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Examining the transfer of fear and avoidance response functions through real-world verbal relations.

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This thesis is dedicated to my wonderful wife and two boys who have contributed to my effort with both their time and their patience. I am forever grateful for the opportunity that their support provided.

Due to the nature of fear generalisation research a large thank you to all the volunteers who agreed to being shocked in both senses of the word.

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Abstract

Language is conceived in modern behaviour analysis as a large network of contextually controlled interconnecting stimulus relations. One process in particular, the derived transfer of response functions, is a central feature of these verbal networks. According to this process, the functions of conditioned stimuli (e.g., words) can emerge spontaneously for other stimuli in the language network (e.g., other words). Given this, it is not difficult to see how fear and avoidance can quickly become a clinical issue for verbally able humans once fear and avoidance have been established through direct conditioning experiences in the real world. Researchers within the associative conditioning field have recently become excited by the possibility that conditioned fear can generalise through non-formal stimulus relations. However, their interest in this is recent, their paradigm differs significantly from the behaviour-analytic one, and no studies from that field have directly tested the idea that natural language networks can produce and maintain spontaneous emergence of fear for unconditioned stimuli (i.e., along a semantic or symbolic stimulus continuum). This thesis represented an attempt to produce and control the transfer of fear and avoidance using existing words as conditioned and novel probe stimuli. In doing so, it attempted to build bridges between the methodologies and nomenclature of associative learning theory and behaviour analysis.

Experiment1 used an operant conditioning procedure to establish an avoidance response for a real word, and then probed for a derived transfer of avoidance to a categorically related word. Avoidance was not observed to transfer through these verbal relations. Experiment 2 employed a similar paradigm, but with an enhanced US and using concurrent physiological measures of fear. It also employed synonyms as conditioned and probe stimuli. Significant levels of transfer of fear, avoidance and US expectancies were observed. Correlations between physiological and behavioural measures produced ambiguous but conceptually interesting outcomes. These are discussed in terms of the nature of the relationship (i.e., causal of otherwise) between fear, overt avoidance and stimulus function appraisals recorded as US expectancy ratings. The implications of these findings for our understanding of the interface between language and anxiety are considered.

Experimental psychopathologists undertake the role of scientists in their attempt to occupy the persistent research void between basic and applied psychological research. The lack of cross citations between the Journal of the Experimental Analysis of Behaviour (JEAB) and the Journal of Applied Behavioural Analysis (JABA), the two leading basic and applied journals relevant to behaviour analysis, is just one demonstration of the degree of disconnection between the basic and applied domains (Wacker, 2000). On one hand, Experimental Psychopathology (EPP) is concerned with the identification and understanding of behaviour and the provision of empirical support for behavioural prediction and control much like basic research (Zvolensky, Lejuez, Stuart & Curtin, 2001). While on the other, the manipulation of laboratorial paradigms and the construction of experimental behavioural models provides for the scientific rigour of basic research to be applied to behaviours often demonstrated among the clinical population in more naturalistic settings.

Figure 1.1 demonstrates how Experimental Psychopathology (EPP) can successfully bridge both the basic and applied domains. The examination of post-intervention behavioural analysis can facilitate the development of laboratory based paradigms examining underlying behavioural processes for specific conditions. Novel findings and hypotheses can also be transmitted to the applied research field for examination of those processes in real world settings. By focussing on the processes and components of behaviour rather than its aetiology, it is possible to identify behavioural norms acquired under ideal and well understood conditions. It can also provide comparative data for the study of abnormal behaviour. EPP research traditionally involves non-clinical human and non-human populations in the examination of behavioural components thought to be present in the more complex or critical syndromes of interest to applied researchers.

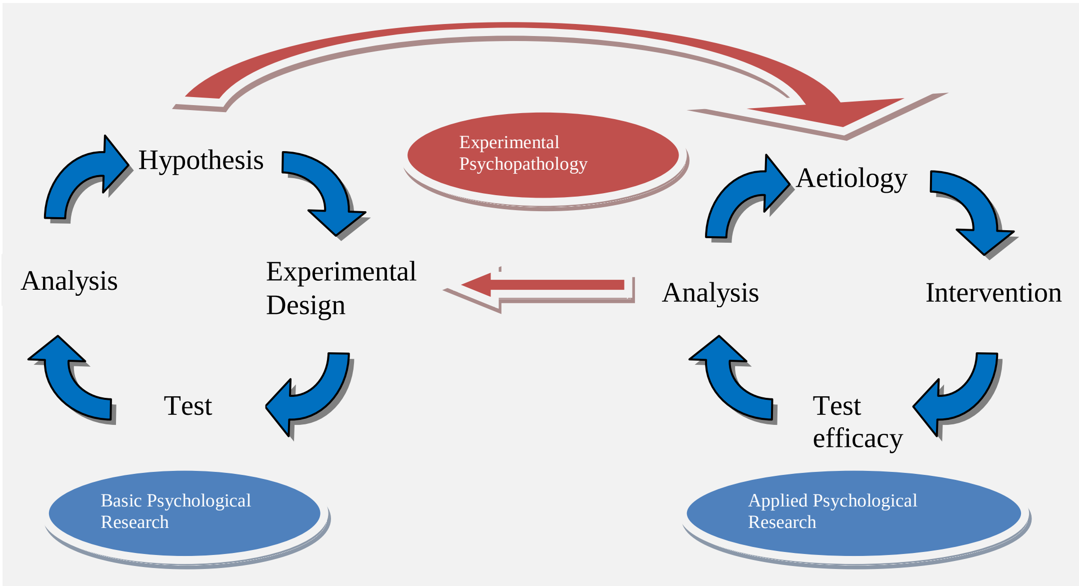

Figure 1.1. The role of experimental Psychopathology in the development of basic and applied psychological research

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In order to support its validity EPP should also involve the regular empirical replication of results and research into their generality in the real world (Leslie & O'Reilly, 1999). The central goal of EPP, however, is to provide bridge studies linking basic and applied research and provide bidirectional benefits to both (Wacker, 2000), as depicted in Figure 1.1.

The ethos of applied research it appears has diverged from theoretical basic research to a more functional interactive, or possibly, reactive form of research (Zvolensky et al., 2001). Research in the area struggles with unique interference from a variety of factors including comorbidity of symptoms and the environmental contexts involved in their occurrence which laboratory developed paradigms rarely encounter. Consequently, the role of clinical practitioners in the diagnosis and treatment of abnormal behaviour (see Figure 1.1) has become more defined by their involvement in the identification of specific syndrome aetiologies and the development of assessment and treatment procedures rather than any underlying behavioural components (Zvolensky et al., 2001). Applied research combines popular intervention techniques and the modification of behaviour in the opposite direction to the socially aberrant behaviour being displayed by the individual. This leads to cumulative research of comparable studies and their outcomes which poorly examines the efficacy of underlying behavioural processes (Wacker, 2000).

The evolution of modern Cognitive Behavioural Therapy (CBT) represents an illustrative example of how an applied research agenda and the development of models or theories of the underlying cognitive and behavioural processes can progress at an uneven pace. CBT has been embraced as a very popular treatment for a range of abnormal psychological behaviours since its development in the 1970s, as demonstrated by the availability of a "Cognitive Behavioural Therapy for Dummies" from all good bookstores (Branch & Wilson, 2010). The majority of available studies appear to support the hypothesis that CBT is equivalent or superior to alternative treatments available for depressive disorders or symptoms (Addis & Jacobson, 2000). However, the degree of influence which individual factors, such as behavioural and cognitive elements or the influence of the practitioner, have in treatment success still remain to be clarified (Butler, Chapman, Forman & Beck, 2006; Addis & Jacobson, 2000). As highlighted by Wacker (2000), rather than an accumulation of research examining the effect of the underlying anxiety or basic behavioural or cognitive functions, this popular intervention is supported by its efficacy in treatment and its comparable effectiveness in relation to other popular interventions. Given the role of clinical psychologists in the field, this applied approach in the development of treatments is appropriate. However, by focusing on basic behavioural functions controlled within a laboratory setting and utilising defined scientific parameters EPP combines the scientific rigour and theoretical bias of basic research but examines underlying behaviour involved in psychological disorders.

While EPP has endeavoured to understand the psychological processes underlying common disorders, symptoms of which are generated and studied in the laboratory, it has struggled to effectively translate its research findings in such a way as to facilitate direct alteration or creation of clinical interventions. Studies that combine basic research aims with applied utility require a high degree of skill and rarely display sufficient co-directionality in theoretical breakthroughs to appeal to both applied and basic researchers (Wacker, 2000). Over a decade ago, Leslie and O'Reilly (1999) cautioned that the experimental analysis of behaviour and applied behaviour analysis are the "science and technology of behaviour" but their newness means that their relationship is not sufficiently defined yet. Such concerns have been echoed by behavioural psychologists working in the field of EPP, who recently lamented the dearth of research into basic behavioural processes underlying common behavioural disorders (e.g., Dymond & Roche, 2009).

Further support for the newness of the field was supplied in a recent review and analysis of the EPP field. Vervliet and Raes in 2012 maintained that while EPP displays *strong construct validity* thanks to its reliance on basic theory and good *diagnostic validity*, due to its provision of comparable behavioural norms, its *predictive validity* was still to be adequately examined. Clinical treatments of behavioural processes examined using a non-clinical convenience sample, for example, may struggle to provide the required theoretical support for specific interventions in a more naturalistic setting (Zvolensky et al., 2001). This external validity, Vervliet and Raes (2012) claimed was a requirement to provide that footing from which an insight into basic psychological processes, that may support abnormal behaviour, can be gained. But EPP's footing should already be assured given that its roots are firmly embedded in early experimental psychology extending over 100 years and it has provided major contributions to psychological science over that period.

1.2 A Historical Sketch of EPP

The emergence of experimental psychopathology can be traced from the early behaviourism of Pavlov through to the cognitive and neuroscience revolutions and beyond (see Figure 1.2). Modern technological and scientific breakthroughs have diverted the field from those early animal studies to the examination of complex, higher order, behavioural components of psychopathology (Zvolensky et al., 2001). The introduction of the experimental analysis of behaviour resulted from Pavlov's observations of the effect certain stimuli had on the behaviour of the dogs in a laboratory setting. He maintained that psychology should promote the empirical analysis of physical behaviour and environmental influence. In doing so it should abandon the quest for understanding of consciousness and its related "psychical phenomena" (Leahy, 2000).

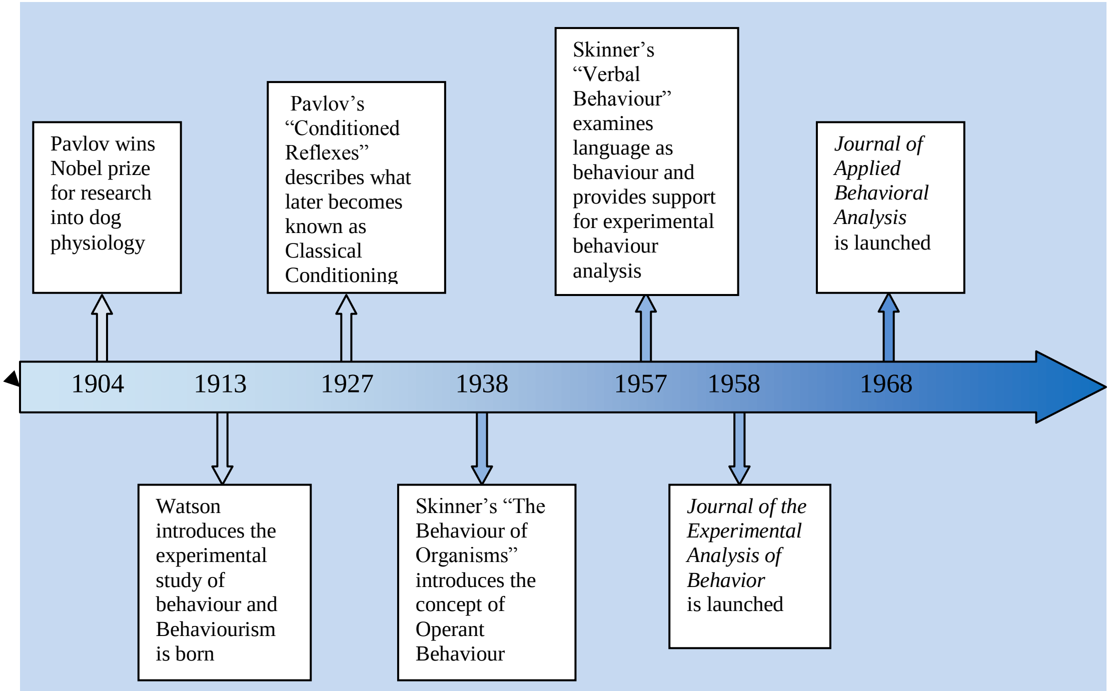

Figure 1.2. Timeline showing the development of the experimental analysis of behaviour from the early physiological research of Pavlov to its emergence as the more recognised modern disciplines of applied research and experimental psychopathology.

Pavlov's observations promoted researchers to develop laboratory based paradigms in which all influencing factors could be controlled and abnormal behaviours could be examined (Zvolensky et al., 2001). Classical early 20th century conditioning experiments by Pavlov, Thorndike and Watson demonstrated basic stimulus response behaviour in animals in laboratory controlled conditions and set the empirical foundation for EPP.

As depicted in Figure 1.2, the emergence of EPP resulted from many of the major early discoveries of modern psychological science. Pavlov, Skinner and Watson are still renowned outside of the world of psychology as the scientists associated with the scientific basis of both human and non-human behaviour. Although, when Watson declared in the early 1900s that human behaviour was comparable to and should be observed scientifically in the same way as that of the laboratory rat, such views were not so palatable to the general public. He claimed that psychology should provide a similar amount of awareness to the consciousness of a human as it does to the rat in the prediction and control of behaviour (Leahy, 2000). These early experimental demonstrations and proclamations formed the basis for the emergence of Behaviourism and the recognition of the role of environmental factors in behaviour. Skinner's research in the 1930s applied operant and respondent conditioning theory to human behaviour and developed those behavioural principles to enable prediction and control techniques to be demonstrated in the laboratory (Miltenberger, 2008). His research successfully remodelled observable behavioural processes from Pavlov's reflexive conditioning and Thorndike's mentalistic learned responding into the study of "observable correlations among objective events and behaviour" (Pierce & Chaney, 2008). In particular, Skinner maintained that behaviour was contingent on the context, the reinforcement available and the reinforcer, all of which could be controlled in the laboratory (Leahy, 2000).

Until the emergence of specialists in the field during the 1960s, applied behavioural analysts were basic researchers who demonstrated Skinner's behavioural principles. These researchers formed a behavioural analysis offshoot in psychology, setting up their own division in the American Psychological Society (APA) and producing their own research journals (the Journal of Experimental Analysis of Behavior and the Journal of Applied Behavior Analysis; Leahy, 2000). Their applications were highly successful and led to the expansion of the applied behaviour analysis field of study (Pierce & Chaney, 2008). This understanding promoted both experimental behaviour modification and the attempt to replicate underlying processes involved in abnormal behaviour (Miltenberger, 2008; Zvolensky et al., 2001). Early experimental psychopathology began to attempt the observation of functional differences in the behaviour of humans in a laboratory setting. Their aim was to identify defects, possible supporting structures or reinforcers involved in the development or maintenance of selected disorders (Zvolensky et al., 2001).

1.3 Basic conditioning model

While applied behaviour analysis may have moved on from the basic operant conditioning model in the examination of abnormal behaviour, the model has accumulated a large amount of supporting research into a range of abnormal behaviours demonstrated by animal research in experimental settings (Leslie & O'Reilly, 1999). By the 1970s, learning behaviours specific to classical and operant conditioning had been scientifically demonstrated as being instrumental in the development of emotional disorders ranging from depression, hallucinations and aggression (Zubin, 1972). Naturally occurring behavioural learning processes can provide for the aberration of behaviour and resulting dysfunction in individuals. In order to illustrate how basic processes feed through to the understanding of problem behaviour in the real world, it is worth summarising some examples of processes as they articulate with diagnosed behavioural problems.

Table 1.1 highlights the possible resulting behaviour that may occur due to the reinforcement provided by, or as a consequence of, applying basic learned behavioural processes to everyday scenarios.

Table 1.1.

