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Abstract

The fact that renewal of fear can be due to a contextual mismatch between the exposure treatment context and the context where subsequent re-encountering occurs suggests that exposure does not completely remove the underlying fear associations. Conducting exposure in a context that is similar to the re-encounter context may be an effective method of attenuating renewal of fear. The current study examined the effects of context similarity using a single session in-vivo exposure in a sample of 61 moderate to high spider fearful first year psychology students at Griffith University (mean age was 25.36 years). Participants received standardised, in-vivo exposure with a golden orb spider. Fear was measured using self-report, behavioural avoidance, and heart rate measures. Four different contexts were utilised for this study with two being located indoors and two located outdoors. Self-reported fear ratings and heart rate showed that conducting exposure in contexts that are similar to subsequent re-encounter contexts attenuated renewal. This study shows how a simple modification to the exposure process can enhance the long-term cross contextual generalizability of exposure treatment in spider fearful individuals.

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1. Introduction

Exposure therapy is the most effective treatment for a specific phobia (Choy, Fyer & Lipsitz, 2007; Götestam, 2002; Norberg et al., 2018; Wolitzky-Taylor, Horowitz, Powers & Telch, 2008). Despite the effectiveness of exposure, up to 62% of those who are treated experience return of fear (Andersson et al., 2009; Öst, 1996; Rachman 1979; Vasey Harbaugh, Buffington, Jones & Fazio, 2012). Laboratory-based computerized studies with rats and humans have shown that return of fear via renewal can be attenuated by conducting exposure in a context that is similar to subsequent re-encounter contexts (Bandarian-Balooch & Neumann, 2011; Thomas, Larsen, & Ayres, 2003; Todd, Winterbauer, & Bouton, 2012). The current study extends these findings by examining the effects of context similarity on renewal of fear in a sample of spider fearful individuals using a clinical-analogue design. Findings from this study would further the literature supporting single-session in-vivo exposure, as well as the use of context similarity as an enhancement for exposure therapy. This research endeavours to provide grounding for further research on attenuation of renewal within the clinical populations using context similarity.

1.1. Pavlovian Conditioning and Exposure Therapy

There are a number of theoretical models have been constructed to explain fear acquisition. One of the longest standing and most supported of the three theories is classical conditioning, also known as Pavlovian conditioning (Pavlov, 1927). It posits that fear arises from a stimulus that has previously been paired with an anxiety-provoking event or other aversive stimulus, such as pain, that prompts an automatic biological reaction (Pavlov, 1927). Pavlovian conditioning is the pairing of an unconditioned stimulus (US; e.g. pain from a spider bite) that already elicits a set unconditioned response (UR; e.g. fear) with a neutral stimulus (NS; e.g. the sight of a spider), which on its own does not cause a response until paired with a US. The response to the NS then becomes a conditioned response (CR; e.g. fear of spiders) and the stimulus is therefore now a conditioned stimulus (CS) because there is a learnt association between the CS and US through one or more pairings. Utilising classical conditioning principles, Wolpe (1958) developed exposure therapy to treat phobias.

Exposure therapy refers to a cluster of interventions designed to reduce fear by exposing the client to the feared stimuli for a prolonged period of time, until anxiety levels decrease significantly (Barlow & Durand, 2005; Choy et al., 2007; Götestam, 2002; Norberg et al., 2018; Todd & Pietrowski, 2011; Wolitzky-Taylor et al., 2008; Wolpe, 1958). This

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decrease in fear despite the presence of the feared stimuli is known as habituation (Borkovec, & Sides, 1979). The aim of exposure therapy is to reduce fear and to maintain the fear reduction effects through subsequent re-encounters with the feared stimuli in post-therapy situations and locations (Todd & Pietrowski, 2011). Repeated exposure to feared stimuli has shown to reduce conditioned fear and result in what is known as extinction (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). A cognitive-behavioural approach to exposure has been suggested as an effective approach to specific phobia (Choy et al., 2007; Craske et al., 2014). This works by challenging the subject's appraisal of the feared object and subsequently the behaviour (Craske et al., 2014). There is evidence to suggest the efficacy of different types of exposure treatments including imaginal exposure (Bryant, Moulds, Guthrie, Dang & Nixon, 2003; Jaycox, Foa & Morral, 1998), virtual reality exposure (Carl et al., 2019; Olasov Rothbaum, Hodges, Smith, Lee & Price, 2000; Powers & Emmelkamp 2007; 2008), augmented reality exposure (Baus & Bouchard, 2014), and in-vivo exposure (Botella et al., 2016). In-vivo exposure is currently the gold standard in exposure therapy (Abramowitz, Deacon & Whiteside, 2019; Miloff et al., 2019) and will be used as primary treatment method in the current study. In-vivo exposure refers to encounters with real-life stimuli or situations that trigger fear until the presence of the feared stimuli or situation no longer triggers crippling fear (Richard & Lauterbach, 2006; Rosqvist, 2005).

Numerous studies (e.g. Andersson et al., 2009; Bandarian-Balooch et al., 2015; Gilroy, Kirkby, Daniels, Menzies & Montgomery, 2000; Mystkowski, Craske & Echiverri, 2002; Öst 1996; Rachman & Whittal, 1989) have shown that exposure is effective with up to 90% success rate (Richard & Lauterbach, 2007) for treatment completers. However, the treatment benefits of exposure are often not maintained with a return of fear occurring for up to 62% of successfully treated individuals (Andersson et al., 2009; Öst, 1996; Rachman 1979; Vasey et al., 2012).

1.2. Renewal of fear

Evidence of return of fear has been demonstrated in several studies (e.g. Andersson et al., 2009; Bandarian-Balooch et al., 2015; Gotestam 2002; Mystkowski et al., 2002; Rachman, 1979; Shiban, Schelhorn, Pauli & Mühlberger, 2015). There are four distinct ways return of fear can occur (Bouton 2002; Boschen, Neumann & Waters, 2009) including spontaneous recovery, reinstatement, reacquisition and renewal of fear. Renewal of fear refers to a return of fear occurring due to a change in context between where the stimulus was originally encountered and where exposure therapy took place (Bouton 2002). Renewal of fear has been widely studied and is one of the more researched and reproducible types of

return of fear (Rauhut, Thomas & Ayres, 2001; Shiban, Pauli & Mühlberger, 2013; Thomas, Larsen & Ayres, 2003; Todd, Winterbauer & Bouton, 2012) and will therefore be focused on in the current study.

