of spiders to determine if relational responding on the IRAP predicted self-reported spider fear and approach behavior towards a live spider (Nicholson & Barnes-Holmes, 2012). Images of nature scenes were presented as the contrast category. Participants were required to respond in a pattern that was consistent with an anti-spider bias on half of the blocks of trials and a pro-spider bias on the remaining blocks of trials. That is, on one block of trials participants were required to respond as if "spiders are scary" and they want to avoid them, and that "nature is pleasant", and you want to approach it. On another block of trials, the opposite pattern of responding was required. All spider and nature trials were presented an equal number of times and in a random sequence within each block. Results demonstrated that response latencies were faster for anti-spider blocks of trials compared to the pro-spider blocks and that IRAP performance successfully predicted approach behavior on the behavioral approach task (BAT) that involved a live spider. In simpler terms, participants were faster to respond that "spiders are scary", and they wished to avoid them, and that this pattern of responding on the IRAP predicted actual approach behavior towards a live spider.

One limitation to the study reported by Nicholson and Barnes-Holmes is that the IRAP conflated the measurement of fear and avoidance/approach whereby participants were required to confirm that spiders were scary in some trials and that they could approach spiders on other trials. It was not therefore possible to determine the extent to which the fear and/or avoidance/approach trial-types were independently predictive of participants self-reported spider fear and actual approach behavior on the BAT. Indeed, it is possible that the spider-fear trials would be more predictive of self-reported fear whereas the spider-approach trials would be more predictive of BAT performance. In order to address this, Leech, Barnes-Holmes and Madden (2016) sought to replicate and extend the previously published study by employing two separate IRAPs designed to measure fear and avoidance/approach as independent response biases. The Fear-IRAP only contained trials pertaining to fearful versus pleasant responses to spiders, whereas the Avoidance-IRAP only contained trials pertaining to approach and avoidance of spiders. Both IRAPs presented images of pets (i.e., puppies or kittens depending on the participants preference) as the positive contrast category. Results reported by Leech et al. indicated that performance on the Fear-IRAP predicted self-reported fear but not actual approach on the BAT, whereas Avoidance-IRAP performance successfully predicted approach behavior on the BAT. The findings were consisted with those reported by Nicholson and Barnes-Holmes, (2012) and in a broader sense with the findings reported by Luciano and colleagues (2013, 2014) whereby fear and avoidance/approach responding may be considered functionally independent classes of behavior.

More recently, research reported by Leech, Barnes-Holmes and McEnteggart (2017) sought to determine if performances on the IRAP and/or BAT could be modified by a relevant intervention or treatment for spider fear and/or avoidance. The research attempted to manipulate IRAP performances to determine the impact, if any, on actual approach behavior towards a live tarantula. The researchers sought to identify what would be the minimal level

of intervention required to modify performances on the measures? In doing so, an acceptance and commitment therapy (ACT) based intervention was designed that involved a simple "verbal rehearsal" task. Participants were randomly assigned to a fear acceptance or fear reduction condition. The "verbal rehearsal" task simply required participants to confirm a strategy of reducing or accepting their fear in order to cope with a fear inducing situation. That is, for the accept-fear condition, participants were required to confirm a strategy of accepting their fear, rather than attempting to control or reduce it; the task also involved denying that the opposite strategy applied to them. The rationale behind the task was to determine if requiring participants to rehearse these verbal relations would produce relevant changes in IRAP and/or BAT performances, or relations between the two measures. Unlike previous analogue intervention studies that have employed ACT based protocols in order to assess therapeutic efficacy for behaviour change (e.g., Paez-Blarrina, et al., (2008); Donati, Masuda, Schaefer, Cohen, Tone, & Parrott,. (2019)), the intervention employed by Leech at al. was not intended as a therapeutic intervention but rather a simple responding task where participants were required to rehearse and respond to a relational network. To that end, the authors deliberately did not include analogies or metaphors as part of the intervention. Results indicated that no significant differences between the two conditions emerged on the self-report measures, IRAPs or the BAT. However, significant correlations between IRAP and BAT performances were reported for the reduce-fear condition, and with one exception, none were reported in the accept-fear condition. Similar to the previously published study by Leech et al. (2016), the correlations for the reduce fear-condition were generally consistent with "common sense" expectations where higher levels of pro-spider bias on both the Fear- and Avoidance-IRAPs predicted greater number of steps taken on the BAT. Furthermore, the differential pattern of correlations could have been seen as revealing the impact of the "verbal-rehearsal" task on a behavior-behavior relation. The authors argued that the reduce-

fear task may have served to strengthen the causal relations between the statements about reducing one's own fear and actual fear relevant behaviour (Hayes & Brownstein, 1986). In contrast, the accept-fear task may have served to undermine the causal relations. Indeed, it should be noted that the effect reported by Leech et al., was not defusion per se but may be seen as relevant to the concept of defusion, where the intervention appeared to weaken the relation between the participants verbal network and approach behaviour. In other words, the intervention appeared to reduce the coherence of the relational network for participants in the accept-fear condition but not for those in the reduce-fear condition.

One of the limitations of the Leech et al (2017) study was the absence of a control condition. Without a control condition it is not possible to determine if the accept-fear or reduce-fear condition, or perhaps both, were responsible for the change in the relational network between the behaviors measured by the IRAP and BAT. The current study, therefore, was an attempt to replicate and extend the previously published study by including a control condition which would act as comparison group as a source of counterfactual causal inference. Without a control condition, it was not possible for us to establish whether the verbal rehearsal task did not significantly impact upon participants responding in a way that we were not expecting. In other words, the control condition allowed us to compare participants pre-experimentally established responding with experimentally established responding for participants in the accept- and reduce-fear conditions.

A second limitation to the Leech et al, (2017) study is that no follow up IRAP or BAT performances were recorded. It is, therefore, unclear if the effects observed were indicative of participants learning history or if the task modified responding. If we assume that participants were not responding in accordance with their pre-experimentally established history, it is unclear if this change in relational responding withstands a period of elapsed time. The current research sought to address this shortcoming of the previously published study by

including a control condition and follow-up measures of the IRAPs and BAT. Specifically, participants were randomly assigned to one of three conditions, control, accept-fear, and reduce-fear condition. This allowed us to determine which condition is likely to increase/decrease the causal relations between the IRAP and BAT. In addition, the experiment was conducted over three separate days to measure participants responding during task [1]exposure and at follow up.

A third limitation to the study is that there appeared to be some ambiguity surrounding some of the statements used in the Fear-Related Verbal-Rehearsal task. That is, some of the statements could have been applicable to both the accept- and reduce-fear conditions. Specifically, the statements that read "When I conquer my fear I achieve my goals" and "When I overcome my fear I succeed". The statements were presented in English and the participants were native Dutch speakers where English was a second language. Therefore, depending on the participants understanding of the words "conquer" and "overcome" in the context of fear acceptance or reduction, these statements could have been interpreted as belonging to either strategy. The current study modified the original statements to ensure that the statements were clear and precise about being related to either fear acceptance or fear reduction. In addition, participants were required to provide a personal example of when they employed either a fear acceptance or fear reduction strategy. This was to ensure the participants fully understood the difference between the two strategies by personally relating to it. Participants were also required to complete homework where they were asked to recall a number of examples where they employed a particular fear coping strategy. The rationale for the modifications to the Fear-Related Verbal-Rehearsal task statements and the inclusion of homework was to determine if engaging with these tasks with more personal experiences had a greater impact on IRAP performances, BAT performances

[1] By the term exposure we mean in the physical presence of/responding to the stimuli/tasks and not in a highly technical way or clinical/therapeutic sense.

and/or the relationship between the two behavioral measures. Given the research was somewhat exploratory we refrained from making specific predictions.