Naturalistic examples of learned behavioural processes developing into problematic behaviour as understood by behaviour analysis

Learning process	**Original behaviour**	**Consequence**	**Resulting behaviour**
Classical conditioning	Involved in Motor accident with a bus	General loss of confidence in driving	Approaching buses produce fear response
Operant conditioning	Moderately depressed, so prescribed medication	Mood improves	More likely to persist with taking medication
Avoidance	Fear of speaking in public	Avoids social interaction	Both original fear and contingency efficacy are reinforced
Extinction	Individual involved in civil unrest	Low chance of being identified due to large crowd	Individual’s behaviour becomes more aggressive
Generalisation	Individual has winning streak gambling on horse racing	Appreciates a sense of being lucky/skilled in judgement	Individual’s gambling becomes more regular and more diverse

It is easy to construct a sequence of behavioural events that would explain the development of something as serious as a major social phobia from an initial trauma. For example, perhaps fear acquired by classical conditioning as outlined in the chart due to a collision could generalise to all other road users. The subsequent overuse of avoidance by the individual could lead to social isolation. Not exposing oneself to the hypothetical dangers of other road users would provide for the reduction of possible panic attacks (i.e. extinction) and reinforce future isolation. The successful demonstration of these basic behavioural processes in the laboratory has provided behavioural psychologists with the opportunity to produce abnormal behaviour during experiments which is also supported by applied research in a more naturalistic setting. For example, classical conditioning and the pairing of an unconditioned stimulus (US) with a previously unrelated conditioned stimulus (CS) was demonstrated by Pavlov famously in 1927. An aural tone (the CS) associated with the presentation of food (the US) induced salivation of dogs upon presentation in the laboratory. While this was a purely laboratory demonstration, Edwards in 1962 demonstrated strong physiological responses by US Navy War Veterans to the original battle station alarm which they would have experienced 15 years before during the Second World War (Passer et al., 2009) – a process which involved naturalistic fear conditioning.

For over 80 years, fear conditioning has been implicated in the pathological development of anxiety related disorders and subjected to laboratory based recreations (Lissek et al., 2005). It has been instrumental in the development of aversion and exposure therapies in the laboratory (Rachman, 1964; Todd & Petrowski, 2007). To a large extent the analysis of the behavioural basis of anxiety related conditions is traditionally reliant on studies involving fear conditioning and assorted extinction or avoidance studies. While early non-human conditioning models provided basic insight into the development of fear and the associated behaviour, later EPP studies focused on the creation of behavioural models of the development, maintenance or extinction of anxiety. Their use of threat and avoidance to demonstrate behaviour provides both an explicit behavioural response and a neurophysiological effect (e.g. skin conductance, startle reflex) which can be subjected to quantifiable measurement and analysis. Using these experimental paradigms to explain anxiety related behaviours in the laboratory has resulted in another learned behaviour - fear generalisation being extensively studied and demonstrated.

1.4 Generalisation of fear

Fear generalisation refers to the extending of fear to other either physically or semantically similar or perhaps merely novel objects based on our appreciation of the threat provided by an original conditioned stimulus (CS). As described previously, a collision with a bus may cause us to fear approaching buses in the future (classical conditioning). However, our extension of that fear of buses to a fear of all other road users describes the behaviour of *fear generalisation*. Among his early discoveries Pavlov found that by adjusting the frequency of the tone being used as a CS, the conditioned response (CR) of the dogs was moderated, with the greatest response being recorded to the CS closest to the original (Passer et al., 2009). The early study of generalisation in a laboratory setting was popular possibly due to its simplicity. Once a subject had demonstrated conditioning using a discriminative stimulus, physically similar objects could be introduced as stimuli and the subsequent behaviour would typically be observed reliably. Early generalisation studies provided support for the relationship between the degradation of the physical or semantic similarity between the CS and related stimuli and the probability of observing the CR.

For example, Guttman & Kalish in 1956 demonstrated there was a bidirectional gradient of responding by pigeons to a spectrum continuum of coloured discs. In other words, by initially conditioning the birds to peck at specific colours and by then modifying the colours presented, they observed equivalent reductions in responses in line with the changes in the wavelength of the light presented. Their graph depicted in Figure1.3 highlights the pigeon responses at the first presentation of the trials and divides subjects into high, medium and low respondent groups.

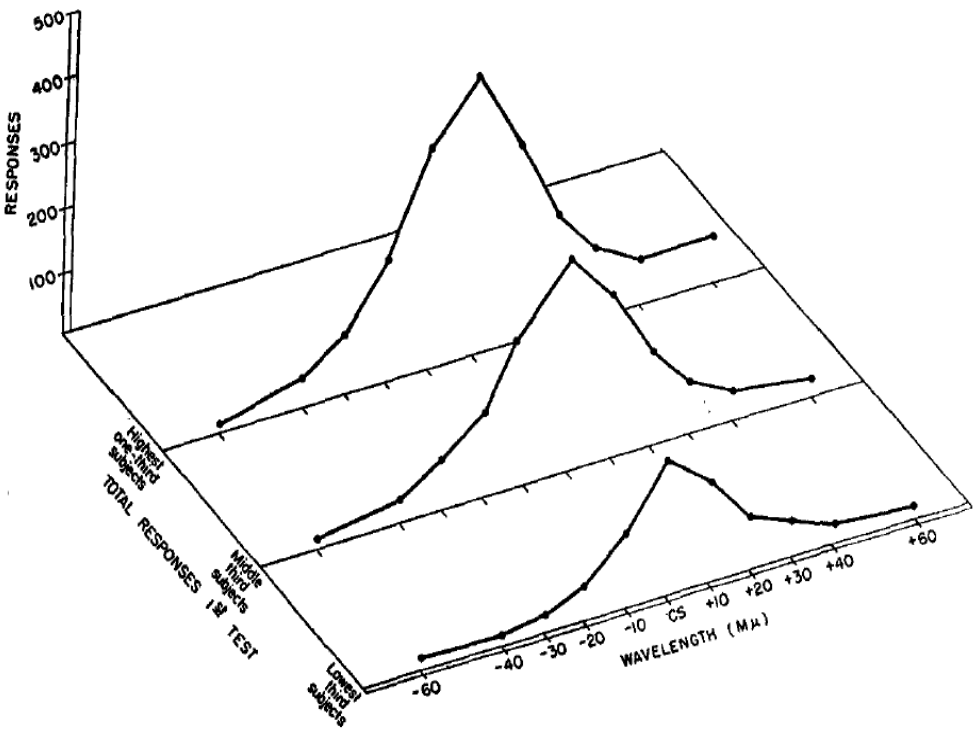

Figure 1.3. Graphic representation of stimulus generalisation demonstrated by the conditioned pecking behaviour of pigeons to graduated colour manipulations of a CS (Guttman & Kalish, 1956).

This figure clearly demonstrates bidirectional stable generalisation gradients among all groups. While these similarities can, as in the case of Guttman & Kalish (1956), be along continua related to physical characteristics in animals, humans can demonstrate the phenomenon with more abstract associative networks when their responses to an original CS have been previously conditioned (Bandura, 1969).

Das and Nanda in 1963, for example, demonstrated the generalisation of positive and negative attitudes to two different Aboriginal tribes when they were paired with two nonsense words. The participants were then conditioned with the nonsense words and the adjectives “Good” and “Bad”. When presented with a collection of other positive and negative adjectives, the participants selected attributes which supported the generalisation of attitudes from the nonsense words to the tribes paired earlier. Their experiment highlighted the ease with which generalisation can occur in humans through verbal networks of quite abstract stimuli.

Human learning however requires successful generalisation for the development of basic skills. Indeed early evolutionary survival facilitated by threat avoidance was probably dependent on the individual’s responses to generalise along a continuum of threat inducing signals. They attribution of possible danger to sudden rustlings in the undergrowth would be of great benefit to the survival of early man for example. Generalisation as a basic learned behaviour has been translated over time from the laboratory to specialist teaching methodologies for those suffering from learning and behavioural deficits (Pierce & Chaney, 2008). Generalised fear has also been translated from the laboratory to the treatment of anxiety disorders (e.g. Exposure therapy or Acceptance and Commitment Therapy) despite the fact that only in recent times has the long accepted association between generalisation and anxiety related disorders been subjected to experimental paradigms involving human participants (Lissek et al., 2008).

Laboratory demonstrations of the reduction of fear along generalised continua have long been demonstrated in animal fear conditioning research. The reliable behavioural and physiological characteristics of fear generation, coupled with the ease with which generalisation can be demonstrated among similar stimuli, has prompted a large body of this type of research to accumulate. Theories relating anxiety disorders in humans to fear conditioning have also been prominent since the 1920's (Lissek et al., 2005). Behaviours such as PTSD and the development of phobias appeal to the process of overgeneralisation and of behavioural responses (Dunsmoor, Mitroff & LaBar, 2012). Modern research has developed from early animal conditioning studies into more complex human conditioning models which examine the manifestation and development of fear. Fear learning theory promotes the role of conditioned fear as the motivator and reinforcer of behaviours such as avoidance, generalisation and resistance to extinction which support anxiety related dysfunction. Basic research has now developed to involve comparable human/ non-human neuroscientific studies regarding fear learning areas in the brain as well as the applied analysis of the efficacy of exposure therapy and has provided support for the learning model (Lissek et al., 2005).

In 2008, Lissek et al. claimed that fear generalisation was "a central, conditional-correlate of pathologic anxiety". They provided behavioural and physiological evidence which supported equivalent graduated fear generalisation in normal human participants to that which had been previously demonstrated in animal studies. Participants with clinical anxiety demonstrated less steep generalisation gradients as well as greater startle magnitudes and self-reported threat expectancy to the physically related visual stimuli (rings). These results supported predictions based on animal fear generalisation studies and also the theoretical role of generalisation in anxiety related dysfunction. This role has been successfully demonstrated in subsequent studies examining Panic Disorder (Lissek et al., 2010), common and persistent fears (Haddad, Xu, Raeder & Lau, 2012) and chronic anxiety (Haddad, Pritchett, Lissek & Lau, 2012). Evidence examining the neurobiological correlates has also provided support for the role of generalisation in anxiety and depression (Dunsmoor, Prince, Murty, Kragel & LaBar, 2011; Greenberg, Carlson, Cha & Hajcak, 2013).

Examination of fear generalisation along physical, relational and conceptual continua has also provided evidence of its role in our everyday lives. While early research explored the effects of manipulations of stimulus features such as aural tone or colour and form on the responding of animals and humans in paradigms examining generalisation (e.g., Pavlov, 1927; Guttman & Kalish, 1956), modern EPP has examined fear generalisation along more novel paradigms. In 2012, Haddad, Pritchett, Lissek & Lau demonstrated the phenomenon between a threat stimulus (CS+) consisting of the image of an individual wearing a fearful expression presented simultaneously with a loud scream and a previously conditioned safe image of a similar individual also wearing a fearful expression (1 of 2 CS-). This paradigm they claimed was designed to provide a simulated real world threat appraisal in the laboratory. Geometrically related shapes were used as conditioned and probed stimuli in Vervliet, Kindt, Vansteenwegen & Herman's study on human generalisation (2010). By pre-exposing selected participants to geometric shapes similar to those later used as the CS+, they examined the differences in SCR and self-reported expectancy ratings between the two test groups. While the effect was not significant, a reduction in generalisation was demonstrated by SCR. Importantly however it demonstrates the clinical interest in the aetiology of fear generalisation and its possible utility in the treatment of anxiety disorders. Dunsmoor, Martin and LaBar in 2012 demonstrated increased SCR and self-reported expectancies for stimuli categorically related to a conditioned CS+. They highlighted an increase in recognition after for both the CS+ and those stimuli categorically related to it but not paired with a shock.

All of these novel demonstrations provide support for the generalisation model of fear development in a naturalistic setting. Recently however, a small group of behaviour analysts have examined the phenomenon along highly abstract continua represented by verbal relations which may prove to be very important in the understanding of human fear conditioning (Dymond et al., 2011). The role of verbally supported or language based transfer of fear possibly provides the greatest opportunity to examine the real world acquisition of fear and provide support for the treatment of clinically relevant conditions. According to their paradigm, the uniquely human capacity to use language provides a natural vehicle for the rapid overgeneralisation of fears along continua that do not arise for non-human populations. They refer to these verbal relations using a concept called "stimulus equivalence" and understand their naturalistic origin in terms of Relational Frame Theory (Hayes, Barnes-Holmes & Roche, 2001). These advances represent a significant progression in the analysis of both the behavioural processes involved in human fear conditioning, but also have included specific recommendations for therapeutic practice. Such recommendations have been accepted and implemented by behaviourally orientated therapists in the mindfulness and acceptance traditions. While the details of modern behaviour analytic advances will be examined in a later section, the suspected importance of human language in fear conditioning, maintenance and generalisation is indicated by a long established and continuing but thin strand of research into what is known as *Semantic Generalisation.* Because this phenomenon is critically relevant to the concerns of the current thesis, it deserves particular consideration.

1.5 Semantic generalisation

When we examine the role of semantic generalisation in human behaviour we can appreciate both the complexity of language and its function in the development and understanding of a complex knowledge base on which predictions and assumptions are made. Indeed, Lambon-Ralph and Patterson (2008) argued that theories proposing semantic representation as a product of the parallel activation of modality specific areas of the brain were not the most parsimonious. In other words, mere neural organisation was insufficient to account for the complexity of everyday language. Their contention was that a specific amodal semantic system, located possibly in the anterior temporal lobes, would be more likely to explain complex associative language based functions. The human ability to recognise core concepts and subsequently generalise across conceptual continua is indeed incredibly complex. The level of sophistication in the information processed (e.g. differing layers of generalisation involving explicit and implied characteristics) combines readily with our already comprehensive knowledge base to develop our understanding of the world around us. The ease with which humans utilise this complex language function in combination with acquired reflexes was studied by the early behaviourists (e.g., Pavlov, 1927) prompted the scientific analysis of semantic generalisation for almost a century.

By tracing the development of experimental paradigms and techniques, as highlighted in Table 1.2, it is possible to understand the conditions and discoveries that led to semantic generalisation and the transfer of conditioned fear becoming a widely accepted phenomenon between the 1940s and the 1970s before disappearing from the public view only to re-emerge with an initial insight into a behavioural basis for fear generalisation provided by trained equivalence relations in 1994 by Dougher, Augustson, Markham, Greenway and Wulfert. It also provides a demonstration of the development of behaviourism from its heady early days to its decline in popularity as a relevant scientific field.

Early semantic generalisation studies began in Russia in the late 1920s with the effect demonstrated using individual words and associated objects (Feather, 1965). Translations of the research papers of Russian researchers such as Kapusnik or Smolenskaya among others from the 1920s had revealed sematic generalisation, between objects and their spoken names and vice versa, being empirically demonstrated among human participants (See Cofer & Foley,1942 for summary). These experimental paradigms resulted from early behaviourism and were developed side-by-side with conditioning experiments in the behavioural field which were popular at that time.

Table 1.2.

Overview of the empirical behavioural study of Semantic Generalisation 1900-2000

Period	**Main Effects Examined**	**Main Contributors**
Pre 1940's	Word/Object generalisation	Hull (1939); Kransnogorsky & Ivanov; Smolenskaya; Kapusnik
1939 - 1949	Synonyms, Antonyms & Homophones. Topographical and categorical similarities	Razran (1939,1949); Reiss (1940,1946); Cofer & Foley (1942)
1950 - 1960	Novel psychophysiological measuring techniques, generalisation gradients	Eisen (1954); Branca (1957); Lipton & Branton (1957); Luria & Vinogradova (1959); Philips (1958)
1961 - 1977	Gradients, generalisation without preconditioning, expectancies and cognitive semantic norms.	Mednick & Wild (1962); Mink (1963); Maltzman et al. (1964; 1970; 1977); Peastral (1961; et al. 1968)
1977 - 1994	None recorded	None recorded

Hull (1939) included indirect or *secondary generalisation* in his theoretical examination of behaviour which he described as *Stimulus Equivalence*. He maintained that rather than any physiological similarities, *secondary generalization* was the result of the conceptual relationship between the implicit characteristics of the stimuli. For the next decade, research into semantic generalisation focussed mainly on synonyms and homophones and the measurement of physiological responding to either positive or negative reinforcement (Feather, 1965).

