The Implicit Relational Assessment Procedure (IRAP) as a Measure of Spider Fear, Avoidance, and Approach

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Abstract

The current study examined the use of the Implicit Relational Assessment Procedure (IRAP) as a measure of spider fear, approach, and avoidance. Participants were drawn from a normative sample of university undergraduates. Experiment 1employed two IRAPs, one targeting spider fear, the other targeting spider approach/avoidance. The Fear of Spiders Questionnaire (FSQ) and a Behavioral Approach Task (BAT) using a spider moult were also employed. Negative response biases for spider fear and avoidance, but not for approach, were recorded. The bias for fear was significantly stronger than for avoidance and approach. Both IRAP's failed to provide evidence for the predicative validity of the IRAP in terms of the BAT. Experiment 2 was a partial replication of Experiment 1 but using a live house spider instead of a moult for the BAT. A similar pattern of results was obtained across the two IRAPs but one specific trial-type (*Spider-Approach*) predicted approach responses on the BAT. The research thus replicated a previously published study by Nicholson and Barnes-Holmes (2012), thus supporting the predictive validity of the IRAP but at a level of precision not provided in the earlier study. Implications for applied research are considered.

One of the ways in which behavior-analytic researchers have interpreted and studied human language and cognition is through an account known as Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001). The core analytic units of this theory are labelled relational frames, and one of the key properties of these units is the derived transformation of functions. This property is used to describe and explain response patterns that emerge in the absence of direct or explicit learning histories (see Hughes, De Houwer & Barnes-Holmes, 2016, for a recent detailed review). A simple example of the derived transformation of functions would first involve training a series of matching responses among arbitrary stimuli, such as *Cug*-*Vek* and *Vek*-*Yim*, and testing for derived relations to confirm that the three stimuli now participate in a relational frame of equivalence or coordination (e.g., the participant may match *Cug* to *Yim* and *Yim* to *Cug* in the absence of direct training, prompting or instruction). To observe the transformation of functions, a particular response to *Cug* might be established through direct pairing with a negatively valenced stimulus, for example, and then a similar response would be observed for *Yim* although it had not been paired directly with a negatively valenced event.

Over 20 years ago behavioral researchers began to use the derived transformation of functions as a paradigm to explore how verbally-able humans come to fear and avoid stimuli in the absence of direct stimulus pairings or differential reinforcement. Some studies, for example, established frames of coordination among arbitrary stimuli and then paired one or more of the stimuli in the frame with the presentation of mild electric shock. Various measures of fear, including skin conductance responses (SCRs), indicated increased levels of fear to the stimuli that had been directly paired with shock and those that were indirectly related to those stimuli via the frame of coordination (Dougher, Augustson, Markham, Greenway, & Wulfert, 1994). Similar derived transformation effects were also demonstrated for the extinction of fear responses (Dougher, et al., 1994) and also avoidance responding (Augustson & Dougher, 1997).

Recent research on the derived transformation of functions has begun to explore the functional independence of derived fear and avoidance. Specifically, one study by Luciano, et al. (2013) established a fear response for a stimulus using a respondent conditioning paradigm and electric shock as a UCS, and then demonstrated the derived transformation of that function to other stimuli that participated in a frame of equivalence. In effect, the researchers provided matching-to-sample training designed to establish an equivalence relation among six stimuli (A-B-C-D-E-F) and when the A and B stimuli were paired with shock the E and F stimuli also elicited fear, although they were never directly paired with shock. Subsequently, the fear responses were extinguished for both the respondently conditioned stimuli, and the other members of the equivalence class, by presenting the directly conditioned stimuli in the absence of shock. Critically, however, participants continued to engage in avoidance responding even though the fear had been extinguished (i.e., as measured by skin conductance). In effect, avoidance continued in the apparent absence of fear. In a broadly similar study, Luciano et al. (2014) demonstrated again that it was possible to establish a derived transformation of fear and avoidance functions via equivalence relations, but this time they did not employ an extinction procedure. Rather they presented an analogue intervention based on acceptance and commitment therapy, which they labelled a defusion protocol. Participants exposed to this protocol continued to show fear responses (as measured using skin conductance) but avoidance responses dropped to near zero. In this second study, therefore, fear continued in the absence of avoidance. Taken together, therefore, the two studies demonstrated the functional independence of fear and avoidance using the derived relations (and transformation of functions) paradigm.

The derived transformation of functions paradigm has also been used to explore how individual differences in the levels of fear may moderate the observed transformation effects. Specifically, Smyth, Barnes-Holmes, and Forsyth (2006) showed that when a stimulus from an equivalence frame was paired with film clips of spider-attack scenes not only did the directly paired stimuli acquire fear functions, but so too did the other stimuli in the relational frame, although they were never directly paired with the spider stimuli. Critically, the levels of fear that were involved in the transformation of function were moderated by the participants' self-reported levels of spider-fear. That is, participants who reported that they were highly spider-fearful yielded higher levels of spider fear based on the transformation of functions relative to those participants who reported only low levels of spider fear.

Although the derived transformation of functions paradigm has provided one means by which to study how verbally-able humans may come to fear and avoid specific stimuli, and suggests that derived fear effects may differ across individuals, behavior-analytic researchers have also explored other research methods in this domain. One such method involves employing a measure that was designed to target the strength or probability of relational responding that had been established during the pre-experimental history of the participant (see Hussey, Barnes-Holmes, & Barnes-Holmes, 2015). The method, known as the Implicit Relational Assessment Procedure (IRAP), is a computer based task that requires participants to respond quickly and accurately (under time pressure) to sets of stimuli employing a response pattern that may be considered consistent or inconsistent with their previous learning histories (see Barnes-Holmes, Barnes-Holmes, Stewart, & Boles, 2010). Participants are presented with trials where one of two label stimuli are presented at the top of a computer screen and one of two target stimuli that are presented in the middle of the screen. The task for the participant is to choose between two response options presented at the bottom right and left of the screen. The fundamental hypothesis is that relational responding should be quicker and more accurate on history-consistent rather than history-inconsistent blocks of trials.

A simple example of the IRAP might involve presenting one of two label stimuli on each trial, one positively valenced (e.g., pictures of flowers) and the other negatively valenced (pictures of insects). On each trial a positively or negatively valenced word would also be presented ("Safe", "Pleasant", Peaceful" versus "Dangerous", "Harmful" "Bad"). Participants would then be required to choose between one of two response options (i.e. "True" or "False") presented at the bottom of the screen. During a block of history-consistent trials, participants would be required to respond in a manner assumed to reflect prevailing verbal contingencies for insects (e.g., choosing "True" given a picture of an insect and the word "Dangerous") and for flowers (e.g., choosing "True" given a picture of flowers and the word "Safe"). During history-inconsistent trials the opposite pattern of responding would be required (e.g., choosing "False" given insects and positive words).