Method

Ethical Considerations

The study reported here was conducted in accordance with the ethical guidelines of Ghent University. Prior to the experiment, participants read and signed a consent form informing them that they could withdraw from the study at any time. Upon completion, participants were fully debriefed.

Participants

One hundred students attending Ghent University, Belgium, volunteered to participant in the study (N = 100, 80 Females, 20 Males). Participants were paid €25-30 for their participation. The study involved counterbalancing participants across a number of method factors, and this was achieved by assigning participants based on the order in which they volunteered for the study (i.e., all counterbalanced conditions were run in parallel). Thirteen participants were eliminated due to their failure to achieve the necessary performance criteria on the IRAPs (see "procedure" section), leaving 70 females and 17 males (N = 87), the results of whom were subject to analysis. The mean age was 22.1 years (SE = .56), with a range of 17 – 50 years. The participants completed the study individually in the Department of Experimental-Clinical and Health Psychology at Ghent University. Given that the current study is a systematic replication of the previously published study by Leech et al., (2017), the sample sizes reported here, were based on those of the previously published study. That is, including approximately 29 participants per condition in order to conduct first order correlations.

Design

The current study was conducted across three separate days. Day 1 involved three stages: 1. Questionnaires; 2. Fear-Related Verbal-Rehearsal Task; and 3. Homework. Day 2 involved four stages: 1. Fear-Related Verbal Rehearsal Task; 2. Fear- and Avoidance-IRAPs; 3. Fear-Related Verbal-Rehearsal Task; and 4. a Behavioral Approach Task (BAT). Day 3 involved two stages: 1. Fear- and Avoidance-IRAPs; and 2. BAT. The current study comprised of three conditions: 1. accept-fear condition, 2. reduce-fear condition, and 3. control condition. Note, that on Day 2 participants were exposed to the Verbal Rehearsal Task immediately before the IRAPs and again immediately before the BAT; this strategy was adopted to ensure that both behavioral measures (IRAPs and BAT) were immediately preceded by the Rehearsal Task.

Materials and Apparatus

The study employed four questionnaires: A Spider Fear Rating Question, the Depression, Anxiety and Stress Scale-21 (DASS, deBeurs, vanDyck, Marquenie, Lange, & Blonk, 2001); the Acceptance and Action Questionnaire II (AAQ-II 7-item version; Bernaerts, De Groot, & Kleen, 2012); and the Fear of Spiders Questionnaire (FSQ, Muris & Merckelbach, 1996). The study also employed a Condition Script, a Fear-Related Verbal-Rehearsal Task, homework related to the Rehearsal Task, two Test-IRAPs (i.e., Fear-IRAP, and Avoidance-IRAP), and a BAT.

Spider Fear Rating Question. Prior to completing the questionnaires, participants were asked to rate their fear of spiders on a Likert scale from 1-5, where 1 was “No fear” and 5 was “Very fearful”.

Depression, Anxiety and Stress Scale (DASS-21). The Depression Anxiety and Stress Scale is a 21 item self-report questionnaire which covers a range of core symptoms of anxiety, depression and stress. The English version of this scale (Lovibond & Lovibond, 1995), for a non-clinical sample, has demonstrated excellent internal consistencies among its

three subscales (Cronbach's Alpha's = .82 - .90), good convergent and discriminant validity (r's = .70 - .72) and adequate reliability (Cronbach's alpha = .90 - .95) (Henry & Crawford, 2005). The Dutch translation has been reported to yield similar excellent internal consistency (deBeurs, et al. 2001).

Acceptance and Action Questionnaire – II (AAQ- II 7-item version). The Acceptance and Action Questionnaire – II is a 7-item self-report scale which measures acceptance, experiential avoidance and psychological inflexibility. The AAQ yields an overall score with a maximum of 49 indicating *low psychological flexibility* and a minimum of 7 indicating *high psychological flexibility*. The English version of this scale has been shown to have good psychometric properties and good convergent, discriminant, and incremental validity (Bond et al., 2011). The Dutch translation has yielded similar reliability values (Bernaerts, et al., 2012).

Fear of Spiders Questionnaire (FSQ). The Fear of Spiders' Questionnaire (FSQ) is an 18-item self-report scale for assessing spider phobia. The FSQ is capable of assessing both low and high levels of reported spider phobia with high retest reliability (.97) and high internal consistency (Cronbach's Alpha = .92; Szymanski & O'Donohue, 1995). The Dutch translation has yielded similar reliability values (Muris & Merckelbach, 1996).

Condition Script The condition scripts for the accept-fear and reduce-fear conditions were similar and described two core ways in which people may respond to fear. The script was presented to all participants in English and read as follows:

> *In general, there are two ways of coping with fear. One strategy involves a "feel the fear and do it anyway" approach. In this strategy a person is feeling scared but is not allowing the fear to stop them from doing what they want to do. For example, if a person is afraid of flying and are about to board a plane, they will get onto the plane feeling scared, anxious, worried but the feelings of fear does not stop them.*

> *A second strategy involves a "get calm and then continue" approach. With this strategy, when a person feels scared or frightened, they try to reduce their fear and feelings of worry until they no longer feel afraid and can then do what they want to do. Take the example above, the person who is afraid of flying and is about to board a plane will try to calm themselves down, reduce their fear until they no longer feel frightened and when they are feeling in control and have no fear will then board the plane calmly and unafraid. They are feeling in control and have little or no fear.*
>
> *Both of these strategies are legitimate ways of dealing with fear.*
>
> *[Participants in the accept-fear condition were given the following instruction: "For the next task you are required to respond as if you live your life by the first strategy. Can you please write down/or describe to the experimenter about a detailed example of a time in your life where you "felt the fear and did it anyway". This can be anything that you are/were afraid of (i.e., thing, person, event) but you faced it and achieved what you wanted to achieve."]*
>
> *[Participants in the reduce-fear condition were given the following instruction: "For the next task you are required to respond as if you live your life by the second strategy. Can you please write down a detailed example of a time in your life where you felt scared/worried and you were able to reduce or eliminate your fear and then were successful in achieving a goal thereafter. This can be anything that you are/were afraid of (i.e., thing, person, event)"]*

The control condition was presented with a script that provided detailed information related to social phobias and statistics but had no information on how people manage their fear (i.e., nothing related to reducing or accepting fear in a fearful situation). The control condition script was presented in English (see Appendix).

Fear-Related Verbal Rehearsal Task. The task was programmed in Windows Visual Basic 6.0. Only the participants assigned to the accept-fear or reduce-fear condition completed this task. The task presented 10 statements (5 of which were related to reducing fear and 5 to accepting fear) along with two response options "Me" and "Not Me" (see Table 1). Each statement was presented 6 times (in a quasi-random order). Participants were required to categorise each of the statements as "Me" or "Not Me" according to their

assigned condition by using a mouse and clicking the appropriate answer on screen. For example, in the reduce-fear condition, participants were required to respond "Me" to the statement *"When I reduce my fear I succeed"* and "Not Me" to the statement "*I can feel my fear and still succeed".* No feedback was presented during any stage of this task; participants were simply instructed to respond as accurately as possible to the statements according to their assigned condition. Participants assigned to the control condition were given no exposures to the Fear-Related Verbal-Rehearsal Task. Instead, they were asked to read the social phobia fact sheet and to write down a list of examples of phobias.

Table 1.

