Symbolic and semantic fear and avoidance generalisation in humans: An examination of boundary conditions and convergence with trait measures

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Abstract

The primary aim of this thesis was to investigate whether commonly used personality, anxiety and experiential avoidance trait related measures provide any predictive utility in identifying observed levels of Pavlovian conditioning and the symbolic or semantic generalisation of fear and avoidance. A small number of previous studies had already attempted to correlate empirically observed levels of generalised threat and avoidance responding with scores on a number of trait and experiential avoidance questionnaires but had limited success. However, these studies focused on generalisation along perceptual gradients, while this thesis focused more on ecologically valid symbolic and semantic generalisation.

Seven exploratory computer-based experiments are outlined, six of which provided participants with the opportunity to successfully avoid the US and then subsequently generalise either SCRs, US expectancy ratings or instrumental avoidance responses across symbolically or semantically related nonsense or English words. Experiment 1 sought to address the previous omission of trait anxiety and experiential avoidance measures from the symbolic generalisation literature. The paradigm consisted of three phases; equivalence learning, fear and avoidance learning and finally, probes for generalisation. Results indicated that avoidance behaviour and threat-expectancy readily conditioned and then generalised to symbolically related stimuli. However, trait anxiety and experiential avoidance do not predict symbolic generalization of avoidance.

Experiments 2a and 2b returned to the examination of less complex forms of fear and avoidance by comparing the relationship between trait scores and Pavlovian conditioning rates to that between trait measures and semantic

generalisation rates. Specifically, Experiment 2a employed a Pavlovian conditioning method, with only a single phase of avoidance learning, while Experiment 2b included a generalisation probe phase, using real words and their synonyms as cues. Both experiments successfully demonstrated the ease with which avoidance learning and generalisation occurs, as well as identifying a number of tantalising co-relations between the trait questionnaires and the dependent measures.

Experiment 3, 4, 5 and 6, all used the Boyle et al. (2016) paradigm, comprising of 3 phases; fear conditioning, avoidance conditioning and final probes, with a range of procedural modifications to attempt to identify specific effects. Experiment 3 produced successful conditioning of two cues across all phases. Generalisation between the cues was supported by discriminated differences in avoidance responding and US expectancy, but not for arousal response magnitudes. Similar to the previous experiment, the predictive utility of the questionnaires was more pronounced for the conditioned responses than for generalised ones.

In an attempt to address a number of possible confounds, Experiment 4 replaced the single press low-cost avoidance response from Experiment 3, with a higher physical (20x press) cost response. Overall, regardless of participant's US avoidance success, rates of attempted avoidance (i.e., ≥ 1 key-presses) to the CS+ and CS- during all phases supported the successful conditioning of safety and threat to the cues, which then was shown to semantically generalise. A participant's success in regularly cancelling the delivery of the US, was also related to their likelihood of attempting avoidance during probe trials. Questionnaire scores were not significantly correlated with either the observed rates of generalisation or individual success in making an avoidance response.

Experiment 5 sought to examine whether the introduction of a novel unrelated probe stimulus, during the final phase, would result in increased mean magnitudes of SCRs and affect levels of generalisation. The interference provided by the novel probe reduced levels of generalisation and negated a number of previously identified correlations between the trait questionnaires and the dependent measures, when results were directly compared to those from Experiment 3. However, Experiment 5 highlighted that there existed a clearly distinguishable cohort of participants who showed robust and reliable generalisation across all of the dependent measures despite any interference.

Experiment 6 sought to discriminate between ‘generalisers’ and ‘non-generalisers’ by adding additional semantic generalisation cues (i.e., antonyms) during generalisation testing and further examine the interfering effect of additional probe stimuli. It was hoped that this group of persistent generalisers would be more likely to be discriminable from the non-generalisers using the questionnaire. Despite significant differences in the avoidance responses and generalising behaviour of both groups, a comparison of trait scores across the two cohorts revealed no significant differences for any of the trait questionnaires examined.

The overall conclusion of this program of research was that while both the semantic and symbolic generalisation phenomenon have been consistently supported, correlations between anxiety, personality or experiential trait measures and the observed behaviour have resisted identification. From the evidence outlined herein, it is clear that while more and less avoidant cohorts of participants exist, they do not appear to be easily identifiable based on trait test scores.

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Chapter 1

The generalisation of fear provides individuals with the opportunity to predict and react to possible threats within their environment based on the combination of their historical experience and the information currently available. This phenomenon is easily replicated in the laboratory using Pavlovian conditioning paradigms and has been extensively studied (see Dymond, Dunsmoor, Vervliet, Roche, & Hermans, 2015 for review). In the outside world, the generalisation of safety behaviours that accompany the generalisation of fear, often results in the reduction of appreciated levels of anxiety and so these behaviours may become more entrenched and difficult to reduce. As a result, the generalisation of fear and avoidance have been widely implicated in the pathology of anxiety related dysfunction. While generalisation is easily generated and has been extensively studied, individual differences in generalisation propensities have only recently re-emerged as a subject of enquiry. This is particularly surprising, given that, within applied or clinical settings, anxiety or experiential avoidance trait questionnaires are commonly used in the assessment process of anxiety related dysfunction in individuals. The programme of research into the generalisation of fear detailed in this thesis, attempts to contribute to this field by focusing on the influence of individual differences in threat appreciation and its generalisation.

1.1 Fear and avoidance generalisation

Human learning requires successful generalisation of a range of stimulus functions for the development of basic skills. Evolutionary survival was most likely dependent on generalisation along a perceptual continuum of threatening signals. For early man the likelihood of surviving an encounter with a predator would have been enhanced by their ability to recognise situations or environments which could expose them to possible harm. For example, the ability to attribute a level of danger to predator related sounds (e.g. rustling in the tall grass) or other cues (e.g. fresh footprints or tracks) would provide the individual with the opportunity to either prepare for a possible attack or evacuate the area. The success of this behaviour in reducing anxiety would have then supported the development of possibly more complex generalisations and safety seeking behaviours e.g. avoiding areas with a similar topography to where the aversive event had previously occurred. For instance, remaining with the early man scenario, imagine a small and fluffy cat-like animal that approaches the camp of a tribe. Its features naturally endear the animal to the tribe members. However, one of them has previously observed a much larger version of this cat which, while visually similar, looked a lot more threatening. Based on his experience of children growing bigger and becoming less cute with age, and also his experience that bigger animals tend to be protective of smaller ones, the presence of this small cat represents a source of anxiety for the individual. Despite the fact that, at face value, they should have no cause to fear such a small and endearingly cute object, he recommends that the group move to a much safer location. This provides for much merriment among the other tribe members, who may or may not be available for dinner later that evening. The development of this ability i.e., for any fear or safety behaviour to generalise to novel situations and stimuli from familiar but related single exemplars or combinations of exemplars, was most likely important from an evolutionary perspective.

Threat generalisation is readily apparent in a laboratory. Pavlov's discovery in the 1920s of the appetitive characteristics of an auditory tone for dogs, when that sound was repeatedly delivered prior to their receipt of food, is one of the most publicly recognised scientific findings in history. However, what is possibly less well known is that Pavlov also found that by adjusting the frequency of the tone being used as a conditioned stimulus (CS), the conditioned response (CR) of the dogs was moderated, with the greatest response being recorded to the CS closest to the original (Passer, & Smith, 2009). Further research into the phenomenon has since established that once a subject demonstrated conditioning to a stimulus, physically similar objects could then be introduced as stimuli and the previously conditioned behaviour would be reliably observed to the novel stimuli (e.g. Lissek et al., 2008; Vervliet, Kindt, Vansteenwegen, & Hermans, 2010). This readiness to generalise between conditioned and perceptually similar novel stimuli has repeatedly been demonstrated in the laboratory over the last 100 years.

1.2 Pavlovian fear and avoidance generalisation

During a typical Pavlovian fear conditioning procedure, novel neutral stimuli are repeatedly presented and paired with an aversive stimulus to generate a conditioned (i.e., learned) fear related response to each cue. Once reliably established, this conditioned stimulus (CS), serves as a laboratory analog of real-world stimuli that may produce fear responses. The CS can now produce a conditioned fear response. However, features of the CS can be manipulated to test for the extent of generalization of fear. Specifically, Pavlovian conditioned fear readily generalises to stimuli perceptually similar to the CS, without requiring further conditioning. The apparent ease with which conditioned fear generalises has implicated generalisation in the development of anxiety related disorders such as Post Traumatic Stress Disorder (PTSD), Panic Disorder (PD) and Generalised Anxiety Disorder (Dymond, Dunsmoor, Vervliet, Roche & Hermans, 2015; Hunt, Cooper, Hartnell & Lissek, 2017). More specifically, individuals experiencing PTSD or phobias are more likely to show generalisation than non-clinical populations and do so further along any perceptual continua between the CS and probe stimuli (Dunsmoor, Martin & LaBar, 2012). This over-generalisation of fear is considered to be an important factor in the aetiology of pathologic anxiety (Hunt et al., 2017). Where CS manipulations occur along semantic or symbolic continua, rather than perceptual ones, the resulting generalisation extends beyond that typically predicted by the Pavlovian model and is a form of more extreme generalisation than has been traditionally studied in the literature on over-generalisation.

Similar to the conditioned fear response, the generalisation of avoidance is an adaptive behaviour easily generated through Pavlovian fear paradigms in the laboratory. Avoidance is a behavioural manifestation of fear. During a fear conditioning paradigm, providing the opportunity to avoid any consequences of an aversive CS presentation mimics the adaptive avoidance behaviour which was necessary for evolutionary development (Dymond et al., 2015). Most likely as a result, avoidance behaviour generalises between conditioned stimuli and perceptually similar stimuli as readily as does the original conditioned threat (Arnaudova, Krypotos, Effting, Kindt, & Beckers, 2017). Unfortunately, avoidance maintains anxiety levels by interfering with exposure to the CS, and therefore the possibility of extinction or habituation (Dymond et al., 2015). As a result, excessive avoidance, or the over-generalisation of avoidance, has been implicated in the maintenance and development of anxiety related disorders (Krypotos, Arnaudova, Effting, Kindt, & Beckers, 2015). Within perceptual generalisation, any fear or avoidance responses to stimuli closely resembling the original CSs indicate adaptive learning. However, fear responses to novel cues which are not perceptually similar to the CS may indicate maladaptive over-generalisation (Krypotos, Vervliet & Engelhard, 2018). In effect, we may think of over-generalisation as the non-adaptive extension of fear and avoidance to stimuli not functionally related to the CS.

It is important to understand that there is no one standard definition of over-generalisation in the literature. The one used here refers to the mere extent of generalisation to stimuli increasingly distant to CS in perceptual, semantic or symbolic terms. This research has a particular interest in the extent to which symbolic and semantic generalisation of fear and avoidance are observed for individuals high in trait anxiety. However, it may be possible to imagine other forms of "over"-generalisation, such as for example, cases in which fear or avoidance responding is observed for the CS- or probe stimuli semantically or symbolically related to the CS- (i.e., safety cues). This seems to be an approach adopted by a small number of researchers, such as the Vervliet and Indeku (2015) study. And indeed, in the results section of a number of the experiments detailed in this thesis, over-generalisation in this form i.e., avoidance to the CS- safety stimuli or their related GSs has been observed and reported. However, given that the initial interest of the current research was to question the relevance of trait anxiety measures in laboratory studies of generalisation, the main focus of this research into over-generalisation is to examine the extent of generalisation of fear and avoidance as a function of trait anxiety indices, rather than to examine any one model of anxiety based on a model-specific definition of over-generalisation.

1.2 Symbolic fear generalisation

In the real world, the generalisation of fear is sometimes reliant on the human ability to appreciate the level of threat provided by novel stimuli, beyond any direct conditioning experience or perceptual generalisation of a Pavlovian based paradigm. In the early man scenario described previously for example, the individual had to derive a possible relationship between the novel cue (the small cat) and perhaps a larger and more threatening parent animal, without any evidence that the latter cat even existed. His appreciation of this threat, relied upon a previous observation of the larger cat and its predatorial attributes (e.g. size, gait, sharp claws, large teeth, etc.), which may have had unconditioned or acquired threat functions. Despite never having seen the larger cat in attack mode, the early man's estimation of threat posed by the small cat would have been generalised from these other experiences, without any direct association between the larger and smaller cats.

Humans have the ability not only to combine multiple sources of information, but also to relate the data to events from the past, present and future, to influence their future behaviour (Dymond, Bennett, Boyle Roche & Schlund, 2018). This ability is referred to as arbitrarily applicable relational responding (AARR) and describes when humans interact relationally with their environment. Dymond et al. (2018) argued that generalisation was a naturally occurring form of human relational responding and that rather than confine our understanding of generalisation to those arising from specific perceptual similarities between cues, AARR allows for novel, untrained responses to emerge in the laboratory that do not represent examples of perceptual generalisation. This behaviour is apparent in language-enabled humans, who when taught a series of arbitrary (i.e., not physically similar) and inter-related conditional discriminations, can subsequently relate stimuli in ways not explicitly trained.

In 1997 Augustson and Dougher provided a novel demonstration of highly abstracted generalisation between stimuli which were neither perceptually similar nor had a direct relationship with an aversive event. Their experiment was based on the earlier work of Dougher, Augustson, Markham, Greenway and Wulfert's (1994), who had produced a novel demonstration of the generalisation of fear, as evidenced by skin conductance response (SCR) magnitudes generalised across purely symbolic derived equivalence classes among nonsense words. In both experiments, participants were trained to generate two equivalence classes of nonsense words each containing four members (A1-B1-C1-D1 and A2-B2-C2-D2; these alphanumeric labels have replaced the nonsense words actually used as cues for the purpose of clarity) using a matching to sample (MTS) procedure. In other words, when provided with a target nonsense word (A1 or A2) and a choice of two other nonsense words on-screen (B1, C1, D1, B2, C2 or D2), participants were required to match which of the two available options were related to the target cue. By then reinforcing only the correctly selected response with feedback, participants subsequently learned which words were related to the target cue (either A1 or A2). Repeated presentations of all of the possible combinations eventually resulted in the two separate classes of cues being successfully established. The procedure then paired one class member (e.g. B1) with an aversive shock (US) and one member from the alternate class with no shock (B2) to generate a CS+ cue (with shock) and a CS- cue (without shock). In the 1997 Augustson et al. study, this procedure was supplemented by making an avoidance response to the CS+ possible. If made, tis response cancelled any cue-related shock. During the final probe phase of both studies the C1, D1, C2 or D2 cues were individually presented in extinction (i.e., without shock) and the participants then demonstrated derived threat (indicated by skin conductance responses) across the other class members.

In both the Augustson et al. and Dougher et al. studies, derived threat was observed to generalise across non-perceptual continua and this changes the extent to which threat can "normally" generalise. In other words, it became known for the first time, that threat can generalise to an extent that may be considered pathological in comparison to simple Pavlovian (perceptual) generalisation.

Dymond et al. (2018) argued that while symbolic generalisation of various responses was so successful for the human race that it enabled us to explore the abyss of Space despite being located on earth, it also provides for the development of maladaptive responses – such as excessive fear. The personal experience of anxiety, or threat, related to objects and events is complex and subjective in the sense that it emerges from the idiosyncratic histories that generate networks of related stimuli, such as in language. The organisation of these networks of arbitrarily related stimuli (i.e., related words and physical objects are not formally similar), can facilitate very extensive, and unique forms of generalisation, that may explain, if identified, why certain forms of fear related avoidance behaviour appears "irrational" (e.g., avoidance of invisible germs or spiders; see Guinther & Dougher, 2015). In this manner human generalisation behaviour in the real world differs significantly from that generated using perceptually based fear generalisation paradigms which appear more like those observable in animal behaviours (Dymond et al. 2018). This latter, and far less frequently studied form of generalisation is of great interest in the understanding of anxiety conditions, and may in fact differ in extent across individuals of varying levels of trait anxiety.

Research examining the human ability to derive novel generalisations have since continued apace with Dymond, Roche, Forsyth, Whelan and Rhoden (2007) extending the Augustson et al. (1997) study beyond relations simply based on equivalence, by initially training both *same as* and *opposite to* relations between the target and the probe cues. Providing an arbitrary symbol as the contextual cue for *same as,* and another indicating *opposite to,* during the MTS process and using nonsense words as cues, the procedure successfully trained the following relations; A1=B1, A1=C1 and A1 *is opposite to* B2, A1 *is opposite to* C2 (see Figure 1.1). By pairing a selected nonsense word with the presentation of aversive image onscreen and an accompanying aversive sound, they successfully conditioned the B1 cue as the CS+. While the B2 cue was paired with a non-aversive sound and image and provided the CS-. During this phase participants were provided with the opportunity to avoid the oncoming pictures by pressing the spacebar.

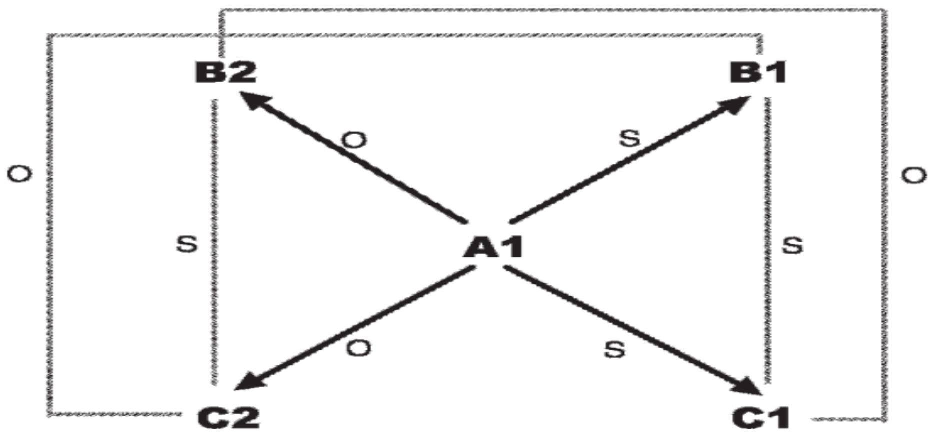

Figure 1.1. Graphical representation of the trained and derived relations from Dymond et al. (2007) with alphanumerics in place of the nonsense syllables used as cues. Arrows indicate the trained relations between cues while the lighter lines indicate the relations derived by the participants. O denotes the relations in opposition between cues while S (same) denotes those in equivalence.

During the final phase, generalisation of the avoidance responses to B1 related to C1 (same as B1) but not B2 or C2 (both opposite to B1) was observed, when the cues were probed in extinction. This demonstration of *symbolic avoidance* (i.e., between cues based on their relationship with the CS+ rather than any direct association with the aversive event), elaborated on the Dougher et al. (1997) generalisation effect and demonstrated even greater possible complexity in the generalisation of threat responses. Importantly, it also showed that the functions of all stimuli could be brought under contextual control, such that stimuli opposite to one another had opposing derived functions.

While a number of subsequent studies have supported the symbolic generalisation phenomenon (e.g. Dymond, Schlund, Roche, and Whelan, 2014; Gannon, Roche, Kanter, Forsyth, & Linehan, 2011; Roche, Kanter, Brown, Dymond, & Fogarty, 2008), a more critical examination of the contextual control that the same and opposite relations provided in the generalisation of avoidance between nonsense cues was undertaken in 2015 by Bennett, Hermans, Dymond, Vervoort, & Baeyens (2015). Specifically, that study was designed to address a procedural artefact of the Dymond et al. (2007) study, in which non-avoidance responses to stimuli Opposite to the CS+ were treated as symbolically generated, non-threat responses mediated by the Opposite relationship between class members. However, Bennett et al. (2015a) claimed that any generalisation of safety from threat, between cues in opposition, may have equally been due to the generalisation from the conditioned safety B2 stimulus of which the probe was in derived equivalence. To prevent this possible interference, Bennett et al. conditioned only the B1 stimulus as the CS+ and used a previously unseen nonsense word which was not followed by the aversive images and sounds (US) to provide the CS- during the avoidance conditioning phase. During the final probes for generalisation the B1 and C1 (same as A1), the B2 and C2 (opposite to A1) and a novel nonsense word were presented to identify the levels of conditioning and generalisation. Their results supported this hypothesis, and also the findings of the Dymond et al. (2007) study, with the generalisation of the avoidance response observed only to the cues in equivalence to the B1 (CS+) cue but not to either of the opposition cues or the novel stimulus. It also demonstrated that in humans semantic-like, symbolic categories may be readily formed which then facilitate the spread of conditioned fear and avoidance functions within networks of other, now related stimuli.

1.3 Semantic fear generalisation

Research into the *symbolic generalisation* of fear has highlighted the role of verbal relations in the over-generalisation of threat, insofar as within the tradition in which this research has largely taken place, derived relational stimulus networks are viewed as functional explanations for language networks. Within this field, little distinction is made between derived relational responding and natural language phenomena (see Dymond et al., 2015). In an effort to look specifically at threat generalisation in a natural language context, Boyle et al. (2016) revisited an all but forgotten semantic generalisation paradigm (see Feather, 1965, for a review). Specifically, that study used similar conditioning methods to those previously described in the symbolic generalisation field (e.g., Dymond et al, 2011; Bennett et al. 2015a), as well as incorporating skin conductance arousal (SCR) as a threat-related metric similar to that previously used in Gannon et al. (2011). Specifically, participants were first exposed to a fear conditioning phase in which one word (e.g., SICK) was paired with the presentation of a small cutaneous shock in order to establish that words as a CS+, while another word (e.g., WEEP) which was never followed by shock was designated as the CS-. During a subsequent avoidance learning phase, the space-bar press functioned as an available avoidance response, which cancelled the delivery of the CS+ signalled shock in 100% of cases. During the phase and without a break in the procedure, words semantically related to the CS+ (e.g., ILL) and CS- (e.g., CRY) were presented in extinction to examine for any generalisation of the conditioned CS+ related threat. Differences across all of the dependent measures (i.e., levels of avoidance, SCR and post-hoc US expectancy ratings), were significant between the CS+ and CS- stimuli and also between their semantic counterparts. While the three measures did not co-vary reliably (e.g., raised levels of avoidance responding did not mirror higher SCR levels for the generalised stimuli), the synonyms produced levels of avoidance, SCRs, and US expectancy ratings consistent with their semantic relation to the previously conditioned CS+ or CS-. In this study, Boyle et al. provided further evidence regarding the ease with which generalisation may occur within natural or trained language categories, and provided further support for the idea that these effects may provide a useful analogue of over-generalisation in the clinical context (Dymond et al., 2009).

1.4 Clinically relevant anxiety

The diagnostic criteria for anxiety disorders was clearly set out in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) by the American Psychiatric Association. The manual parsed individual anxiety disorders by detailing the identifying possible symptoms of patients in response to different anxiety related contexts or events. For example, excessive worry about having panic attacks was denoted Panic Disorder (PD), while anxiety regarding contamination or other obsessions was indicative of Obsessive-Compulsive Disorder (OCD) and the regular and recurrent reminders of traumatic events was a symptom of Post-Traumatic Stress Disorder (PTSD). By clearly defining the context in which the anxiety manifested it was possible to differentiate these specific disorders from Generalised Anxiety Disorder (GAD), the condition which describe excessive and persistent levels of non-specific anxiety. Anxiety related disorders in the DSM-IV are regarded as such if behaviours they manifest include many or all of the following symptoms. The level of experienced anxiety must be excessive, recurring, sufficiently extreme to interrupt or modify everyday behaviour and must not be as a result of any substance or medical condition. It may also involve feelings of physical discomfort, helplessness or a lack of control or alternatively, may involve levels of avoidance or suppression.

Updated in 2013, to improve diagnostic utility the DSM-V separated disorders into categories more accurately describing their aetiology rather than on their symptomology. For example, OCD is now included under Obsessive-Compulsive and Related Disorders while PTSD now appears in a new section entitled "Trauma and Stressor Related Disorders" (Kupfer, 2015). While the methodology of the manual has been updated the diagnostic criteria for the relevant appear to have remained intact.

1.5 Clinically relevant research

The clinical literature has long viewed traditional laboratory-based differential fear conditioning procedures as a paradigm within which to understand anxiety conditions (Boddez, Baeyens, Hermans, & Beckers, 2014; Lissek et al., 2005). The generalisation of fear and avoidance "are evolutionarily adaptive processes that are commonly experienced in everyday life. However, individuals with anxiety disorders are excessively fearful, anxious, or avoidant of perceived threats in their environment (p.117)" (Pittag et al. 2018). In the laboratory, levels of conditioned fear are easily generated using Pavlovian-based conditioning techniques. Individual levels of adaptive generalisation are then observable by providing perceptually related stimuli and measuring the participant's response. Within a conditioning and generalisation paradigm reliant on perceptual similarities, any generalisation of the response to either perceptually stimuli dissimilar to the aversive CS, or alternatively similar to the safety CS, is regarded as an over-generalisation of the fear response. Beckers et al., (2013) proposed that this behaviour is maladaptive and may indicate the presence of pathological fear or anxiety similar to that observed in behaviour of those suffering with anxiety disorders in the real world.

The pathological generalisation of fear or its related response often extends beyond experiences perceptually similar to the original aversive event. Individuals suffering with anxiety related disorders often demonstrate generalised threat responses to distantly similar, or apparently arbitrary, scenarios or environments to those assumed to have been involved in the original conditioning experience (Dunsmoor et al., 2012). According to the American Psychiatric Association's DSM identification of anxiety related disorders, the diagnostic criteria include behaviours which regularly interfere with or modify the patient's everyday behaviour. For example, after recovering from a traumatic car crash an individual suffering from PTSD may suffer raised anxiety levels with regard to any approaching vehicles perceptually similar either in colour or style to the one involved in the collision. Alternatively, they may experience heightened tension when approaching the location in which the crash occurred. Additionally, they may prefer to avoid that location and perhaps similar types of junctions or roads which they now may deem unsafe. However, they may also experience fear responses in situations that are symbolically related to, but apparently bear no resemblance to the original conditioned stimuli, such as dissimilar cars made by the same manufacturer, but not dissimilar cars made by other manufacturers. These types of clearly symbolically or semantically controlled generalisations and avoidance behaviours are the focus of this research programme. This focus on these more complex forms of threat generalization attempted to contribute to the understanding of more clinically relevant anxiety-related behaviours than has been attempted to date.

Until relatively recently, laboratory-based examinations of basic fear conditioning, perceptual generalisation and subsequent safety behaviours, such as US avoidance, have repeatedly been drawn up in an effort to provide a complete account of the pathology of anxiety disorders (Arnaudova, Kindt, Fanselow, & Beckers, 2017; Beckers, Krypotos, Boddez, Effting, & Kindt, 2013; Pittag et al., 2018). This was met with some success, as these basic processes are surely a very important component of the aetiology of many anxiety-related disorders. In 2005, Lissek et al. provided a meta-analysis of laboratory-based fear conditioning experiments, which highlighted differences in threat generalisation rates between clinically anxious patients and healthy controls. They discovered that clinically anxious patients with a range of disorders including PTSD, Panic Disorder (PD) and Generalised Anxiety Disorder (GAD) demonstrate higher levels of anxiety during conditioning trials and were slower to show extinction of the conditioned responses during the extinction phase than healthy controls. Within the DSM-IV

(American Psychiatric Association, 2012) both PD and OCD are indicated by individuals reporting regular and excessive levels of anxiety or distress to everyday activities beyond those which would be normally experienced as stressful. This diagnostic criterion was also empirically supported by Lissek et al. (2009) who provided evidence that PD patients were also more likely to overgeneralise a conditioned threat than healthy controls along a perceptual gradient. Studies have also indicated that the over-generalisation of a conditioned threat along a perceptual continuum is also more likely for those suffering from both GAD and PTSD (Lissek et al., 2014; Lissek & Grillon, 2012).

Excessive avoidance is related to the degree of success in removing any real or suspected threat, regardless of errors in the identification of prospective dangerous scenarios (Hunt, Cooper, Hartnell, & Lissek (2017). Because the individual never experiences the lack of any consequence when they avoid a safe stimulus, their erroneous threat related beliefs are never challenged. This paradox ensures that the over-generalisation of avoidance is notoriously difficult to extinguish (Pittag et al., 2018). In 2012, *Avoidant Personality Disorder* was included in the DSM-IV by the American Psychiatric Association. While the over-generalisation of avoidance has been implicated in anxiety disorders such as PTSD and obsessive-compulsive disorder (OCD), its distinct role in their development or maintenance is yet to be determined (Hunt et al., 2017; Lissek, 2012; Pittag et al. 2018).

To date, in addition to the empirical evidence in support of the effect, the implication of over-generalisation of avoidance in the development of anxiety related disorders is supported by the success of exposure-based treatment interventions. These therapies promote the extinction of any maladaptive avoidance behaviour to safe stimuli by exposing the patient to their already aversive object or event and inhibiting their opportunity to avoid (Vervliet et al, 2015; Krypotos.et al., 2015). This intervention is clinically relevant as the overuse of excessive avoidance behaviour is prevalent in those suffering from both OCD and PTSD (DSM-IV; American Psychiatric Association, 2012). Specifically, Vervliet and colleagues are interested in undermining forms of over-generalisation that include the extension of fear and avoidance to the CS-, although as discussed above this is not an agreed-upon approach to over-generalisation but represents at least one facet of the phenomenon. Response prevention / exposure ensures that ineffective maladaptive avoidance responding is weakened by exposure to the safe consequences of not avoiding in the presence of safety cues. However, this has not proven to be effective in laboratory studies, in which excessive avoidance persists post-extinction of the US within a non-clinical sample of participants (see Vervliet et al. 2017). In this manner, the interaction between avoidance over-generalisation and anxiety related dysfunction appears clearer in the theoretical models of clinical psychologists than it does to basic researchers.

While the early conditioning and generalisation models have provided valuable insight into anxiety-related conditions, there are knowledge gaps in relation to the ecological validity of the experimental models (i.e., understanding the naturalistic occurrence of fear and avoidance generalisation) and how these process are related to traits widely used in assessments in the diagnostic context (Pittag et al., 2018).

1.6 Modern generalisation research and personality correlates

In contrast to the use of subjective scales (i.e., trait questionnaires) by clinicians in the diagnostic context, the attempt to identify an individual's propensity to generalise either threat or avoidance in the laboratory, is most likely along a long established and empirically supported experimental process. Using a proto-typical fear or avoidance generalisation experiment, researchers can identify an individual's level of threat appreciation to novel stimuli, which will reliably indicate their degree of over-generalisation of learned avoidance for example, in a manner that would not be so readily apparent perhaps in the outside world. During this experiment an object will be paired with an aversive stimulus (US), such as a small electric shock, to establish a reliable threat cue known as the conditioned stimulus (CS) which may then be physically avoided by actively inhibiting the shock. Stimuli not paired with the US but conceptually (e.g. Dunsmoor et al., 2014), perceptually (e.g. van Meurs, Wiggert, Wicker, & Lissek, 2014) or semantically related (e.g. Boyle et al., 2016) to the CS will be then presented to examine for any generalisation of the conditioned fear or resulting avoidance between the stimuli. Threat appreciation is assessed using a combination of the individual's physiological responses (e.g. skin conductance or startle reflex), level of behavioural avoidance and self-reported measures of US expectancy (see Boyle et al., 2016 for a detailed procedure). The degree of generalised avoidance between conditioned and novel related stimuli under laboratory conditions is readily apparent and can provide an indication of an individual's propensity to perceive threat in otherwise safe stimuli. In the world outside of the laboratory, however, clinicians often rely on the more traditional metrics provided by personality or anxiety trait questionnaires, among other techniques, to provide an equivalent level of insight into this behaviour.

The proliferation of trait anxiety questionnaires is due primarily to their acceptance and use within medical and clinical studies in the examination process concerned with the diagnosis of somatic and psychological illness (Julian, 2011; Torrents-Rodas et al., 2013). For example, the State-Trait Anxiety Inventory (STAI; Spielberger, 1983; 2010) is, with over 16,000 citations by 2018, the most widely used and empirically cited measure of anxiety currently available (Booth, Sharma & Leader, 2016). Similarly, since its development the Acceptance and Action Questionnaire (AAQ-II; Bond et al., 2011) has received over 1600 citations in its short existence (June, 2018) and has become a widely used measure of fear and avoidance in laboratory studies. The demand for trait-related metrics is also due to the historical assumption that there must be a correlation between laboratory recorded emotional responding and trait anxiety (Fahrenberg, 1992).

Historically, however, studies have provided contradictory evidence for the correlation between trait and fear conditioning or generalisation levels in both healthy participants and those suffering with clinical anxiety (Torrents-Rodas et al., 2013). For instance, Haddad et al. (2012) demonstrated the generalisation of a conditioned fear response along a perceptual gradient and found that both conditioning and generalisation were predicted by scores on the STAI Trait questionnaire. Torrents-Rodas et al. (2013) also examined the effect of individual trait differences on levels of fear conditioning and perceptual fear generalisation with groups of low, medium and high scorers on the STAI-T questionnaire using a sample of over 1000 people. Ten rings of various sizes provided the conditioned and generalised stimuli, with the ring at either end of the size continuum either paired with a small shock to function as the CS+ or without a shock to function as a CS-. During a subsequent phase, the in-between sized rings were presented to examine for generalisation using fear potentiated startle (FPS), skin conductance

(SCR) and risk ratings as measures. In contrast to Haddad et al. (2012), no significant relationship was identified between trait anxiety levels and either fear responses or levels of fear generalisation to the rings of decreasing size in relation to the CS+. This outcome failed to support the role of anxiety in the over-generalisation of conditioned fear that Lissek and colleagues had proposed in 2008.

Other studies which have targeted high trait anxiety samples have struggled to identify correlations between trait and avoidance in fear related research. For instance, Lommen et al. (2010) focused on those with high Neuroticism levels (EPQ-N; Eysenck & Eysenck, 1975) when they examined fear and avoidance generalisation along a perceptual gradient of different coloured circles (i.e., white to black). While levels of Neuroticism and avoidance generalisation were initially found to correlate, they only did so when an extended period of time to consider the stimuli was provided to participants. The authors theorised that this afforded participants the opportunity to consider any possible threat relative to the ambiguous stimuli. Established metrics used in their study which identify state anxiety (STAI) or the neurotic traits of uncertainty (IUS; De Bruin, Rassin, van der Heiden, & Muris, 2006) and worry (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) failed to correlate with either generalised avoidance or expectancies of aversive stimuli. They found that state anxiety measured by the STAI and the neurotic traits of uncertainty and worry were not correlated with either generalised avoidance or expectancies of aversive stimuli. In their experiment, procedurally similar to that of Lommen et al. (2010), Arnaudova et al. (2017) also failed to find correlations between various trait measures and SCR, Fear Potentiated Startle, risk ratings or instrumental avoidance. This evidence indicated that the relationship between most commonly used trait measures and fear and avoidance generalisation may not be obviously apparent when assessed under laboratory conditions.

The reason why trait measures may not reliably predict fear and avoidance and their generalisation may be due to some procedural artefacts of the conditioning paradigms typically used, that render them ecologically invalid. Research into the phenomenon has to date has relied on experimental paradigms using mostly visual cues to provide the conditioned stimulus (Lonsdorf et al. 2017). Vervliet and Indeku. (2015) proposed that these widely used conditioning techniques may be overly simplistic and unambiguous when compared to avoidance scenarios encountered in real life (see Beckers et al., 2013). Indeed, experimental paradigms currently used to examine the phenomenon of fear conditioning and avoidance generalisation have varied little since the Pavlovian based animal experiments of the early 1900's. If so, then the examination of other and perhaps more subtle conditioning effects could be more fruitful in terms of identifying inter-group differences. But it is still a concern that popular trait measures do not appear to have face validity as a direct and unambiguous measure of the readily established fear and avoidance of effective threat stimuli. This problem suggests that either the trait measures or the conditioning paradigms are less than satisfactory frameworks within which to understand anxiety related behaviours.

Hunt et al. (2017) attempted to improve the overall validity of the Multi-dimensional Experiential Avoidance Questionnaire (MEAQ; Gamez, Chimielewski, Kotov, Ruggero, & Watson, 2011), by examining its inherent trait factors in a manner that would provide for greater predictability of levels of avoidance and threat generalisation observable in the laboratory. Specifically, they examined the influence of two factors contained in the MEAQ i.e., Distraction/Suppression (DS) & Distress Endurance (DE) on both conditioned and generalised threat and avoidance behaviour. Their experiment used the "virtual farmer" procedure developed by van Meurs, Wiggert, Wicker and Lissek (2014), an onscreen video game in which the participant was required to enable the onscreen character to score points by accomplishing tasks as quickly as possible. During the game however, with the appearance of a specific shape (circle) onscreen, the participant would receive a small shock delivered to their forearm to provide the CS+. An available onscreen diversion for the character if selected cancelled the oncoming cutaneous shock but resulted in the game player forfeiting the points in relation to that task. In this manner Hunt et al., provided an avoidance response that could be selected but came with an associated cost for the individual. An alternate shape (triangle), which appeared onscreen and was not paired with a shock, provided the CS- similar to that established in a typical Pavlovian based discriminative conditioning paradigm. Later in the game similar shapes along a sized based continuum were presented, and never paired with the shock, to examine for threat generalisation. Generalisation was also measured using fear potentiated startle and self-reported risk ratings.

Results from the procedure confirmed that conditioning was successful on all three measures (avoidance, FPS and expectancy), as indicated by significant differences between responses for the CS+ and the CS-. Generalisation of all three measures was observed to the shapes related to the CS+ along the perceptual continuum. While overall the MEAQ failed to significantly predict levels of avoidance, the authors claimed that insights provided by the comparison of the DS and DE trait factor scores indicated that both had a moderating effect on generalisation levels relative to the perceived ambiguity of the stimuli. They suggested that the factors were associated with vulnerability to protection from over-generalisation of threat, depending on the scores. Although initially optimistic in their findings, the authors did acknowledge that a possible confound was present in that the accumulation of reward points was the object of the game. As a result they argued it may not have been possible to determine the extent to which variations in individual reward motivation affected the participant's avoidance rates. In other words, the competing motivations of earning points and avoiding the shock may were pitted against each other to produce an outcome in combination, with no clear quantification of the reinforcing value of the earned points. Overall, however, the study served to highlight that, within experimental paradigms which utilize perceptual gradients, broad trait measures such as the MEAQ struggle to provide a significant level of predictive utility in the generalisation of threat and avoidance.

A novel attempt to investigate the predictive utility of factors within a measure, rather than the overall trait score, was conducted by Flores, Lopez, Vervliet, & Cobos (2018), in their examination of the effect of US devaluation on avoidance. Flores et al. hypothesised that, for those scoring highly on scales which identified general worrying (i.e., the STAI and the Prospective (IUS-P) factor of the Intolerance to Uncertainty Scale), reducing the intensity of the US from a high volume sudden noise (97dB) to that of a more comfortable and lower volume (27dB) would not interfere with their level of avoidance responses to the conditioned stimulus. In other words, levels of avoidance for anxious individuals should persist at a high rate even when the threat posed by the conditioned stimuli was at a reduced level. For individuals with lower anxiety related scores they proposed, levels of avoidance would reduce comparative to the level of the aversiveness of the US. To examine this, Flores et al. initially paired a nondescript image with high volume noise delivered to the right ear, with a separate nondescript image paired with the noise to the left ear, in order to provide a pair of aversively conditioned stimuli (2 x CS+). A third image was not followed by the US and therefore functioned as the CS-. Subsequent to a Pavlovian conditioning phase, an avoidance response was then conditioned wherein the pressing of a specific key, depending on whether the US was presented to the left or the right ear, would cancel the upcoming aversive sound.

Using an experimental and a control group, Flores et al. inserted an additional phase in the experimental group's procedure. In this phase the volume of the US was reduced, with an example given to the participant prior to the final test phase. For those in the control group there was no phase insertion or further instruction given previous to the test phase, during which the US was in extinction for both groups. The final test phase then examined the level of avoidance by both groups. Flores et al. found that those who scored higher on the IUS-P were more likely to be inflexible in their avoidance behaviour. In other words, and as predicted, IUS-P scores correlated with the level of avoidance which was resistant to both the devaluation of the US and also its extinction. Any correlation between STAI scores and the readily generated and easily observable level of avoidance responding in this experiment is not reported and perhaps highlights once again the lack of predictive ability of the more traditional and general trait measures.

Vervliet et al. (2015) study's attempt at refining the traditional conditioning paradigm also provided improved levels of predictability for trait measures in relation to behavioural avoidance. Their study examined low cost avoidance during extinction by comparing danger-safety ratings, SCRs and instrumental avoidance levels using a modern derivative of the Pavlovian analog. During the initial conditioning phase, based on the cue provided by the colour of a light visible on screen, participants were or were not subjected to a small electric shock (US). For example, if the light was blue (CS+) then they might receive a shock, but if the light was yellow (CS-) then they would not receive a shock. During the second phase, participants were also provided with an on-screen icon which indicated the availability of an avoidance response opportunity. In other words, when the icon was available on-screen, if the participants clicked on it using the mouse any impending shock would be cancelled. During a subsequent phase, the CS+ was presented in extinction (i.e., without shock and also without the avoidance icon being presented). During this phase higher stimulus fear ratings rapidly returned. Later in this phase, the icon returned on-screen once again with the absence of shock, and levels of avoidance were measured to investigate the persistence of avoidance during extinction. The authors found that the return of avoidance availability, despite the preceding extinction phase, facilitated the return of significant avoidance responding. SCR and avoidance levels from both the conditioning and extinction phases were then compared to the scores from a number of anxiety and avoidance questionnaires including the STAI.

No significant correlation was found between trait anxiety scores and levels of skin conductance or avoidance of the CS+. Interestingly however, the authors found that STAI scores correlated significantly with the number of CS- trials avoided (unnecessarily) during the conditioning phase. In 2017, Vervliet, Lange, & Milad used this paradigm once again, to examine levels of reported relief felt by the individuals subsequent to the omission of shock provided by the avoidance rather than levels of avoidance itself. The levels of relief experienced post avoidance successfully correlated with scores on the Distress Tolerance Scale (DTS: Simons & Gaher, 2005). The DTS measures individual levels of ability in enduring negative emotional states. Throughout all phases of the experiment those scoring lower on the DTS (i.e., less tolerance of distress) reported significantly greater levels of relief after the use of the avoidance response than their higher scoring counterparts. Overall, these findings suggest that trait measures may still be capable of discriminating the fear and avoidance behaviours of anxious and non-anxious individuals. But they also highlight that, going forward, it appears likely that the traditional paradigms used to examine the phenomenon, which mainly focus on straight forward conditioned effects and perceptually based gradients, need to be refined or improved upon to assess more subtle inter-relationships between traits and anxiety-related behaviours, as studied in the laboratory (Beckers et al., 2013; Lonsdorf et al. 2017; Vervliet et al., 2015).

Symbolic generalisation (e.g. Dymond, Schlund, Roche, Whelan, Richards, & Davies, 2011) and semantic generalisation (e.g. Boyle et al., 2016) are reliant exclusively on verbal rather than perceptual processes and therefore are more analogous to many forms of complex or arbitrary threat generalisations commonly associated with anxiety related disorders in the real world. In addition, these processes may draw more obviously on the types of traits we associate with anxiety; such as worry and rumination. More specifically, symbolic generalisation of fear and avoidance results from the individual rationalizing the derived, indirect and entirely symbolic relationships between conditioned fear stimuli and other physically dissimilar stimuli (e.g., see Dunsmoor , Niv, Yaw, & Phelps, 2015; Dymond et al., 2015) Indeed, as already highlighted in Lommen et al. (2012), it was only when individuals are afforded the opportunity for rumination with regard to the possible threat related qualities of an ambiguous stimulus, that EPQ Neuroticism scores predicted overall levels of generalisation to perceptually related stimuli.

While the use of the STAI in the Dymond et al. study on symbolic generalisation was reported, no relationships between trait measures and the generalisation of fear were commented upon. Other studies of symbolic generalisation have also failed to report information regarding any observed relationship between trait anxiety measures and the degree to which a participant was likely to show generalisation of fear or avoidance along entirely symbolic continua (see Bennett et al., 2015a & Vervoort, Vervliet, Bennett, & Baeyens, 2014). Given the obviously verbal / cognitive nature of symbolic generalisation as a process (see Boyle et al., 2016; Cameron, Roche, Schlund, & Dymond, 2015; Dymond et al., 2014), it is possible that individual differences in degrees of cognizing and rationalising around feared events (i.e., resilience and worry) may facilitate levels of symbolic or semantically related fear and avoidance generalisation. If this is the case, it was hoped that trait anxiety levels would correlate more readily with degrees of symbolically or semantically generalised fear and avoidance than they do with directly conditioned or perceptually generalised threat levels.

1.7 The current experimental programme

The research programme detailed in this thesis employed symbolic or semantic generalisation paradigms similar to those of Dymond et al. (2011) and Boyle et al., (2016). One of the main aims of the project was to further develop the original Boyle et al. (2016) design and identify possible enhancements or boundary conditions to the already observed semantic generalisation phenomenon. As an additional aim, the research project sought to provide a number of exploratory experiments to examine the predictive utility of commonly used personality, anxiety and experiential avoidance trait measures in identifying observed levels of Pavlovian style conditioning and the symbolic or semantic generalisation of fear and avoidance.

The first study replicated the Dymond et al. (2011) symbolic generalisation of avoidance study, but this time examined in an exploratory fashion for any significant correlations between rates of avoidance, US expectancy ratings and the scores from three commonly used trait anxiety questionnaires. During the first phase, participants were trained to generate two, three-member (A-B-C; X-Y-Z) stimulus relations, consisting entirely of nonsense words by using a matching to sample (MTS) analog. During Phase 2, a combined threat and avoidance conditioning procedure, a nonsense word from one relation (B) was paired with aversive images and sounds and established as a threat cue for avoidance (i.e., CS+), and another nonsense word from the other relation (Y) was not paired with aversive stimuli, and established as a cue for safety (i.e., CS-). During the final and crucial test for symbolic generalization phase, the avoidance response was available and all directly and indirectly related stimuli were presented individually in extinction. In this manner, observed levels of symbolically generalised fear or avoidance could then be compared to individual trait anxiety levels, measured using three commonly used sub-clinical questionnaires (i.e., STAI, BEAQ & AAQ), to identify any possible correlations between trait scores and either of the dependent measures (i.e., rates of avoidance or US expectancy ratings).

Chapter 2

Experiment 1: Do trait and experiential avoidance measures predict levels of avoidance in a symbolic generalisation paradigm?

Experiment 1: Do trait and experiential avoidance measures predict levels of avoidance in a symbolic generalisation paradigm?

Experiment 1 is modelled on the original Dymond et al. (2011) experiment and explored whether levels of conditioned and generalised fear or avoidance, along controlled and completely arbitrary symbolic continua, correlated significantly with scores from three commonly used trait and experiential avoidance measures. During Phase 1 of that study, to establish the initial relations which would later contain the conditioned and generalised stimuli, two 3-member networks of nonsense words were generated using a matching to sample (MTS) procedure. Only four stimulus matches were trained using this procedure (i.e., AV1-AV2, AV1-AV3, N1-N2, N1-N3, where all alphanumerics refer to arbitrary nonsense words). Untrained relations among the stimuli could be derived by responding to the trained relations in combination, in accordance with what it referred to widely as the stimulus equivalence phenomenon i.e., participants could derive AV2-AV3 and N2-N3 relations '(Augustson et al. 1997; Dymond et al. 2011; Bennett et al., 2015a). In this manner two arbitrary (i.e., symbolic) stimulus networks were established, each comprised of three nonsense words (i.e., AV1-AV2-AV3, N1-N2-N3).

During the subsequent fear conditioning phase, the AV2 nonsense word from the first network was then paired with aversive images and sounds (US) to create a CS+. Participants were informed at the beginning of this phase of the availability of an avoidance response, which consisted of a single spacebar press on a computer keyboard. The N2 nonsense word from the other network was not paired with the US but its presentation was not consequated by a US (i.e., it became the CS). Once conditioned avoidance to the AV2 and not N2 had been established, differential generalisation of avoidance was then tested for using AV3 (GS+) and N3 (GS-). These words had never been directly paired with the CS+ or CS- during any previous phase. In such paradigms, if recorded levels of avoidance and US expectancy ratings (if the avoidance response was not made) for the CS+ and GS+ are significantly greater than for the CS- and GS-, then a symbolically generalised fear and avoidance response has been created under laboratory conditions. The verbal and cognitive nature of symbolic generalisation as a process suggests that there may be individual differences in degrees of cognizing and rationalising around feared events that facilitate varying degrees of generalisation. If this is the case, we might expect trait anxiety levels, measured using three commonly used sub-clinical questionnaires (i.e., STAI, BEAQ & AAQ), to correlate more readily with degrees of symbolically generalised fear and avoidance than those previously observed for perceptual generalisation.

2.1 Method

2.1.1 Ethics

All of the experiments in this research programme were approved by the Maynooth University research ethics committee prior to commencement, and all health and safety procedures of that institution were observed in the use of all equipment. The original research programme was covered by ethical approval (ref: BSRESC-2015-022) granted by the Biomedical and Life Sciences Research Ethics Sub-Committee of the Maynooth University Research Ethics Committee on the 10th December, 2015 for the period extending until 31ST December, 2017. A subsequent application (ref: BSRESC-2017-018) was approved on the 11th October, 2017 for the period until the 31ST October, 2018.

2.1.2 Participants

In the novel Dymond et al. 2011 study only 21 participants were recruited and yet the derived generalisation effect was successfully demonstrated. To re-examine that paradigm and also possibly facilitate the subsequent correlational analyses between any observed generalisation and the trait questionnaires the decision was taken to increase the participant sample by doubling the sample size. Ultimately, thirty-seven participants were recruited via word-of-mouth and a snowballing convenience sampling method although this number was not derived from a power analysis but on the basis of ad-hoc availability of research volunteers. Two individuals (P17 & P20) had to be excluded from further analyses because they failed to successfully demonstrate derived equivalence (see Procedure). Data for another individual (P7) was lost due to an equipment malfunction and a single participant (P23) failed to complete the questionnaires. In all 33 volunteers (26 females) were included in the final analysis ranging in age from 19 to 22 years old (M = 21.06, SD= .933).

Participants were not screened formally for prior or current anxiety conditions for reasons of respecting volunteer privacy but were carefully briefed as to the aversive nature of the experiment and advised to self-exclude if they had concerns regarding their suitability given a list of exclusion criteria including medical and psychological conditions (see Appendix 1).

2.1.3 Apparatus

The apparatus, stimuli and procedure were identical to those used in the Dymond et al. 2011 study. A computer program written in *Visual Basic 6.0* controlled all stimulus presentations and recorded all responses. Six nonsense words comprised the sample and comparison stimuli used during stimulus equivalence training and testing (i.e., JOM, CUG, VEK, BEH, PAF, ZID designated randomly as A1, A2, B1, B2, C1 & C2 for identification purposes). Stimuli were presented in capitals, in uppercase bold size 24 Arial font. Two stimulus sets were constructed from these six stimuli and counterbalanced across participants. Visual and auditory stimuli were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005) and the International Affective Digitized Sounds (IADS; Bradley & Lang, 1999) databases for use as aversive stimuli during the avoidance conditioning and testing phases. A total of 10 aversive photographs (e.g., bodily mutilations) and 10 aversive sounds (e.g., a female screaming) were selected. The auditory stimuli were presented via headphones.

Each phase of the computer-based experiment ended with participants completing an onscreen expectancy rating questionnaire, a Likert style metric which examined their expectancy of a US for the each presented stimuli in the case of both their producing and not producing an avoidance response. In this study, expectancy ratings were taken post-hoc rather than in-line during trials. Three questionnaires, the STAI (Spielberger et al., 1983), the AAQ-II (Bond et al., 2011) and the BEAQ (Gamez et al., 2014), were also completed post-hoc. These questionnaires were selected based on their inclusion in previously reported fear-related studies e.g., STAI – Vervliet et al., 2015; AAQ-II - Boyle et al., 2016; MEAQ – Hunt et al., 2017.