Typically, the IRAP consists of a minimum of two practice block pairs and three test block pairs. Each block pair consists of two blocks of trials (one history-consistent block and one history-inconsistent block). Each block presents the same number of trials, which is typically comprised of four different trial-types. The trial-types are created using a 2x2 crossover of the label and target stimuli. Given the previous example, the trial-types would be as follows: *Insect-Positive*; *Insect-Negative*; *Flower-Positive;* and *Flower-Negative*. In order to complete a block of trials successfully, participants are generally required to maintain specific performance criteria of 80% accuracy of responding with a median response time of less than 2000ms.

One of the important features of the IRAP is that it produces four separate metrics, one for each of the individual relational response classes (trial-types) that are targeted by the IRAP (Barnes-Holmes, et al., 2010). Additionally, it appears that the IRAP can measure the strength and directionality of relatively simple stimulus relations (e.g., Spider-Fear) and more complex relational networks (I fear spiders but I can approach them). The Relational Elaboration and Coherence (REC) model, which underpins the IRAP, aims to provide an RFT-based explanation for the type of effects that have typically been obtained with the IRAP (Barnes-Holmes, et al., 2010; Hughes, Barnes-Holmes, & De Houwer, 2011; Hughes, Barnes-Holmes, & Vahey, 2012). Consider the earlier example involving four trial-types, *Insect-Positive*; *Insect-Negative*; *Flower-Positive;* and *Flower-Negative*. All things being equal, faster responses would be expected when participants are required to respond in a manner that is consistent rather than inconsistent with their prior relational or verbal histories (e.g., responding *False* more rapidly than *True* on *Insect-Positive* trials). The REC model argues that when an individual is required to respond under time pressure, it is useful to conceptualize such behavior as composed of brief and immediate relational responding (BIRR). In addition, the REC model predicts that, all things being equal, BIRRs that are congruent with the individual's behavioral history will be emitted more rapidly than BIRRs that are incongruent with that history. In other words, BIRRs that overlap functionally with an individual's behavioral history tend to occur at a higher probability on the IRAP than those that do not overlap with that history. The difference in relative probabilities is revealed in the difference scores, in accuracy and latency, which has often been formalized as the *D*-IRAP effect. As an aside, the REC model was developed, in part, to provide a behavior-analytic account of the concept of implicit cognition, which has attracted increasing attention across a range of areas in non-behavioral psychology in recent years (see Barnes-Holmes, et al., 2010; Hughes, et al., 2012, for detailed discussions).

An growing body of research has used the IRAP in a range of clinically relevant domains including, for example, depression (Hussey & Barnes-Holmes, 2012), obsessive compulsive disorder (OCD, Nicholson, Dempsey, & Barnes-Holmes, 2014), and the study of fear of spiders. For example, Nicholson and Barnes-Holmes (2012) conducted a study measuring anti-spider bias on the IRAP as a predictor of avoidant behavior to a live spider. Participants were required to respond in a manner that was deemed either consistent with an anti-spider bias or inconsistent with that bias. For example, the IRAP required responses on some trials that either confirmed or denied that pictures of spiders were negatively valenced (e.g. Spider-Scares-Me = True versus Spider-Scares-Me = False). On other trials, the IRAP required responses that confirmed or denied that the participant could approach the spider pictures (e.g. Spider-I-Can-Approach-True/False). These spider trials were intermixed with an equal number of trials that presented pictures of nature scenes that were deemed to be relatively neutral and functioned as a contrast category. Participants were required to respond in accordance with two pre-specified alternating rules. The anti-spider rule was *"Spiders are scary and I can approach nature",* whereas the pro-spider rule was *"I can approach spiders and nature is scary*". Results indicated that response latencies were faster for anti-spider blocks versus pro-spider blocks for participants who were rated highly fearful based on explicit self-report measures of spider-fear as measured by the Fear of Spiders Questionnaire (FSQ; Szymanski & O'Donohue, 1995). Additionally, the IRAP successfully predicted avoidant behavior on a Behavioral Approach Task (BAT), which involved approaching a live tarantula.

One of the key limitations to the study reported by Nicholson and Barnes-Holmes (2012) is that the IRAP conflated the measurement of fear and approach/avoidance. That is, the IRAP effect that was used to capture fear of spiders involved combining the *D*-scores for trial-types that asked participants to confirm or deny that spiders were aversive (e.g., fear-inducing) with the trial-types that asked them to confirm or deny that they could approach spiders. As noted above, the IRAP performance on these trial-types predicted both self-reported fear and actual approach behavior. However, it is not possible to determine the extent to which the fear and/or approach trial-types were independently predictive of these two response domains. For example, perhaps the spider-fear trial-type would be more predictive of self-reported fear whereas the spider-approach trial-type would be more predictive of performance on the BAT. The two studies reported in the current article aimed to address this question. Or more specifically, the current research sought to use the IRAP to separate the measurement of BIRRs related to fear of spiders from BIRRs related to spider approach/avoidance responses.

Determining if the IRAP could provide separate measures of fear and avoidance (of spiders) was deemed important because behavior-analytic research by Luciano and colleagues, as outlined above, had examined the relationship between fear and avoidance using the transformation of functions paradigm. A recent study also employed the IRAP as a measure of fear (and disgust) related to spiders but no data pertaining to approach/avoidance were presented (Ritzert, Forsyth, Berghoff, Barnes-Holmes, & Nicholson, 2015). The research reported here therefore employed two separate IRAPs, one targeting fear and the other targeting approach/avoidance. The Fear of Spiders Questionnaire (FSQ), and a behavioral approach task (BAT) were also used. The current research was largely exploratory in the sense that the key purpose was to determine if response biases on both IRAPs (for fear on one IRAP and approach/avoidance on the other) would be observed, and to what extent such biases would correlate with the questionnaire and BAT measures.

The current research also differed from the previously published IRAP studies on spider fear in a number of ways. First, a different contrast category from that employed in the two previous IRAP studies on spider fear was used. Specifically, the earlier work presented pictures of natural scenes (Nicholson & Barnes-Holmes, 2012; Ritzert, et al., 2015), which upon reflection might have evoked some of the psychological properties of spiders (e.g., one frequently finds spiders in gardens or forests, and so on). Thus participants in the present research were asked to indicate their preference for dogs versus cats and their preferred category of animal was then inserted into the IRAP as a contrast category for spiders. The aim here was to present an IRAP with a relatively strong positively valenced stimulus category against which responses to spiders could be assessed. Second, unlike the research reported by Nicholson and Barnes-Holmes, which employed a live tarantula, Experiment 1 employed a spider moult whereas Experiment 2 employed a live Irish house spider. Third, Nicholson and Barnes-Holmes employed a dichotomized sample in that participants were selected based on whether they were deemed to be high or low in spider-fear in terms of their scores from the FSQ. In adopting this strategy it is possible that the correlational analyses may have been somewhat inflated, as indeed acknowledged by the authors (p. 271). Thus for the current research the participants were sampled randomly with no effort to dichotomize high- from low-fear participants.