During the 1940s, Razran who was one of the leading researchers in the field, developed semantic conditioning and generalisation experimental paradigms from the early Russian research into word/object generalisation. By the measurement of salivatory responses to food, he identified human differences regarding the generalisation between conditioned words and their synonyms (strong effect) and homophones (to a lesser degree). Razran's combined experiments, summarized in his meta-analysis of generalisation studies in 1949, provided comparative data for stimuli related to a range of semantic and aural characteristics. He reported a vague gradient of generalisation between stimuli and similar sounding words dependent of the strength of their rhyme. He also reported similarities between the strength of generalisation and their free association reported frequency (Razran, 1949). At the same time his findings regarding the generalisation differences between synonyms and homophones of the CS were also supported by the analysis of SCR differences when fear conditioning was established using a loud tone (Reiss, 1940, 1946; Feather, 1949). By the close of the decade, semantic generalisation had progressed from the rarely discussed phenomenon as described by Keller in 1943 to the recognised variable behavioural effect supported by both SCR and salivatory measurements as highlighted by Razran in his meta- analysis of 1949.

Research in the 1950s primarily focussed on the examination of innovative physiological measuring techniques (e.g., heart rate, SCR & vasoconstriction). Due to its reliability in generating fear and its ease of use these experiments also commonly utilised electric shocks as the unconditioned stimulus. Using SCR Eisen (1954) and Branca (1957) provided evidence that generalisation required the influence of specific semantic relationships rather than merely a responding to word/object associations (Feather, 1965). In doing so they highlighted a level of behavioural complexity in the process. Further evidence of this was provided by Lacey and Smith (1954) who demonstrated significant generalisation effects when words were related along rural (e.g., cow) or non-rural (e.g., book) continua. Curiously however, they found a larger effect for generalised stimuli than that generated by their conditioning paradigm. Unfortunately in 1962, Chatterjee and Ericksen demonstrated a lack of semantic generalisation unless there was an expectancy of shock provided by verbalised instructions as to the nature of the relationship between conditioned and target stimuli (Feather, 1965). Both the Lacey and Chatterjee studies used heart rate increases as their physiological measure and their conflicting results may possibly have influenced the fact that this measure has not been used in subsequent published studies in the area. Luria and Vinogradova (1959) provided a novel paradigm when they successfully conditioned a measureable physiological pain response by pairing the word "violin" with a shock. The *parallel vasoconstriction* of blood vessels measured in the participant's finger and head they claimed represented "a specific pain reaction" and demonstrated generalisation of fear with stimuli involving the names of similar musical instruments (Feather, 1965). Other novel measures utilised in semantic generalisation research during that period included latencies in conditioned eyelid blinking (Hartman, 1963) and blood coagulation (Markosian, 1958). However, the most reliable physiological measure and the one most conducive to the identification of any generalisation gradient was supplied during this period by SCR.

The measurement provided by the rise in skin conductance in the palmer regions of the human hand, provided as a direct response to signals from the sympathetic nervous system, can be accurately recorded by a polygraph device (Dawson, Schell & Filion, 1990). Any increase in conductivity of the skin is in proportion to the strength of the response. It is therefore possible to quantify the response of an individual to each stimulus and provide comparable data for analysis. Subsequent to Reiss's identification of a generalisation gradient along a semantic continuum in 1946, a number of other experiments using SCR demonstrated successfully the graduated generalisation effect using nonsense words combined with shapes (Lipton & Blanton, 1957) or light intensity (Phillips, 1958). A flurry of published articles utilising the electric shock/SCR paradigm in the early 1960s examined semantic generalisation using conceptually related words (e.g., light/lamp) as well as synonyms and homophones (Feather, 1965). While some of the studies identified clear gradients of generalisation (e.g. Mednick & Wild, 1962), others failed to support the graduated effect (e.g. Lang, Greer & Hnatiow, 1963). The pursuit of a well-defined gradient persisted throughout the decade with a final study by Cramer in 1970 utilising Electromyogram (EMG) results to highlight a linear graph of generalised responding in relation to the associative strength of the semantically related words (i.e., the CS and the probe stimulus used for testing for generalisation).

Throughout the 1960s empirical interest in semantic generalisation appears to have waned. There had been a brief attempt by Peastral (1961) to examine differences in generalising behaviour between clinical and non-clinical groups, to provide some insight into pathological behaviour. Despite his success in demonstrating significant differences in behaviour between groups, it appears that the topic also fell from popularity. Emphasis in the 1970s, albeit from a dramatically reduced number of published studies focussed on the role of subjective expectancies and also the human ability to generalise semantically without any pre-exposure to the novel stimuli in the relationship being examined (Maltzman, Langdon & Feeney, 1970; Malzman, Langdon, Pendery & Wolff, 1977). In 1964, Maltzman and Belloni had demonstrated that generalisation is likely even without the participant providing the correct response during the respondent conditioning phase. Then in 1970, Malzman et al. demonstrated equivalent levels of generalisation without the requirement for any training of a mediation effect between the stimulus and the SCR as other studies had in the past achieved with traditional conditioning techniques. By explicitly informing participants to raise their foot every time they heard the word "Light" instead of conditioning the response, they were able to identify significant SCR increases for the word "Lamp". This result, they claimed, called into question the relevance and contribution that traditional Stimulus Response theories had to explaining all instances of fear and its generalisation. Malzman et al. (1970) attributed the semantic generalisation effect to more "complex thought processes" rather than stimulus response processes and promoted a cognitive explanation of the phenomenon. For example, in 1977 Malzman et al. suggested that "semantic conditioning and generalisation are a consequence of thinking rather than vice versa". This represented a critical paradigmatic position that would juxtapose the behavioural and cognitive positions and which until recently rendered the phenomenon and its explanation of little interest to behaviourists.

1.6 Verbal behaviour

The mentalistic view of behaviour as promoted in the field of cognitive psychology since the 1970s would appear reminiscent of the early "black box" appraisal which Watson had railed against during the early 1900s (Leahy, 2000). Their interpretation requires the cognitive analysis of external events which subsequently promote specific behaviour and responses. This internalisation could explain the development of more complex mental processes unexplainable by basic stimulus response theory. Skinner (1978) claimed that cognitive psychologists merely "invent internal surrogates which become the subject matter of their science". Behaviour analysts on the other hand regard higher cognitive processes (i.e., thinking) as private verbal behaviour rather than the driving force behind any observable behaviour (Pierce & Cheney, 2008). The apparent complexity of verbal behaviour has been sufficient for the acceptance by psychologists that higher cognitive processes are required for the control of such behaviour (Pierce et al., 2008).

In their defence, behaviour analysts don't reject the role of higher cognitive processing in behaviour. Skinner argued that they seek out "contingencies in which they occur" rather than merely accepting the mystery of their manifestation (Hayes & Bronstein, 1987). Skinner's theoretical account of verbal behaviour (1957) provided that the speaker's behaviour was reinforced by the listener's responding. This reinforcement was dependent on the history of the listener in similar situations and their behaviour was socially constructed and controlled. He describes verbal behaviour as a tool which is used to produce a response or behaviour at first in others and then eventually in themselves. In this manner, he claims that language is acquired and that its effect is dependent on the social practices of their own specific verbal community (Skinner, 1974). In *About Behaviourism*, Skinner described the effect by explaining that while an individual knows that they can easily open the door themselves, requesting a person present to "open the door" results in the behaviour of others being modified to comply with this request. The resultant behaviour change is dependent on the listener having learned both the language of that class and also the function of the door previously. More complex behaviours, he claims, can also be explained by verbal behaviours developed after basic operant responding has been successfully learned by individuals.

Metaphors, for example, provided for generalisation as similar characteristics between novel and historical stimuli influenced behavioural responding (Skinner, 1974). He also contended that the ability to abstract meaning from the verbal behaviour of others and also to create concepts for stimuli containing more than one property developed a behavioural repertoire in humans which could account for novel and more complex verbal responding. The reinforcement provided by the listener in understanding or responding to the verbal cues provided by such behaviour, increased the probability of the verbal behaviour being repeated. Skinner argued that while complex human behaviours were the most difficult to study scientifically, they shouldn't be regarded as a different field to other behavioural analysis (1974).

Unfortunately his account of verbal behaviour, which may successfully explain basic learning through reinforcement, fails to address more complex language which is "not requiring environmental support" (Vaughan, 1987). In other words, critics have argued that Skinner's account is itself too simplistic to provide a full account of everyday verbal behaviour. Indeed Chomsky prefaced his review of Skinner's Verbal Behaviour by describing it as "a paradigm example of a futile tendency in modern speculation about language and mind" (1967). The over-riding simplicity of stimulus-response theories of behaviourism, which were applied by Skinner in his theoretical examination of language, had struggled to provide sufficient insight into verbal behaviour to dissuade the more mentalistic scientists of the time.

Skinner's "Verbal behaviour" (1957) as an alternative to mentalism, faltered due to the limitations of stimulus response theories in relation to complex verbal behaviour and a lack of empirical research to support his case. For instance, Skinner's theoretical description of verbal behaviour required the spoken word being reinforced by the behaviour of the listener (even if the listener was themselves in private thought). The significance of the words was to be deciphered not by their literal meaning but by the context of their occurrence and the historical experience of the listener. According to Skinner (1974), this process prompted the acquisition of language along social and cultural practices of specific verbal communities. This functional definition struggled primarily because of the reliance on the experience of the listener to provide such reinforcement. Simply put, Skinner's theory requires knowledge of the history of the listener to provide an accurate analysis of the behaviour of the speaker. As a functional definition of a behavioural process requires the context of the behaviour and the history of the organism being examined to be identified, his theory fails to meet these criteria as it focuses on the history of the listener (Hayes et al., 2001).

Another definitional weakness of Skinner's account is that verbal comprehension is reliant on the behaviour of a listener, but by this definition the listener's behaviour cannot be defined as verbal because their role is to provide reinforcement for the person speaking. This becomes problematic for the theoretical definition of verbal behaviour when the listener is the researcher involved in behaviour analysis. All laboratory based operant experiments involve the delivery of reinforcement in support of the behaviour of an organism by a historically and socially trained researcher. Skinner's broad theoretical definition provides that all behaviour demonstrated in the laboratory, including that of animals but excluding that of the researcher, would be considered verbal. Quite apart from the confusion regarding its definition, the inability to demarcate specific verbal behaviour within a laboratory based paradigm fails to provide the opportunity for any accumulation of reliable empirical analysis (Stewart & Roche, 2012). Despite its shortcomings, Hayes et al. (2001) reminded us that there is much of value in Skinner's account of verbal behaviour and it is the broadness of his definition rather than any lack of motivation or creativity on the part of behavioural researchers which has accounted for the lack of empirical analysis for over 50 years.

Hayes and Brownstein predicted in 1987 that the examination of complex behaviours using paradigms developed from already existing behavioural scientific methodology would provide valuable insight into human interactions in the future. Given the previously discussed limitations of Skinner's account for verbal behaviour and its inability to successfully explain complex behaviours not governed by environmental influences, this would appear at first glance to be a rather optimistic claim. However in those intervening years between Skinner' Verbal Behaviour (1957) and the publication of Hayes et al. (1987), the behavioural analysis of more complex processes had been empirically examined using paradigms developed from those early Skinner studies involving schedules of reinforcement incorporating differing stimuli, operants and consequences (Pierce et al., 2008). As predicted by Hayes and Brownstein, traditional behavioural paradigms examining the role of positive (e.g., punishment) and negative (e.g., avoidance) reinforcement in behaviour modification among non-humans provided vital clues in the explanation of behaviours in humans. They also highlighted the behavioural differences between the two groups and led to a greater understanding of why a Skinnerian account alone may not be sufficient to explain the full range of human verbal processes.

1.7 Beyond the Skinnerian paradigm

By developing existing behavioural paradigms, often using animals, and by manipulating different schedules of reinforcement insight was provided into human behaviour in the decades following Skinner's *Verbal Behaviour*. For example, *Discriminated Avoidance* describes operant behaviour traditionally demonstrated in a laboratory by the production of a response (e.g., lever press) to cancel the delivery of an electric shock following the supply of a warning stimulus (e.g., tone). Although this effect is easily conditioned in humans, early research in the 1960s demonstrated this avoidance behaviour in animals is only successfully conditioned after intensive and lengthy training unless the operant response is typical avoidance behaviour for the organism (e.g., running away for a rat; Pierce et al., 2008). Early avoidance studies by Sidman (1953) focussed on the contingencies of negative reinforcement and he was the first to empirically examine *non-discriminated avoidance* (i.e., avoidance when no previous warning signal has been supplied). His research demonstrated that the phenomenon occurred with rats if the delay between responding and the receipt of a shock was greater than that between shocks when there had been no operant response. This behavioural insight supported the utility of avoidance in the suppression of an aversive consequence but also demonstrated the limitations of that utility when schedules of reinforcement are manipulated. Sidman determined that avoidance behaviour increases according to its effectiveness in reducing the appearance of aversive consequences but that the effectiveness of that avoidance results in reduced responding over time unless occasional reinforcement is provided (Pierce et al., 2008). From his research using non-humans, Sidman was responsible for some major insights into avoidance and its role in human conditioning and behaviour. But more importantly, Sidman's research had directed researchers' attention to some interesting behavioural differences between humans and other organisms.

The observed differences in responding under schedules of reinforcement for animals and humans may be attributed predominantly to the role of verbal processes in behaviour modification. The ability to speak privately and be influenced by "symbolic" rather than environmental stimuli contributes to the development of quite complex but easily observable behaviour in humans (Stewart & Roche, 2012). More specifically, in 1971 Sidman developed a reading development program for an individual that had previously been described as "unteachable". His technique focussed on the easily observed word-object association ability that most verbally-able humans acquire at an early age. By combining pictures with spoken and printed words, Sidman was able to transform the written word into what it primarily is, merely a representative symbol of the object in question. During the education process in which the participant successfully acquired the ability to recognise the printed word for a large (60+) number of trained spoken words and pictures, Sidman discovered the emergence of a number of untrained associations which together would be considered a reading repertoire. The participant not only identified the correct printed word relative to the spoken word or selected picture as he had been trained to do, but also demonstrated untrained responding by correctly either identifying the picture or providing the spoken word when the printed one was presented (see Figure 1.4). He referred to this ability as *Stimulus Equivalence* which he contended was defined by three core verbal processes; *Reflexivity, Symmetry and Transitivity*.

Reflexivity describes the matching of two identical stimuli to each other (i.e. A is the same as A if both are present at the same time). *Symmetry* refers to the inverse relationship that exists between two stimuli (i.e., if A is matched with B, then B is matched with A). *Transitivity* provides for the complex relational process of derived conditional responding when more than two responses have been trained (i.e., if A is matched with B and A matched with C, then B is matched with C).

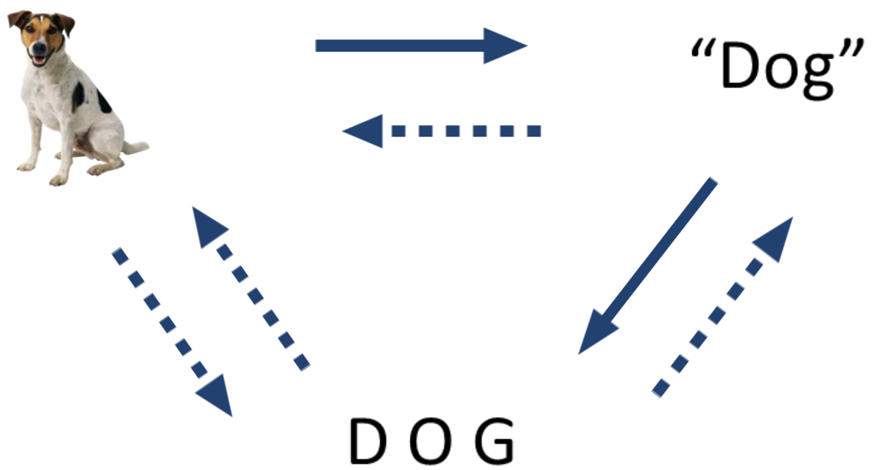

Figure 1.4. Demonstration of the Stimulus Equivalence phenomenon with solid lines representing trained relations and dashed lines representing the derived relations of Symmetry and Transitivity. "Dog" represents the spoken word while DOG represents the printed word.