1.2.1 Bouton's memory retrieval model and renewal

From the models that have been developed to explain return of fear more widely (for a review, see Hofmann, 2008), the one that will be used here is Bouton's memory retrieval model (Bouton, 1999; 2002; 2004; Bouton & Bolles, 1979) because it closely explains all four return of fear mechanisms including renewal. Bouton's memory retrieval model suggests that conditioning memories can transfer across contextual change, whereas extinction memories do not. This study focuses on return of fear occurring through renewal, which occurs because the CS-US association is not completely eliminated during the extinction process. Rather, extinction results in a novel CS-noUS association. With two associations (CS-US and CS-noUS) in memory storage, the retrieval process relies on contextual factors. If the context evokes a CS-US association retrieval, a renewal of fear will occur, and if the context evokes a CS-noUS association retrieval a renewal of fear will not occur. A wide array of research conducted in laboratory settings with rats (e.g., Bouton & Bolles, 1979; Goode, Holloway-Erickson & Maren, 2017; Rauhut et al., 2001), laboratory settings with humans (e.g., Bouton, 1993; Krisch, Bandarian-Balooch & Neumann, 2018), and clinical analogue research (e.g., Bandarian-Balooch et al., 2015; Rachman & Whittal, 1989) has shown support for Bouton's memory retrieval model.

A number of previous studies have demonstrated the renewal effect within rats (Chelonis Calton, Hart, & Schachtman, 1999; Laborda, & Miller, 2013; Thomas, Vurbic, & Novak, 2009) and humans (Mineka, Mystkowski, Hladek, & Rodriguez, 1999; Neumann, Lipp, & Cory, 2007; Vansteenwegen et al., 2007). All of these studies investigated the impact of contextual change on renewal. Variation between these studies include an assessment of the effect of a delay after extinction before the test phase (Laborda, & Miller, 2013) and using multiple exposure sessions (Neumann, Lipp, & Cory, 2007; Thomas, Vurbic, & Novak, 2009; Vansteenwegen et al., 2007). Despite variation in methodology, all of these studies demonstrate renewal effects, which are enhanced when extinction/exposure is conducted in a novel context compared to the test condition. Of particular importance to the current study, Bouton's memory retrieval model suggests how the exposure treatment process can be modified to attenuate renewal of fear. Numerous studies have implemented modified methods to enhance the generalisability of the exposure process including conducting exposure in multiple contexts (Bandarian-Balooch et al., 2015; Neumann, Lipp & Cory 2007; Shiban et al.,

2013), conducting exposure to multiple stimuli (Rowe & Craske, 1998; Shiban, Brütting, Pauli, & Mühlberger, 2015), promoting memory reconsolidation (Agren et al., 2014; Soeter & Kindt, 2015), extending the number exposure trials (Krisch et al., 2017), mental reinstatement of the exposure context (Mystkowski, Craske, Echiverri, & Labus, 2006), and enhancing the similarity between the exposure and subsequent re-encounter contexts (Bandarian-Balooch & Neumann, 2011; Thomas et al., 2003; Todd, Winterbauer, & Bouton, 2012). This latter method is of interest in the current study because it can be readily applied in clinical settings. Thus, the current study examines whether extinction learning transfers more readily across similar contexts compared to dissimilar contexts.

1.3. Context Similarity

Three studies have examined the effect of context similarity on renewal (Bandarian-Balooch & Neumann, 2011; Thomas et al., 2003; Todd, Winterbauer, & Bouton, 2012). Using rats, Thomas et al., (2003) found that changing odour and location of the enclosure between treatment and post-treatment testing resulted in renewal. When only one of these factors (either odour or location of box) were changed between treatment and test, renewal was attenuated.

Todd et al., (2012) examined the effects of context similarity on renewal of fear in rats and modified context through changing scent (vinegar, pine and lemon) and chamber design. Food pellets and electric shocks were used as CS's and US respectively. Similar to the Thomas et al., 2003 study, findings showed that renewal of fear was attenuated when the extinction context and subsequent re-encounter contexts shared a significant number of contextual cues.

Bandarian-Balooch and Neumann (2011) examined the effects of context similarity in humans using a laboratory-based computerized study, pairing geometric shapes with electric shocks. The study used self-reported expectancy of shock and startle blink response to test the effects of multiple contexts on ABC renewal. However, results of using electric shocks to induce fear does not necessarily generalise to a sample with naturally occurring, pre-existing fears. Currently, there are no known clinical or clinical-analogue studies that have used a fearful sample to examine the effect of context similarity on renewal of fear.

2. Current Study

The current study contributes to previous research speaking to the efficacy of single session in-vivo exposure on reduction of fear. Moreover, this study aimed to enhance and further previous research on context similarity, including the work of Bandarian-Balooch and

Neumann (2011), with the implementation of the methodological practises used in the Bandarian-Balooch et al., (2015) study.

2.1. Single session in-vivo exposure.

It has been shown in previous studies (e.g. Andersson et al., 2009; Gilroy et al., 2000; Mystkowski et al., 2002; Öst 1996; Rachman & Whittal, 1989) that exposure can be successfully performed in a single session. This exposure was conducted within the guidelines of the treatment manual originally developed by Öst (1989). Unfortunately, a limitation of in-vivo exposure therapy is that many people avoid it due to the severity of their fear, despite its noted efficacy.

The methodology of this study more closely followed Bandarian-Balooch et al., (2015), who used in-vivo exposure to assess multiple extinction contexts on renewal within a non-clinical, fearful sample.

Similar to previous research (Bandarian-Balooch et al., 2015; Bandarian-Balooch & Neumann, 2011), participants were randomly allocated to different groups including a Control group, a Dissimilar group and a Similar group. Participants completed a variety of questionnaires, to ensure group homogeneity on secondary measures. Due to successful use in many previous studies (e.g. Bandarian-Balooch et al., 2015; Hellstrom & Öst, 1995; Koch, Spates, & Himle, 2004; Mineka, Mystkowski, Hladek, & Rodriguez, 1999), the present study created a fear hierarchy with 12 steps ranging from low anxiety provoking to high anxiety provoking. Bandarian-Balooch et al., (2015) used a 16-step fear hierarchy, however this study acknowledged that some steps were not effective in producing a fear reaction (e.g. touching a spider with boxing gloves on), while other steps were limited by issues with clothing requirements (e.g. lift the spider from the cage and place it on your naked shoulder). Therefore, the present study used a revised hierarchy of 12 steps in attempts to reduce these difficulties. This also works to reduce potential participant burden. During each step of the hierarchy instructions and modelling were used to increase participant engagement and efficacy (Bandarian-Balooch et al., 2015; Ellis, Ala'i-Rosales, Glenn, Rosales-Ruiz, & Greenspoon, 2006; Öst, 1989; Richard & Lauterbach, 2007; Todd & Pietrowski, 2006). When assessing fear reduction previous findings highlight a need for multiple sources to create a multidimensional assessment (Bandarian-Balooch et al., 2015; Hellström & Öst, 1995; Öst, Salkovskis & Hellström, 1991). Subsequently the present study used a Behavioural Avoidance Test (BAT; as the behaviour measure), the Standard Units of Distress Scale (SUDS; as the self-report measure) and heart rate (HR; as the physiological measure).