The STAI (Spielberger, 1983, 2010) is, with over 16,000 citations by 2018, the most widely used and referred to measure of trait anxiety currently available. The STAI initially provides 20 statements similar to “I feel pleasant” on which the individual is asked to rate, on a four-point scale with “not at all” and “very much so” as the boundary conditions, their current or State level of anxiety. The remaining 20 statements form the Trait scale and, while similar, measure the level of anxiety the participant generally feels by using a four-point scale bounded by “almost never” and “almost always”. While it is more commonly used within health and applied psychological research, it is regularly included in trait and behavioural test batteries within the field of basic fear and anxiety related research. However, most of these studies provide little or no evidence that the test was of any predictive utility in their study. While some *failures* of the STAI to predict fear and avoidance levels have been reported, none of these are in relation to the process of symbolic generalisation as a distinct aetiology of at least some (albeit laboratory generated) forms of fear and avoidance.

The Acceptance and Action Questionnaire (AAQ-II; Bond et al., 2011) has received over 1600 citations in its short existence (May, 2018) and is fast becoming a widely used measure of fear and avoidance in laboratory studies. The AAQ-II is a seven-item scale which provides statements such as “Worries get in the way of my success” for participants to rate on a seven point scale from “almost always” to “almost never” which the author’s claimed examine the individual’s psychological flexibility in responding to anxiety. Designed to function as a predictor of psychological flexibility and experiential avoidance, this test’s discriminant validity and its ability to satisfy the brief has been questioned (Wolgast, 2014). This increasingly popular measure of experiential avoidance requires assessment in terms of its functional utility in predicting measurable avoidance behaviour.

The Brief Experiential Avoidance Questionnaire (BEAQ; Gamez et al., 2014) is a short form measure of experiential avoidance created from the 62-item MEAQ (Gámez, Chmielewski, Kotov, Ruggero, & Watson, 2011). The BEAQ comprises of 15 questions and uses individual responses ranging from "strongly disagree" to "strongly agree" to statements such as "I would give up a lot". While the BEAQ has yet to feature in the basic fear research literature, the MEAQ subscales of Distress Endurance (DE) and Distraction Suppression (DS) have been recently examined in connection with generalised avoidance between perceptually related shapes (Hunt et al., 2017). It was considered appropriate to include the shortened version of the MEAQ due to its novelty and also its strong reported convergence with respect to each of the MEAQ's 6 dimensions and its stated purpose of measuring experiential avoidance.

2.1.4 Procedure

Participants once recruited were provided with a briefing document detailing the experiment at least 24 hours previous to taking part (see Appendix 1). On arrival at the laboratory, participants signed a consent form acknowledging the distasteful nature of some of the stimuli to be used during the experiment and indicating that they did not have a history of psychopathology (see Appendix 2). Participants were then seated comfortably at a table in front of a computer in a small experimental room.

2.1.4.1 Phase 1: Stimulus equivalence training and testing (see Figure 2.1).

During this phase, a delayed matching-to-sample (DMTS) procedure was used to train a series of conditional discriminations (A1 – B1, A1 – C1, A2 - B2 & A2 – C2) and then test for the emergence of combined symmetry and transitivity (i.e., stimulus equivalence) relations (B1 – C1, B2 – C2, C1 – B1 & C2 – B2). No feedback was provided during the equivalence testing phase.

Participants were first given the following on-screen instructions, which were read aloud by the experimenter:

In a moment some words will appear on the screen. Look at the words at the top of the screen and then look at the two words at the bottom of the screen, on the left and right. Choose one of the two words at the bottom of the screen by clicking on it. Sometimes the computer will give you feedback, and at other times it will not. However, you can get all of the tasks without feedback correct by carefully attending to the tasks with feedback. Press here to continue.

On every trial, a nonsense word (designated as A1 or A2 for identification purposes) first appeared in the top centre of the computer screen (called the sample stimulus) for 1500 ms and was immediately followed by two further nonsense words (e.g., B1 and B2 or C1 and C2) positioned in the bottom left and right corners of the screen (called the comparison stimuli). The comparisons remained on-screen until a response was made by clicking on their selection with the computer mouse. When A1 was presented, clicking on the comparison stimulus B1/C1 produced the feedback, "Correct" in the centre of the screen, while clicking on B2/C2 produced the feedback "Wrong". When A2 was presented, clicking on the comparison stimulus B2/C2 produced the feedback, "Correct" in the centre of the screen, while clicking on B1/C1 produced the feedback "Wrong". Feedback was displayed in size 14 Arial red font within a 4.5 " 2 cm square in the middle of the screen for 2 s, and was followed by an inter-trial interval (ITI) of 2 s. All four tasks (A1 – B1, A1 – C1, A2 - B2 & A2 – C2) were presented in a block of 8 trials (each presented twice) in a pseudorandom order, with the constraint that the same task was not presented across more than two consecutive trials. Blocks were repeated until a participant made eight consecutive correct responses.

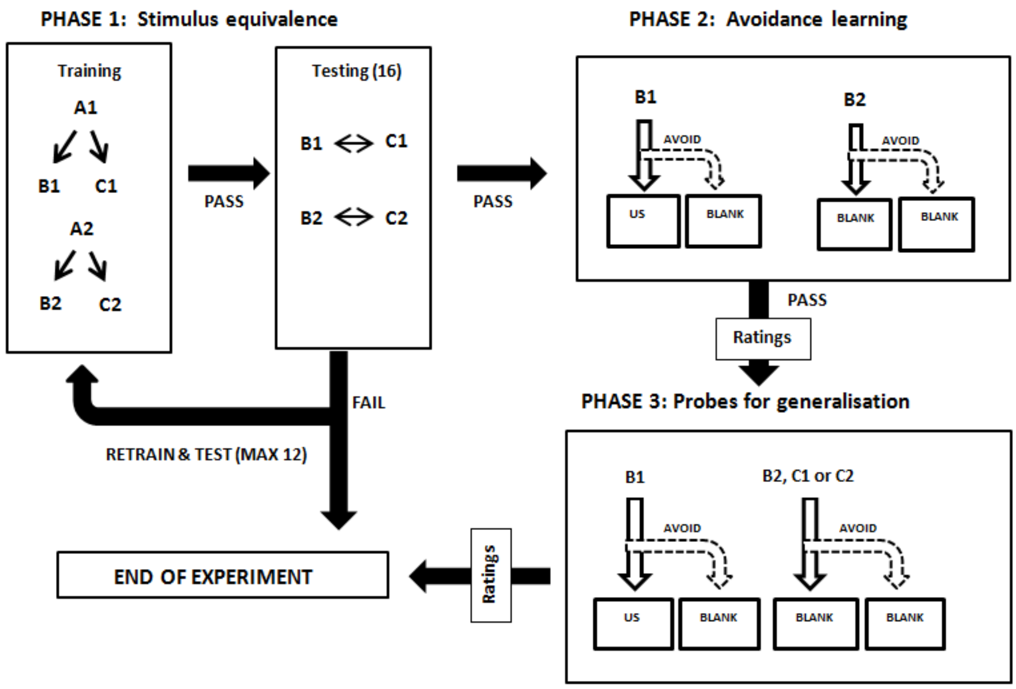

Figure 2.1. Illustration of the experimental phases of Experiment 1. For illustrative purposes, alphanumerics have been inserted in the figure in place of the original nonsense words used as cues in the experiment.

On meeting the training criterion, a block of 16 trials were presented that tested for the emergence of combined symmetry and transitivity (i.e., stimulus equivalence) relations. Each of the four tasks was presented four times in the absence of feedback. Specifically, when B1 was presented, clicking on the comparison C1 not C2 was the correct response; when B2 was presented, clicking on the comparison C2 not B1 was correct; When C1 was presented, clicking on the comparison B1 not B2 was correct; when C2 was presented, clicking on the comparison B2 not B1 was correct. If participants failed to produce 16 consecutive correct responses, they were re-exposed to the training and testing cycle again until this criterion was met, up to a maximum of 12 cycles.

2.1.4.2 Phase 2: Avoidance learning

The purpose of this phase was to learn to avoid B1which was established as a CS+ by pairing it with an aversive image and sound. B2 was established as a safety stimulus (CS-) by not consequating its presentation with aversive stimuli, and therefore should not generate avoidance responses. At the beginning of the avoidance conditioning phase, participants read the following on-screen instructions:

> *In a moment, you will be presented with some nonsense words, pictures and sounds. The pictures and sounds are from real life events and may be considered upsetting to some people. Pictures will be presented on the computer screen and sounds will be presented via headphones. Your task is to learn to cancel pictures and sounds before they are presented, by pressing the space bar. Later, you will be asked to make some ratings, by using a slider-scale, about the pictures and sounds. Please follow the on-screen instructions and make your ratings as honestly as possible. It is important that you pay attention and concentrate on the screen at all times. If you have any questions, please ask the experimenter now. When you are ready to begin, press any key to continue.*

Once participants had clicked any key to proceed, a blank screen was displayed for 1700 ms. Next, either B1 (CS+) or B2 (CS-) appeared in the centre of the screen for 5s. If participants did not press the space bar following the B1 (CS+) the stimulus was followed by a 2 s interval, after which a 600 X 800 pixel photograph and a sound were presented. Subsequent to the presentation of the B2 (CS-) a blank screen appeared. If participants pressed the space bar while either stimulus was present, no feedback was provided. Aversive images and sounds followed all presentations of the CS+ when the space bar was not pressed (i.e., 100% contingency between non-avoidance and presentation of the US). A blank screen followed all presentations of CS- whether the space bar was or was not pressed (i.e., 100% contingency between non-avoidance and absence of the US).

The stimuli were presented in a pseudorandom order (i.e., no more than two consecutive exposures to either) until participants made six consecutive avoidance responses during presentations of the CS+. If necessary, tasks were re-presented until the participant demonstrated conditioned avoidance according to this criterion. On meeting the avoidance conditioning criteria, the first ratings period was introduced. Participants were presented on screen with four individual, randomly displayed questions about the likelihood of pictures and sounds being presented both with and without the avoidance response during CS+ and CS- trials. The questions read as follows:

> *Please rate your expectancy of the pictures and sounds being presented in each of the following scenarios. You may use the slider scale to rate your expectancies. 1 = uncertain and 10 = certain. What is your expectancy of pictures and sounds if CUG appears and you do not press the space bar.*

Participants moved the slider-scale with the computer mouse and confirmed their rating by clicking on a button labelled “confirm [value chosen]”. The ratings period ended once all four questions were rated.

2.1.4.3 Phase 3: Tests for generalisation

Phase 3 began immediately after Phase 2 with the onset of the following instructions:

> *Now you will again be presented with nonsense words, pictures and sounds. Once again, your task is to learn the relationship between nonsense words and the appearance of pictures and sounds. When some nonsense words are presented, pressing the spacebar may prevent the occurrence of pictures and sounds. You should learn when to press the spacebar or whether not to press at all. The parts of the experiment that you just completed are related, so think about what you have just done to make the correct response/ non response. Later, you will be asked to make some ratings by using a slider scale. Please make your ratings as honestly*

as possible. If you have any questions, please ask the experimenter now. When you are ready to begin, press any key…

As before, once participants had pressed a key to proceed, a blank screen was displayed for 1700 ms, followed by a block of trials that presented CS+ (B1), generalised CS+ (GS+; C1), CS- (B2), and generalised CS- (GS-; C2). Stimuli remained on-screen for 5s whether the participant pressed the space bar or not during B1and no feedback was provided. During this test phase, not pressing the space bar during the presentation of either of the other remaining stimuli was never followed by an aversive image or sound (i.e., 0% contingency between GS+, CS- and GS- and the presence of the US). If a participant did not press the space bar during the presentation CS+, the same contingencies were in place as in Phase 2. Probes for derived avoidance consisted of a block of 12 trials containing the following cues: CS+ x 2, CS- x 2, GS+ x 4 and GS- x 4). All trials were presented in a pseudorandom order with the only constraint that no more than two consecutive trials of the same type could occur. After the test trials, the second ratings period was presented. Following the single block of generalisation probes, participants were presented on screen with eight individual, randomly displayed questions about the likelihood of pictures and sounds being presented both with and without the avoidance response for each cue. When participants had completed the STAI, BEAQ and the AAQ-ii questionnaires they were debriefed (see Appendix 3) and given the opportunity to ask any questions relating to the procedure, before the experiment was fully brought to a close.

2.1.5. Dependent measures and analyses

As parametric assumptions were violated, the nonparametric Kruskal-Wallis Test was used to explore differences, with stimulus as the within-subject factor with 4 levels (CS+, CS-, GS+ & GS-), to examine both the rate of initial avoidance learning and the generalisation of avoidance and expectancy ratings. Where the assumptions of a parametric test were violated, a nonparametric equivalent was used. Differences between stimuli were subsequently examined using pairwise comparisons with a Bonferroni correction.

However, the exploration of the relationships between avoidance rates, reported US expectancies and the post-hoc questionnaire scores was the primary focus of the analysis. For each of these relationships simple multiple models of regression were employed in an exploratory fashion to test whether individual or combined questionnaires best predicted levels of conditioned/generalised avoidance or perceived threat. Due to the exploratory nature of the analyses between the dependent measures and the questionnaires, the use of a Bonferroni correction would reduce the power of the tests and would make the identification of any significant effects unlikely. As a result, significant correlations between the two groups of measures are reported without correction. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

2.2 Results

2.2.1 Stimulus equivalence training and testing

During Phase 1, only two participants (5.4%) failed to show derived equivalence within the permitted (max. 12) training cycles and were excluded from the experiment. The mean number of training and test cycles required by participants to progress to Phase 2 was 1.97 (SD=1.237).

2.2.2 Avoidance

During the Phase 2 learning trials, rates of avoidance were higher for conditioned and generalised threat stimuli than for conditioned and generalised safety stimuli (see Figure 2.2). Planned comparisons were conducted to examine if differences in avoidance response rates between the conditioned threat and safety cues and also between the two probes for generalisation cues were significant. Preliminary analyses indicated that the distribution of the scores had violated the assumption of normality and as a result non-parametric Wilcoxon signed-rank tests were conducted with a Bonferroni correction applied ($p = .017$). During the avoidance learning there was a significant median (IQR) difference between the rate of avoidance responding to the CS+ and the CS-, $z(33)=-5.096$, $p < .001$, $r = .63$**.**

The directly established aversiveness of the CS+ was maintained during the Phase 3 test trials when there was a very high rate of avoidance to the conditioned threat. Successful threat conditioning was supported with a significant median (IQR) difference between the rate of avoidance responding to the CS+ and the CS-, $z(33)=-5.476$, $p < .001$, $r = .67$. during the final test phase. The difference in avoidance rates between the GS+ and the GS- stimuli was also statistically significant, $z(24)=-3.952$, $p < .001$, $r = .57$ showing that the CS+/CS- avoidance rate differential was maintained for the indirectly related GS+ and GS-.

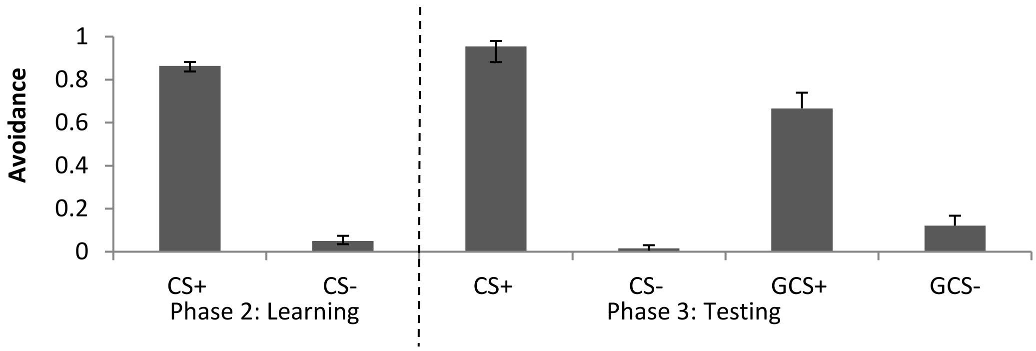

Figure 2.2. Mean percentage of avoidance responses to the CS+, CS-, Generalised CS+ and Generalised CS- stimuli during Phase 2 avoidance learning and Phase 3 tests for avoidance generalisation.

2.2.3 Expectancy

During the test trials significant differences were recorded for US expectancy levels between the CS+ and CS-, $z(32)=-4.929$, $p < .001$, $r = .62$ and the GS+ and GS-, $z(32)=-4.048$, $p < .001$, $r = .51$ if hypothetical avoidance response was not made. If, however, a hypothetical avoidance response was made, there was no significant difference. Figure 2.3 shows the mean US expectancies taken after Phase 3 for each of the four stimuli under the conditions of an avoidance response hypothetically being made or not being made. Differences were also present and significant in US expectancy levels, between the hypothetical use of an avoidance response and a non-avoidance response, for the CS+, $z(32)=-4.974$, $p < .001$, $r = .62$ and the GS+, $z(32)=-4.362$, $p < .001$, $r = .55$. The difference for the CS-, $z(33)=-2.458$, $p = .014$, $r = .30$ was also significant but with a greater expectancy of the US if the response had been made. Expectancies of the US following the GS- were not significantly different in the case that avoidance was or was not hypothetically made, $z(32)=-1.541$, $p = .123$, $r = .19$.

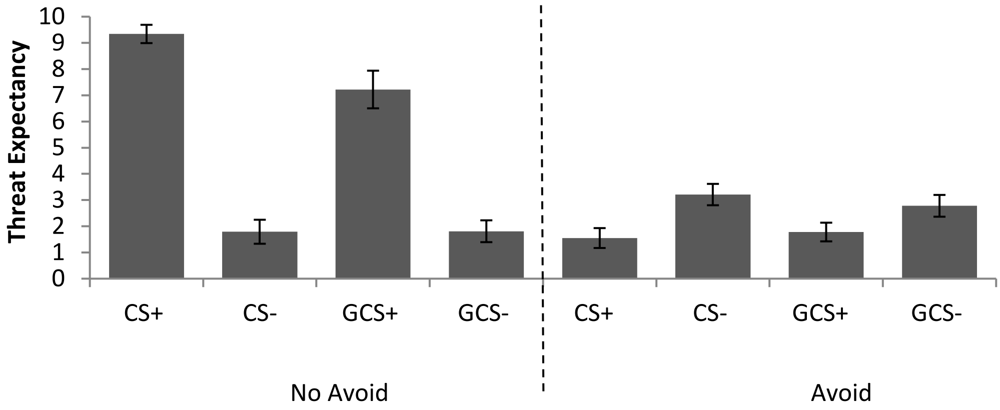

Figure 2.3. Mean Phase 3 expectancy ratings with regard to the US following each stimulus and in the case that an avoidance response hypothetically was or was not made. Error bars represent standard error.

2.2.4 Questionnaires

Questionnaires provided no significant predictive ability, either individually or combined, with regard to the number of equivalence training cycles required during Phase 1 for test progression or levels of avoidance to either the CS+ or the CS- during Phase 2 avoidance learning. Simple regression analyses also indicated the unique and non-significant contribution of individual trait measures in predicting Phase 3 levels of instrumental avoidance of conditioned and generalised stimuli. Similar analyses also indicated the non-significant contribution of individual trait measures in predicting US Expectancies.

As was expected, given their intentional psychometrically convergent relationship, there were medium to strong significant correlations between scores on the STAI-T and the AAQ-ii (see Table 2.3). However, despite their strong correlation, preliminary analyses indicated that there had been no violation of the multicollinearity assumption by including all of the tests in the hierarchical regression model.

Table 2.1

Summary of Correlations between Individual Trait Measures

	STAI-T	AAQ	BEAQ
STAI-T	1		
AAQ	.817**	1	
BEAQ	.431*	.597**	1

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Multiple regression analyses examining the relationship between equivalence or avoidance learning and combinations of the questionnaires examined failed to highlight the questionnaires' predictive utility. . In relation to conditioned or generalised avoidance levels, only the rate of avoidance to the CS- (R^2 = .285, p = .02) was statistically significant when the STAI, AAQ and BEAQ were combined in a hierarchical model.

The substitution of BEAQ subscales Distress/Endurance (DE) or Distraction/Suppression (DS) for the BEAQ failed to improve predictive utility for CS-avoidance (R^2= .065 & .168 respectively, both $p > .05$). Also contrary to the findings of Hunt et al. (2017), who used the complete MEAQ, no evidence was found for any predictive ability of the two BEAQ subscales in terms of levels of avoidance generalisation to either the GS+ or the GS-.

To examine for possible individual differences Phase 2 and 3 avoidance rates to all stimuli were compared across participants scoring high or low (i.e., split by half) in the STAI-T (*M*= 41.24), AAQ (*M*=20.27) and BEAQ (*M*= 47.45) questionnaires. In Phase 2 training no significant differences were found between high and low scorers across all questionnaires for rates of avoidance responding to the CS+: t= .910,-.133,.109 or the CS- t= -1.138,-1.288, -1.092 (all p > .05). No significant differences were also found between high and low scorers across all questionnaires for rates of avoidance responding to each stimulus during Phase 3 testing (CS+: t= -.308, -1.826, -.645; CS-: t= .846, .751, -.969; GS+: t= 1.062, .644, .068; GS-: t= 1.612, 1.685, 1.410; all p > .05) or expectancy of the US if no hypothetical avoidance response was given (CS+: t= 1.414, 1.703, 864, ; CS-: t= -410, -619, -.079; GS+: t= 1.512, .308, -.282; GS-: t= -.393, -.634, .120; all p > .05).

2.3 Discussion

As predicted, and in line with the Dymond et al. (2011) results, participants showed a generalisation of avoidance from the CS+ to a symbolically related stimulus (GS+) but not a symbolically unrelated stimulus (GS-). Unfortunately however, rates of avoidance during the conditioning and probes for generalisation were not predicted by scores on any of the three individual questionnaires. The combined model of all three questionnaires was significantly correlated with levels of CS- avoidance, a result which provided support for the Vervliet et al. (2015) finding linking higher STAI scores with erroneous avoidance to the conditioned safety stimulus. All of the tests also failed to predict US expectancies in the case that an avoidance response was not made. Dividing the participant sample into cohorts above and below the mean failed to improve the predictive utility of each questionnaire for either reported avoidance or expectancy rates. Similarly, and contrary to the findings of Hunt et al. (2017), extracting and examining either of the two BEAQ subscales did not provide for any improvement in their predictive utility with regard to the levels of avoidance generalisation to either the GS+ or the GS-. It is important to appreciate however, that the experimental sample of participants was taken from a non-clinical population and perhaps the range may not have provided sufficient variability to successfully identify correlations between the measures and any observed behaviour. Similar to the Vervliet et al. and Hunt et al. studies highlighted above, the aim of the research was to examine for correlations within a normal sample of participants rather than focus on any hypothesised clinically-relevant outcomes.

The purpose of the experiment was to capitalise upon the verbal and cognitive nature of symbolic generalisation to identify possible individual differences in degrees of cognizing and rationalising around feared events. These individual differences can be readily observed in the decrement of generalization to the GS+. Despite the pass criterion in relation to successful equivalence learning during the initial training phase, levels of generalised avoidance responding to the GS+ were lower than to the CS+. This effect supported a similar reduced level of generalised avoidance observed during the Dymond et al. (2011) study. It is this very cognizing that supports the generalisation of fear and avoidance responses. Despite the raised level of complexity in the procedure provided by this paradigm and the successful emergence of high levels of derived avoidance and expectancy, the three widely used psychometric tests for fear, anxiety and experiential avoidance provided only a limited degree of predictability. Although the reduced sample size in this exploratory study may have been slightly underpowered when compared to the 100+ participants of the Hunt et al., (2017) for example, these results still demonstrate a concerning disconnect between the tools of the clinician and the methods and instruments of the laboratory researcher.

Chapter 3

Experiment 2a: The utility of sub-clinical questionnaires in predicting rates of directly avoidance learning.

Experiment 2b: The utility of sub-clinical questionnaires in predicting the semantic generalisation of threat between real words and their synonyms.

In the previous chapter, Experiment 1showed that within a complex fear generalisation paradigm commonly used sub-clinical questionnaires struggled to identify differences in conditioning and generalisation behaviour in a laboratory. Symbolic generalisation requires the individual to rationalise the derived, indirect and entirely symbolic relationships between conditioned fear stimuli and other physically dissimilar stimuli. This behaviour is far more complex than traditional demonstrations of generalisation along perceptual continua such as size or colour. Yet the lack of predictability is apparent and appears contrary to the contentions of both Beckers et al. (2013) and Vervliet et al. (2015) that it is possibly the simplicity of existing paradigms which is interfering with the predictive ability of tests specifically designed for the applied filed. On the other hand, Vervliet et al. (2015) did identify correlations between avoidance rate in a basic Pavlovian paradigm and commonly used questionnaires, albeit in relation to responses to the conditioned safety stimulus rather than the aversively conditioned stimulus.

Experiments 2a and 2b were designed in tandem to explore the differences in the predictive utility of widely used sub-clinical questionnaires for avoidance and derived avoidance across two paradigms that required less arbitrary forms of generalisation than examined in Experiment 1. Experiment 2a was a single-phase experiment which employed only the avoidance learning phase from Experiment 1. It used a selection of aversive pictures and sounds as the US's and provided the opportunity for the participants to avoid by pressing a computer key. In contrast to the Experiment 1which provided only a blank screen however, the conditioned safety stimulus (CS-) in both Experiment 2a and 2b was followed by a visually pleasant image i.e., a flower. To enhance conditioning and make it robust, the functions of the CS+ and CS- were made more salient by the presentation of appetitive stimuli after the CS- was presented. Participants had no previous exposure to either the cues or to any fear conditioning trials previous to this phase. Rates of avoidance and expectancy of the US were the two dependent measures for threat appreciation. In keeping with the exploratory nature of the experiment in the examination of the relationship between observed behaviours and trait related tests, the questionnaire test battery was expanded from Experiment 1 with the original STAI, BEAQ and the AAQ being supplemented with the Eysenck Personality Questionnaire Revised (Eysenck, Eysenck & Barrett, 1985) and the Toronto Alexithymia Scale (Bagby, Parker, & Taylor, 1994).

In Experiment 2b, the former paradigm was re-employed with the important difference that real English words were used as the CSs and an additional probe phase for semantic, rather than truly symbolic generalisation, was presented following conditioning. The use of real words as stimuli provided participants with the opportunity to generalise between conditioned and probe stimuli due to their naturally occurring semantic relations. This procedural deviation from Experiments 1 and 2a detailed previously, circumvents the requirement of an initial relationship training phase and provides a more natural demonstrating of generalisation it was hoped. Once again both avoidance and expectancy of the US provided the dependent measures in the subsequent analyses. The test battery in Experiment 2b was maintained as for 2a, with the exception of the omission of the TAS.

By examining the conditioning and generalisation of fear and avoidance separately using near identical paradigms, it may be more likely that the relationship between questionnaire scores and conditioned or generalised avoidance, or their associated expectancy levels would become apparent.

Experiment 2a: The utility of sub-clinical questionnaires in predicting rates of directly avoidance learning.

In a traditional Pavlovian based experiment by repeatedly pairing a previously neutral cue, contiguously and continuously, with an aversive stimulus (US) a conditioned stimulus (CS+) is established. Additional cues are often also presented in inter-mixed trials within the procedure, but their presentation is not contingent or contiguous with aversive events. Thus, the latter becomes established as the CS- or safety cue. Following this simple fear conditioning procedure, additional learning phases can establish avoidance responses, which if made upon the presentation of the CS+ can eliminate the presentation of the aversive stimulus (US). However, what is not known is how expectancies and the predictive utility of sub-clinical questionnaires may alter across the two learning phases. The extinguishing of fear across trials could possibly impede their predictive utility or perhaps it may simply vary between fear and avoidance rates. Because avoidance rather than fear is a key focus of the current research, Experiment 2a provided only a single avoidance conditioning phase to participants. By its nature, an avoidance conditioning phase contains both instrumental and Pavlovian conditioning simultaneously but does so in a discrete training block. Experiment 2a was a back to basics effort to explore whether or not sub-clinical questionnaires would predict fear, avoidance and US expectancy levels in such a simple paradigm. Results would then be compared to those obtained using a sample semantic generalisation paradigm in the subsequent experiment.

3.1.2 Method

3.1.2.1 Ethics

This procedure was approved by the Maynooth University research ethics committee prior to commencement and all health and safety procedures of that institution were observed in the use of all equipment.

3.1.2.2 Participants

In keeping with the experimental procedure of Experiment 1, a similar number of thirty-four unpaid participants were recruited via word-of-mouth and a snowballing sampling method. Volunteers ranged in age from 18 to 60 years old (M = 26.8, SD=12.90). Participants were not screened formally for prior or current anxiety conditions but were carefully briefed as to the aversive nature of the experiment. They were also advised to exclude themselves from the experiment if they had any concerns regarding their suitability, having already been provided with a list of exclusion criteria that included both medical and psychological conditions (see Procedure).

3.1.2.3 Apparatus

The apparatus, stimuli and procedure were similar to those used during the avoidance learning phase in Experiment 1. A computer program written in *Visual Basic 6.0* controlled all stimulus presentations and recorded all responses. Two nonsense cues i.e., JOM & CUG, each comprised of three letter pronounceable single syllable non-words in the format of consonant-vowel-consonant, provided the aversive and safety stimuli (CS+ & CS-). These stimuli were presented in capitals, in uppercase bold size 24 Arial font. The unconditioned stimuli (US) were provided by visual images and auditory sounds which were once again selected from IAPS (Lang et al., 2005) and IADS (Bradley et al., 1999) databases for use as aversive stimuli during the trial phase. A total of 12 aversive photographs (e.g., bodily mutilations), 12 pleasant images (e.g., flowers) and 11 aversive sounds (e.g., a female screaming) were selected. The auditory stimuli were presented via headphones.

At the end of the computer based experiment participants completed a rating questionnaire which examined their expectancy of a US for the each presented stimuli in the case of both their producing and not producing an avoidance response(see Appendix 4). Five questionnaires were selected for use in the study and were completed post-hoc. The STAI, AAQ and BEAQ used in Experiment 1 remained but the questionnaire battery was expanded with the inclusion of the EPQ-R and the TAS. The Eysenck Personality Questionnaire Revised Short Form (EPQ-R; Eysenck et al., 1985) is a shortened form of the original EPQ and consists of 48 questions, the results of which correlate strongly with its original form in relation to the traits of *Extraversion*, *Neuroticism* and *Psychoticism*. The Toronto Alexithymia Scale (TAS; Bagby et al., 1994) provides 20 statements which require the participant to rate their opinion for each on a Likert type scale ranging from "strongly disagree" to "strongly agree". The TAS identifies individual difficulties in identifying or describing feelings as well as the ability to relate physiological responses to emotional states.

3.1.2.4 Procedure

Participants were provided with a briefing document detailing the experiment at least 24 hours previous to taking part (see Appendix 1). On arrival at the laboratory, participants signed a consent form acknowledging the distasteful nature of some of the stimuli to be used during the experiment and indicating that they did not have a history of psychopathology which would exclude any further participation (see Appendix 2). If they were happy to proceed, they were then seated comfortably at a table in front of a computer in a small experimental room.

3.1.2.4.1 Avoidance learning

The purpose of this task was to learn to avoid the nonsense word which was paired with an aversive image and sound to generate the CS+ and to learn safety (non-avoidance) to the nonsense word followed by a pleasant picture providing a CS-. Participants were read the following on-screen instructions:

> *In a moment some images will appear on this screen. These will consist of words and pictures. Please concentrate on the screen at all times. It is important that you continue to pay attention. Do not look away from the screen at any time. Do not remove the headphones or reduce the sounds you are hearing at any time. You may cancel a picture before it is displayed by pressing the space bar. If you choose not to press the space bar then you must look at the picture that is then displayed. Please be aware that some of the following images may be upsetting for some people. If you do not wish to see the upsetting pictures then you should avoid them by pressing the spacebar rather than looking away. If you have any questions, please ask the experimenter now. Press any key to continue.*

Once participants had clicked the screen to proceed, a blank screen was displayed for 1700 ms. Next, either the CS+ or CS- appeared in the centre of the screen for 5 s. If participants pressed the space bar while either CS was present no feedback was provided. Pressing the spacebar for either CS cancelled both the on-screen cue and the appearance of the US in 100% of trials. If participants did not press the space bar, the CS was followed by a 2 s interval, after which either an aversive 600 X 800 pixel photograph and a sound (following CS+) or a pleasant picture was presented (following CS-). In other words there was 100% contingency between non-avoidance of the CS and the presentation of the related

US. The stimuli were presented in a pseudorandom order (i.e., no more than two consecutive exposures to either) and after 24 trials (12 x CS+ & 12 x CS-) the task ended (see Table 3.1).

Participants then completed the STAI, BEAQ, AAQ, EPQ-R and TAS questionnaires, were debriefed and then given the opportunity to ask any questions relating to the procedure, before the experiment was brought to a close (see Appendix 3).

Table 3.1

Trial schedule detailing the Number of Stimulus Presentations of Each Cue

Stimulus	Avoidance Learning Phase
CS+	12
CS-	12

3.1.2.5 Dependent measures and analyses

Inferential statistics were conducted to explore differences, with stimulus as the within-subject factor with 2 levels (CS+, CS-), in both rates of avoidance and expectancy of the US if avoidance was or was not hypothetically used. Where the assumptions of a parametric test were violated, a nonparametric equivalent was used. Differences between stimuli were subsequently examined using pairwise comparisons with a Bonferroni correction. The relationship between rates of avoidance (as a percentage) and expectancy ratings was also investigated.

However, the exploration of the relationships between the rates of avoidance learning, reported US expectancies and the *post-hoc* questionnaire scores was the primary focus of the analysis. For each of these relationships we employed simple multiple models of regression to test whether individual or combinations of questionnaires best predicted the rate of avoidance learning or perceived threat as identified by self-report expectancies. Due to the exploratory nature of the analyses between the dependent measures and the questionnaires, the use of a Bonferroni correction would reduce the power of the tests and would make the identification of any significant effects unlikely. As a result significant correlations between the two groups of measures are reported without correction. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

3.1.3 Results and Discussion

3.1.3.1 Avoidance

Rates of avoidance were higher for the conditioned threat stimuli (CS+) than for the conditioned safety stimuli (CS-) during the trials (see Figure 3.1). A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference between the rate of avoidance responding to the CS+ and the CS-, $z(34)=-4.713$, $p < .001$, $r = .57$.

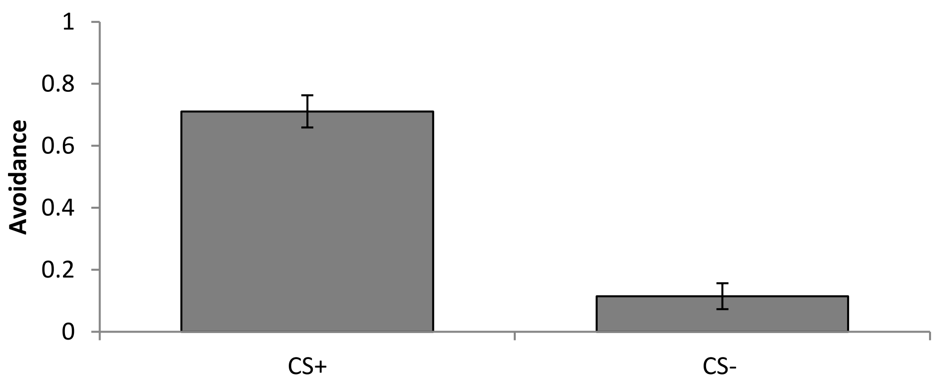

Figure 3.1. Percentage of avoidance responses to CS+ and CS- stimuli during condition. Error bars represent standard error.

3.1.3.2 Expectancy

Figure 3.2 shows the mean US expectancies for each of the stimuli under the conditions of either an avoidance response hypothetically being made (*Press*) or not (*No Press*). A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference significant difference between US expectancy levels for the CS+ and the CS- if a hypothetical avoidance response was not made, $z(34) = -4.551$, $p < .001$, $r = .55$. If, however, the response was hypothetically made, the difference was not significant, $z(34) = -1.338$, $p > .05$, $r = .16$.

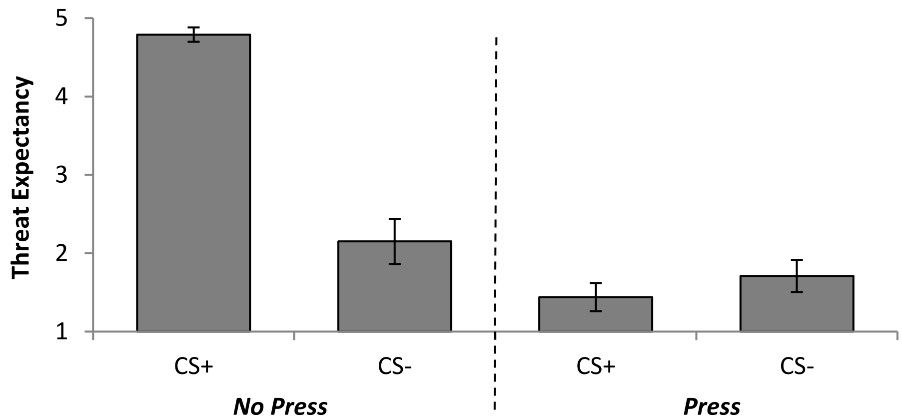

Figure 3.2. Mean US expectancy ratings following the appearance of each stimulus and in the case that an avoidance response hypothetically was (*Press*) or was not (*No Press*) made.

3.1.3.3 Avoidance and expectancy

Spearman's correlational analyses were conducted to examine the relationship between levels of avoidance and the reported expectancy of the US if a hypothetical avoidance response was not made for either stimulus. The relationship between avoidance to the CS+ and its related expectancy rating provided a medium strength correlation $r_s = -.354$, $p = .04$. There was no correlation between rates of avoidance and expectancy for the CS- cue $r_s = -.042$, $p = .816$.

3.1.3.4 Questionnaires

There were medium to strong significant correlations between scores on the various questionnaires (see Table 3.2). However, despite their strong correlation, preliminary analyses indicated that there had been no violation of the multicollinearity assumption by including all of the tests in our hierarchical regression models.

Table 3.2

Summary of Correlations between Individual Trait Measures

	STAI-T	AAQ	BEAQ	EPQ-N	EPQ-P	TAS
STAI-T	1					
AAQ	.324	1				
BEAQ	**.601****	.098	1			
EPQ-N	**.702****	**.397***	.325	1		
EPQ-P	-.243	-.280	.062	**-.442***	1	
TAS	.150	.300	**.396***	-.108	.178	1

*Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

3.1.3.4.1 Questionnaires and avoidance

Questionnaires were examined both individually and in combinations to discover their predictability for levels of avoidance to either the CS+ or the CS- during avoidance learning. Simple regression analyses indicated the unique contribution of individual trait measures in predicting levels of instrumental avoidance for the conditioned stimuli (see Table 3.3). Individually the BEAQ R^2= .259, F(1,32)=10.628, p = .003, AAQ R^2= .148, F(1,32)=5.547, p = .025 and TAS R^2= .189, F(1,32)=7.476, p = .010 scores all significantly predicted levels of CS+ avoidance.

The total combined model, which included all of the examined questionnaires, significantly predicted 64.4% of the variability in CS+ avoidance R^2= .644, F (6, 22) = 6.643, p <0.001 but only 18.7% for the CS- R^2= .187, F (6, 22) = .845, p = .549 (see Table 3.3). When the interaction between all tests was examined in relation to levels of avoidance, those scales which had already best predicted the CS+ avoidance response i.e., BEAQ, TAS and AAQ all made significant contributions to the variance in the overall combined model.

Table 3.3

Summary of Simple Regression Analyses indicating the Unique Contribution of the Total Combined Model in predicting rates of Avoidance to the CS+ and CS- stimuli

Avoidance	**CS+**		**CS-**	
	R^2	*β(p)*	R^2	*β(p)*
STAI-T	.003	.050(.782)	.089	-.194(.145)
AAQ	**.148***	.384(.025)	.001	-.253(.056)
BEAQ	**.259****	.499(.003)	.050	.208(.244)
EPQ-N	.085	.291(.126)	.006	.016(.094)
EPQ-P	.097	.312(-.137)	.016	-.172(.198)
TAS	**.189***	.435(.010)	.008	-.219(.220)
Total Combined	**.644****	.349(.000)	.187	.158(.549)

*Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed

Combining these three effective tests in a separate model along with the EPQ-N provided the most parsimonious predictors of CS+ avoidance with 64.4%

of total variance explained R^2= .644, F (4, 24) = 10.860, p < .001 (see Table 3.4). In line with their poor individual predictive ability in relation to avoidance to the CS-, this model only accounted for 15.5% of variance R^2= .155, F (4, 24) = 1.103, p = .378.

Table 3.4

Summary of Hierarchical Regression Analyses examining the Unique Contribution of the Best Combined Model in the Variability of Avoidance

Avoidance	Independent Variables	R^2	p	ΔR^2	F for ΔR^2	B
CS+	Step 1: BEAQ	**.261**	**.005***	.261	9.519	.511
	Step 2: AAQ	**.452**	**.000****	.192	9.100	-.440
	Step 3: EPQ-N	**.568**	**.000****	.116	6.714	-.390
	Step 4: TAS	**.644**	**.000****	.076	5.114	.347
CS-	Step 1: BEAQ	.089	.115	.089	2.647	.299
	Step 2: AAQ	.094	.279	.004	.123	-.066
	Step 3: EPQ-N	.138	.287	.044	1.280	.241
	Step 4: TAS	.155	.378	.018	.499	.167

*Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

3.1.3.4.2 Questionnaires and expectancy

Similar simple regression analyses also indicated the unique contribution of individual trait measures in predicting recorded stimulus fear ratings if hypothetical avoidance responses had or had not been made in response to conditioned stimuli (see Table 3.5). Although the individual questionnaires failed to provide a high level of predictability in the self -reported expectancy of the US, whether an avoidance response was hypothetically made or not, a number of initially significant correlations were identified. The STAI-T accounted for 17% of the variance in US expectancy levels if the CS+ was not avoided R^2= .170, F(1,32)=6.365, p = .017. In the event of providing a hypothetical avoidance response to the CS- safety cue, the BEAQ individually predicted 15.1% of the variability in expectancy of the US as well as contributing significantly (β = -.571, p < .05) to the total combined model. Scores on the TAS questionnaire initially significantly predicted the variability (21.1%) in US expectancy if the avoidance response was not used for the CS- cue R^2= .211, F(1,32)=5.699, p = .006.

Table 3.5

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait, and a Total Combined Model in predicting the Variability of US Expectancy Ratings if a Hypothetical Avoidance Response had (Press) or had not (No Press) been made

Expectancy	**CS+**				**CS-**			
	Press		*No Press*		*Press*		*No Press*	
	R^2	B	R^2	β	R^2	β	R^2	β
STAI-T	.001	-.037	**.170***	.011	.001	.032	.082	-.287
AAQ	.007	-.086	.002	.042	.106	.325	.001	-.024
BEAQ	.070	-.265	.027	-.164	**.151***	-.389	.065	-.255
EPQ-N	.041	.203	.002	-.043	.055	.235	.000	-.006
EPQ-P	.058	-.241	.017	-.131	.080	-.283	.037	-.192
TAS	.094	-.307	.007	-.085	.001	-.036	**.211****	-.459
Total combined	.334	-.164	.171	.144	**.418***	.117	.339	.169

*Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

Combining the most effective questionnaires into a single model did not increase predictive utility for the expectancy of the US if an avoidance response was not made. The level of variability, in this *No Press* condition for US expectancy ratings, explained by the model was 12.6% for the CS+ and 29.6% for the CS- (both p > .05). In the *Press* condition (i.e., if a response was hypothetically made), the model demonstrated improved predictability for the both the CS+ R^2= .314, F(4,24)=2.749, p = .052 and the CS- R^2= .401, F(4,24)=4.024, p = .012.

3.1.3.5 Results Summary

Overall, differences in the avoidance response rates recorded for the CS+ and CS- suggest that successful avoidance conditioning was observed. This was supported by US expectancy levels which indicated both the successful conditioning of the CS+ threat (but not the CS-) and the success of the spacebar press in providing US avoidance. A medium strength correlation indicated that the expectancy of the US subsequent to the CS+ was somewhat predictive of overt avoidance rates for the CS+ during avoidance learning.

Individually the BEAQ, AAQ and the TAS, all significantly predicted levels of CS+ avoidance and then greatly contributed to the significant predictability of both the total combined model and the most effective model (BEAQ, AAQ, EPQ-N & TAS). In contrast to the findings of Vervliet et al. (2015), none of the tests, either individually or combined, predicted the relatively low levels of observed CS- avoidance. In relation to expectancies, there were significant correlations between the STAI-T and the CS+ *No Press* condition as well as the BEAQ and the TAS in the CS- *Press* condition. Similarly, the total combined model and the best model both improved their predictive utility for expectancy of the US in the CS- *Press* condition. Importantly however, the experiment demonstrated that there was sufficient variability in rates of avoidance learning and post-hoc expectancy ratings across participants to reveal correlations between their response rates and the scores on the questionnaires examined.

Experiment 2b: The utility of sub-clinical questionnaires in predicting the semantic generalisation of threat between real words and their synonyms.

Experiment 2a provided support for the use of questionnaires in the prediction of CS+ avoidance levels and post hoc expectancy of the US ratings. Experiment 2b expanded on this paradigm by exploring whether scores from commonly used sub-clinical trait and experiential avoidance questionnaires correlated significantly with levels of generalisation during a semantic generalisation paradigm. In order to be able to provide generalisation probes without requiring a prior relational stimulus class training phase, the nonsense cues of the previous experiment were replaced with real English words. The synonyms of these CSs were employed as generalisation probes during a subsequent phase and were presented in extinction (i.e. not followed by either appetitive or aversive US). Due to a concern that the conditioning effects needed to be more robust in order to support generalisation, the avoidance learning phase was slightly extended.

During Phase 1 of the experiment participants were required to correctly avoid 100% of presentations of the CS+ and none of the CS- in a single block of 12 trials (max 4 recycles to criterion) before progressing to the final probe phase without a pause. While all participants completed the probe phase, only those who had achieved the conditioning criterion by the fourth block of learning trials were included in the final analyses. In this manner successful conditioning of the CS+ and CS-was assured before synonyms of the conditioned cues were introduced to probe for semantic generalisation.

3.2.2 Method

3.2.2.1 Ethics

This procedure was approved by the Maynooth University research ethics committee prior to commencement and all health and safety procedures of that institution were observed in the use of all equipment.

3.2.2.2 Participants

Similar to the Boyle et al. 2016 semantic generalisation study, twenty-eight unpaid participants were recruited via word-of-mouth and a snowballing sampling method. During the post experimental analyses, participants who required all four of the training blocks of trials and failed to avoid over 50% of the total CS+ presentations or more than 25% of the total CS- presentations were deemed not to have conditioned successfully. By these criteria six participants; 6, 13, 14, 21, 22 and 23 failed to demonstrate successful conditioning and were excluded from all subsequent statistical analyses. The remaining 22 volunteers (11 females) ranged in age from 18 to 23 years old (M = 19.82, SD=1.181).

Participants were not screened formally for prior or current anxiety conditions but were carefully briefed as to the aversive nature of the experiment and advised to self-exclude if they had concerns regarding their suitability given a list of exclusion criteria including medical and psychological conditions (see Procedure).

3.2.2.3 Apparatus

A computer program written in *PsyScope* (Version B57; Cohen, MacWhinney, Flatt & Provost, 1993) controlled all stimulus presentations and recorded all responses. Two common use English words and their synonyms (i.e., SOUP/BROTH & FIB/LIE) were selected based on their robust strength of association from the University of South Florida Word Association Norms to function as the aversive and safety stimuli (CS+ & CS-) as well as the probes for generalisation (GS+ & GS-). They were also selected based on the fact that they were included as synonyms in the previously published Boyle et al. (2016) experiment on semantic generalisation. Stimuli were presented in capitals, in uppercase bold size 72 Arial font. As in Experiment 2a the unconditioned stimuli (US) were once again visual images and auditory sounds selected from the IAPS (Lang et al., 2005) and the IADS (Bradley et al., 1999) databases for use as aversive stimuli during the conditioning and testing phases. A total of 12 aversive photographs (e.g., bodily mutilations), 12 pleasant images (e.g., flowers) and 11 aversive sounds (e.g., a female screaming) were selected. The auditory stimuli were presented via headphones.

At the end of the computer-based experiment participants completed a ratings questionnaire (see Appendix 4) which examined their expectancy of the appearance of a US for the each presented stimuli in the case that a hypothetical avoidance response was or was not performed. Four questionnaires (STAI, AAQ, BEAQ & EPQ-R short scale) were selected for use in the study and completed post-hoc

3.2.2.4 Procedure

Participants once recruited were provided with a briefing document detailing the experiment at least 24 hours previous to taking part (see Appendix 1). On arrival at the laboratory, participants signed a consent form acknowledging the distasteful nature of some of the stimuli to be used during the experiment and indicating that they did not have a history of psychopathology (see Appendix 2). Participants were requested to self-exclude themselves from taking any further part if they had any concerns with regard their suitability. Participants were then seated comfortably at a table in front of a computer in a small experimental room.

3.2.2.4.1 Avoidance learning

The purpose of this phase was to learn to avoid the CS+ i.e. a word paired with an aversive image and sound and to learn non-avoidance to the CS- i.e. a word which was followed by a pleasant picture. See Table 3.6 below for a summary of the full procedural detail. Participants were presented with the following on-screen instructions:

> *In a moment some images will appear on this screen. Please concentrate on the screen at all times. It is important that you continue to pay attention. If you think that a picture is likely to be displayed you may, if you wish, cancel it before it is displayed by pressing the space bar on the computer keyboard. You should learn to view only the images you find pleasant. If you have any questions, please ask the experimenter now. Press any key to continue.*

Once participants had clicked the screen to proceed, a blank screen was displayed for 1200 ms. Next, either the CS+ or CS- appeared in the centre of the screen for 5 s. If participants pressed the space bar while either stimulus was present, then the screen immediately cleared and no feedback was provided. If participants did not press the space bar, the stimulus was followed by a 2 s interval, after which either an aversive 600 X 800 pixel photograph and a sound (following the CS+) or a pleasant picture (following the CS-) was presented. Either an aversive or pleasant US followed all presentations of each CS when the space bar was not pressed (i.e., 100% contingency between non-avoidance and presentation of the US). The stimuli were presented in a pseudorandom order (i.e., no more than two consecutive exposures to either) in blocks of 12 trials (6 x CS+ & 6 x CS-). All participants progressed to the final test phase, either after four blocks of learning trials (4x12 presentations), or earlier if they had successfully demonstrated conditioning by avoiding 100% of the aversive stimuli in a block previous to the final one. This progression to the avoidance probe phase occurred without interruption or warning.

3.2.2.4.2 Tests for generalisation

The test phase contained four presentations each of the CS+, the CS- and their respective synonyms (GS+ & GS-). After all 16 presentations were completed the following instructions immediately appeared on screen:

"This is the end of the experiment. Please contact the experimenter now."

Participants then completed the expectancy ratings (see Appendix 4) questionnaire as well as the STAI, BEAQ, AAQ and EPQ-R questionnaires, were debriefed and then given the opportunity to ask any questions relating to the procedure, before the experiment was fully brought to a close (see Appendix 3).

Table 3.6

Trial Schedule detailing the Number of Stimulus Presentations of Each Cue during Each Phase

Stimulus	Avoidance learning	Tests for generalisation
CS+	6 X 4 (max) blocks	4
CS-	6 X 4 (max) blocks	4
GS+	NO	4
GS-	NO	4

3.2.2.5 Dependent measures and analyses

As parametric assumptions were violated, the nonparametric Kruskal-Wallis Test was used to explore differences, with stimulus as the within-subject factor with 4 levels (CS+, CS-, GS+ & GS-), to examine both the rate of initial avoidance learning and the generalisation of avoidance and expectancy. . Differences between stimuli were subsequently examined using pairwise comparisons with a Bonferroni correction. However, the exploration of the relationships between avoidance rates, reported US expectancies and the *post-hoc* questionnaire scores was the primary focus of the analysis. For each of these relationships, simple multiple models of regression were employed to test whether individual or combined questionnaires best predicted levels of conditioned or generalised avoidance or the perceived threat. Due to the exploratory nature of the analyses between the dependent measures and the questionnaires, the use of a Bonferroni correction would reduce the power of the tests and would make the identification of any significant effects unlikely. As a result significant correlations between the two groups of measures are reported without correction. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

3.2.3 Results and discussion

3.2.3.1 Avoidance

3.2.3.1.1 Phase 1: Avoidance learning

During Phase 1, eleven participants (39.3%) required all four blocks of training (48 trials) before progressing to the final test phase. The mean number of blocks required by all participants combined was 2.86 (*SD* = 1.113). Six participants were deemed to have not successfully conditioned and were excluded from all of the following reported analyses (amended n = 22).