In other words, in Sidman's educational intervention the participant was trained to select the correct printed word when presented with an object in pictorial form or provided with the word verbally, but they also successfully demonstrated the (untrained) ability to derive the correct picture or verbally name the word which had been provided on a card (Stewart & Roche, 2012). The ability in humans to demonstrate generalised derived relations when only a limited number of associations have been trained both contradicted traditional learning theory and provided an empirically available phenomenon in the behavioural study of language (Stewart et al, 2012).

While research into the phenomenon of stimulus equivalence has focussed on educational development techniques it has also been addressed by more complex experimental and applied behaviour analysis in the last 40 years. The predominant area of research in this period however has been the attempt to establish the parameters in which the human relational ability contributes to language development and learning behaviour. One of the major learning theories known as Relational Frame Theory (Hayes et al, 2001), proposes that the human ability to show generalised responses that appear to extend beyond mere formal relations among stimuli is due to stimulus equivalence. This learning theory is supported by many empirical findings highlighting the close links between language and Sidman's pioneering research (Rehfeldt, 2011). Relational Frame Theory (RFT) highlights the similarity between stimulus generalization and language and provides a reliable and scientifically supported demonstration of the underlying verbal behavioural processes that differentiate humans from other organisms (Stewart et al, 2012). Importantly for our research, RFT provides the theoretical foundation for the empirically demonstrated *transfer of function* between stimuli that appear to constitute generalisation along non-formal stimulus continua. This approach also appears to complete the operant account attempted by Skinner in 1957.

1.8 Relational Frame Theory

RFT proposes that stimulus equivalence and language are based on the same behavioural process which they describe as *arbitrarily applicable relational responding (AARR).* This phenomenon provides for the generalisation of stimulus functions between items without the reliance on any topographical similarity. This is to be distinguished from *non-arbitrary relational responding,* which refers to the phenomenon demonstrated in the early non-human generalisation of fear studies (e.g., Guttman et al., 1956) discussed previously in the chapter. For instance, in the case of Guttman et al. research the modification of behaviour by successive manipulations of stimulus wavelengths was dependent on the physical similarity between the CS and novel shades of colour used as the probe stimuli. This behaviour has been successfully demonstrated by a number of non- human organisms and could be described as responding to the formal or directly established (i.e., non-arbitrary) relations between stimuli. However, RFT proposes that when acquiring language humans also learn relational responding repertoires that include arbitrary relational responding, which can then be applied to any set of stimuli.

In effect humans have the learned ability to respond to stimuli in terms of other stimuli to which they are only indirectly or symbolically related. While the ability has long been noted by cognitive psychologists, the key to RFT is the explanation it provides for this process regarding the learning histories required for this skill to emerge. An example of this would be if we were to ask a verbally able child to identify any similarities between a mouse, cat and an elephant. The child may answer in accordance to a number of physical or categorical similarities (e.g., number of legs or perhaps that they are all animals). In humans, relations between the members of this class could either be non-arbitrarily related in terms of physical characteristics or arbitrarily related in terms of their categorical definition. As this latter classification is a socially constructed event, animals would fail to discern any relationship between the class members on these grounds. Knowledge of class membership provides for the ability to discriminate similarities, but also to derive differences between them and other stimuli presented, based on that knowledge (e.g., novel stimuli could be identified as either animal or not an animal). This verbal and socially moderated behaviour provides a defining difference in learning between us and non-human organisms and according to RFT provides the basic framework for the rapid acquisition of language without resorting to a mentalistic approach.

Basic training of word-object comparisons by parents to children provides for very early training of relational responding. For example, teaching the child "Teddy" when holding toy promotes object/word *symmetry* and the seeking out behaviour by the child when "where's Teddy" is not accompanied by toy holding. This early learning in children, facilitated by word/object naming, develops the use of verbally delivered contextual cues such as the spoken phrase "where is". In the development of generalisation of relational responding, RFT proposes that a *contextual cue* for responding is established determined by the appropriate reinforcement of responses in the presence of the environmental stimulus (usually auditory) "same as". For example, "eat this because it's the same as an apple and you like apple" provides the child with a reference to a novel stimulus previous to their experiencing it. Once sufficient examples have been socially provided and their responses properly reinforced, the child develops more complex relational responding insofar as the cue can come to control the generalisation of response across two stimuli. This phenomenon would be regardless of any formal similarity between the stimuli. In this way formal generalisation becomes generalised along non-formal continua. The only environmental features that are needed for this to occur are relevant contextual cues presented with a specific arrangement of other words and stimuli, each in sequence, accompanied by phrases such as "this is the same as". Given a history of appropriate multiple exemplar training a child quickly learns to respond to novel words or stimuli in accordance with a complex relational network.

Because the functional *contextual cue* (i.e., "same as" in the previous example), controls the behaviour in verbally-able humans, it can be substituted with other cues (e.g., "bigger than") and further increase the complexity of the interlocking network of related stimuli. Of course, these additional cues would have to be established first in a non-arbitrary manner using commonly occurring social interactions (such as those outlined above). Rather than psychological constructs, these *relational frames* refer to the behavioural process involving the generation of "patterns of arbitrarily applicable relational responding" (Stewart et al., 2013).

RFT suggests that the ability to create relational frames is reliant on the acquisition in language training of three key properties, *Mutual Entailment, Combinatorial Entailment and Transformation of Function.* Much empirical evidence supporting the ease with which diverse *relational frames* ranging from the basic (e.g. same or opposite) to more complex (e.g. analogies) can be acquired by humans has been accumulated in the decades since relational frame theory was proposed initially in 1985 (Dymond, May, Munnelly & Hoon, 2010). RFT describes the transfer of response functions from one stimulus to another, similar to but slightly different to Sidman's verbal properties. For the purpose of this thesis it is sufficient to merely to highlight that the three key relational processes of RFT (i.e., *Mutual* and *Combinatorial Entailments* and *Transformation of Function*s) relate to modulated differences in effect across different types of stimulus relations not covered by Sidman's account (see Hayes et al, 2001).

Mutual entailment, of which Sidman's symmetry is a subset, provides that when an A to B relation is defined by a contextual cue, then the perhaps novel or untrained B to A relation is also defined by that cue. Figure 1.5 shows, for example, if we learn that a cat is larger than a mouse, we also know that the mouse is smaller than the cat. Combinatorial entailment provides for a greater range of relations to be defined as it allows for the deriving of a third relation from the combination of two others previously learned. In other words if we learn that the mouse is smaller than the cat and the cat is smaller than an elephant, then it is possible to derive that the mouse is smaller than the elephant. By training two relations between three arbitrary stimuli, their combinatorial mutual entailment leads to the emergence of other derived relations, assuming that the appropriate history of multiple exemplar training using the relevant contextual cue has been provided. *Transformation of function,* the third and key property of verbal behaviour, according to RFT, is specifically relevant to the matter of response generalisation and is of central concern to this thesis.

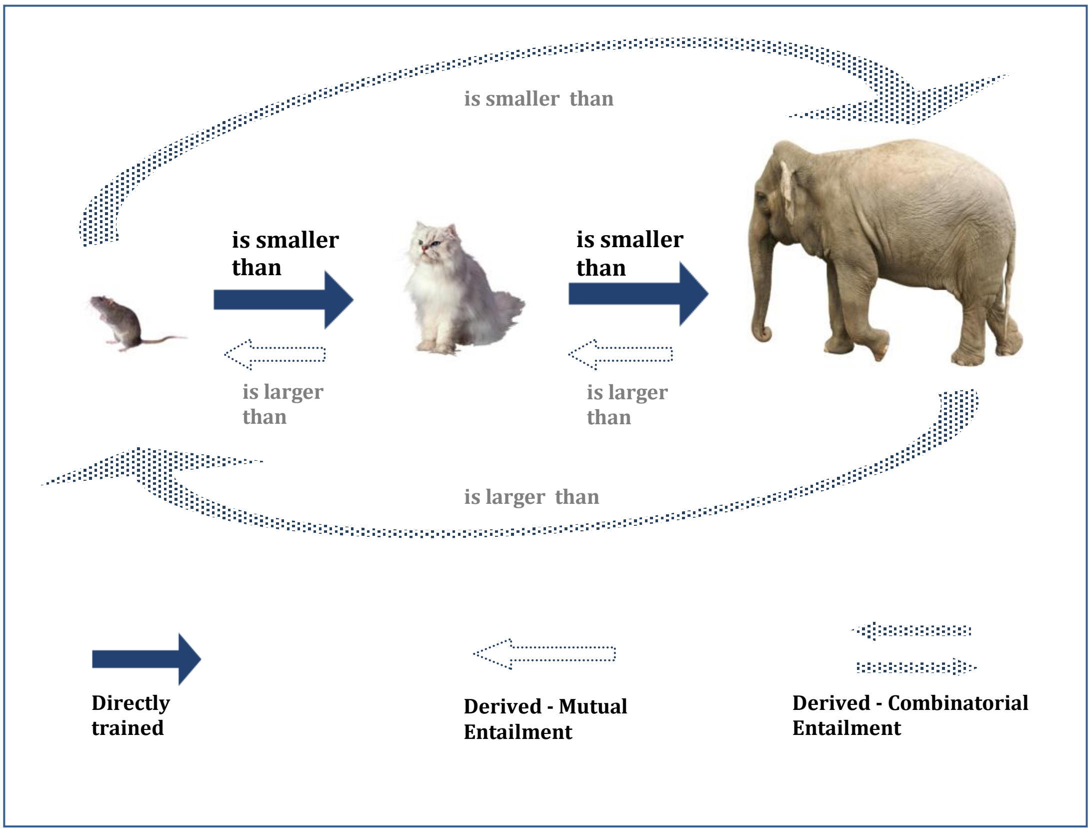

Figure 1.5. Demonstration of the additional derived relations available to a verbally able human, proficient in Mutual and Combinatorial Entailment, when a single 3 member relational network is created using the contextual cue of "is smaller than".

Transformation of function refers to the alteration in the response function of a stimulus by virtue of its entailed relation to other stimuli in a relational network without the need for further training (Valverde, Luciano & Barnes-Holmes, 2009). For example, if you were attacked by a dog then your previous approach behaviour to that dog that resulted in the attack now would almost certainly become less likely. But the same change in behaviour could also be produced from the verbally delivered instruction to "that dog is dangerous". This rule frames the dog in relation to a verbal stimulus with directly established stimulus functions. Based solely on this our response to the dog will be transformed by our response to the word "dangerous". Simply put, the functions present for the word are also now present for the dog, despite the lack of any formal relation between these two stimuli. In this instance, our altered behaviour towards the dog is determined not by experiential evidence of being bitten but has been modified by the verbal cues that controlled the transformation of the functions of the dog vis-à-vis its arbitrarily established relation to the word "dangerous".

This learned ability to demonstrate the three defining features of relational frames or arbitrarily applicable relational responding (AARR), forms the basis for a modern behaviour analytical account of complex human behaviour including language and complex forms of response generalisation. The significance of this rests with the awareness that operant behaviour is malleable and able to change, thus providing an opportunity to modify and control behaviour, taking advantage of the influence that language has over us (Torneke, 2010).

1.9 Applying the Derived Transformation of Functions paradigm to the analysis of fear and avoidance

In a typical RFT experiment examining derived transformation of response functions (see Figure 1.6), researchers will establish and test equivalence or another stimulus relation (e.g., comparative relations such as greater than or less than) between arbitrarily related cues, then pair one member of the relation with a US and then probe for the transfer of the established psychological function (e.g. fear elicitation) between the other members of the earlier learned stimulus classes.

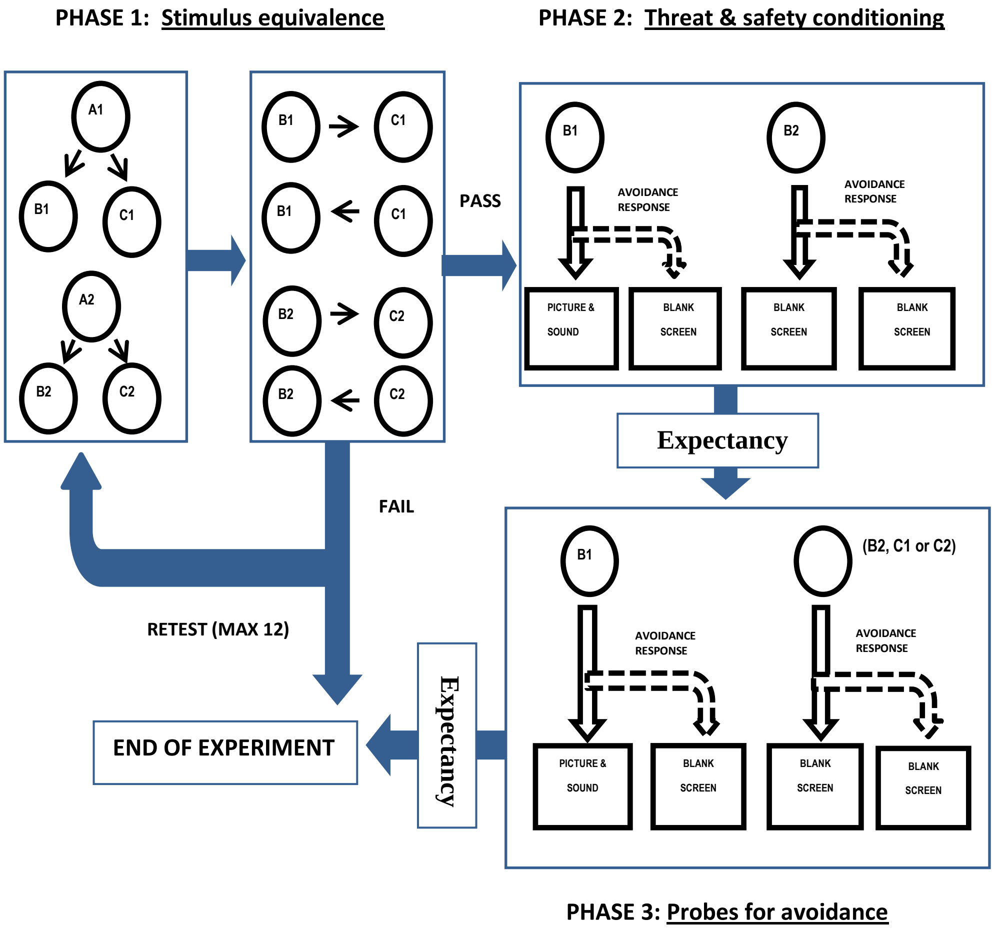

Figure 1.6. Diagrammatic representation of a typical RFT experiment examining inferred avoidance and expectancy ratings for a trained 2 X 3 member equivalence relational network.

Early RFT research provided evidence of the transformation of a variety of discriminative functions between differing relational networks (Dymond & Barnes, 1995) but studies examining the transfer of fear are restricted to a few key contributions. Initial insight into a behavioural basis for fear generalisation was provided in 1994, when Dougher, Augustson, Markham, Greenway and Wulfert successfully demonstrated the transfer of a conditioned fear response between members of a trained equivalence set of arbitrary stimuli. They provided a basic demonstration of the transfer of a fear eliciting function, measured by SCR, between arbitrary stimuli previously trained in 2 x 4 member equivalence classes (A1-B1-C1-D1 and A2-B2-C2-D2). Training individual relations between the A stimulus and the B, C and D for both classes, provides the opportunity for the deriving of conditioned responses to the C and D stimuli when the B has been conditioned as the CS+. By pairing B1 with a small electric shock and B2 with no shock in a respondent conditioning paradigm and measuring SCR to various stimulus presentations, they demonstrated derived transfer of fear to the C1 stimulus but not to members of the other class (i.e., C2). This empirically supported phenomenon of derived relational responding has subsequently been used to provide insight into the non-experiential development of fear (e.g., phobias) and its possible role in the development and maintenance of anxiety related dysfunction (Valverde et al., 2009).