Fear-Related Verbal Rehearsal Statements

Reduce-Fear Condition	**Accept-Fear Condition**
When I eliminate my fear then I can achieve anything	I can succeed even when I am frightened
When I reduce my fear, I succeed	Even when I am terrified, I am successful
When I lower my levels of fear, I achieve my goals	Feeling scared doesn't stop me from achieving my goals
Only when I diminish my fear, I achieve my goals	I can feel my fear and still succeed
I must supress my fear to succeed	Even when I am scared, I keep going

The Implicit Relational Assessment Procedure (IRAP). Participants were required to complete both the Fear- and the Avoidance-IRAPs. The label stimuli for the IRAPs consisted of twelve images; six images were of various species of spiders, and the other six were various images of either puppies or kittens. The pictures of pets presented to participants depended on whether they preferred cats or for dogs; this preference was assessed simply by asking participants which animal they preferred. All the images were taken from Leech et al. (2017). The label stimuli consisted of pleasant/fearful statements for

the Fear-IRAP and approach/avoidance statements for the Avoidance-IRAP[2] similar to those employed by Leech et al. (2017). Two of the target statements in the Fear-IRAP and in the Avoidance-IRAP were changed for the current study based on a process of forward-backward translation that was used to validate the Dutch versions of the stimuli (see Table 2 for stimuli). The statements were presented in Dutch to the participants but are reported in English in the Table below.

Table 2.

Target stimuli for the Fear- and Avoidance-IRAPs

Fear-IRAP Stimuli		**Avoidance-IRAP Stimuli**	
Calms me	Scares me	I get away	I approach it
Gives me warm feelings	Makes me uncomfortable	I leave	I stay
Makes me happy	Worries me	I flee	I touch it
Let's me be happy	I hate it	I run away	I pick it up
I love it	Gives me stress	*I take myself away*	I play with it
Comforts me	Makes me shudder	*I'm going away*	I carry it
Makes me smile	*Shocks me*	I avoid it	I hold it
Reassures me	Frightens me	I jump away	I look at it

Note: The stimuli in italics indicate the four statements that were changed for the current IRAPs.

Behavioral Approach Task (BAT). There were seven steps involved in the BAT, which progressively asked participants to move physically closer to the live spider. This was scored from 0 to 7 as participants progressed through each step. A live Chilean Rose tarantula approximately 10cm in diameter (including legs) was employed for the first half in the

[2] Some of the phrases used in the Avoidance-IRAP may be considered as referring to escape rather than avoidance *per se*. Here we wish to clarify that the statements are reflective of a participants desire to avoid the stimulus by means of escape or avoidant behaviour. That is, the statements are reflective of experiential avoidance and the IRAP is assessing the relational networks that cohere with avoidance behaviours.

current study. Due to the death of the spider, a live Mexican red knee tarantula approximately 8cm in diameter (including legs) was employed for the second half of the study.

Procedure

The current study was conducted across 3 separate days and was always completed within the maximum of a single 7-day period.

Day 1. Day 1 involved four stages: 1. Questionnaires; 2. Script read; 3. Fear-Related Verbal Rehearsal Task; and 4. Assignment of homework.

Questionnaires. Participants completed the four questionnaires in a fixed sequence (a Spider Fear Rating Question, DASS, the AAQ-II, and the FSQ).

Script read. Participants were required to read a script that was based on the condition to which they were assigned. Participants in the control condition were required to read a script that gave details on social phobias to control for the time exposed to the experimental procedure (i.e., to ensure that the time all participants spent completing the experimental procedure was generally consistent across the three conditions).

Participants in the reduce- and accept-fear conditions were required to read a script that described two core ways in which people respond to fearful situations (i.e., accept fear and reduce fear). Participants were asked to read the script in full and then to summarise the strategies that were described in the script. It was important for participants to demonstrate their understanding of the differences between the two strategies to promote adherence to their assigned condition in the Fear-Related Verbal-Rehearsal Task. To check for such understanding, the experimenter asked participants to provide examples of the two different strategies. If the examples provided suggested to the experimenter that a participant did not understand the differences between the strategies, the experimenter provided additional examples of the two strategies. Following this, the participant was again asked to explain their understanding of the two strategies using different examples to those provided

previously. No participant required more than one clarification (with additional examples) before continuing. Before proceeding to the Verbal-Rehearsal Task, each participant was asked to think of a time in their life where they adopted their given strategy and were successful in doing so; for ethical reasons, participants were allowed either to write down the personal example or to report it directly to the experimenter. Specifically, participants in the accept-fear group were asked to recall a time in their life where they "felt the fear and did it anyway"; participations in the reduce-fear condition were asked to recall a time in their life when they were "controlled and calm" in a fearful situation and were successful.

Fear-Related Verbal Rehearsal Task. Participants in the accept- and reduce-fear groups were then required to complete the Fear-Related Verbal-Rehearsal Task. During the task, participants were required to categorise the 10 statements (six times each) as either "Me" or "Not Me" according to the strategy that was assigned to them. The task thus consisted of 60 individual trials with a single statement presented on each trial. Participants were simply asked to read the statement and then choose one of the two response options by clicking on the response option using a mouse. Each click cleared the screen and the next statement appeared 400ms later. No programmed feedback was presented, and participants were not required to respond within a specific time-window. If participants produced fewer than 50 correct trials (according to their assigned condition) they were re-exposed to the 60-trial task. No participant required more than two exposures to the task before producing >50 correct responses.

Assignment of homework. Participants in the control condition were asked to think of as many phobias as they could for the next day. The participants in the accept- and reduce-fear conditions were asked to think of another example in their lives when they adopted their assigned strategy and were successful doing so. For ethical reasons, participants were free to

write down the examples they thought of and bring them to the next session or to report them verbally to the experimenter.

Day 2. Day 2 involved four stages: 1. Homework check and Fear-Related Verbal-Rehearsal Task; 2. Fear and Avoidance IRAPs; 3. Fear-Related Verbal-Rehearsal Task; and 4. BAT.

Homework check. Upon returning to the laboratory on Day 2, participants were immediately asked to report on their homework either verbally or by providing their written record before proceeding.

Fear-Related Verbal Rehearsal Task. Participants in the accept- and reduce-fear conditions were administered a second exposure of the Fear-Related Verbal-Rehearsal Task. Participants in the control condition were required to read the information script again.

Fear- and Avoidance-IRAPs. On these IRAPs where blocks of trials were deemed consistent with pre-experimental history, participants were required to respond in a manner that coordinated pictures of spiders with fear/avoidance statements and pictures of pets with pleasant/approach statements (hereafter referred to as anti-spider blocks). On blocks of trials that were deemed inconsistent with pre-experimental history, the opposite response pattern was required. That is, coordinating spiders with pleasant/approach statements and pets with fear/avoidance statements (hereafter referred to as pro-spider blocks). The order in which the two types of blocks were presented was counterbalanced across participants. For half of the participants, therefore, all odd numbered blocks required anti-spider responses and all even-numbered blocks required pro-spider responses; the opposite was the case for the remaining half of the participants.

Participants were exposed to a maximum number of three pairs of practice blocks, on which they could reach the performance criteria of 80% and <=2000 ms. Once participants achieved these criteria, they automatically advanced to the test blocks. No performance

criteria were applied for progression through the test blocks, but performance feedback, detailed below, was presented at the end of each block to encourage participants to maintain the practice-block criteria (> 80% correct and <= 2000ms latency).

Each practice block and each test block consisted of 32 trials composed of four trial-types, each presented eight times within a block. The four trial-types were defined in terms of a 2x2 combination of the two label stimuli with the two types of target stimuli. For the Fear-IRAP the trial-types are as follows: *Pet-Pleasant*; *Pet-Fear*; *Spider-Pleasant*; *Spider-Fear*. Examples of these four trial-types are as follows; (i) Pet Picture/ "Makes me smile"; (ii) Pet Picture/ "Terrifies me"; (iii) Spider Picture/ "I like it"; (iv) Spider Picture/ "Scares me". For the Avoidance-IRAP the trial-types were as follows: *Pet-Approach*; *Pet-Avoid*; *Spider-Approach*; *Spider-Avoid*. Examples of these four trial-types are as follows; (i) Pet Picture/ "I can touch it"; (ii) Pet Picture/ "I want to avoid"; (iii) Spider Picture/ "I need to leave"; (iv) Spider Picture/ "I can approach it". The trial-types were presented in a quasi-random order, such that each trial-type was presented once every four trials (the same trial-type was never presented twice in succession).