2.2. Renewal and attenuation

In line with Bouton's memory retrieval model (Bouton, 1999; 2002; 2004; Bouton & Bolles, 1979) it is expected that post-exposure contextual changes will affect renewal rates between the groups. This effect has been shown through previous studies (Bandarian-Balooch et al., 2015; Bouton & Bolles, 1979; Goode et al., 2017; Rauhut et al., 2001; Bouton, 1993; Rachman & Whittal, 1989), therefore, the present study theorised that a single one-hour session of exposure in a similar context to the follow up assessment will attenuate renewal to a greater extent than exposure conducted in a dissimilar context. To assess renewal effects the aforementioned fear measures were used, with a focus on post to follow-up (Arntz & Lavy, 1993; Bandarian-Balooch et al., 2015; Hellstrom & Öst, 1995; Öst et al., 1991). This study is the first of its kind to assess context similarity using in-vivo exposure on spider fearful participants. This research aimed to improve the way exposure is conducted and ultimately reduce or eliminate the effects of renewal on ROF, thus furthering the research on effective and robust treatments for clinical phobias.

2.3. Hypotheses

Based on previous research (e.g. Bandarian-Balooch & Neumann, 2011; Thomas et al., 2003; Todd et al., 2012) it was first hypothesised that there would be a significant decrease in fear after in-vivo exposure in the exposure context for all groups as shown by a decrease in standard units of distress, behavioural activation test scores and heart rate. Second, it was hypothesised that there would be a significant increase in fear, as shown by an increase in standard units of distress, behavioural activation test scores and heart rate between exposure context and test context for the dissimilar group, showing that renewal of fear occurred. Third, it was hypothesised that participants who received exposure across similar exposure and test contexts would have significantly less fear renewal, as shown by a decrease in standard units of distress, behavioural activation test and heart rate, than those who received exposure in dissimilar exposure and test contexts at follow-up, showing that renewal of fear was attenuated by context similarity.

3. Method

3.1. Participants

Seventy-four participants with self-reported moderate to high fear of spiders (scoring up to 27 on the Spider Phobia Questionnaire) were recruited from a subject pool of undergraduate psychology students. Participants were offered partial course credit in exchange for their research participation. A minimum sample of forty-six participants was required for desired power calculated through G*Power version 3.1 (1-β) of .80 and with an alpha level of .05 to detect a between group effect, based upon the smallest effect sizes found in previous renewal

research $\eta_p^2 = .14$ (Bandarian-Balooch et al., 2015). The data of 13 participants were excluded for a variety of reasons, including insufficient fear as measured by the pre-test BAT (3), not meeting criteria for fear extinction (7) or not completing the follow-up (FU) of the study (3). Participants were considered to have reached fear extinction when they were able to reach step 12 of the fear hierarchy, while maintaining low self-reported fear and a non-elevated heartrate. Participants with extremely high fear of spiders were also excluded from this particular study due to the more severe nature of their phobia and the need for more in-depth exposure therapy. As a result, 61 participants (38 female, 23 male), with a mean age of 24.49 (SD = 6.97) years (age ranged from 17-49) remained in the final sample at this stage of the analyses. Excluded participants were deleted listwise from the data. The sample was primarily of an Australian nationality (57.8%) (European: 15.6%; Asian: 7.8%; other: 18.8%). Participants were randomly assigned to either Control (n = 21), where participants received all tests and exposure in the same context, Dissimilar (n = 17) where participants received exposure in a dissimilar context to FU, or Similar groups (n = 23) where participants received exposure in a similar context to FU. The project was granted ethical approval by the Griffith University Human Research Ethics Committee (GU Ref No: 2017/449).

3.2. Materials

A golden orb (*Nephila plumipes*) Spider was used as the fearful stimuli for this study. It is a non-harmful species of spider that is not prone to biting, even after provocation (Brunet, 1998). The same species was used throughout the experiment, with a total of five spiders throughout the experiment. All spiders used were female. The spiders used had an approximately 7.5cm leg span. This species of spider has been successfully used in previous experiments (e.g. Bandarian-Balooch et al., 2015; Brunet, 1998). The spider was kept in a plastic container with a black and clear clip-on lid. This was the container used for all participants and was filled with foliage and bark through the duration of the experiment to ensure consistency between participants. Participants used the same spider between different phases, with change of spider occurring only between participants.

There were four contexts used in this study, all located at Griffith University Gold Coast Campus. The first two were office based: one large office (Large Office) and one smaller more narrow shaped office (Small Office). The other two contexts were outdoor locations. The outdoor areas included a grass opening surrounded by trees (Outdoor 1), while the other was a concrete area next to a building on one side and trees on the other sides (Outdoor 2). The size, lighting, odour, temperature and background noise varied naturally between each context, however other features such as sequence of events, spider size and

species, cage, furniture (for the indoor contexts), process of exposure and other general features were kept consistent.

3.2.1. Self- Report Measures

The Spider Phobia Questionnaire (SPQ; Klorman, Weerts, Hastings, Melame & Lang, 1974) was used to assess fear of spiders prior to exposure and one week later at FU. The SPQ is a true/false self-repost measure of fear of spiders. It contains questions such as 'I dislike looking at pictures of spiders in a magazine'. Higher scores signified increased fear of spiders. This measure has been used in numerous studies previously (e.g. Hellstrom & Öst, 1995; Koch et al., 2004; Öst 1996). This measure has been shown to have sound reliability (Fredrikson, 1983; Muris & Merckelbach, 1996) and validity (Olatunji et al., 2009) Cronbach's α = .83-.90 (Klorman et al., 1974). The Cronbach's alpha in the current study was α = .79.

The Depression, Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995) is a multidimensional measure consisting of 21 items relating to depression, anxiety and stress. It is measured on a four-point scale (0 = did not apply to me at all, to 3 = applied to me very much, or most of the time) with questions such as 'I found it hard to wind down.' Higher scores signified increased depression, anxiety and/or stress. For the present study the DASS-21 was used as a measure of groups homogeneity prior to assessment. The DASS-21 has shown excellent validity (Ng et al., 2007) and reliability (Lovibond & Lovibond, 1995; Ng et al., 2007). The Cronbach's alpha in the current study was α = .87 for depression, α = .81 for anxiety and α = .76 for stress.