In 2007, Dougher, Hamilton, Fink and Harrington provided evidence that RFT could account for the development of "relational repertoires" that would explain higher order abilities such as abstraction and extrapolation which had up to then been described in purely cognitive terms. With a combination of three experiments, one of which utilised shock as the US and SCR as the dependent measure, they demonstrated that relational training provided for the transformation of a *greater than/less than* function between arbitrary stimuli subsequently influenced respondent behaviour involving key pressing and threat appreciation measured by SCR. Specifically, in Experiment 1 a matching task established a relation between three arbitrary symbols and a discriminative function regarding size (i.e., for symbol A participants selected the smallest object, for symbol B they selected the medium sized object and for C the largest). During the second phase of Experiment 1 the participant had to rhythmically tap a computer key when one of either stimuli A, B or C appeared on-screen. Results for this phase, in contrast to the control group, demonstrated an increasing number of key taps for A,B and C in accordance with the function trained in phase 1. In the final phase an electric shock, with the maximum shock intensity set by the participant, was delivered when stimulus B was displayed onscreen. A lesser shock was delivered for stimulus A, with no shock accompanying the appearance of C in the final part of the testing phase (Phase 3). SCR recorded for Phase 3 supported the expectation of a transformation of function insofar as a large increase in threat appreciation was observed for the C stimulus compared to the A or B stimuli. In Experiments 2 and 3 similar paradigms to those in Experiment 1 were used to establish *greater than/less than* relations between A,B and C stimuli.

In Experiment 2, of the arbitrary cues established in the greater than /less than relation during Phase 1 of the experiment, A was used to establish an arbitrary size ranking between 4 differently coloured but similar sized discs presented on-screen using a matching procedure. During the third phase of the experiment, the participant was trained in the correct rate of key tapping for one of the other three remaining discs not involved in the matching procedure. Probes for generalisation examined for and confirmed different speeds of key presses for the untrained discs in line with the *greater than/less than* hierarchy established earlier in the experiment. In Experiment 3 the same matching to sample paradigm was used but with the mathematical symbols < and > used to establish the relations between numbers initially and arbitrary symbols in Phase 2. Once the relations were established between arbitrary symbols, novel stimuli were then introduced to examine for "correct inferences of relative size ranking among novel stimuli". Based on their findings, particularly from experiment 1, Dougher et al. (2007) contended that the behavioural processes demonstrated provided a better explanation of clinically relevant fear generalisation effects with regard to non-experienced based anxiety than any previously accepted cognitive structures.

In a series of two experiments Valverde et al. (2009) attempted to replicate the earlier Dougher et al. (1994) study. Questions regarding the validity of the earlier results existed, they claimed, due to the pseudo-random nature of the stimulus presentation during the probe phase. Questions were also raised regarding the methodology involved in SCR quantification used by Dougher et al., with tonic levels (measuring against a preconditioning baseline) rather than more reliable phasic changes in SCR being recorded. In Experiment 1, all 17 participants demonstrating the emergence of two 4 member trained equivalence classes during Phase 1 (A1-B1-C1-D1 & A2-B2-C2-D2) by training the relation between the A stimulus and the other three (B,C &D) in both classes. Twelve of those participants then exhibited raised SCR levels during the respondent conditioning phase using shock for the CS+ stimulus (B1) and not for the CS- (B2). However, only 3 participants reached the criteria required for transfer of function (greater increase in SCR between C1or D1 than for C2 or D2) during the Phase 3. The final phase (Phase 4) retested the derived relations established during the first phase with a 95% accuracy retest level. The lack of a generalisation effect was attributed by the researchers to the confusion possibly provided by the C1 and D1 being presented in extinction during the probe phase.

However, Experiment 2 attempted to account for the possible confound by increasing the number of CS+ and CS- stimuli to 2 per condition during Phase 2 operant conditioning. The number of equivalence class members established in Phase 1 was also increased to 5 to accommodate this. During the probe phase (Phase

3), stimuli were not presented in extinction as the anticipatory SCR effect was deemed sufficient to identify any transfer, regardless of whether the stimulus was followed by a shock or not. Also added was an *aversive conditioning reversal* (Phase 4) after the probe phase, during which the B2 and D2 (previously the CS-) stimuli became the CS+ with the original two CS+ (B1 & D1) becoming the CS-. Once again a probe phase (Phase 5) examined for any transfer between other established class members. The purpose of the reversal was to examine transfer between class members in the opposite condition to the one previously probed for in Phase 3. As in Experiment 1, the final phase tested for the maintaining of the original equivalence networks. While only 17 (of the original 30 participants) made it through to the first conditioning stage, 14 (82%) of those successfully demonstrated transfer. Of the 5 who made it through the aversive conditioning reversal, 3 (60%) demonstrated the transfer effect. These findings provided the first empirically valid evidence of the transfer of fear through a trained equivalence relational network.

Transformation of function through trained relational networks has been demonstrated very effectively over a number of studies. However, the transfer of aversive response functions including overt avoidance are of the most interest clinically in the analysis of anxiety related behavioural patterns (Roche, Kantor, Brown, Dymond & Fogarty, 2008). Traditionally from a behavioural perspective the development and treatment (exposure therapy) of anxiety related conditions was reliant on classical conditioning techniques associating anxiety inducing stimuli with previously neutral ones or the removal of opportunities to escape, thereby leading to the extinction of avoidance behaviour. This straightforward “Skinnerian” approach, however, fails to provide a satisfactory explanation for either the development of fear without any pre-exposure or the empirically and clinically demonstrated resistance to extinction of conditioned fear or the emergence of avoidance before it is reinforced (Roche et al., 2008). Despite the success of *Exposure Therapy* in the reduction of fear, avoidance as an operant process is considered to play a major part in the development and maintenance of anxiety disorders (Luciano et al., 2013). Specifically, fear without avoidance is not in itself dysfunctional. It may not either severely disrupt a person's life or lead on to a situation in which therapy is required. In simple terms, as long as an individual is not avoiding feared objects and situations to the detriment of normal functioning, they are continuing to function well. In fact, by exposing themselves to the feared stimuli and extinction of any avoidance responses, they are very likely reducing the aversive functions of the discriminative stimuli for avoidance in their environment (see Dymond and Roche, 2009). In effect, the core problem in anxiety is not necessarily fear, but avoidance (Augustson & Dougher, 1997).

Augustson and Dougher (1997) were the first to provide evidence of the derived transfer of both eliciting functions and avoidance responding in accordance with a derived stimulus network. In this study, the authors replicated their earlier (Dougher et al., 1994) basic demonstration of the transfer of fear between arbitrary stimuli previously trained in 2 x 4 member equivalence classes, but in addition examined whether an available avoidance response would also be generalised across class members. Training individual relations between the A stimulus and the B, C and D for both classes, provides the opportunity for the deriving of conditioned responses to the C and D stimuli when the B has been conditioned as the CS+. By then pairing B1 with a small electric shock and B2 with no shock and subsequently providing an operant avoidance response (i.e., key press), all 8 participants demonstrated derived avoidance responding to the C1 stimulus but not to members of the other class (i.e. C2). Dymond, Roche, Forsyth, Whelan and Rhoden (2007) extended the Augustson et al. (1997) study by initially training a *same/opposite* relational frame rather than just equivalence. Initial relational training established an arbitrary symbol as the contextual cue for *same* and another for *opposite* by reinforcing the selection of the correct comparison stimulus when the cue appeared with a sample, and all comparisons were related to each other and the sample along a physical continuum (e.g., shape). In this case, choosing the comparison identical to the sample was reinforced. In the presence of the other arbitrary cue, choosing the comparison that was not unlike the sample was reinforced. Participants then underwent arbitrary relational training using the new contextual cues in order to establish the relations; A1-B1-C1 *SAME* and A1-B2 A1-C2 *OPPOSITE*. During the avoidance conditioning phase the B1 and C1 stimuli were established as a CS+ and a CS- using aversive images and sounds as the US, with a key press provided as the avoidance response. During the final phase, the C1 and C2 stimuli were presented repeatedly in extinction to examine for any derived avoidance. All but one (7/8) of the participants who successfully met the conditioning criteria demonstrated derived avoidance to the C1, while none did so given the C2 stimulus. These results showed that avoidance functions not only transform in accordance with the verbal relations, but can be contextually modulated. A healthy number of subsequent RFT studies have now demonstrated the phenomenon of the derived transfer (or transformation) of fear and derived avoidance. These provide support for the derived relations approach as a viable paradigm within which to understand the emergence of fear and avoidance, even in situations in which their emergence cannot be predicted by traditional operant or respondent accounts (see Dymond, Roche, Forsyth, Whelan &

Rhoden, 2008; Gannon, Roche, Kanter, Forsyth & Linehan, 2011; Roche, Kanter, Brown, Dymond & Fogarty, 2008; Dymond, Schlund, Roche, Whelan, Richards & Davies, 2011; Dymond, Schlund, Roche &Whelan, 2013). RFT related research examining fear and avoidance now appears to provide clear evidence for the role of verbal processes in the emergence and maintenance of many forms of psychopathology (Stewart et al., 2012).

Gannon, Roche, Kanter, Forsyth and Linehan in 2011 extended the simple "transfer of avoidance" paradigm, by developing a derived relations model of approach-avoidance conflicts. Avoidance responding in itself is a successful coping behaviour and in no way a dysfunctional response to anxiety. In the real world, avoidance alone is not responsible for the pathological development of anxiety related conditions but rather the conflicting behaviours of approach and avoidance appear to be present in clinical phobias for example (Gannon et al., 2011). EPP research over the decades however, has traditionally focussed on operant conditioning paradigms and the possible role of avoidance or escape responding in the development and maintenance of phobic behaviour, rather than examining the approach-avoidance conflict. Based on the clinical research neither of these behaviours contribute to the real world experience of anxiety related disorders but rather are often successful as coping behaviours in non-clinical anxiety. The accumulation of research identifying the possible role of derived relational processes in the development of non-historically reinforced fear and avoidance behaviour and the lack of suitable experimental paradigms examining the approach – avoidance conflict prompted Gannon et al. (2011) to undertake this study.

In their study, they successfully demonstrated an *Approach- Avoidance Conflict* in humans using two 4 member equivalence classes when competing appetitive and aversive stimuli were introduced into each class. Two cues (denoted here as B1 and B2) were paired with an aversive or non-aversive picture in the initial respondent conditioning phase. Phase 2 trained approach in the presence of the B1 cue ("press the YELLOW key to view the image") and avoidance behaviour for the B2 cue ("press the BLUE key to avoid the image"). The participants were then provided with equivalence training which paired A1 with B1, C1 and D1 and A2 with B2, C2 and D2. Those who passed the training and testing for derived relations progressed to the probe phase (Phase 5). The participants were presented with other members of the derived relations to probe for derived approach and avoidance using C stimuli only. In Phase 6, approach and avoidance functions were established for the D stimuli but with the intention of creating a derived function conflict. Specifically, while D1 might be expected to have derived approach functions (but this was not previously probed for), it was employed in Phase 6 as a discriminative stimulus for avoidance. Similarly, while D2 might be expected to have derived avoidance functions (but this was not previously probed for), it was employed in Phase 7 as a discriminative stimulus for approach. This training now created a situation in which the C stimuli should show both derived approach and avoidance functions, a situation expected to lead to response disruption as evidenced by response variability and reaction time delays. During phase 8 the probe phase involving C1 and C2 was replicated to see if any change in response function was apparent.

In the initial probe phase (Phase 5) the participants reliably demonstrated approach behaviour for the C1 and avoidance responses for the C2 stimuli. When contradictory response functions were trained for the D stimuli, participants in the final probe phase demonstrated derived approach and avoidance responses in an unpredictable manner, although patterns were stable within participants (but not across participants). Longer response latencies between the initial and final probe phases provided further evidence of an approach-avoidance conflict and also highlighted its disruptive effects, which served as an analogy of behavioural disruption in the real lives of anxious clients. As can be seen, RFT based paradigms have developed beyond the basic behavioural model of derived relational responding provided by Augustson and Dougher (1997) to a more complex demonstration of the role that it can play in the understanding of a behaviour basis for psychopathology.

1.10 Current trends in the analysis of fear and avoidance

While all of this behavioural research was being conducted over the past two decades, associative learning theorists continued with the basic analysis of fear generalisation using cognitive style interpretive frameworks. While they have not managed to study fear and avoidance at the level of complexity discussed here, they have developed interpretations that in principle predict these very complex experimental outcomes. For example, Declercq and De Houwer (2009) claimed that what they called "inferred avoidance" can be explained by Lovibond's expectancy theory (2006) which in turn posits that both the function of the avoidance response and expectancies related to the appearance of an aversive stimulus after an aversive cue result from the previous associations learned during equivalence training. This is a quite familiar cognitive style interpretation of the derived transfer of fear effect, but it is intrinsically unsatisfying to the experimental analyst of behaviour. Expectancies themselves as an explanatory concept do not then become explained – and yet they are employed in a mediational style account, thereby leaving part of the behavioural process of interest unaccounted for. Rather than approach the observed fear transfer effect as the product of the controlled laboratory environment alone, these researchers and others in the associative conditioning field maintained that conditioning contingencies serve merely to allow the organism to develop mental associations, and in some cases propositions, regarding CS-US relations. In other words, it is this mental knowledge, rather than the conditioning, that explains experimental outcomes. This approach is clearly not the most parsimonious interpretation from a behaviour- analytic perspective, but has great intuitive appeal to many researchers outside the behavioural field.

Rather than decry the lack of functional thinking within the fear generalisation literature, it may be a better strategy to attempt to meet the associative community half way. By employing some of their procedures and addressing questions in the manner that they would, but all the while keeping a critical eye on a functional analysis, a small number of studies have attempted to build bridges between the associative and behavioural traditions. In their 2011 study examining derived transfer of avoidance between arbitrarily related nonsense words in two 3 member equivalence classes, Dymond et al. provided in-trial expectancy ratings similar to those applied by associative researchers to examine their relationship to overt avoidance rates. They included two sets of expectancy ratings which examined Declercq and De Houwer's (2009) contention that inferred avoidance could be explained by Lovibond's 2006 expectation theory. The experiment also extended the findings of Augustson et al. (1997), which had previously examined inferred avoidance between trained relations but not ones directly associated to each other as had been demonstrated in the Declercq et al. (2009) study. By establishing verbally related stimuli rather than relations based along a topographical continuum, Dymond et al. (2011) provided evidence of symbolic generalisation of anxiety and avoidance, rather than mere conditioning phenomenon, between exposed and related stimuli. Initially they trained conditional discriminations for two sets of 3 stimuli (e.g., AV1=AV2, AV1=AV3) and subsequently examined for symmetry and transitivity (e.g., AV2=AV3, AV3=AV2). One member of each group (i.e., AV2 or N2) was then conditioned as either a threat or safety cue. By probing for avoidance using all of the trained stimuli they attempted to demonstrate inferred threat (avoidance response) and safety behaviour (no response) for arbitrary, indirectly associated stimuli in a laboratory.

Their results successfully demonstrated the transformation of avoidance function in accordance with derived relations and also the transfer of expectancies. Participants not only avoided the derived CS+ (DCS+), but also reported increased expectation of an aversive consequence relative to the derived CS- cue. Rather than explaining the derived avoidance by appealing to the derived expectancies, Dymond et al. contended that both were part of the same single (i.e., parsimonious) process of derived transformation of the stimulus functions. Dymond and colleagues have subsequently demonstrated similarities between symbolic generalisation and explicit learning as indicated by reported threat appreciation and avoidance responding (Dymond, Schlund, Roche, De Houwer, & Freegard, 2012) and also by examining event related potentials (ERPs) evoked at parietal and occipital areas in the brain (Wang & Dymond, 2013).

However, in their study in 2009, Declercq and De Houwer claimed that their reported significant relation between expectancy ratings and avoidance was consistent with their hypothesis regarding the mediating role of expectancy in producing avoidance behaviour. Their evidence supported the role of learning and cognitive processes in the selection of an avoidance response when their participants were provided with a choice between two available conditioned avoidance responses. Their analysis of correctly reported expectancy ratings provided convincing evidence in relation to the correct avoidance response being selected when 100% accuracy in expectancy was recorded. For those participants with a less than perfect expectancy response record, they observed a level of correct avoidance which was above the level of chance. Declercq and De Houwer theorised that participants who provided incorrect expectation but with accurate avoidance may have cognitively chosen to ignore expectancies which were insufficiently learned and reverted to chance behaviour. They claimed that their reported statistics provided unique support to the cognitive theory of avoidance of Lovibond (2006). Examination of their statistics indicated their preferred choice of measure to be the subjective and self-reported expectancy results, over possibly the more reliable physical response levels to support their argument.