On each trial, an image of either a spider or a pet appeared in the upper centre of the screen. Below this, in the centre of the screen a target stimulus appeared (i.e., a phrase related to either fear or pleasant). In the bottom third of the screen, the response options were presented ("*Yes*" and "*No*"). One response was presented on the bottom right corner; the other was presented on the bottom left corner. These response options alternated randomly across trials with the software ensuring that they did not appear in the same positions for more than three successive trials.

On anti-spider blocks of trials, participants were required to press the "*Yes*" key if spiders were presented with a fear/avoidance statement, and to press the "*No*" key if spiders were presented with a pleasant/approach statement. For example, responding "*Yes*" was

deemed correct when presented with a picture of a spider and a fear/avoidance statement (e.g. "Scares me" or "Terrifies me"), or when a picture of a pet was presented with a pleasant/approach statement (e.g. "I like it" or "Makes me smile"); responding "*No*" was deemed correct when presented with a picture of a spider and a pleasant/approach statement, or when a picture of a pet was presented with a fear/avoidance statement. On pro-spider blocks of trials, the opposite pattern of responding was required. That is, responding "*No*" when presented with a spider and fear/avoidance statement, or when presented with a pet and a pleasant/approach statement; and responding "*Yes*" when presented with a spider and a pleasant/approach statement, or a pet and a fear/avoidance statement.

Responses deemed correct for a given block of trials cleared the label, target and response option stimuli; the next set of stimuli appeared 400ms later. Incorrect responses produced a red "X" below the target stimulus, which remained on screen (with the label and response option stimuli) until the correct response was emitted. If a participant did not emit a response before 2000ms on any trial, "Too Slow!" appeared directly below where the red X was presented for incorrect responses, and it remained on screen until a response (correct or incorrect) was emitted.

Fear-Related Verbal Rehearsal Task. Participants in the accept- and reduce-fear conditions were exposed again to the Fear-Related Verbal-Rehearsal Task. Participants in the control condition were required to read the information script for a final time.

Behavioral Approach Task (BAT). There were seven steps involved in the BAT, which progressively asked participants to move physically closer to the live spider. Each of the BAT steps were read aloud by the experimenter. The instructions were as follows:

"The following test is to measure how willing you are to approach a live spider. I will ask you if you are willing to

do a number of items, one at a time, and if you are willing to do the items, I'll ask you to do so. If at any time you do not want to continue, please feel free to stop."

The steps were scored from 0 to 7 as participants progressed through each step. The first step involved participants opening the door to the room where the tarantula was kept. If participants failed to complete the first step of opening the door they scored 0, if they opened the door they scored 1 (this score was increased as participants completed the different steps). For the second step, participants were asked if they were willing to enter the room. The third step brought participants closer again and required them to look closely at the tarantula with their face level with the terrarium. The fourth step required participants to place their hands on either side of the terrarium and hold them in place for 10 seconds. The fifth step required participants to sit down and place the terrarium on their lap for 20 seconds whilst also keeping their hands on either side of the terrarium. The sixth step required participants to open the feeding latch in the lid of the terrarium and keep it open. The seventh and final step required participants to place their hand inside the terrarium ensuring at no point they come into contact with the tarantula.

Day 3. Day 3 involved two stages: 1. Re-exposure to Fear and Avoidance IRAPs; and 2. The BAT.

Results

Scoring the Fear-Related Verbal Rehearsal Task

Each correct response on the rehearsal task was awarded one point (points did not appear on screen). Only participants who achieved a minimum of 50 correct answers (i.e., 50 points) on each presentation of the rehearsal tasks were included in the analyses (i.e., participants were required to produce a minimum of 50/60 correct answers on each task). The

data for 0 participants were removed on this basis. An independent *t*-test indicated that there were no significant differences between the accept-fear and reduced-fear conditions on task performance on day one (*Mdiff* = -.244, *df* = 56, *t* = -.393, *p* = .695), day two's first exposure (*Mdiff* = .236, *df* = 56, *t* = 1.286, *p* = .203), or day two's second exposure (*Mdiff* = .340, d*f* = 56, *t* = 1.392, *p* = .169).

Validating the Self-report questionnaires and the BAT

Preliminary analyses involving six one-way analyses of variance (ANOVAs) indicated no significant main effect for condition on the self-reported measures, including the FSQ, the DASS (and its three sub-scales), or the AAQII (all *ps* > .3).

Two one-way ANOVAs conducted with BAT scores as the dependant variable and condition as the independent variable indicated no significant main effect for condition on BAT performances on day 2 or day 3 (all *ps* > .84). A follow up paired *t*-test indicated a significant difference between overall BAT performances from day 2 to day 3 (*Mdiff* = -.310, *df* = 86, *t* = -3.506, *p* = .007).

Consistent with previously published studies by Leech et al. (2016), and Nicholson and Barnes-Holmes (2012), a series of correlations were conducted between the FSQ and the BAT on days 2 and 3 for each condition. In the Control condition, the correlations proved to be strong and significant on day 2 (*r* = -.792, *p* < .0001), and day 3 (*r* = -.663, *p* < .0001). In the Reduce-Fear condition, the correlations also proved to be strong and significant on day 2 (*r* = -.680, *p* < .0001) and day 3 (*r* = -.484, *p* = .008). In the Accept-Fear condition, however, the correlations proved to be relatively weak and non-significant on day 2 (*r* = -.286, *p* = .127), and day 3 (*r* = -.175, *p* =.359).

Scoring the IRAPs

The primary datum from the IRAPs was response latency, which was defined as the time in milliseconds that elapsed from the onset of a trial to the emission of a correct

response. Consistent with previously published studies employing the traditional IRAP, the data were screened before being subject to statistical analyses. If a participant's accuracy fell below 75% or the median latency exceeded 2000ms during a test block, this was taken to indicate that the participant had not maintained performance at a level close to that required to pass the practice blocks. Consistent with Leech et al. (2016), if participants failed to maintain these criteria for one or both test blocks from a given pair (1 & 2, or 3 & 4, or 5 & 6), the data from those two blocks were excluded and the data from the remaining two test-block pairs were analysed (this applied to 16 participants). If participants failed to maintain the criteria across two or more pairs of blocks on either of the two IRAPs, then all the data from that participant were excluded from further analysis. The data for 13 participants were removed on this basis. The latency data from the Fear-IRAP and Avoidance-IRAP were transformed into *D*-IRAP scores.

Given the forgoing transformation, a larger *D*-IRAP score indicated a greater difference in mean response latencies between the two types of blocks (pro- versus anti-spider blocks) for each trial-type. Positive scores on the Fear-IRAP thus indicated a bias towards fearing and not finding spiders pleasant, and a bias towards finding pets pleasant and not fearing them. In order to facilitate direct comparisons across the spider and pet trial-types, the signs for the *Spider-Fear* and *Spider-Pleasant* trial-types were inverted (i.e., + scores became negative, and – scores became positive). Positive *D*-IRAP scores now indicated a positive bias for both spiders and pets and negative scores indicated a negative bias for both types of stimuli. The raw data from the Avoidance-IRAP were subjected to the same scoring procedure as the Fear-IRAP, and thus positive *D*-IRAP scores indicated a positive bias (pro-approach/anti-avoidance) for both spiders and pets and negative scores indicated a negative bias (anti-approach/pro-avoidance) for both types of stimuli.