The Treatment Credibility Questionnaire (TCQ; Borkovec & Nau, 1972) was used to assess changes in participant's expected improvement through exposure. It is rated on two scales (0 to 100% and 1 to 9; Devilly & Borkovec, 2000). Higher scores represented higher expectancy of positive outcomes from exposure. Results are calculated by adding the scores from items 1-3. An example of a question from this measure is, 'how logical does the therapy offered to you seem.' This measure has been used in many previous studies (e.g. Hellstrom & Öst, 1995). This scale has been shown by Devilly and Borkovec (2000) to have good reliability and validity (Cronbach's α = 0.81 and 0.86). The Cronbach's alpha in the current study was α = .83.

The Self-Assessment Manikin (SAM) by Lang, Öhman and Vaitl (1988) was used to assess participant feeling regarding the context they were in prior to exposure to the spider. It is a pictorial based, non-verbal self-assessment (Morris, 1995). Originally it contained three lines, which assessed valance, arousal and dominance. This has been revised for the current

study to mood (1= negative mood to 9 = positive mood), arousal (1 = completely calm to 9 = high arousal) and threat (1= very safe to 9 = very threatened) to increase relevance. Backs, da Silva & Han (2005) examined the SAM scale for validity, reliability (Cronbach's $\alpha = 0.89$ and 0.83; Nazari, Chianeh, Vahedi & Rostami, 2012) The Cronbach's alpha in the current study was $\alpha = .51$.

3.2.2. Dependent Measures.

The Subjective Units of Distress Scale (SUDS) was used as a verbal measure for participants to express their anticipated and actual fear level throughout the experiment. The measure is a Likert-type 11-point scale (0 = not at all afraid to 100 = very severe fear. Increasing in segments of 10; Wolpe, 1973). This is a widely used self-assessment fear rating scale (Bandarian-Balooch et al., 2015; Hellstrom & Öst, 1995; Koch et al., 2004; Öst 1996). Psychometric properties of the SUDS ratings have been assessed and validated by Thyer, Papsdorf, Davis, and Vallecorsa (1984); Kaplan, Smith, and Coons (1995) and Kim, Bae, and Park (2008). The scale showed good convergent, discriminate, predictive and concurrent validity.

The Behavioural Avoidance Test (BAT) was used across groups as a measure of willingness to approach a feared stimulus. The BAT corresponds to each of the 12-steps in the exposure hierarchy (refer to Figure 1). Higher scores on the BAT represent higher avoidance of the stimulus compared to lower scores, which represent increased willingness to approach the stimulus (1 = lifting spider from the cage and allowing to crawl on naked lower arm compared to 12 = standing three meters away). Each step from 1 to 12 is designed to increase incrementally in difficult and fear provocation to create a graded exposure. This is a widely used behavioural measure of fear (Bandarian-Balooch et al., 2015; Hellstrom & Öst, 1995; Koch et al., 2004). Steketee, Chambless, Tran, Worden & Gillis, 1996), examined the psychometric soundness of the BAT. It was found to have good validity (particularly convergent and divergent) and reliability (Steketee et al., 1996).

Heart rate (HR) was used as a physiological measure of fear. It was recorded throughout the experiment with an ambulatory monitor (Polar V800). This monitor has been shown to produce accurate and reliable results (Engström et al., 2012). Baseline HR will be measured with participants standing up to reduce potential interference from movement or posture. Lubricant was applied to a coded transmitter belt (T31, Polar CIC, Inc) to enhance the detection of electrical activity. All data was transmitted to a training computer (Polar V800) worn on the researcher's wrist. The participant wore the HR monitor around their lower chest.

Bat Step	Bat Score	Action
1	12	Stand 3 meters away from spider in a closed cage
2	11	Stand 2 meters away from spider in a closed cage
3	10	Stand 1 meters away from spider in a closed cage and look at the spider
4	9	Place one hand on closed spider cage
5	8	Place both hands on closed spider cage and have your face within 30cm of the spider
6	7	Stand at arms length to the open spider cage and concentrate on the spider
7	6	Use a 20cm long stick to gently direct the movement of the spider
8	5	Touch the spider with latex gloves
9	4	Touch the spider with bare index finger
10	3	Allow the spider to be placed and walk on bare hand
11	2	Allow the spider to be placed and walk on your covered arm
12	1	Lift spider from the cage and place it on your naked lower arm

Figure 1. Revised Fear Hierarchy with step numbers in the left column and the corresponding Behavioural Avoidance Test score down the middle column.

A five-minute acclimatisation period was completed followed by a five-minute HR baseline. HR data was calculated with a max and an average for each step. (Bandarian-Balooch et al., 2015). HR was coded using baselines scores for pre and FU by subtracting baselines scores from the max scores (Bandarian-Balooch et al., 2015). Increase in HR is thought to represent an increase in anxiety/fear levels.

4. Procedure

The study consisted of two parts (exposure/extinction phase and test phase). The exposure/extinction phase (or Pre and Post) was conducted to assess fear reduction after exposure. The test phase was used as a measure of renewal as well as spontaneous recovery. Both parts of the study were completed with one participant at a time. Part one of the study lasted a maximum of 90 minutes. Each participant was randomly assigned to one of three groups: Control, Similar or Dissimilar. Each of these groups contained four possible subgroups (numbered 1 to 12; refer to Table 1) with counterbalanced context order. The context order was counterbalanced to avoid possible order effects creating potential confounding variables. Each participant was blind to which group they had been assigned to in order to avoid potential biases (i.e., single-blind study design). Randomisation was completed by sign-up order determining group allocation.

4.1. Pre assessment

To begin, the participant was escorted to the context they had been randomly assigned

to. They were provided with an information sheet to review, while the experimenter answered any questions.

Written consent was obtained from each participant, after which the HR monitor was given to fit around the lower chest. A five-minute acclimatisation period was completed followed by a five-minute HR baseline, which was logged. During this time the participant was asked to

Table 1

Experimental Conditions for Control, Dissimilar (Renewal) and Similar Groups (Attenuation)

	Subgroup	*n*	Pre/Post	FU
Control (*n* = 21)	1	5	Large Office	Large Office
	2	5	Small Office	Small Office
	3	6	Outdoor 1	Outdoor 1
	4	5	Outdoor 2	Outdoor 2
Dissimilar (*n* = 17)	5	4	Large Office	Outdoor 1
	6	4	Small Office	Outdoor 2
	7	5	Outdoor 1	Large Office
	8	4	Outdoor 2	Small Office
Similar (*n* = 23)	9	5	Large Office	Small Office
	10	5	Small Office	Large Office
	11	7	Outdoor 1	Outdoor 2
	12	6	Outdoor 2	Outdoor 1

Note. FU = Follow Up. Pre/Post represent the initial testing phase and exposure phase. The contexts will be counterbalanced between groups to eliminate order as a potential confounding variable.

complete a number of self-assessment items, including: demographics (including medical and psychological history), SPQ, DASS-21, SAM and the TCQ. The participant was then shown the SUDS scale and instructed on how to verbalise their fear based on this scale (0 to 100). Following this, a 10-minute pre-exposure fear assessment was completed by allowing the participant to select any step on the 12-step hierarchy (refer to Figure 1) they would be willing to complete, without any guidance by the experimenter.