Declercq and De Houwer (2009) claimed that 29 participants demonstrating 100% correct avoidance also provided accurate expectancies, with a further 13 providing less than 100% accurate expectancies. They also claimed that 33 participants had provided 100% accurate expectancy ratings. From their sample of 56 participants, their statistics then would indicate that while only 33 participants (59%) provided correct expectancy ratings, 42 (75%) provided 100% correct avoidance. Although it may have been contrary to their stated hypothesis, these results indicated a greater accuracy rate for avoidance than for correct expectancy ratings and were not reported. Declercq and De Houwer (2009) claimed that there was a significant relationship between expectancy and avoidance which provided support for Lovibond's cognitive theory (2006) and the mediating role of expectancy, yet their evidence may be interpreted to dispute this role.

In a more recent study by Dunsmoor, Martin and LaBar (2012), the researchers paired exemplar images of one category of objects (i.e., tools) with shock and exemplars of another (animals) with a safety (no shock) outcome. They measured generalisation of fear from trained exemplars to novel category consistent exemplars using skin conductance measures. They also examined self-reported expectancy ratings taken during the trials and memory recognition tests - 24 hours or more following the training and testing procedure. They observed significant fear generalisation within categories to novel exemplars, higher levels of reported shock expectancies and greater memory recall for the CS+ over the CS-. Dunsmoor et al. however failed to provide any insight into the underlying behavioural mechanisms which would explain the ease with which "conceptual knowledge" was accurately "accessed" to predict the appearance of the US. The authors were content merely to highlight that "higher order cognitive systems interact with basic conditioning mechanisms". They claimed that current fear conditioning research involving humans is ill equipped to examine how previously learned conditioned stimuli are maintained in memory and so easily accessed in threatening situations.

Interestingly, the Dunsmoor et al. (2012) study was not entirely novel in its conceptualisation. In 1943, Keller demonstrated the generalisation of fear within categories of objects, as measured by SCR. His study involved establishing a picture of a boy scout hat as a threat cue (among other stimuli) but presenting a fireman hat during the probes for the transfer of fear. Indeed, the use of a dedicated probe phase is arguably a superior procedure to that used by Dunsmoor et al. as a separate probe phase was not provided. The researchers relied instead on the recorded differences in SCR between multiple exemplars of the CS+, not all of which was intermittently followed by shock during the conditioning phase. It might be suggested that a more ecologically valid measure of fear transfer would involve the measurement of fear in a separate phase, or even context, in which all stimuli are presented in extinction. Moreover, the use of trial by trial expectancy ratings in the Dunsmoor study may also have interfered with behavioural processes in such a manner as to enhance the transfer of fear effect by "piggy-backing" it on top of a transfer of a simple verbal expectancy effect. This is a well-known procedure in the behavioural laboratory designed to increase transfer of function rates (e.g., see Roche, Barnes-Holmes, Smeets, Barnes-Holmes and McGeady, 2000). An important second question, therefore, may be how much we may extrapolate the Dunsmoor findings to the real world if variables assisting the transfer effect are not present in naturalistic environments? Finally, regardless of the outcome of any improved procedure, it still remains the case that the overwhelming majority of associative learning studies into transfer of functions effects, focus only on fear rather than on operant avoidance responses, although interest in what that community call "instrumental learning" is on the rise due largely to the efforts of behaviour analysts.

It is the contention of the current thesis that the process known as the *transformation of functions* is sufficiently well understood, researched and parsimonious, to qualify as the explanatory mechanism for all the transfer of fear effects studied in the associative learning laboratory. Moreover, it is progressive insofar as it is an operant rather than associative account and takes a special interest in avoidance as a key component of the generalised anxious response to threat. Without an analysis of avoidance, our understanding of anxiety as a condition is seriously limited. The current research attempts to examine generalisation of fear in a more ecologically valid manner than that usually observed in the behaviour-analytic literature. It will also endeavour to articulate the traditional behavioural procedures used to study the derived transfer of fear and avoidance with the procedures employed by associative learning theorists. In doing so, it is hoped that the approach and findings will more easily speak to researchers in that that domain. In essence, the current research represents a refocus of attention on the abandoned semantic generalisation literature, but using modern behaviour-analytic procedures that might inform us better about how transfer of fear and avoidance occur in natural language in the real world.

In the next chapter, two experiments will be reported. The first experiment examined the generalisation of fear across semantic categories already existing in the vernacular (i.e., items of furniture and fruit). During the initial operant conditioning phase (Phase 1) participants were shown, in random sequence, either a word representing a piece of furniture (e.g., *chair*) or a word representing a fruit (e.g., *apple*). Whichever was to be established as the CS+ cue was always followed by the presentation of an aversive image and sound. The other word (CS-) functioned as a safety cue. The participant had the opportunity to cancel the appearance of the unconditioned stimuli (US) by pressing on the spacebar when the CS+ cue appeared on the screen. When participants successfully showed acquired avoidance under stimulus control of the CS+ and CS- cues, they were presented with a series of Likert style scales designed to record their expectancies of aversive consequences under a variety of hypothetical stimulus conditions.

Phase 2 was a probe phase in which words semantically related to the CS+ and CS- were presented in extinction. For example, *table* and *pear* would function as derived CS+ and derived CS- stimuli, respectively, in the case that chair and apple had been employed as CS+ and CS- stimuli, respectively. After a block of such probes interspersed with baseline conditioning trials, participants once again rated their expectancies of aversive consequences under various stimulus conditions. It was expected that participants would show avoidance learning in Phase 1, but also show spontaneous avoidance of a word cue semantically related to the CS+ but not one related to the CS-. Moreover, based on the findings of several recent studies, it was expected that participant expectancies of aversive consequences would correlate with their rates of overt avoidance of the CS+ and semantically related words.

Experiment 2 sought to revisit the abandoned semantic generalisation paradigms described in an effort to link this paradigm to the analysis of derived avoidance, by using derived avoidance, a physiological measure of fear and self-reported rating of aversive consequence expectancy as dependent measures. This experiment also utilised small electric shock as the US, an aversive stimulus commonly used in traditional semantic generalisation paradigms.

During Phase 1, the participants were exposed to 20 respondent conditioning trials using two words as discriminative stimuli, one of which was a designated CS+ cue (e.g., *broth*) and the other a CS- (e.g., *assist*). The CS+ was always paired with a shock. Phase 2 commenced with an operant conditioning phase designed to establish an avoidance response for the CS+. The avoidance response made available to participants was a space bar press on a computer keyboard, produced during the presentation of the CS+. Immediately following the conditioning trials and without warning, a synonym of each CS cue was introduced to probe for derived avoidance. During all of the trials, skin conductance responses to the CS+, the CS- and their synonym probes were recorded.

As in Experiment 1, it was expected that a conditioned fear response would be readily established, followed by avoidance conditioning using an English word as a CS+. It was also expected that participants would show spontaneous avoidance of a word cue semantically related to the CS+, but not one related to the CS. The physiological arousal (i.e., fear) observed in the presence of synonyms of the CS+ was expected to be greater than that observed for the CS- synonyms. It was also expected that participant expectancies of aversive consequences would correlate with their rates of overt avoidance of the CS+ and semantically related word cues, as well as with their skin conductance response magnitudes to these stimuli.

Chapter 2

Experiment 1

Traditional research paradigms examining the semantic generalisation of fear usually involve the training of a relation between two stimuli, pairing one of those stimuli (CS) with an aversive US and then examining for any transfer of fear to the stimulus originally related to the CS. This is often measured by SCR and/or expectancy ratings. In their study, Augustson and Dougher in 1997 provided a new behavioural model which demonstrated that inferred avoidance was transferred through equivalence rather than though directly trained relations. Developing on from this, Dymond et al. (2011) provided evidence of symbolic generalisation of anxiety and avoidance between verbally related stimuli established using an equivalence relation. However, Declercq and De Houwer (2009) had previously questioned the validity of equivalence training in producing the phenomenon outside the laboratory, if the empirically demonstrated high level of training was required.

In a more recent study by Dunsmoor, Martin and LaBar (2012), researchers paired exemplar images of one category of objects (i.e., tools) with shock and exemplars of another (animals) with a safety (no shock) outcome. They measured generalisation of fear from trained exemplars to novel category consistent exemplars using skin conductance measures. While they observed significant fear generalisation within categories to novel exemplars and higher levels of reported shock expectancies, they failed to provide any insight into the underlying behavioural mechanisms which would explain the ease with which "conceptual knowledge" was accurately "accessed" to predict the appearance of the US. They also required a high number of training trials to establish the categorical relationship between the individual cues.

This experiment attempted to provide a real-world demonstration of fear generalisation and inferred avoidance along a naturally occurring semantic continuum, without the pairing of the CS+ and the DCS+ being explicitly trained and using modern behavioural techniques. Having initially established the name of a piece of furniture or a fruit as the CS+ cue using an operant conditioning procedure in which an avoidance contingency was available, another novel name from the relevant category was suddenly introduced during the subsequent probes phase. In doing so the experiment wanted to see whether it would promote inferred avoidance between untrained semantically related cues.

Method

2.2.1 Participants

Fifteen participants were recruited from the family and peers of the experimenter. The sample comprised of 8 males and 8 females, ranging from 20 to 52 years old (mean age = 35.92 years). Participants were randomly selected from experimenter's contacts and no remuneration was offered or given for their participation. Subjects were not screened for prior or current anxiety conditions, but were made aware of the nature of the experiment on a number of occasions (see procedure).

2.2.2 Apparatus

Software written in Visual Basic 6.0 was used to present the stimuli and record the responses. Two pairs of cues (words) were composed randomly based on the criteria of categorical relatedness and a maximum of 5 letters each (see Table 2.1). The cues selected were selected from the words *chair, table, apple, grape* and *pear*. The categories (furniture and fruit) provided the discriminatory relationship for conditioning and derived avoidance. These CS cues were presented in black uppercase size 24 bold font and were restricted to nouns containing 5 letters solely due to the restriction on screen display size.

The aversive visual images and auditory effects (US) were obtained from previous experimental designs examining fear conditioning and symbolic generalisation (Dymond et al. 2009, 2011). These stimuli were originally selected from the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 2005) and the International Affective Digitized Sounds (IADS; Lang, Bradley & Cuthbert, 1999) databases and used as aversive stimuli in Phase 1 conditioning and Phase 2 probes. Ten images of mutilated and decaying dead bodies and sounds of screaming and torture were used for the experiment. Images were presented on a standard 15" computer monitor and the sounds delivered by headphones set at medium volume and worn by the participants.

Participants also completed a self-evaluation questionnaire, consisting of 40 questions taken from the State – Trait Anxiety Inventory (Spielberger, 1983).

2.2.3 Ethics

Completed Research Proposal and Ethical Approval Forms were submitted to both the N.U.I.M. Biomedical Sciences and the Social Research Ethics Sub-committees for approval. Once approval was obtained, a briefing document was provided to possible participants for their consideration. The document contained an introduction to the experiment, as well as a detailed summary of the procedure involved. The aversive nature of the images and sounds that the participants would encounter during the experiment was highlighted, as well as the individual's ability to withdraw from the experiment at any time. Confidentiality was assured and the name and location of the supervisor responsible was provided. Comprehensive contact details of both the N.U.I. Counselling Service and other publicly accessible counselling services (e.g., AWARE) were provided on the briefing document, should any participant experience any post experimental distress. Briefing documents were provided a minimum of 24 hours before any testing took place, to provide a sufficient period of notice.

At the beginning of the experiment, a consent form was considered and signed by each participant with regard to their understanding of the issues addressed in the briefing document and also the reaffirmation of their right to withdraw at any stage during the experiment. A debriefing form was supplied at the end of the experiment, providing a brief overview of the experiment as well as contact details for the research supervisor for any subsequent enquiries that the participant may have. All documentation complied with the British Psychological Society's code of professional ethics and was approved by both the Biomedical Sciences and the Social Research Ethics Sub-committees in N.U.I. Maynooth.

2.2.4 Experimental design

During Experiment 1 conditioned stimuli (CS+ and CS-) and derived stimuli (DCS+ and DCS-) were examined for evidence of derived avoidance responding and also the self- reported expectancy ratings regarding the appearance of aversive stimuli subsequent to each individual cue. All participants were exposed to the same procedure and a within subjects analysis was undertaken using planned comparisons, to examine differences in responding and self-reported expectancies between conditioned CS+ and CS- stimuli and also derived CS+ and CS- to DCS-. The study was also interested in correlations between avoidance and expectancy ratings, so the design is also partly correlational in nature.

This experiment sought to examine the hypothesis of Dymond et al. (2011) regarding the symbolic generalisation of fear. By utilising their 2011 experimental design but by substituting nonsense words previously trained in equivalence relations with English words related in a naturally occurring verbal category, the experiment attempted to replicate a *real world* behavioural experience. The primary hypothesis, as in Dymond et al., was that conditioned and inferred threat cues would produce greater avoidance than conditioned and inferred safety cues. The dependent measure was the mean percentage of trials in which avoidance occurred for each cue. It was also expected that ratings of the impending occurrence of aversive stimuli would be greater for the learned and inferred threat cues than for the learned and inferred safety cues, in the circumstance that an avoidance response was not emitted. A related hypothesis was that there would be no difference in expectancies between conditioned threat and safety or between inferred threat and safety cues. The dependent measure used to test these hypotheses, was the mean self-reported expectancy rating provided post trial for each cue by the software. Finally, this study examined the hypothesis that the self-reported expectancy ratings for the occurrence of the aversive stimuli by the participants would correlate positively with rates of avoidance.

2.2.5 Procedure.

Once approval from the relevant Ethics Sub-Committees had been received, a selection of the experimenter's family and peers were invited by email to take part in the study. Included in the email was a copy of the briefing document with an instruction that they read the briefing and indicate by replying, if they were interested in being tested. After a period of at least 24 hours, candidates who expressed an interest in partaking, were contacted and offered a selection of available laboratory times.

Participants were tested individually in the Psychology experimental laboratory. Upon arrival, the participants confirmed that they had been given in excess of 24 hours in which they could opt out of participation. They also confirmed that they had been advised of the distasteful nature of the aversive stimuli and were aware of the content of those images. After they had read the study briefing sheet for the second time and confirmed their understanding of the task, the participant was seated in front of a standard 15" computer monitor connected to a keyboard and supplied with a pair of headphones. They were once again reassured regarding their ability to cease the experiment at any time, if they felt uncomfortable

Phase 1: Fear and avoidance conditioning

Figure 2.1 shows the operant conditioning phase during which the participants were exposed to the aversive stimuli of images and sounds. The object was to provide possible negative (CS+) and positive (CS-) associations to cue words (e.g., table or chair; apple or pear), which would introduce avoidance behaviour. The following onscreen directions were provided for the participants to read and were then repeated aloud by the experimenter:

In a moment, you will be presented with some 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 the relationship between nonsense words and the occurrence of pictures and sounds. When the words are presented, pressing the spacebar may prevent the occurrence of pictures and sounds. You should learn when to press the spacebar. Later, you will be asked to make some ratings, by using a slider-scale. Please 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.

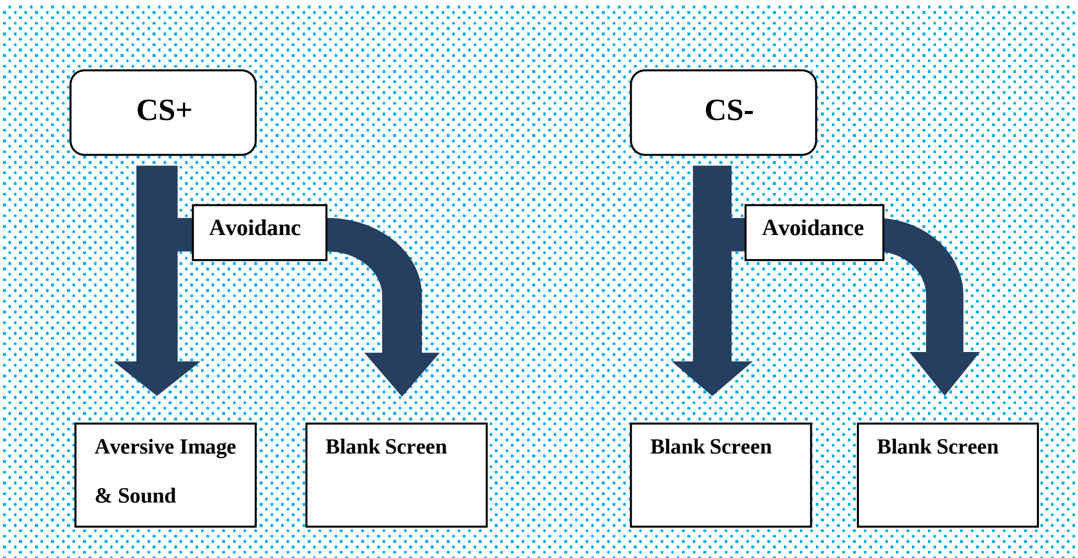

Figure 2.1: Diagrammatic representation of the operant conditioning phase (Phase 1) training both the discriminatory function and avoidance responding for both categorically distinct classes of stimuli.