EXPERIMENT 1

Method

Participants

Fifty five undergraduate students attending Maynooth University, Ireland, volunteered to participate in the study (*N* = 55; 26 Females, 29 Males). All participants completed a brief pre-screening questionnaire, which asked for age, gender, levels of self-reported spider fear, and the participant's preference for dogs or cats. Ten participants were eliminated due to their failure to achieve the necessary performance criteria (see "procedure" section), leaving 21 females and 24 males (*N* = 45), the results of whom were subject to analysis. The mean age was 21.5 years (*SE* = .42; range = 18–38). The participants completed the study individually in the Department of Psychology at Maynooth University. Upon completion, participants were fully debriefed. Prior to the experiment, participants read and signed a consent form, which informed them that they could withdraw from the study at any time. The two studies reported here were conducted in accordance with the ethical guidelines of Maynooth University.

Materials

Fear of Spiders Questionnaire. The Fear of Spiders' Questionnaire (FSQ; Szymanski & O'Donohue, 1995) 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; Symanski & O'Dononhue, 1995).

Tarantula Moult Behavioral Approach Task (BAT). A tarantula moult approximately 10cm in diameter was used as the stimulus for the BAT. A tarantula moult is the skin that remains after a spider has shed/moulted. It is an exact mould of the spider with fine details including hair. The moult was kept in a small plastic transparent container with a closed lid. There were five steps involved in the BAT, which took participants progressively closer to the tarantula moult and was scored 0 – 5. Participants were informed they could stop or withdraw at any point. The first step involved participants opening the door to the room where the tarantula moult 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 and look at the tarantula moult. The third step brought participants closer again and required them to touch the box containing the tarantula moult for thirty seconds. The fourth step required participants to open the lid of the box where the tarantula moult was kept. The fifth and final step required participants to put their hand into the box and touch the tarantula moult for ten seconds.

The Implicit Relational Assessment Procedure. The IRAP is a computer based programme that requires participants to respond quickly and accurately to specific stimuli that are deemed either consistent or inconsistent with their prior learning histories and/or response biases. The stimuli are presented in the forms of trials within a series of blocks. The fundamental hypothesis of the IRAP is that relational responding should be quicker and more accurate across blocks of trials that require responding that is consistent with the participant's learning history and/or response biases than on blocks that require responding in a manner that is inconsistent with that history and/or response biases. The primary datum from the IRAP is response latency, which is measured in milliseconds, and defined as the time that elapses from the onset of stimuli in each trial to the emission of a correct response. Participants were required to respond in a manner that was either deemed consistent with an anti-spider/pro-pet bias or inconsistent with that bias. Participants were required to complete two separate IRAPs, one targeting Fear (i.e. F-IRAP) and another targeting avoidance (i.e. A-IRAP).

The label stimuli for the two IRAPs consisted of one of twelve images: six were colour images of various spiders and the other six were various images of either puppies or kittens. Some of the spider images were taken from the Nicholson and Barnes-Holmes (2012) study on High/Low spider fear. The remainder of the images were sourced freely on Google. In the case of the spider images, the pictorial stimuli were chosen because they reflected a range of spiders, some of which were common house spiders, some highly poisonous and the rest unknown. The pet images were selected because they represented a range of different popular breeds of puppies or kittens.

Procedure

All participants completed three types of measures; two IRAPs, the FSQ and the BAT. The order in which three measures were completed was counterbalanced across participants. The order in which the two IRAPs were presented was also counterbalanced across participants.

F-IRAP. In this IRAP, participants were required to complete some blocks of trials that required responding in a manner that coordinated pictures of spiders with fear-related words and pictures of pets with positively-valanced words (hereafter referred to as anti-spider blocks). On other blocks of trials the opposite response pattern was required – coordinating spiders with positively valenced words and pets with fear-related words (hereafter referred to as pro-spider blocks). At the beginning of each anti-spider block participants were presented with the rule; *"Please respond as if, Spiders are Scary and Puppies [or Kittens] are Pleasant. Please try to avoid the red X"*, and at the beginning of each pro-spider block participants were presented with the rule; *"Please respond as if, Spiders are Pleasant and Puppies [or Kittens] are Scary`. Please try to avoid the red X."*. A message of encouragement appeared below the rule that read *"Try to get as many as possible 'right' according to the rule above"*. Instructions for beginning each block of trials were presented beneath the rule and read "*Press space to continue"*. 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.

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: *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". The four 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). Target Stimuli for the F-IRAP can be found in Table 1.

Table 1

Target Stimuli for F-IRAP.

Target Stimuli - Fear	Target Stimuli - Pleasant
Scares me	Calms me
Terrifies me	Comforts me
Frightens me	Cheers me up
Worries me	Makes me happy
Creeps me out	I like it
Horrifies me	Relaxes me
Panics me	Makes me smile
Alarms me	Pleases me

Participants were required to achieve two performance criteria (see below) to complete one pair of practice blocks (i.e. one anti-spider block and one pro-spider block) before progressing onto the test blocks. Participants were allowed to attempt three practice-block pairs; if a participant was unsuccessful after the three pairs the program did not progress onto the test blocks and a message appeared that read "*Please contact the researcher"*. Participants were then debriefed and thanked for their time. The criteria for advancement to the test blocks required participants to produce >80% accuracy while maintaining < 2000ms average latency for each practice block within a pair. Once participants achieved these criteria they were 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).

On each trial, an image of either a spider or a pet (puppy or kitten) 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.

Each block commenced with the presentation of either an anti-spider or pro-spider rule. When the anti-spider rule was presented the task for the participant was to press the "*Yes*" key if the stimulus pair were consistent with the rule and to press the "*No*" key if the stimulus pair were inconsistent with the rule. For example, responding "*Yes"* was deemed correct when presented with a picture of a spider and a fear appraisal phrase (e.g. "Scares me" or "Terrifies me"), or when a picture of a pet was presented with a pleasant appraisal (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 appraisal, or when a picture of a pet was presented with a fear appraisal. When a pro-spider rule was presented at the beginning of a block the opposite pattern of responding was required. That is, responding "*No"* when presented with a spider and fear appraisal, or when presented with a pet and a pleasant appraisal; and responding *"Yes"* when presented with a spider and a pleasant appraisal, or a pet and a fear appraisal.