Rates of avoidance were higher for the conditioned threat stimuli (CS+) than for the conditioned safety stimuli (CS-) during training (see Figure 3.3). Planned comparisons were conducted to examine if differences in avoidance response rates between the conditioned threat and safety cues were significant. A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference between the rate of avoidance responding to the CS+ and the CS-, $z(22)=-4.116$, $p < .001$, $r = .62$.

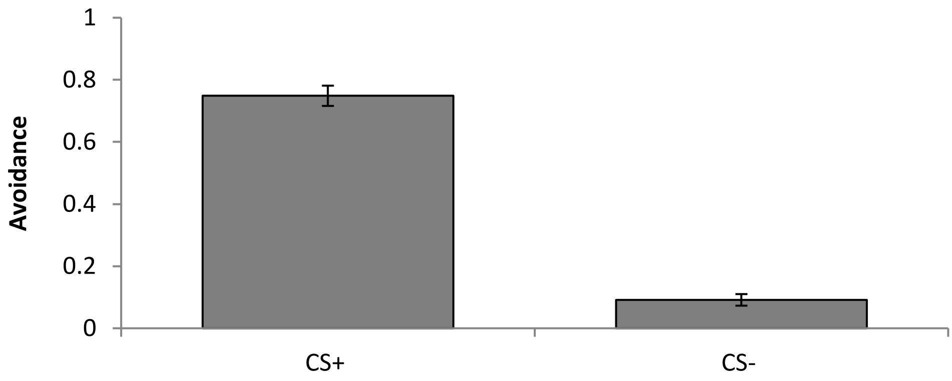

Figure 3.3. Percentage of avoidance responses to CS+ and CS- stimuli during Phase 1 avoidance learning. Error bars represent standard error.

3.2.3.1.2 Phase 2: Tests for generalisation

Unfortunately, due to a hardware malfunction, avoidance responses to the CS+ and the CS- during the final probe phase were not recorded. Rates of avoidance were higher for the synonym of the conditioned threat stimuli (GS+) than for the synonym of the conditioned safety stimuli (GS-) during the final phase test trials (see Figure 3.4). A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference in avoidance rates between the GS+ and the GS- $z(22)=-2.440$, p = .015 indicating that the CS+/CS- avoidance rate differential observed during Phase 1 was maintained for the semantically related GS+ and GS- during Phase 2.

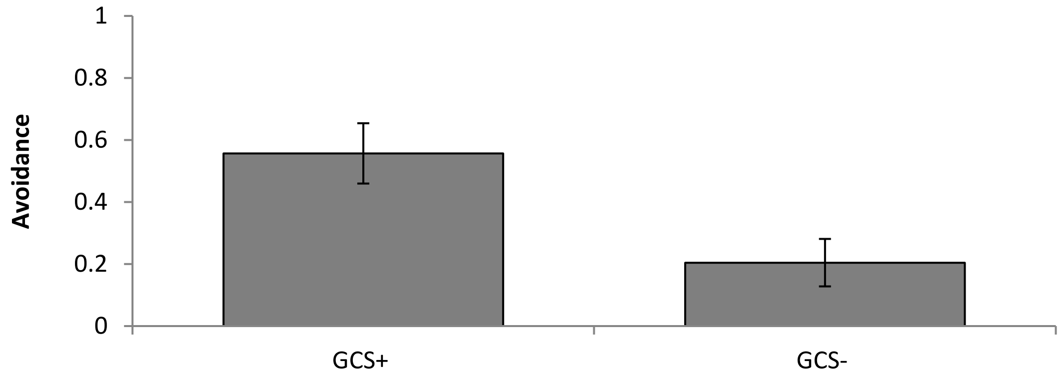

Figure 3.4. Percentage of avoidance responses to GS+ and GS- stimuli during Phase 2 generalisation probes. Error bars represent standard error.

Spearman's correlational analyses were conducted to examine the relationship between actual levels of avoidance observed across specific stimulus pairs during the conditioning phase and levels of generalised avoidance to the synonyms during the final probe phase. No significant correlation was found between rates of avoidance to the CS+ during Phase 1 learning and the GS+ cue in Phase 2 generalisation. There was a medium strength correlation between rates of avoidance to the CS- during conditioning and the GS+ which was significant however r_s = .493, n=22, p = .02. No correlation was evident between the individual number of training trails required during Phase 1and the level of generalised avoidance to either the GS+ or the GS- (r_s =.070, .025 respectively; all p >0.05).

3.2.3.2 Expectancy

A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference in US expectancy levels between the CS+ and CS- $z(22)=-3.789$, $p < 0.001$, $r = .57$ if a hypothetical avoidance response was not made (*No Press*). If, however, there had been a hypothetical response (*Press*), there was no significant difference in rated expectancy between the conditioned stimuli $z(22)=-.333$, $p = .739$, $r = .05$. Differences in ratings between the synonyms followed a similar pattern to the conditioned stimuli with only a significant difference between GS+ and GS- $z(22)=-2.725$, $p = 0.006$, $r = .41$ in the *No Press* condition. The difference between the GS+ and GS- in the *Press* condition was not significant $z(22)=-.135$, $p = .892$, $r = .02$. Figure 3.5 shows the mean US expectancies for each of the stimuli under the conditions of both an avoidance response hypothetically being made or not.

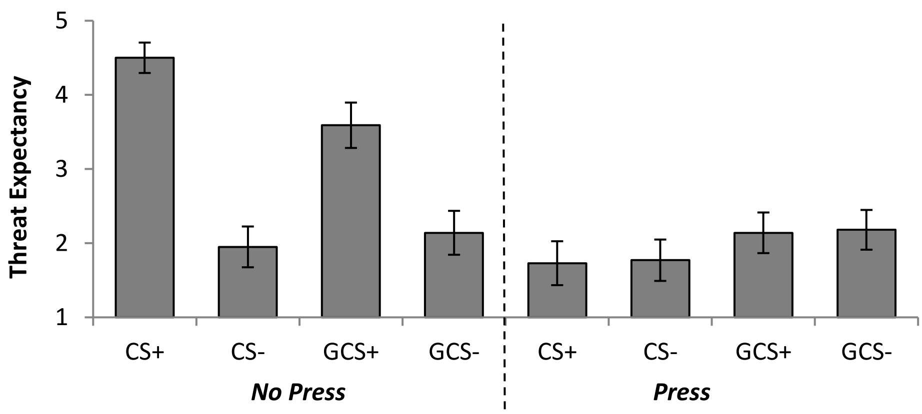

Figure 3.5. Mean US expectancy ratings following the appearance of each stimulus and in the case that an avoidance response hypothetically was (*Press*) or was not (*No Press*) made. Error bars represent standard error.

3.2.3.3 Avoidance and expectancy

Spearman's correlational analyses were conducted to examine the relationship between the rate of avoidance learning during conditioning and the reported US expectancy if an avoidance response had not been made in the presence of a stimulus. Medium strength but not significant correlations were found between the number of training blocks required and the reported expectancy of the US in the *No Press* condition for the CS+, CS- and GS+ stimuli(r_s = .309, 333 & .382 respectively, all p >0.05). For the GS- there was no correlation between the cue and the *No Press* expectancy (r_s = .123, p > 0.05).

In the final phase, the relationship between US expectancy levels in the *No Press* condition and probed avoidance rates was significant for the GS+ r_s = .740, p <0.001, but not the GS-. As previously noted, due to a hardware malfunction avoidance responses to the CS+ and CS- during the final probe phase were not recorded.

3.2.3.4 Questionnaires

There were medium to strong significant correlations between many of the scores on the various questionnaires (see Table 3.7). However despite their strong correlation, preliminary analyses indicated that there had been no violation of the multicollinearity assumption by including all of the tests in our hierarchical regression model.

Table 3.7

Summary of Correlations between Individual Trait Measures

	STAI-T	AAQ	BEAQ	EPQ-N	EPQ-P
STAI-T	1				
AAQ	**.900****	1			
BEAQ	**-.476***	**-.602***	1		
EPQ-N	**.738****	**.679****	**-.571****	1	
EPQ-P	-.058	-.022	-.139	.006	1

*Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

3.2.3.4.1 Questionnaires and avoidance

Questionnaires were examined both individually and in combinations to discover their predictive utility for levels of avoidance and individual rates of learning. Simple regression analyses were initially undertaken to indicate the unique contribution of individual trait measures in predicting both measures (see Table 3.8). Individually only the STAI-T and the AAQ significantly predicted levels of avoidance to any of the stimuli, accounting for 30.6% and 30.9% of the variance in CS+ avoidance (both $p < .01$).

The total combined model, which included all of the examined questionnaires, failed to significantly predict levels of avoidance during either the avoidance learning phase (CS+ R^2= .336; CS- R^2= .431, both $p > .05$) or the final probe phase (GS+ R^2= .364; GS- R^2= .164, both $p > .05$).

Table 3.8

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures and the Total Combined Model in predicting the Variability of Avoidance

Avoidance	CS+		CS-		GS+		GS-	
	R^2	*B*	R^2	*B*	R^2	*β*	R^2	*β*
STAI-T	**.306****	-.553	.116	.340	.042	.205	.027	.163
AAQ	**.309****	-.556	.032	.178	.001	-.026	.006	.078
BEAQ	.091	.301	.001	-.036	.087	.295	.023	.151
EPQ-N	.133	-.364	.003	-.056	.002	.048	.009	.096
EPQ-P	.003	-.052	.001	.035	.057	-.239	.093	-.306
Total Combined	.336	.579	.431	.657	.364	.604	.164	.405

**. Correlation is significant at the 0.01 level (2-tailed)

The best model comprised of only the most effective questionnaires i.e., the AAQ, EPQ-N and STAI-T provided the most parsimonious predictor of conditioned avoidance with 32.9% of total variance in the CS+ explained R^2= .329, F (3, 18) = 2.946, p >.05 . This model also accounted for 39.5% of variance in the avoidance to the CS- during conditioning R^2= .395, F (3, 18) = 3.914, $p < .05$.

The most parsimonious model to predict the generalisation of avoidance between the conditioned stimuli and their synonyms however was provided by in the model combining the AAQ, BEAQ, STAI-T and the EPQ-P. Unfortunately, this model failed to predict a significant level of the variability in avoidance of either the GS+ R^2= .363, F (4, 17) = 2.425, $p = .088$ or the GS- R^2= .160, F (4, 17) = .812, $p = .535$.

3.2.3.4.2 Questionnaires and Expectancy

Simple regression analyses were used to examine the ability of the questionnaires in predicting self-reported stimulus fear ratings (see Table 3.9).

Although most of the individual questionnaires failed to account for the variability in the self -reported expectancy of the US, a number of significant correlations were identified. The EPQ-P provided a significant level of predictability in the expectancy of the US if the CS+ was hypothetically avoided R^2=.276, F (1, 21) = 7.624, p = .012. In the event of providing a hypothetical avoidance response to the GS-, the STAI-T, AAQ and BEAQ all significantly predicted the variability in expectancy of the US R^2= .209, .330 and .193 respectively, all p <.05. In other words, for some participants a degree of uncertainty appeared to be present regarding the function of the avoidance response in relation to the generalised safety stimulus. Generating a total combined model consisting of all the questionnaires did not provide a significant level of predictability in the expectancy of the US for any of the stimuli in either condition.

Table 3.9

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in the variability of US Expectancy Ratings if a Hypothetical Avoidance Response had (Press) or had not (No Press) been made

Expectancy	**CS+**		**CS-**		**GS+**		**GS-**	
	Press	*No Press*	*Press*	*No Press*	*Press*	*No Press*	*Press*	*No Press*
	R^2	R^2	R^2	R^2	R^2	R^2	R^2	R^2
STAI-T	.000	.052	.000	.024	.001	.102	**.209***	.012
AAQ	.002	.119	.002	.058	.006	.025	**.330****	.036
BEAQ	.030	.000	.029	.142	.012	.005	**.193***	.001
EPQ-N	.024	.040	.024	.019	.000	.047	.158	.047
EPQ-P	**.276***	.000	.109	.155	.001	.069	.008	.163
Total Combined	.440	.289	.248	.367	.075	.252	.364	.300

Combining only the most effective questionnaires into a single best model (STAI-T, AAQ, BEAQ & EPQ-P) failed to provide any increase in predictive ability over that of the individual questionnaires or total combined model. Much like its individual contribution the EPQ-P provided a significant level of predictability (β= -.589, t = -3.138, p = .006) to the model for CS+ expectancy in the *Press* condition which contributed to the model's overall significance R^2=.425, F (4, 17) = 3.145, p = .042. Similarly, the combination of the individually effective STAI-T, AAQ and the BEAQ questionnaires enhanced the level of predictability of the model regarding the expectancy of the US if the avoidance response was given to the GS-. The overall model however did not ultimately provide a significant level of predictability for responses to the GS- in the *Press* condition R^2 =.363, p = .089. There were no other significant levels of predictive utility to the other stimuli in the *Press* or the *No Press* condition.

3.2.3.5 Results Summary

In summary, the significant difference between avoidance response rates recorded for the CS+ and the CS- was maintained during Phase 2 tests for generalisation and this indicated a significant level of semantic generalisation. No relationship was apparent between the number of training blocks required and the level of generalised avoidance to either the GS+ or the GS-. With regard to the expectancy data, while significant differences existed between CS+/CS- and GS+/GS- in the *No Press* expectancy of the US, they were predictive only of avoidance rates for the GS+.

Examination of the post-hoc questionnaires indicated that, taken individually, both the AAQ and STAI-T afforded a significant level of predictive utility for avoidance to the CS+ during avoidance learning. They successfully combined with the EPQ-P in the most effective model to provide raised, but not significant, levels of predictability for avoidance to both of the conditioned stimuli. Unfortunately, none of the individual tests or combined models accounted significantly for the variability in generalised avoidance for either probed stimuli. In the relationship between questionnaires and expectancies, the trio of STAI-T, AAQ and EPQ-P provided the most effective predictive ability in the *Press* condition.

3.4 Discussion

Both Experiment 2a and Experiment 2b satisfied the requirements of Pavlovian based fear conditioning and avoidance laboratory-based paradigms. They successfully demonstrated the ease with which avoidance learning occurs and its effectiveness in generating a reliable base to probe for generalisation within a semantic paradigm. The levels of generalisation observed in Experiment 2b between conditioned and generalised word stimuli also compares favourably with levels measured in Experiment 1, as well as those recorded in both Dymond et al. (2011) and Boyle et al. (2016). Self-report expectancy measures from Experiments 2a and 2b support both the successful conditioning of the cues and the appreciation of the role of the keypress in cancelling the US. A level of uncertainty was anecdotally observed however, in relation to the function of the keypress in response to the synonym of the conditioned safety stimulus (GS-), ratings of which may explain its failure to correlate with the rates of avoidance responding to the GS-.

The questionnaires were also taken post-hoc and appeared to successfully predict levels of avoidance learning but not the generalisation of threat to the probes. Individually, only the AAQ provided a significant level of predictive utility for CS+ avoidance during learning in both experiments, while the BEAQ and TAS did so during Experiment 1 and the STAI-T in Experiment 2. The best combined model of questionnaires in the two experimental procedures indicated significant contributions from both the AAQ and the EPQ-N in the overall predictive utility. While the best combined model was significant for levels of avoidance to the CS- during conditioning, the AAQ and EPQ-N were reliant on the significant contribution of the STAI-T to do so. Generalisation to the GS+ or GS- in Experiment 2b was not supported by significant correlations between response levels and either individual or combined questionnaire scores.

In relation to expectancy, the best models in the two experiments provided significant levels of predictive ability for a number of stimuli in the *Press* condition. However, apart from the inclusion of the STAI-T and the BEAQ in the construction of both models, there was no consistent pattern in their predictive utility. For example, in Experiment 2a there was a significant correlation between the best combined model and CS- *Press* ratings, while in Experiment 2b model the correlation was significant for only CS+ in the *Press* condition. The questionnaires did appear to provide greater predictive utility in relation to expectancy ratings for the generalised stimuli with the STAI-T, AAQ, and BEAQ significantly correlating with the GS- expectancy ratings in the *Press* condition and the total combined model providing a similar significant result.

The current two experiments allowed for a comprehensive examination of the predictive utility of commonly used questionnaires, which are explicitly promoted as indexing experiential avoidance or trait anxiety. These experiments have used only basic and operant conditioning processes and the most common questionnaires, from both the experimental and applied fields, to explicitly seek out correlations between the two. Hypothetically, stripping the processes back to their basic states perhaps could have provided more insight or perhaps, and is probably more likely, the bluntness of the tools has dulled the detail which may have provided the required insight. For example, the possible uncertainty experienced by some participants during Experiment 2a regarding the function of the avoidance response, as evidenced by the expectancy ratings in relation to the CS-, was not apparent during Experiment 2b. This was most likely due to the increased salience of the CSs, as a result of the improved instrumental avoidance training procedure. By focusing on the basic conditioning and generalisation paradigms, perhaps as Beckers et al. (2013) suggested, the experiments may not provide for more subtle response patterns or effects that might be identified by the sub-clinical questionnaires. However, there are patterns in the data of both experiments that suggest that there are some relationships between the questionnaires, the avoidance rates and expectancy ratings worth exploring. Amplifying and elaborating these relationships will be a protracted endeavour, but the experiments that follow attempt to do just this.

Chapter 4

Experiment 3: The utility of personality questionnaires in predicting rates of semantic generalisation in appreciated threat and avoidance.

Experiment 3: The utility of personality questionnaires in predicting rates of semantic generalisation in appreciated threat and avoidance.

Experiment 1 struggled to identify any significant relationship between avoidance conditioning or symbolic generalisation and scores on the trait questionnaires. In an effort to extend this investigation, Experiments 2a and 2b expanded the test battery by including the EPQ-R personality questionnaire. Across the two experiments the tests, either individually or in the best regression model combinations, highlighted a number of significant results which prompted further investigation.

Several fear conditioning or generalisation experiments have used combinations of anxiety or avoidance trait questionnaires to examine correlations between scores on the self-report measures and fear or avoidance behaviours (see Arnaudova et al., 2017; Flores et al., 2018; Vervliet et al., 2017). A few studies have employed the *Neuroticism* scale from the Eysenck Personality Questionnaire (EPQ) with varying degrees of success (Krypotos, Arnaudova, Effting, Kindt, & Beckers, 2015; Lommen et al., 2010). The EPQ-R (Eysenck et al., 1985) is a shortened form of the original EPQ and consists of 48 questions, the results of which correlate strongly with its original form in relation to the traits of *Extraversion*, *Neuroticism* and *Psychoticism*. To this extent it might be expected that more interesting correlations between EPQ scores and avoidance rates should perhaps have been observed. As a result and in a further effort to investigate possible relationships between self-report measures of anxiety-related behaviours and avoidance, Catell's 16 personality factor (16PF) test was considered as a suitable addition to the test battery. The 16PF 5th Edition (Cattell & Cattell, 1995) possibly provides a more comprehensive trait profile than others by relying on the combination of 16 sub-traits to provide 5 global traits *Extraversion, Anxiety, Toughmindedness, Independence* and *Self-control*.

Given the exploratory nature of this research and rather than endlessly extend the battery of questionnaires employed in these investigations, it was decided that two different batteries might be employed across two different samples. This had the advantage of avoiding a blunderbuss approach to investigation and also reduced the time involved for participants, for whom the 16PF in particular may require extended engagement with the research. Experiment 3 drew on the Boyle et al. (2016) semantic generalisation procedure and used regression models of analyses to explore whether personality or other commonly used trait questionnaires correlated significantly with observed levels of conditioned or generalised fear or avoidance behavioural measures during the paradigm. A power analysis suggested that to achieve an extremely large effect size similar to the level of generalised avoidance observed in the Boyle et al. (2016) study, the projected sample size needed was n= 52 with 26 participants in each of the two experimental conditions (i.e., questionnaire batteries). Two competing test batteries were assembled with the original EPQ-R, STAI, AAQ and BEAQ from Experiment 2b combined with the Intolerance of Uncertainty Scale - Short Form (IUS) and the Penn State Worry Questionnaire (PSWQ) in *Battery1*. In *Battery2* the 16PF was combined with the STAI, AAQ and BEAQ, but the IUS and the PSWQ were omitted due the time demands of the 185 questions required for the 16PF. By using two of the most popular personality questionnaires it was hoped to provide a more comprehensive examination of the correlations between anxiety and avoidance in a laboratory conditioning and generalisation paradigm.

Experiment 3 drew on the conditioning and semantic generalisation paradigm of Boyle et al. (2016). That study had successfully shown a strong level of generalisation between the conditioned and naturally semantically related probe cues presented during generalisation testing. However, unlike in Experiment 2b, the current study will employ skin conductance response (SCR) as a dependent measure. This feature may add additional sensitivity to the analysis. In addition, a brief electric cutaneous stimulation will be used as a US, in an effort to increase its salience, and therefore the generalisation of any fear and avoidance. More robust conditioning and avoidance procedures may make for a more reliable analysis of the predictive utility of the questionnaire batteries. For the first time pre-test and post-test valence measures were also included to function as manipulation checks for the conditioning procedure.

In keeping with the procedure of the Boyle et al., (2016) study, the acquisition criterion for successful conditioning during Experiment 3 was set at a minimum of 75% avoidance during the final 4 presentations of the CS+ and not more than 25% attempted avoidance during the final 4 presentations of the CS-. This exclusion criterion was applied post hoc during results analyses rather than within the procedure during the procedure. During Experiments 1 and 2b however, participants had been required to successfully avoid 100% of the CS+ stimuli before being permitted to progress to the generalisation phase. This procedural change, carried over from the Boyle et al. (2016) semantic generalisation paradigm, was introduced to in the attempt to include as many participants as possible who demonstrated generalisation between English words and their synonyms. When compared, levels of generalisation between the semantically-related stimuli during Experiment 2b were less than between the arbitrary pairs of stimuli relationally trained during Experiment 1. To accommodate this possible reduction in the level of generalisation using naturally occurring semantic relations, and facilitate the identification of individual differences in behaviour, it was deemed appropriate to reduce the acquisition criterion in an attempt to include as many of the participants who demonstrated a level of generalisation as possible.

As a result, Experiment 3 consisted of only two experimental phases which were separated by a pause in the experimental procedure. Phase 1 involved administering 12 conditioning trails in order to establish two words as a CS+ and a CS- for fear and safety, respectively. A further phase then established an avoidance response upon presentation of the CS+. Finally, a probe phase examined the generalisation of fear (as measured by SCR) and avoidance to synonyms of the CS+ and CS-. One of two batteries of trait questionnaires was provided pre-test. Expectancy ratings of the US following each stimulus were collected post-test. Stimulus related fear questionnaires were completed pre and post-test to provide comparative time-related levels of fear ratings towards individual cues.

4.2 Method

4.2.1 Ethics

This procedure was approved by the Maynooth University research ethics committee prior to commencement and all health and safety procedures of that institution were observed in the use of the cutaneous electrical stimulator and all recording equipment.

4.2.2 Participants

During the initial design phase, a statistical power analysis was performed using GPower 3.1 for sample size estimation, based on data from Boyle et al. (2016). The reported effect size ($n^2_{p\,=}$.958) was considered to be extremely large using Cohen's (1988) criteria. With an alpha = .05 and power = 0.80, the projected sample size needed for this effect size was approximately n= 52 with 26 participants in each group. Fifty-three unpaid participants were then recruited via a convenience sampling method. Participant 30 failed to learn the avoidance response and was subsequently excluded. Participants 4 and 21 were excluded due to an equipment malfunction. During the post experimental analyses, participants who failed to avoid 75% of the final 4 presentations of the CS+ or avoided more than 25% of the final 4 presentations of the CS- during Phase 2 avoidance conditioning were deemed not to have shown successful conditioning. By these criteria four participants; 20, 22, 24 and 31failed to demonstrate successful conditioning and were excluded from all subsequent statistical analyses. The remaining 46 volunteers (33 females) ranged in age from 18 to 53 years old (*M* = 27.2, *SD*=10.637).

Participants were not screened formally for prior or current anxiety conditions but were carefully briefed as to the aversive nature of the experiment and advised to self-exclude if they had concerns regarding their suitability given a list of exclusion criteria including medical and psychological conditions (see Procedure).

4.2.3 Apparatus

The laboratory design comprised of an Apple MacBook (*primary laptop*) using *Psyscope* (Version B57; Cohen, MacWhinney, Flatt & Provost, 1993) software to present the stimuli and record avoidance responding. The *primary laptop* also recorded response times and event marked the skin conductance recorder (*Biopac*™ MP45) with 1ms integrity. A third function of the *primary laptop* was the generation and transmission of a signal to trigger a *Square Wave Stimulator* (*Lafayette*™ model 82415) in order to administer brief cutaneous electric shocks, with the maximum DC output limited to 20mA, as unconditioned stimuli 5s following the onset presentation of the CS+ stimuli.

A set of Velcro finger straps containing Ag-AgCl (silver-silver chloride) electrodes were connected to the distal phalanges of the index and middle finger of the participant's non-dominant hand. These in turn were connected to the *Biopac*™ *MP45 Skin Conductance Recorder*. Mounted in polyurethane holders, each electrode measured 6mm in diameter, but the analysis software corrected for this non-uniform size and recorded all skin conductance in Siemens per cm^2. The electrodes were non-polarisable and shielded to reduce noise interference. A PH balanced and isotonic electrode gel was employed to secure the electrode contact points. A secondary laptop operating the *Biopac*™ supplied *Acquire* software was used to continuously record skin conductance levels throughout the experiment. An insulated "safety-bar" was used to attach a pair of stimulating electrodes, located 50mm apart, to the non-dominant forearm of the participant using adhesive tape.

Two pairs of synonyms (CRY/WEEP & ILL/SICK) were selected from *The University of South Florida Word Association, Rhyme and Word Fragmentation Norms* database of free association (Nelson, McEvoy, & Schreiber, 1998). The chosen pairs all scored highly (i.e., above 80%) for frequency of free association when single word priming was provided and were previously used as stimulus pairs in Boyle et al. (2016). All stimuli were presented on a standard 15" computer monitor in uppercase size 72 bold font, in black. The two pairs of stimuli provided aversive/ non-aversive cues during both the conditioning and probe phases with their synonyms functioning as the probes for generalisation. Both pairs employed were counterbalanced across participants.

Previous to the computer task, participants were required to complete a battery of anxiety, personality and experiential avoidance trait questionnaires. Two collections of questionnaires were available for the participants to complete which were assigned randomly, on an ad-hoc basis, at the beginning of the procedure. Battery1 comprised of the battery from Experiments 2a and 2b i.e., EPQ-R, STAI, AAQ and BEAQ, but added both the PSWQ and the IUS as well as an additional valence questionnaire (see Appendix 4). The Penn State Worry Questionnaire (Meyer, Miller, Metzger & Borkovec, 1990) is a 16 item questionnaire which measures the trait of worry. Statements such as "Many situations make me worry" and "I do not tend to worry about things" are presented with a Likert style five point scale with "Not at all typical of me" and "Very typical of me" as the boundary measures. The Intolerance of Uncertainty Scale - Short Form (IUS; Carleton, Norton, & Asmundson, 2007) provides 12 statements such as "Unforeseen events upset me greatly" and which require the participant to rate their opinion for each on a 5 point Likert type scale ranging from "Not at all characteristic of me" to "Entirely characteristic of me". The IUS identifies individual difficulties in identifying the possibility of a negative event occurring, irrespective of its probability. The pre-test semantically related stimulus fear ratings questionnaire measured any existing fear attributed by the individual to a number of common use words including the prospective CS+ and CS-. The post-test semantically related stimulus fear ratings questionnaire was identical, save for the addition of the synonyms used as probes for generalisation (see Appendix 5).

Battery2 contained the STAI, AAQ and BEAQ from the previous experiments, but also included the 16PF personality questionnaire. The 16PF 5th Edition (Cattell et al., 1995), comprises of 185 questions, and possibly provides a more however provides a possibly more comprehensive trait profile than other measures by relying on the combination of 16 sub-traits to provide 5 global traits *Extraversion, Anxiety, Toughmindedness, Independence* and *Self-control*. The pre and post-test Likert style valence questionnaires were only completed by those who were assigned the shorter (completion time) Battery1.

All participants completed an Expectancy Rating Questionnaire post-test which examined their expectancy of a shock for all eight possible configurations of stimuli and responses (i.e., four stimuli, each with two possible hypothetical responses: avoid or do not avoid; see Appendix 4).

4.2.4 Procedure

Participants once recruited were provided with a briefing document detailing the procedure and experiment at least 24 hours previous to taking part (see Appendix 1). On arrival at the laboratory, participants signed a consent form acknowledging the aversive nature of the electrical stimulation to be used as the US during the experiment and also indicating that they did not have a history of psychopathology (see Appendix 2). They were then seated comfortably at a table in a small experimental cubicle in the Maynooth University Psychology Department laboratory and were tested individually.

After completing their assigned battery of questionnaires, and before the Phase 1 Pavlovian fear conditioning took place, a work up procedure was employed to identify the highest acceptable stimulation level to which participants would consent given the descriptor, "uncomfortable but not painful". The wave amplitude level (i.e., shock level) was manipulated by the participant as they self-administered successive shocks at their own pace from an indiscernible shock level set by the experimenter to the highest they deemed acceptable. This level was then fixed and maintained throughout the experiment. Finally, a set of Velcro finger straps containing Ag-AgCl (silver-silver chloride) electrodes were connected to the distal phalanges of the index and middle finger of the participant's non-dominant hand. Once the welfare of the participant was verified and they had no further questions the experimental procedure was initiated on screen.

4.2.4.1 Phase 1: Fear conditioning

The purpose of this phase was the conditioning of a single stimulus as the CS+ i.e., a word paired with a shock, and another as the CS- i.e. a word which was not. Participants were presented with the following on-screen instructions:

In a moment some words will begin to appear on this screen. You will also receive mild electric shocks. During the first stage you will not be able to avoid these shocks, but we will provide you with further instructions when this is possible. Please concentrate on the screen at all times. It is important that you continue to pay attention. If you have any questions please ask the experimenter now. Press any key to continue.

Once the participant pressed a key to proceed, a blank screen appeared for 20 s before trials began. For a fixed set of 12 trials participants were presented with common use English words which were either followed (CS+) or not followed (CS-) immediately by a short (50ms) electric shock delivered at the previously established level to their forearm (see Table 4.1). The 12 trials provided 6 individual exposures to each of the CS+ and CS- in a quasi-random order separated by a random inter-trial interval of between 10 and 20s (during which time the screen remained blank). Neither stimulus was presented more than twice in succession and there was no pass criterion to be met before progressing to Phase 2 avoidance conditioning.

Table 4.1

Trial Schedule detailing the Number of Stimulus Presentations of Each Cue during Each Phase

Stimulus	Fear Conditioning Phase	Avoidance Conditioning Phase	Probe Phase
CS+	6	10	4
CS-	6	10	4
GS+	NO	NO	4
GS-	NO	NO	4

4.2.4.2 Phase 2a: Avoidance learning

After the completion of Phase 1 (12 trials), the participants were provided with the following onscreen instructions:

> *At this point you will be given the opportunity to avoid any further electric shocks. You can avoid the shocks by pressing the spacebar on the computer keyboard at the appropriate time. Please pay careful attention to everything that is happening on screen. If you have any questions please ask the experimenter now. Press any key to continue…*

Once participants had clicked the screen to proceed, a blank screen was displayed for 1200 ms. Next, either the CS+ or CS- appeared in the centre of the screen for 5 s. If participants pressed the space bar while either stimulus was present, then the screen immediately cleared and no feedback was provided. If participants did not press the space bar, the stimulus was followed by a 2 s interval, after which the participant received either a shock at the previously established level (CS+) or no shock (CS-). The shock followed all non-avoidance to presentations of the CS+ and never to avoided CS+ stimuli or to the CS- whether the space bar was or was not pressed (i.e., 100% contingency in all avoidance conditions). The stimuli were presented in a pseudorandom order (i.e., no more than two consecutive exposures to either) for 20 trials (10 x CS+ & 10 x CS-). Upon completion, all participants progressed to the final avoidance probe phase which occurred without interruption or warning.

4.2.4.3 Phase 2b: Avoidance probe phase

During this probe phase the original trial schedule and stimulus parameters were maintained and only the CS+ was paired with an avoidable shock. In addition to the CS+ and CS-, a synonym of either cue were presented in extinction (i.e., without shock) for a total of 16 trials (4 x CS+, CS-, GS+ & GS-). After all presentations were completed the following instructions immediately appeared on screen:

"This is the end of the experiment. Please contact the experimenter now."

Group 1 participants (Battery1) only, were then provided with post-test semantic fear ratings for a selection of words including all four of the conditioned and generalisation cues (see Appendix 5). All participants completed the US expectancy rating scales (see Appendix 4) and were then debriefed and given the opportunity to ask any questions relating to the procedure, before the experiment was fully brought to a close (see Appendix 3).

4.2.5 Dependent measures and analyses

Within subject analyses were conducted to explore differences in fear (SCR) and avoidance levels across stimuli, as well as in the valence ratings and US expectancy rating s they provoked. Where parametric assumptions were violated, a nonparametric test was used. Differences between stimuli were subsequently examined using pairwise comparisons with appropriate Bonferroni correction.

An important focus of the analysis, was the examination of the correlational relationship between fear and avoidance levels observed for conditioned and generalised stimuli and scores on the individual questionnaires. For each of these relationships, simple multiple models of regression were used to test whether individual or combined questionnaire models best predicted levels of conditioned or generalised avoidance or the perceived threat (SCR magnitudes). Due to the exploratory nature of the analyses between the dependent measures and the questionnaires, the use of a Bonferroni correction would reduce the power of the tests and would make the identification of any significant effects unlikely. As a result, significant correlations between the two groups of measures are reported without correction. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

4.3 Results

4.3.1 Skin Conductance

Skin conductance response levels were recorded by calculating both the baseline i.e., *u*S (microsiemens) level at the time of presentation and the maximum skin conductance level within a 5-second period subsequent to each presentation. Resulting values were then square root transformed to normalise the data distribution and to produce SCRs for each stimulus type on each trial. Negative values were reported as zero. For each participant mean SCRs for each stimulus were calculated. Figure 4.1 shows the mean transformed SCR value for each cue across all participants combined, during each experimental phase.

During Phase 1, SCR levels were higher for conditioned threat stimuli (CS+) than for conditioned safety stimuli (CS-) during training. A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference between recorded SCR levels in response to the CS+ compared to the CS-, $z(46)=-4.474$, $p < .001$, $r = .47$. This difference was maintained during Phase 2a avoidance conditioning, despite the ability of participants to avoid the US, $z(46)=-5.195$, $p < .001$, $r = .54$. Similarly during Phase 2b the difference in SCRs produced by the conditioned stimuli was significant, $z(46)=-4.516$, $p < .001$, $r = .47$. SCR levels for the GS+ and the GS- were significantly different when presented during this final probe phase, *z*(46)= -2.201, *p* = .028, *r* = .23. However, this initially significant result failed to persist after Bonferroni correction (*p* = .0125).

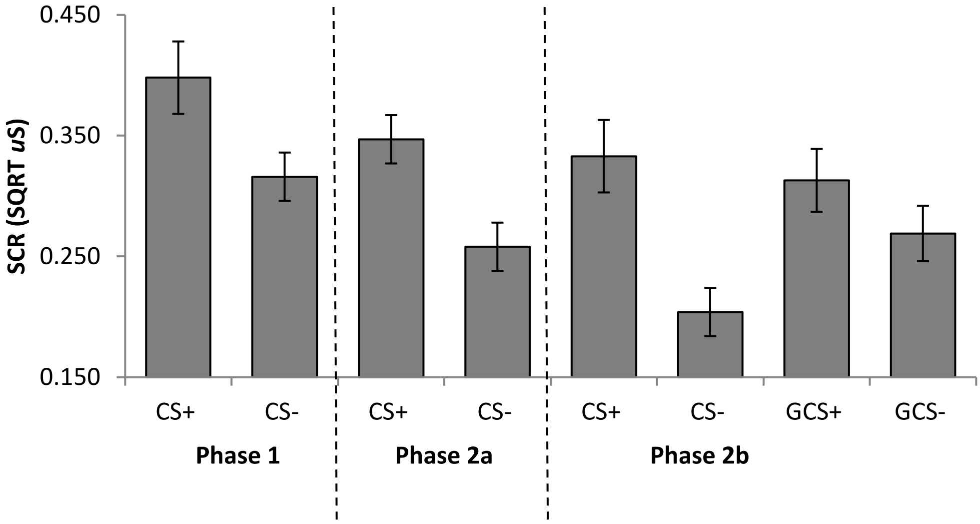

Figure 4.1. Square root transformed skin conductance responses to all stimuli during fear conditioning, avoidance conditioning and final probe phase. Error bars represent standard error

4.3.2 Avoidance

Planned comparisons were conducted to assess differences in avoidance response rates between the threat and safety cues (CS+ & CS-) and across the probes for generalisation (GS+ & GS-). Figure 4.2 shows the mean avoidance responses for each of the stimuli across both the conditioning and probe phases. A Wilcoxon Signed-Rank Test indicated that the rate of avoidance was higher for conditioned threat stimuli (CS+) than for conditioned safety stimuli (CS-) during the avoidance conditioning phase with a significant median (IQR) difference, *z*(46)=-6.051, $p < .001$, *r* = .63. During the Phase 2b probes, this difference in rates of avoidance between the conditioned stimuli was maintained, *z*(46)=-6.280, $p < .001$, *r* = .65.

Importantly the difference in avoidance rates between the GS+ and the GS- stimuli was also statistically significant, $Z(46)=-4.255$, $p < .001$, $r = .44$, indicating that the differential rate of avoidance had generalised to synonyms of the cues conditioned during Phase 2.

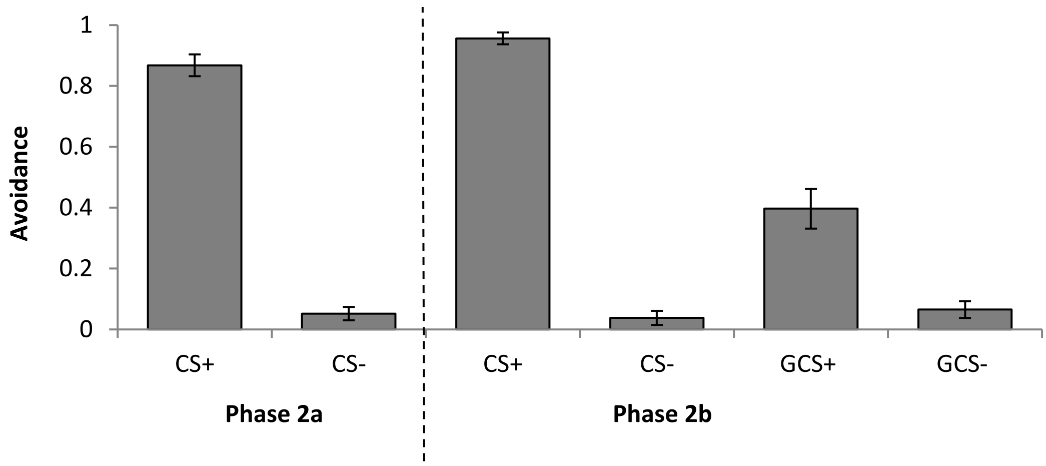

Figure 4.2. Percentage of avoidance responses to all stimuli during both Phase 2a avoidance conditioning and Phase 2b probes. Error bars represent standard error**.**

Spearman's correlational analyses were conducted to examine the relationship between actual levels of avoidance observed across specific stimulus pairs during the conditioning and probe phases and levels of generalised avoidance to the synonyms during the final probe phase. During conditioning correlations between rates of avoidance to the CS+ or CS- and either generalisation cue were small and not statistically significant (GS+ $r_s = .207, -.151$; GS- $r_s = -.194, .273$ respectively). During the probe phase however the correlation between levels of avoidance to the CS- and GS- cues was very strong and positive, $r_s = .741$, n=46, $p < .001$. There was also a medium strength positive correlation between levels of avoidance to the GS+ and the GS- during final probes, $r_s = .413$, n=46, $p = .004$.

4.3.3 Avoidance and SCR

Spearman's correlational analyses were also conducted to examine the relationship between the rate of avoidance during the probe phase and the recorded SCR for each stimulus. There were no significant correlations between levels of avoidance and their corresponding level of SCR for any of the probed stimuli during the final phase.

4.3.4 Expectancy

Differences between mean US expectancies for each of the stimuli, under the conditions of both an avoidance response hypothetically being made (*Press*) or not (*No Press*), supported both the successful conditioning of the original cues as well as a level of generalisation between their synonyms (see Figure 4.3). A Wilcoxon Signed-Rank Test indicated that the difference between the CS+ and CS- for recorded US expectancy levels if a hypothetical avoidance response was not made was significant, $z(46)=-6.487$, $p < .001$, $r = .68$. The difference between mean GS+ and GS- expectancy levels was also significant under the same condition, $z(46)=-3.640$, $p < .001$, $r = .38$. Similarly, the difference was between the CS+ and the CS- was significant if the response was hypothetically made, $z(46)=-3.878$, $p < .001$, $r = .40$, but with a raised expectancy of the US if the avoidance response was made in the presence of the safety cue. The difference in US expectancy ratings across the synonyms of the conditioned stimuli i.e., GS+ and GS- was also significant and in a similar direction, $z(46)=-2.559$, $p = .01$, $r = .27$.

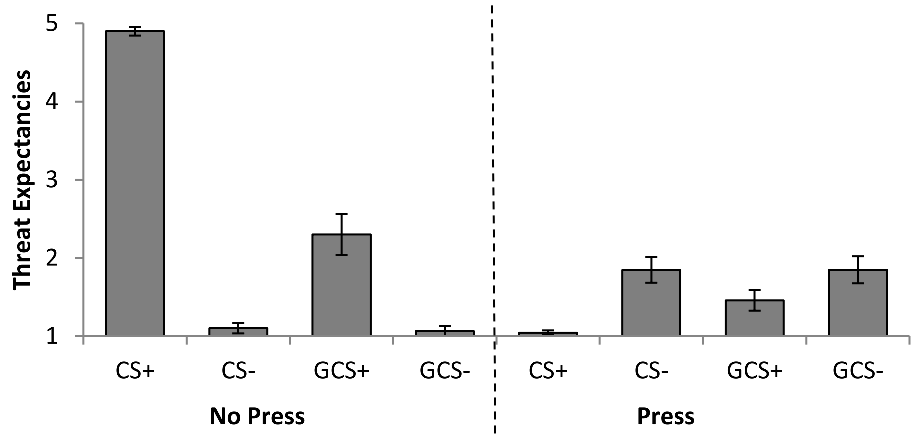

Figure 4.3. Mean US expectancy ratings following the appearance of each stimulus and in the case that an avoidance response hypothetically was (*Press*) or was not (*No Press*) made. Error bars represent standard error**.**

4.3.5 Expectancy and avoidance

Spearman's correlational analyses were conducted to examine the relationship between the rate of avoidance during the probe phase and the recorded US expectancy if an avoidance response had not been made (*No Press*) in the presence of a stimulus. Only the CS+ failed to demonstrate a strong significant positive correlation between avoidance rates during the probe phase and the reported expectancy of the US if hypothetically the avoidance response had not been made for that cue (CS+ $r_s = .099$, $p > .05$; CS- $r_s = .517$, $p < .001$; GS+ $r_s = .827$, $p < .001$; GS- $r_s = 0.405$, $p < .05$). In the *Press* condition, US expectancy ratings in the negatively correlated with rates of observed avoidance responses only for the GS+ and the GS- cues ($r_s = -.486$, $p < .001$; GS- $r_s = -.327$, $p = .026$).

In the examination of correlations between the different conditioned and generalised stimuli in either the *Press* and *No Press* conditions, avoidance response rates to the CS- correlated strongly with US expectancy ratings for hypothetically not avoiding the GS-, $r_s = .504$, $p < .001$, and *vice versa*, $r_s = .405$, $p < .001$. In other words, both avoidance and expectancy of the US given for the CS- successfully predicted avoidance rates to the generalised GS-. No other significant relationships were observed.

4.3.6 Expectancy and SCR

Spearman's correlational analyses were also conducted to examine the relationship between the SCR levels during the probe phase and the recorded US expectancy if an avoidance response had not been made in the presence of a stimulus. No significant relationships were observed.

4.3.7 Semantically Related Stimulus fear ratings

Due to the amount of time required to complete the 16PF (approx. 45 mins), only those participants who were assigned questionnaire *Battery1* (i.e. Group 1) also completed the pre and post-trial valence ratings. Twenty-three participants recorded their levels of appreciated semantically related fear immediately before (Time1) and after (Time2) the computer task. Figure 4.4 shows the mean level of semantically related fear attributed to each of the cues as well as an innocuous and novel control word, not used in the computer task. Wilcoxon Signed-Rank Tests indicated that at Time 1, there was no significant difference between mean levels of semantically related fear between the CS+ and the CS-, $z(19) = -.828$, $p = .41$, $r = .13$.

Post-test however, and as expected, the CS+ cue demonstrated a significant increase in levels of semantic fear from Time1, $z(19)= -3.025$, $p = .002$, $r = .49$. The CS- cue on the other hand, experienced a significant mean reduction in appreciated semantic fear between Time1 and Time2, $z(19)= -2.000$, $p = .046$, $r =$

.32. The successful conditioning of both cues was also supported by a significant difference in reported valence for the CS+ and the CS- cues at Time2, $Z(19) = -3.275$, $p < .001$, $r = .53$. Generalisation of the conditioned response functions was indicated by a significant and positive difference in levels of reported semantically related fear across the GS+ and GS-, $Z(19) = -2.126$, $p = .033$, $r = .34$.

Strong significant correlations were found between the generalisation of conditioned avoidance (GS+) and semantically related fear levels for both the CS+ ($r_s = .589$, $p = .008$) and the GS+ ($r_s = .840$, $p < .001$). GS- avoidance correlated strongly with the GS+ semantically related fear levels also ($r_s = 0.596$, $p = .007$). CS- avoidance correlated strongly with post-test valence levels for the GS+ and the GS- ($r_s = 0.537$ & 0.502 respectively, all $p < .05$). Of all the observed relationships between avoidance and valence levels only that between GS+ avoidance and its related level of semantic fear remained significant after Bonferroni correction ($p = .003$). No significant correlations were observed between SCR levels during the final probe phase and semantically related stimulus fear ratings for any stimuli.

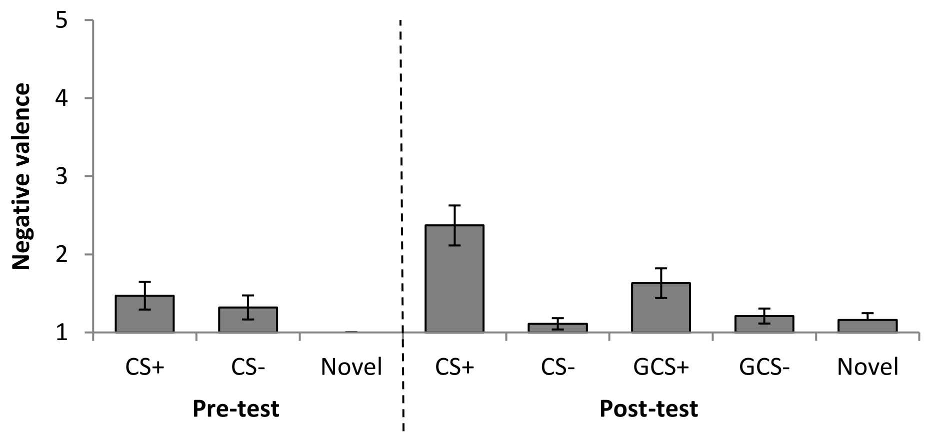

Figure 4.4. Mean stimulus ratings of semantically related fear for all stimuli taken pre (*Time1*) and post (*Time2*) computer task. Error bars represent standard error.

4.3.8 Questionnaires

There were medium to strong significant correlations between scores on a number of various questionnaires (see Table 4.2). However, despite their strong correlation, preliminary analyses indicated that there had been no violation of the multicollinearity assumption by including all of the tests in our hierarchical regression models.

Table 4.2

Summary of Correlations between Scores on Individual Trait, Personality and Experiential Avoidance Measures

	STAI-T	AAQ	BEAQ	EPQ-N	EPQ-P	EPQ-E	PSWQ	16PF-E	16PF-A	16PF-T	16PF-I
STAI-T	1										
AAQ	**.745****	1									
BEAQ	**549****	**.593****	1								
EPQ-N	**.742****	**.683****	**.584****	1							
EPQ-P	-.164	-.146	-.243	-.028	1						
EPQ-E	-.165	-.351	-.237	-.170	.239	1					
PSWQ	**.894****	**.696****	**.583****	**.834****	-.198	-.274	1				
16PF-E	-.139	.019	-.064	-	-	-	-	1			
16PF-A	**.394***	**.528****	.386	-	-	-	-	.390*	1		
16PF-T	-.024	.044	.105	-	-	-	-	.336	.462	1	
16PF-I	-.229	.003	-.038	-	-	-	-	.572**	**.552****	**.520****	1
16PF-	.070	.215	-.142	-	-	-	-	.153	**.520****	**.661****	.304
IUS	**.622****	**.641****	**.675****	**.614****	-.232	-.040	**.641****	-	-	-	-

*Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

4.3.8.1 Questionnaires and skin conductance

Questionnaires were examined both individually and in combined models to discover their predictability for levels of arousal during both conditioning and probe phases. Simple regression analyses were initially undertaken to indicate the unique contribution of individual trait measures in predicting SCR levels for conditioned stimuli and their synonyms (see Table 4.3). The IUS provided the most notable result with large and significant levels of predictability of the variability in SCR arousal during both the fear conditioning (CS+ R^2= .424; CS- R^2= .389; both p < .01) and avoidance conditioning (CS+ R^2= .349; CS- R^2= .403; both p < .01) phases of the experiment. These correlations however, did not persist into the final 2b Probe phase. The IUS did provide a large and significant level of predictability in SCR levels for the GS-, R^2= .337, $F(1,17)$=8.624, p = .009. The PSWQ also provided significant results for SCR levels for both the CS+ and CS- stimuli during the initial conditioning phase only.

For Battery1 participants the EPQ trait measures failed to provide any level of predictability in SCR for any of the stimuli in either the conditioning or generalisation phases. The 16PF included in Battery2 was more successful with the *Global* trait of *Anxiety* significantly correlating with avoidance response rates to the CS+ during Phase 2a and 2b, the CS- during phase 2a as well as both the GS+ and the GS- during final probes. The 16PF global trait of *Self-control* also correlated with avoidance levels in each phase for the CS+, CS- and the GS-. These results were used to construct the models subsequently used in the multiple regression analyses.