When the participant proceeded with Phase 1, a blank screen appeared for 12 seconds, followed by either the CS+ or CS- word for 1.5 seconds. The CS+ word provided the cue for the subsequent appearance of the aversive image (a 600 x 800 mm photograph) and accompanying sounds played through the headphones. The aversive stimulus appeared for five seconds and was followed by the 12 second blank screen before the production of the next cue. Avoidance behaviour (pressing the spacebar) while the CS+ cue was on-screen cancelled the production of the aversive image and sound and provided only the blank screen for 12 seconds. No feedback was given regarding any cancellation of the aversive stimuli. The cue provided by the CS- preceded a blank screen of 17 second duration. Avoidance responding in this condition was also followed by a blank screen for 17 seconds. No feedback was given for any of the conditions and there was 100% contingency between CS- with or without avoidance, CS+ with avoidance and the absence of aversive stimuli. Lack of avoidance to the CS+ cue preceding the appearance of the picture and sounds was also 100% contingent. The CS+ and CS- cues were presented pseudo-randomly, until the participant correctly provided avoidance behaviour to six consecutive presentations of the CS+ cue.

With the successful completion of Phase 1, the participant was presented with the first block of rating scales. They were asked to measure on a Likert type scale, their expectancy of the appearance of sounds and images if one of the possible conditions was met. An example of the question was 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 apple appears and you do not press the space bar.

The four conditions (i.e. CS+ with press/ no press and CS- with press/ no press), were presented for consideration. By moving the slide indicator along the scale using the mouse, the participant selected from 1 to 10 their expectancy of the appearance of the aversive stimuli for each stimulus condition. Questions were presented individually until all four were completed and the participant proceeded to Phase 2 and the probes for derived avoidance.

Phase 2: Avoidance probes

Phase 2 began after a short pause for a break which had been indicated on-screen. As shown in Figure 2.2, this phase replicated the previous (Phase 1) but also included the cues DCS+ and DCS- without any prior warning of their appearance.

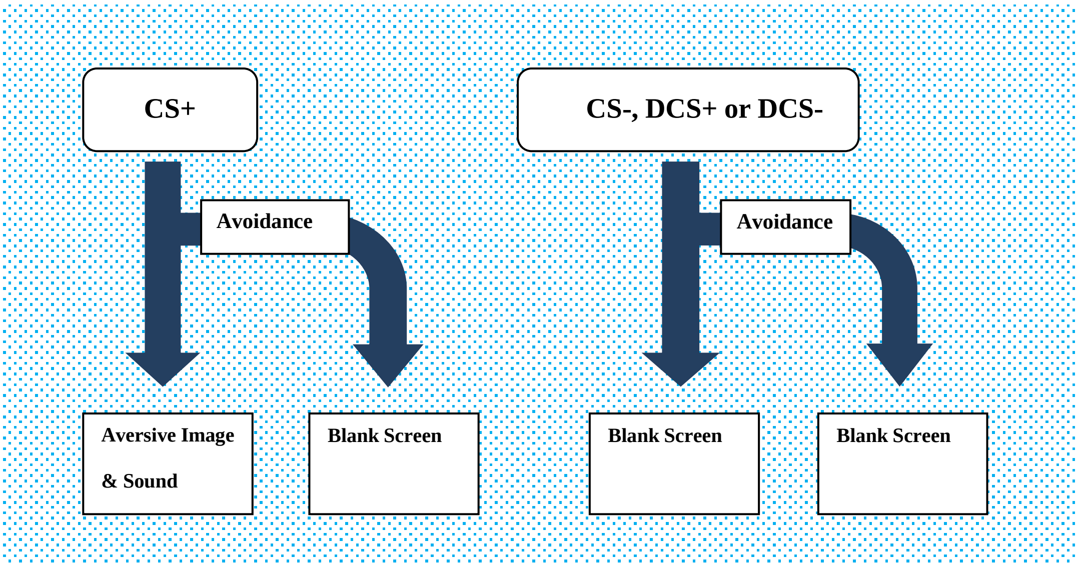

Figure 2.2: Diagrammatic representation of the probe phase (Phase 2) examining for any transfer of function between categorically related class members which would be indicated by avoidance responding.

Following this break an introduction screen provided details of the task ahead. The participant was asked to read the following instructions, which was then read aloud by the experimenter to ensure the procedure is understood:

Now you will again be presented with words, pictures and sounds. Once again, your task is to learn the relationship between words and the appearance of pictures and sounds. When some 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…

When the participant proceeded to the probe phase (Phase 2), just as with they had experienced previously, a blank screen for 12 seconds was initially followed by a CS+ or CS- cue and the presentation of the appropriated conditioning stimulus (i.e., the blank image or the aversive picture and sound). Probes for avoidance introduced, without any warning, the DCS+ and DCS- cues which were categorically related to the original CS+ and CS- (see Table 2.1). Pressing the spacebar provided the avoidance response for all cues, but only in the case of the CS+ cue was the presentation of an aversive image and sounds contingent upon the subject's non-response (see Table 2.1). Probes for derived avoidance consisted of a block of 16 trials containing the following cues: CS+ x 2, CS- x 2, DCS+ x 4 and DCS- x 4).

Upon completion of all trials, participants once again provided expectancy ratings for the appearance of pictures and sounds for the eight stimulus conditions (CS+, CS-, DCS+ and DCS- with either *press* or *no press* avoidance) using the slider scale for each one individually.

Table 2.1.

Words assigned to the CS+, CS-, DCS+ and DCS- conditions for participants P1 to P15.

	P1-P8	**P9-P12**	**P12-P15**
CS+	chair	table	chair
CS-	apple	pear	apple
DCS+	table	chair	table
DCS-	pear	apple	grape

Upon completion of the ratings, the participants were informed that the experiment was complete and thanked for their participation. The participants then completed the *Self –evaluation Questionnaire*. A debriefing sheet was provided and they were given the opportunity to ask any questions relating to the experiment, before the experiment was fully brought to a close.

Results

2.3.1 Avoidance

All 15 of the participants in Experiment 1 progressed from the initial operant conditioning phase (Phase 1) to the probe trials of Phase2. The reader is reminded that the criterion for progression was the production of an avoidance response to six consecutive pseudo-random presentations of the CS+ cue. The mean number of trials required to do so was 21.07 indicating that the function of both the CS+ and CS- cues were well established. .

Figure 2.3 shows the percentage of trials in which participants avoided when presented with the learned threat (CS+) and learned safety (CS-) cues during the training (Phase 1) and the percentage of trials on which they avoided the inferred threat (DCS+) and inferred safety (DCS-) cues during probes for avoidance (Phase 2). The graph shows that there is clear stimulus discrimination between the CS+ and the CS- as well as between the DCS+ and the DCS-.

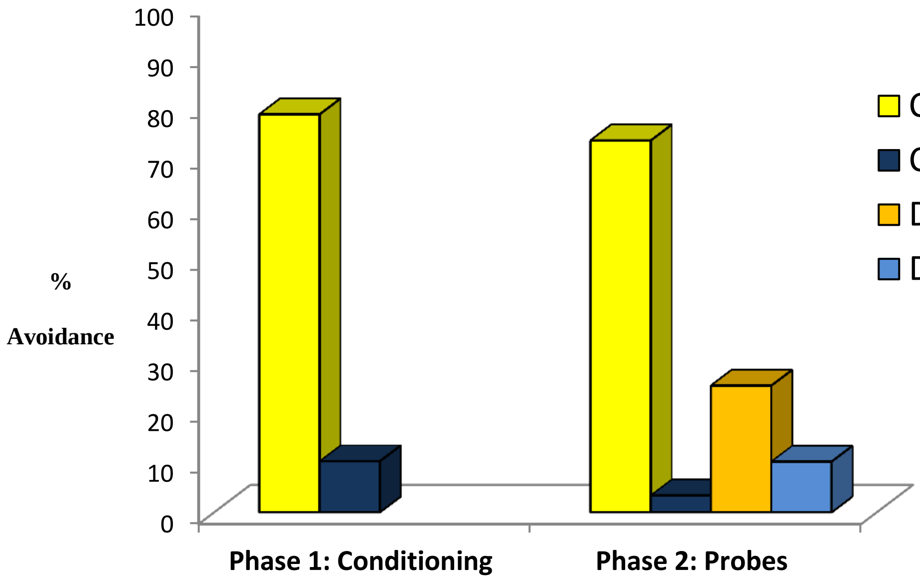

Figure 2.3. Percentage of avoidance responses to learned threat and safety cues (CS+ & CS-) and also to inferred threat and safety cues (DCS+ & DCS-) during Phase 1(Conditioning) and Phase 2 (Probes) of Experiment 1.

Table 2.2 shows that rates of avoidance were higher for conditioned and derived threat cues than for conditioned and derived safety cues during both Phase 1 and Phase 2. During Phase 1, the mean avoidance to the CS+ cue was 78.47% of trials while for the CS- a mean of only 10.07% was recorded. Phase 2 provided similar mean responses for the CS+ and CS- with 73.33% and 3.33% respectively. The derived cues while not producing an equivalent differentiation between DCS+ and DCS- cues still provided a mean avoidance response of 25% and 10% respectively.

Table 2.2

Mean and standard deviation for the percentage avoidance response rates for all stimuli during both phases.

Phase	Stimulus	Mean % of trials on which there was avoidance	SD
1: Conditioning	CS+ Learned Threat	78.47	12.64
	CS- Learned Safety	10.07	12.37
2: Probes	CS+ Learned Threat	73.33	37.16
	CS-Learned Safety	3.33	12.91
	DCS+ Inferred Threat	25.0	40.09
	DCS- Inferred Safety	10.0	28.03

Results from the training trials (Phase 1) confirmed that during conditioning the difference in avoidance rates across the learned threat cue and the learned safety cue was significant, $t(14) = 13.537$, $p < .005$. During the probe trials (Phase 2), this avoidance rate differential was maintained, with significantly more avoidance observed for the learned threat cue than the learned safety cue ($t[14] = 6.548$, $p < .005$). This indicates that the directly established avoidance and non-avoidance functions maintained across the extinction conditions of Phase 2. However during the probe phase the observed difference in avoidance rates across the derived threat (DCS+) and the derived safety (DCS-) cues was not significant ($t[14] = 1.500$, $p > .005$).

2.3.2 Expectancies

Figure 2.4 shows that expectations of encountering the aversive stimuli were low across Phases 1 and 2 after avoidance responding in the presence of CS+ and CS-. In contrast, Figure 2.5 shows that if no avoidance response was made, expectancies of the aversive stimuli were substantially raised for the CS+ cue while those for safety and inferred threat remained low.

Table 2.3 shows that lower expectancy of the appearance of the aversive stimuli was reported in the event of an avoidance response being made in the presence of the learned threat cue and whether or not an avoidance response was made to the safety cue. During the probe trials of Phase 2, with the exception of the learned threat cue (CS+) without avoidance, little difference was evident between the expectancies of aversive stimuli for all cues if avoidance was or was not produced.

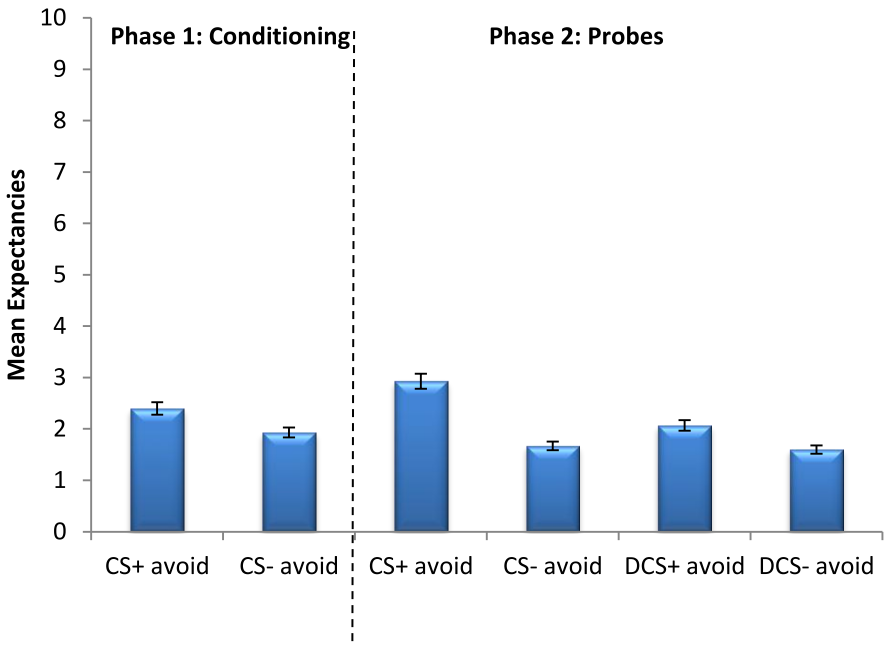

Figure 2.4. Mean expectancy ratings for the occurrence of aversive images and sounds, if an avoidance response was made during Phase 1 (avoidance conditioning) and Phase 2 (probes).

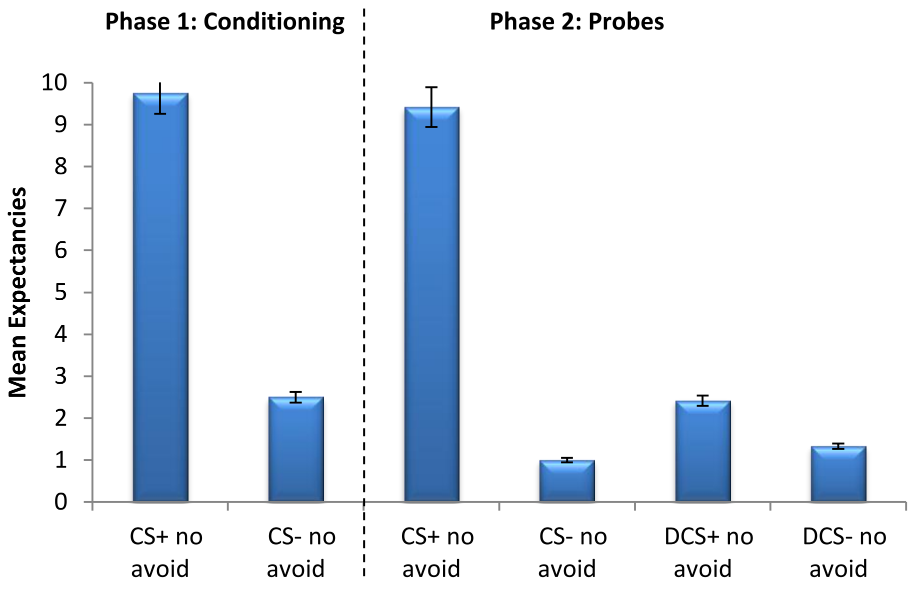

Figure 2.5. Mean expectancy ratings for the occurrence of aversive images and sounds, if an avoidance response was not made during Phase 1 (avoidance conditioning) and Phase 2 (probes).

During operant conditioning (Phase 1), expectancies of an aversive stimulus following no avoidance were significantly higher for the learned threat cue than the learned safety cue (t[14]= 7.875, $p<0.005$).

During probes for derived avoidance (Phase 2), a similar differential pattern was observed for expectancy ratings following no avoidance of the learned threat and safety stimuli (CS+ and CS-). That is, the learned CS+ threat cue with no avoidance was associated with significantly higher expectancies than the learned CS- safety cue (t[14] = 6.023, $p<0.005$). However the difference in expectancy ratings between the derived threat and derived safety cues (DCS+ and DCS-) with no avoidance was not significant (t[14] = 1.356, $p> 0.05$). In other words, measures of expectancy and avoidance for the CS+ stimulus were almost at the maximum level for both on their individual scales while for the derived threat cue and safety cues (CS- and DCS-) they were substantially lower.