Between Group Analyses

The IRAP data were entered into a 2x2x3x4 mixed measures ANOVA with IRAP-type, IRAP-exposure, and trial-type as the within-group variables, and condition as the between group variable (see supplementary material for Table). The results indicated a significant main effect for IRAP-Exposure $F(1,84) = 10.771$, $p = .0015$, $\eta p^2 = .06$, a significant main effect for IRAP-Type $F(1,84) = 18.727$, $p = .0001$, $\eta p^2 = .16$, a significant main effect for Trial-Type $F(3,84) = 238.236$, $p = .0001$, $\eta p^2 = .9$, a significant interaction effect for IRAP-Type and condition $F(2,84) = 3.183$, $p = .0465$, $\eta p^2 = .06$, and a significant 3 way interaction effect for IRAP-Type, IRAP-Exposure, and Trial-Type $F(3,84) = 35.142$, $p < .0001$, $\eta p^2 = .42$. The three-way interaction effect is illustrated in Figure 1 and is summarized subsequently.

The effects for the F-IRAP on days 2 and 3 produced a positive bias on the *Pet-Pleasant* and the *Pet-Fear* trial-types. Relatively weak negative biases were observed for the *Spider-Pleasant* trial-type but this was close to zero across both days. Negative biases were also observed, for the *Spider-Fear* trial-type. In concrete terms, participants tended to respond "Yes" more quickly than "No" when presented with a picture of a spider and fear appraisal phrase or a picture of a pet and a pleasant appraisal. When presented with a picture of a pet and fear appraisal, participants showed a tendency to respond "No" rather than "Yes". Finally, when presented with a picture of a spider and a pleasant appraisal, participants produced a very weak tendency to respond "No" rather than "Yes".

The effects across days 2 and 3 for the A-IRAP produced a positive bias on the *Pet-Approach* trial-type. The *Pet-Avoid* trial-type also demonstrated a positive bias, the largest of which was observed on day 2. A relatively weak positive bias was observed for the *Spider-Approach* trial-type (i.e., these effects were close to zero). Negative biases were observed for the *Spider-Avoid* trial-type, the largest of which was recorded on day 2. In concrete terms, across all conditions, participants tended to respond "Yes" more quickly than "No" when

presented with a picture of a spider and an avoidance statement or a picture of a pet and an approach statement. When presented with a picture of a pet and an avoidance statement, participants showed a tendency to respond "No" rather than "Yes". Finally, when presented with a picture of a spider and an approach statement, participants produced a very weak tendency to respond "Yes" rather than "No".

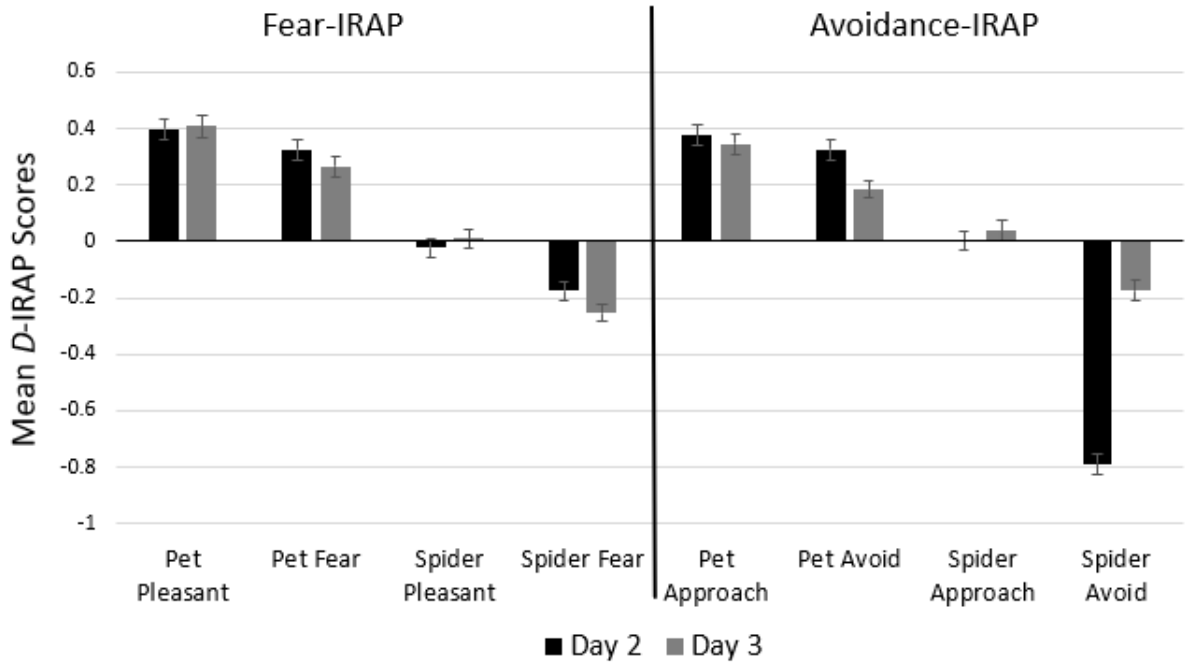

Figure 1. Mean *D*-IRAP scores for the Fear- and Avoidance-IRAPs on days 2 and 3 with error bars.

Post-hoc Analyses

A post-hoc Bonferroni multiple comparison correction was used to compare trial-type performance from day 2 to day 3 for each IRAP, where 8 comparisons were made (i.e., the four trial-types from Fear IRAP days 2 and 3, and the four trial-types from the Avoidance-IRAP days 2 and 3) resulting in a new alpha significance level of $p = .0018$. Significant differences were revealed for the *Spider-Avoid* trial-type (*Mdiff* = -.618, $p < .0001$), and a marginally significant effect for the *Pet-Avoid* trial-type (*Mdiff* = .146, $p = .0026$). Overall, the *D*-IRAP effect for the *Spider-Avoid* trial-type was considerably more substantive than the

remaining 15 effects across the two days for both IRAPs. As such, the three-way interaction appears to be driven primarily by the extremely large reduction in the negative bias from day 2 to day 3 for the *Spider-Avoid* trial-type**.**

BAT Analyses

Within Group BAT Comparisons. A series of paired *t*-tests for the BAT scores across days 2 and 3 for each condition revealed no significant difference between BAT performances for the Accept-Fear condition (*Mdiff* = -.200, *df* = 29, *t* = -1.293, *p* = .2). A marginally significant difference was observed for the control condition (*Mdiff* = -.241, *df* = 28, *t* = -2.045, *p* = .05) and a significant difference was observed for the Reduce-Fear condition (*Mdiff* = -.500, *df* = 27, *t* = -2.750, *p* = .01).

IRAP-FSQ/BAT Correlational Analyses

Two correlation matrices, one for each IRAP, split by condition, were calculated to determine if any of the eight trial-types predicted self-reported fear of spiders (FSQ) on day 1, and/or approach responses on the BAT on days 2 and 3. The results of these correlations are presented in Table 3 (F-IRAP) and Table 4 (A-IRAP). To control for Type 1 errors, a Bonferroni adjustment was made for each of the conditions where 4 comparisons were made (i.e., the four trial-types of each IRAP) resulting in a new alpha significance level of *p* = .0125. Based on this adjustment, across the three conditions, six significant correlations emerged. Of these six significant correlations, four were significant for the Control condition (two involving the BAT and two involving the FSQ), and two were significant for the Reduce-Fear condition (one involving the FSQ and one involving the BAT). In each case, the correlations were in the intuitively correct direction; for example, increased positive biases on the *Spider-Approach* trial-type predicted a higher number of approach responses on the BAT. In effect, it appears that performance on the IRAP and other measures of spider fear correlated to some extent in the control but not in the Accept- or Reduce-fear conditions.