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, a red exclamation mark 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. To avoid "over-loading" the participants when they first began the IRAP, the latency-prompt (the exclamation mark) was not presented during the first pair of practice blocks; but it was presented during all subsequent practice (and test) blocks. An additional message appeared on screen before each such block that read *"If you go over time on any trial '!' will appear"* in red text.

Upon completion of each block, participants were presented with a screen displaying performance feedback for that block. Following completion of the first practice block, a message displaying accuracy for the previous block appeared in black colored text (i.e. Your scores on the previous block: Accuracy: 91%). Below this, in red colored text, the target for the next block was displayed (i.e. Your targets for the next block: Accuracy: More than 80%). On completion of the second practice block, *and every block thereafter,* the participants' accuracy scores and their speed scores were displayed in black coloured text (i.e. Your scores on the previous block: Accuracy 91%, Speed: 1100 milliseconds). Below this in red text, a message describing the participants target for the next block appeared (i.e. Accuracy: More than 80%, Speed: Less than 2000 milliseconds). After each pair of practice blocks (one anti-spider and one pro-spider) a screen appeared displaying two messages. The first was a message of encouragement that read *"Keep practicing until your accuracies are at least 80% correct and your speeds are less than 2000 milliseconds".* The second message displayed performance on each block within that block pair, for example; *"Your scores on the previous pair of blocks: Accuracies: 91% and 91%. Speeds: 1100 and 1280 milliseconds".* Similar performance feedback was presented after each test block (the second message providing feedback after each pair of test blocks was not presented). Once all test blocks were completed, a blue screen appeared with the following text "*Please contact the researcher"*.

A-IRAP. The procedure for the A-IRAP was similar to the F-IRAP except the target stimuli and the rules presented at the beginning of each block were modified. Specifically, the target stimuli referred to approach and avoidance responses (see Table 2), and the two rules were as follows: anti-spider rule, *"Please respond as if, Spiders are Distressing and Puppies* *[or Kittens] are Pleasant. Please try to avoid the red X";* pro-spider rule, *"Please respond as if, Spiders are Pleasant and Puppies [or Kittens] are Distressing. Please try to avoid the red X"*.

Table 2

Target Stimuli for A-IRAP

Target Stimuli - Avoid	Target Stimuli - Approach
I need to escape	I can stay
I need to run away	I can touch it
I need to get out	I can pick it up
I need to avoid it	I can approach it
I need it removed	I can play with it
I need to get away	I can carry it
I need to leave	I can hold it
I need to retreat	I can face it

Results and Discussion

Validating the BAT

The correlation between the FSQ and the BAT proved to be relatively strong and significant (r = -.481, p = .0007), indicating that higher reported levels of fear on the FSQ predicted fewer approach steps on the BAT.

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 78% 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 Nicholson and Barnes-Holmes (2012), 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 analyzed. If participants failed to maintain the criteria across two or more pairs of blocks all of the data from that participant were excluded from further analysis. The data for 10 participants were removed on this basis (two participants failed the F-IRAP, six failed the A-IRAP, two failed both IRAPs). The latency data from the F-IRAP and A-IRAP were transformed into *D*-IRAP scores detailed in Table 3.

Table 3

Method for Converting the Response Latencies from Each Participant into D-IRAP Scores

1	The response latencies from only the six test blocks were utilised for the data analysis.
2	Any latency that exceeded 10,000 ms was removed from the data set.
3	If the data of a participant contained response latencies of less than 300 ms in more than 10% of test block trials, the participant was removed from the data set.
4	Standard deviations were calculated for each of the four trial-types per pair of test blocks: four from the response latencies from the first and second test blocks, four from the response latencies from the third and fourth test blocks, and four from the response latencies from the fifth and sixth test blocks.
5	A mean latency score was calculated for each of the four trial-types in each test block. This resulted in 24 mean latencies for the four trial-types over the six test blocks.
6	A difference score was calculated for each of the four trial-types in each test block. This was done by subtracting the latency of the anti-spider test block from the corresponding pro-spider test block.
7	Each difference score was divided by its corresponding standard deviation (Calculated in step 4) which yielded 12 *D*-IRAP scores, one for each trial-type for each pair of test blocks.
8	Four overall *D*-IRAP scores were calculated for each trial-type. This was done by averaging the scores for each of the four trial-types across each of the three pairs of test blocks.

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 F-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 reversed (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 A-IRAP were subjected to the same scoring procedure as the F-IRAP, and thus positive *D*-IRAP scores indicate a positive bias (pro-approach/anti-avoidance) for both spiders and pets and negative scores indicate a negative bias (anti-approach/pro-avoidance) for both types of stimuli.

Mean Scores Analyses

The eight *D*-IRAP scores, four for the F-IRAP and four for the A-IRAP, are presented in Figure 1. The F-IRAP produced a strong negative bias for the *Spider-Fear* trial-type but positive biases for the remaining three trial-types, although the effect for the *Spider-Pleasant* trial-type was close to zero. 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 strong 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 “Yes” rather than “No”.

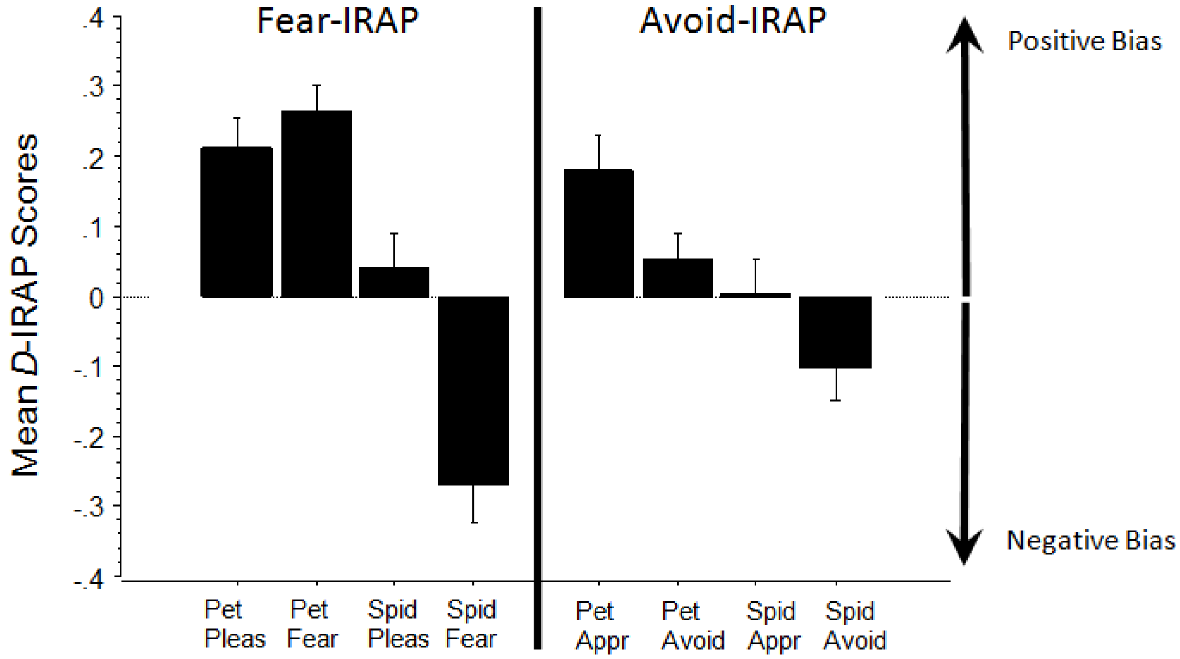

Figure 1: Eight mean *D*-IRAP scores for the F-IRAP and A-IRAP.