The participant then expressed the level of fear they anticipated experiencing while completing the step. The spider, which was placed four meters away, was then revealed (with removal of towel from over the cage). The participant completed the step they had previously indicated while HR, SUDS and BAT score was recorded. The participant was directed back to the initial step (standing three metres away from the cage) and the exposure session was initiated. Any participant who selected and completed step 10 or above, without hesitation, on this pre-exposure assessment was excluded from participating further due to a lack of fear.

4.2. Exposure

The exposure comprised of a one-hour guided session where the fear hierarchy was attempted step by step, with support from the experimenter. For each step, the experimenter modelled the task for the participant and when ready the participants completed the step themself and reported their fear rating. If the initial fear rating was reported on the lower end of the SUDS scale (30 or below on the 100-point scale) the experiment continued to the next step. Otherwise, if the SUDS rating sat higher on the scale (31 or above) the participant repeated the step until fear habituation had occurred. Following this the participant was once again asked to report their fear rating before continuing to the next step. Measures of HR, time, SUDS and BAT were recorded at each step. This process was repeated until each step had been completed or until the one-hour time period had elapsed.

4.3. Post assessment

Following the exposure session another 10-minute Post assessment was completed by allowing the participant to once again select any step on the 12-step hierarchy they would be willing to complete, without guidance by the experimenter. The participant then expressed the level of fear they anticipated experiencing while completing the step.

4.4. Follow-up (renewal and spontaneous recovery)

One week after exposure was conducted participants returned for the follow-up assessment (FU). Context for this assessment was varied depending on group allocation. This was run identical to the initial fear assessment. FU lasted approximately 25 minutes. It consisted of 15 minutes of self-assessments (DASS-21, SPQ, TCQ, SAM and demographic information) and a 10-minute follow-up fear assessment. Both were completed in the same manner as the Pre-assessment.

5. Results

5.1. Design and Scoring

The between-subjects factors were group (Control, Dissimilar and Similar) and context (Large Office, Small Office, Outdoor 1, Outdoor 2). The within subjects factors were time (Pre to Post and Post to FU). The dependent variables were fear renewal, measured by SUDS, BAT and HR data. Variables were measured during every step of the exposure.

5.2. Statistical Analyses

Group differences on secondary measures (depression, anxiety, stress, age, and initial phobia of spider, expected treatment credibility and self-reported physiological state were analysed using separate one-way ANOVAs (refer to Table 2 for descriptive data). These were conducted to assess the equivalence of the three groups at initial assessment. Group

membership was independent of gender as shown by cross-tabulation analysis $\chi 2$ (2, N = 61) = 2.61, p = .272. Assumptions of normality and homogeneity were assessed with only violations reported. Similar to previous research (Bandarian-Balooch et al., 2015; Havermans, Keuker, Lataster & Jansen, 2005), 3 x 2 mixed factorial ANOVAs were conducted separately for each dependent variable. Post hoc testing was conducted using t-tests with Bonferroni corrections applied. A Huyn-Feldt correction was applied to the degrees of freedom when sphericity was violated. Effect sizes were reported as Cohen's *d* and partial eta squared (η_p^2) with an alpha (α) level set at .05

5.3. Data Preparation

Examination of the data using histograms, boxplots, distant and leverage matrices, and Levene's test of homogeneity of variance revealed four outliers, significant positive skew for the heart rate data, and violation of homogeneity for SUDS at FU. Violations of normality and outliers appear to not be the result of data recording errors, sampling errors or mis-reporting (Osborne & Overbay, 2004), furthermore ANOVA is robust to some violations of normality (Blanca, Alarcon, Arnau, Bono, & Bendayan, 2017; Ito, 1980). Transformations of the data and exclusion of outliers did not significantly change the interpretation of analyses so original data were retained. Violations of sphericity were reported and treated with Greenhouse-Geisser. All other assumptions were met (Field, 2013).

5.4. Main Analysis

5.4.1. Exposure

To determine whether reduction of fear had occurred a 3 × 2 (Group × Time) mixed factorial ANOVA was conducted for each of the dependant measures (SUDS, HR and BAT). The within subjects factor was time with two levels (Pre and Post) and the between subjects factor was Group with three levels (Control, Dissimilar and Similar). The analysis revealed a significant fear reduction across all groups between Pre to Post shown by a significant main effect of time for SUDS $F(1, 58) = 132.77$, $p < .001$, $\eta_p^2 = .696$, HR $F(1, 58) = 15.17$, $p < .001$, $\eta_p^2 = .207$, and BAT $F(1, 58) = 333.58$, $p < .001$, $\eta_p^2 = .852$. There was no significant interaction between Time x Group for SUDS, HR, or BAT, $F's < 1.95$, $p's > .151$, $\eta_p^2 < .063$ and there was no significant main effect of group for SUDS, HR, or BAT, $F's < .736$, $p's > .483$, $\eta_p^2 < .025$, confirming that reduction of fear had occurred for all groups between pre and post-exposure with no significant differences between the groups at pre or post on any of the measures (see Figure 2).

Table 2
Descriptive statistics of participant information on secondary measures (demographics, DASS, SPQ, TCQ and SAM) ($N = 61$).

	Groups											
	Control ($n = 21$)			Dissimilar ($n = 17$)			Similar ($n = 23$)			Group Equivalence		
		95% CI			95% CI			95% CI				
Variables	*M*	Lower	Upper	*M*	Lower	Upper	*M*	Lower	Upper	*F*	*df*	*p*
Age (years)	25.36	22.37	28.36	22.63	19.75	25.51	24.96	21.67	28.25	0.90	58	.618
SPQ	16.73	14.32	19.14	16.26	13.73	18.79	13.88	11.30	16.45	1.69	58	.484
DASS - Depression	7.09	5.03	9.15	6.95	2.44	11.45	9.21	6.02	12.40	0.67	58	.304
DASS - Anxiety	5.91	3.17	8.65	7.68	3.32	12.05	10.08	6.99	13.18	1.78	58	.515
DASS - Stress	12.00	9.14	14.86	12.95	8.58	17.31	14.92	11.78	18.06	0.87	58	.306
TCQ	22.24	20.93	23.54	20.65	19.20	22.20	22.09	20.84	23.33	1.59	58	.214
SAM - Mood	2.76	1.20	3.63	3.71	2.75	4.67	3.22	2.39	4.04	1.07	58	.350
SAM - Arousal	4.48	3.67	5.28	4.88	3.99	5.78	5.30	4.54	6.07	1.12	58	.335
SAM - Threat	3.38	2.40	4.37	3.06	1.96	4.15	3.17	2.23	4.12	.10	58	.904

Note. CI = confidence interval. *M* = mean. DASS = Depression, Anxiety and Stress Scale 21-item. SPQ = Spider Phobia Questionnaire. TCQ = Treatment Credibility Questionnaire. SAM = Self-Assessment Manikin.