Table 4.3

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in predicting the Variability of SCRs during All Phases

SCR	**CS+**			**CS-**			**GS+**	**GS-**
Phase	1	2a	2b	1	2a	2b	2b	2b
	R^2	R^2	R^2	R^2	R^2	R^2	R^2	R^2
STAI-T	.027	.005	.004	.017	.001	.001	.010	.003
AAQ	.003	.002	.003	.011	.001	.013	.052	.005
BEAQ	**.100***	.028	.005	.114	.076	.008	.004	.067
EPQ-N	.060	.023	.000	.052	.022	.024	.007	.085
EPQ-P	.071	.062	.002	.051	.000	.009	.000	.012
EPQ-E	.000	.012	.006	.002	.031	.083	.001	.006
PSWQ	**.367****	.078	.039	**.213***	.060	.041	.000	.072
IUS	**.424****	**.349****	.070	**.389****	**.403****	.014	.043	**.337****
16PF-E	.025	.015	.006	.121	.002	.003	.000	.003
16PF-A	.040	**.156***	**.243***	.001	**.162***	.001	**.231***	**.238***
16PF-T	.000	.046	.032	.009	.026	.032	.050	.035
16PF- I	.000	.062	.076	.024	.025	.005	.010	.007
16PF-SC	**.216***	.129	.100	.151	**.307****	**.168***	.134	**.255****

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

To examine the overall contribution of the combined questionnaires to the variability in SCR, simple multiple regression analyses were undertaken on models which consisted of all tests included in each test battery (see Table 4.4). The total combined model of all the examined questionnaires in Battery1 (EPQ, STAI-T, AAQ, BEAQ, PSWQ & IUS) significantly predicted SCR levels to the CS+ during Phase 1, R^2= .833, $F(8,10)$= 6.235, p = .005, while Battery2 (16PF, STAI-T, AAQ & BEAQ) did so for arousal levels in relation to the GS- during the final probe phase, R^2= .585, $F(8,17)$= 3.000, p = .027.

Table 4.4

Summary of Simple Multiple Regression Analyses indicating the Unique Contribution of the Total Combined Models from Battery1 and Battery2 Questionnaires in predicting SCRs during All Phases

SCR		Test Battery	*n*	R^2	*p*	*F*
Phase 1	CS+	1	19	**.833****	**.005**	6.235
		2	26	.443	.173	1.687
Phase 1	CS-	1	19	.653	.103	2.350
		2	26	.502	.089	2.141
Phase 2a	CS+	1	19	.580	.207	1.723
		2	26	.333	.433	1.061
Phase 2a	CS-	1	19	.600	.174	1.874
		2	26	.499	.093	2.114
Phase 2b	CS+	1	19	.284	.834	.496
		2	26	.386	.293	1.334
Phase 2b	CS-	1	19	.241	.899	.396
		2	26	.259	.653	.744
Phase 2b	GS+	1	19	.292	.821	.515
		2	26	.446	.168	1.709
Phase 2b	GS-	1	19	.446	.487	1.006
		2	26	**.585***	**.027**	3.000

Battery1: STAI-T, AAQ, BEAQ, EPQ-P, EPQ-N, EPQ-E, PSWQ, IUS.
Battery2: STAI-T, AAQ, BEAQ, 16PF-E, 16PF-A, 16PF-I, 16PF-T, 16PF-SC.

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

Overall both test batteries provided higher levels of predictability of arousal during the earlier conditioning trials than in the later probe trials. Battery1 also tended to provide a greater level of predictability than Battery2 during conditioning while the opposite was the case during final probes.

When the interaction between all the tests in each model was examined in relation to levels of SCR, those scales which provided the greatest R^2 change within that model for each stimulus were combined into separate models to identify the most parsimonious predictor of both conditioned and generalised arousal. From the tests included in Battery1, combining the IUS, STAIT-T, AAQ and PSWQ into a hierarchical regression model (Model1) provided the most parsimonious predictor of arousal levels during both the conditioning and probe phases. In line with the total model results however only those responses obtained during the conditioning phases (1 & 2a) were significant (see Table 4.5).

Table 4.5

Summary of Hierarchical Regression Analyses examining the contribution of the Total Combined Model from Model1 in the Variability of SCR during Phases 1 and 2a

SCR	Independent Variables	R^2	*p*	ΔR^2	*F* for ΔR^2	*B*
Phase 1: CS+	Step 1: IUS	**.424****	**.003**	.424	12.530	.651
	Step 2: STAI-T	**.457****	**.008**	.033	.967	.231
	Step 3: AAQ	**.510***	**.012**	.053	1.626	-.337
	Step 4: PSWQ	**.561***	**.016**	.050	1.607	.529
Phase 1: CS-	Step 1: IUS	**.389****	**.004**	.389	10.841	.624
	Step 2: STAI-T	**.395***	**.018**	.005	.136	-.091
	Step 3: AAQ	**.404***	**.046**	.009	.228	-.140
	Step 4: PSWQ	**.477***	**.046**	.073	1.964	.638
Phase 2a: CS+	Step 1: IUS	**.349****	**.008**	.349	9.112	.591
	Step 2: STAI-T	**.350***	**.032**	.002	.037	-.050
	Step 3: AAQ	**.458***	**.024**	.108	2.976	-.480
	Step 5: PSWQ	.469	.051	.011	.278	-.242
Phase 2a: CS-	Step 1: IUS	**.403****	**.004**	.403	11.456	.634
	Step 2: STAI-T	**.440***	**.010**	.038	1.084	-.249
	Step 3: AAQ	**.500***	**.013**	.059	1.778	-.357
	Step 5: PSWQ	**.501***	**.035**	.001	.036	-.085

Model1: IUS, STAI-T, AAQ & PSWQ.

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

Model1 produced significant levels of predictability for SCR levels in response to the CS+ and CS- during Phase 1 fear conditioning, R^2= .561 & .477 respectively (both p < .05). It also accounted for 50.1% of the variability in arousal to the CS- during Phase 2a avoidance conditioning R^2= .501, F(4,14)=3.515, p = .035.

However, the model failed to significantly predict arousal levels for any of the stimuli during the final Probe phase (see Table 4.6).

Table 4.6

Summary of Hierarchical Regression Analyses examining the contribution of the Total Combined Model from Model1 in the Variability of SCRs during Phase 2b Probes

SCR	Independent Variables	R^2	p	ΔR^2	F for ΔR^2	B
Phase 2b: CS+	Step 1: BEAQ	.001	.873	.001	.026	.033
	Step 2: 16PF- SC	.100	.297	.099	2.531	-
	Step 3: 16PF-A	**.303***	**.044**	.203	6.409	-
Phase 2b: CS-	Step 1: BEAQ	.056	.247	.056	1.411	.236
	Step 2: 16PF- SC	.200	.077	.145	4.161	-
	Step 3: 16PF-A	.220	.134	.020	.558	.196
Phase 2b: GS+	Step 1: BEAQ	.002	.844	.002	.040	.041
	Step 2: 16PF- SC	.143	.170	.141	3.790	-
	Step 3: 16PF-A	.261	.078	.118	3.524	-
Phase 2b: GS-	Step 1: BEAQ	.044	.306	.044	1.096	.209
	Step 2: 16PF- SC	**.274***	**.025**	.230	7.297	-
	Step 3: 16PF-A	**.437****	**.005**	.163	6.393	-

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

From the questionnaires included in Battery2, combining the BEAQ, 16PF-SC and the 16PF-A provided the most parsimonious model (Model2) during the conditioning and probe phases. This model produced significant levels of predictability for SCR levels in response to the CS+ and CS- during Phase 2 avoidance conditioning, R^2= .370 & .373 respectively (both p < .05).

Model2 also accounted for 43.7% of the variability in arousal to the GS- during Phase 2b probes, R^2= .437, $F(3,22)$=5.703, p = .005 (see Table 4.7).

Table 4.7

Summary of Hierarchical Regression Analyses examining the contribution of the Total Combined Model from Model1 in the Variability of SCRs during Phase 2b Probes

SCR	Independent Variables	R^2	p	ΔR^2	F for ΔR^2	B
Phase 2b: CS+	Step 1: BEAQ	.001	.873	.001	.026	.033
	Step 2: 16PF- SC	.100	.297	.099	2.531	-
	Step 3: 16PF-A	**.303***	**.044**	.203	6.409	-
Phase 2b: CS-	Step 1: BEAQ	.056	.247	.056	1.411	.236
	Step 2: 16PF- SC	.200	.077	.145	4.161	-
	Step 3: 16PF-A	.220	.134	.020	.558	.196
Phase 2b: GS+	Step 1: BEAQ	.002	.844	.002	.040	.041
	Step 2: 16PF- SC	.143	.170	.141	3.790	-
	Step 3: 16PF-A	.261	.078	.118	3.524	-
Phase 2b: GS-	Step 1: BEAQ	.044	.306	.044	1.096	.209
	Step 2: 16PF- SC	**.274***	**.025**	.230	7.297	-
	Step 3: 16PF-A	**.437****	**.005**	.163	6.393	-

Model2: BEAQ, 16PF-SC & 16PF-A.

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

4.3.8.2 Questionnaires and avoidance

Questionnaires were examined both individually and in combined regression models to discover their predictive utility for levels of conditioned and generalised avoidance. Simple regression analyses were initially undertaken to indicate the unique contribution of individual trait measures in predicting levels of avoidance for conditioned stimuli and their synonyms. During Phase 2a, none of the questionnaires provided a significant level of predictability for levels of avoidance to either the CS+ or the CS-. During the final probes (Phase 2b) they also struggled to predict avoidance levels. However, the *16PF* global trait of *Independence* did account for a significant 15.5% of the variance in CS+ avoidance, R^2= .155, $F(1,24)$=4.394, p = *.047* . The IUS was the only questionnaire to significantly predict levels of generalised avoidance to any of the stimuli, accounting for 21.8% of the variance in GS+ avoidance, R^2= .218, $F(1,17)$=4.732, p = .044.

To examine the overall contribution of the combined questionnaires to the variability in avoidance levels, simple multiple regression analyses were undertaken on models which consisted of all tests included in each test battery (see Table 4.8). The total combined model of all the examined questionnaires in Battery1 (EPQ, STAI-T, AAQ, BEAQ, PSWQ & IUS) significantly predicted avoidance levels to the CS- safety cue during both conditioning and probe trials R^2= .789 & .717, both p <0.05. It also performed better at predicting levels of generalisation than the Battery2 model (16PF, STAI-T, AAQ & BEAQ) which failed to provide any significant predictability for avoidance for any of the stimuli in either phase.

Table 4.8

Summary of Simple Multiple Regression Analyses indicating the unique contribution of the Total Combined Trait Models from Battery1 and Battery2 in predicting the Variability of Avoidance during Phase 2a Conditioning and Phase 2b Probes

Avoidance	Test	*n*	R^2	*p*	*F*
CS+ conditioning	1	19	.306	.795	.551
	2	26	.490	.103	2.042
CS- conditioning	1	19	**.789***	**.013**	**4.677**
	2	26	.457	.149	1.789
CS+ probes	1	19	.386	.626	.786
	2	26	.405	.248	1.446
CS- probes	1	19	**.717***	**.045**	**3.175**
	2	26	.110	.970	.264
GS+ probes	1	19	.506	.350	1.281
	2	26	.406	.246	1.451
GS- probes	1	19	.651	.105	2.335
	2	26	.245	.697	.688

Battery1: STAI-T, AAQ, BEAQ, EPQ-P, EPQ-N, EPQ-E, PSWQ, IUS.
Battery2: STAI-T, AAQ, BEAQ, 16PF-E, 16PF-A, 16PF-I, 16PF-T, 16PF-SC.

*Correlation is significant at the 0.05 level (2-tailed)

When the interaction between all the tests in each model was examined in relation to levels of avoidance, those scales which provided the greatest R^2 change within that model for each stimulus were combined into separate regression models to identify the most parsimonious predictor of both conditioned and generalised avoidance. From the tests included in Battery1, combining the STAIT-T, EPQ-P, BEAQ, EPQ-E and IUS provided the most parsimonious model (Model1) during the conditioning and probe phases.

While the model accounted for a mere 19.9% of CS+ avoidance variability in the probe phase, it accounted for significant levels of variability in CS- avoidance during both the conditioning R^2= .622, F(5,13)=4.287, p = .016 and the probe phase R^2= .550, F(5,13)=3.173, p = .043. Also, while not at a statistically significant level, Model1 also accounted for a respectable 47.8% of variance in response levels to the GS+ and 53.1% to the GS- (all p > .05).

From the questionnaires included in Battery2, combining the AAQ, BEAQ, 16PF-SC and the 16PF-I provided the most parsimonious model (Model2) during the conditioning and probe phases. Despite its parsimony, the model performed poorly regarding its predictability for avoidance to both conditioned and generalised stimuli during both the conditioning (R^2= CS+ .177; CS- .125) and the final probe phases (R^2= CS+ .343; CS- .083; GS+ .200; GS- .197, all p > 0.05).

4.3.8.3 Questionnaires and Expectancies

Similar simple regression analyses also indicated the unique contribution of individual trait measures in predicting recorded stimulus fear ratings if hypothetical avoidance responses had or had not been made in response to conditioned stimuli . Almost all of the individual questionnaires failed to provide a level of predictive utility in the self -reported expectancy of the US whether an avoidance response was hypothetically made or not. The EPQ-Extraversion provided the only significant level of predictability in the expectancy of a shock if the avoidance response was not given to the GS+ safety stimulus R^2= .207, F(1,17)=4.434, p <0.05.

Regression analyses for all of the 16PF global traits examined was not possible due to their lack of variability in the responses for CS+ *Press*, CS- *No Press* and GS- *No Press* conditions.

Total combined multiple regression models were assembled using of all the available questionnaires in each test battery to examine their predictive utility for US expectancy ratings if a hypothetical avoidance response had not been made.

The model from Battery1 provided the only initially significant findings accounting for 76% of the variability in both CS- and GS- expectancy of the US in the *No Press* condition, both R^2= .760, F(8,10)=3.967, p = .023. These unusually similar results were likely due to a lack of variability in expectancy ratings for both the CS- and the GS- in the *No Press* condition. The Battery1 model produced levels of predictive utility for the CS+ (R^2= .258) and GS+ (R^2= .549) which were not statistically significant. Similarly, the total combined model from Battery2 also failed to produce statistically significant levels of predictive utility for the *No Press* condition for the CS+ (R^2= .511) and the GS+ (R^2= .362), both p > .05. The lack of variability in the responses for CS- and GS- in the *No Press* condition, as well as for the CS+ in the *Press* condition, compromised the regression analyses for this model.

Total combined multiple regression models were also assembled using of all the available questionnaires in each test battery to examine their predictive utility for US expectancy ratings if a hypothetical avoidance response had been made. In the context of a hypothetical *Press*, both total combined models provided raised but not significant levels of predictability for all stimuli. Perhaps, given that the expectancies were taken post hoc, there was a lack of variability in expectancy ratings which compromised the sensitivity of these analyses.

When the interaction between all the tests in each model was examined in relation to expectancy levels, those scales which provided the greatest R^2 change within that model for each stimulus were combined into separate models to identify the most parsimonious predictor of the post hoc expectancy ratings. Due to their lack of predictive ability, separate models for ratings in the *Press* and *No Press* conditions had to be assembled.

From the tests included in Battery1, combining the IUS, AAQ, EPQ-E, and STAI-T provided the most parsimonious model (Model1) in the event of an avoidance response not being hypothetically made. This model accounted for a 50.4% of GS+ expectancy variability which was the model's only significant finding. For the model which combined only questionnaires from Battery2, the optimum model in the *No Press* condition comprised of STAI-T, AAQ, 16PF-T and 16PF-I. Model2 performed poorly for all stimuli and failed to provide a significant result.

For expectancy ratings in the event that they hypothetical avoidance response had been used the optimum Battery1 model consisted of STAI-T, EPQ-E, IUS and PSWQ . Despite it parsimony, none of the stimuli ratings were significantly predicted by this model. Model4 was constructed from Battery2 tests and consisted of the 16PF-A, 16PF-T and 16PF-SC. It was more successful and accounted for a significant level of the variability in GS- *Press* expectancy R^2= .312, $F(3,22)=3.327$, p = .038.

4.3.9 Summary of results

Recorded levels of SCRs throughout all three phases supported the successful conditioning of the two original cues, one providing the aversive CS+ and the other the safety related CS-. Generalisation between the cues and their synonyms however, despite the initial mean difference between the GS+ and GS- being significant, was not supported by SCRs, post Bonferroni correction. However, the generalisation of threat and safety from the conditioned cues to the probed stimuli was supported by significantly greater levels of instrumental avoidance responding to the GS+ than to the GS-. The generalisation of the conditioned threat was supported by US expectancy ratings which were recorded post-hoc. In the *No Press* condition i.e., if a hypothetical avoidance response had not been given, significantly higher expectancy ratings for receiving the shock for both the CS+ and related GS+ than for the CS- and GS- supported a level of generalised threat and the efficacy of the response in preventing the US. Surprisingly however, in the *Press* condition the possible consequences of erroneously providing an avoidance response to either the safety cue or its related synonym appeared to be less clear. Valence levels, also taken post-hoc, supported the conditioned and generalised threat or safety related characteristics of each stimulus.

While the evidence provided by the dependent measures supported generalisation, the predictive utility of the questionnaires in relation to the behaviour appeared to be reliant on the level of variability in the measured responses. For example, the variability in the recorded SCR data supported the identification of a number of significantly correlated individual trait scores. The IUS, 16PF-Anxiety and 16PF- Self Control accounted for significant amounts of the variability in SCRs to both the conditioned cues and the GS- across the three experimental phases. The best combined models (Model1 & Model2) from both experimental groups also produced significant levels of predictive utility for SCR arousal for the CS+ and the CS- cues, during either the fear or avoidance conditioning phases. In contrast, regression analyses between the questionnaire scores and the other dependent measures i.e., avoidance, expectancies or valence were not so prolific. Individually, only the IUS and 16PF-*Independence* provided a significant level of predictive utility in levels of either conditioned or generalised avoidance. While avoidance to the CS- stimulus was the only variable to significantly correlate with either of the combined best models (Group 1; STAI-T, EPQ-P, BEAQ, EPQ-E & IUS). For expectancies, only Extraversion (EPQ-E) and the best model from Group 1 (IUS, AAQ, EPQ-E & STAI-T) produced significant correlations, and both with only the GS+ in the *No Press* condition.

4.4 Discussion

In support of the original hypothesis, all four dependent variables used in the paradigm for threat identification (SCR, avoidance, expectancy & valence) appear to have indicated the successful conditioning of the words and, with the exception of SCR, generalisation to their synonyms. SCR results indicated that the significant differential between the CS+ and the CS- persisted through all three experimental phases, despite the availability of an effective avoidance response option. While the difference in SCR between the GS+ and the GS- was encouraging, it was not significant once the alpha correction for multiple comparisons was made. However, the significant differences between avoidance response rates recorded for the CS+ and the CS- persisted through all phases and did generalise to the GS+ and GS-. Post-hoc recorded ratings of US expectancy and valence were also consistent with both the successful conditioning and the generalisation of threat related properties between the conditioned cue and their synonyms.

A correlation between the SCR and avoidance measures also supported the conditioning and generalisation behaviours. During the probe phase levels of avoidance to the CS- correlated significantly with raised SCR levels for both the CS+ and GS+. However, results indicated that the relationships were strongly negative. GS- avoidance also correlated negatively with SCRs for the GS+. In other words, with a corresponding lack of avoidance to the conditioned or generalised safety cues, participant's SCR responses indicated that only the CS+ and GS+ cues provided any level of threat. If on the other hand an excessive level of conditioned fear had been observed, participants could have adopted a "better safe than sorry approach" and may have begun to avoid the novel or previously conditioned safe stimuli (Lommen et al., 2010). By responding only to those cues which were either aversively conditioned, or their semantically related synonyms, participants indicated that the procedure provided a good level of stimulus control. As a result, the strong correlation between fear arousal levels for the CS+ and GS+ and low levels of avoidance of the CS- and GS- could perhaps have been previously predicted. Unfortunately, no other significant relationships were observed between avoidance and SCRs for any of the other stimuli.

The expectancy data also corresponded with the emergence of fear and avoidance conditioning and generalisation. Between the dependent measures, there were strong significant positive correlations found between the *No Press* expectancy ratings and observed levels of avoidance for each individual stimulus, except the CS+. In other words, if participants had provided an avoidance response to a specific cue apart from the CS+ during the final probe phase, they rated their expectancy of receiving a shock higher in the post-hoc ratings if they did not provide that response to that cue. However, in contrast, there were no significant relationships observed between expectancy ratings and levels of SCR across any of the stimuli.

In relation to the specific predictive utility of personality traits, despite the consistency between the dependent measures regarding conditioning and generalisation, only the 16PF *Global* traits of *Anxiety* and *Self-control* individually produced significant levels of predictive ability for conditioned and generalised SCR. These traits were also combined with the BEAQ, in the model which significantly correlated with arousal levels for both the CS- during conditioning and the GS- during the final probe phase. In comparison none of the EPQ related traits, either individually or combined, demonstrated any significant predictive utility. Similarly, of all the personality traits examined, only the 16PF trait of *Independence* produced a significant relationship with levels of CS+ avoidance but only during the conditioning phase. Within combined models, the inclusion of personality related traits from either the 16PF or the EPQ, failed to correlate significantly with avoidance responses for any of the cues and across any of the phases. The 16PF traits were slightly more successful in predicting levels of variability in the US expectancy ratings. When combined into a separate regression model (Model4) the 16PF-*Anxiety*, 16PF-*Toughmindedness* and 16PF-*Self -control* correlated significantly with ratings for the GS- in the *Press* condition. Individually however, of all the examined personality traits, only the relationship between *Extraversion* (EPQ-E) significantly correlated with any of the expectancies (GS- *Press*) in either the *Press* or *No Press* condition. As previously discussed, the low level of predictive utility of the questionnaires overall may have been contributed to by the lack of variability among the dependent measure responses.

The binary nature of the avoidance response used in this experimental procedure for example, did not lend itself to the provision of a variety of response options. Successful avoidance resulted when participants produced a single press on the keyboard spacebar. In this manner, the individual's appreciation of cue related threat was inferred by the researcher from the observed response. However, Vervliet et al. (2015) suggested that the lack of an associated cost to the avoidance response may make it more likely to occur. As previously highlighted experiments such as van Meurs at al. (2014) may incentivise non-avoidance in their conditioning and generalisation paradigms. This provides a laboratory-based simulation of the cost commonly associated with anxiety related over-avoidance behaviours in the real world (Hunt et al., 2017). For example, individuals suffering from PTSD after a motor accident, may avoid driving despite the fact that they would now be required to walk or use public and possibly less efficient transport measures. In this experiment, there was no incentive (e.g. money or game-based points) offered to participants to not avoiding the US. Perhaps as a result, this may have promoted unrestrained avoidance and rather than successfully discriminating individual avoidance behaviour across the probed threat and safety stimuli.

Similarly, with any overuse of any potential US avoidance response, any relief provided by the non-receipt of a shock would interfere with variability in cue related SCR for all subsequent presentations. For example, when the participant successfully avoids the US during an early presentation of the cue, for any subsequent reappearance they may respond with an aroused SCR due to its aversive properties. Alternatively, they may respond with a reduced level of arousal due to the relief associated with the successful avoidance of the CS+ related US or indeed any other stimulus the participant has chosen to avoid during the task. As a result, any SCR related data may be confounded by the interaction between (raised) cue related arousal and (reduced) avoidance related relief across a number of presentations of each cue.

Another possible artefact of any relief associated with successful avoidance may have been an increased level of autonomic arousal of a kind qualitatively different from fear but nevertheless significant. Studies within the field of pain-related research have highlighted evidence supporting the resulting arousal provided by relief (see Andreatta, Mühlberger, Glotzbach-Schoon, & Pauli, 2013). Perhaps understandably, within pain avoidance paradigms the removal of the US can provoke a raised level of skin conductance. This does not appear to be the case within the field of fear and avoidance research however, where the response to the cancelling of the US results traditionally with a reduction in SCR (see Boyle et al., 2016). For example, Vervliet, Lange and Milad (2017) using a similar avoidance procedure to that of Experiment 3 here, reported "as expected, skin conductance reactivity decreased following avoidance actions that were effective (csþee) versus unproductive (csþuu), a pattern that was paralleled by retrospective US- expectancy ratings (p.75)". Their results showed that the effective use of the avoidance response correlated with the reduction in arousal levels of the participants after they had made the response. Such an effect may have been ameliorated by the extension of the SCR recording period. However, in this research, SCR was calculated after each stimulus presentation within 5 seconds. This is a very commonly used paradigm (Lonsdorf et al., 2017). Using this procedure ensures that the empirical focus was on the immediate skin conductance response to the stimulus rather than to any extended cognizing or rumination. For this reason, the brief SCR recording period is at odds with an interest in extended SCRs free of confounding by qualitatively different emotional responses that occur immediately following successful avoidance responses. Indicating good contextual control and the validity of the procedure , variability within levels of recorded SCR during Experiment 3 supported the other threat related dependent variables and appeared to be somewhat identifiable by trait measures. However, without any avoidance cost or response related difficulty in the procedure, the reduced variability observed in either avoidance or SCR related behaviour would not have promoted the identification of any individual differences.

Another possibly confounding effect in the examination of individual differences in the dependent measures, may have been the post-hoc nature of the expectancy ratings. Bennett et al., (2015a) suggested that retrospective expectancy ratings measure only the participant's recall of confirmed or disconfirmed expectancies, as USs were encountered during the training and testing procedure, rather than the accurate assessment of their within-trial expectancies. A possible solution may have been to extend the CS-US interval to include a brief in-line expectancy measure. However, requiring operant responses in the CS-US interval would more strongly associate the US with the emission of the expectancy rating response than the CS and therefore disrupt the conditioning process, at least from a behaviour-analytic point of view. This procedural manipulation may ultimately result in the weakening of the conditioning effect. This research chose to rely on robust conditioning procedures to generate strong conditioning, reliable generalisation and the prediction of both, using paper and pencil tests. It was considered futile to obtain any more reliable US ratings at the expense of the main phenomenon of interest.

What cannot be denied however is that, the experiment did succeed in providing a level of variety for behaviours that the questionnaires were designed to index e.g. anxiety, avoidance, risk taking, etc. In the experiment, some individuals did not show discrete and robust conditioning as readily as others, and the questionnaires should have been able to identify such individuals. From this point of view, the current data set is representative of that which would be obtained from any other random sample of the population. The variances observed in this conditioning and generalisation paradigm are likely replicable and have broadly been across the previous two experiments. For ethical reasons, it is not possible to do this research with more sensitive and vulnerable individuals or to increase further the salience of the US. To that extent, perhaps the popular questionnaires used here are indeed of little utility in predicting rates of fear levels or avoidance for conditioned or generalised threat cues, but there is some tantalising evidence that scores on such questionnaires are at least weakly related to the overt behavioural measures.

Chapter 5

Experiment 4: The effects of high (physical) cost on avoidance levels and appreciated threat in a semantic generalisation experiment.

Experiment 4: The effects of high (physical) cost on avoidance levels and appreciated threat in a semantic generalisation experiment.

Experiment 3 provided robust support for the Boyle et al. (2016) study findings, with the observed generalisation of conditioned responses for common-use words and their synonyms, across of all the dependent measures. The differences between observed levels of SCR, avoidance, expectancy of the US and semantic fear between the CS+ and CS- during all phases supported the successful conditioning of the common use words as cues. Differences in responses to the GS+ and GS- on all measures indicated a naturally occurring semantic generalisation between words and their synonyms without the need for any pre-training of these verbal class relations, or previous exposure to the generalisation probe cues. The exploration of the relationship between the measures and the trait questionnaires was the primary focus of the experiment however, and despite the robustness of the paradigm, the questionnaires provided only a limited number of significant findings in relation to their predictive ability in identifying conditioned and generalised threat related behaviours.

One possible reason for the lack of correlation between some of the dependent variables and the questionnaires may have been due to an interesting methodological aspect of the avoidance paradigm. Specifically, during Experiment 3 participants learned that a single press of the spacebar cancelled all impending cutaneous electric stimulations and this response option was reliably and readily used. The low-cost effectiveness of the response may have facilitated the generalisation of avoidance to the synonyms regardless of individual psychometric differences in trait. To date, all the experiments presented, as well as the Boyle et al. (2016) and the Dymond et al. (2011) studies examining semantic or symbolic generalisation, have relied upon the single press avoidance response to indicate aversion to the US. By providing a low-cost response option with 100% contingency, regardless of arousal levels the participants had the opportunity to avoid without consequence. This may have promoted the overuse of the response option for some participants. A more ecologically valid response should perhaps require an increase in physical effort or a loss of resources e.g., time or money, on the part of the participant to successfully avoid what they believe to be a potential hazard or consequence. Without these consequences the procedure may be susceptible to what is anecdotally described within the field of fear conditioning as a “better safe than sorry approach” (Lommen et al., 2010). In effect, the increase in response cost may nudge some participants towards not avoiding during generalisation probes and individual differences may become apparent. As a result, even though the questionnaires provided a degree of predictive ability for SCRs, with regard to their relationship with SCR levels, the guaranteed success of the avoidance response may have tempered arousal levels during the avoidance probe trails for some of the participants. Indeed, the previously reported negative correlation found between SCR magnitudes and avoidance rates, could have arisen due to the disjunction that arises when these two measures when avoidance is fluent (i.e., avoidance responses reduce the fear of the threat stimuli).

The availability of the single press avoidance response, which cancelled the receipt of a shock in 100% of the CS+ related trials, also possibly compromised the expectancy measures with regard to identifying any individual differences in ratings. As noted by Bennett et al. (2015a), post hoc ratings of US expectancy measure only the participant’s recall of confirmed or disconfirmed expectancies based on their overall trial experience rather than on a trial by trial assessment of the threat provided by novel cues. As a result, in Experiment 3 there were strong significant correlations between cue avoidance and their related expectancy ratings for the probed stimuli in the *No Press* condition. In other words, when compared to those who had not previously done so, those who avoided any of the probed stimuli reported a higher rating of expectancy of experiencing the US if they had not pressed the spacebar. As a result, it was probably not surprising that there was a very low number of significant correlations between the two measures.

The common factor between both of these possible confounds lies with the binary effect that a low-cost avoidance response provides. As already described, an avoidance response which has a 100% success rate in cancelling the US provides a possible SCR related conflict, either by providing competing cue relate anxious arousal and avoidance relief related arousal during each trial. Alternatively, any reduction in the differential SCRs between the CS+ and CS- may be merely due to the reduced level of US reinforcement that the avoidance response provided (Morriss, Chapman, Tomlinson & van Reekum, 2018; Xia, Dymond, Lloyd, & Vervliet, 2017). The overuse of the low-cost avoidance response also provides participants with the opportunity to report threat expectancy ratings which are indicative of their overall trial experience rather than any predisposition for the generalisation of threat to a novel stimulus. In this manner, by reducing stimulus fear ratings and SCRs so that scores were more homogeneous across participants, the use of a no-cost avoidance response may mask any pre-experimental individual differences. This is a significant confound, given that the central aim of using naturally occurring semantic relations to examine generalisation of fear and avoidance was to provide a more ecologically valid demonstration of the generalisation effect than is usually observed in the literature.

To provide an appropriate empirical demonstration of avoidance in the real world, the availability of the response may need to be context specific or perhaps comes with a level of physical cost (Morriss et al., 2018; Hunt et al., 2017). For example, to avoid a possibly threatening location-specific stimulus (e.g., a dog), an individual may have to take a longer route to work to circumnavigate the threat. Van Meurs et al., (2014) provided a laboratory-based model of this behaviour using their experimental *Virtual Farmer* paradigm. Alternatively, a more immediate and less easily avoidable threat may require a significantly larger physical expenditure from the individual to avoid any negative consequences (e.g., running quickly past the location, before the dog becomes aware of your presence). This behaviour was simulated in the laboratory by Bennett, Meulders, Baeyens and Vlaeyen (2015) who systematically manipulated the resistance level of a computer joystick, the operation of which was required to make an effective avoidance response. While these experiments did not specifically look for trait correlates of fear and avoidance, the extent to which individuals make such higher cost avoidance responses, may be more unequally distributed across the population than the low-cost avoidance response rates used in this experimental programme to date. As a result, any differences in observed avoidance may be more easily indexed by the measures of individual differences.

A number of studies have also shown that the use of low-cost avoidance response requirements may actually interfere with levels of conditioned and generalised avoidance. For instance, Vervliet et al., (2015) claimed that the low cost of avoidance does not mimic avoidance costs typical in real life scenarios and showed that single key press avoidance to the aversive US in contrived laboratory preparations persisted after the CS-US relationship had been extinguished and then readily re-emerged in similar contexts. More importantly perhaps, Laufer and Paz (2012) provided evidence that response cost can also "modulate" the degree of generalisation between stimuli. In other words, in a near-zero cost avoidance paradigm, where there is therefore almost no incentive not to avoid, a natural trajectory of learning may not be visible and possibly result in unexpected or paradoxical outcomes. The semantic generalisation research to date however, has shown consistent and reliable differences in avoidance rates across the CS+ and the CS- and also levels of generalisation between semantically related stimuli which suggest that low response cost does not entirely undermine discriminated avoidance patterns. Nevertheless, it may still be that individual variations in avoidance rates are compromised by the low-cost nature of typical avoidance response requirements.

Based on the clear utility of the semantic generalisation paradigm, Experiment 4 once again employed this approach but introduced a modification to examine the effect of a high physical avoidance cost on conditioned and generalised threat measures. More specifically, Experiment 4 explored whether anxiety or personality related measures of individual differences would significantly correlate with levels of observed fear or avoidance behaviour during a high response cost semantic generalisation paradigm. The experiment was in effect a replication of Experiment 3 with the difference that the single press response requirement for avoidance was increased to 20 presses with 5s (i.e., a higher response cost criterion). Phase 1 once again involved 12 conditioning trails in which, six presentations of a word (CS+) were paired with an aversive US (i.e., a brief shock delivered to participant's forearm) and six presentations of a further word (CS-) which were never followed by the shock. Subsequently, in Phase 2a participants could avoid the shock by pressing the spacebar 20 times in quick succession on a computer keypad while the cue remained onscreen (i.e., the 5s duration of the conditioned stimuli). Participants were not instructed as to the exact number of presses required to successfully avoid the shock but were told that multiple presses could be required. This meant that achievement of the criterion may be more likely by more motivated individuals. By achieving this criterion, the impending shock was cancelled in 100% of the CS+ trials. For those not producing the required number of keypresses within 5s of the CS+ onset, a shock was delivered with100% probability. After 20 trails, and without warning or interruption, Phase 2b was initiated. This involved four presentations of the CS+, CS- and a synonym of either word (GS+ or GS-) pseudo-randomly (i.e., four presentations each) for 16 trails. Throughout the phase, the participant's electrodermal activity was continuously recorded and time marked to identify individual in-trial SCR levels. Trait questionnaires were administered pre-experimentally, while expectancy of the US ratings were collected following the final probe phase. Semantically related fear measures were completed pre and post-experiment to provide comparable levels of semantic fear towards individual cues.

5.2 Method

5.2.1 Ethics

This procedure was approved by the Maynooth University research ethics committee prior to commencement and all health and safety procedures of that institution were observed in the use of the cutaneous electrical stimulator and all other equipment.

5.2.2 Participants

During the initial design phase, it was decided to maintain an equivalent sample size to that used in Experiment 3 (n=53) which could ultimately allow for a retrospective between groups comparison of high and low-cost avoidance rates across Experiment 3 and 4. Fifty-one unpaid participants were recruited via word-of-mouth and a snowballing sampling method. Participant 19 experienced a level of discomfort during the procedure and did not complete the computer task of the experiment. During the post experimental analyses, participants who failed to attempt avoidance for 75% of the final four presentations of the CS+ or attempted avoidance for more than 25% of the final four presentations of the CS- during Phase 2 avoidance conditioning were deemed not to have conditioned successfully. Participants were deemed to have attempted avoidance if they provided one or more presses on the spacebar within 5s of the onset of the stimulus presentation. By these criteria nine participants (P7, P16, P20, P22, P23, P39, P41, P47 & P50) failed to demonstrate successful conditioning and were excluded from all subsequent statistical analyses. The remaining 41 volunteers (27 females) ranged in age from 18 to 46 years old (M = 22.1, SD=5.860).

Participants were not screened formally for prior or current anxiety conditions but were carefully briefed as to the aversive nature of the experiment and advised to self-exclude if they had concerns regarding their suitability given a list of exclusion criteria including medical and psychological conditions (see Procedure).

5.2.3 Apparatus

The laboratory design comprised of an Apple MacBook (*primary laptop*) using *Psyscope* (Version B57; Cohen, MacWhinney, Flatt & Provost, 1993) software to present the stimuli and record avoidance responding. The *primary laptop* also recorded response times and event marked the skin conductance recorder (Biopac MP45) with 1ms integrity. A third function of the *primary laptop* was the generation and transmission of a signal to trigger a *Square Wave Stimulator* (Lafayette model 82415) in order to administer brief (15ms) cutaneous electric shocks as unconditioned stimuli at key junctures.

A set of Velcro finger straps containing Ag-AgCl (silver-silver chloride) electrodes were connected to the distal phalanges of the index and middle finger of the participant's non-dominant hand. These in turn were connected to the *Biopac MP45 Skin Conductance Recorder*. Mounted in polyurethane holders, each electrode measured 6mm in diameter, but the analysis software corrected for this non-uniform size and recorded all skin conductance in Siemens per cm^2. The electrodes were non-polarisable and shielded to reduce noise interference. A PH balanced and isotonic electrode gel was employed to secure the electrode contact points. A secondary laptop operating *Biopac Acquire* software was used to continuously record skin conductance levels throughout the experiment. *Biopac* safety bar electrodes were used to deliver brief cutaneous stimulations to the participants from the *Square Wave Generator*. The insulated bar provides a pair of electrodes, located 50mm apart, which is attached onto the non-dominant forearm using adhesive tape.

Two pairs of synonyms (see Table 5.1) were selected from *The University of South Florida Word Association, Rhyme and Word Fragmentation Norms* database of free association (Nelson et al., 1998). The chosen pairs all scored highly (i.e., above 80%) for frequency of free association when single word priming was provided and were previously used as stimulus pairs in both Experiment 3 and the Boyle et al. (2016) study.

Table 5.1

Words used as Conditioned Cues and Probes for Generalisation during All Phases

	CS+	**CS-**	**GS+**	**GS-**
SET1	CRY	ILL	WEEP	SICK
SET2	ILL	CRY	SICK	WEEP

All stimuli were presented on a standard 15” computer monitor in uppercase size 72 bold font, in black. The two words CRY and ILL functioned as aversive or non-aversive cues during both the conditioning and probe phases with their synonyms functioning as the probes for generalisation. Both originally conditioned words were counterbalanced as the CS+ and CS- across participants.

Prior to the computer task, participants completed a battery of six personality and anxiety-related trait questionnaires comprising of the EPQ-R, STAI, AAQ, BEAQ, PSWQ and IUS. This battery was previously assembled for Experiment 3 and in that procedure was denoted as *Battery1*. Due to the time demands for administering *Battery2* it was decided that only *Battery1* would be administered in Experiment 4.

In addition to the above, and prior to the commencement of the conditioning phases, participants also completed the Likert style semantically related fear scales used in Experiment 3. These ratings functioned as a control procedure to ensure that stimuli did not already possess aversive functions which could provide differences in fear responding between the CSs throughout the procedure (see Appendix 4). Due to the use of common English words as CSs, they inevitably have some semantic meaning which may interact with conditioning and generalisation processes. Nevertheless, it is important to understand that the stimuli were assigned randomly to the roles as CS+ and CS- stimuli and that differential conditioning and generalization were reliably observed, suggesting that any interference in processes by the pre-experimentally established stimulus functions was minimal. Post-experimental stimulus fear rating scales re-examined the original words as well as the novel synonyms used as probes for generalisation (see Appendix 5). Participants also completed an Expectancy Rating Questionnaire (see Appendix 4) post-test which examined their expectancy of a shock for all eight possible configurations of stimuli and responses (i.e., four stimuli, each with two possible hypothetical responses: avoid or do not avoid).

5.2.4 Procedure

Participants were provided with a briefing document detailing the experiment at least 24 hours previous to taking part (see Appendix 1). On arrival at the laboratory, participants signed a consent form acknowledging the aversive nature of the electrical stimulation to be used as the US during the experiment and also indicating that they did not have a history of psychopathology (see Appendix 2). Participants were requested to self-exclude themselves from taking any further part if they had any concerns with regard their suitability. Once they had completed the battery of trait and avoidance questionnaires, they were then seated comfortably at a table in in a small experimental cubicle in the Maynooth University Psychology Department laboratory and were tested individually.

In compliance with the health and safety guidelines for the use of the isolated square-wave stimulators of the Maynooth University Psychology Department 2010-2011, initially a work up procedure was employed to identify the highest acceptable stimulation level to which participants would consent. . Participants were first exposed to a very low level of stimulation (approx. 40 volts as indicated on-screen) which is usually not registered as a cutaneous sensation by participants. By increasing the level of stimulation in increments of 5 – 10v, the wave amplitude level (i.e., shock level) was manipulated by the participant to the level that they deemed as "uncomfortable but not painful". Throughout the process the participant self-administered successive shocks using a key-press until they reached an amplitude level which was to the highest they deemed acceptable. This level was then fixed and maintained throughout the experiment. Finally, a set of Velcro finger straps containing Ag-AgCl (silver-silver chloride) electrodes were connected to the distal phalanges of the index and middle finger of the participant's non-dominant hand. Once the welfare of the participant was verified and they had no further questions the experimental procedure was initiated on screen.

5.2.4.1 Phase 1: Fear conditioning

This phase replicated the fear conditioning phase during the previous experiment (Experiment 3). For additional detail see Table 5.2 below.

Table 5.2

Trial Schedule detailing the Number of Stimulus Presentations of Each Cue during Each Phase

Stimulus	Fear Conditioning Phase	Avoidance Conditioning Phase	Probe Phase
CS+	6	10	4
CS-	6	10	4
GS+	NO	NO	4
GS-	NO	NO	4

5.2.4.2 Phase 2a: Avoidance conditioning

While the procedure of Phase 2a and Phase 2b replicated that of Experiment 3 with the exception of the increase in the criterion for successful avoidance from a single press to 20 presses within 5s from the onset of the stimulus. If participants successfully pressed the space bar 20 times or more within the 5 secs that the CS+ stimulus was presented, the screen immediately cleared and the imminent shock was cancelled. No feedback was provided. If participants did not successfully reach the criterion by providing 20 consecutive presses of the space bar while the CS+ was visible onscreen, there followed a 2 s interval, after which the participant received a shock at the previously established level. The shock followed all unsuccessful avoidance attempts for presentations of the CS+ and never followed a successfully avoided CS+. An avoidance attempt was recorded as such, if the participant produced one or more presses of the spacebar within 5s of the cue being presented on-screen and regardless of any success in cancelling the US. Pressing, or not pressing, the spacebar in the presence of the CS- stimulus on-screen provided no feedback or shock for any of the trials.

5.2.4.3 Phase 2b: Avoidance probe phase

The procedure of Phase 2b replicated that of Experiment 3 (see Table 5.2 above for further detail).

5.2.5 Dependent measures and analyses

Analyses were conducted to explore differences, with stimulus as the within-subject factor with 4 levels (CS+, CS-, GS+ & GS-), to examine both the conditioning of fear and avoidance and their generalisation. The dependent variables used as indicators of the effects were levels of behavioural avoidance, skin conductance responses (SCR), reported expectancy of the US and valence ratings. The interaction between all dependent variables was examined but particular attention was paid to the differences in their relationships due to the success or otherwise in attempted avoidance. An avoidance attempt was adjudged to have occurred if the participant pressed the spacebar one or more times in response to the appearance of any cue regardless of its related success in cancelling the US. The criterion for successful avoidance was 20+ keypresses in response to the CS+ and the cancelling of the impending US. Where parametric assumptions were violated, a nonparametric test was used. Differences between stimuli were subsequently examined using pairwise comparisons with a Bonferroni correction.

An important focus of the analysis, was the exploration of any correlational relationships between fear and avoidance levels observed for conditioned and generalised stimuli and scores on the individual questionnaires. For each of these relationships, simple multiple models of regression were used to test whether individual or combined questionnaire models best predicted levels of conditioned or generalised avoidance or the perceived threat (SCR magnitudes). Due to the exploratory nature of the analyses between the dependent measures and the questionnaires, the use of a Bonferroni correction would reduce the power of the tests and would make the identification of any significant effects unlikely. As a result, significant correlations between the two groups of measures are reported without correction. Bonferroni adjustments were undertaken when pairwise comparisons were calculated. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

5.3 Results

5.3.1 Avoidance

5.3.1.1 Attempted avoidance

Planned comparisons were conducted to examine if there were differences in the levels of attempted avoidance (i.e., ≥1 keypress in response to any cue) between the threat and safety cues (CS+ & CS-) and also between the probes for generalisation (GS+ & GS-; see Figure 5.1). A Wilcoxon Signed-Rank Test indicated that the rate of attempted avoidance in Phase 2a conditioning was higher for the conditioned threat stimulus (CS+) than for the conditioned safety stimulus (CS-) with a significant median (IQR) difference $z(50)=-6.137$, $p < .001$, $r = .61$. During the Phase 2b probes, this difference in rates of attempted avoidance between the conditioned stimuli was maintained $z(41)=-5.850$, $p < .001$, $r = .65$. Importantly the difference in attempted avoidance rates between the GS+ and the GS- stimuli was also statistically significant $z(41)=-4.250$, $p < .001$, $r = .47$ indicating that the differential rate of attempted avoidance had generalised to synonyms of the cues conditioned during Phase 2a.

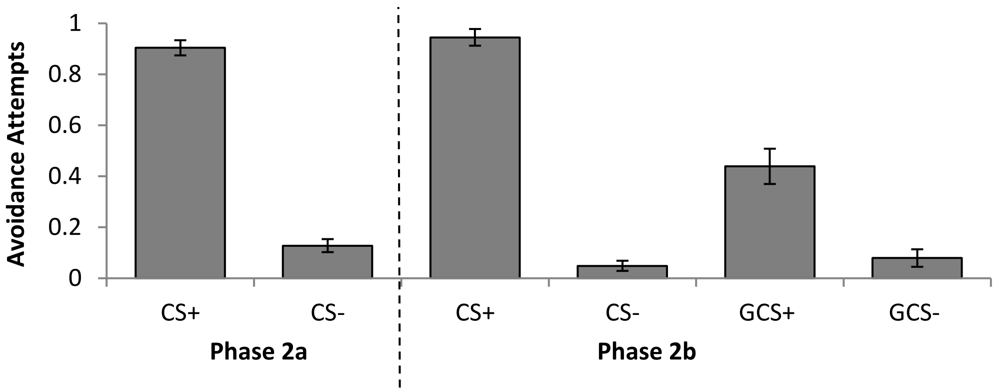

Figure 5.1. Percentage of attempted avoidance responses (≥1 keypresses) to all stimuli during both Phase 2a avoidance conditioning and Phase 2b probes. Error bars represent standard error**.**

Spearman's correlational analyses were conducted to examine the relationship between levels of attempted avoidance observed across specific stimulus pairs during the conditioning and probe phases and levels of generalised attempted avoidance to the synonyms during the final probe phase. Moderate strength correlations were present between the conditioning and probe phase levels of attempted avoidance for both the CS+ (r_s = .400, p = .009) and the CS- (r_s = .315, p = .045). During the probe phase correlation between rates of attempted avoidance between the CS+ and GS+ was small and not statistically significant, r_s = .206, n=41, p = .196. This contrasted with the strongly correlated levels of attempted avoidance between the CS- and GS-, r_s = .645, n=41, p < .001. There was a medium strength significant correlation between attempted avoidance of the GS+ and the GS-, r_s = .439, n=41, p = .004.

5.3.1.2 Successful avoidance

During Phase 2a conditioning 100% of participants (n= 41) attempted to make an avoidance response to the CS+, while 39% (n=16) made at least one attempt to avoid the CS-. Sixty percent of those participants who attempted avoidance of the CS+ successfully managed to cancel one or more of the impending shocks during conditioning (n= 30). In line with the previous experiments outlined here, participants were deemed to have learned to avoid the aversively conditioned cue (AVOIDERS) if they demonstrated 75% successful avoidance to the CS+ (i.e., 20 presses within 5s) and did successfully avoid over 25% of the CS- cues during the final four presentation of each cue during Phase 2a (n=19). Participants were deemed to be NON-AVOIDERS, if they failed to successfully avoid the US to this required criterion. In contrast to the previous studies however, due to the successful avoidance criterion of 20 presses in 5s, participants who attempted to avoid over 75% of the final four presentations of the CS+ cue, and less than 25% of the last four CS- cue, but failed to successfully avoid the US, were also deemed as NON-AVOIDERS. In other words, AVOIDERS satisfied both the successful instrumental learning and the successful avoidance criteria detailed above, while NON-AVOIDERS may have only successfully learned to attempt to avoid the US.

During Phase 2a the difference between AVOIDERS and NON-AVOIDERS (see Figure 5.2) in their respective number of trails in which they attempted CS+ avoidance was significant, $t(39) = -2.728$, $p = .011$. Subsequent correlational analyses indicated that successful avoidance during the conditioning phase did not predict levels of attempted avoidance for any of the probed stimuli during the final phase. The only significant difference between the groups during the probe phase was in relation to levels of attempted avoidance was in response to the generalised GS+ cue $t(39) = -2.574$, $p = .014$.

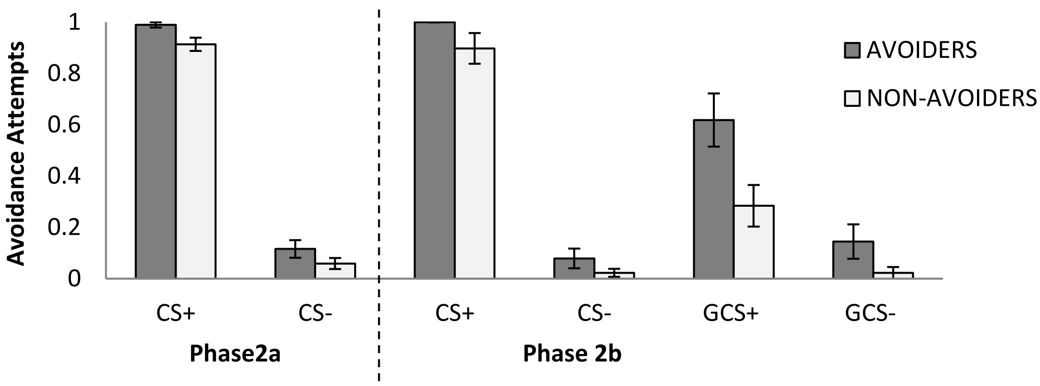

Figure 5.2. Percentage of trials in which AVOIDERS and NON-AVOIDERS attempted an avoidance response for each stimulus presented during both Phase 2a avoidance conditioning and Phase 2b probes. Error bars represent standard error**.**

5.3.1.3 Key press rates per trial

Differences between the two groups in the mean number of key presses in response to each presentation of the CS+ provided a measure of response effort (see Figure 5.3). AVOIDERS made significantly more key presses in response to the CS+ during conditioning than NON-AVOIDERS, $t(39) = -8.224$, $p < .001$. This was understandable given the high number of key presses required for cancellation of any impending shock. This difference between the groups was observed during final probes for both the CS+ $t(39) = -7.599$, $p < .001$ and GS+ $t(39) = -3.781$, $p = .001$. The difference between the number of keypresses in response to the first presentation of the CS+ between AVOIDERS and NON-AVOIDERS was also significant $t(39) = -3.269$, $p = .004$. The overall correlation between number of keypresses to the initial presentation of the CS+ during the instrumental conditioning phase and success in US avoidance during the phase was also significant $r_s = .538$, $n=41$, $p < .001$.