The A-IRAP produced a negative bias for the *Spider-Avoidance* trial-type but positive biases for the remaining three trial-types, although the effect for the *Spider-Approach* trial-type was almost zero. In concrete terms, participants tended to respond "Yes" more quickly than "No" when presented with a picture of a spider and an avoidance phrase or a picture of a pet and an approach phrase. When presented with a picture of a pet and an avoidance phrase, participants showed a weak tendency to respond "No" rather than "Yes". Finally when presented with a picture of a spider and an approach phrase, participants responded "Yes" and "No" with almost equal bias.

The eight *D*-IRAP scores for each participant were entered into a 2x4 repeated measures analyses of variance (ANOVA) with IRAP type (F-IRAP and A-IRAP) and each of the four trial-types as repeated measures. The main effect for trial-type was significant, F (3, 132) = 25.764, $p < .0001$, $\eta_p^2 = .37$, but the effect for IRAP type was not ($p > .3$). Critically, however, the interaction effect was significant, F (3, 132) = 5.984, $p = .0007$, $\eta_p^2 = .12$. To better understand the nature of this interaction, the data from each IRAP were first analyzed separately; between-IRAP comparisons are presented thereafter.

The F-IRAP. A one way repeated measures analysis of variance (ANOVA) was conducted with trial-type as the repeated measure and this proved to be significant, F (3,44) = 25.794, p <.0001, η_p^2 = .37. Post-hoc comparisons using Fisher's PLSD tests indicated that the mean score for the *Spider-Pleasant* trial-type (M = -.04, SE = .05) was significantly different from the scores for the other three trial-types (*ps* < .0001), *Spider-Fear* (M = .27, SE = .05); *Pet-Fear* (M = .26, SE = .04); *Pet-Pleasant* (M = .21, SE = .04). In addition, the mean scores for the *Spider-Fear* trial-type were significantly different from the *Pet-Fear* and *Pet-Pleasant* trial-types (*ps* <.0001). Four one-sample *t*-tests indicated that the *Pet-Pleasant*, *Pet-Fear,* and *Spider-Fear* trial-type effects were each significantly different from zero (*ps* < .0001), but the effect for *Spider-Pleasant* was not (p = .4). The inferential statistics for the F-IRAP therefore confirmed the descriptive statistics presented in Figure 1.

The A-IRAP. The one way repeated measures analysis of variance (ANOVA) was conducted with A-IRAP trial-type as the repeated measure and this proved to be significant, F (3,44) = 6.677, p =.0003, η_p^2 = .132. Post-hoc comparisons using Fisher's PLSD tests indicated that the mean score for *Pet-Approach* trial-type (M = .18, SE = .05) was significantly different from the scores from the other three trial-types, *Pet-Avoid* (M = .05, SE =.04), *Spider-Approach (*M = .006, SE = .05), and *Spider-Avoid* (M = -.102, SE = .05). The Mean score for *Pet-Avoid* was also significantly different from the *Spider-Avoid* trial-type (p = .016). Four one-sample *t*-tests indicated that the *Pet-Approach* and *Spider-Avoid* trial-types were significantly different from zero (p = .028) but the effect for the *Pet-Avoid* and *Spider-Approach* trial-types were not. The inferential statistics therefore confirmed the descriptive statistics presented in Figure 1.

Between-IRAP analyses. Four separate paired *t*-tests were used to examine the differences between the corresponding trial-types from each IRAP (i.e. 1. *Pet-Pleasant* vs. *Pet-Approach;* 2. *Pet-Fear* vs. *Pet-Avoid;* 3. *Spider-Pleasant* vs. *Spider-Approach;* 4. *Spider-Fear* vs. *Spider-Avoid*). The differences for the second and fourth comparisons, respectively, proved to be significant, $t = 4.183$, $p < .0001$; $t = -2.648$, $p = .011$, but the remaining two did not ($ps > .5$).

Overall, therefore, the interaction effect between the two IRAPs and their respective trial-types appeared to be driven by larger *D*-IRAP effects for the *Pet-Fear* and *Spider-Fear* relative to the *Pet-Avoid* and *Spider-Avoid* trial-types.

IRAP-Explicit/BAT Correlational Analyses

A correlation matrix was calculated to determine if any of the eight trial-types from the two IRAPs predicted self-reported fear of spiders (on the FSQ) and approach responses on the BAT. The only significant correlation between the IRAP and the explicit/BAT measures was recorded for the *Spider-Fear* trial-type in the F-IRAP and the FSQ ($r = -.329$, $p = .03$), indicating that higher levels of fear on the IRAP predicted higher self-reported fear. The negative correlation between the *Spider-Approach* trial-type and the FSQ approached significance ($p = .07$), suggesting that decreasing approach towards spiders predicted higher self-reported fear.

Table 4

Correlation Matrix for F-IRAP, A-IRAP and Explicit Measures

	F-IRAP Correlation Matrix				A-IRAP Correlation Matrix			
	Pet Pleasant	Pet Fear	Spider Pleasant	Spider Fear	Pet Approach	Pet Avoid	Spider Approach	Spider Avoid
BAT	.14	.167	-.178	.128	.062	.081	.014	.214
FSQ	-.105	.023	.214	-.329*	.184	.019	-.265#	-.201

**p* < .05
# p < .1

Summary and Conclusion

Consistent with Nicholson and Barnes-Holmes (2012), a negative bias for spiders was recorded. Unlike the previous experiment, two separate IRAPs were employed one targeting fear and one targeting approach/avoidance, and both IRAPs revealed significant negative biases. The negative biases for each IRAP were recorded with one specific trial-type in each case (*Spider-Fear* and *Spider-Avoid*), although the strength of the negative bias was stronger for fear than for avoidance. This is the first study, therefore, that has provided evidence that fear and avoidance of spiders may be measured separately using the IRAP.