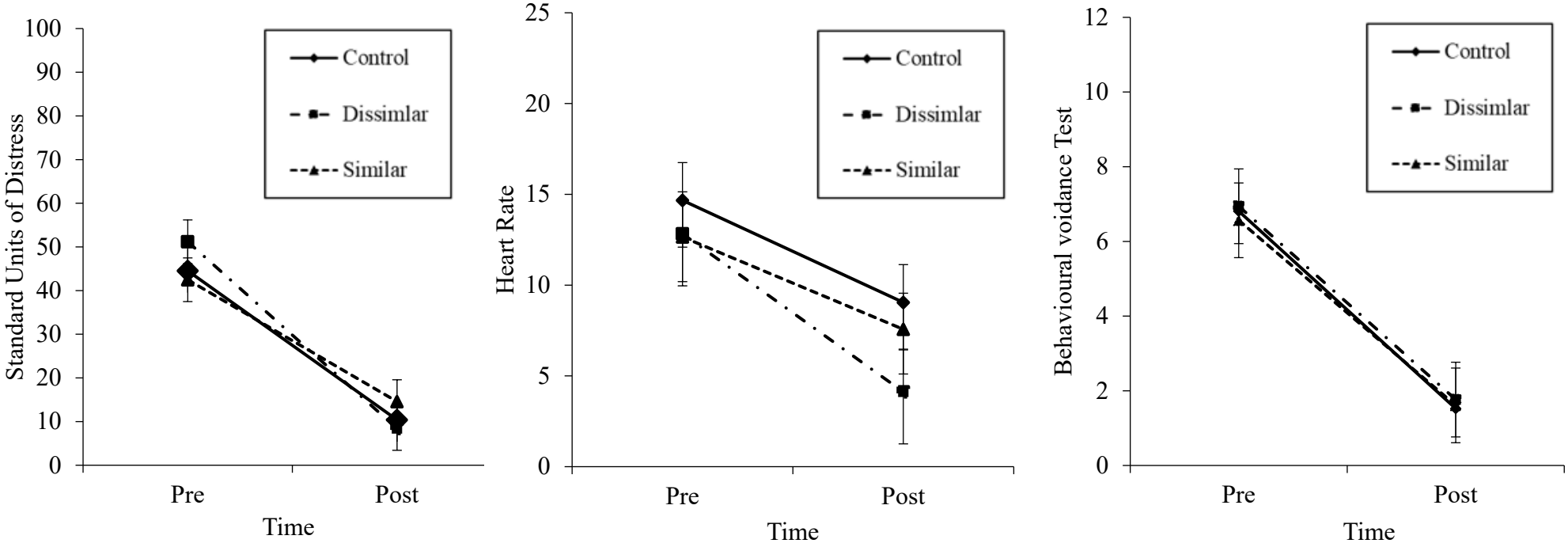

Figure 2. Mean Standard Units of Distress, Heart Rate and Behavioural Avoidance Test scores from Pre to Post assessment for Control, Dissimilar and Similar. Errors bars represent standard error of the mean. Heart Rate was calculated by subtracting baselines scores from the max scores.

5.4.2. Renewal

To test for renewal, a two-way (3 × 2) mixed factorial ANOVA was conducted for each dependent variable separately to establish the difference between the Control, Dissimilar, and Similar groups from Post to FU (refer to Figure 3). The results show a significant Group x Time interaction for the SUDS ratings $F(2,58) = 9.43$ $p < .001$, $\eta_p^2 = .245$ and HR measure $F(2,58) = 9.16$ $p < .001$, $\eta_p^2 = .240$ from post-exposure to FU. To examine these differences, a series of independent sample t-tests were performed comparing the groups at FU separately for the dependent measures SUDS and HR. The Control ($M = 15.10$, $SD = 12.44$) group reported significantly lower SUDS than the Dissimilar group ($M = 30.59$, $SD = 27.78$) at FU $t(36) = -2.56$, $p = .034$, $d = 0.75$. There was no significant difference between the Control group ($M = 15.10$, $SD = 12.44$) and the Similar group ($M = 14.13$, $SD = 14.35$) on SUDS scores $t(42) = 0.17$, $p = .980$, $d = 0.07$. The Similar group reported significantly lower SUDS score than the Dissimilar group ($M = 30.59$, $SD = 6.74$) $t(38) = 2.77$, $p = .020$, $d = 0.78$.

To further examine whether renewal was attenuated using context similarity, paired samples t-tests were used to examine whether there was a significant difference for between Post and FU on SUDS and HR separately for each group. For the Dissimilar group SUDS scores were significant $t(16) = -3.51$, $p = .003$, $d = -0.40$ as were HR scores $t(16) = -2.02$, $p = .047$, $d = -0.26$. However for the Similar group there was no significant increase for SUDS $t(22) = 0.19$, $p = .855$, $d = 0.04$ or HR $t(22) = 0.64$, $p = .526$, $d = 0.15$ The Control group also showed no significant increase for SUDS $t(20) = -1.90$, $p = .072$, $d = 0.16$ or HR $t(20) = -0.02$, $p = .986$, $d = 0.00$. These results demonstrate that based on SUDS and HR renewal was attenuated between Post and FU using context similarity.

The results show no significant Time x Group interaction for the BAT measure $F(2,58) = 1.39$ $p = .257$, $\eta_p^2 = .046$. Results showed a significant main effect of time $F(1,58) = 12.87$ $p = .001$, $\eta_p^2 = .182$, and no significant main effect of group at FU, $F(2,58) = 0.92$, $p = .403$, $\eta_p^2 = .031$. Suggesting that all groups reduced significantly in behavioural avoidance from post to FU. There was a significant difference on HR scores at FU with Control scoring lower ($M = 9.10$, $SD = 12.06$) than the Dissimilar group ($M = 18.18$, $SD = 13.96$) $t(36) = -2.15$, $p = .038$, $d = -0.72$, and the Control group scoring higher ($M = 9.10$, $SD = 12.06$) than the Similar group ($M = 6.73$, $SD = 6.64$) $t(42) = 0.92$, $p = .364$, $d = 0.28$, and the Similar group scoring lower ($M = 6.73$, $SD = 6.64$) than the Dissimilar group ($M = 18.18$, $SD = 13.96$) $t(38) = 3.54$, $p = .001$, $d = 1.15$. There was no significant difference between the Control group and the Similar group on HR $t(42) = 0.71$, $p = .427$, $d = 0.09$.