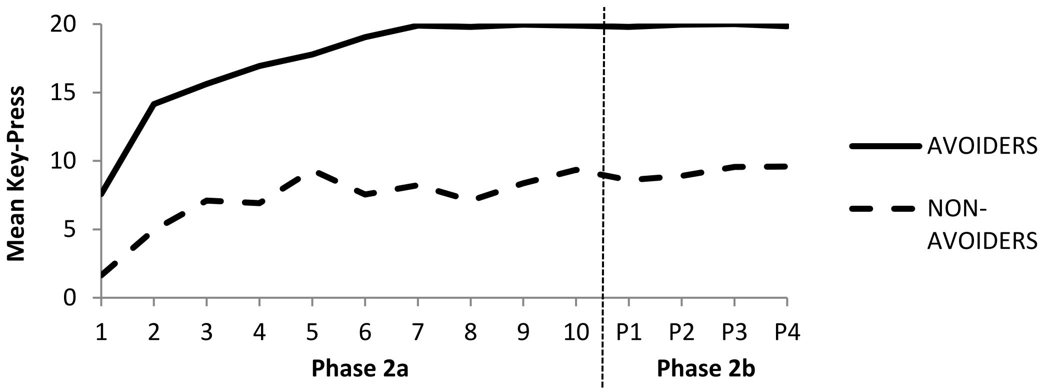

Figure 5.3. Mean number of key Presses during attempted avoidance responses for Avoiders and Non-avoiders during each CS+ presentation during Phase 2a avoidance conditioning (1-10) and Phase 2b final probes (P1-P4) .

5.3.2 Skin Conductance

Skin conductance response levels were recorded by calculating both the baseline i.e., *u*S (microsiemens) level at the time of presentation and the maximum skin conductance level within a 5-second period subsequent to each presentation. The difference between these two values was recorded as the individual raw ski conductance response (SCR) for each trial, where negative responses were recorded as zero. For each participant mean raw values were calculated for the CS+, CS-, GS+ and GS- stimuli and then square-root transformed prior to any analyses to reduce skew and kurtosis. Figure 5.4 shows the mean transformed value in microsiemens (*u*S) for each cue during each experimental phase for all participants combined.

During Phase 1, SCRs for all participants were higher for conditioned threat stimuli (CS+) than for conditioned safety stimuli (CS-) during training. A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference between recorded SCR levels in response to the CS+ and the CS-, $z(41)=-4.944$, $p < .001$, $r = .55$. This inter-stimulus difference between the CS+

and the CS- maintained, albeit at a reduced level, during Phase 2a avoidance conditioning despite the availability of a 100% effective response option, $z(41)=-2.728$, $p = .006$, $r = .43$. Similarly, during Phase 2b probes, the median difference between the conditioned stimuli (i.e., CS+/CS-) was significant, $z(41)=-3.155$, $p = .002$, $r = .35$. SCRs for the GS+ and the GS- were not significantly different to each other during this final probe phase, $z(41)=-0.112$, $p = .911$, $r = .01$. Separating participants into AVOIDER and NON-AVOIDER cohorts failed to indicate any significant between-group differences in SCRs throughout all phases and across all stimuli.

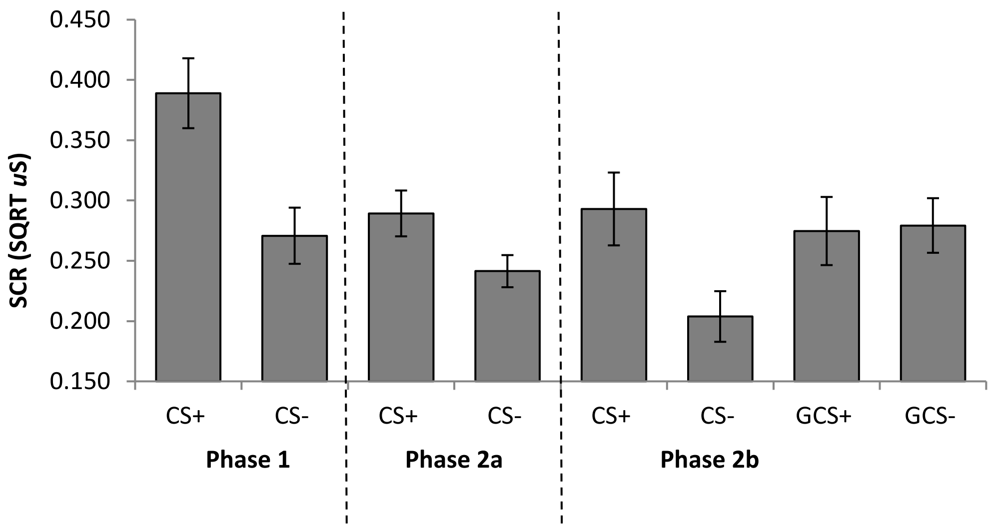

Figure 5.4. Square root transformed skin conductance responses to all stimuli for all participants during fear conditioning, avoidance conditioning and final probe phases. Error bars represent standard error**.**

Spearman's correlational analyses were conducted to examine the relationship between attempted avoidance during the probe phase and the recorded SCR for each stimulus. Overall only SCR levels for the CS- during the probe phase were significantly and positively correlated with the generalisation of attempted avoidance to the CS+ and GS- (r_s =.320, .355 respectively; both $p < .05$).

When participants were separated based on whether they successfully avoided the shock or not, only the relationship between GS- SCR and GS+ attempted avoidance for the AVOIDERS was significant with a medium and positive correlation, r_s =.491, p = .033. Neither of these results survived Bonferroni correction (p = .003) and no other significant relationships were observed between avoidance and SCRs for any of the other stimuli.

5.3.2.1 Skin Conductance and successful avoidance

During Phase 1 conditioning, the difference in arousal levels between the CS+ and CS-was significant for both AVOIDERS, $t(18)=3.367$, $p = .003$, and NON-AVOIDERS, $t(21)=6.913$, $p < .001$. Those participants who successfully cancelled the CS+ during conditioning (AVOIDERS) did not, as a group, demonstrate greater SCRs for the CS+ over the CS- during either the avoidance conditioning or the final probe phases (see Figure 5.5). The NON-AVOIDERS also failed to demonstrate larger SCRs to the CS+ over the CS- during Phase 2a avoidance conditioning, $t(21)=1.947$, $p = .065$, but unexpectedly did so during the final probe phase, $t(21)=3.355$, $p = .003$. There was a significant reduction in SCRs to the CS+ for NON-AVOIDERS from Phase 1 to Phase 2a, $t(21)=3.017$, $p = .007$, which did not persist into the final probe phase, $t(21)=1.143$, $p = .266$. CS+ arousal levels during avoidance conditioning across the AVOIDERS and the NON-AVOIDERS were not significantly different from each other, $t(39)=-.374$, $p = .710$.

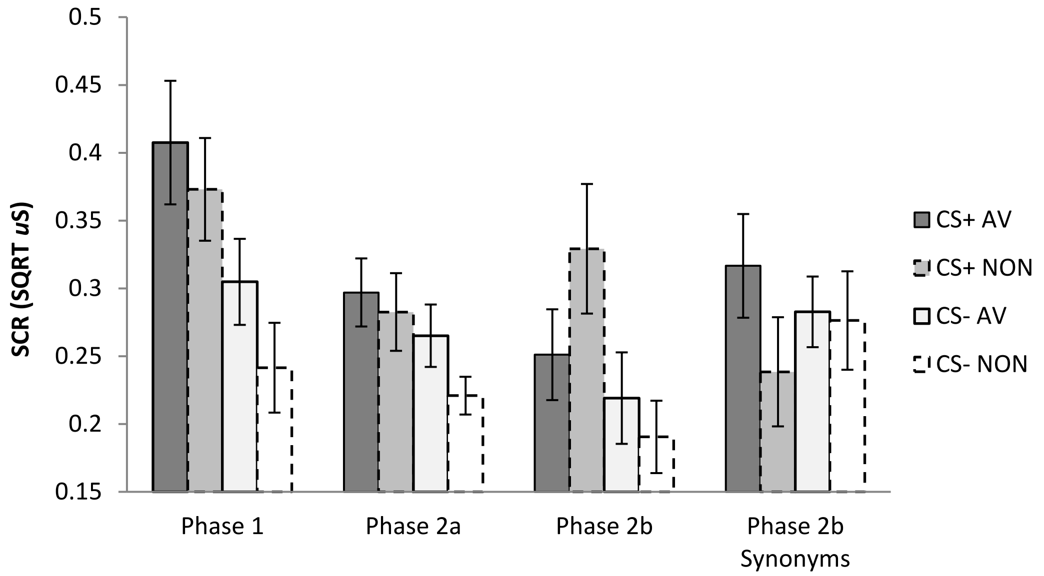

Figure 5.5. Square root transformed skin conductance responses to the CS+ and the CS- for AVOIDERS and NON-AVOIDERS during Phase 1fear conditioning, Phase 2a avoidance conditioning, Phase 2b and to the GS+ and GS- during the probe phases.

5.3.3 Expectancy

For the sample taken as a whole, differences between mean US expectancies for each of the stimuli, under the conditions of both a hypothetical avoidance response being made (*Press*) or not (*No Press*), seemed to corroborate the successful conditioning patterns observed, as well as a level of generalisation of this effect to their synonyms. A Wilcoxon Signed-Rank Test indicated that the difference between the CS+ and CS- for recorded US expectancy levels if a hypothetical avoidance response was not made was significant, $z(40)=-6.023$, $p < .001$, $r = .67$. The difference between mean GS+ and GS- expectancy levels was also significant under the same condition, $z(40)=-2.776$, $p = .006$, $r = .31$. In the case of a hypothetical response being made however, there was a significant US expectancy difference between the CS+ and CS-, $z(40)=-3.321$, $p = .001$, $r = .37$. No difference in US expectancy between the GS+ and the GS- was identified in the same condition.

Separating participants into AVOIDERS and NON-AVOIDERS highlighted some interesting differences across cohorts (see Figure 5.6). In the *Press* condition, AVOIDERS reported significantly lower expectancy of the US than NON-AVOIDERS, if the avoidance response was made to the CS+, $z(40)=-2.573$, $p = .014$, $r = .29$. A significant difference was also observed for NON-AVOIDERS in US expectancies following the CS+ and the CS- if a hypothetical response was made, $z(22)=-3.184$, $p = .001$, $r = .48$, which was surprisingly not present for the AVOIDERS, $z(18)=-.978$, $p = 0.328$, $r = .16$. In this *Press* condition the difference in expectancy levels between GS+ and GS- was not significant for either group, despite the clear overt transfer of fear and avoidance patterns observable for the AVOIDERS.

In the *No Press* condition there was no significant difference between groups in relation to CS+ expectancy of the US, $z(40)=-1.583$, $p > .05$, $r = .18$. However, there was a significant between-group difference between AVOIDERS and NON-AVOIDERS in relation to GS+ expectancy if a hypothetical response had not been made, $z(40)=-2.043$, $p > .05$, $r = .23$. For AVOIDERS, this elevated consideration of risk associated with the GS+ over the GS- supported a significant difference between the generalised cues if an avoidance response was not made $z(18)=-3.945$, $p < .001$, $r = .66$. None of the other group differentials in relation to the success of avoidance were significant for any of the other stimuli in either condition.

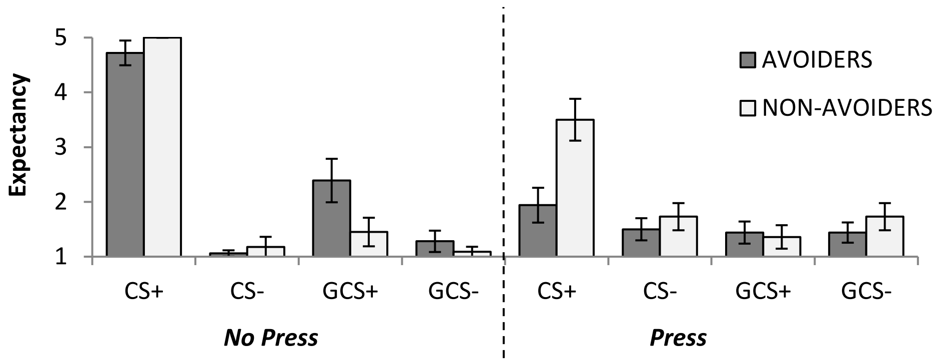

Figure 5.6. Mean US expectancy ratings for AVOIDERS and NON-AVOIDERS following the appearance of each stimulus and in the case that a hypothetical avoidance response was (*Press*) or was not (*No Press*) made. Error bars represent standard error**.**

5.3.3.1 Expectancy and avoidance

Spearman's correlational analyses were conducted to examine the relationship between the rate of attempted avoidance during the probe phase and the recorded US expectancy if an avoidance response had not been made (*No Press*) in the presence of a stimulus. Overall and for each stimulus, only the synonyms demonstrated strong significant positive correlations between avoidance rates during the probe phase and the reported expectancy of the US if a hypothetical avoidance response had not been given for that cue (GS+ $r_s = .627$, $p < .001$; GS- $r_s = 0.481$, $p = .002$).

Separating the groups once again, a strong positive correlation was found between avoidance to the GS+ and the expectancy of receiving a shock if a response was not given to that cue for both AVOIDERS and NON-AVOIDERS ($r_s = .568$ & $.607$ respectively, both $p < .05$). Only for AVOIDERS, however, was this correlation maintained between avoidance and US expectancy for the GS- in the *No Press* condition $r_s = 0.684$, $p < .01$. No other significant relationships were observed.

5.3.3.2 Expectancy and SCR

Spearman's correlational analyses were conducted to examine the relationship between the SCR levels during the probe phase and the recorded US expectancy if an avoidance response had not been made in the presence of a stimulus. No significant relationships were observed.

5.3.4 Semantically Related Stimulus fear ratings

Participants rated the valence of both of the conditioned cues and novel word immediately before (Time1) and after (Time2) the conditioning probe phases. At Time2 the synonyms of the cues were also examined for any semantic related stimulus fear ratings. Figure 5.7 shows the mean level of semantically related fear attributed to each of the cues as well as an innocuous and novel control word, not used in the conditioning phases. Wilcoxon Signed-Rank Tests indicated that prior to the commencement of the conditioning phase (Time 1), there was no significant difference between mean levels of semantically related fear between the CS+ and the CS-, $z(41) = -.061$, $p = .951$, $r = .01$. Post-test however, the CS+ cue demonstrated a significant increase in levels of semantic fear between Time1 and Time2, $z(41)= -4.960$, $p < .001$, $r = .55$. The small decrease in semantically related fear in relation to the CS-, $z(19)= -2.165$, $p = .03$, $r = .35$, while initially significant, failed to survive Bonferroni correction ($p = .025$), but was a borderline effect. The successful conditioning of both cues was supported by a significant difference between valences of the CS+ and the CS- at Time2, $z(41)= -5.156$, $p < .001$, $r = .57$. Generalisation between the conditioned cues and their synonyms was indicated by a significant and positive difference in levels of reported semantically related fear between the GS+ and GS-, $z(41)= -3.337$, $p = .001$, $r = .37$.

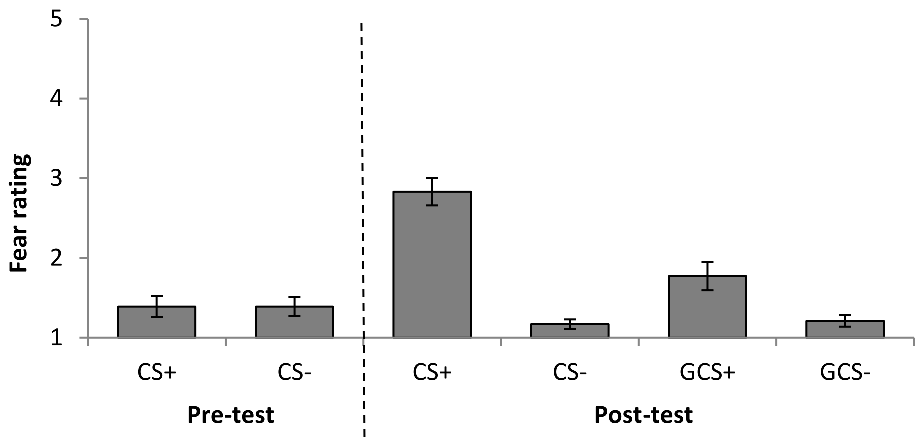

Figure 5.7. Mean stimulus valence ratings for all stimuli taken pre (*Time1*) and post (*Time2*) conditioning probe phases. Error bars represent standard error.

AVOIDERS and NON-AVOIDERS did not differ in their fear ratings for any of the stimuli at either Time1 or Time2, except for the CS+ cue at baseline. Despite counterbalancing measures taken to ensure that CS+ word choices varied across participants, the difference in pre-test semantically related stimulus fear ratings of the CS+ between AVOIDERS and NON-AVOIDERS was significant, $Z(41)= -2.662$, $p = .008$, $r = .42$. This may have compromised the conditioning effects, subsequent generalisation effects and relationships between SCRs, avoidance and the questionnaire scores.

5.3.4.1 Semantically Related Stimulus fear ratings and avoidance

Among all participants no significant correlations were identified between attempted avoidance levels during Phase 2a conditioning and semantically related stimulus fear ratings for any of the probed stimuli. Medium strength and significant correlations were found however between Phase 2b attempted avoidance levels and their related semantically related stimulus fear ratings for both the CS- ($r_s = 0.335$, $p = .033$) and the GS+ ($r_s = .477$, $p = .002$). Levels of CS- attempted avoidance during Phase 2b also correlated moderately with post-test valence levels for the GS- (r_s= 0.481, $p < .001$). GS- attempted avoidance levels correlated strongly with the GS- fear ratings (r_s = 0.616, $p < .001$) and moderately with CS- ratings (r_s = 0.325, p =.038). Dividing the total sample into AVOIDERS and NON-AVOIDERS, failed to provide further insight into the relationship between valence and attempted avoidance.

5.3.4.2 Semantically Related Stimulus fear ratings and SCR

In the overall sample no significant correlations were discovered between recorded SCR levels during the final probe phase and mean semantically related stimulus fear ratings for all stimuli. When separated into their respective cohorts, a strong positive correlation between levels of semantically related fear for the GS+ and recorded levels of SCR for both the CS- (r_s = 0.702, $p < .001$) and the GS- (r_s = 0.564, $p = .012$) during the probe phase was observed for AVOIDERS. A medium to large correlation between the semantically related fear for the GS- cue and SCR levels for the CS- during probes was also observed, r_s = 0.499, $p = .030$. No other correlations were found.

5.3.4.3 Semantically Related Stimulus fear ratings and expectancy

Overall for each individual stimulus the relationship between its *No Press* expectancy and corresponding valence value correlated strongly for all stimuli except the CS+ (CS- r_s = 0.498, $p = .001$; GS+ r_s = 0.511, $p = .001$; GS- r_s = 0.334, $p = .035$). A degree of generalisation was apparent between levels of semantically related fear to the CS- and the *No Press* expectancy rating for the GS- r_s = 0.356, $p = .024$. When separated into groups, no significant correlations between the expectancy and valence for any of the stimuli, was found for NON-AVOIDERS. In contrast, very strong relationships between stimulus semantically related fear levels and their related *No Press* expectancies (CS- r_s = 0.686, p < .002; GS+ r_s = 0.826, p < .001; GS- r_s = 0.756, p < .001) were found for NON-AVOIDERS. A strong correlation was also observed between GS- valence and levels of both CS- and GS+ *No Press* expectancy for AVOIDERS (CS- r_s = 0.576, p = .012; GS+ r_s = 0.611, p < .007). In the *Press* condition there were no significant correlations between valence and expectancy for any of the stimuli.

5.3.5 Questionnaires

There were medium to strong significant correlations between scores on a number of various questionnaires (see Table 5.3).

Table 5.3

Summary of Correlations between Scores on Individual Trait, Personality and Experiential Avoidance Measures

	STAI-S	STAI-T	AAQ	BEAQ	EPQ-N	EPQ-P	EPQ-E	PSWQ
STAI-S	1							
STAI-T	**.380***	1						
AAQ	**.573****	**.750****	1					
BEAQ	.308	**.429****	**.383***	1				
EPQ-N	.309	**.684****	**.703****	**.558****	1			
EPQ-P	-.040	-.194	-.192	-.034	**-.402***	1		
EPQ-E	-.266	-.160	-.172	-.168	**-.406****	.199	1	
PSWQ	**.315***	**.621****	**.587****	**.394***	**.781****	**-.463****	-.234	1
IUS	**.490****	**.454****	**.563****	**.375***	**.593****	**-.315***	-.224	**.745****

5.3.5.1 Questionnaires and skin conductance

Questionnaires were examined both individually and in combined models to discover their predictability for levels of arousal during both the conditioning and probe phases. Simple regression analyses were initially undertaken to indicate the unique contribution of individual trait measures in predicting SCR levels for conditioned stimuli and their synonyms (see Table 5.4). The BEAQ provided the most notable predictive utility across various behavioural measures, with a significant level of predictability of SCR variability during the final probe phase of the experiment for the CS-, R^2= .188, $F(1,39)$= 9.042, p = .005. The relationship between the EPQ-P and the CS+ arousal during final probes, R^2= .133, $F(1,38)$= 5.811, p = .021 was also significant. Finally, the EPQ-E accounted for a significant level of variability in CS- arousal levels during the initial fear conditioning phase, R^2= .105, $F(1,38)$= 4.466, p = .041.

Table 5.4

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in Predicting the Variability of SCR for Stimuli presented across all Experimental Phases

SCR	**CS+**			**CS-**			**GS+**	**GS-**
Phase	1	2a	2b	1	2a	2b	2b	2b
	R^2	R^2	R^2	R^2	R^2	R^2	R^2	R^2
STAI-S	.019	.014	.002	.036	.083	.017	.000	.001
STAI-T	.001	.027	.003	.001	.002	.035	.001	.006
AAQ	.007	.001	.014	.014	.001	.019	.016	.002
BEAQ	.010	.084	.056	.021	.036	**.188****	.070	.017
EPQ-N	.001	.004	.006	.031	.002	.042	.047	.000
EPQ-P	.064	.057	**.133***	.013	.031	.001	.003	.008
EPQ-E	.021	.010	.000	**.105***	.034	.077	.082	.077
PSWQ	.000	.003	.026	.001	.006	.012	.005	.022
IUS	.006	.024	.000	.025	.039	.031	.052	.000

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

To examine the overall contribution of the combined questionnaires to the variability in SCR, simple multiple regression analyses were undertaken on models which consisted of all tests included in the test battery. The total combined model of all the examined questionnaires (STAI-S, STAI-T, AAQ, BEAQ, EPQ-P, EPQ-N, EPQ-E, PSWQ & IUS) only significantly predicted SCR levels to the CS+ stimulus during the Phase 2a avoidance conditioning trials, R^2= .412, F(9,30)= 2.338, p = .039.

When the interaction between all the tests in each model was examined in relation to levels of SCR, those scales which provided the greatest R^2 change within that model for each stimulus were combined into a separate model to identify the most parsimonious predictor of both conditioned and generalised arousal. Combining the BEAQ, EPQ-P, EPQ-E and STAIT-T into a hierarchical regression model provided the most parsimonious predictor of arousal levels during both the conditioning phase. During the avoidance conditioning phase, the model provided for a significant level of predictability for SCR levels in response to the CS+, R^2= .287, F(4,35)=2.967, p = .016.

During the probe phase phases (see Table 5.5), the best combined model also accounted for 22.9% of the variability in arousal to the CS+, R^2= .229, F(4,35)=2.602, p = .053, and a significant 25.3% for the CS-, R^2= .253, F(4,35)=3.528, p = .033.

Table 5.5

Summary of the Hierarchical Regression Analyses examining the Contribution of the Best Combined Model of Trait Measures in the Variability of SCR for All Stimuli during the Probe Phase

SCR	Independent Variables	R^2	*p*	ΔR^2	*F* for	*B*
Phase 2b: CS+	Step 1: BEAQ	.056	.141	.056	2.262	-.237
	Step 2: EPQ-P	**.196***	**.018**	.139	6.409	-.374
	Step 3: EPQ-E	**.196***	**.047**	.000	.002	.006
	Step 4: STAI-T	.229	.053	.034	1.527	.213
Phase 2b: CS-	Step 1: BEAQ	**.188****	**.005**	.188	8.810	-.434
	Step 2: EPQ-P	**.191***	**.020**	.002	.109	-.049
	Step 3: EPQ-E	**.249***	**.015**	.059	2.817	.246
	Step 4: STAI-T	**.253***	**.033**	.004	.181	.072
Phase 2b: GS+	Step 1: BEAQ	.070	.099	.070	2.862	-.265
	Step 2: EPQ-P	.075	.238	.005	.187	-.068
	Step 3: EPQ-E	.149	.118	.074	3.122	.276
	Step 4: STAI-T	.195	.099	.046	2.016	.250
Phase 2b: GS-	Step 1: BEAQ	.017	.425	.017	.649	-.130
	Step 2: EPQ-P	.026	.619	.009	.334	-.094
	Step 3: EPQ-E	.105	.258	.079	3.173	.285
	Step 4: STAI-T	.145	.229	.040	1.652	.233

Model: BEAQ, EPQ-P, EPQ-E & STAIT-T.

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

5.3.5.2 Questionnaires and avoidance

The questionnaire scores of successful AVOIDERS and unsuccessful NON-AVOIDERS were examined for any individual differences using Wilcoxon Signed-Rank Tests. Only scores on the EPQ- P and the EPQ-N identified significant differences between the groups, $z(41)=-1.989$, -2.012, respectively (both $p < .05$).

Questionnaires were then examined both individually and in combined regression models to discover their predictive utility for levels of conditioned and generalised attempted avoidance. Simple regression analyses indicated that during Phase 2a avoidance conditioning, none of the questionnaires provided a significant level of predictability in levels of attempted avoidance to either the CS+ or the CS-. During the final probe phase the STAI-T (18.6%), AAQ (24.4%) and EPQ-N (13.3%) all accounted for a significant proportion of the variance in CS+ attempted avoidance (see Table 5.6). With regard to generalised threat, only the EPQ-E significantly predicted levels of attempted avoidance responses to the generalisation probes, accounting for 11.2% of the variance in GS- attempted avoidance R^2= .112, $F(1,39)$=4.788, p = .035.

Table 5.6

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in Predicting the Variability of Attempted Avoidance to Stimuli during the Final Probe Phase

	CS+		CS-		GS+		GS-	
	R^2	β	R^2	*B*	R^2	*B*	R^2	β
STAI-S	.001	.023	.167*	.408	.001	-.028	.083	.288
STAI-T	**.186****	**-.431**	.015	.124	.002	.044	.000	.001
AAQ	**.244****	**-.494**	.088	.297	.000	.012	.027	.165
BEAQ	.030	-.172	.005	-.070	.008	-.088	.039	-.198
EPQ-N	**.133***	**-.364**	.061	.247	.010	-.098	.004	.062
EPQ-P	.044	-.209	.011	.107	.019	.139	.006	.078
EPQ-E	.027	.164	.073	-.271	.043	.206	**.112***	**-.335**
PSWQ	.003	-.059	.083	.288	.012	.110	.042	.205
IUS	.007	-.082	.060	.246	.005	.070	.006	.079

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

To examine the overall contribution of the combined questionnaires to the variability in avoidance levels simple multiple regression analyses were undertaken on the model which consisted of all nine questionnaires (see Table 5.7). This total combined model (STAI-S, STAI-T, AAQ, BEAQ, EPQ-P,EPQ-N,EPQ-E, PSWQ & IUS) significantly predicted avoidance levels to the CS+, CS- and GS- safety cue during the probe trials, R^2= .445, .414 and .415 (all $p <$ .05).

Table 5.7

Summary of Simple Multiple Regression Analyses indicating the Unique Contribution of the Total Combined Trait Model in Predicting Rates of Attempted Avoidance to Stimuli during the Conditioning and Probe Phases

Attempted avoidance	Stimulus	R^2	p	F
Phase 2a	CS+	.205	.569	.861
	CS-	.239	.428	1.046
Phase 2b	CS+	**.445***	**.021**	2.675
	CS-	**.414***	**.038**	2.356
	GS+	.191	.629	.788
	GS-	**.415***	**.037**	2.363

Model: STAI-S, STAI-T, AAQ, BEAQ, EPQ-P, EPQ-N, EPQ-E, PSWQ, IUS.

** p <0.05*

When the interaction between all the tests in the model was examined in relation to levels of avoidance, those scales which provided the greatest R^2 change for each stimulus were combined into a separate hierarchical regression model to identify the most parsimonious predictor of both conditioned and generalised avoidance attempts. Combining the BEAQ, PSWQ, STAIT-S and EPQ-P provided the most parsimonious model during the conditioning and probe phases (see Table 5.8).

Table 5.8

Summary of the Hierarchical Regression Analyses indicating the Unique Contribution of the Best Combined Model in predicting the Variability of Avoidance to All Stimuli during the Conditioning and Probe Phases

Attempted Avoidance	Independent Variables	R^2	*p*	ΔR^2	*F* for ΔR^2	*B*
CS+	Step 1: BEAQ	.002	.795	.002	.068	.042
	Step 2: PSWQ	.023	.650	.021	.805	.160
	Step 3: STAI-S	.047	.623	.024	.912	.164
	Step 4: EPQ-P	.054	.737	.007	.249	-
CS- conditioning	Step 1: BEAQ	.050	.166	.050	1.993	-
	Step 2: PSWQ	.051	.377	.002	.062	.044
	Step 3: STAI-S	.149	.117	.098	4.137	.330
	Step 4: EPQ-P	.197	.096	.047	2.064	.251
CS+ probes	Step 1: BEAQ	.031	.275	.031	1.226	-
	Step 2: PSWQ	.032	.552	.000	0.014	.021
	Step 3: STAI-S	.039	.689	.008	.295	.094
	Step 4: EPQ-P	.098	.446	.059	2.277	-
CS- probes	Step 1: BEAQ	.004	.692	.004	.160	-
	Step 2: PSWQ	.123	.089	.118	4.995	.379
	Step 3: STAI-S	**.290****	**.006**	.168	8.509	.432
	Step 4: EPQ-P	**.375****	**.002**	.085	4.759	.336
GS+ probes	Step 1: BEAQ	.007	.616	.007	.256	-
	Step 2: PSWQ	.030	.564	.024	.907	.170
	Step 3: STAI-S	.032	.756	.002	.057	-
	Step 4: EPQ-P	.093	.478	.061	2.342	.284
GS- probes	Step 1: BEAQ	.038	.231	.038	1.482	-
	Step 2: PSWQ	.135	.069	.097	4.418	.343
	Step 3: STAI-S	**.239***	**.019**	.105	4.950	.341
	Step 4: EPQ-P	**.296***	**.013**	.057	2.834	.275

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

The model's strength appears to have been in relation to the prediction of attempted avoidance to the CS- stimulus and its synonym. During the instrumental conditioning phase it accounted for 19.7% of CS- variability in attempted avoidance, R^2= .197, $F(4,35)=2.141$, p = .096. In the probe phase it performed better and provided for 37.5% of variance to CS-, R^2= .375 (p = .02), and 29.6% to the GS-, R^2= .296 (p = .013).

5.3.5.3 Questionnaires and key presses

Overall questionnaires either individually or combined failed to predict rates of key pressing during either the conditioning or probe phase for either the CS+ or the GS+. When the relationship between first CS+ trial rate of key pressing and the questionnaire scores were examined however, the PSWQ provided good individual predictive utility for the response level, R^2= .285, $F(1,39)=15.554$, $p <$ .001. The best combined model, included the PSWQ with the STAI-T and the EPQ-P, provided a significant 34.6% of variability in the rate of key pressing to the initial CS+ presentation during the instrumental conditioning phase, R^2= .346, $F(3,36)=6.363$, p = .001.

5.3.5.4 Questionnaires and Expectancies

Simple regression analyses also indicated the unique contribution of individual trait measures in predicting recorded stimulus fear ratings if hypothetical avoidance responses had or had not been made in response to conditioned stimuli. Most of the individual questionnaires failed to demonstrate predictive utility in the self -reported expectancy of the US whether an avoidance response was hypothetically made or not. The EPQ-N provided the only significant level of utility, in the expectancy of a shock if the avoidance response was given to the GS+ stimulus, R^2= .109, $F(1,40)$=4.528, p = .040.

The total combined model was assembled using of all the available questionnaires. The only significant finding accounted for 49.8% of the variability in the CS+ expectancy of the US should an avoidance response be hypothetically made, R^2= .498, $F(9,29)$=3.195, p = .008.

When the interaction between all the tests in the model was examined in relation to expectancy levels, those scales which provided the greatest R^2 change for each stimulus were combined into a separate model to identify the most parsimonious predictor of the post-hoc expectancy ratings. Combining the EPQ-N, EPQ-E, IUS, PSWQ and EPQ-P provided the most parsimonious model in both the *Press* and *No Press* conditions. Despite the large number of tests included in the model, it accounted for very little variability in the expectancy levels for all stimuli in the event that an avoidance response was not made (CS+ 2.4%, CS- 9.5%, GS+14.7% & GS- 17.6%, all p >.05).

Similar to the *No Press* condition findings, combining the most effective questionnaires into a single model did not lead to a significant level of predictive utility in the expectancy of the US if the avoidance response was made. The levels of variability in the *Press* condition for US expectancy ratings explained by the model was: CS+ (23.9%), CS- (16.2%), GS+ (26.0%) and GS- (17.5%), all p > .05.

5.3.5.5 Questionnaires and Stimulus Fear Ratings

Simple regression analyses were conducted to examine the unique contribution of individual trait measures in predicting recorded valence ratings for all words used as stimuli as well as a novel word not used during the computer based trials. Results failed to identify any significant predictive utility for any of the questionnaires, either individually or combined together in a single model, in relation to any level of semantically related fear for each word.

5.4 Discussion

Despite less than half of participants successfully producing a reliable avoidance response to the CS+, differences between the rates of attempted avoidance (i.e., ≥ 1 key-presses) to the CS+ and CS- during all phases supported the successful conditioning of safety and threat to the cues, which then generalised to their synonyms. While levels of attempted avoidance to the CS+, during either phase, was a poor predictor of generalised avoidance to the GS+, there were strong correlations between the attempted avoidance for the GS- and both the CS- and the GS+. When the generalisation of avoidance was further examined, the AVOIDERS' success in regularly cancelling the US did appear to increase the likelihood that they were more likely to attempt avoidance during the probe trials than the NON-AVOIDERS. Interestingly, any successful avoidance may have been predicted by their responses to the CS+ during conditioning, as AVOIDERS were more likely to provide a greater rate of key pressing for the first presentation of the CS+ than NON-AVOIDERS. Between the groups, there was a significant difference in the mean number of key presses provided at the initial appearance of the cue. This may have indicated that AVOIDERS were perhaps more motivated than the others, with regard to making a successful response (i.e., 20 presses within 5s) and responded with additional vigour. Unfortunately, from the avoidance data, it is difficult to determine whether it was their original motivation to avoid the shock or their success in doing so which may explain their raised level of generalisation in comparison to their more unsuccessful peers.

Alternatively, for NON-AVOIDERS, although they persisted throughout with their attempts to avoid the CS+, their lack of success may have interfered with the use of the response for any novel or possibly ambiguous stimuli. In other words, given the lack of reinforcement provided by the key press and their repeated exposure to the US, it would be understandable for NON-AVOIDERS not to generalise the response to any of the other stimuli. As previously described, a regular criticism of the low-cost avoidance paradigm is that it is the success of the avoidance response, as well as its lack of associated cost, that promotes the overuse of the response. In this experiment, the relationship between the participant's success in CS+ avoidance and levels of avoidance generalisation to the GS+ does appear to support this perspective. The results clearly demonstrated that AVOIDERS i.e., those who successfully avoided the CS+ cue, were almost twice as likely to generalise the key press avoidance response than the NON-AVOIDERS.

Additional insight into the behaviour provided by the SCR results also benefitted from the separation of the groups, based on their avoidance success. Significant differences in levels of skin conductance between the CS+ and the CS- were maintained throughout all three trial phases and provided additional support for the successful conditioning of cue related threat and safety during the experiment. However, with the full sample of participants, SCR failed to identify generalisation between the cues and their synonyms during the final phase. Initial correlations between avoidance and SCR magnitudes also failed to persist post correction in either Phase 2a or 2b. Separating the participants into their respective groups according to avoidance success however, provided sufficient variability in the behaviour to identify a number of significant effects. To be more specific, successful avoidance of the CS+ appeared to interfere with the inter-stimulus difference in SCR, in two different and noteworthy ways.

Firstly, while conditioning was quickly apparent in arousal levels for both cues during Phase 1, the availability of the avoidance response tempered the magnitude of the response during Phase 2a. During initial conditioning, as to be expected, SCR arousal magnitudes were dependent on whether the CS was followed by the US (CS+) or not (CS-). This difference persisted during Phase 2a instrumental conditioning but at a reduced, albeit still significant, level. This was most likely due to the availability of the avoidance response option and the resulting reduction in overall CS+ arousal levels. Interestingly however, when participants were separated into successful avoidance related cohorts, the reduction in CS arousal magnitudes was for both the AVOIDERS and NON-AVOIDERS. More specifically, the mean levels of CS+ arousal for both groups were the same and not related to their success in cancelling any subsequent shock. When examined further, incremental reduction in trial-by-trial arousal levels was common to both groups of participants, despite NON-AVOIDERS still receiving the dermal stimulation at an “uncomfortable but not painful level”. However, this apparent disconnect between avoidance success and arousal levels is not unique. Xia et al. (2017) reduced the effectiveness of an avoidance response in cancelling the US (shock) for a number of groups during an operant conditioning task. For the boundary groups in the procedure, pressing the spacebar either cancelled the US in 100% of cases or for 0% of trials for those at the opposite end of the avoidance reinforcement scale. Dependent measures used in the study were avoidance rates, SCR and expectancy of the US levels. Their results clearly showed that while there was a significant reduction in observed avoidance levels between the 100% and 0% reinforcement groups, this was not matched by a between-group reduction in SCR arousal levels. Morris et al. (2018) also observed a reduction in SCR levels during trials where participants were provided with a reduced ability to avoid the CS+. In their threat conditioning and extinction paradigm, despite the lack of efficacy of the avoidance response, levels of SCR were similar to those recorded during trials where participants could avoid all presentations of the CS+. These recent results appear to support the observed reduction in CS+ SCR during Experiment 4, which persisted only through the instrumental conditioning phase. With the introduction of the additional stimuli during the final probe phase, the CS+ related SCR levels appeared to reinvigorate for NON-AVOIDERS, but not for the AVOIDERS.

A possible explanation for the lack of a significant difference in between-group SCR arousal levels may be due to the availability of the response rather than its efficacy in cancelling the US. In 1969 Glass, Singer & Friedman discovered that providing a button to participants, which the experimenters claimed would cancel an erratic and aversive short blast of noise, successfully reduced associated stress levels during the experiment. This reduction was present only for the group given this instruction and not for a control group who were not told about the button. Despite the aversiveness of the noise, none of the participants attempted to use the button which was merely an ineffectual prop. Indeed, the relationship between the perception of control and levels of emotionality is readily accepted among more cognitively focused researchers (Zvolensky, Eifert, & Lejuez, 2001). Based on the findings of Experiment 4, in addition to Xia et al. (2017) and Morriss et al. (2018) this phenomenon is worthy of further investigation. The second noteworthy effect highlighted the significant contribution that the successful avoidance response made to the level of SCR generalisation demonstrated by each group. Similar to the results of Experiment 3 (which used a low response-cost avoidance paradigm), during the final probe phase successful AVOIDERS no longer showed raised arousal levels to the CS+. They also demonstrated strong levels of generalisation with significantly larger SCR magnitudes in response to the GS+ cue when compared to the GS-. For NON-AVOIDERS however, while the difference between the conditioned stimuli returned to a statistically significant level during the final probe phase, this difference was not apparent between the GS+ and GS- cues. To be more specific, successfully avoiding the CS+ corresponded with increased generalisation of arousal to the GS+. NON-AVOIDERS on the other hand, had already demonstrated poor levels of generalised attempted avoidance to the synonyms. These results indicated that the generalisation of both SCR and the attempted avoidance were similarly affected by the success of the avoidance response.

Unfortunately, in this exploratory analysis, overall the questionnaires performed poorly in identifying individual differences in any of the dependent measures. In the variability of SCR for all stimuli, the individual or combined contribution of the questionnaires was small and not significant. The best model (BEAQ, EPQ-P, EPQ-E & STAI-T) significantly predicted Phase 1 levels of CS+ and Phase 2b levels of CS- SCR. Although, the identification of correlations between SCR and the questionnaires may have been confounded by the arousal levels observed for NON-AVOIDERS in response to the CS+ during Phase 2a, which appear to run contradictory to the participants' experienced level of US stimulation. In addition, regardless of any of the observed behavioural differences during the experiment, there was no difference between the recorded scores of AVOIDERS and NON-AVOIDERS for any of the questionnaires. The only noteworthy effect was a possibly tenuous relationship may have been identified between the PSWQ and the rate of key pressing in relation to the first presentation of the CS+ during Phase 2a. This relationship was significant, and as previously reported, there was a strong positive correlation between the number of first presentation CS+ key presses and the overall success in avoidance. In other words, PSWQ scores may have predicted the raised level of motivation in responding for certain individuals and provides a possible line of future enquiry. The best combined model (BEAQ, PSWQ, STAI-S & EPQ-P) provided the only significant results with regard to overall avoidance levels to the CS- and GS- cues during the probe phase. However, none of the individual tests or combined models provided a significant level of predictive ability for either valence or expectancy ratings for any of the stimuli.

It is important to note that some interference in identifying correlations between the observed avoidance behaviour and the trait questionnaires may have been attributable to the exclusion criterion applied during the analyses. Participants who attempted to avoid on less than 75% of the CS+ trials during the last four presentations of training, or attempted to avoid on more than 25% of the last four CS- training presentations, were excluded. As a result, nine participants were excluded reducing the overall sample to 41. As well as reducing the sample size for comparisons between variables, the criterion may have also excluded variations in avoidance behaviour which was one of the main variables being explored. However, by excluding participants who failed to show robust discriminated avoidance, it was ensured that responses on the probe phase were not likely due to factors other than a failure to generalise (i.e., failure to learn the stimulus functions in the first instance). This was important from a stimulus control point of view as failure to learn may be related to psychometric variables but also to a whole host of other factors. It must be highlighted as a possible confound however, that participants who had demonstrated the most variety in their avoidance responses during the instrumental conditioning phase may have been excluded, and as such their absence possibly contributed to a lack of variability in generalisation rates and therefore compromised the correlational analysis.

In summary, Experiment 4 provided some expected, and also some noteworthy, results with regard to the insertion of a high physical cost criterion into this traditional semantic generalisation paradigm. For those who had successfully learned to avoid, the responses across all four dependent variables (avoidance, SCR, expectancy & valence) mirrored those from the earlier low-cost experiment. Surprisingly however, for the sample as a whole, and regardless of their level of success in avoidance, levels of conditioned and generalised avoidance to the CS+ and its synonym also corresponded very closely with levels observed during Experiment 3 (low avoidance response cost). In addition, mean SCR differences between the conditioned stimuli across all phases, as well as between the generalisation probes during the final phase, were of a similar magnitude to those observed in Experiment 3. Expectancy ratings between the two studies were also similar across all stimuli. In other words, while a number of differences within the dependent measures were identified between cohorts separated by their success in avoiding the CS+, these differences did not appear to affect the overall generalisation phenomenon. As a result, it was probably not surprising then to discover that there were no significant between-group differences uncovered by any of the examined trait questionnaires. Overall, the insertion of a higher physical cost into the avoidance response criterion did not appear to produce sufficient variability in the observed responses, within a semantic paradigm, to identify individual trait differences.

Any lack of variety in the recorded responses may have been due to the robustness of the semantic generalisation effect. Semantic generalisation between words and their synonyms has been supported across a number of fear and avoidance related dependent measures, in the Boyle et al. (2016) study as well as Experiment 3 and Experiment 4 detailed in this thesis. As previously described, during the final probe phase of the experimental procedure, synonyms of the CS+ and CS- are introduced to examine for the generalisation of either the conditioned avoidance response or raised SCR levels, either of which would infer a level of cue related threat. However, in the study of psychophysiological measures, an orienting response of the autonomic nervous system is common in response to novel, unexpected or task related stimuli (Nieuwenhuis, de Geus, & Aston-Jones, 2011). This response includes the dilation of the pupils, a momentary change in heart rate and, more importantly for the semantic generalisation paradigm, a phasic rise in skin conductance. In other words, when a novel or related stimulus is presented, participants may experience a phasic increase in SCR magnitude. This possible confound to the SCR analysis is circumvented in the design of the experiment, by counterbalancing the in-trial order of stimulus presentation to ensure that both the GS+ and GS- are presented as the first probe stimulus in equal numbers between all participants. The success of this precaution is evident during the final probe phase of Experiment 4, when NON-AVOIDERS produced SCRs of equivalent magnitude for both the GS+ and the GS-. In this manner, the experimental paradigm supported the NON-AVOIDERS lack of generalised avoidance, with a lack of discriminated generalisation between the synonyms demonstrated in the recorded SCR data.

As well as the orienting response to the novel probe stimuli, there appears a curious return to raised SCR levels during the Probe phase for the CS+ among a cohort of participants. As previously highlighted, during the avoidance conditioning phase of the experiment, participants experienced a similar reduction of CS+ arousal levels during avoidance conditioning, whether they were successfully avoiding the cue related shock or not. But in the final phase, for NON-AVOIDERS, the magnitude of the CS+ related arousal returned to levels statistically similar to those recorded during Phase 1 conditioning. From these results, it appears that the introduction of the synonyms as novel generalisation probes coincides with the reinvigoration of the original conditioned arousal to the CS+.

This reinvigoration of CS+ related arousal during the final phase also appears susceptible to the success or otherwise of the avoidance response among participants. From the results, the higher arousal responses to the CS+ cue are specific only to those who were unsuccessful in avoiding the CS+, and not for those successfully producing the conditioned avoidance response. A possible explanation may have been that, during the previous avoidance conditioning phase, NON-AVOIDERS who were responding in extinction (i.e., their key pressing behaviour was not being reinforced by the cancelling of the shock) may have habituated to the level of the cutaneous stimulation they were receiving. Alternatively, they may have been operating under the previously discussed perception of control during the instrumental conditioning phase. Either behaviour may have been interrupted by the appearance of the novel probe stimuli without warning and resulted in a return to the original level of arousal experienced during the fear conditioning phase. For AVOIDERS, any ambiguity or perceived loss of control produced by the appearance of the probe stimuli would possibly be resolved by the success of their avoidance responding in cancelling any potential US. This would have tempered the magnitude of the AVOIDERS SCRs during the task. In other words, while Morriss et al. (2018) highlighted that the availability of the avoidance response option successfully reduces the inter-stimulus difference between threat and safety cues, the introduction of novel stimuli could possibly have likewise introduced a sufficient degree of ambiguity between all of the cues so as to interfere with controlled and predictable generalisation for those not successfully avoiding the US. over-generalisation

In an attempt to investigate the extent to which novel probe stimuli may produce confounding effects, the experiment in the next chapter introduced a truly novel and semantically unrelated stimulus during the probe phase of a semantic generalisation paradigm. To date, the probe cues used in the experiment designs described in this thesis have functioned to promote generalisation. Experiment 5 sought to actively interfere with levels of generalisation across the four dependent measures (SCR, avoidance, expectancies & valence), using the low-cost avoidance response paradigm from Experiment 3. By providing the availability of a low-cost avoidance response, which required only a single press of the spacebar, the experiment removed any possible ambiguity regarding the function of key press. In addition, reusing the avoidance response as well as the original words and their synonyms from Experiment 3 as conditioning cues and probes for generalisation, supported the direct comparison of the results across the dependent measures between the two experiments. In this manner Experiment 5 sought to identify whether levels of semantic generalisation could be interfered with, by merely introducing an unrelated novel probe stimulus into the procedure.

Chapter 6

Experiment 5: The effect of irrelevant probe stimuli on semantic generalisation.

Experiment 5: The effect of irrelevant probe stimuli on semantic generalisation.

In the previous experiment, there was a reinvigoration of arousal levels to the CS+ for some participants, which was not accompanied by any over-generalisation of arousal or attempted avoidance to the synonyms of the CSs. This effect could be construed as counter-intuitive, as traditionally there has been an accepted association between anxiety and excessive avoidance (Arnaudova et al., 2015). While the exact contribution of the generalisation of fear and avoidance to the psychopathology of anxiety disorders has yet to be identified, these behaviours are regularly implicated in the development and maintenance of anxiety related dysfunction (Pittag et al. 2018). This relationship is most likely due to the evidence that the interaction between fear or anxiety and avoidance is readily apparent in the laboratory. Successful avoidance, generated in an experimental conditioning paradigm, can contribute to an observable reduction in conditioned SCR arousal magnitudes (Morriss et al., (2018). During the final phase of Experiment 4 for example, significantly lower SCR response magnitudes were recorded for those who were successfully avoiding the CS+ compared to those still experiencing the cutaneous stimulation. However, for those NON-AVOIDERS who had not learned to successfully avoid the CS+, their subsequent fear-related behaviour appears to run contrary to a number of behavioural expectations.

Throughout Phases 2a and 2b of Experiment 4, NON-AVOIDERS demonstrated a number of behaviours which appeared not to support the contribution of fear arousal magnitude to rates of avoidance. For example, during Phase 2a conditioning the availability of the avoidance response had provided a significant reduction in CS+ related mean SCR magnitude from Phase 1.

Interestingly however, this effect was not specific to any success in cancelling the CS+. In other words, there was no significant difference in mean SCR magnitude for the CS+ cue between NON-AVOIDERS and AVOIDERS during the avoidance conditioning phase, despite NON-AVOIDERS failing to avoid the repeated presentations of the CS+ related shocks. With the introduction of the novel synonym probes during the final phase, the reduced arousal to the CS+ persisted only for those who were successfully avoiding the US (shock). For NON-AVOIDERS, skin conductance responses to the CS+ during the probe phase, returned to a level of magnitude that was not significantly different to that observed during Phase 1fear conditioning. But, as highlighted in chapter 5, this reinvigoration of CS+ related SCRs did not prompt any corresponding increase in the NON-AVOIDERS rate of avoidance responding to the cue. Also, and perhaps contrary to expectation, the sudden increase in SCR magnitude and repeated exposure to the US, did not result in the generalisation to the GS- and the GS+ for either arousal or rates of attempted avoidance by the NON-AVOIDERS. In other words, the generalisation of SCRs or avoidance rates was more likely to be produced by those who were successfully avoiding the shock and not, as one might suspect, by those who showed most fear to the CS+ and who were most exposed to the aversive US.

This apparent paradox may not be specifically due to individual differences in avoidance however, as it may merely indicate the inaccurate identification of the relationship between the conditioned and probed cues by some participants (i.e., the semantic relations were weak for some individuals). In the semantic experiments to date, both published and included in this thesis, the generalisation phenomenon has been examined by attempting to correlate SCR magnitudes or rates of avoidance with trait measures, to identify individual differences in behaviour using words as conditioned stimuli and their synonyms. These naturally occurring semantic categories it was hoped, would allow for a more real-world demonstration of fear generalisation than is often reported in the literature using often perceptually similar stimuli. However, the correlation between degrees of generalisation and the trait measures is inevitably impacted upon by the extent to which generalisation is itself a robust and reliable phenomenon, when it is occurs along semantic, rather than, for instance spatial dimensions. Poor semantic relations may partly explain any observed disconnect between SCR magnitudes and any generalised avoidance to the new cues. The word association scores for the stimulus pairs used in the semantic generalisation experiments to date have all been selected as they scored highly (i.e., above 80%) for frequency of free association when single word priming was provided. These frequency scores from the University of South Florida Word Association, Rhyme and Word Fragmentation Norms database of free association (Nelson, McEvoy, & Schreiber, 1998) while high, still allow for a level of uncertainty regarding their semantic relationship for some individuals. In addition, the word association norms used are over twenty years old and the meanings of words like WEEP or ILL may have slightly lost their clarity within the modern English language. For example, synonyms of the word BROTH which was included on the *Post- Test Semantic Stimulus fear ratings* (see Appendix 6) had to be provided to a large number of participants during testing due to their unfamiliarity with the noun. In a semantic generalisation paradigm, salient task-related synonyms would be most likely to provide for levels of discriminated arousal and avoidance. However, for those who failed to appreciate the semantic relationship between conditioned cues and their synonyms, merely the novelty of the probes could produce similar levels of arousal to both cues, and also a lack of discriminated avoidance. This variation in responses would most likely confound any attempt at identifying individual differences using trait questionnaires.