The correlational analyses indicated that spider fear and approach biases predicted self reported fear levels, although the relationship for approach only showed a trend towards significance. Interestingly, the correlational analyses failed to provide evidence that fear or approach/avoidance biases on the IRAPs predicted behavior on the BAT. Thus, the current study yielded some evidence to support the predictive validity of the IRAPs in terms of predicting self-reported fear levels but little if any evidence that they predicted actual behavior. Critically, the previously published study by Nicholson and Barnes-Holmes (2012) on spider fear using an IRAP reported a moderate to strong correlation (*r* = -.41) with number of steps completed on a BAT. The current study thus failed to replicate the finding that performance on a spider-related IRAP predicts actual approach behavior. Given that a recent meta-analysis of the IRAP in clinically-relevant domains had reported relatively high predictive validity for first-order correlations (*r* = .45), the failure to replicate forced us to reconsider the nature of the BAT we had employed in the current study. Specifically, unlike the Nicholson and Barnes-Holmes study a spider moult was employed in the BAT rather than a live tarantula. Although somewhat speculative, we reasoned that it may be important to use a live spider in a BAT rather than a moult. Indeed, anecdotally, many of the participants reported that the moult was “not a real spider”, either during the actual BAT itself or during de-briefing. In the next experiment, therefore, a live Irish house spider was employed in the BAT. Another issue that we felt required attention related to the anti- and pro-spider rules that were employed with the A-IRAP. Specifically, the pre-block rules asked participants to respond as if spiders are distressing (and pets are pleasant) and vice versa, rather than referring directly to approach and avoidance responses, per se. This was rectified in the next experiment.

EXPERIMENT 2

Method

Participants

Thirty three undergraduate students attending Maynooth University, Ireland, volunteered to participate in this experiment. Prior to the experiment, participants read and signed a consent form informing them that they could withdraw from the experiment at any time. Two participants were eliminated due to their failure to achieve the necessary performance criteria, leaving 18 females and 13 males (*N* = 31). The mean age was 21.68

years (SE = 1.27), with a range of 17 – 55. The participants completed the experiment individually in the Department of Psychology at Maynooth University in accordance with ethical guidelines. Upon completion, participants were fully debriefed.

Materials

The FSQ was employed in the current study. Completing and scoring of the BAT was similar to the previous experiment. Given that the spider was a live specimen, however, on occasion it would move when touched (gently) by participants before the 10 second requirement had been met. When this occurred they were invited to touch the spider again for a full 10 seconds to complete the BAT. If the spider moved again when touched before 10 seconds lapsed, the full 5-steps of the BAT were recorded because the participant had clearly demonstrated a strong approach response and we wished to avoid distressing the spider unnecessarily. The live spider was housed in a transparent container with a flexible lid. The spider was cared for throughout the study and was used with all participants. Upon completion of the study, the spider was released.

Procedure

Apart from a change in the instructions for the A2-IRAP, described below, all other procedural features of the current study were similar to those described for Experiment 1. The *anti-spider* and *pro-spider* rules presented to participants at the beginning of each block of trials for the A2-IRAP specified avoidance and approach responding. Specifically, the *anti-spider* rule now read *"Please respond as if, you want to Avoid Spiders and you want to Approach Puppies [or Kittens]. Please try to avoid the red X"*. The *pro-spider* rule read, *"Please respond as if, you want to Approach Spiders and you want to Avoid Puppies [or Kittens]. Please try to avoid the red X"*. All other criteria employed in the A2-IRAP replicated the A-IRAP in the previous experiment including all mastery criteria and feedback.

Results and Discussion

Validating the BAT

Consistent with the previous study, the correlation between the FSQ and the BAT proved to be strong and significant ($r = -.819$, $p < .0001$), indicating that higher reported levels of fear on the FSQ predicted fewer approach steps on the BAT.

Scoring the IRAPs

Scoring of the two IRAPs was similar to that employed in Experiment 1 as shown in Table 3. If participants failed to maintain the performance criteria (as described in the Results and Discussion section of Experiment 1), then they were excluded from further analysis. The data for two participants were removed on this basis (one participant failed the A-IRAP, and one failed both IRAPs).

Mean Scores Analyses

The eight *D*-IRAP scores, four for the F-IRAP and four for the A2-IRAP, are presented in Figure 2. The F-IRAP produced a strong negative bias for the *Spider-Fear* trial-type. The *Spider-Pleasant* trial-type also produced a negative bias but was close to zero. The pet trial-types produced medium to strong positive biases. 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 strong 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”.

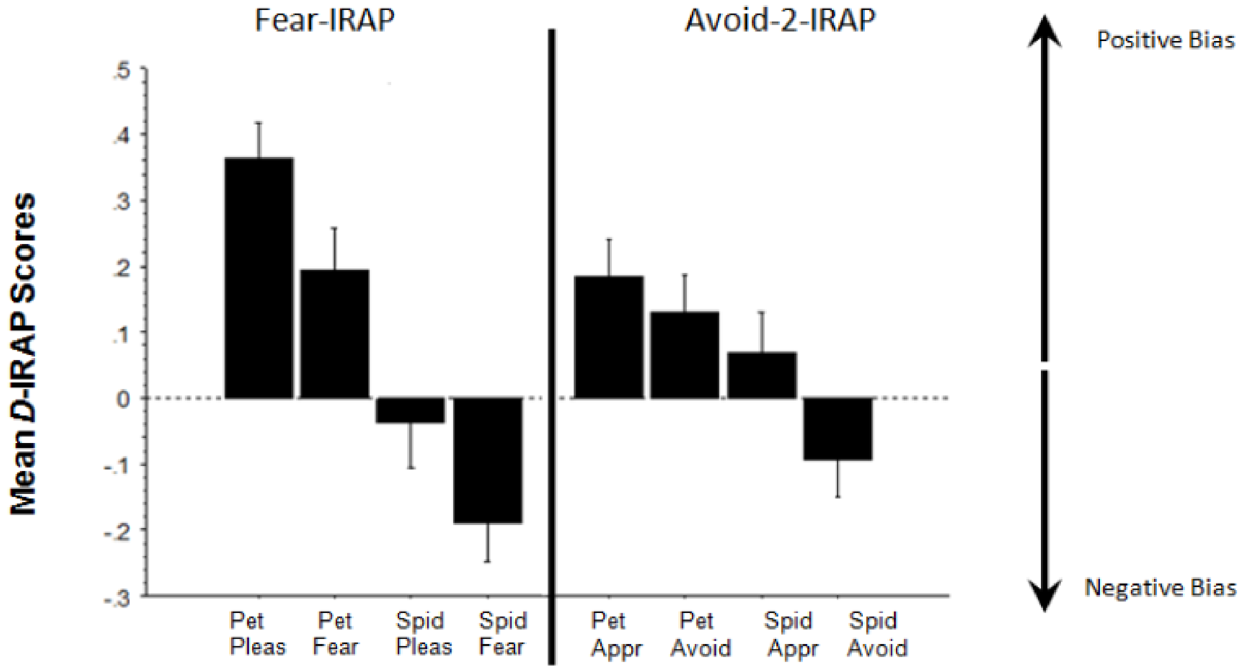

Figure 2: Eight mean *D*-IRAP scores for the F-IRAP and A2-IRAP.