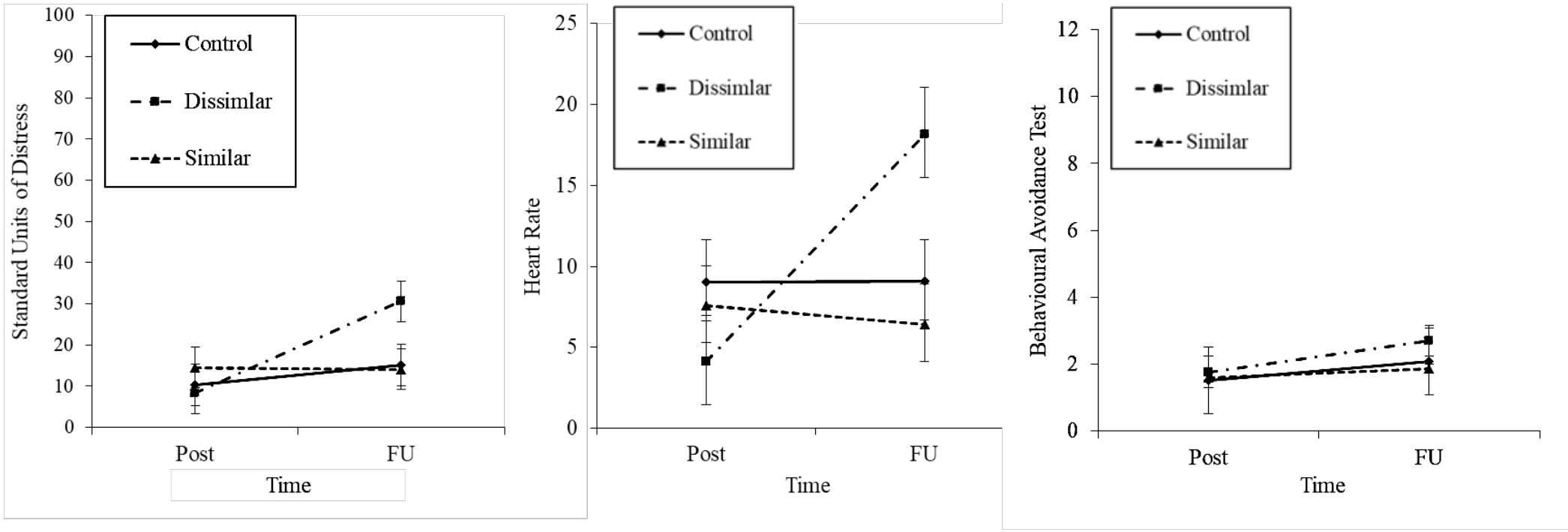

Figure 3. Mean Standard Units of Distress, Heart Rate and Behavioural Avoidance Test scores from Post assessment to FU for Control, Dissimilar and Similar. Error bars represent standard error of the mean. Heart Rate calculated by subtracting baselines scores from the max scores.

Further, to assess if reduction of fear was maintained at FU paired samples t-tests were conducted between Pre and FU for SUDS, HR and BAT separately. For the Similar group, there was a significant decrease between Pre to FU for the SUDS $t(22) = 6.33$, $p < .001$, $d = 1.58$, BAT, $t(22) = 9.85$, $p < .001$, $d = 2.84$, and for HR, $t(22) = 2.63$, $p = .015$, $d = 0.78$. A significant decrease was also seen for the Dissimilar group on SUDS $t(16) = 3.14$, $p = .006$, $d = 0.78$, and BAT $t(16) = 7.40$, $p < .001$, $d = 2.22$, with a nonsignificant decrease for HR $t(16) = -1.42$, $p = .175$, $d = 0.43$. A significant decrease was also seen for the Control group on SUDS $t(20) = 4.55$, $p < .001$, $d = 1.38$, and for BAT $t(20) = 9.37$, $p < .001$, $d = 2.64$, with a nonsignificant decrease for HR $t(20) = 1.86$, $p = .077$, $d = 0.52$. These results demonstrate that reduction of fear was maintained at FU as indicated by the SUDS, BAT, and HR for the Similar group, and SUDS and BAT for the Dissimilar and Control groups.

6. Discussion

The present study investigated the effect of context similarity on renewal of fear. Taken together, the findings confirmed that a one-hour in-vivo exposure session was effective in reducing fear in spider fearful participants. This study also adds support for the benefits of context similarity on attenuating renewal. When participants were exposed to their feared stimulus, either in the same context or a similar context to that of the exposure, there was a substantial reduction in renewal. Likewise, when exposure was conducted in a similar condition renewal was attenuated to a greater extent. However, when exposure was conducted in a dissimilar condition renewal was greatly increased. The current study elucidates the role context similarity plays in attenuating ROF that arises from renewal. Findings from this study further previous research on contextual mismatch by demonstrating that similar contexts for exposure can reduce renewal more than dissimilar contexts.

6.1. Fear Reduction

The first hypothesis that all groups would experience reductions in fear levels from Pre to Post-exposure, was confirmed. This was evidenced through a decrease in fear as shown through behavioural (BAT), self-report (SUDS) and physiological measures (HR). At Post-assessment, all three groups had significantly decreased in fear. This finding supports previous work, which has shown that a single exposure session can significantly reduce fear of spiders (Andersson et al., 2009; Bandarian-Balooch et al., 2015; Carlbring, 2017; Choy et al., 2007; Gilroy et al., 2000; Deacon & Abramowitz, 2004; McNally, 2007; Mystkowski et al., 2002; Öst 1996; Rachman & Whittal, 1989; Richard & Lauterbach, 2006).

6.2. Renewal

The second hypothesis, that there will be a significant increase in fear between Post-exposure and FU for the Dissimilar group, was supported. Analyses revealed a significant increase in SUDS and HR between Post-exposure and FU for the Dissimilar group but not the Control or Similar group. The results presented herein indicate that exposure treatment of spider fear provided in one context and follow-up provided in a different context increases fear renewal. The results of this analysis support the memory retrieval model of fear renewal (Bouton, 1993; 2002; 2004). According to the memory retrieval model by Bouton (1993; 2002; 2004), introduced the idea that contextual mismatch between acquisition of fear and extinction context is a basis of renewal (Bouton, 2004). This maps onto the present study as dissimilar contexts may provide fewer overlapping contextual cues between the extinction context and the follow up context, thereby reinforcing the retrieval of the CS-US association (fear memory) and subsequently resulting in dissimilar contexts having increased renewal (Bouton, 1993; 2002; 2004).