As already discussed in the general introduction chapter, during perceptual, conceptual, symbolic and semantic generalisation paradigms the generalised response is probed using novel stimuli which are related in some manner to the original conditioned cues. These relationships are usually overtly apparent from formal characteristics of the stimuli, or else the relations are previously established in training similar to that used during Experiment 1. In the semantic paradigms employed here however, pre-training was not used and instead the researcher relied on the pre-experimental fluency of the semantic relations, albeit based on the widely used databases of natural semantic relations. While this appears to have generally been the case, correlations between response rates and magnitudes and the questionnaire scores have struggled to reach statistical significance, perhaps due to the unreliability of the robust generalisation patterns.

Semantic generalisation can occur between two different stimuli which may or may not be related along readily discernible semantic continua. Perceptual generalisation on the other hand relies on very specific perceptual similarities between conditioned and probe stimuli to examine for adaptive generalisation, while symbolic generalisation focuses on generalizing along relations derived from combinations of previously established trained pairs. As such, the relationship between stimuli such as the words CRY and WEEP may be due to similarity in meaning. This is often a subtle process and derived or generalised relations may be weak and transitory. This is evidenced by the fact that semantically or symbolically generalised fear and avoidance is usually at lower rates than conditioned fear and avoidance and such generalisation is dependent on the nodal distance between the stimuli. Thus, the discrimination of semantic relations between probe and conditioned stimuli is already less than certain to produce generalisation and this discrimination. It is also more likely to be easily interfered with by the presentation of other verbal stimuli that may obscure any salient semantic relationships between a single pair from the stimulus array. In other words, the greater the number of additional stimuli non-equivalent to the CS+, the greater is the likelihood that a discrimination of the CS-GS equivalence relation will not be made. If this conjecture is correct, it is not surprising that the introduction of novel stimuli in this research was associated with a break down in orderly generalization of responding.

Experiment 5 sought to investigate the extent to which probe stimulus novelty per se produces confounding effects. That is, Experiment 5 asked the question; does the presence of a truly novel and semantically unrelated stimulus in the generalisation stimulus probe array produce significant SCRs and avoidance, or is it more likely to interfere with SCRs and avoidance of other semantically related probe cues? Answering this question is an important component of trying to understand why semantic generalisation of fear and avoidance does not correlate more clearly with anxiety-related questionnaire scores. Experiment 5 elaborated upon Experiment 3 by employing an unrelated novel cue word during the final probe phase, along with semantically related probe cues. As before, the three phases of the experiment involved the initial conditioning of the CS+ and CS- using shock as the US, the conditioning of the spacebar press as the available avoidance response with 100% contingency and the presentation of the probe cues without warning during Phase 2b. Dependent measures remained as before with SCR, avoidance, expectancy of the US and valence. However, the avoidance response returned to a single press of the spacebar to remove any ambiguity regarding the efficacy of the response. Experiment 5 explored whether the insertion of an unrelated novel probe cue during the critical probe phase within the semantic generalisation paradigm would reduce the overall levels of generalisation of the conditioned responses to the synonyms when compared to levels observed in Experiment 3

6.2 Method

6.2.1 Ethics

This procedure was approved by the Maynooth University research ethics committee prior to commencement and all health and safety procedures of that institution were observed in the use of all equipment.

6.2.2 Participants

During Experiment 3, a power analysis had identified that the projected sample size needed for very large generalisation effect size was approximately twenty-six participants in each group. Experiment 5 required only a single overall sample of participants and so an initial target of approximately twenty-six volunteers was established previous to any recruitment process. Ultimately however, only twenty-four unpaid participants were successfully recruited via word-of-mouth and a snowballing sampling method. During the post experimental analyses, participants who failed to attempt avoidance during 75% of the final 4 presentations of the CS+, or attempted avoidance on more than 25% of the final 4 presentations of the CS- during Phase 2 avoidance conditioning were deemed not to have conditioned successfully. By these criteria five participants; P6, P8, P12, P14 and P17 failed to demonstrate successful conditioning and were excluded from all subsequent analyses. The remaining cohort consisted of 19 volunteers (11 females) ranged in age from 19 to 22 years old (*M* = 20.62, *SD*=.824).

Participants were not screened formally for prior or current anxiety conditions but were carefully briefed as to the aversive nature of the experiment and advised to self-exclude if they had concerns regarding their suitability given a list of exclusion criteria including medical and psychological conditions (see Procedure).

6.2.3 Apparatus

All components and set up procedures were identical to those detailed in Experiment 3, with the exception of the inclusion of a novel stimulus (NS) during the final phase (see Table 6.1). The word which was selected as the novel stimulus (NS; APPLE) had in the previous experiment produced a very low level of fear when included in the ratings. Throughout the experiment, stimuli were presented pseudo-randomly ensuring no word was presented twice in succession and all stimuli were viewed in equal numbers. During the final phase, each probe stimulus had the equal probability of being presented as the first new cue and so any effects by first presentation e.g., orienting response, extinction) were likely averaged out across participants.

Table 6.1

Word Sets used as Conditioned Cues and Probes for Generalisation

	CS+	**CS-**	**GS+**	**GS-**	**NS**
SET1	CRY	ILL	WEEP	SICK	APPLE
SET2	ILL	CRY	SICK	WEEP	APPLE

6.2.4 Procedure

The procedure during Experiment 5 was a replication of that from Experiment 3 (see Chapter 4) with the exception of the inclusion of the novel stimulus (NS) in extinction along with the semantic synonyms of the CSs during the final probe phase (see Table 6.2).

Table 6.2

Trial Schedule detailing the Number of Stimulus Presentations of Each Cue during Each Phase

Stimulus	Fear Conditioning	Avoidance Conditioning	Probe Phase
CS+	6	10	4
CS-	6	10	4
GS+	NO	NO	4
GS-	NO	NO	4
NS	NO	NO	4

6.2.5 Dependent measures and analyses

Analyses were conducted to explore differences, with stimulus as the within-subject factor with 5 levels (CS+, CS-, GS+, GS- & NS), to examine both the conditioning of fear and avoidance and their generalisation. The dependent variables used as indicators of the effects were behavioural avoidance levels, levels of skin conductance responses (SCR) and reported expectancy and valence ratings.

Where parametric assumptions were violated, a nonparametric test was used. Differences between stimuli were subsequently examined using pairwise comparisons with a Bonferroni correction.

The interactions between all the dependent variables were examined (i.e., avoidance rates, SCR, US expectancies and valence ratings) as well as the relationships between them and the *post-hoc* questionnaire scores. For each of these relationships, we employed simple multiple models of regression to test whether individual or combined questionnaires best predicted levels of avoidance or any perceived threat. Due to the exploratory nature of the analyses between the dependent measures and the questionnaires, the use of a Bonferroni correction would reduce the power of the tests and would make the identification of any significant effects unlikely. As a result, significant correlations between the two groups of measures are reported without correction. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

6.3 Results

6.3.1 Avoidance

Planned comparisons were conducted to examine if apparent differences in avoidance response rates between the threat and safety cues (CS+ & CS-) and also the probes for generalisation (GS+ & GS-) were significant (see Figure 6.1). In Phase 2a conditioning a Wilcoxon Signed-Rank Test indicated that the rate of avoidance was higher for conditioned threat stimuli (CS+) than for conditioned safety stimuli (CS-) with a significant median (IQR) difference, $z(19)=-4.060$, $p < .001$, $r = .66$. During the Phase 2b probes, this difference in the rate of avoidance between the conditioned stimuli maintained, $z(19)=-3.943$, $p < .001$, $r = .64$. The difference in avoidance rates between the GS+ and the GS- stimuli was also statistically significant, *z*(19)=-2.232, p = .026, r = .36 but this failed to survive Bonferroni correction (p < .01). Similarly, while the difference in avoidance levels for the GS+ and the NS was initially significant, *z*(19)=-2.070, p = .038, r = .34, it failed to persist after correction. The difference in avoidance rates across the GS- and the NS was not significant, *z*(19)=-.447, p = .655, r = .07.

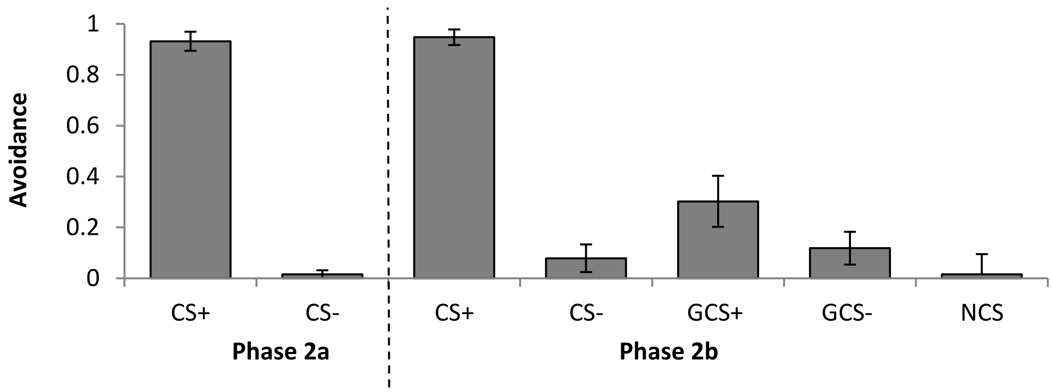

Figure 6.1. Percentage of avoidance responses to all stimuli during both Phase 2a avoidance conditioning and Phase 2b probes. Error bars represent standard error**.**

Spearman's correlational analyses were conducted to examine the relationship between actual levels of avoidance observed across specific stimulus pairs during the conditioning and probe phases and levels of generalised avoidance to the synonyms during the final probe phase. Correlations between rates of avoidance to the CS+ or CS- during the conditioning phase, and rates of avoidance to either generalisation cue during the probe phase were small and not statistically significant (GS+ r_s = -.017, .146; GS- r_s =-.266, .392, respectively). However, the correlation between levels of avoidance responding to the CS- and GS- cues during the probe phase was strong and positive, r_s = .524, n=19, p = .021. The correlation between avoidance to the CS+ and the GS+ in this final phase was small and not significant r_s = -.150, n=19, p > .05. Similar to that observed during Experiment 3, there was a very strong significant and positive correlation between avoidance to the GS+ and the GS- r_s = .644, n=19, p <0.01.

6.3.2 Skin Conductance

During Phase 2b probes, SCR levels were higher for conditioned threat stimuli (CS+) than for conditioned safety stimuli (CS-) during training (see Figure 6.2). A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference between recorded SCR levels in response to the CS+ and the CS- z(19)=-2.575, p = .01, r = .42. In line with the findings from both Experiment 3 and 4, the difference between arousal levels for the CS+ and GS+ was not significant, z(19)=-1.938, p = .053, r = .31, nor was the difference significant between the CS+ synonym and the CS-, z(19)=-2.032, p = .042, r = .33, following Bonferroni correction. The GS+ was also not significantly different in associated arousal levels from either of the GS- or the NS during the final probe phase. The lack of threat produced by the unrelated NS was evidenced by a significant difference in SCRs produced by the conditioned threat CS+ and the NS, z(19)=-2.656, p = .008, r = .43, but not between the CS- and NS-. These results indicate that while the conditioned stimuli were apparently discriminated in terms of threat levels, the relationship between the threat levels produced by the probed stimuli was considerably less that that observed for the conditioned stimuli. The homogeneity in skin conductance responsivity to the semantically related and unrelated novel probe stimuli is clearly visible in Figure 6.2, in which the GS-, NS and GS+ appear to share roughly comparable threat functions.

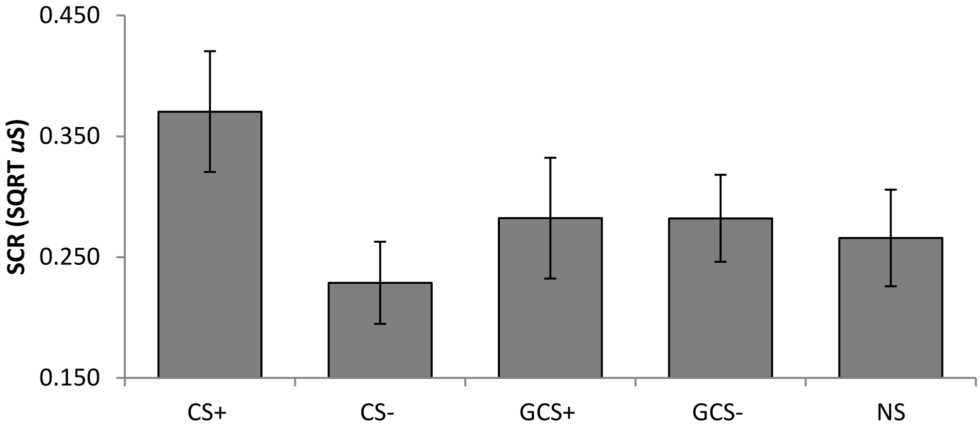

Figure 6.2. Square root transformed skin conductance responses to all stimuli during the final probe phase. Error bars represent standard error**.**

6.3.2.1 Avoidance and SCR

Spearman's correlational analyses were also conducted to examine the relationship between the rate of avoidance during the probe phase and the recorded SCR for each stimulus. No significant relationships were observed between avoidance and SCRs for any of the stimuli.

6.3.3 Expectancy

Differences between mean US expectancies for each of the stimuli, under the conditions of both a hypothetical avoidance response being made (*Press*) or not (*No Press*), was in line with the successful conditioning of the CS+ and CS- but, unlike during Experiment 3, there was no generalisation of this difference to the synonym cues (see Figure 6.3). Specifically, a Wilcoxon Signed-Rank Test indicated that the difference between the CS+ and CS- for recorded US expectancy levels if a hypothetical avoidance response was not made (*No Press*) was significant, $z(19)=-3.943$, $p < .001$, $r = .64$. The difference between mean GS+ and GS- expectancy levels was not significant under the same condition, $z(19)=-.272$, *p*

= .785, *r* = .04. Similarly, the difference in expectancies produced by the NS and the CS- was not significant in the case that a hypothetical response was not made, *Z*(19)=-.736, *p* = .461, *r* = .12, perhaps indicating a level of perceived safety for the novel cue. Differences between the probed synonyms of the conditioned stimuli and the CS- in the *No Press* condition were also not significant. Specifically, for the GS+ test values were *Z*(19)=-1.382, *p* > .05, *r* = .22 and for the GS- they were *Z*(19)=-1.706, *p* > .05, *r* = .28.   In the PRESS condition there were, as expected, no significant differences in expectancies between any of the SCRs produced by the stimuli.

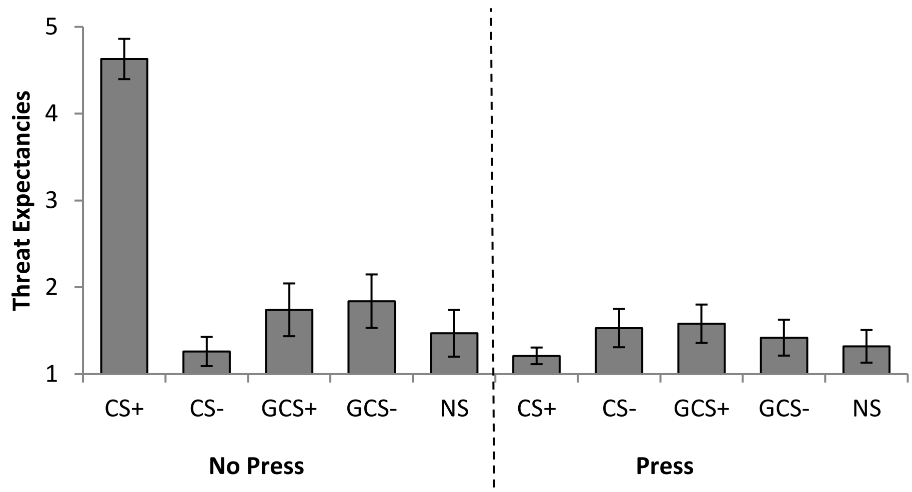

Figure 6.3. Mean US expectancy ratings following the appearance of each stimulus and in the case that an avoidance response hypothetically was (*Press*) or was not (*No Press*) made. Error bars represent standard error**.**

6.3.3.1 Expectancy and avoidance

Spearman's correlational analyses were conducted to examine the relationship between the rate of avoidance during the probe phase and the recorded US expectancy if an avoidance response had not been made (*No Press*) in the presence of a stimulus. No significant correlations were found between avoidance rates during the probe phase and the reported expectancy of the US if hypothetically the avoidance response had not been made for that cue, r_s = .186 (CS+); -.186 (CS-); .020 (GS+); .448 (GS-); .436 (NS), all $p > .05$.

Inter-correlations between all stimuli indicated that avoidance response rates to the CS+ correlated strongly with US expectancy ratings in the case of not making an avoidance response to the NS, $r_s = -.597$, $p = .007$. Furthermore, avoidance to the NS correlated strongly with the expectancy of a shock if a hypothetical avoidance response was not made to the GS-, $r_s = .581$, $p = .009$. Neither of these results persisted after Bonferroni correction ($p = .002$) and no other significant relationships were observed.

6.3.3.2 Expectancy and SCR

Spearman's correlational analyses were also conducted to examine the relationship between the SCR levels during the probe phase and the recorded US expectancy if an avoidance response had not been made in the presence of a stimulus. No significant relationships were observed.

6.3.4 Semantically Related Stimulus Fear Ratings

Participants recorded their estimated levels of semantically related fear immediately before (Time1) and after (Time2) the conditioning and probe phases (see Figure 6.4). Wilcoxon Signed-Rank Tests indicated that at Time 1 there was no significant difference between mean levels of semantically related fear between the CS+ and the CS-, $z(19) = -1.213$, $p > .05$, $r = .20$. Significant differences were present however, between levels of semantically related fear for the NS and both conditioned cues; CS+, $z(19) = -2.980$ and CS-, $z(19) = -2.724$, both $ps < .01$, suggesting that the unrelated probe word was non-threatening.

Post-test the CS+ cue demonstrated a significant increase in levels of associated semantically related fear, $z(19) = -2.745$, $p = .006$, $r = .45$. As expected, this increase in stimulus fear ratings was not present for either the CS-, $z(19) = -1.809$, $p = .07$, $r = 29$. or the NS, $z(19) = -1.289$, $p = .197$, $r = .21$. Successful conditioning was also supported by a significant difference between the fear ratings for the CS+ and the CS- at Time2, $z(19) = -3.279$, $p < .01$, $r = .53$. However, there was no evidence of a difference in semantically related fear attributions between the generalisation cues at Time2, which suggest that generalisation effects were weak to non-existent using this measure. This contrasted with the support this measure had provided to the observed generalisation effect during Experiment 3.

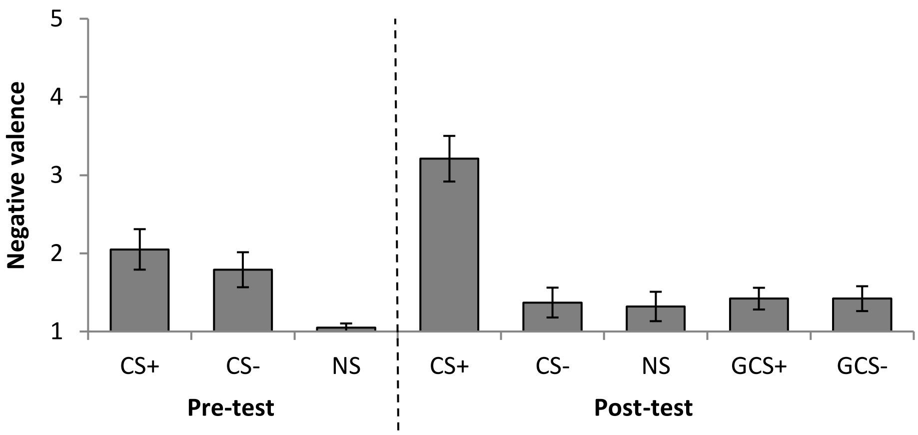

Figure 6.4. Mean stimulus ratings of semantically related fear for all stimuli taken pre (*Time1*) and post (*Time2*) computer task. Error bars represent standard error.

Inter-correlations for each individual stimulus, between rates of avoidance and semantically related fear levels were strong and significant for all stimuli, except the CS-: CS+ $r_s = .552$, $p = .014$; GS+ $r_s = .540$, $p = .017$; GS- $r_s = .510$, $p = 0.026$ and the NS $r_s = .788$, $p < .001$. Post-test fear ratings for the NS correlated strongly and significantly with avoidance to all probed stimuli during the final phase while NS avoidance correlated strongly and significantly with valence ratings for both the generalised stimuli. This pattern seems to indicate a homogenising of the effects of all probe stimuli.

GS- avoidance rates also correlated significantly with semantically related fear levels for all stimuli, except the CS- : CS+ $r_s = .476$, $p = .040$; GS+ $r_s = .693$, $p = .001$; GS- $r_s = .510$, $p = 0.026$ and the NS $r_s = .859$, $p = .001$. However only the relationships between GS- levels of avoidance and both the GS+ and the NS remained significant after Bonferroni correction. Overall the generalisation of avoidance appears to correspond to raised levels of semantically related stimulus fear ratings for probes in the final phase. In contrast, there were no significant correlations between SCRs and mean semantically related stimulus fear ratings for any of the stimuli during the probe phase.

6.3.5 Questionnaires

There were medium to strong significant correlations between scores on a number of various questionnaires (see Table 6.3). However, despite their strong correlation preliminary analyses indicated that, provided the STAI-S and STAI-T were not combined in the same multiple model, there was no violation of the multicollinearity assumption in our multiple or hierarchical regression models. In order to provide the most comprehensive analyses, during examination of the data, separate exploratory models were constructed using either the STAI-T or STAI-S. The model with the best predictive ability was then reported. No manipulation or centralisation of questionnaire scores was undertaken before their inclusion in any of the regression models.

Table 6.3

Summary of Correlations between Scores on Individual Trait, Personality and Experiential Avoidance Measures

	STAI-S	STAI-T	AAQ	BEAQ	EPQ-N	EPQ-P	EPQ-E	PSWQ
STAI-S	1							
STAI-T	**.644****	1						
AAQ	**.511***	**.791****	1					
BEAQ	-.302	-.252	**-.521***	1				
EPQ-N	**.502***	**.730****	**.738****	-.113	1			
EPQ-P	-.168	-.423	**-.474***	.223	**-.476***	1		
EPQ-E	-.163	-.204	-.334	.240	-.303	.234	1	
PSWQ	.399	**.737****	**.673****	-.185	**.806****	**-.502***	-.241	1
IUS	**.502***	**.544***	**.784****	-.337	**.769****	**-.583****	-.216	**.692****

*Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

6.3.5.1 Questionnaires and avoidance

Questionnaires were examined both individually and in combined regression models to discover their predictive utility for levels of conditioned and generalised avoidance. Simple regression analyses were initially undertaken to indicate the unique contribution of individual trait measures in the variability of levels of avoidance for conditioned stimuli and their synonyms. During Phase 2a, none of the questionnaires provided a significant level of predictive utility in levels of avoidance to either the CS+ or the CS-. During the final probes (Phase 2b) they also only marginally predicted avoidance levels. However, the IUS did account for a significant 23.3% of the variance in GS+ avoidance, R^2= .233, $F(1,18)$=5.164, p = .036 and 35.8% of avoidance to the NS R^2= .358, $F(1,18)$=9.493, p =.007 (see

Table 6.4). The IUS also predicted 18.6% of generalised avoidance to the GS- stimulus R^2= .186, F(1,18)=3.895, p = .065. The AAQ (24.6%) and EPQ-N (29.1%) both predicted significant levels of avoidance to the NS.

Table 6.4

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in Predicting Rates of Avoidance during the Final Probe Phase

Avoidance	**CS+**	**CS-**	**NS**	**GS+**	**GS-**
	R^2 *(p)*	R^2*(p)*	R^2*(p)*	R^2*(p)*	R^2*(p)*
STAI-S	.003(.833)	.007(.741)	.008(.718)	.016(.611)	.001(.915)
STAI-T	.019(.578)	.045(.381)	.105(.176)	.039(.419)	.009(.698)
AAQ	.003(.837)	.009(.696)	**.246*(.031)**	.181(.069)	.027(505)
BEAQ	.171(.079)	.121(.145)	.007(.737)	.073(.263)	.010(.677)
EPQ-N	.000(.971)	.107(.172)	**.291*(.017)**	.160(.090)	.115(.155)
EPQ-P	.000(.938)	.086(.224)	.125(.137)	.177(.073)	.080(.240)
EPQ-E	.036(.436)	.060(.313)	.000(.976)	.154(.097)	.008(.716)
PSWQ	.003(.817)	.118(.149)	.174(.076)	.162(.088)	.170(.080)
IUS	.000(.996)	.075(.255)	**.358**(.007)**	**.233*(.036)**	.186(.065)

*Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

To examine the overall contribution of the combined questionnaires in the variability of avoidance levels simple multiple regression analyses were undertaken on models which consisted of all tests combined excluding the STAI-S. The total combined model of all the examined questionnaires (STAI-T, AAQ, BEAQ, EPQ-P, EPQ-N, EPQ-E, PSWQ & IUS) failed to significantly predict avoidance levels to any of the cues during either conditioning or probe trials. Substituting the STAI-T with the STAI-S failed to improve the predictability of the model for all stimuli.

When the interaction between all the tests was examined in relation to levels of avoidance, those scales which provided the greatest R^2 change within that model for each stimulus were combined into a separate regression model to identify the most parsimonious predictor of both conditioned and generalised avoidance. Combining the AAQ, EPQ-N, BEAQ, EPQ-E and IUS provided the most parsimonious model during the conditioning and probe phases. While the model accounted for good levels level of avoidance variability for all stimuli during both the conditioning and probe phases, none of the levels improved on the total combined models or were significant at the alpha level.

6.3.5.2 Questionnaires and skin conductance

Questionnaires were examined both individually and in combined models to discover their predictive utility for levels of arousal during the probe phase. Simple regression analyses were initially undertaken to indicate the unique contribution of individual trait measures in predicting SCR levels for conditioned stimuli and their synonyms during the final probe phase. The EPQ-P provided the most notable correlation with SCRs during the probe phase for the CS+ (R^2= .375, p = .005) and the GS- (R^2= .278, p = .02).

To examine the overall contribution of the combined questionnaires to the variability in SCR, simple multiple regression analyses were undertaken on a model which consisted of all tests. While the total model in relation to the levels of avoidance contained the STAI-T, preliminary analyses revealed that the model with the strongest predictive ability for SCRs contained the STAI-S. The total combined model of scores did not significantly predict SCR levels to any of the stimuli, during any of the phases. Substituting the STAI-T for the STAI-S reduced the overall predictability of this model.

When the interaction between all the tests in each model was examined in relation to levels of SCR, those scales which provided the greatest R^2 change within that model for each stimulus were combined into separate models to identify the most parsimonious predictor of both conditioned and generalised arousal. Combining the EPQ-P, EPQ-N, PSWQ and STAI-S into a hierarchical regression model provided the most parsimonious predictor of arousal levels during the probe phase. This model (see Table 6.5) produced a significant level of predictive utility for SCRs in response to the CS+ during the final phase, R^2= .476, F(4,14)=3.179, p = .047. It also accounted for 41.3% of the variability in arousal to the GS- during Phase 2a avoidance conditioning, R^2= .413, F(4,14)=2.465, p =.093.

Table 6.5

Summary of Hierarchical Regression Analyses examining the Contribution of the Best Combined Model of Questionnaires in the Variability of SCR during the Probe Phase

SCR	Independent Variables	R^2	p	ΔR^2	F for ΔR^2	B
CS+	Step 1: EPQ-P	**.375****	**.005**	.375	10.190	.612
	Step 2: EPQ-N	**.388***	**.020**	.013	.351	.132
	Step 3: PSWQ	**.449***	**.027**	.061	1.652	.428
	Step 4: STAI-S	**.476***	**.047**	.027	.723	.191
CS-	Step 1: EPQ-P	.003	.830	.003	.048	.053
	Step 2: EPQ-N	.004	.972	.001	.013	.032
	Step 3: PSWQ	.081	.725	.078	1.272	.484
	Step 4: STAI-S	.167	.604	.085	1.435	.339
GS+	Step 1: EPQ-P	.007	.739	.007	.115	.082
	Step 2: EPQ-N	.007	.947	.000	.000	.006
	Step 3: PSWQ	.249	.219	.242	4.836	.854
	Step 4: STAI-S	.263	.335	.014	.273	.139
GS-	Step 1: EPQ-P	**.278***	**.020**	.278	6.542	.527
	Step 2: EPQ-N	.302	.056	.024	.551	.176
	Step 3: PSWQ	.355	.079	.053	1.243	.401
	Step 4: STAI-S	.413	.093	.058	1.383	.280

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

6.3.5.3 Questionnaires and Expectancy

Similar simple regression analyses also indicated the unique contribution of individual trait measures in predicting recorded stimulus fear ratings if hypothetical avoidance responses had or had not been made in response to conditioned stimuli (see Table 6.6). Most of the individual questionnaires failed to provide a level of predictive utility in the self -reported expectancy of the US whether an avoidance response was hypothetically made or not.

Table 6.6.

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in predicting the variability of US Expectancy Ratings if a Hypothetical Avoidance Response had (Press) or had not (No Press) been made

Expectanc	**CS+**		**CS**		NS		**GS+**		**GS-**	
	Pres	*No*	*Pres*	*No*	*Pres*	*No*	*Pres*	*No*	*Pres*	*No*
	R^2		R^2		R^2		R^2		R^2	
STAI-S	.004	.108	.001	.00	.029	.01	.010	.095	.010	.008
STAI-T	.006	.149	.064	.01	.000	.00	.012	.000	.019	**.225***
AAQ	.005	.119	.138	.03	.000	.00	.070	.030	.004	**.292***
BEAQ	.002	.126	.016	.00	.070	.03	.083	**.363****	.006	.001
EPQ-N	.010	**.235**	.161	.01	.024	.00	.087	.000	.013	**.427****
EPQ-P	.010	.001	**.229**	.06	.004	.04	.085	.000	.003	.055
EPQ-E	.113	.116	.006	.08	.109	.04	.000	.098	.143	.065
PSWQ	.017	**.295**	.128	.05	.005	.00	.060	.004	.001	.170
IUS	.011	.144	**.257**	.04	.115	.00	.200	.010	.076	.176

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

The EPQ-N displayed respectable levels of predictive utility for US expectancy if the avoidance response was not made to the CS+, R^2= .235, *p* = .036 and the GS-, R^2= .235 *p* = .044. US expectancies for the GS-, in the case of *No Press,* were also significantly predicted by the STAI-T, R^2= .225, *p* = .040 and the AAQ, R^2= .292, *p* =.017. The BEAQ accounted for 36.3% of variability in the GS+ *No Press* expectancy condition, R^2= .363, *p* = .006, while the PSWQ accounted for a significant 29.5% of variability in the CS+ *No Press* condition, R^2= .295, *p* = .016. Finally, only the EPQ-P significantly predicted US expectancy in the *Press* condition and then it only for the CS-, R^2= .229, $F(1,17)$=5.056, $p < .038$.

A total combined multiple regression model was assembled using all of the available questionnaires. This model provided high, but not statistically significant levels of predictive utility for the CS+ (67.2%) and GS- (63.0%) if an avoidance response was not given. In the *Press* condition, the total combined model provided raised but not significant levels of predictive utility for all stimuli. Substituting the STAI-S for the STAI-T did not improve levels of predictive utility for the model.

When the interaction between all the tests in each model was examined in relation to expectancy levels, those scales which provided the greatest R^2 change within that model for each stimulus were combined into a separate model to identify the most parsimonious predictor of the post hoc expectancy ratings. Despite its parsimony however none of the stimulus ratings were significantly predicted by this model (EPQ-P, BEAQ, IUS & AAQ).

6.3.5.4 Questionnaires and Stimulus Fear Ratings

Simple regression analyses were conducted to examine the unique contribution of individual trait measures in predicting recorded valence ratings for all words used as stimuli as well as a novel word not used during the computer-based trials. The BEAQ displayed predictive utility for levels of semantically related fear towards the CS+ (R^2= .216, p = .045) and EPQ-E also did so to a greater extent for the GS+ (R^2= .368, p = .006). Overall results, however, failed to identify a successful level of predictive ability for any of the questionnaires combined together in a single model (see Table 6.7).

Table 6.7

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in predicting the variability of Semantically Related Stimulus fear ratings taken Pre and Post Conditioning and Probe Phases

Valence	**CS+**		**CS-**		**Novel**		**GS+**	**GS-**
	Pre	Post	Pre	Post	Pre	Post	Post	Post
	R^2	R^2	R^2	R^2	R^2	R^2	R^2	R^2
STAI-S	.039	.043	.044	.001	.020	.003	.002	.001
STAI-T	.000	.006	.100	.012	.046	.019	.004	.005
AAQ	.021	.051	.041	.035	.041	.005	.095	.008
BEAQ	.021	**.216***	.015	.000	.010	.000	.009	.027
EPQ-N	.003	.055	.014	.079	.139	.024	.066	.014
EPQ-P	.090	.029	.006	.014	.133	.174	.033	.004
EPQ-E	.124	.000	.015	.003	.000	.067	**.368****	.002
PSWQ	.063	.135	.012	.002	.011	.060	.067	.051
IUS	.018	.102	.018	.047	.052	.021	.066	.046
Total Model	.379	.479	.551	.213	.433	.358	.530	.196

* Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

6.4 Discussion

The evidence provided by all of the threat related measures in Experiment 5, indicated that the introduction of a novel and unrelated probe during the final phase did indeed interfere with levels of generalisation but not the conditioned response. This experiment was a replication of Experiment 3, albeit with the addition of the single novel stimulus during the probe phase. In all other respects the procedure used across the two experiments was identical. Thus, a comparison of data from the earlier study helped to identify the level of interference produced by the inclusion of a novel and semantically unrelated probe stimulus.

In Experiment 5, the inter-stimulus difference in levels of conditioned avoidance persisted from Phase 2a conditioning to Phase 2b probes and corroborated the successful conditioning of the cues. The difference in rates of avoidance between the GS+ and GS- probes, which would indicate generalisation, were initially significant but did not persist post Bonferroni correction. In contrast, for Experiment 3, while the inter-stimulus difference during conditioning between the CSs maintained during the final probes, a level of generalisation was observed between the GS+ and the GS- which survived correction for multiple comparisons.

During the probe phase of the current experiment, the expected inter-stimulus SCR difference between the CS+ and the CS- was present and significant. Unfortunately, there was no significant SCR difference between the CS- and either the GS+, GS- or NS cues. This indicated a lack of discriminated threat generalisation between the CS+ and the probe cues. In contrast, generalisation of arousal during Experiment 3 was demonstrated by the significant difference between SCRs for the GS+ and the GS- and was further corroborated by the lack of a significant SCR difference in magnitude between the CS+ and its related synonym (GS+).

No Press expectancy ratings, in both Experiment 3 and Experiment 5, corroborated the successful conditioning of the CS+ and CS- and also the efficacy of the avoidance response in cancelling the CS+. However in Experiment 5, there was no evidence of any threat generalisation, with non-significant differences in US expectancy ratings between the CS- and any of the probed stimuli in both conditions. In contrast however, Experiment 3 probes evidenced significant differences between the GS+ and both the GS- and the CS- in the *No Press* condition.

Valence ratings taken post-test in the current study also corroborated the successful conditioning of the CSs, with a significant valence difference found between the CS+ and CS-. However, much like as demonstrated in the *No Press* expectancy ratings, there were no significant differences between valence ratings for the CS- and any of the GS-, GS+ or the NS cues. In contrast, Experiment 3 had previously identified significant differences across semantically related cues in the post-test ratings.

In relation to the specific predictive utility of personality traits, only the *EPQ-P* individually and the best combined model (EPQ-P, EPQ-N, PSWQ and STAI-S) produced significant levels of predictive ability for conditioned and generalised SCRs. In a result similar to that recorded during Experiment 3, the IUS demonstrated significant individual predictive utility for levels of avoidance responding to the GS+. The IUS, as well as the AAQ and the EPQ-N, individually demonstrated significant predictive utility for avoidance to the NS. While in the *No Press* condition, individual questionnaire scores from the EPQ-N (CS+), PSWQ (CS+), BEAQ (GS+), STAI-T (GS-), AAQ (GS-) and EPQ-N (GS-), significantly predicted cue-related US expectancy ratings. In the *Press* condition, only the EPQ-

P and IUS demonstrated any significant utility and both only for the CS-. While a number of correlations were uncovered, due to the lack of observed generalisation in Experiment 5, the relationship between the IUS and GS+ avoidance was the only original significant correlation from Experiment 3 to re-emerge during the current experiment.

Comparisons between the Experiment 5 and Experiment 3 results supported the hypothesis that the insertion of a novel unrelated stimulus during the probe phase would decrease the threat discriminability between the semantically related cues. At the same time however, the inter-relations between stimuli and the different dependent measures indicated that generalisation did occur across all measures for some participants. For example, there was a strong positive correlation between CS+ and GS+ avoidance identified in Phase 2b. GS+ avoidance was also at a significantly greater rate, than the level of observed avoidance for the CS-. In line with the other studies in this thesis, a strong significant correlation was also found between levels of GS+ and GS- avoidance. In addition, levels of generalised avoidance strongly correlated with semantically related stimulus fear ratings for all of the probed stimuli. Unfortunately however, the lack of variability in threat related arousal across the probe stimuli ensured none of the correlations between either levels of generalised avoidance and SCRs, or between SCRs and questionnaires were significant.

This experiment and the body of work detailed to date in this thesis, has demonstrated clear semantic generalisation effects which can significantly correlate with the questionnaires under some conditions. While the phenomenon does appear to attenuate with the inclusion of unrelated stimuli during the probe phases, it is still apparent with more interrogative analyses and with varying dependent measures. However, it cannot be denied that the number of possible confounds, identified in this research programme, push the hope of predicting generalised avoidance behaviour and SCRs using commonly used anxiety-related questionnaires, even further from reach. Any hope then, may perhaps be garnered from the examination of the conditioned responses and their relationship with questionnaires. Across the semantic generalisation experiments detailed so far in this thesis, significant correlations between individual or combinations of questionnaires and levels of CS+ and CS- related avoidance and arousal have been identified. For example, the STAI and the AAQ have accounted for a significant level of the variability in CS+ avoidance, during both Experiment 2b and Experiment 4. Additionally, during Experiments 2b, 3 and 4 the best models of questionnaires have provided significant levels of predictive utility in relation to CS- avoidance during the conditioning phase. The best models have also successfully demonstrated a significant level of predictive utility in CS+ related SCR arousal across both fear and avoidance conditioning phases for Experiments 2b, 3, 4 and 5, while the EPQ-P has been significantly correlated with SCRs for the CS+ during avoidance conditioning in both Experiment 4 and Experiment 5. From these results, it is apparent that in the semantic generalisation paradigm, during generalisation there are sufficient confounding variables to interfere with the effect, to the degree that it interferes with the identification of individual differences.

As already described, the generalisation of fear related behaviours suffers from interference due to a number of possible procedurally based effects. For example, the initial use of aversive images and sounds as the US during Experiments 1 and 2a was replaced subsequently with cutaneous shock, in an attempt to increase the aversiveness of the US. This, it was hoped, would promote more reliable levels of generalisation due to an increased level of avoidance motivation provided by the more extreme US. Whether through any habituation, as possibly demonstrated during Experiment 4, or possibly due to the participants initially selecting a level of stimulation during the work up procedure which was individually tolerable rather than aversive, manipulating the US failed to improve on levels of observed generalisation across the experiments. Another possible confound already discussed, was that for semantic generalisation to occur, participants are required to successfully identify the relations between the conditioned word cues and their synonyms, without any further information being available. Either, through a lack of appreciation of the salience of the novel cues or perhaps a lack of bias towards generalisation, a substantial cohort of participants have repeatedly over the studies failed to generalise a condition threat from a word to its synonym. Given this level of interference, it is reasonable to assume that any correlations observed between the conditioned stimuli and the questionnaires would be unlikely to then generalise successfully.

Despite any inherent or inserted procedural interferences (e.g., high-cost avoidance response or non-related probes), successive experiments have however, identified a cohort of the participants who reliably show levels of generalisation. Indeed, within this group there are even a cohort of generalisers who reliably overgeneralise to all of the probe stimuli. This behaviour has been repeatedly identified by significant correlations between levels of GS- and GS+ avoidance, across all of the studies to date. This evidence indicates that, for a subset of the participant sample, the generalisation effect is rather robust. By focusing on this group, rather than the sample as a whole, the examination of the paper and pencil tests may indicate individual differences in the behaviour, more similar to those observed for participants who had successfully conditioned to the CS+. In other words, by focusing on this group for whom the insertion of the novel stimulus did not interfere with their generalised responses, future studies investigating the relationship between trait and generalisation behaviour may perhaps be more successful identifying any between-group difference for generalisers and non-generalisers.

Experiment 6 sought to discriminate between generalisers and those less likely to do so, by elaborating on the interference provided during Experiment 5 by introduction of the novel stimulus. By inserting additional cues and thus extending the semantic network of novel probes, it was hoped to identify individuals with perhaps a raised probability of generalisation.

Rather than unrelated novel stimuli, the novel probes took the form of antonyms i.e., words meaning the opposite to the CS words, and it was hoped that their semantic relationship would also highlight any differences in the generalisation behaviour within the group. In other words, would some generalisers do so along the semantic relationship between words and their antonyms i.e., in opposition and derive a level of threat from safety and vice versa. Or alternatively, would they generalise to the antonym merely due to its class membership i.e., because it is related to the CS and the synonym. By focusing on the behaviour of generalisers, it was hoped to improve on the very low levels of predictive utility for the questionnaires in relation to the generalisation of fear and avoidance behaviour observed in the research programme to date.

Chapter 7

Experiment 6: The effect of increasing stimulus network complexity on semantic generalisation of fear and avoidance.

Experiment 6: The effect of increasing stimulus network complexity on semantic generalisation of fear and avoidance.

In the previous experiment the introduction of a novel stimulus during the probe phase resulted in a reduced level of generalisation across all four dependent measures when compared to that previously recorded in Experiment 3 for example. In addition, significant differences between the GS+ and GS- observed during Experiment 3 for SCR arousal levels, expectancy and valence ratings also failed to materialise during Experiment 5. Despite this reduction in generalised fear and avoidance, it is important to recognise that the semantic generalisation of avoidance effect was observed for a large number of participants. The series of experiments detailed in this thesis have repeatedly revealed that a large percentage of individuals commonly demonstrate the generalisation of avoidance, SCRs, expectancy and semantically related stimulus fear ratings along a naturally occurring semantic relationship involving words and their synonyms. In effect, there appears to be a subset of each participant cohort for whom the effect is rather robust, even despite factors that appear to diminish the generalisation effects on the whole. Identifying this cohort of 'generalisers' using paper and pencil tests, however has remained a challenge.

Throughout this experimental programme, the number of participants who have not demonstrated generalised avoidance to the synonyms of the conditioned cues is consistently slightly larger than the number that do. There could be a number of possible reasons why generalisation may have not occurred such poor stimulus control within the experiment e.g., poorly conducted conditioning, poor stimulus salience or merely a lack of appreciation by participants of the semantic relationship between the conditioned and probed stimuli. Alternatively, or possibly additionally, variations in levels of generalisation between participants may be due to individual differences in their propensity to generalise, as has been suspected and pursued as a possibility from the outset of this research. This idea is supported by the observation that even under conditions that make generalisation less likely (e.g. presence of novel unrelated stimuli during the probe phase), there is always a cohort that shows robust generalisation.

There may be an experimental means by which to identify the cohort of generalisers. Specifically, by pursuing manipulations that make generalising avoidance even more unlikely, the cohort may titrate down to identify that smaller subset who persist in demonstrating generalisation of fear and avoidance. This subset may indeed be identifiable by paper and pencil tests, once they have been segregated from those participants for whom generalisation is easily undermined by minor procedural modifications. In effect, it may be a worthwhile strategy to consciously attempt to find the boundary conditions for the generalisation effect, while paying special attention to those increasingly fewer participants for whom boundary conditions are not easily met for the generalisation phenomenon. An obvious starting point for such an investigation is to increase further the number of stimuli presented during the probe phase, and to introduce even more complex relations between the trained CSs and their semantically related probe stimuli.

Specifically, Experiment 6 aimed to elaborate on the semantic network used thus far by adding antonyms, as well as synonyms to the CSs during the probe phase. It is not immediately apparent how participants will respond to antonyms of the CSs, insofar as they are both related to the CS, but relationally they may acquire an opposing response function by virtue of the process involved in the derived transformation of response functions. For example, if the CS+ cue is the word CRY and its antonym SMILE is used as a probe for generalisation, participants may show generalisation on the basis of the relationship between the two words. Specifically, they are related through a relation of semantic oppositeness and, as a natural feature, both also are labels for emotional states. In this manner, the use of natural language cues attempted to demonstrate for the first time, a more ecologically valid examination of the contextual control that the same and opposite relations provide in the generalisation of avoidance, than that demonstrated in the stimulus equivalence studies detailed in Chapter 1 (e.g. Bennett et. al. 2015a; Dymond et al., 2007).

The primary aim of Experiment 6 was to explore whether the insertion of additional cues i.e., antonyms of the CSs during the probe phase, would titrate levels of generalisation which would identify a cohort of generalisers who's levels of fear and avoidance would correlate significantly with scores on commonly used behavioural trait questionnaires'. By eliminating from the sample under analysis those individuals failing to show generalisation for reasons other than inherent or acquired personal traits it was hoped that the remaining generalisers could be identified by use of the questionnaire scores. While the range of avoidance rates may be small within a cohort of generalisers, at least the cohort under analysis will not contain individuals for whom generalisation was not demonstrated but which in turn consists of both "genuine" (i.e., trait-based) non-generalisers and confounded non-generalisers (i.e., based on poor stimulus control, etc.). To this end the paradigm used in Experiment 6, was drawn from that used in Experiment 6. A novel stimulus was again introduced during probes for generalisation, but also antonym of both the CS+ and CS- cues, rendering the probe phase considerably more complex than has been used to date in the examination of semantically related generalisation. .

As before the three phases of the experiment involved the initial conditioning of the CS+ and CS- using shock as the US, the conditioning of the spacebar press as the available avoidance response with 100% contingency, and the presentation of the probe cues without warning during Phase 2b. Dependent measures remained as before with SCR, avoidance, expectancy of the US and valence, with the avoidance response remaining a single press of the spacebar and so remove any avoidance related ambiguity. Firstly, it was expected that the presentation of a novel unrelated stimulus, along with other semantically related probes (i.e., synonyms and antonyms), will reduce the rates of generalisation compared to that observed during Experiment 6, but that single-subject effects will still be apparent for some of the participants. Secondly, it was expected that the generalisation rates of generalisers, who fulfil the basic criteria for generalisation, will correlate with scores on the trait questionnaires.

7.2 Method

7.2.1 Ethics

This procedure was approved by the Maynooth University research ethics committee prior to commencement and all health and safety procedures of that institution were observed in the use of all equipment.

7.2.2 Participants

Similar to the rationale of Experiment 5 regarding the projected sample size required for a very large generalisation effect size and also mindful of the number of participants subsequently excluded from the final analysis, twenty-nine unpaid participants were recruited via word-of-mouth and a snowballing sampling method. During the post experimental analyses, participants who failed to attempt avoidance for 75% of the final 4 presentations of the CS+ or attempted avoidance for more than 25% of the final 4 presentations of the CS- during Phase 2 avoidance conditioning were deemed not to have conditioned successfully. By these criteria six participants; 3, 12, 15, 20, 22 and 28 failed to demonstrate successful conditioning and were excluded from all subsequent statistical analyses. The remaining 23 volunteers (11 females) ranged in age from 18 to 41 years old (*M* = 20.04, *SD*=4.753).

Participants were not screened formally for prior or current anxiety conditions but were carefully briefed as to the aversive nature of the experiment and advised to self-exclude if they had concerns regarding their suitability given a list of exclusion criteria including medical and psychological conditions (see Procedure).

7.2.3 Apparatus

All components and set up procedures were identical to those detailed in Experiment 3 and elaborated upon in Experiment 5, which included the novel unrelated probe stimulus. In Experiment 6, (see Table 7.1) the set of conditioning and probed stimuli comprised of two English words (ILL & WEEP) and a synonym and antonym of each (i.e., SICK/HEALTHY & CRY/SMILE), as well as the novel stimulus (APPLE).

Table 7.1

Word Sets used as Conditioned Cues and Probes for Generalisation

	CS+	**CS-**	**GS+**	**GS-**	**ACS+**	**ACS-**	**NS**
SET1	CRY	ILL	WEEP	SICK	SMILE	HEALTHY	APPLE
SET2	ILL	CRY	SICK	WEEP	SICK	WEEP	APPLE

7.2.4 Procedure

The procedure during Experiment 6 was a replication of that from Experiment 3 (see Chapter 4), with the exception of the inclusion of the novel stimulus (NS) in extinction from Experiment 5, and the inclusion of novel semantic antonyms of the CSs during the final probe phase (see Table 7.2).

Table 7.2

Trial Schedule detailing the Number of Stimulus presentations of Each Cue during Each Phase

Stimulus	Phase 1	Phase 2a	Phase 2b
CS+	6	10	3
CS-	6	10	3
GS+	NO	NO	3
GS-	NO	NO	3
ACS+	NO	NO	3
ACS-	NO	NO	3
NCS	NO	NO	3

7.2.5 Dependent measures and analyses

Analyses were conducted to explore differences, with stimulus as the within-subject factor with 7 levels (CS+, CS-, GS+, GS-, ACS+, ACS- & NCS), to examine both the conditioning of fear and avoidance and their generalisation. The dependent variables used as indicators of the effects were behavioural avoidance levels, levels of skin conductance responses (SCR) and reported expectancy and valence ratings. Where parametric assumptions were violated, a nonparametric test was used. Differences between stimuli were subsequently examined using pairwise comparisons with a Bonferroni correction.

The interactions between all of the dependent variables were examined (i.e., avoidance rates, SCR, US expectancies and valence ratings) as well as the relationships between them and the *post-hoc* questionnaire scores. For each of these relationships, we employed simple multiple models of regression to test whether individual or combined questionnaires best predicted levels of avoidance or any perceived threat. Bonferroni adjustments were undertaken only when pairwise comparisons were calculated between the dependent measures. Due to the exploratory nature of the analyses between the dependent measures and the questionnaires, the use of a Bonferroni correction would reduce the power of the tests and would make the identification of any significant effects unlikely. As a result, significant correlations between the two groups of measures are reported without correction. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

7.3 Results

7.3.1 Avoidance

Planned comparisons were conducted to examine if the apparent differences in avoidance response rates between the threat and safety cues (CS+ & CS-) and also the probes for generalisation (GS+/GS- & ACS+/ACS-), were significant (see Figure 7.1). In Phase 2a conditioning a Wilcoxon Signed-Rank Test indicated that the rate of avoidance was higher for conditioned threat stimuli (CS+) than for conditioned safety stimuli (CS-) with a significant median (IQR) difference, $z(23)=-4.412$, $p < .001$, $r = .65$. During the Phase 2b probes, this difference in rates of avoidance between the conditioned stimuli was maintained, $z(23)=-4.564$, $p < .001$, $r = .67$. The difference in avoidance rates between the GS+ and the GS- stimuli was also statistically significant, $z(23)=-2.570$, $p = .01$, $r = .38$ and remained so after Bonferroni correction ($p < .0125$). The difference between avoidance levels for the antonyms (ACS+& ACS-) was not significant, $z(23)=-.447$, $p = .655$, $r = .07$.