The *D*-IRAP effects produced on the A2-IRAP revealed a negative bias for the *Spider-Avoidance* trial-type but positive biases for the remaining three trial-types. Participants tended to respond "Yes" more quickly than "No" when presented with a picture of a spider and an avoidance phrase or a picture of a pet and an approach phrase. When presented with a picture of a pet and an avoidance phrase, participants tended to respond "No" more quickly than "Yes". Finally, when presented with a picture of a spider and an approach phrase, participants showed a weak tendency to respond "Yes" rather than "No".

The eight *D*-IRAP scores for each participant were entered into a 2x4 repeated measures analyses of variance (ANOVA) with IRAP type (F-IRAP and A2-IRAP) and each of the four trial-types as repeated measures. The main effect for trial-type was significant, F (3, 90) = 13.182, $p < .0001$, $\eta_p^2 = .31$, but the effect for IRAP type was not ($p > .7$). Critically, however, the interaction effect was significant F (3, 90) = 3.341, $p = .023$, $\eta_p^2 = .1$. To better understand the nature of this interaction, the data from each IRAP were first analyzed separately; between-IRAP comparisons are presented thereafter.

The F-IRAP. A one way repeated measures analysis of variance (ANOVA) was conducted with trial-type as the repeated measure and this proved to be significant F (3,30) = 14.38, $p < .0001$, $\eta_p^2 = .32$. Post hoc comparisons using Fisher's PLSD tests indicated that the mean scores for the *Pet-Pleasant* (*M* = .365, *SE* = .052) and *Pet-Fear* trial-types (*M* = .194, *SE* = .063) were significantly different from the scores for the *Spider-Pleasant* (*M* =.-.038, *SE* = .065) and *Spider-Fear* (*M* = -.188, *SE* = .061) trial-types. Four one-sample *t*-tests indicated that the *Pet-Pleasant*, *Pet-Fear and Spider-Fear* trial-type effects were each significantly different from zero (*ps* < .005), but the effect for *Spider-Pleasant* was not (*p* = .6). The inferential statistics for the Fear-IRAP therefore confirmed the descriptive statistics presented in Figure 2.

The A2-IRAP. The one way repeated measures ANOVA proved to be significant, F (3, 30) = 4.033, p =.0097, $\eta_p^2 = .118$. Post-hoc comparisons indicated that the mean score for the *Spider-Avoid* (*M* = -.093, *SE* = .056) trial-type was significantly different from *Pet-Approach* (*M* = .184, *SE* = .056) and *Pet-Avoid* (*M* = .132, *SE* = .056). Four one-sample *t*-tests indicated that the *Pet-Approach* and *Pet-Avoid* trial-types were significantly different from zero (*ps* < .025) but the effects for the *Spider-Avoid* and *Spider-Approach* trial-types were not (*ps* > .1). The inferential statistics therefore confirmed the descriptive statistics presented in Figure 2.

Between-IRAP Analyses. Four separate paired *t*-tests were used to examine the differences between the corresponding trial-types from each IRAP (i.e., 1. *Pet-Pleasant* vs. *Pet-Approach;* 2. *Pet-Fear* vs. *Pet-Avoid;* 3. *Spider-Pleasant* vs. *Spider-Approach;* 4. *Spider-Fear* vs. *Spider-Avoid*). The difference for the first comparison proved to be significant, t = 2.881, p =.007, but the remaining three differences did not (*ps* > .1).

Overall, therefore, the interaction effect between the two IRAPs and their respective trial-types appeared to be driven mostly by larger *D*-IRAP effects for the *Pet-Pleasant* trial-type relative to *Pet-Approach.*

IRAP-FSQ/BAT Correlational Analyses

A correlation matrix was calculated to determine if any of the eight trial-types from the two IRAPs predicted self-reported fear of spiders (FSQ) and approach responses on the BAT. A significant correlation was recorded between the *Spider-Approach* trial-type and the BAT ($r = .377$, $p = .036$), indicating that increasing approach bias towards spiders on the IRAP predicted actual approach behavior on the BAT. The negative correlation between the *Spider-Approach* trial-type and the FSQ approached significance ($p = .052$), suggesting that decreasing approach bias towards spiders predicted higher self-reported fear. The *Pet-Pleasant* trial-type positively correlated with the FSQ ($r = .373$, $p = .038$), indicating that increasing bias towards pets as pleasant predicted higher self-reported fear of spiders. The negative correlation between the *Pet-Pleasant* trial-type and the BAT was marginal ($p = .07$), suggesting that increasing bias towards pets as pleasant predicted fewer approach steps on the BAT. The negative correlation between the *Pet-Avoid* trial-type and the BAT was also marginal ($p = .08$), suggesting that negative bias towards pets predicted increased approach (to spiders) on the BAT. Additionally, the positive correlation between the *Pet-Avoid* trial-type and the FSQ was marginal ($p = .06$), suggesting that negative bias towards pets predicted higher self-reported fear of spiders.

Table 5

Correlation Matrix for F-IRAP, A2-IRAPand Explicit Measures

	F-IRAP Correlation Matrix				A2-IRAP Correlation Matrix			
	Pet Pleasant	Pet Fear	Spider Pleasant	Spider Fear	Pet Approach	Pet Avoid	Spider Approach	Spider Avoid
BAT	-.331#	-.051	.08	-.166	.137	-.323#	.377*	.174
FSQ	.373*	.091	.070	.015	-.077	.344#	-.352#	-.176

*$p < .05$
# $p < .08$

Summary and Conclusion

Consistent with the previous study, and Nicholson and Barnes-Holmes (2012), a negative bias for spiders was recorded. Unlike the previous study, however, the difference between the *Spider-Fear* and *Spider-Avoid* trial-types was not significant. On balance, the effect for the former trial-type was significantly different from zero, whereas the latter effect was not. Thus, the same general pattern was observed across the two studies. The correlational analyses indicated that spider approach bias on the IRAP predicted self reported levels of fear, although this relationship was only marginally significant. Additionally, spider approach bias on the A2-IRAP predicted actual approach behavior on the BAT. Thus, the current study not only replicated the predictive validity reported by Nicholson and Barnes-Holmes, but indicated that predicting the BAT across the two IRAPs was specific to the *Spider-Approach* trial-type (rather than avoidance or fear). Interestingly, a number of other correlations between the pet trial-types and the BAT/explicit measures were also recorded.