Table 3.

Correlation matrix for the Fear-IRAPs on days 2 and 3 for each condition.

	Fear-IRAP Correlation Matrix Day 2						Fear-IRAP Correlation Matrix Day 3					
	Control		Accept-Fear		Reduce-Fear		Control		Accept-Fear		Reduce-Fear	
Trial-Type	BAT	FSQ	BAT	FSQ	BAT	FSQ	BAT	FSQ	BAT	FSQ	BAT	FSQ
Pet Pleasant	-.237	.116	-.117	.166	.160	-.190	-.072	-.158	.012	-.062	-.182	-.215
Pet Fear	-.091	.065	.279	-.403	-.103	.092	-.345	.440	.350	-.178	-.007	.012
Spider Pleasant	.298	-.196	.306	-.104	.385	-.369	-.036	.097	.017	.019	.208	-.334
Spider Fear	.501*	-.424	.006	-.331	.229	-.027	.119	-.376	.185	-.116	.522*	-.146

Table 4.

Correlation matrix for the Avoidance-IRAPs on days 2 and 3 for each condition.

	Avoidance-IRAP Correlation Matrix Day 2						Avoidance-IRAP Correlation Matrix Day 3					
	Control		Accept-Fear		Reduce-Fear		Control		Accept-Fear		Reduce-Fear	
Trial-Type	BAT	FSQ	BAT	FSQ	BAT	FSQ	BAT	FSQ	BAT	FSQ	BAT	FSQ
Pet Approach	-.338	.298	.364	-.337	.325	-.491*	-.252	.085	-.200	.077	.082	-.390
Pet Avoid	-.442	.475*	.279	.127	-.005	-.006	-.439	.243	.086	.228	.040	-.138
Spider Approach	.585*	-.700*	.337	.059	-.076	-.133	.233	-.160	.223	-.134	.071	-.316
Spider Avoid	-.19	-.302	.013	.068	.309	-.167	.230	-.203	.108	-.326	.087	-.351

*$p < .0125$

Discussion

One of the main aims of the current study was to replicate and extend the previously published study by Leech et al., (2017). The current study employed an experimental procedure that was conducted across three separate days. Day 1 involved randomly assigning the participants to one of three experimental conditions; control, accept-fear, or reduce-fear. Next, participants were exposed to a modified version of the Fear-Related Verbal-Rehearsal task and were then asked to complete a homework task. The modifications to the Fear-Related Verbal-Rehearsal task and the inclusion of homework were employed as an attempt to encourage participants to personally engage with a fear coping strategy that was based on their assigned condition. Day 2 involved a second exposure to the Fear-Related Verbal-Rehearsal task and exposure to the Fear- and Avoidance-IRAPs and a BAT. The third and final day involved a second exposure to the Fear- and Avoidance-IRAPs and the BAT as a follow-up to investigate whether the effects, if any, would be indicative of the participants learning histories or if the task modified responding on the behavioural measures.

The rationale for the modifications to the Fear-Related Verbal-Rehearsal task and the inclusion of homework was to determine if engaging with these tasks with more personal experiences would impact on IRAP performances, BAT performances and/or the relationship between the two behavioral measures. The modified versions of the Fear-Related Verbal-Rehearsal task, and the inclusion of homework, appeared to have a limited (non-significant) impact in terms of self-report, IRAP or BAT performances across the three conditions. Whilst it was disappointing that the modifications to the Fear-Related Verbal-Rehearsal tasks, and the inclusion of homework, appeared to have little direct impact on performances on the behavioural measures, the findings are consistent with the results reported in the previously published study by Leech et al. (2017). Furthermore, the overall pattern of IRAP effects reported in the current study were broadly similar to those reported by Leech et al. (2016).

As mentioned above, the Fear-Related Verbal-Rehearsal tasks and the homework did not appear to directly impact the relational networks contained within, and measured by, the IRAP, on any of the three conditions at first measurement or at follow-up. Furthermore, the modified tasks and homework did not yield significant differences between the three conditions in terms of approach behavior towards a live spider. Given the absence of any significant effects for the Fear-Related Verbal-Rehearsal tasks in terms of modifying IRAP or BAT performances, the *D*-IRAP scores for each condition were collapsed and resulted in a single mean *D*-IRAP score for each trial-type for the IRAPs on days 2 and 3. Interestingly, a significant difference in mean *D*-IRAP scores was recorded for the *Spider-Avoid* trial-type between days 2 and 3. In simple terms, participants showed quite a dramatic reduction in spider avoidance bias on day 3, but virtually no change in spider fear bias. One possible explanation for the decrease in spider avoidance bias, but not spider fear, could be exposure to the BAT. Specifically, on day 2, participants were exposed to the Avoidance-IRAP *prior* to exposure to the BAT. Thus, at this point in the experiment, participants were responding according to their pre-experimentally established history with spiders. On day 3, participants were given a second exposure to the Avoidance-IRAP and the BAT. Given that participants had been exposed to the BAT on day 2, which involved actually approaching (i.e., not avoiding) a live spider, perhaps the change in IRAP performance on this trial-type reflected their most recent interaction with a spider. Critically, no such change was observed on any of the four trial-types for the Fear-IRAP, thus supporting the conclusion that the IRAPs were differentially sensitive to fear and avoidance biases.

In a related vein, it is worth noting that the *Spider-Approach* trial type showed no significant difference in response biases from day 2 to day 3. Thus, it appears that exposure to the BAT impacted participants response bias on the IRAP in terms of *avoiding* but not approaching spiders. Of course, this is a post-hoc interpretation of the findings, but it is

consistent with the conclusion that approach and avoidance responding on the IRAP may be functionally independent behaviors.

The previously published research by Leech et al, (2016) suggested that the IRAP provides a certain level of precision in terms of measuring approach and avoidance as functionally independent behaviors. Specifically, the authors reported that the *Spider-Approach* trial-type on the Avoidance-IRAP predicted BAT performance but the *Spider-Avoid* trial-type did not. In the current study, we replicated the findings of Leech et al., (2016) for the control condition. Specifically, on day 2, a significant correlation was recorded between the *Spider-Approach* trial type and the BAT but not for the *Spider-Avoid* trial-type and the BAT. That is, for the control condition, the *Spider-Approach* trial-type predicted BAT performance but the *Spider-Avoid* trial-type did not.

It is worth noting that similarities between the current study and the previously published study suggest that this finding should not be surprising. First, the demographic nature of the participants in each study were similar, in terms of education, age, sex and *N* size. That is, all participants were attending university, were of similar age, were gender balanced, and had similar *N* sizes for each group. Second, participants were exposed to the same order of presentation of the IRAP and BAT in both studies. Third, and perhaps most importantly, neither the participants of the first study nor the participants assigned to the control condition in the current study were exposed to an intervention designed to target fear or approach/avoidance responding. In short, the control condition on day 2 of the current study could be seen as a direct replication of the previously published study by Leech et al. (2017). The experimental similarities between the current study and the previously published study, and the replication of results reported here, provide further evidence of the functional independence of approach and avoidance responding, and to a certain extent, the utility of the IRAP as a measure of these functionally independent behaviors.