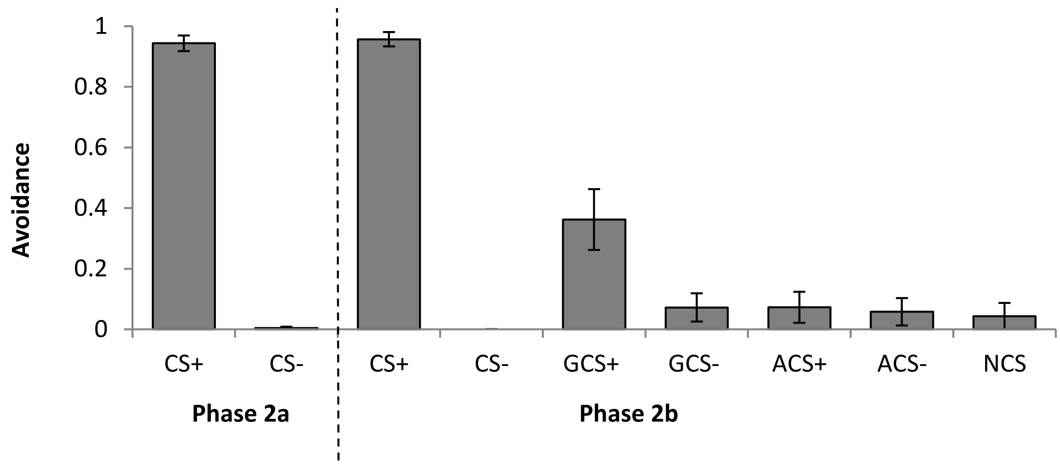

Figure 7.1. Percentage of avoidance responses to all stimuli during both Phase 2a avoidance conditioning and Phase 2b probes. Error bars represent standard error**.**

Spearman's correlational analyses were also conducted to examine the relationship between levels of avoidance across specific stimulus pairs. There were no significant correlations between levels of avoidance for the CS+ or CS- during either the conditioning Phase 2a or the probe Phase 2b and any of the probed stimuli.

Dividing the participants based on their generalisation of the avoidance response to the GS+ indicated that only those who generalised to the synonym of the CS+ did so for the other probed stimuli (see Figure 7.2). In other words, those who did not show generalised avoidance to the GS+ also did not do so for any of the other probed stimuli. This result was supported by a number of strong significant correlations between rates of avoidance among the probed stimuli. Specifically, avoidance to the GS- correlated strongly with avoidance rates to both the ACS-, $r_s = .817$, $p < .001$ and the NCS, $r_s = .604$, $p = .002$. In addition, avoidance of the NCS correlated strongly with that for both the ACS+, $r_s = .723$, $p < .001$ and the ACS- $r_s = .723$, $p < .001$. Finally, a strong correlation was found between avoidance rates to the ACS+ and the ACS-, $r_s = .500$, $p = .015$, however this failed to remain significant after Bonferroni correction (p= .002).

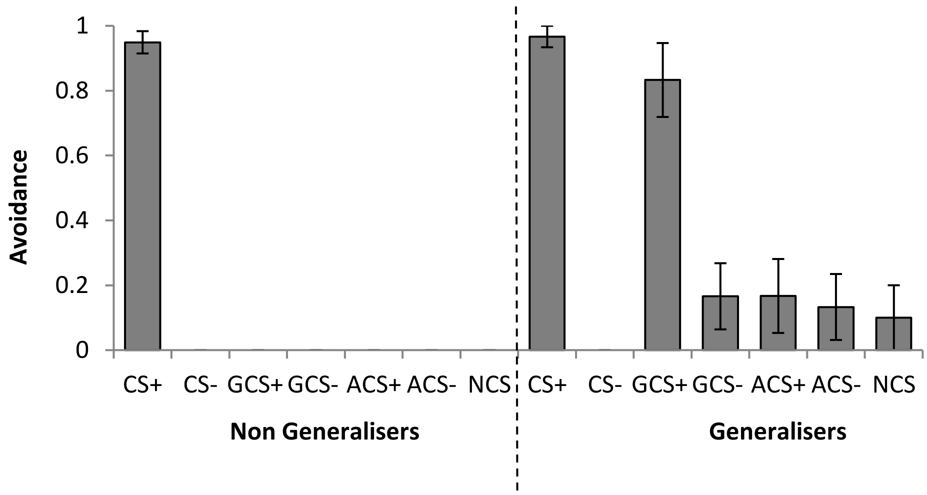

Figure 7.2. Percentage of avoidance responses to all stimuli during Phase 2b probes for those who generalised to the GS+ and those who did not. Error bars represent standard error**.**

7.3.2 Skin Conductance

Skin conductance response levels were recorded by calculating both the baseline i.e., *u*S (microsiemens) level at the time of presentation and the maximum skin conductance level within a 5 second period subsequent to each presentation. The difference between these two values (or zero if the response was negative), was recorded as the individual raw SCR for each trial. For each participant, mean raw values were calculated for the CS+, CS-, GS+, GS-, ACS+, ACS- and NCS stimuli across all presentations and then square-root transformed prior to any subsequent analyses. Figure 7.3 shows the mean transformed value in *u*S for each cue during each phase.

During Phase 1, SCR levels for all participants were higher for conditioned threat stimuli (CS+) than for conditioned safety stimuli (CS-) during training. A Wilcoxon Signed-Rank Test indicated that there was a significant median (IQR) difference between recorded SCR levels in response to the CS+ and the CS-, $z(23)=-2.220$, $p = .026$, $r = .33$. This inter stimulus difference between the CS+ and the CS- maintained during Phase 2a avoidance conditioning despite the 100% contingency of a successful avoidance response in cancelling the shock, $z(23)=-3.406$, $p = .001$, $r = .50$. Similarly, during Phase 2b probes, the median difference between the conditioned stimuli (i.e., CS+/CS-) was significant, $z(23)=-3.880$, $p < .001$, $r = .57$. There was no significant difference between SCR levels for either the GS+/GS- or the ACS+/ACS- relationships, $z(23)=-.782$ and -.730 respectively, both $p > 0.05$. There was also no significant difference between the NCS and the CS- which indicated a lack of perceived threat for the novel cue $z(23)=-.795$, $p = .426$, $r = .12$. This perceived safety of the novel stimulus is supported by the observation that a significant difference in SCRs between the conditioned threat cue and the NCS cue, $z(23)=-3.442$, $p = .001$, $r = .51$.

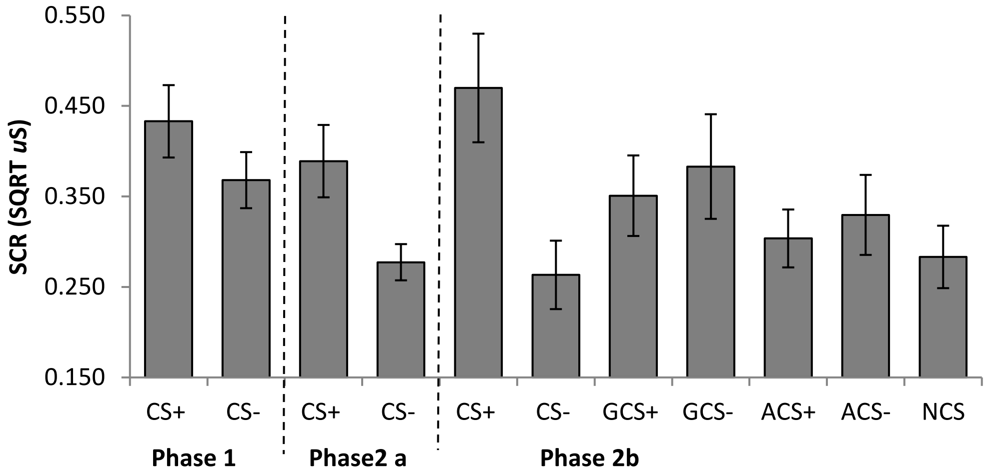

Figure 7.3. Square root transformed skin conductance responses to all stimuli during all phases. Error bars represent standard error**.**

7.3.2.1 Avoidance and SCR

Spearman's correlational analyses were conducted to examine the relationship between the rate of avoidance during the probe phase and the recorded SCR for each stimulus. Only for the GS-, however, was a significant relationship between stimulus avoidance rates and SCRs found, r_s = .443, n=23, p = .034. In the analyses which examined the inter-relations between stimuli with regard to rates of avoidance and levels of SCR the only significant correlation observed was between ACS+ arousal and avoidance to the GS+ (r_s = .528, p = .01). However, neither of these results persisted after Bonferroni correction (p = .001).

The relationship between avoidance and arousal levels becomes clearer if those who showed generalised avoidance to the GS+ (n=13) are separated from the 'non-generalisers' (n=10). Specifically, a one way between-groups multivariate analysis of variance (MANOVA) was performed to investigate differences in generalisation between the two groups in relation to SCR levels for each stimulus. The generalisation of threat indicated by GS+ avoidance was supported by a statistically significant difference in arousal levels between *Generalisers* and *Non-Generalisers*, $F(7,21)=3.651$, $p = .014$, eta squared = .63. Post-hoc comparisons between the groups, however, failed to identify any significant differences in SCR levels for any specific cue during either the Phase 2a avoidance conditioning or Phase 2b probes for generalisation. Further examination however, indicated that there was a significant difference in arousal levels between the groups regarding the relationship between SCRs to the conditioned safety stimulus CS- and the probed stimuli (see Figure 7.4). More specifically, for *Non-Generalisers* there were no significant differences between the SCR levels for the CS- and any of the probed stimuli, excluding the CS+. For *Generalisers*, however, SCR levels for the CS- were significantly less than those recorded for the GS+, $z(10)=-2.666$, $p = .008$, $r = .60$, the GS-, $z(10)=-2.599$, $p = .009$, $r = .58$, the ACS+ $z(10)=-2.701$, $p = .007$, $r = .60$ and the NCS, $z(10)=-2.090$, $p = .037$, $r = .47$. Across the probe stimuli, there was a lack of significant inter-stimulus difference in SCRs. In effect, while responses were of greater magnitude to these stimuli than they were for *Non-Generalisers*, they were not different to each other.

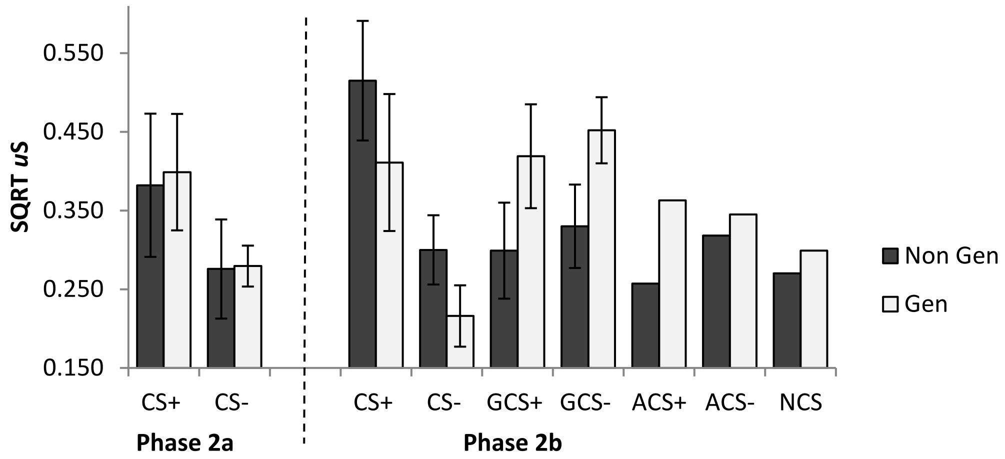

Figure 7.4. Square root transformed skin conductance responses to all stimuli for those who showed generalised avoidance to the GS+ (Gen) and those who did not (Non Gen) during Phase 2a (avoidance conditioning) and Phase 2b (final probe phase). Error bars represent standard error**.**

7.3.3 Expectancy

Differences between mean US expectancies for each of the stimuli, under the conditions of both an avoidance response hypothetically being made (*Press*) or not (*No Press*), supported the successful conditioning of the original cues but not any level of generalisation between their synonyms (see Figure 7.5). A Wilcoxon Signed-Rank Test indicated that the difference between the CS+ and CS- for recorded US expectancy levels if a hypothetical avoidance response was not made was significant, $z(21)=-4.583$, $p < .001$, $r = .71$. The difference between mean GS+ and GS- expectancy levels was significant under the same condition, $z(22)=-2.232$, $p = .026$, $r = .34$ but failed to persist after Bonferroni correction (p < .013). The difference between the antonyms (ACS+ & ACS-) was not significant if the response was hypothetically not made, $z(22)=-1.342$, $p = .180$, $r = .20$. An analysis of the relationships between the US expectancies for the conditioned safety stimulus and each of the probed cues, should the hypothetical avoidance response not be made, indicated that only the expectancy difference between the CS-and the GS+ was significant $z(22)=-2.232$, $p = .026$, $r = .34$. In the *PRESS* condition there were no significant differences for expectancies for any of the conditioned or probed stimuli.

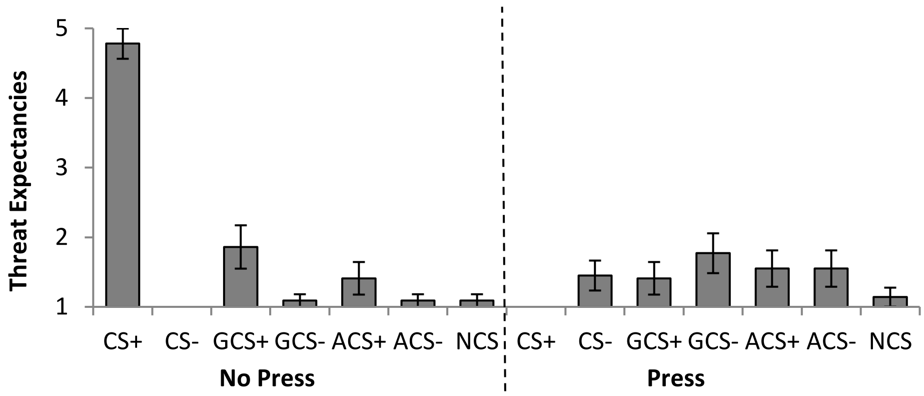

Figure 7.5. Mean US expectancy ratings for each stimulus and in the case that an avoidance response hypothetically was (*Press*) or was not (*No Press*) made. Error bars represent standard error**.**

7.3.3.1 Expectancy and avoidance

Spearman's correlational analyses were conducted to examine the relationship between the rate of avoidance during the probe phase and the recorded US expectancy if an avoidance response had not been made (*No Press*) in the presence of a stimulus. Curiously, only for the probed stimuli, rather than the conditioned stimuli, were significant correlations between avoidance rates and expectancies found, under the condition that the avoidance response had not been made, GS+ $r_s = .854$; GS- $r_s = .606$; ACS+ $r_s = .789$; ACS- $r_s = .724$; NCS $r_s = 1.000$, all $p < .01$.

Inter-correlations between all stimuli indicated that, the generalisation of avoidance to the GS+ corresponded with the generalisation of threat expectancy to the other probe stimuli (see Figure 7.6). For example, ACS+ avoidance strongly correlated with expectancy ratings for hypothetically not avoiding the GS+, GS-, ACS- and the NCS (r_s = .479, .724, .724, .724 respectively, all $p < .01$). Similarly, those who avoided the NCS also perceived a threat for the GS-, ACS+ and ACS- cues.

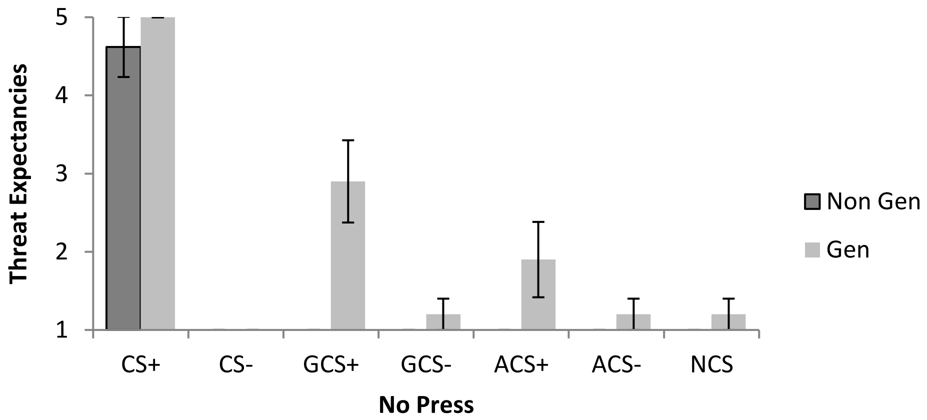

Figure 7.6. Mean US expectancy ratings for those who showed generalised avoidance to the GS+ (Gen) and those who did not (Non Gen) following the appearance of each stimulus and in the case that an avoidance response hypothetically was not (*No Press*) made. Error bars represent standard error**.**

7.3.3.2 Expectancy and SCR

Spearman's correlational analyses were also conducted to examine the relationship between the SCR levels during the probe phase and the recorded US expectancy if an avoidance response had not been made in the presence of a stimulus. No significant relationships were observed.

7.3.4 Semantically Related Stimulus Fear Ratings

Participants reported their levels of appreciated semantically related fear immediately before (*Time1*) and after (*Time2*) the conditioning and probe phases. Figure 7.7 shows the mean level of semantically related fear attributed to each of the cues at the beginning, and towards the end of the experiment. Wilcoxon Signed-Rank Tests indicated that at *Time 1*, there was no difference between mean levels of semantically related fear between the CS+ and the CS-. A significant difference was present at *Time1*, however, in levels of semantic fear between the NCS and the prospective CS+, $z = -2.236$, $p = .025$, $r = .33$, but not the prospective CS- cue, $z = -1.890$, $p = .059$, $r = .28$.

The CS+ cue was associated with a significant increase in levels of semantic fear between *Time1* and *Time2*, $z(22) = -3.552$, $p < .001$, $r = .54$, which was not present for either the CS-, $z(22) = -.962$, $p = .336$, $r = .15$, or the NCS $z(22) = .000$, $p = 1.0$. Successful conditioning was also supported by a significant difference between the CS+ and the CS- at Time2, $z(22) = -3.879$, $p < .001$, $r = .59$. Generalisation between the conditioned cues and their synonyms was indicated by significant differences in levels of reported semantically related fear between the GS+ and the GS-, $z(22) = -2.388$, $p = .017$, $r = .36$. There were no significant differences between levels of semantic fear for either the ACS+/ACS- or the CS-/NCS-. Indeed, among the probe stimuli, the only significant difference in expectancy ratings was between the CS- and the GS+, $z(22) = -2.090$, $p = .037$, $r = .32$.

Separating the participants based on their avoidance behaviour in response to the GS+ (i.e., into *Generalisers* and *Non-Generalisers*), did not interfere with the overall semantically related fear ratings for all stimuli, with the exception of the GS+. In other words, post-hoc there was a very low level of rated fear attributed to any of the probed stimuli, apart from the GS+, in which case the rating was related to whether a participant had generalised or not across any of the other dependent measures.

The overall lack of variability in both CS- avoidance rates and probe valence ratings appeared to have compromised correlational analyses between avoidance rates and valence ratings. However, there was a strong significant correlation between the generalisation of avoidance to the GS+ and semantically related fear levels for the cue, $r_s = .639$, $p < .001$.

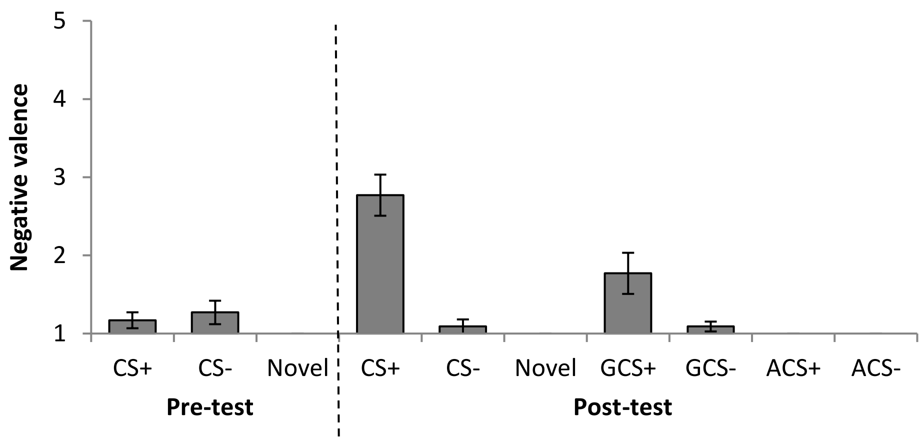

Figure 7.7. Mean stimulus ratings of semantically related fear for all stimuli taken pre (*Time1*) and post (*Time2*) conditioning. Error bars represent standard error.

7.3.5 Questionnaires

There were medium to strong significant correlations between scores on a number of various questionnaires (see Table 7.3). However, despite their strong correlation, preliminary analyses indicated that, provided the STAI-S, STAI-T and the PSWQ were not combined in the same multiple model there was no violation of the multicollinearity assumption in our multiple or hierarchical regression models. As a result, all possible models were initially constructed each including only one of the three tests, with the strongest combined model overall was then reported in the text.

Table 7.3

Summary of Correlations between Scores on Individual Trait, Personality and Experiential Avoidance Measures

	STAI-S	STAI-T	AAQ	BEAQ	EPQ-N	EPQ-P	EPQ-E	PSWQ
STAI-S	1							
STAI-T	**.858****	1						
AAQ	**.759****	**.737****	1					
BEAQ	**.491***	**.588****	**.731****	1				
EPQ-N	**.642****	**.799****	**.741****	**.713***	1			
EPQ-P	**-.482***	**-.493***	-.403	-.153	-.305	1		
EPQ-E	**-.550***	-.469	-.220	.045	-.158	.169	1	
PSWQ	**.767****	**.896****	**.803****	**.633****	**.903****	-.334	-.198	1
IUS	**.736****	**.683****	**.789****	**.661****	**.652****	-.325	-.172	**.682****

*Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

A one way between groups multivariate analysis of variance (MANOVA) was performed to investigate differences in questionnaire scores between the *Generalisers* and *Non-Generalisers*. There was no statistically significant difference in scores between those who showed GS+ avoidance generalisation and those who did not, $F(9,7)=.816$, $p=.621$, eta squared = .51. As a result, regression analyses examined the relationships between individual or combined models of questionnaires and the total sample of participants.

7.3.5.1 Questionnaires and avoidance

Questionnaires were examined both individually and in combined regression models to discover their predictive ability for levels of conditioned and generalised avoidance. Simple regression analyses were initially undertaken to indicate the unique contribution of individual trait measures in predicting levels of avoidance for conditioned stimuli and their synonyms. During Phase 2a, none of the questionnaires provided a significant level of predictive ability in levels of avoidance to either of the conditioned cues. During the final probes (Phase 2b) they also struggled to predict avoidance levels, however the AAQ did account for a significant 18.8% of the variance in ACS- avoidance R^2= .188, F(1,20)=4.622, p=0.044 (see Table 7.4). The PSWQ predicted 19.3% of avoidance to the CS+ R^2= .193, F(1,20)=4.797, p=0.041.

Separating the total sample of participants into *Generalisers* and *Non-Generalisers* produced a lack of variability in rates of avoidance which subsequently interfered with the exploratory regression analyses. As a result, a series of exploratory Spearman correlations were conducted, to attempt in the identification of any significant relationships between the questionnaires and rates of avoidance from both phases. For Generalisers, there was only a significant correlation between AAQ scores and rates of GS+ avoidance during the probe phase, r_s = .710, n=9, p = .032. For *Non-Generalisers*, no significant correlations were discovered.

Table 7.4

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in predicting Rates of Avoidance during the Probe Phase

Avoidance	**CS+**	**CS-**	**GS+**	**GS-**	**ACS+**	**ACS-**	**NCS**
	R^2	R^2	R^2	R^2	R^2	R^2	R^2
STAI-S	.141	-	.012	.003	.002	.003	.000
STAI-T	.108	-	.025	.023	.022	.023	.014
AAQ	.170	-	.062	.206	.064	**.188***	.114
BEAQ	.080	-	.048	.087	.033	.074	.025
EPQ-N	.142	-	.044	.043	.010	.014	.002
EPQ-P	.034	-	.044	.004	.034	.004	.002
EPQ-E	.121	-	.034	.006	.000	.000	.008
PSWQ	**.193***	-	.036	.037	.023	.015	.003
IUS	.112	-	.017	.103	.003	.058	.014

*Correlation is significant at the 0.05 level (2-tailed)

To examine the overall contribution of the combined questionnaires in the variability of avoidance levels, simple multiple regression analyses were undertaken on models which consisted of all tests combined. Separating the overall sample into cohorts based on any generalisation to the CS+ failed improve on the overall predictive utility of the model. After examining models which included either the STAI-S, STAI-T or the PSWQ, the best total combined model of all the examined questionnaires (STAI-T, AAQ, BEAQ, EPQ-P,EPQ-N,EPQ-E & IUS) failed to significantly predict avoidance levels to any of the cues during either conditioning or probe trials.

When the interaction between all the tests was examined in relation to levels of avoidance, those scales which provided the greatest R^2 change within that model for each stimulus were combined into a separate regression model to identify the most parsimonious predictor of both conditioned and generalised avoidance. Combining the AAQ, EPQ-N, EPQ-P and the STAI-T provided the most parsimonious model during the probe phase. While the model accounted for good levels of avoidance variability for all stimuli during both the conditioning and probe phases, none of the levels improved on the total combined models or were significant at the $p<.05$ alpha level. Separating the overall sample into the respective *Generalisers* and *Non-Generalisers* cohorts did not improve the predictive utility of the model.

7.3.5.2 Questionnaires and skin conductance

Questionnaires were examined, using simple regression analyses, both individually and in combined models, to discover their predictive ability for levels of arousal during the probe phase. During Phase 1 and Phase 2a the EPQ-N was the only questionnaire to provide a significant level of predictive ability and only for the CS+ SCR arousal levels during avoidance conditioning, $R^2= .230$, $F(1,17)=4.775$, $p = .044$. Table 7.5 summarises the simple regression analyses relating to the final probe phase.

Table 7.5

Summary of Simple Regression Analyses indicating the Unique Contribution of Individual Trait Measures in predicting the variability of SCRs during the Probe Phase for the Total Sample of Participants

SCR	**CS+**	**CS-**	**GS+**	**GS-**	**ACS+**	**ACS-**	**NCS**
	R^2	R^2	R^2	R^2	R^2	R^2	R^2
STAI-S	.085	.058	.054	.028	.001	.019	.031
STAI-T	.072	.048	.125	.060	.057	.047	.063
AAQ	.178	.077	.174	.139	.120	.103	.078
BEAQ	**.268***	**.211***	.094	.141	.141	.157	.077
EPQ-N	.185	.089	.200	.209	.129	.186	.116
EPQ-P	.039	.005	.059	.003	.004	.006	.051
EPQ-E	.026	.001	.001	.003	.002	.010	.005
PSWQ	.055	.029	.104	.070	.036	.068	.050
IUS	**.240***	.154	.169	.160	.075	.092	.127

* Correlation is significant at the 0.05 level (2-tailed)

The BEAQ provided the most notable result with medium strength levels of predictive ability of the variability in SCR arousal for the CS+, R^2= .268, $F(1,20)=7.330$, $p = .041$ and the CS-, R^2= .211, $F(1,20)=5.343$, $p = 0.032$. The IUS was also significant in relation to CS+ SCR levels during the probe phase, R^2= .240, $F(1,20)=6.319$, $p = .021$.

When separated between *Generalisers* and *Non-Generalisers*, during the probe phase none of the results remained significant for the *Generalisers*. For *Non-Generalisers* however, the significant levels of SCR predictive utility provided by the BEAQ remained for the CS+, R^2= .586, $p = .002$ and the CS-, R^2= .386, $p = .023$, and was also significant for the GS+, R^2= .328, $p = .041$ and the GS-, R^2= .329, $p = .040$. The IUS remained significant in relation to CS+ SCRs, R^2= .463, $p = .010$. Novel significant findings were found in relation to GS+ SCRs for the STAI-S, R^2= .330, STAI-T R^2= .451, EPQ-N R^2= .372 and the AAQ R^2=.368, all *ps* < .05. In effect, these questionnaires improved in predictive utility when applied only to the non-generalising participants.

To examine the overall contribution of the combined questionnaires to the variability in SCR in the overall sample of participants, simple multiple regression analyses were undertaken on a model which consisted of all tests excluding the STAI-S and the STAI-T. The total combined model of all the examined questionnaires (AAQ, BEAQ, EPQ-P,EPQ-N,EPQ-E, IUS & PSWQ) did not significantly predict SCR levels to any of the stimuli the during any of the trials. Substituting the STAI –T or the STAI-S for the PSWQ reduced the overall predictive ability of this model. Separating the overall sample into the respective *Generalisers* and *Non-Generalisers* cohorts did not improve the predictive utility of the model.

When the interaction between all the tests in each model was examined in relation to levels of SCR, those scales which provided the greatest R^2 change within that model for each stimulus were combined into separate models to identify the most parsimonious predictor of both conditioned and generalised arousal. Combining the PSWQ, EPQ-N and IUS into a single hierarchical regression model, provided the most parsimonious predictor of arousal levels. Despite not doing so during Phase 1, the model successfully demonstrated a significant degree of predictive utility for SCRs for both the CS+, R^2= .449, $F(3,14)$= 3.798, p = .035, and the CS-, R^2= .581, $F(3,14)$= 6.471, p = .006, during Phase 2a. When separated into their respective avoidance generalisation cohorts, only the correlation between the *Non-Generalisers'* SCRs and the model remained significant, R^2= .683, $F(3,14)$= 5.020, p = .036.

During the Probe Phase (see Table 7.6), within the overall sample of participants the model provided for a significant level of predictive ability for SCR levels in response to the GS+ during the final phase, R^2= .485, $F(3,14)=4.398$, p = .022. It also accounted for 44.1% of the variability in arousal to the GS-, R^2= .441, $F(3,14)=3.682$, p = .038.

Table 7.6

Summary of Hierarchical Regression Analyses examining the Contribution of the Best Combined Model of Questionnaires in the variability of SCRs during the Probe Phase for the Total Sample of Participants

SCR	Independent Variables	R^2	p	ΔR^2	F for	B
CS+	Step 1: PSWQ	.113	.173	.113	2.034	.336
	Step 2: EPQ-N	.200	.188	.087	1.627	.686
	Step 3: IUS	.361	.090	.161	3.537	.597
CS-	Step 1: PSWQ	.024	.541	.024	.391	.154
	Step 2: EPQ-N	.161	.268	.137	2.456	.863
	Step 3: IUS	.240	.265	.079	1.450	.417
GS+	Step 1: PSWQ	.166	.093	.166	3.188	.408
	Step 2: EPQ-N	.200	.187	.034	.638	.430
	Step 3: IUS	**.485***	**.022**	.285	7.751	.793
GS-	Step 1: PSWQ	.091	.223	.091	1.605	.302
	Step 2: EPQ-N	.277	.088	.185	3.846	1.003
	Step 3: IUS	**.441***	**.038**	.164	4.118	.602
ACS+	Step 1: PSWQ	.040	.427	.040	.664	.200
	Step 2: EPQ-N	.212	.167	.172	3.284	.967
	Step 3: IUS	.321	.133	.109	2.239	.489
ACS-	Step 1: PSWQ	.082	.250	.082	1.427	.286
	Step 2: EPQ-N	.244	.123	.162	3.215	.938
	Step 3: IUS	.334	.117	.090	1.901	.447
NCS	Step 1: PSWQ	.051	.367	.051	.864	.226
	Step 2: EPQ-N	.152	.292	.100	1.774	.738
	Step 3: IUS	.270	.207	.119	2.276	.512

* Correlation is significant at the 0.05 level (2-tailed)

When separated into their respective avoidance generalisation cohorts, none of the correlations between SCRs and questionnaires were significant for either *Generalisers* or *Non-Generalisers*.

7.3.5.3 Questionnaires and Expectancy

Similar regression analyses also indicated the unique contribution of individual trait measures in predicting recorded stimulus fear ratings if hypothetical avoidance responses had or had not been made in response to conditioned stimuli. Most of the individual questionnaires failed to provide a level of predictive ability in the self -reported expectancy of the US whether an avoidance response was hypothetically made or not. The BEAQ provided a significant level of predictive ability in the expectancy of a shock if the avoidance response was given to the GS+ stimulus, R^2= .216, $F(1,19)$=5.242, p = .034. *No Press* expectancy to the CS+ stimulus was also significantly predicted by the STAI-S, STAI-T and the EPQ-E, R^2= .250, .275 & .224 respectively (all $p < .05$).

Separating the total sample of participants into *Generalisers* and *Non-Generalisers* produced a lack of variability in US expectancy ratings which subsequently interfered with the exploratory regression analyses. As a result, a series of exploratory Spearman correlations were conducted, to attempt in the identification of any significant relationships between the questionnaires and US expectancy ratings from both phases. For *Generalisers*, there was only a significant correlation between STAI-S scores and US expectancy ratings for the CS- in the *Press* condition, r_s = -725, n=9, p = .027. For *Non-Generalisers*, the observed variability in individual responses across the probe ratings, provided a number of significant correlations in the *Press* condition. For example, PSWQ scores significantly correlated with the GS+ (r_s = .443), GS- (r_s = .443), ACS+ (r_s = .443) and ACS- (r_s = .443), all p < .05. The BEAQ scores also correlated with the GS+ (r_s = .640), ACS+ (r_s = .640) and ACS- (r_s = .640), all p < .05. Finally, the AAQ scores correlated significantly with US expectancy ratings for the GS- for the *Press* condition, r_s = .443, n = 12, p = .028. Expectancy ratings in the event that a hypothetical response had not been made i.e., *No Press*, failed to correlate significantly for either *Generalisers* or *Non-Generalisers* across all of the questionnaire scores.

A total combined multiple regression model was assembled using all of the available questionnaires excluding the STAI-S and the PSWQ. This model provided raised but not statistically significant levels of predictive ability for the only the CS+ (63.0%) if an avoidance response was not given. In the *Press* condition the total combined model also provided raised but not significant levels of predictive ability for all stimuli except the CS+ stimulus. Substituting the STAI-T with the STAI-S or the PSWQ failed to improve the predictive ability of the model for all stimuli.

When the interaction between all the tests were examined in relation to expectancy levels, those scales which provided the greatest R^2 change within the model for each stimulus were combined into a separate model to identify the most parsimonious predictor of the post hoc expectancy ratings. Despite its parsimony, only ratings in the *No Press* condition for the CS+ were significantly predicted by this model R^2= .531, F(4,13)=3.402, p = .044.

7.3.5.4 Questionnaires and Stimulus Fear Ratings

Simple regression analyses were conducted to examine the unique contribution of individual trait measures in predicting recorded valence ratings for all words used as stimuli. Overall results failed to identify a successful level of predictive ability for any of the questionnaires, either individually or combined together in a single model, in relation to any level of semantically related fear for each word.

Separating the total sample of participants into *Generalisers* and *Non-Generalisers* produced a lack of variability in valence ratings which subsequently interfered with the exploratory regression analyses. As a result, a series of exploratory Spearman correlations were conducted, to attempt in the identification of any significant relationships between the questionnaires and valence rates from both Time1 and Time2. For Generalisers, there was only a significant correlation between BEAQ scores and ratings for the GS- post-test, $r_s = -.725$, n=9, $p = .027$. For *Non-Generalisers*, there were significant correlations between ratings for the CS- pre-test and scores on both the BEAQ scores and the IUS, $r_s = -.642$ and -.585 respectively, n=12, both $ps < .05$.

7.3.6 Summary of results

The successful conditioning of the CSs, was supported by significant differences in recorded levels of avoidance between the CS+ and the CS- during both Phase 2a and 2b. Any subsequent generalisation of threat was then evidenced by a significant difference between rates of avoidance to the GS+ and the GS-, but not between the ACS+ and ACS-. Dividing the cohort of participants, depending on their avoidance responding or not to the GS+, highlighted that, for those who did not generalise to the CS+, they also did not do so for any of the other probed stimuli. In other words, levels of avoidance responding correlated significantly and strongly across the probe stimuli. Recorded levels of SCRs throughout all three phases, also supported the successful conditioning of the CS+ and CS- cues. During the final probe phase however, generalisation between the CSs and any of the probe cues was not supported by SCRs. Separating the cohorts as before, identified significant differences between *Generalisers* and *Non-Generalisers* in their respective relationships between CS- related SCRs and those for the probe stimuli. More specifically, for *Generalisers*, there were significantly greater magnitudes in SCRs for the probe stimuli than for the CS-, indicating a greater threat appreciation by participants. In contrast, for *Non-Generalisers*, SCRs to the CS- were not significantly different to any of those observed for the probe stimuli. Similarly, for US expectancy ratings, significant differences between the ratings recorded for the probe stimuli only emerged when participants were divided into their respective GS+ avoidance groups. To elaborate, in the *No Press* condition, while the difference in ratings for the CS+ and the CS- were significant for the sample overall, only when participant cohorts were separated were differences between the GS+ and GS-, as well as the ACS+ and ACS-, significant and then, only for *Generalisers*. Significant differences between cue related fear ratings, taken at the end of the experiment, supported both the successful conditioning of the stimuli and the generalised threat or safety related characteristics of the GS+ and GS-, however, no significant difference in ratings were identified between the ACS+ and ACS-.

While the evidence provided by the dependent measures supported different generalisation behaviours among the separated groups, there were no between-group differences across scores for any of the questionnaires. When examined individually, only the AAQ (ACS-) and the PSWQ (CS+, phase 2b) provided scores with significant levels of predictive utility for rates of avoidance. Separating the sample, by GS+ generalisation or not, provided only a single correlation between rates of GS+ avoidance and (AAQ) scores, and only for *Generalisers*. For SCRs, the EPQ-N score significantly contributed to the variability within Phase 1 CS+ arousal levels. While none of the questionnaire scores individually provided any predictive utility for Phase 2a SCRs, during the Probe phase, scores from the BEAQ and IUS were significantly correlated with levels of arousal, but for the conditioned stimuli (CS+ & CS-) only. When the groups were separated, the variability of the responses among *Non-Generalisers*, and not as expected *Generalisers,* provided the only significant levels of individual predictive utility for a number of the questionnaires (i.e., BEAQ, IUS, STAI-S, EPQ-N, STAI-T & AAQ). Combining the most effective questionnaires into the best model (PSWQ, EPQ-N & IUS) accounted for a significant level of variability of SCRs for both the GS+ and GS- stimuli. However, when the groups were separated, there were no significant correlations for either *Generalisers* of *Non-Generalisers* between arousal levels and questionnaire scores, for any of the stimuli. For US expectancies, individually, only the BEAQ was significantly predictive of ratings in the *Press* condition and only for the GS+. In the *No Press* condition, the STAI-T, STAI-S, EPQ-E and the best combined model (STAI-T, EPQ-N, EPQ-P & AAQ), accounted for significant levels of variation in the ratings of US expectancy for the CS+. No other questionnaire scores, or combinations of scores, provided any significant level of predictive ability in US expectancies, either from the complete sample, or when divided into separate generalisation cohorts. Any variability in semantic fear ratings was not significantly accounted for by either the individual questionnaire scores, or the total combined model. However, when separated, *Generalisers'* BEAQ (GS-) scores and *Non-Generalisers'* BEAQ and IUS scores (both CS- pre-test) provided a significant level of predictive utility in valence ratings.

7.4 Discussion

During Experiment 6, and in line with the other semantic generalisation experiments to date, the generalisation of threat between the CS+ and the GS+ was indicated by significantly higher levels of attempted avoidance to the synonym of the conditioned threat cue, than synonym of the safety cue. This paralleled significant differences, between the GS+ and the GS- in relation to post hoc levels of appreciated negative valance. This generalisation, however, was not supported by mean levels of SCR or the expectancy of receiving a shock should the hypothetical response not be made. In an effect similar to the results from Experiment 5, for these two measures, the introduction of the additional probe stimuli appeared to interfere with the generalisation of the threat between the conditioned cues and their related probes. This may explain the very low level of generalised avoidance responding and a lack of significant differences between cues for all of the probe stimuli, excluding with the GS+. The lack of significant differences between levels of avoidance to the ACS+, or the ACS-, and the NCS may also indicate poor discrimination of the relationship between these and the CS+ and CS-. This effect was also apparent from the SCR and expectancy data. As hypothesised, however separating generalisers from the non-generalisers based on avoidance rates increased the levels of correlation and differences across the dependent measures. Specifically, those participants who did not show generalisation for the GS+, also made no attempt to do so for any of the other probed stimuli. Only those who showed generalisation to the GS+ did so for any of the other non-aversively related stimuli during the probe phase. This basic trend was noted in the previous experiments in this thesis and may be thought of as an over-generalisation.

Until now, this over-generalisation was attributed to participant error, or possibly, poor stimulus control within the experimental design. This now appears to be a misinterpretation. It appears that, rather than treating generalisation as an adaptive behaviour, as the number of stimuli that are potentially threatening is increased it becomes more economical to treat all stimuli, except the unambiguous CS+ and CS-, as threatening. This cohort of *Generalisers*, which has possibly been titrated down through the addition of a range of possibly-related probe stimuli, so reliably demonstrate the behaviour that it perhaps makes them more susceptible to over-generalisation. While this over-generalisation effect was observed in the previous chapter for the NS, it was also reported here for the cue and also for the ACS+ and ACS- for many participants. Regardless of the underlying causes, overall there appears to be poor discrimination of these stimuli as being differentially threatening, despite significantly more threat being exhibited for all probe stimuli combined for *Generalisers* compared to *Non-Generalisers*.

The initial examination of the SCR results also revealed more meaningful correlations and response differences, when the groups were separated based on the participant's GS+ avoidance behaviour. For the full sample or participants, significant differences in SCR levels supported the successful conditioning of the CS+ and the CS- in Phase 1, which was then maintained through Phase 2a and 2b. During the final probes, however, there was a lack of discrimination between all of the probe stimuli, including the GSs. However, it then emerged that the relationship between the conditioned safety stimulus (i.e., the CS-) and the probed stimuli differed significantly, depending on the participant's classification as a *Generaliser* or a *Non-Generaliser*. More specifically, for *Generalisers,* all of the probed stimuli produced significantly higher SCRs than that recorded for the CS-. This included raised arousal levels for both the GS- and the NCS. This was not the case for *Non-Generalisers*, for whom no significant differences in SCR levels between the CS- and any of the probe stimuli were apparent. For *Non-Generalisers,* there appeared to be no generalisation to the probe cues, with only the CS+ producing elevated SCRs. It appears, that cohorts differed significantly in relation to the generalisation of threat to novel stimuli, with one group displaying only a conditioned threat, while the others showing generalisation of threat or over-generalisation of threat to the novel stimuli and antonym stimuli. As previously reported, there were no significant differences between the two groups in mean SCR for each probe. Only by examining the inter-relations between CS- related SCRs and the probed stimuli, were the differences across cohorts uncovered.

Expectancy ratings also identified differences between cohorts, which highlight the *Generalisers* propensity for generalisation. More specifically, *Generalisers* reported a significantly increased likelihood of receiving a shock, following the GS+, when compared to their GS- expectancy rating. The shock expectancy ratings for all of the other probed stimuli, in the event that a hypothetical response was not made, correlated strongly with avoidance to the GS+, despite the low level of observed avoidance to the other probed stimuli. This result was supported for *Generalisers*, by similar levels of recorded arousal recorded for all probed stimuli. For *Non-Generalisers,* generalisation was not present for any of the probes, and this group reported low expectancy of receiving the shock if an avoidance response was not made to any of the stimuli, excepting the CS+.

Post-test valence differences across the stimuli corresponded with both conditioning and generalisation to the synonyms, but not with responses to any of the other probe stimuli. There were no significant between-group differences in the low levels of semantically related stimulus fear ratings recorded post-hoc for any of the probed stimuli, excluding the GS+. The GS+ valence rating corresponded with whether a participant had generalised or not, across any of the other dependent measures. As a result, there was a strong correlation observed between rates of avoidance for stimuli and related levels of negative valence, within the sample as whole.

The rationale for the current experimental design was that the additional cues would provide sufficient interference in levels of generalisation, to eliminate from the cohorts under analysis, those individuals who were failing to show generalisation for reasons other than inherent or acquired personal traits. In the previous experiments detailed here, many of the non-generalisers were classified as such, despite a lack of generalisation for possible non-trait based reasons (e.g., salience of the probe cues, aversiveness of the US, etc.). However, it was proposed that the demonstration of generalisation may be always related to underlying trait factors. In other words, the generaliser group was the only one of the two groups whose composition is linked reliably to the trait measures of interest. With previous non-trait based, non-generalisers included in the overall sample, it may have been unlikely that regression analyses would have found strong contributions on the part of individual tests, or combinations of tests, to overall fear or avoidance generalisation probabilities. Better results were predicted by separating those who had failed to show generalisation for reasons such as poor stimulus control, stimulus salience, low motivation, and other standard laboratory experiment confounding attribute variables, from truly trait-based *Generalisers*. In this procedure, it was hoped that this focus would provide an improved predictive utility for questionnaires, when applied only to the generalising participants, despite the reduced range in their data and the low sub-sample size.

In the examination of the relationship between the questionnaires and all of the dependent measures, however, only the best combined model of the PSWQ, IUS and EPQ-N accounted for a significant amount of the variability in both the GS+ and GS- mean SCRs.   When generalisation cohorts were examined separately, significant levels of predictive ability were identified between SCRs across the stimuli, and a number questionnaire scores, but for *Non- Generalisers* only. While *Generalisers* produced a significant correlation between rates of GS+ avoidance and AAQ score, no group-related correlations were identified in relation to US Expectancies. In fact, the predictive utility for the BEAQ in relation to valence was significant for both *Generalisers* and *Non-Generalisers*, albeit for different stimuli. More frustratingly, a comparison of trait scores across the two cohorts found no significant differences, either overall or individually, for any of the trait questionnaires examined. This somewhat surprising result represents a cul-de-sac in terms of identifying clues as to how to predict the avoidance and fear response generalisation of individuals. While clearly more and less avoidant cohorts of participants exist, they do not appear to be easily identifiable based on traits.

Chapter 8

General Discussion

CHAPTER 8: GENERAL DISCUSSION

One of the aims of this thesis was to explore whether commonly used personality, anxiety and experiential avoidance trait related measures provided any predictive utility in identifying observed levels of Pavlovian conditioning and the symbolic or semantic generalisation of fear and avoidance. An additional aim was that the research project sought to further develop the original Boyle et al. (2016) paradigm and identify possible enhancements or boundary conditions to the already observed semantic generalisation phenomenon. The Boyle et al. (2016) study looked specifically at threat generalisation in a natural language context and provided evidence regarding the ease with which generalisation can occur within natural or trained language categories. It was proposed that that the semantic generalisation paradigm, which focuses on threat-related levels of SCRs, US expectancies or rates of avoidance responses, provided a useful analogue of over-generalisation in the clinical context. It was hoped then, that trait measures used in the clinical assessment of anxiety related behaviour, as well as personality trait measures, would be capable of discriminating the fear and avoidance behaviours of anxious and non-anxious individuals.

Specifically, it was hoped that empirically observed levels of generalised threat and avoidance responding would correlate significantly with scores on a number of trait and experiential avoidance questionnaires. A small number of previous studies had already attempted to do just that but had limited success. In addition, these studies focused on generalisation along perceptual gradients, while this thesis focused more on ecologically valid symbolic and semantic generalisation. Across the preceding chapters, seven computer-based experiments were outlined, six of which provided participants with the opportunity to successfully avoid the US and then subsequently generalise either SCRs, US expectancy ratings or instrumental avoidance responses across symbolically or semantically related nonsense or English words. This concluding chapter will discuss the most important results of these experiments, explore the limitations of the paradigms employed and briefly discuss the conceptual and empirical implications of the findings.

8.1 Summary of Results

During Experiment 1, generalised fear and avoidance were observed between stimuli along controlled and completely arbitrary symbolic continua. Levels of generalisation were then examined in relation to scores on the STAI-T, AAQ and the BEAQ sub-clinical questionnaires. Neither rates of avoidance during the conditioning and probes for generalisation, or the post-hoc US expectancy ratings were predicted by scores on any of the three individually examined questionnaires. However, the combined model of all three questionnaires provided a significant degree of predictive utility for levels of avoidance response rates to the conditioned safety stimulus, an effect previously identified by Vervliet et al. (2015). Despite this finding, the poor overall results provided from this quite complex demonstration of symbolic generalisation may have suffered from the small (n= 33) participant sample.

In an effort to further chase down potential correlations between trait measures and generalisation, Experiments 2a and 2b returned to the examination of less complex forms of fear and avoidance by comparing the relationship between trait measures and Pavlovian conditioning rates to that between trait measures and semantic generalisation rates. Specifically, Experiment 2a employed a Pavlovian conditioning method, with only a single phase of avoidance learning. The individual, and combined, predictive utility of questionnaires such as the BEAQ, AAQ and the TAS was supported both for rates of CS+ avoidance and post-hoc expectancy ratings observed across participants. This also demonstrated that there was sufficient variability across the measures, to reveal correlations between response rates and scores on the questionnaires examined.

Experiment 2b expanded on the Experiment 2a paradigm, by including a semantic generalisation probe phase. Once again, the AAQ and STAI-T, both individually and combined, afforded a significant level of predictive utility for both the rate of avoidance to the CS+ and the US expectancies. Unfortunately, despite a significant level of avoidance generalisation, none of the individual tests or combined models accounted for variability in generalised avoidance for either probed stimulus. Overall, however, both Experiment 2a and Experiment 2b successfully demonstrated the ease with which avoidance learning and its generalisation occurs. The levels of generalisation observed in Experiment 2b also compared favourably with levels measured in Experiment 1, as well as those reported by both Dymond et al. (2011) and Boyle et al. (2016).

Experiment 3 expanded upon Experiment 2b by including additional personality trait measures (i.e., EPQ and 16PF), in the batteries. It also included two additional dependent measures during the procedure; SCRs and pre/post-phase ratings of semantically related fear. All four of the dependent measures supported the successful conditioning of the two original cues across all phases. Generalisation between the cues and their synonyms was supported by differences in avoidance responding and US expectancy between the GS+ and GS- only, but not by any corresponding differences in arousal response magnitudes. Just as in the previous experiments, the predictive utility of the questionnaires was more pronounced for the conditioned responses than for generalised ones.

In an attempt to address a number of possible confounds regarding the low-cost nature of the avoidance response used to date, Experiment 4 replaced the single press low-cost avoidance response with a higher physical (20 x press) cost response in a replication of the Experiment 3 procedure. This elaborated key-press response provided a number of additional individual and between-group variables for analysis. For example, the number of key-presses produced by the participants upon presentation of a conditioned or probe cue, could be used to index individual levels of experienced threat on a trial-by-trial basis. The relationship between the PSWQ and the rate of key-pressing to the first CS+ presentation during conditioning provided the only notable correlation between generalisation rates and the trait questionnaire scores in Experiment 4. Overall, the questionnaires performed poorly in identifying individual differences for any of the dependent measures. Results similar to those from the previous experiment indicated that the predictive utility of the best combined model was significant for SCR arousal, but only for the CSs during the conditioning phases. Correlations between the questionnaires and rates of avoidance generalisation were unlikely to have been significant, given that there was no significant difference between the recorded scores of AVOIDERS and NON-AVOIDERS for any of the questionnaires.

Experiment 5 sought to investigate the interaction between novel probe stimuli and the dependent measures. Specifically, the experiment wanted to examine whether the introduction of a novel unrelated probe stimulus would result in increased mean magnitudes of SCRs and levels of generalisation. To achieve this, Experiment 5 replicated Experiment 3's low cost avoidance response paradigm, with the addition of a single novel unrelated stimulus during the probe phase. Differences between the results of the two experiments subsequently highlighted that the insertion of a novel unrelated stimulus into the semantic generalisation paradigm, produced sufficient ambiguity regarding the function of the cues to interfere with levels of generalisation across the dependent measures. Specifically, the level of generalised responses, as indicated by significant differences between the synonyms of the CS+ and CS- i.e., the GS+ and GS-, for rates of avoidance, SCRs, US expectancies in the No Press condition or post-test valence ratings previously demonstrated during Experiment 3, were no longer significantly different during Experiment 5. In addition, of all the significant correlations observed between questionnaire scores and conditioned or generalised behaviour during Experiment 3, only the relationship between IUS scores and GS+ avoidance remained significant in the later experiment.