General Discussion

One of the aims of the current research programme was to replicate a key finding from the previously published study by Nicholson and Barnes-Holmes (2012). That is, to produce a significant correlation between the IRAP and the BAT. The BAT from the previously published study employed a live Chilean rose tarantula, which would be considered exotic or unusual in Ireland. For the BAT in Experiment 1, we used the moult of a tarantula. We reasoned that given that the moult was almost identical to a live specimen, its functions would therefore be similar and thus would evoke fear and approach/avoidant responding. In the event, however, this assumption was not entirely up-held, given that (anecdotally) many of the participants reported that the moult was “not a real spider”, either during the actual BAT itself or during de-briefing. As a result, for the second experiment a live common Irish house spider was employed in the BAT, and it was only in this context that a significant correlation between a spider trial-type, (i.e. *Spider-Approach)* and the BAT was recorded. Although not definitive, this supports the argument that the live spider was critical in replicating the key finding from the previously published study.

Correlational analyses from the second experiment with the F-IRAP suggested that participants who responded to puppies and kittens as positive, tended to have higher self-reported fear of spiders and were less likely to approach a spider in the BAT. Furthermore, additional correlational analyses, with the A2-IRAP, suggested that lower levels of avoidance of pets predicted higher self-reported fear of spiders and fewer approach steps taken on the behavioral measure. Overall, therefore, positivity towards puppies and kittens predicted greater negativity towards spiders. This finding may be seen as challenging the claim that the IRAP provides a non-relative measure of verbal response biases (e.g., Barnes-Holmes, et al., 2010; Nicholson & Barnes-Holmes, 2012). That is, responses to the contrast category (in this case puppies and kittens) also predicted, in some cases, reactions (self-report and approach responses) to spiders. On balance, it is possible that reactions to the two classes of stimuli employed in the IRAPs were not entirely functionally independent of each other. Nicholson and Barnes-Holmes used relatively neutral pictures of nature scenes (in terms of emotional valence), whereas the current research employed "cute" and "cuddly" pets as a contrast category. Reactions to these positively valenced stimuli may have been genuinely inversely correlated with responses to the more exotic variety of pet, such as spiders, snakes, and reptiles (cf. Archer, 1997). Insofar as this is the case, then the current pattern of correlations would be expected. Future research might test this post-hoc explanation. For example, it might be interesting to determine if pictures of adult dogs and cats that were rated as not particularly cute or cuddly, would fail to produce the inverse correlations with the spider stimuli.

Based on the evidence provided in the current research programme, the IRAP has demonstrated its utility in separating spider fear from spider approach/avoidance. Given that a normative sample was employed this finding may reflect that many individuals have a mildly negative reaction to spiders but are able to approach them, for example when removing a house spider from the bath. This may explain why, in Experiment 1, the negative fear bias was considerably stronger than the negative avoidance bias; this was replicated in Experiment 2 although the difference was not significant (but the *n* was lower). A further test of the precision of the IRAP would be to employ a sample of high spider fear individuals (who actively avoid or certainly do not approach spiders in the natural environment) to determine if they produce stronger negative approach/avoidance biases on the IRAP than those observed in the current study. If such a result emerged this would further bolster the validity of the IRAP as a measure of "real-world" clinically-relevant behaviors.

An unexpected level of (potential) precision for the IRAP emerged in Experiment 2. Specifically, the spider-approach trial-type on the A2-IRAP predicted performance on the

BAT, but the spider-avoidance trial-type did not. It appears, therefore, that not only did the current research provide evidence for the functional independence of fear and avoidance response biases; it also suggests that avoidance may be functionally independent from approach. Of course, it will be important to replicate this finding in future studies, but the functional independence of these two repertoires is consistent with the fact that the direction of the approach and avoidance biases observed in Experiments 1 and 2 were in opposite directions. In one sense, this finding makes intuitive sense in that most individuals in a normative sample may prefer to avoid direct contact with spiders but, as noted previously, can approach a specimen if required to do so. In any case, perhaps a future study could employ a task that involves an active avoidance component (rather than approach). For example, a task could be devised in which participants have the opportunity to push a joystick away from them to reduce the size of a picture of a spider on screen. Would performance on this task correlate with the avoidance trial-type but not the approach trial-type on the IRAP?

At this point it is worth noting that developing the IRAP into a measure that could offer high levels of precision in separating fear, avoidance, and approach could be extremely useful in helping applied researchers to determine exactly how different treatments or interventions impact upon irrational fears. For example, it may be possible to determine if different types of therapy have similar or differential effects on fear, avoidance, and approach (verbal) response biases. For example, an intervention that emphasized fear reduction over approach, versus an intervention that emphasized approach over fear reduction, might lead to differential outcomes on the fear and approach IRAPs employed in the current study. And more importantly, perhaps, if differential outcomes were revealed, would these outcomes predict the longer-term success or failure of the therapy in the natural environment?

In reflecting upon the current research a number of issues seem important to note. First, the use of a spider moult, rather than a live specimen, may impact upon the correlations obtained between the IRAP and behavioral approach measures. It is possible; for example, that the use of a moult serves to elicit so called “disgust” rather than “fear” responding in participants, and this may then impact upon how actual approach behavior correlates with the verbal response bias measure. Second, no “standard” physiological or other measures of fear were taken during the current research programme. In future research, therefore, it may be useful to record skin conductance responses (SCRs) and/or electromyography (EMG) reactions to the relevant stimuli as another means by which to test the predictive validity and relative precision of the IRAPs. For example, would an IRAP that targeted fear rather than approach/avoidance better predict SCR and EMG measures? Previous research in the domain of body-size bias has already demonstrated that IRAP performances may correlate with EMG (Roddy, Stewart, & Barnes-Holmes, 2011) and thus the use of such measures is certainly a direction worth pursuing in future IRAP research in the context of fear and approach/avoidance. Overall, therefore, the current research provides a strong starting point to continue with a systematic analysis of fear, approach, and avoidance response biases on the IRAP and how they predict both self-reports and relevant real-world behaviors, including psycho-physiological reactions. In so doing, it is hoped that the development of the IRAP in this regard may allow for experimental analyses that serve to inform intervention-research in more directly applied domains.

Compliance with Ethical Standards

Conflict of Interest: Aileen Leech declares that she has no conflict of interest. Dermot Barnes-Holmes declares that he has no conflict of interest. Lara Madden declares that she has no conflict of interest.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

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