Although no significant effects for the Fear-Related Verbal-Rehearsal tasks were recorded in terms of modifying IRAP or BAT performances across the three conditions, the differential pattern of correlations between the measures across the conditions could be important. Critically, on day 2, IRAP performances correlated with the BAT and FSQ in the control condition but failed to do so in the accept-fear condition and with one exception, the reduce-fear condition. Specifically, on day 2 in the control condition, the *Spider-Fear* and *Spider-Approach* trial-types correlated with the BAT, and the *Pet-Avoid* and *Spider-Approach* trial-types correlated with the FSQ. In the reduce-fear condition, the *Pet-Approach* trial-type correlated with the FSQ. Given that there were no significant correlations for the accept-fear condition and with one exception in the reduce-fear condition, it appears that the Fear-Related Verbal-Rehearsal task had an impact on the relation between the IRAP and BAT measures. That is, on day 2, the Fear-Related Verbal-Rehearsal task seemed to undermine or defuse the relation between the IRAP and BAT for the accept-fear and reduce-fear conditions; no such effect was observed for the control condition (presumably because participants did not complete a Fear-Related Verbal-Rehearsal Task). Interestingly, on day 3, IRAP performances failed to correlate with the BAT or FSQ in the control condition, accept-fear condition and with one exception, the reduce-fear condition. Although again rather post-hoc, a reasonable interpretation is that exposure to the BAT on day 2 undermined the relation between the IRAP and explicit measures (as recorded on day 3). Furthermore, these findings also suggest that the accept-fear condition, at least to some extent, nullified exposure to the BAT because there were no significant correlations recorded between the IRAP and explicit measures on days 2 or 3 for the accept-fear condition.

In simple terms, for the accept- and reduce-fear conditions, the Fear-Related Verbal-Rehearsal task appeared to impact the behaviour-behaviour relation between the behavioural measures (i.e., IRAP and BAT) rather than directly impacting on participants performance

on, or relational responding within the measures (i.e., D-IRAP and BAT scores). Given the apparent absence of these effects in the control condition on day 2, a reasonable post-hoc interpretation would suggest that the Fear-Related Verbal-Rehearsal task was responsible for the change in the behavior-behavior relations between the IRAP and BAT for the accept- and reduce-fear conditions. Of course, this effect requires further study robust.

Correlations between the FSQ and BAT performances also reveal some interesting results. The reduce-fear and control conditions produced relatively strong and significant correlations on days 2 and 3, whereas the accept-fear condition effects were relatively weak. That is, for the control and reduce-fear conditions, the higher a participants self-reported fear of spiders, the fewer steps they took on the BAT. While this pattern is also observed for the accept-fear condition, the effects are non-significant, further supporting the suggestion that the accept-fear condition may have undermined the relation between the two measures (i.e., between reporting fear and actual approach behaviors).

As mentioned previously, there were no significant differences in BAT performance among the three conditions on Days 2 and/or 3. However, in an attempt to investigate the potential impact of the Fear-Related Verbal Rehearsal task on BAT performances following immediate exposure to the task, and at follow-up without exposure to the task, comparisons between BAT performances were conducted within the three conditions. The rationale for this was to investigate whether the effects observed, if any, were indicative of the participants learning histories or if the task had indeed modified behavioural responding at two separate timepoints. Comparisons between BAT performances from day 2 to day 3 for the accept-fear condition revealed no significant difference. This finding suggests that the accept-fear condition may have reduced the impact of exposure to the BAT as a source of actual change in approach behaviors. Comparisons between BAT performances for the control condition for days 2 and 3 indicated a marginally significant difference. Given that the control condition

was not exposed to the Fear-Related Verbal Rehearsal task, a possible explanation for this finding is that physical exposure to the spider on the BAT on day 2 may have impacted BAT performance on day 3. BAT comparisons for the reduce-fear condition revealed a significant difference between performances from day 2 to day 3. This finding is perhaps the most interesting, because it suggests that the absence of a fear reducing exercise between days 2 and 3 impacted BAT performance rather than physical exposure to the spider, as was the case for the control condition. Specifically, by not requiring participants to complete the Fear-Related Verbal Rehearsal task on day 3, even after BAT exposure on day 2, resulted in a significant difference in BAT performances.

Reflecting upon the data reported here, and the previously published study by Leech et al. (2017), it is interesting to note that a relatively robust correlation was obtained between the BAT and the *Spider-Approach* trial-type. A possible (post-hoc) explanation for this specific correlation has been provided by a recent model; the differential arbitrarily applicable relational responding effects (DAARRE) model. A core assumption of the model is that differential trial-type effects may be explained by the extent to which two broadly defined properties (Cfunc and Crel) of the label and target stimuli contained within an IRAP cohere with the specific properties of the two response options. At the current time, two broad classes of Cfunc properties have been proposed – orienting and evoking functions. The former function refers to the extent to which a stimulus causes an organism to orient towards (or notice) a stimulus; the latter function refers the aversive or appetitive properties of the stimuli. The Crel properties of the stimuli refer to the relational functions of the stimuli (e.g., label x “goes with” target y). A graphical representation of the *Spider-Approach* trial-type in terms of the DAARRE model is presented in Figure 2.

The current model assumes a negative Crel between spiders and approach, and thus a correct response on a history consistent trial would be “No”. Let us assume that the orienting

functions for spider stimuli for low-fear participants will relatively strong and evoking functions relatively weak (because they neither like nor fear spiders). Let us also assume that the evoking functions for high-fear participants will be relatively strong and aversive (negative); the orienting functions might also be relatively strong, but the evoking functions predominate because spiders are perceived to be extremely threatening/disgusting or aversive If these assumptions are correct then the DAARRE model may help to explain why this particular trial-type has produced relatively robust correlations with BAT.

In simple terms, low-fear participants may experience a type of "Yes-Yes" effect when presented with the *Spider-Approach* trial type -- because they simply "notice" that the label stimulus is a spider. Consequently, they may experience a tendency to pick the coherent response option (in this case "Yes"). In contrast, the high-fear participants may experience a type of "No-Yes" effect because they not only notice (orient towards) the spider but find it highly aversive. The incoherence of this "No-Yes" effect may thus facilitate picking the incoherent response option (in this case, "No"). In effect, low- versus high-fear participants may be particularly sensitive to responding differentially to the two different response options, and this would explain the apparently robust correlations with performance on the BAT.[3] Of course, this differential sensitivity may be undermined when participants have recently been exposed to a BAT and/or completed a verbal rehearsal task that modifies the strength of the verbal relations targeted by the IRAP.

Given the exploratory nature of the current research and post-hoc interpretations of the results, there are a number of limitations worth noting. First, participants completed the self-report questionnaires at the beginning of the experiment on day 1. The correlational

[3] The other spider trial-type (*Spider-Avoid*) could also be seen as producing different responses from high- and low-fear participants but in this case they both produce a tendency towards picking "No". That is, the low-fear participants may experience a "Yes-No" effect and thus tend towards picking "No", based on the incoherence between the label and target; the high-fear participants may experience a "No-No" effect and thus also tend towards picking "No" but simply because two "Negative" reactions may cohere with False more readily than "Yes".

analyses reported here between self-report measures, IRAPs and BATs are thus based on participants pre-experimental self-reporting. Following exposure to the IRAPs and BATs, it would be interesting to see if participants self-reported fear of spiders reduced or increased following the first and second exposure to the spider. Future research would benefit from recording participants self-reported fear of spiders pre- and post-exposure to the BAT. This would allow for multiple comparisons of participants self-reported fear with relational responding on the IRAP and overt behavior on the BAT.