Perhaps the stand out result from Experiment 5, was that there existed a clearly distinguishable cohort of participants who showed robust and reliable generalisation across all of the dependent measures. The casual identification of a particularly resilient cohort of generalisers in Experiment 5, prompted the effort to examine more closely differences in avoidance and its generalisation across the most and least avoidant participants. The differences were stark and not distributed along a meaningful continuum. Specifically, ‘generalisers’ tended to show generalisation across all measures and, sometimes, across all stimuli (i.e., over-generalisation), whereas ‘non-generalisers’ did not show generalisation at all on any measures. This clearly dichotomous generalisation effect, however, was not predictable by paper and pencil test scores.

Experiment 6 sought to discriminate between these ‘generalisers’ and ‘non-generalisers’ using a questionnaire battery and also to further examine the interfering effect of additional probe stimuli. More specifically, by adding additional semantic generalisation cues (i.e., antonyms) during generalisation testing, it was hoped that the sample size could be titrated down to identify the most persistent cohort of ‘Generalisers’. It was also hoped that this group should surely be discriminable from the ‘non-generalisers’ using the questionnaire battery. During Experiment 6, while overall the successful conditioning of the CSs and the subsequent generalisation of threat to the GS+, but not the GS-, was shown in terms of avoidance but not SCRs, a number of effects only became apparent, however, when participants were divided into their respective groups as avoiders or non-avoiders. Those who did not show generalisation to the GS+, either for rates of avoidance or SCRs, also did not do so for any of the other probed stimuli. Those who made an avoidance response to the GS+, however, were more likely to avoid the other probe stimuli as well as demonstrate higher SCRs for these stimuli. Similarly, for US expectancy ratings, only avoiders generalised a level of threat to any of the probe stimuli, if a hypothetical avoidance response was not made. Despite this, a comparison of trait scores across the two cohorts revealed no significant differences, either overall or individually, for any of the trait questionnaires examined.

It was also assumed that within the group of generalisers, there would be individuals more likely to show good discrimination of the synonym and antonym generalisation probe cues, responding differently to both. However, this turned out not to be the case. Specifically, rates of avoidance of the GS+ correlated positively with the avoidance rates to other stimuli, when in fact this correlation should have been negative for the antonym stimulus. The generalisers, in other words, appeared to show over-generalisation of threat to all probe stimuli regardless of its specific relation to the CS+. The non-generalisers, in contrast, appeared not to show generalisation at all, even in error. From the evidence then, while it is clear that cohorts of participants exist who are more and less avoidant, they do not appear to be easily identifiable based on trait test scores.

8.2 Semantic generalisation

This programme of research sought to examine the relatively poorly understood phenomenon of semantic generalisation and consider the extent of its occurrence in terms of trait measures. The range of behavioural, psycho-physiological and self-report measures used in this programme of research, uncovered a number of effects that have extended our understanding of the semantic generalisation of avoidance phenomenon. For example, the results of Experiment 4 indicated that levels of attempted avoidance did not differ between those who were successfully avoiding the US and those who were not. In addition, the reduction in SCRs observed upon the introduction of an avoidance response option, did not result in any change in rates of attempted avoidance. Similarly, when SCRs were reinvigorated following the introduction of novel probe stimuli, rates of attempted avoidance were still unaffected. It is as yet unclear why avoidance rates and SCRs diverged in this way, but it points to the complexity of the concept of threat, and the relationships between its components.

Another, interesting effect identified during Experiment 5, was that any interference in generalisation created by the introduction of a novel stimulus during the probe phase, was not observed, for the more resilient cohort of 'Generalisers'.

However, across all of the experiments reported here, that cohort of robust generalisers has resisted identification using a battery of commonly used trait questionnaires. Nevertheless, the one constant in this research, is that across studies the semantic generalisation of threat is reliably observed. This would suggest that the phenomenon in not in doubt and was controlled well here. What is in clear doubt, is that either, a) the utility of trait questionnaires for predicting generalisation of threat rates in the laboratory and possibly the clinical context, or b) the utility of generalisation of threat models for understanding anxiety conditions as indicated by many popular questionnaires.

A number of effects identified across the final four experiments also shed light on the parameters of the semantic generalisation effect. For example, Experiment 4 explored the effect that a high avoidance cost would have on levels of generalisation. The results indicated that levels of attempted avoidance did not differ between those who were successfully avoiding the US and those who were not. Additionally, response cost was not associated with the level of avoidance generalisation observed. This is an important finding because response cost has been mentioned in several sources as a likely co-variate of avoidance rates (e.g., Laufer et al., 2012; Vervliet et al., 2015) and it appeared to have a sound conceptual basis. The current findings, however, do not bear this out.

Despite a number of attempts to increase variability in the degrees of semantic generalisation, the phenomenon proved to be robust and relatively resistant to variation. The generalisation between semantically related words contributes to the search for a more clinically or ecologically relevant model of human fear and avoidance generalisation beyond that provided by a rather meagre perceptual similarity model (e.g., Lissek et al., 2008; Lommen et al., 2010).

Indeed, this research appears to confirm the likely ubiquitous nature of complex forms of fear and avoidance generalisation in the real world and provides a more well-developed over-arching framework within which to understand real world anxiety conditions, than those suggested by specific studies with a narrower focus, such as those examining generalisation across human facial expressions (Haddad et al., 2012), complex shapes (Vervliet et al., 2010), and categorically related images (Dunsmoor et al., 2012).

With regard to its contribution in the examination of the role of individual differences in conditioning and generalisation, while having only a limited degree of success in identifying correlations between trait and behaviour, the experiments herein do contradict the Beckers et al. (2013) suggestion that Pavlovian conditioning may fail to vary significantly across individuals based on traits. As previously discussed, Beckers et al. (2013) had highlighted that Pavlovian conditioning provides sufficient training that "mostly everyone will learn to exhibit fear upon confrontation with a cue (CS) that reliably predicts the occurrence of an aversive outcome (US); it is a rather robust and reliable phenomenon (p.91)". However, the reverse was shown in Experiment 2b, in that conditioning effects were somewhat predictable from trait measures, although not for the variability in generalisation. Beckers et al. (2013) also argued that the simplicity of the CS-/US pairing may interfere with levels of response variability, so making identification of individual differences difficult. They argued that use of more-subtle relations between stimuli or perhaps "weak situations (p.95)" within the procedure would provide for greater success in identifying variations in conditioned behaviour. Later experiments in this semantic generalisation research programme attempted to examine generalisation along different, and perhaps less salient, relations between stimuli (i.e., real words and their antonyms). Results from Experiments 2a, 2b and 6 indicated that rather than variations in avoidance between participants, the responses became more binary in relation to the probed stimuli and failed to be successfully predicted by trait measures.

8.3 Semantic generalisation and AARR

The complex forms of generalised fear and avoidance shown here seem to constitute a promising new paradigm within which to understand anxiety conditions, which are by their nature complex and idiosyncratic. Indeed, Dymond et al. (2018) claimed that an AARR model of anxiety enjoyed a high level of face validity. However, during Experiment 5 and 6, when the number of probe stimuli was increased, well discriminated generalisation of fear and avoidance was actually decreased. This may indicate that, while humans have the ability to relate stimuli in an arbitrary manner, they may not do so as easily or as reliably as first thought when the complexity of the relations in increased even slightly. Indeed, evidence from Experiment 6 highlighted that participants in a laboratory procedure may have a propensity to either show arbitrary generalisation or not. What is not apparent in the data are varying degrees of generalisation to various stimuli, commensurate with the degree of relatedness of those stimuli to the original CS. In simple terms, the relational complexity of the probe phase appears to have breached the boundary conditions of the semantic generalisation phenomenon. However, it is important to highlight that results from experiments such as these provide further theoretical insights and perhaps nevertheless support the diagnostic and predictive validity of the AARR model (Dymond et al., 2018), which may not be exhaustive in its utility.

8.4 Clinical and broader implications

While the relationship between trait anxiety levels and extent of generalisation was generally not obviously apparent in this research, a number of subtle behavioural patterns may serve as sources of speculative information about such a relationship. During Experiment 4 for example, those successfully avoiding the CS+ were more likely to semantically generalise. They were also more likely to have provided a greater rate of key pressing for the first presentation of the CS+, from the outset. This additional vigour or motivation to successfully avoid the shock may have made a significant contribution to their level of successful CS+ avoidance overall. Rates of key-pressing upon the initial CS+ presentation significantly correlated with both their rates of success in CS+ avoidance and their PSWQ scores. Future experiments should examine the predictive utility of the initial sympathetic or avoidance response during conditioning procedures to test for correlations between these measures and subsequent levels of generalisation, or their relationship with individual trait scores. Given the observed correlation between the PSWQ and the initial avoidance response probability reported here, as well as to levels of generalisation, it seems reasonable to propose that higher trait anxiety worry levels would be associated with active avoidance generalisation in the real world.

Empirical support for the relationship between an individual's perception of control and reduced skin conductance magnitudes, as discovered by Glass et al. (1969) was provided during Experiment 4. During the instrumental conditioning phase, avoidance of the CS+ appeared to interfere with the inter-stimulus difference in SCR, in a potentially complex way. Initially, during Phase 2b, the availability of the avoidance response, regardless of its efficacy, appeared to temper the magnitude of the skin conductance response, to the extent that mean

SCR magnitudes were not significantly different between those who were not successful in cancelling any subsequent shock and those who were. As highlighted in Chapter 5, this apparent disconnect between avoidance success and arousal levels was also observed in both Xia et al. (2017) and Morriss et al. (2018). During Experiment 4, for those individuals who had attempted but failed to avoid the CS+, the threat presented by the CS+ appeared to reduce incrementally throughout the conditioning trials at a rate similar to those who were successfully avoiding the US. This apparent reduction in arousal magnitude, possibly induced by avoidance responding during Experiment 4, which was ineffectual in cancelling the US for some, has been long recognised within the cognitive literature. This subtle effect may provide insight into the mechanisms underlying the development of anxiety-related disorders, and in particular excessive and ritualised avoidance where fear levels are low (e.g., OCD). Interestingly, a similar effect was reported recently by Morriss et al. (2018) and Xia et al. (2017).

Additional evidence that the availability of the avoidance response reduces anxiety regardless of its efficacy was also provided by the stable rate of key-pressing throughout the task for those who were unsuccessful in their attempted avoidance. For non-avoiders, the cue related arousal response magnitude most likely remained large throughout the trials, while for others, the success of the avoidance response in the previous trials may have attenuated SCR magnitude. Yet throughout both the conditioning and probe trials, while levels of key-pressing rose rapidly during the initial trials, both cohorts quickly settled at a stable rate, albeit at a higher number per trial for the successful avoiders than for the non-successful avoiders, for the remaining conditioning and probe trials. The number of key-presses appeared to stabilise regardless of whether it was successful in cancelling the shock or not. This level of responding, while reinforced for those successfully cancelling the US, was also maintained at that rate by those for whom the avoidance response was in extinction (i.e., who failed to avoid shock). It perhaps would have been expected that the unreinforced response would have extinguished across trials. However, neither the reduction in arousal apparently produced by the availability of an avoidance response option, nor the lack of effectiveness of the avoidance response, resulted in a reduction in the level of physical effort being expended on the avoidance attempt throughout the phases. Perhaps there simply were not enough trials across which this behaviour could extinguish, or perhaps a form of covert rule-following rendered the behaviour insensitive to current contingencies. Regardless of the reason for this effect, it raises interesting questions about the obviously complex relationship between avoidance rates, trait measures and the functions of stimuli, be they conditioned or generalised.

The experiments in this research programme gave a number of possible insights into the complexity of the relationship between avoidance and arousal beyond that which could be described as adaptive and warrants further examination. In the real-world, anxiety induced avoidance is a fundamental part of adaptive human behaviour (Hayes, Strohl & Wilson 1999). In other words, the generalisation of a threat from previous aversive experiences to similar situations will likely prompt avoidance if it is possible. A number of experiments detailed herein have shown strong correlations between arousal and avoidance levels and also have highlighted that successful avoidance provides a reduction in anxiety levels and promotes a similar response in future novel encounters e.g., synonyms. In the real-world, the success of avoidance in removing a possible threat or any associated anxiety can result in its over-use and the development of dysfunctional behaviour (Arnaudova et al., 2017). For example, for some individuals the over-generalisation of a previously threatening encounter to similar situations, or the regular over-use of the avoidance response, may support the development of a phobia e.g., arachnophobia. For those experiencing pathologically excessive anxiety however, generalisation is more likely to be ambiguous and results in regular and heightened states of anxiety (DSM-IV, 2013; American Psychiatric Association). Indeed, Lissek et al. (2014) found that GAD sufferers were more likely to over-generalise within a laboratory-based fear conditioning and perceptual generalisation paradigm than those form a randomly selected sample of participants. The DSM-IV also reported that illnesses such as GAD correspond with raised levels of avoidance or suppression behaviours. Experiment 4 possibly supported this diagnostic criterion by highlighting a strong positive correlation between PSWQ scores and the number of key-presses in response to the initial CS+ presentation during instrumental conditioning. This perhaps indicated that individuals with a propensity to worry were indeed more likely to be strongly motivated in providing an avoidance response to the US. In addition, Experiment 4 also reported equivalent mean levels of SCR magnitudes for both the successful and unsuccessful attempted avoidance cohorts during the avoidance conditioning phase. While Hunt et al. (2017) claimed that excessive avoidance was related to the degree of success in removing any real or suspected threat, Vervliet et al. (2015) had already reported that merely the availability of an avoidance response promotes its use as a safety behaviour. If this is the case, then it is reasonable to assume that for a GAD sufferer who experiences recurring and heightened anxiety, any reduction provided by the use of avoidance, regardless of any success, would be susceptible to overuse. While Experiments 5 and 6 were successful in titrating non-clinical samples of participants down to very small robust groups of avoiders, they were not successful in identifying if this behaviour was significantly correlated with trait anxiety. Based on the research to date however, it would be reasonable to expect that in future experiments involving clinically-relevant samples of GAD patients for example, the number of generalisers would be greater than observed here from a random sample of participants.

In the real world, contingency change is constantly occurring and so environmental and threat ambiguity may well be a challenge facing many anxiety patient's day to day. In Experiment 4, the introduction of uncertainty produced by the introduction of novel and ambiguous stimuli perhaps explained the rise in arousal levels observed. It was argued that the introduction of novel but related probe stimuli perhaps provided sufficient levels of uncertainty, to reinvigorate conditioned arousal responses to the CS+. In other words, during the probe phase there were similar magnitudes in SCRs in response to the appearance of the CS+ as during the initial exposures to the stimulus in the first conditioning phase. A commonality in both phases was the introduction of novel stimuli, while possibly naturally aversive in the initial phase, could be described for the final phase as being a change in context within the procedure. This change it was argued, may have reinvigorated the SCR in relation to the CS+ by reorienting it to its original aversive level. During the previously discussed Vervliet et al (2015) experiment, when there was a context change, "differential danger-safety ratings and SCR returned sharply when participants were suddenly told that the avoidance button was unavailable, followed by gradual extinction (p10)". In that experiment, this effect was observed despite participants being made aware that the stimuli were being presented in extinction i.e., without shock. This most likely highlights that participants may be aware of the context in which they are operating and are susceptible to noticing change or ambiguity within the environment, perhaps more so within fear conditioning experiments involving aversive USs and avoidance response options. In this programme, Experiment 5 explored this possible phenomenon and interference in discriminated levels of semantic generalisation was indeed identified across all of the dependent measures. These results highlighted the effect of relational ambiguity on fear levels within a non-clinically specific sample of participants and offers a future thread of enquiry going forward.

8.5 Strengths and limitations

The research programme detailed herein, focused on two aims in relation to symbolic and semantic generalisation. Firstly, it aimed to extend our understanding of both by examining the processes involved and identifying the boundary measures of semantic generalisation. By manipulating the semantic generalisation paradigm of Boyle et al. (2016) in different ways, as detailed above, a number of interesting phenomena and effects were observed which indicated the clinical relevance of this approach to fear conditioning and also highlighted a number of possible future lines of enquiry. In addition, some boundaries of semantic generalisation were successfully identified.

An additional aim of this research was to provide an exploratory analysis of a number of pen and paper measures, commonly used within the field, to identify any possible correlations between them and the degrees of observed generalisation. To achieve this, comprehensive regression analyses were completed throughout to identify significant variables and therefore prospective strands of research. This programme required a number of experiments to be completed using Pavlovian and instrumental learning paradigms, so it was difficult to employ very large participant samples. Interestingly however, within the behaviour-analytic tradition, this is often an accepted feature within the design because high levels of control are usually obtained over the phenomena of interest, observations are usually inductive rather than hypothetico-deductive, and therefore successive participant data sets are treated more like successive replications than as homogenous groups. For example, in the first study to investigate derived avoidance by Augustson and Dougher in 1997, their participant sample comprised of only eight participants. While sample sizes may have been acceptable from the behaviour-analytic perspective in terms of demonstrating well controlled effects, larger samples were surely needed here for analyses involving correlations, regressions and group comparisons.

In general, explorations of the inter-relationships between empirically conditioned behaviour and any resulting generalisation have been taken from samples of a larger size. For example, the Hunt et al. (2017) study supplemented the data from the original 44 participants used during the van Meurs et al. (2014) study with an additional 89 participants, to provide a final experimental cohort of 109 participants, after various exclusions. Similarly, Flores et al., (2018), in their examination of effect of US devaluation on avoidance, reported significant correlations between the IUS questionnaire scores and the phenomenon, from 154 participants. In this respect, the experiments conducted in this programme could be described as underpowered, particularly in comparison to the Torrents-Rodas et al. (2013) study, which examined the effect of individual trait differences on levels of fear conditioning and perceptual fear generalisation, using a sample of over 1000 people. In defence of the semantic paradigms detailed herein however, Lommen et al. (2010) focused on those with high EPQ- Neuroticism levels when they examined fear and avoidance generalisation along a perceptual gradient using only 48 participants. It must be acknowledged however, that their sample comprised of already selected groups of high and low neurotic people to provide variability within groups in the examination of trait related differences. Similarly, Arnaudova et al. (2017) also sought out correlations between various trait measures and SCR using Fear Potentiated Startle, risk ratings or instrumental avoidance from a sample of 58 participants. Experiment 3 and 4 of this programme targeted samples of 50 participants each. Results from these studies indicate that, in the exploratory study of the relationship between commonly used trait measures and fear and avoidance generalisation under laboratory conditions, a larger sample size involving over 100 participants may be required for significant correlations between the measures to emerge. An alternative strategy would be to mimic studies such as that reported by Lommen et al. (2010) and select only those participants scoring highly on anxiety related tests or include only clinically relevant samples of participants. This, however, still requires the initial sampling of vary large population frames.

Attempts to correlate the trait and behavioural measures would also have been limited by the lack of variability within the avoidance response. Correlations between trait scores and rates of avoidance may be unlikely to emerge easily due to the binary nature of the avoidance response (i.e., avoid or do not avoid) and the implication of this for data distributions. Alternative technologies may hold the solution to this limitation. Scherbaum, Dshemuchadse, Fischer, & Goschke, (2010) incorporated behavioural indicators of the underlying cognitive process dynamics to examine response strategies in a simple stimulus selection task. By examining computer-mouse trajectories during selection, and combined with using multiple regression analyses, the authors were able to quantify influences on decision making with regard to the relational congruence between stimuli. By perhaps embracing this technology and response tracking the behavioural movement in conjunction with the individual response time could highlight variety in the response and individual differences in behaviour in the future. In addition, the low-cost nature of the avoidance response also likely facilitated high rates of avoidance, for even the lowest levels of threat and therefore avoidance rates were unlikely to vary much across participants. In contrast, real-world and clinically relevant avoidance often involves response costs, such as physical expenditure (e.g., walking the longer way to work to avoid a dog) or a financial loss (e.g., forgoing job promotions due to the associated anxiety provoking situations). In future experiments, the use of response costs that realistically mimic real-life response costs for avoidance need to be considered. It may be that variation in generalisation rates induced by realistic response costs is explained more fully by trait measures than is extent of generalisation.

The lack of variety in responses to by the US expectancy ratings, which were taken post-hoc and not in-line within trials, similarly provided another limitation on an important fear-related metric. As discussed in Chapter 4, Bennett et al., (2015a) had suggested that retrospective expectancy ratings measure only the participant's recall of confirmed or disconfirmed expectancies, as USs were encountered during the training and testing procedure. The research paradigms detailed here, however, have emerged from a behaviour-analytic tradition in which stimulus control is usually assumed to originate not in private events, such as mental associations or propositions, but to be directly related to the immediate experimental contingencies, of which mental associations and propositions are themselves a product. From this perspective, mental associations as inferred from verbal expectancy reports, are not considered to be mediating variables but to be themselves the product of effective conditioning (see Dymond et al. 2011). For this reason, it felt antithetical to the paradigmatic approach to, in any way, interfere with the CS-US contingency in an effort to identify the emergence of corresponding verbal reports regarding the contingencies used to generate both conditioning effects and such reports.

Another common criticism regarding the validity of subjective US expectancy ratings, is that participant reporting may be influenced by their understanding of the experimental demand, rather than accurately recording their expectancy of the US (Boddiz et al., 2013). In other words, participants may report on the likelihood of receiving a shock based on their experience of the CS+/US pairings during the experiment, rather than accurately reporting on their level of certainty regarding experiencing the US in each condition. In the experiments detailed in this thesis, post-hoc rather than in-trial ratings afforded participants the opportunity to experience a number of presentations across all stimuli before making subjective judgements regarding the likelihood of experiencing the US. This level of learning may account for the comparatively stable mean expectancy ratings for conditioned and generalised stimuli across the seven experiments where the original wording and format of the questionnaires was maintained throughout. As a possible limitation, it is important to recognise that the recorded expectancy ratings may not accurately measure the level of certainty with which participants attributed to the appearance of the US in each condition but may indicate the merely their understanding of the relationship between the US and the presented CSs when the avoidance response is not given.

Another possible confound, related to the reliance on real words in the semantic generalisation paradigm and the loss of experimental control that this entails relative to a symbolic generalisation paradigm. The correlation between degrees of generalisation and the trait measures is inevitably impacted upon by the extent to which the participant recognises the semantic relation between the cues and the 'strength' of that relation. In addition, in relation to the antonyms used in Experiment 6, words can invoke a number of sometimes competing relations. For example, the antonyms used as probe cues were able to operate either in opposition to the CS+ or as equivalent due to their clear relationship to it (i.e., as an antonym). In simple terms, an antonym of a cue may be considered to be more strongly related to the cue than a novel stimulus, insofar as it has a clear relationship to it. In this way, antonyms may function as such, or as synonyms, but in either case, it will do so under clear contextual control. This renders the use of antonyms and novel stimuli rather complex and the derived / generalised responses generated by each needs to be fully elucidated in relation by systematic experimentation.

One radical possibility is that individuals may not be so finely discriminable, in terms of avoidance and SCR generalisation levels, as the trait measures would aspire. Put simply, participants may merely have a propensity to either generalise or not. Their performance may unfortunately be rather dichotomous, as seems to possibly be the case given the current findings. This in itself may be a trait-based phenomenon, but not one easily identified using any validated paper and pencil test, insofar as such tests rely for their validity on the normal distribution of scores. In this case, the behavioural phenomenon of interest appears not to be normally distributed and a psychometric approach may not be as preferable as a functional one, based on understanding the effects of various historical variables that determine whether or not an individual will become one who tends to show generalisation or not in later life. That said, the dichotomous nature of the generalisation phenomenon (i.e., the non-normally distributed nature of the extent of generalisation), may well be related more directly to the types of methodologies employed here rather than external or intra-personal factors.

Rather than any procedural deficit, however, the problem may have been that this body of research was undertaken under the widespread historical assumption that there should be a correlation between laboratory recorded threat-relevant responding and trait anxiety. It was apparent from the outset that this relationship was far from clear, but it was hoped that a dedicated research programme would help to illuminate it. The predictive utility of the STAI for example, demonstrated by Haddad et al. in 2012, for the generalisation of a conditioned fear response along a perceptual gradient, failed subsequently to be supported by Torrents-Rodas et al. in 2013, with their participant sample of over 1000 people. On the other hand, the study by Lommen et al. (2010) highlighted that, correlations between EPQ- Neuroticism scores and avoidance generalisation, were significant, but only when participants were permitted an extended period of time to respond to the stimuli. The authors theorised that this afforded participants the opportunity to consider any possible threat relative to the ambiguous stimuli presented in that paradigm. Similarly, the research of Torrents-Rodas et al. (2013), indicated that individuals with low levels of trait anxiety appeared to be able to maintain lower levels of arousal for safe stimuli, than their higher STAI scoring counterparts. Both of these insights came from similar fear generalisation paradigms, which examined the generalisation phenomenon along a perceptual continuum. Despite the ambiguous relationship apparent between trait measures and conditioned and generalised fear in those paradigms, it was nevertheless worthwhile to continue this line of enquiry using different generalisation paradigms, such as symbolic and semantic generalisation

Part of the reason why it appears so difficult to observe direct and unambiguous relationships between threat generalisation and trait test scores is that trait tests are typically constructed psychometrically only in terms of their convergent and divergent validity with other similar tests rather than on the basis of ground-up process level research. Throughout the experiments detailed in this thesis, most of the trait questionnaire scores inter-correlate at generally a medium to strong level. During a number of the experiments, for example, the STAI and the AAQ and also the PSWQ have had to be excluded from combining in a single model due to their co-linearity. This approach to test development is not surprising given the research paradigms (e.g., psychometric, cognitive) in which many of these tests are developed. While all tests should have face validity in terms of indexing the constructs they purport to measure, they may on occasion be forgiven for not doing so very well when the constructs they measure are sufficiently hypothetical (e.g., abstract personality traits such as Conscientiousness). But anxious arousal and avoidance are easy constructs to assess objectively using modern measurement methods. Avoidant propensity as a construct, for instance, lends itself easily to operationalization. It may behove test developers, therefore, to start thinking of their tests in more functional terms so that clinical and laboratory researchers can meet somewhere in the middle, between both fields.

8.6 Conclusions

This programme of research sought to accomplish two distinct aims; closely examine the symbolic and semantic generalisation of fear and avoidance and also explore the relationship between the observed behavioural and recorded trait measures. Symbolic and semantic generalisation have been supported over seven experiments with a number of significant behaviours having been identified. The exploration of the relationship between empirically observed behaviour and related traits struggled to be identified but in anxiety research, correlations recorded between physiological, self-report and behavioural measures tend to be weak, if present at all (Derakshan, Eysenck & Myers, 2007). In 1992, Fahrenberg reported in the Handbook of individual differences: Biological perspectives that “over many decades research has failed to substantiate the physiological correlates that are assumed for emotionality and trait anxiety. There is virtually no distinct finding that has been reliably replicated” (p. 212-213). From this perspective, as one of the primary aims of this programme of research was to attempt to explore correlations between popular sub-clinical trait measures and observed levels of threat and avoidance generalisation (i.e., emotionality), it perhaps was a naïve endeavour. However, it is important to understand that arriving at such positions in hindsight is part of scientific progress and from that perspective the endeavour has been informative.

By combining an exploratory search methodology and the use of comprehensive regression analyses, exhaustive attempts were made to identify prospective or future strands of research to be completed. As a consequence, the programme required a number of experiments to be completed using Pavlovian and instrumental learning paradigms, so it was perhaps unlikely that very large numbers of participants were to be examined. However, as already highlighted, a number of studies detailed in this thesis contained comparative sample sizes to already published exploratory studies into the relationship between behaviour and trait. While historically there have been very few replications of observed effects within similar studies to date, the sample sizes involved and the possible lack of variability within the reported measures need to be acknowledged as limitations under which this research programme was undertaken. As such, the lack of significant correlations between the measures are reported throughout as exploratory findings rather than definitive or conclusive results.

In conclusion, regardless of the difficulties and limitation involved, this research programme has provided tentative evidence to suggest that variability in rates of conditioning and generalisation of threat may be identified by trait anxiety measures such as the STAI or the AAQ. However, the attempt to predict levels of generalisation across a range of dependent measures may have been naïve due to a number of confounding effects outlined here. At present, therefore, the study of conditioned and generalised threat exists, perhaps stranded, between two worlds. The laboratory researcher develops their chosen research tools and methods to help identify possibly clinically-relevant behaviours and wonders how they may relate to tools already in use in the clinical field. The clinician, on the other hand, develops their tools for diagnostic and applied purposes and wonders how they may be related to processes of avoidance and fear identified in the laboratory. While the phenomena under analysis by both may appear at first to be the same, the different origins of interest, the difference in methodologies, conceptual frameworks, and paradigmatic approaches may differ so greatly, that in fact the phenomena under analysis may be different and may not map well on to one another. We may, in effect, have created a lacuna between the fields that neither can navigate easily. Given this, it may be optimistic, or possibly naïve, to expect that trait questionnaires will demonstrate good predictive utility for generalised threat, which in turn consists of a complex collection of not always well defined and yet co-related fear responses. But that does not mean we shouldn't try.

References

Andreatta, M., Mühlberger, A., Glotzbach-Schoon, E., & Pauli, P. (2013). Pain predictability reverses valence ratings of a relief-associated stimulus. *Frontiers in Systems Neuroscience*, 7, 53.

Arnaudova, I., Krypotos, A. M., Effting, M., Kindt, M., & Beckers, T. (2017). Fearing shades of grey: individual differences in fear responding towards generalisation stimuli. *Cognition and Emotion*, *31* (6), 1181-1196.

Augustson, E.M., & Dougher, M.J., (1997). The transfer of avoidance evoking functions through stimulus equivalence classes. *Journal of Behavioral Therapy and Experimental Psychiatry*, *28*,181-191.

Bagby, R. M., Parker, J. D., & Taylor, G. J. (1994). The twenty-item Toronto Alexithymia Scale—I. Item selection and cross-validation of the factor structure. *Journal of Psychosomatic Research*, *38*(1), 23-32.

Beckers, T., Krypotos, A. M., Boddez, Y., Effting, M., & Kindt, M. (2013). What's wrong with fear conditioning?. *Biological Psychology*, *92*(1), 90-96.

Bennett, M., Hermans, D., Dymond, S., Vervoort, E., & Baeyens, F. (2015a). From bad to worse: Symbolic equivalence and opposition in fear generalization. *Cognition & Emotion*, *29*, 1137-1145.

Bennett, M. P., Meulders, A., Baeyens, F., & Vlaeyen, J. W. (2015b). Words putting pain in motion: The generalization of pain-related fear within an artificial stimulus category. *Frontiers in Psychology*, *6*, 520.

Bennett, M., Vervoort, E., Boddez, Y., Hermans, D., & Baeyens, F. (2015c). Perceptual and conceptual similarities facilitate the generalization of instructed fear. *Journal of Behavior Therapy and Experimental Psychiatry*, *48*, 149-155.

Boddez, Y., Baeyens, F., Hermans, D., & Beckers, T. (2014). A learning theory approach to anxiety disorders: Human fear conditioning and the added value of complex acquisition procedures. In P. Emmelkamp, & T. Ehring (Eds.), *International Handbook of Anxiety Disorders: Theory, Research and Practice* (pp. 85-104). Wiley-Blackwell.

Bond, F. W., Hayes, S. C., Baer, R. A., Carpenter, K. M., Guenole, N., Orcutt, H. K., ... & Zettle, R. D. (2011). Preliminary psychometric properties of the Acceptance and Action Questionnaire–II: A revised measure of psychological inflexibility and experiential avoidance. *Behavior Therapy*, *42*(4), 676-688.

Booth, R. W., Sharma, D., & Leader, T. I. (2016). The age of anxiety? It depends where you look: Changes in STAI trait anxiety, 1970–2010. *Social Psychiatry and Psychiatric Epidemiology*, *51*(2), 193-202.

Boyle, S., Roche, B., Dymond, S., & Hermans, D. (2016). Generalisation of fear and avoidance along a semantic continuum. *Cognition and Emotion*, *30*(2), 340-352.

Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEW): Instruction manual and affective ratings* (Vol. 30, No. 1, pp. 25-36). Technical report C-1, the center for research in psychophysiology, University of Florida.

Cameron, G., Roche, B., Schlund, M. W., & Dymond, S. (2016). Learned, instructed and observed pathways to fear and avoidance. *Journal of Behavior Therapy and Experimental Psychiatry*, *50*, 106-112.

Carleton, R. N., Norton, M. P. J., & Asmundson, G. J. (2007). Fearing the unknown: A short version of the Intolerance of Uncertainty Scale. *Journal of Anxiety Disorders*, *21*(1), 105-117.

Cattell, R. B., & P. Cattell, H. E. (1995). Personality structure and the new fifth edition of the 16PF. *Educational and Psychological Measurement*, *55*(6), 926-937.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, N.J.: L. Erlbaum Associates.

de Bruin, G. O., Rassin, E., van der Heiden, C., & Muris, P. (2006). Psychometric properties of a Dutch version of the Intolerance of Uncertainty Scale. *Netherlands Journal of Psychology*, *62*(2), 87-92.

Derakshan, N., Eysenck, M. W., & Myers, L. B. (2007). Emotional information processing in repressors: The vigilance–avoidance theory. *Cognition and Emotion*, *21*(8), 1585-1614.

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

Dunsmoor, J. E., Martin, A., & LaBar, K. S. (2012). Role of conceptual knowledge in learning and retention of conditioned fear. *Biological Psychology*, *89*(2), 300-305

Dunsmoor, J. E., Niv, Y., Daw, N., & Phelps, E. A. (2015). Rethinking extinction. *Neuron*, *88*(1), 47-63.

Dymond, S., Bennett, M., Boyle, S., Roche, B. & Schlund, M. (2018). Related to Anxiety: Arbitrarily Applicable Relational Responding and Experimental Psychopathology Research on Fear and Avoidance. *Perspectives on Behavior Science* 41(1), 189-213.

Dymond, S., Roche, B., Forsyth, J. P., Whelan, R., & Rhoden, J. (2007). Transformation of avoidance response functions in accordance with same and opposite relational frames. *Journal of the Experimental Analysis of Behavior*, *88*(2), 249-262.

Dymond, S., Schlund, M. W., Roche, B., Whelan, R., Richards, J., & Davies, C. (2011). Inferred threat and safety: Symbolic generalization of human avoidance learning. *Behaviour Research and Therapy*, *49*(10), 614-621.

Dymond, S., Schlund, M. W., Roche, B., & Whelan, R. (2014). The spread of fear: Symbolic generalization mediates graded threat-avoidance in specific phobia. *Quarterly Journal of Experimental Psychology*, *67*(2), 247-259.

Dymond, S., Dunsmoor, J. E., Vervliet, B., Roche, B., & Hermans, D. (2015). Fear generalization in humans: systematic review and implications for anxiety disorder research. *Behavior Therapy*, *46*(5), 561-582.

Eysenck, H. J., & Eysenck, S. B. G. (1975). *Manual of the Eysenck Personality Questionnaire (junior and adult)*. London: Hodder and Stoughton.

Eysenck, S. B., Eysenck, H. J., & Barrett, P. (1985). A revised version of the psychoticism scale. *Personality and Individual Differences*, *6*(1), 21-29.

Fahrenberg, J. (1992). Psychophysiology of neuroticism and anxiety. In A. Gale & M. W. Eysenck (Eds.), *Wiley psychophysiology handbooks. Handbook of individual differences: Biological perspectives* (pp. 179-226). Oxford, England: John Wiley & Sons.

Feather, B. W. (1965). Semantic generalization of classically conditioned responses: A review. *Psychological Bulletin*, *63*(6), 425.

Flores, A., López, F. J., Vervliet, B., & Cobos, P. L. (2018). Intolerance of uncertainty as a vulnerability factor for excessive and inflexible avoidance behavior. *Behaviour Research and Therapy*, *104*, 34-43.

Gámez, W., Chmielewski, M., Kotov, R., Ruggero, C., & Watson, D. (2011). Development of a measure of experiential avoidance: The Multidimensional Experiential Avoidance Questionnaire. *Psychological Assessment*, *23*(3), 692.

Gámez, W., Chmielewski, M., Kotov, R., Ruggero, C., Suzuki, N., & Watson, D. (2014). The brief experiential avoidance questionnaire: development and initial validation. *Psychological Assessment*, *26*(1), 35.

Gannon, S., Roche, B., Kanter, J. W., Forsyth, J. P., & Linehan, C. (2011). A derived relations analysis of approach-avoidance conflict: Implications for the behavioral analysis of human anxiety. *The Psychological Record*, *61*(2), 227-252.

Glass, D. C., Singer, J. E., & Friedman, L. N. (1969). Psychic cost of adaptation to an environmental stressor. *Journal of personality and social psychology*, 12(3), 200.

Guttman, N., & Kalish, H. I. (1956). Discriminability and stimulus generalization. *Journal of Experimental Psychology*, *51*(1), 79.

Haddad, A. D., Pritchett, D., Lissek, S., & Lau, J. Y. (2012). Trait anxiety and fear responses to safety cues: Stimulus generalization or sensitization?. *Journal of Psychopathology and Behavioral Assessment*, *34*(3), 323-331.

Hovland, C. I. (1937). The generalization of conditioned responses: I. The sensory generalization of conditioned responses with varying frequencies of tone. *The Journal of General Psychology*, *17*(1), 125-148.

Hunt, C., Cooper, S. E., Hartnell, M. P., & Lissek, S. (2017). Distraction/suppression and distress endurance diminish the extent to which generalized conditioned fear is associated with maladaptive behavioral avoidance. *Behaviour Research and Therapy*, *96*, 90-105.

Julian, L. J. (2011). Measures of anxiety: State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale-Anxiety (HADS-A). *Arthritis care & research*, *63*(S11).

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). Technical report A-8. *University of Florida*.

Krypotos, A. M., Arnaudova, I., Effting, M., Kindt, M., & Beckers, T. (2015). Effects of approach-avoidance training on the extinction and return of fear responses. *PloS one*, *10*(7), e0131581.

Laufer, O., & Paz, R. (2012). Monetary loss alters perceptual thresholds and compromises future decisions via amygdala and prefrontal networks. *Journal of Neuroscience, 32*(18), 6304-6311.

Lissek, S., Biggs, A. L., Rabin, S. J., Cornwell, B. R., Alvarez, R. P., Pine, D. S., & Grillon, C. (2008). Generalization of conditioned fear-potentiated startle in humans: experimental validation and clinical relevance. *Behaviour Research and Therapy*, *46*(5), 678-687.

Lissek, S., & Grillon, C. (2012). Learning models of PTSD. In *The Oxford handbook of traumatic stress disorders* (pp. 175-190). Oxford University Press, New York.

Lissek, S., Kaczkurkin, A. N., Rabin, S., Geraci, M., Pine, D. S., & Grillon, C. (2014). Generalized anxiety disorder is associated with overgeneralization of classically conditioned fear. *Biological Psychiatry*, *75*(11), 909-915.

Lissek, S., Powers, A. S., McClure, E. B., Phelps, E. A., Woldehawariat, G., Grillon, C., & Pine, D. S. (2005). Classical fear conditioning in the anxiety disorders: a meta-analysis. *Behaviour Research and Therapy*, *43*(11), 1391-1424.

Lissek, S., Rabin, S., Heller, R. E., Lukenbaugh, D., Geraci, M., Pine, D. S., & Grillon, C. (2009). Overgeneralization of conditioned fear as a pathogenic marker of panic disorder. *American Journal of Psychiatry*, *167*(1), 47-55.

Lommen, M. J., Engelhard, I. M., & van den Hout, M. A. (2010). Neuroticism and avoidance of ambiguous stimuli: Better safe than sorry?. *Personality and Individual Differences*, *49*(8), 1001-1006.

Lonsdorf, T. B., Menz, M. M., Andreatta, M., Fullana, M. A., Golkar, A., Haaker, J., ... & Drexler, S. M. (2017). Don't fear 'fear conditioning': Methodological considerations for the design and analysis of studies on human fear acquisition, extinction, and return of fear. *Neuroscience & Biobehavioral Reviews*, 77, 247-285.

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy*, *28*(6), 487-495.

Morriss, J., Chapman, C., Tomlinson, S., & Van Reekum, C. M. (2018). Escape the bear and fall to the lion: The impact of avoidance availability on threat acquisition and extinction. *Biological Psychology*, *138*, 73-80.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (2004). The University of South Florida free association, rhyme, and word fragment norms. *Behavior Research Methods, Instruments, & Computers*, *36*(3), 402-407.

Nieuwenhuis, S., De Geus, E. J., & Aston-Jones, G. (2011). The anatomical and functional relationship between the P3 and autonomic components of the orienting response. *Psychophysiology*, *48*(2), 162-175.

Passer, M.T., & Smith, R. (2009). *Psychology: The science of mind and behaviour*. Boston: McGraw- Hill.

Pavlov, I. P. (1928). *Lectures on conditioned reflexes: Twenty-five years of objective study of the higher nervous activity (behaviour) of animals* (W. H. Gantt, Trans.). New York, NY, US: Liverwright Publishing Corporation.

Pittig, A., Hengen, K., Bublatzky, F., & Alpers, G. W. (2018). Social and monetary incentives counteract fear-driven avoidance: Evidence from approach-avoidance decisions. *Journal of Behavior Therapy and Experimental Psychiatry, 60*, 69-77.

Roche, B. T., Kanter, J. W., Brown, K. R., Dymond, S., & Fogarty, C. C. (2008). A comparison of "direct" versus "derived" extinction of avoidance responding. *The Psychological Record*, *58*(3), 443-463.

Simons, J. S., & Gaher, R. M. (2005). The Distress Tolerance Scale: Development and validation of a self-report measure. *Motivation and Emotion*, 29(2), 83-102.

Scherbaum, S., Dshemuchadse, M., Fischer, R., & Goschke, T. (2010). How decisions evolve: The temporal dynamics of action selection. *Cognition*, 115(3), 407-416.

Spielberger, C. D., & Gorsuch, R. L. (1983). *Manual for the state-trait anxiety inventory (form Y):(" self-evaluation questionnaire")*. Consulting Psychologists Press, Incorporated.

Spielberger, C. D., Gorsuch, R. L., Lushene, R. E., & Vagg, P. R. (2010). State-trait anxiety inventory (STAI). *BiB*, *1970*, 180.

Torrents-Rodas, D., Fullana, M. A., Bonillo, A., Caseras, X., Andión, O., & Torrubia, R. (2013). No effect of trait anxiety on differential fear conditioning or fear generalization. *Biological Psychology*, *92*(2), 185-190.

van Meurs, B., Wiggert, N., Wicker, I., & Lissek, S. (2014). Maladaptive behavioral consequences of conditioned fear-generalization: a pronounced, yet sparsely studied, feature of anxiety pathology. *Behaviour Research and Therapy*, 57, 29-37.

Vervliet, B. (2017). Partial reinforcement of avoidance and resistance to extinction in humans. *Behaviour Research and Therapy, 96*, 79-89.

Vervliet, B., & Indekeu, E. (2015). Low-cost avoidance behaviors are resistant to fear extinction in humans. *Frontiers in Behavioral Neuroscience*, *9*, 351.

Vervliet, B., Kindt, M., Vansteenwegen, D., & Hermans, D. (2010). Fear generalization in humans: impact of verbal instructions. *Behaviour Research and Therapy*, *48*(1), 38-43.

Vervliet, B., Lange, I., & Milad, M. R. (2017). Temporal dynamics of relief in avoidance conditioning and fear extinction: Experimental validation and clinical relevance. *Behaviour Research and Therapy, 96*, 66-78.

Vervoort, E., Vervliet, B., Bennett, M., & Baeyens, F. (2014). Generalization of human fear acquisition and extinction within a novel arbitrary stimulus category. *PloS one*, *9*(5), e96569.

Wolgast, M. (2014). What does the Acceptance and Action Questionnaire (AAQ-II) really measure?. *Behavior Therapy*, *45*(6), 831-839.

Xia, W., Dymond, S., Lloyd, K., & Vervliet, B. (2017). Partial reinforcement of avoidance and resistance to extinction in humans. *Behaviour research and therapy*, 96, 79-89.

Zvolensky, M. J., Eifert, G. H., & Lejuez, C. W. (2001). Offset control during recurrent 20% carbon dioxide-enriched air induction: Relation to individual difference variables. Emotion, 1(2), 148.

Appendices

Appendix 1: Briefing Form

The study in which you are being asked to participate is being conducted by Sean Boyle, under the supervision of Dr. Bryan Roche at the Department of Psychology at Maynooth University.The research forms part of an ongoing programme to understand how people develop aversions to various things in their environment (e.g.,fears and phobias). It is not necessary for you to have any particular fears or phobias to participate in this study. We are studying the basic learning processes that might be involved in acquiring a mild fear, and this may help us to better understand how intense fears and phobias develop.

The experiment involves you being presented with words and brief (0.2 seconds) mild electric stimulations delivered to your forearm. These stimulations are about as strong as you would receive from a static stimulation experienced from touching a car door on a hot day. They are totally harmless unless you have a previous medical condition that makes you vulnerable to such stimulations. You will also learn how to avoid these stimulations by pressing a button on a computer keyboard at the appropriate time.

You should not agree to participate in this study if you are unwilling to experience up to thirty such shocks over the course of the experiment, if you are or have ever been treated for or have ever taken medication for any psychiatric condition (e.g. anxiety, depression, etc.), are possibly pregnant, are under the age of 18 years, or consider yourself vulnerable in any way to the effects of such stimulation.

A final part of this study involves completing a number of questionnaires. These ask simple questions regarding your personality, the emotions that you experience and how you usually respond to them. Your answers on these questionnaires will not allow us to make psychological assessments of you. Your responses to the questionnaires will not be scored until a later date and as such those scores or any interpretation of them will not be available at the end of the experiment.

The study typically takes around 30-45 minutes to complete, depending on how fast you work through the learning stages, although it may take as long as 60 minutes. You will be allowed to take breaks as often as you wish and a full explanation of the purpose of the study will be given at the end.

No names or other forms of identifying information will be recorded and so all of the informtion gathered from research participants will be completely confidential.

All anonymised documentation relating to this experiment will be retained for a period of ten years from publication as outlined in the University's Research Integrity Policy before being securely destroyed by the project supervisor. It must be recognized that, in some circumstances, confidentiality of research data and records may be overridden by courts in the event of litigation or in the course of investigation by lawful authority. In such circumstances the University will take all reasonable steps within law to ensure that confidentiality is maintained to the greatest possible extent.

If you are interested in participating in this study I would appreciate if we could arrange a suitable time for us to meet. Of course, even if you turn up to participate in the study you are free to terminate your procedure in the study at any time.

Appendix 2: Consent Form

This research is being conducted by Mr. Sean Boyle, a postgraduate student under the supervision of Dr. Bryan Roche at the Department of Psychology, Maynooth University (Tel. 01 7086026). It is the responsibility of Mr. Boyle to adhere to ethical guidelines of the Psychological Society of Ireland in the design and conduct of this research.

If I have any concerns about participation, I understand that I may refuse to participate or withdraw at any stage.

I have been informed as to the general nature of the study. I understand that as a requirement of participating in the study I will be exposed to several brief electrical stimulations to my forearm that will be similar to a static shock that people often experience in daily life. I will be asked to fill out a series of questionnaires, relating to my personality and general level of stress and anxiety. These tests are not clinical in nature and cannot be used to make a diagnosis of any kind. I understand that my responses to the questionnaires will not be scored until a later date and as such my scores or any interpretation of them will not be available at the end of the experiment. I am happy that I cannot receive the scores assigned to my responses on any of the tests administered in this study.

I have no medical or psychological condition that would make it harmful for me to experience mild electric stimulations (e.g., no heart condition, or other condition that makes me vulnerable to sudden stimulations, such as anxiety or depression). I also confirm that I am over the age of 18 years and am not pregnant.

All data from the study will be treated confidentially. My data will not be identified by name at any stage of the data analysis or in the final report. I can request that my data be destroyed immediately upon completion of the experiment, but once I have left the experimental setting my data will no longer by identifiable as mine and so cannot be destroyed.

At the conclusion of my participation, any questions or concerns I have will be fully addressed. I may withdraw from this study at any time, and may withdraw my data at the conclusion of my participation.

Signed:

______________________Participant

_____________________ Researcher

_____________________ Date

If during your participation in this study you feel the information and guidelines that you were given have been neglected or disregarded in any way, or if you are unhappy about the process, please contact the Secretary of the Maynooth University Ethics Committee at research.ethics@nuim.ie or +353 (0)1 708 6019. Please be assured that your concerns will be dealt with in a sensitive manner.

Appendix 3: Debriefing Form

Thank you for participating in this experiment.

The current study was designed to examine the idea that people can quickly learn to avoid unpleasant things and experiences and learn quickly to anticipate negative events based on logical reasoning. In this case you may well have learned to avoid the brief static shocks by pressing the space bar on the computer keyboard, whenever particular words appeared on the screen. Even more interesting in this study, however, was the fact that some of the volunteers may have learned to avoid shocks by also pressing the space bar when words only indirectly connected to threatening words appeared on the screen. For instance, in the later parts of the study you may have pressed the space bar based only on guesses that shocks were about to be delivered. These guesses were also assessed by asking you what you had expected to happen following the presentation of various nonsense words on the screen.

Your contribution to the study will allow us to better understand the conditions under which people make these guesses that something negative is about to happen to them in daily life, and therefore better understand anxiety and phobia conditions.

If at any stage you feel like you would talk to someone about the shocks that you have received, or for any reason whatsoever, please contact Dr. Bryan Roche () in the Department of Psychology. He has overseen the running of this study and will be very happy to talk to you about it, your reactions to it or any other aspect of the study.

In the case that you feel distressed regarding any aspect of the study, we would suggest that you contact the Maynooth University Counselling Service during office hours at (01) 7083554. This office can provide free counselling support for students.

If you would like support with your distress outside of office hours we suggest that you contact The Samaritans (Tel: 1850 609090) and GROW (Tel: 1890 474474). Both of these services provide confidential and free assistance for adults in emotional distress.

Due to the confidential nature of the way in which you data will be stored, we will not be able to identify your data after this point. It will be stored for ten years in an anonymized form on a computer in the Department of Psychology at Maynooth University. Your name has not been recorded in any form and is not associated with your data in any way. You are free to ask for the data to be destroyed at this point.

Appendix 4: Expectancy ratings

What is your expectancy of receiving a shock if **WEEP** appears and you **DO NOT** press the space-bar the correct number of times?

1. Definitely won't
2. Maybe won't
3. Not sure
4. Maybe will
5. Definitely will

What is your expectancy of receiving a shock if if **WEEP** appears and you **DO** press the space-bar the correct number of times?

1. Definitely won't
2. Maybe won't
3. Not sure
4. Maybe will
5. Definitely will

What is your expectancy of receiving a shock if if **CRY** appears and you **DO NOT** press the space-bar the correct number of times?

1. Definitely won't
2. Maybe won't
3. Not sure
4. Maybe will
5. Definitely will

What is your expectancy of receiving a shock if **CRY** appears and you **DO** press the space-bar the correct number of times?

1. Definitely won't
2. Maybe won't
3. Not sure
4. Maybe will
5. Definitely will

Appendix 5: Pre- Test Semantic Fear ratings

ID:__________________

Date:___________________

During the experiment commonly used English words such as those listed below will appear on the screen. On each scale please indicate how fearful you are of that word at **this** time.

	Not at all afraid	A little afraid	Somewhat afraid	Very afraid	Absolutely
weep	1	2	3	4	5
ill	1	2	3	4	5
broth	1	2	3	4	5
chair	1	2	3	4	5
apple	1	2	3	4	5

Appendix 6: Post- Test Semantic Fear ratings

ID:__________________

Date:___________________

During the experiment commonly used English words such as those listed below may have appeared on the screen. On each scale please indicate how fearful you are of that word at **this** time.

	Not at all afraid	A little afraid	Somewhat afraid	Very afraid	Absolutely
weep	1	2	3	4	5
ill	1	2	3	4	5
broth	1	2	3	4	5
chair	1	2	3	4	5
apple	1	2	3	4	5
cry	1	2	3	4	5
sick	1	2	3	4	5
soup	1	2	3	4	5
table	1	2	3	4	5
run	1	2	3	4	5