6.3. Attenuation

Finally, the third hypothesis that the participants who received therapy across similar contexts would have significantly higher attenuation of fear renewal than those who received therapy in dissimilar contexts at FU was supported. Essentially these results are suggesting that renewal will be attenuated for those who are treated for a phobia in one context and re-encounter the stimulus in the same or a similar context. The results found substantiate the findings from previous work assessing context similarity in both rats (Thomas et al., 2003; Todd et al., 2012) and humans (Bandarian-Balooch & Neumann, 2011). Analogous to the findings from Bandarian-Balooch and Neumann (2011) cues between extinction and test context appear to allow for greater generalisation for the same and similar contexts over and above dissimilar contexts.

6.4. Broader Application of Previous Research and Theory

Comparable to the conclusions drawn by Bouton the results of this study may be a product of not only contextual mismatches but also of the retrieval of the CS-noUS association for the Similar group due to contextual cue overlap (Bouton, 1993; 2002; 2004; Rescorla, 2001). For the Similar group there was a greater number of overlapping cues, such as: indoor compared to outdoor settings, presence of furniture, environmental odours, lighting etc. Most of these factors varied to a more extreme degree for the Dissimilar group. The implications of this theory and the corroboration from the present study gives support to the

idea that similar contexts may allow for the extinction memory to be more easily transferred and generalised during the testing phase (Bouton, 1993; 2002; 2004).

Interestingly, this study found that while the Similar group experienced significantly less renewal it was still not completely abolished; similar to the findings for the Control group. The Bandarian-Balooch and Neumann (2011) suggested that a combination of modifications might be needed to abolish renewal and minimise renewal occurring in novel contexts. Specifically, it was suggested that an amalgamation of multiple extinction contexts and context similarity might be required for complete abolishment of renewal. Krisch et al., (2017) used extended extinction and multiple extinction contexts and also found that a combination was most successful. Therefore, an explanation for this finding is the potential need for multiple similar extinction contexts rather than one similar context (Bandarian-Balooch & Neumann, 2011). Future research exploring this area would be beneficial

6.5. Strengths of the Study

An overall strength of the present study was the application of a methodology that enhanced standardisation, efficacy and generalisability of findings. The use of an active control group allowed for a more accurate comparison between no contextual change to similar and dissimilar contextual changes. Using an active control group also allowed for a single-blind method to be employed, which assisted in reducing potential participant bias, which can occur when participants are made aware of group allocation (Bang, Ni & Davis, 2004). Another methodological strength was the use of in-vivo exposure with live spiders as stimuli. This created an immersive experience, which was as close as possible to a real-life encounter, while maintaining standardisation. Techniques such as instructions, modelling, and observational learning during exposure were also used to increase the number of participants who reached the final step (Ellis et al., 2006; Öst, 1989; Richard & Lauterbach, 2007; Todd & Pietrowski, 2006) thus improving overall exposure engagement.

6.6. Limitations and Future Research

While this study has contributed to advancements in the efficacy of in-vivo exposure treatment, there were a few limitations that should be considered. Firstly, while the use of hierarchies ensures standardisation of treatment, it does not allow for any individualisation. This could be problematic as all individuals have different levels of fear and history of fear acquisition, meaning that each person likely needs to move at different paces through a fear hierarchy. This could be an issue for the current study as it may reduce exposure for some people who are not ready to complete the steps that are pre-existing in the hierarchy. On the other hand, creating a ceiling effect for those who could have gone further (Norberg et al.,

2018). An interesting finding of this study was that while the BAT scores followed the same pattern as the other fear measures, it did not reach significance. A reason for this may have been the aforementioned ceiling effect, created due to the fear hierarchy steps not reaching a sufficiently aversive level.

In Bandarian-Balooch et al. (2015) and Norberg et al. (2018) both used more adversity steps and found significant group differences. In the present study, the final step was less aversive as it required participants to simply place a spider on their naked forearm. As a result, most of the participants across all three groups managed to complete the final step at Post-assessment and FU, thus creating a ceiling effect. To reduce this issue, future studies could include more aversive fear hierarchies. In anxiety treatment, hierarchies are constructed with individual clients collaboratively process, whereby they are asked to rate the level of fear each step would cause (Moree & Davis, 2010). This allows the client to move at their own pace. Future studies should examine the effects of integrating client tailored exposure hierarchies into context similarity exposure.

Another limitation of this study was the lack of no-exposure control group. In the absence of this group it cannot be said with certainty that the reduction of fear was due to the pre-assessment BAT as opposed to the exposure. Future research should consider the inclusion of a no-exposure control group. Future research should also consider the inclusion of using multiple different spider species as stimuli to increase generalisability of extinction learning.

6.7. Implications of Findings

The present study contributes to the ever-growing body of literature showing support for single session, in-vivo exposure as a means to reduce the fear response in spider fearful individuals. While relapse rates are still an issue, this methodology provides a strong foundation for the implementation of context similarity in future research.

The current study furthers previous research done with rats and laboratory studies using fear acquisition techniques with a non-clinical sample, thus paving the way for the integration of context similarity in clinical samples (Bandarian-Balooch & Neumann, 2011; Thomas et al., 2003; Todd et al., 2012). As mentioned by Menzies and Clarke (1995) and Rachman (1979), clinical presentations of spider phobia predominantly occur from negative encounters, such as bites from spiders, therefore some phobic clients have an increased likelihood of pinpointing when and where fear was acquired. In these cases, the use of similar contexts could be equally effective, less strenuous and less costly than exposure conducted multiple

times to reduce relapse. In cases where the origin of fear is not known context similarity can still be utilised to conduct exposure in contexts where future encounters are likely.

This study also has the potential to assist with other specific phobias where exposure sessions are possible. In these cases, exposure in similar contexts may help with other specific phobias, such as fear of dogs.

7. Conclusion

In summary, the present study used self-report, behavioural and physiological data to demonstrate that context similarity contributes to a reduction in ROF via renewal. Results confirmed hypotheses that single-session, in-vivo exposure worked to reduce fear in all three groups. It was also found that context similarity attenuated ROF, while on the other hand context dissimilarity resulted in the most renewal. This study contributes to the literature supporting context similarity as an enhancement for exposure therapy.

This is the first known study to have used a non-clinical sample to examine the effect of context similarity with in-vivo exposure on renewal. The results provide a promising grounding for further research to continue work on attenuation of renewal within clinical populations using context similarity.

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