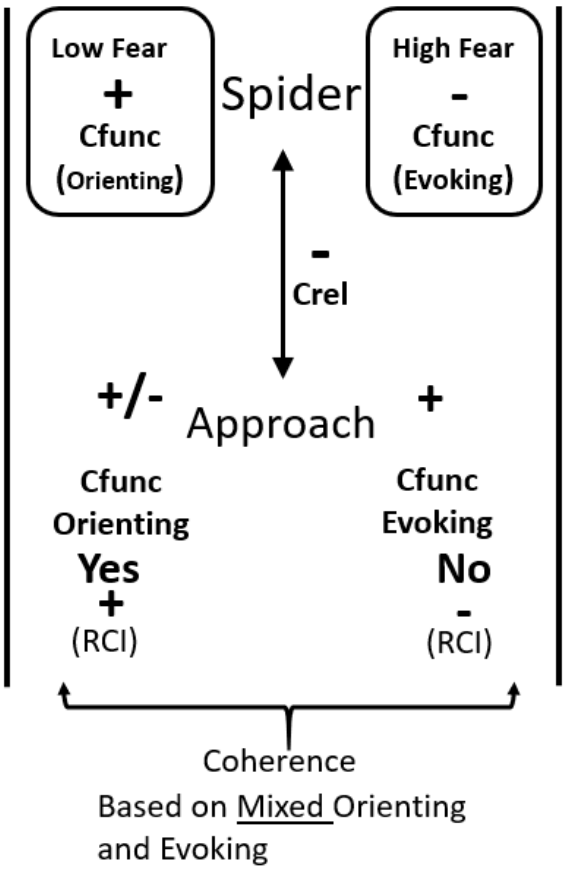

Figure 2. DAARRE model depicting the *Spider-Approach* trial-type.

Second, the Fear-Related Verbal-Rehearsal task employed in the current research was a novel task based on ACT defusion protocol. Given the findings of the current research, and the likely effect physical exposure to the BAT had on the results reported here, future research could explore the utility of a therapeutic exposure intervention versus an ACT

defusion protocol on participants behavioural responding towards fearful stimuli. This would allow researchers to determine the extent to which these approaches may modify participants relational responding on the IRAP, behavioural responding on the BAT, and/or the relations between the measures. Specifically, is physical exposure to the BAT enough to modify and sustain a permanent behavior change or is the inclusion of a therapeutic exposure intervention or an ACT defusion protocol also required to produce the desired changes? Perhaps, a combination of both is necessary to produce long lasting reduction in fear and avoidance behaviors.

Third, the experiment was conducted in two languages. That is, participants were required to complete the Fear Related Verbal Rehearsal task in English but the IRAPs and self-report measures in Dutch. Whilst the inclusion criteria required participants to be fluent in both Dutch and English, the participants were native Dutch speakers. Conducting the experiment in the participants native language would have given us greater contextual control between the behavioural measures. Future research could address this shortcoming by ensuring all aspects of the experiment are conducted in the participants native language.

Last, we did not consider the potential impact of the elapsed time differences between the first, second and third experimental sessions on participants behavioural responding. That is, all experimental sessions took place within a 7-day period, however, we did not check for differences in behavioural responding based on elapsed time differences between each of the sessions. For example, would there be a difference in IRAP or BAT responding on day 3 where a period of 24 hours versus 48 hours had elapsed since the initial exposure to the IRAP or BAT on day 2? Future research would benefit from exploring the potential impact of elapsed time between the first day of behavioural responding and follow up responding.

References

Augustson, E. M., & Dougher, M. J. (1997). The transfer of avoidance evoking functions through stimulus equivalence classes. *Journal of Behavior Therapy and Experimental Psychiatry*, *28(3)*, 181–191. http://doi.org/10.1016/S0005-7916(97)00008-6

Bernaerts, I., De Groot, F., & Kleen, M. (2012). De AAQ-II (Acceptance and Action Questionnaire-II), een maat voor experiëntiële vermijding: normering bij jongeren. *Gedragstherapie*, *45*, 389-400.

Bond, F. W., Hayes, S. C., Baer, R., Carpenter, K., Guenole, N., Orcutt, H., Waltz, T., & Zettle, R. (2011). Preliminary psychometric properties of the Acceptance and Action Questionnaire-II: a revised measure of psychological inflexibility and experiential avoidance. *Behavior Therapy*, *42(4)*, 676–88. http://doi.org/10.1016/j.beth.2011.03.007

deBeurs, E., vanDyck, R., Marquenie, L., Lange, A, & Blonk, R. W. B. (2001). De DASS; een vragenlijst voor het meten van depressie, angst en stress. *Gedragstherapie*, *34(1)*, 35–53.

Donati, M. R., Masuda, A., Schaefer, L. W., Cohen, L. L., Tone, E. B., & Parrott, D. J. (2019). Laboratory analogue investigation of defusion and reappraisal strategies in the context of symbolically generalized avoidance. Journal of the Experimental Analysis of Behavior, 112(3), 225-241.

Dougher, M. J., Augustson, E., Markham, M. R., Greenway, D. E., & Wulfert, E. (1994). The transfer of respondent eliciting and extinction functions through stimulus equivalence classes. *Journal of the Experimental Analysis of Behavior*, *62(3)*, 331–351. http://doi.org/10.1901/jeab.1994.62-331

Hayes, S. C., & Brownstein, A. J. (1986). Mentalism, behavior-behavior relations, and a

behavior-analytic view of the purposes of science. *The Behavior Analyst, 9(2),* 175-190.

Henry, J. D., & Crawford, J. R. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): construct validity and normative data in a large non-clinical sample. *The British Journal of Clinical Psychology*, *44*(Pt 2), 227–39. http://doi.org/10.1348/014466505X29657

Leech, A., Barnes-Holmes, D., & Madden, L. (2016). The Implicit Relational Assessment Procedure (IRAP) as a measure of spider fear, avoidance, and approach. *The Psychological Record, 66(3)*. http://doi.org/10.1007/s40732-016-0176-1

Leech, A., Barnes-Holmes, D., & McEnteggart, C. (2017). Spider fear and avoidance: a preliminary study of the impact of two verbal rehearsal tasks on a behavior–behavior relation and its implications for an experimental analysis of defusion. *The Psychological Record, 67(3),* 387-398.

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behavior Research and Therapy, 33(3),* 335–343. http://doi.org/10.1016/0005-7967(94)00075-U

Luciano, C., Valdivia-Salas, S., Ruiz, F. J., Rodríguez-Valverde, M., Barnes-Holmes, D., Dougher, M. J., Cabello, F., Sanchez, V., Barnes-Holmes, Y., & Gutierrez, G. (2013). Extinction of aversive conditioned fear: Does it alter avoidant responding? *Journal of Contextual Behavioral Science, 2,* 120-134. http://dx.doi.org/10.1016/j.jcbs.2013.05.001

Luciano, C., Valdivia-Salas, S., Ruiz, F. J., Rodríguez-Valverde, M., Barnes-Holmes, D., Dougher, M. J., Lopez-Lopez, J. C., Barnes-Holmes, Y., & Gutierrez-Martinez, G. (2014). Effects of an acceptance/diffusion intervention on experimentally induced

generalised avoidance: A laboratory demonstration. *Journal of the Experimental Analysis of Behavior, 101,* 94-111. doi:10.1002/jeab.68

Muris, P., & Merckelbach, H. (1996). A comparison of two spider fear questionnaires. *Journal of Behavior Therapy and Experimental Psychiatry, 27(3),* 241–244. http://doi.org/10.1016/S0005-7916(96)00022-5

Nicholson, E., & Barnes-Holmes, D. (2012). The Implicit Relational Assessment Procedure (IRAP) as a measure of spider fear. *The Psychological Record, 62,* 263–278. http://doi.org/10.1007/s40732-016-0176-1

Paez-Blarrina, M., Luciano, C., Gutiérrez-Martínez, O., Valdivia, S., Ortega, J., & Rodríguez-Valverde, M. (2008). The role of values with personal examples in altering the functions of pain: Comparison between acceptance-based and cognitive-control-based protocols. *Behaviour Research and Therapy, 46(1),* 84-97.

Szymanski, J. & O'Donohue, W. (1995). Fear of spiders questionnaire. *Journal of Behavior Therapy and Experimental Psychiatry, 26(1),* 31-34. http://dx.doi.org/10.1016/0005-7916(94)00072-T