Table 2.3

Mean expectancy ratings for all stimulus response configurations.

Phase	**Stimulus**	**Avoidance: Mean expectancy**	**No Avoidance: Mean expectancy**
1: Conditioning	CS+ Learned Threat	2.40	9.80
	CS- Learned Safety	1.93	2.20
2: Probes	CS+ Learned Threat	2.93	8.93
	CS- Learned Safety	1.67	2.07
	DCS+ Derived Threat	2.07	2.13
	DCS- Derived Safety	1.60	1.27

Very high expectancy regarding the subsequent appearance of the US was accompanied by high levels of avoidance to the trained CS+ cue and substantially lower levels of both to the CS-, DCS+ and DCS- cues. This appears to provide support to the expectancy model of derived avoidance previously discussed in chapter 1. While an apparent positive correlation appears to be present between levels of avoidance and expectancy, the possible direction of causality between the two remains a conceptual argument at present. Unfortunately, the analysis to this point suggests that although there was a difference between DCS+ and DCS- rates avoidance and expectancies, no evidence of derived avoidance has been established using the current procedure.

Given the discernible pattern of similar levels of expectancies and overt avoidance, a correlational analysis was conducted to examine the relation between the two during Phase 2. Preliminary analyses indicated that the assumption of normality had been violated for the range of percentage avoidance responses and the range of expectancy ratings (for non-avoidance). Thus, a non-parametric correlational analysis was employed. The relationships between percentage avoidance to the CS-, DCS+ and DCS+ stimuli and participant's expectancy rating of an aversive image and sound following no avoidance response, provided evidence of a significant ($p < .005$) positive correlation for each cue (rho = 1.000, .786, .732 respectively). For the remaining CS+ stimulus, no correlation was found (rho values = .289) between avoidance levels and self-reported expectancies during Phase 2.

Experiment 1 successfully demonstrated the conditioning of avoidance to a CS+ cue, which was maintained through a subsequent probe phase. It also produced evidence of a weak derived transfer of fear effect between the CS+ cue and the DCS+. Over twice the level of avoidance was observed for the derived threat cue compared to the derived safety cue. Expectancy ratings supported the successful conditioning of the CS+ as indicated by avoidance rates but also confirmed the lack of a significant degree of transfer of aversive functions (avoidance or expectancy) along a semantic continua.

Discussion

While the high level of overt avoidance to the CS+ clearly indicates successful avoidance conditioning for all participants, generalisation of fear between the CS+ cue and another semantically related item did not occur so readily. The lack of transfer of avoidance may be partly due to the relatively small number of conditioning trials employed. It may be that the CS+ and CS- were sufficiently discriminated in order for a minimal avoidance criterion to be observed in the current case. However discriminated avoidance may not have been well enough established to lead to the transfer of conditioned responses along semantic or other non-formal continua.   This conclusion may tallies with that of Valverde et al. (2009) who suggested that one might expect better conditioning effects if an additional CS+ and CS- are introduced to provide for a greater appreciation of the categorical significance of the various cues and their function in relation to the US. In other words having more than two conditioned stimuli during Phase 1 may have ultimately strengthened the discriminative functions of the stimuli. Of course, this move would also lead to a greater number of conditioning trials being required. Indeed for both Dunsmoor et al. (2013) and Keller (1943), the transfer of fear effect was observed only following many conditioning trials. Specifically, Dunsmoor and colleagues administered 80 conditioning trials to establish the discriminative stimuli while

Keller employed 128. While further conditioning trials may indeed help to generate higher rates of fear and avoidance transfer along semantic continua, it is important to understand that one of the main rationales for the current research was to observe derived transfer of function effects using real world stimuli and under naturalistic conditions. The requirement to administer hundreds of conditioning trials undermines that very effort and the resulting ecological validity of any outcomes (Declercq & De Houwer, 2009).

It is also important to remember that semantic generalisation has been relatively well observed in the past (e.g., Maltzman et al.,1970) and was likely to be replicable here. The issue here was to generate it using avoidance as a key dependent measure, rather than fear alone, and to attempt to understand the conditions and boundary conditions of the effect. The current failure is a contribution in that regard, if it can be used to provide insight into the conditions under which semantic generalisation does not easily occur. While at first glance the low levels of generalisation may be attributed to the low number of training trials employed in Phase 1, there are other factors which may account for this outcome. The first relates to the use of operant avoidance response as the dependent measure of the transfer of respondently conditioned fear rather than the more traditionally used SCR.

Skin conductance is a reliable and easily measureable indicator of a physical response caused by fear. The operation of the autonomic nervous system and specifically the response of the sweat glands in the palmer region has been very well documented and understood for over 100 years (Dawson, Schell & Filion, 2000). Rises in SCR are comparable to the level of threat appreciation on the part of the individual and so provide a precise measure of the specific response. Avoidance responses on the other hand may lack the subtlety of measurement of SCR, being as they are an “all or nothing” response to the threat stimulus (i.e., they produce binary rather than continuous data forms). This alone renders avoidance response measures rather blunt insofar as the degree of avoidance to a particular stimulus cannot be measures while probabilities can. Added to this empirical limitation, is that operant responses are often viewed as involving more complex cognitive systems.

We know that transfer and transformation of function effects involve response latencies that are directly related to the complexity of the verbal network according to which the transformation is occurring (O’Hora, Roche, Barnes-Holmes and Smeets, 2001; Roche, Linhehan, Ward, Dymond & Rehfeldt, 2004; Reilly, Whelan & Barnes-Holmes, 2005). Verbal behaviour is itself a more complex process than respondent processes and involves a longer history of training. In fact, it relies on foundational non-verbal processes such as non-arbitrary relational processes (i.e., operant and respondent conditioning). To this extent, even experimental analysts of behaviour view derived transformations of function as “higher order” processes and as a result they may be slower to emerge. Given the lack of training provided or response time available during the probe phase and the omission of SCR as an available metric, the experiment was reliant on the expectancy ratings to provide insight into whether any transfer of function had occurred. Before progressing to one further important confound that may best explain the current outcomes which relates to the strength of the pre-existing relation between the CS+ and the DCS+ and over which the experimenter had little control, we should consider one important issue regarding the role of expectancies in Experiment 1.

The role of expectancies in the derived transfer of fear, according to Lovibond's (2006) theory, is reliant on the associations learned through training between the stimuli. Given the lack of training in this experiment, the correlation between low threat expectancies and minimal derived avoidance would be expected for the unconditioned cues.   However, two results appear to contradict the expected results from Experiment 1. Firstly, while mean expectancy for the CS- and the DCS+ were similar (2/10), avoidance responses to the DCS+ cue was considerably more frequent than to the CS-. This would indicate that despite the low expectancy regarding the appearance of the aversive stimuli there was, although not significant, a number of participants who avoided during the DCS+. The second contradiction is highlighted by the difference between very high expectancy and lower levels of avoidance for the CS+ cues. The expectancy rating for the appearance of the aversive stimuli subsequent to the appearance of the CS+ cue maintained from maximum level (10/10) after the conditioning phase (Phase 1) to near maximum (9/10) after the probe phase. Mean avoidance response to the CS+ during the probe phase however was only 73%. This means that despite their report that the CS+ would almost always be followed by the US (90%), participants avoided on only 73% of trials for the CS+ cue. Thus expectancies were not a perfect guide to overt avoidance. In related research, Declercq et al. (2009) indicated a greater incidence of derived avoidance than reported expectancies predicted, a pattern which they failed to discuss or highlight. Dymond et al (2011) proposed that both the avoidance and expectancies rather than being causally related are part of the same process of derived transformation of stimulus functions. That is, both can be treated as distinct functions that transform independently of each other.

The lack of a correlation, for the CS+ stimulus, between the avoidance response rates and expectancy rates may be a result of the salience of the stimuli used in the conditioning procedure. More specifically, the aversive stimuli (i.e., the images and sounds) may not have been aversive enough to generate avoidance even when participants could tact the CS-US contingency. While similar to the stimuli used successfully in Dymond et al. (2011), post-experimental reporting by a number of participants indicated that for some the stimuli may not have been very high in negative valence. On the other hand, the fact that reliable avoidance conditioning was produced suggests that this matter was not critical. Nevertheless, it would be wise to reconsider the potency of the stimuli employed in these research paradigms.

Finally, one more important feature of the stimuli employed that may well account for the lack of derived avoidance observed, pertains to the degree of semantic relatedness across the CS+ and DCS+. More specifically, semantic generalisation research involving commonly used words has traditionally relied on word association norms to identify word pairs most likely to facilitate the generalisation effect. For example, in 1970 Cramer demonstrated that semantic generalisation occurred along a gradient based on the strength of the reported association between the words employed. Importantly, this graduated effect based on associative strength has subsequently been discounted (see Hutchinson, 2003 for a meta-analytical review). The area of associative strength in semantics covers many aspects of word association and priming. According to Hutchinson's analysis, words like *chair* and *table* used in the current experiment are not naturally strong for association purposes because they come from "artificial categories". In other words, given a word during a free association task, another word from an artificial category will only be given as a response 5.1% of the time compared to 14.1% of the time for a synonym and 24.3% for an antonym. Further complicating the possibility of the transfer of function between the stimuli was the lack of compatibility of the original chosen cues according to the *University of South Florida Word Association, Rhyme and Word Fragmentation Norm* (Nelson, McEvoy, & Schreiber, 1998). Words like *table* and *chair* have differing levels of association strength depending on the order in which they were presented. Specifically, the original CS+/DCS+ cues were *chair* and *table*. By establishing chair as the CS+ and then presenting table as the probe stimulus, the expectation of derived transfer of function was based on the assumption of a pre-established table-chair word association, which has a strong associative strength of .76 (i.e., given the world *table*, 76% of people would provide the word *chair* as an associate). However, the chair-table association (i.e., given the word *chair*) has an associative strength of only .31 (Nelson, McEvoy, & Schreiber, 1999). Research into this, however, has failed to provide evidence regarding any asymmetrical priming effect between pairs with differing directional associative strengths (Thompson-Schill, Kurtz & Gabrieli, 1998). In the current research and in order to account for any possible confound regarding directionality, the choice of CS+ words varied across participant cohorts and resulted in no discernible difference to either overt avoidance or expectancies. While the directionality of conditioning was not treated at the time as a variable, a post hoc inspection of the data revealed that there was no discernible pattern of conditioning or transfer of functions that could be related to the choice of the CS+ cue.

Experiment 2 was designed to address this and a series of other issues.

Chapter 3

Experiment 2

Experiment 1 failed to provide sufficient evidence of the transfer of derived avoidance across semantic classes. In Experiment 2, rather than using categorically related words, synonyms were used as conditioned and derived cues due to their reported increased association strength (Hutchinson, 2003). Based on association norms provided by the *The University of South Florida Word Association, Rhyme and Word Fragmentation Norm*, word pairs were selected as cues only if they scored above .80 (*very strong*) for association strength.

Rather than re-employ the previously used aversive images and sounds, the current experiment was designed to use electric shock as the US stimuli. As an aversive stimulus, shock has the advantage of providing a measureable level of aversion. It also provides the opportunity for the participant to establish and verify their own level of stimulation, ensuring that stimuli are aversive for each participant.

Finally, this experiment sought to examine any possible relationship between avoidance rates and trait levels of anxiety as measured using the State – Trait Anxiety Inventory (Spielberger, 1983). By searching for correlations between both avoidance rates and SCR levels to the CS+ and DCS+, we may learn about the boundary conditions of the semantic generalisation effect. That is, it may be more or less likely to arise for certain types of individuals.

Method

3.2.1 Participants

Twenty seven participants were recruited from among acquaintances of the experimenter. The sample comprised of 12 males and 15 females, ranging from 18 to 66 years old (mean age = 33.37 years). No remuneration was offered or given for participation. Subjects were not screened formally for prior or current anxiety conditions, but were carefully briefed on the aversive nature of the experiment (see Procedure).

3.2.2 Apparatus

The laboratory design (see Figure 3.1) 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) using a 1ms accurate time-locking event marker feature available via Psyscope. 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 electric shocks at key junctures.

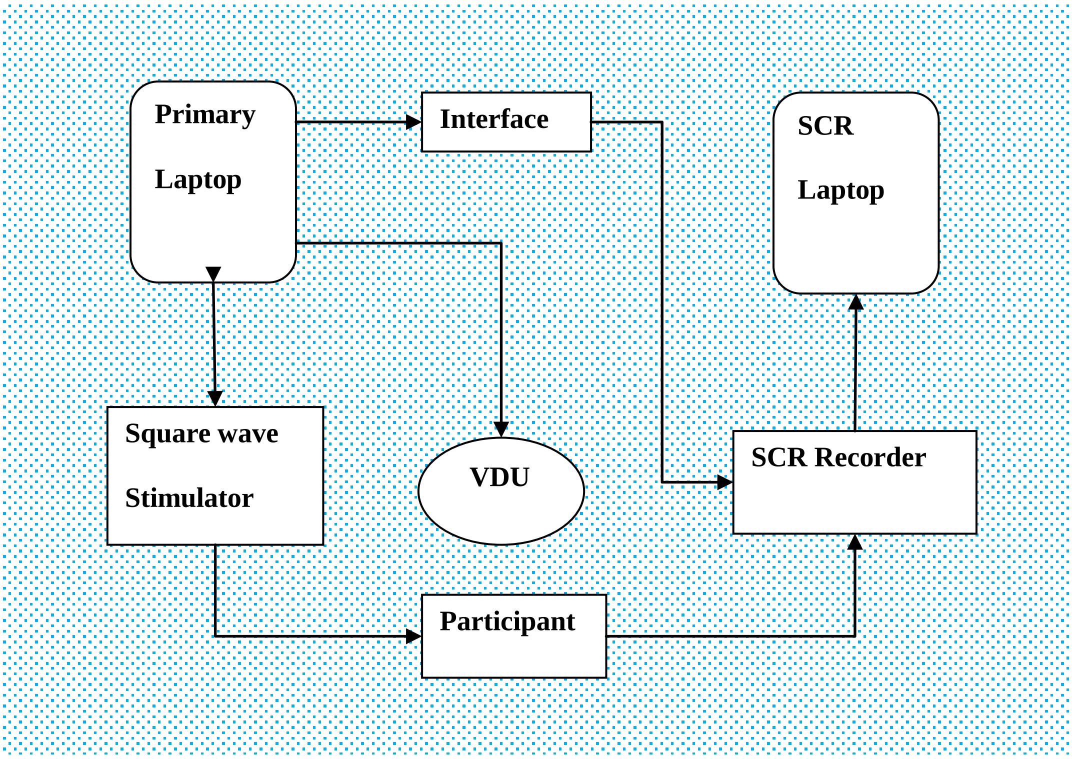

Figure 3.1. Diagrammatical representation of the laboratory apparatus configuration involving primary and SCR laptops, a square wave stimulator (shock) and a SCR recorder, all communicating through an electronic interface panel.

A participant was attached to the *SCR recorder* using a set of Velcro finger straps containing Ag-AgCl (silver-silver chloride) electrodes connected to the distal phalanges of the index and middle finger of the participant's non-dominant hand. Mounted in polyurethane holders, each electrode measured 6mm in diameter. The electrodes were non polarisable and shielded to reduce noise interference. They were also recessed to allow for the use of electrode gel, which was PH balanced and isotonic. The Biopac analysis software corrected for the nonstandard electrode size by providing conductance response in terms of Siemens per cm^2. Increases in skin resistance in Siemens per cm^2 were measured within five seconds of stimulus onset from a floating baseline that was the skin conductance level at the moment of stimulus onset. Negative responses were recorded as zero as is custom, and were included in the analysis. In effect, the response quantification procedure was a combination of response amplitude and magnitude (see Dawson, Schell & Fillion, 1990). The participant was also connected to the two signal wires from the *Square Wave Generator* using a pair of disposable E.E.G. pads that were situated approximately 50mm apart on the non-dominant forearm.

Software written using the Psyscope application was used by the *primary computer* to present the stimuli and record the avoidance responses. Six pairs of synonyms (Table 3.1) were selected from *The University of South Florida Word Association, Rhyme and Word Fragmentation Norms* database of free association developed by Nelson, McEvoy, and Schreiber (1998). The chosen pairs all scored highly (i.e. above 80%) for frequency of free association when single word priming was provided. Simply put, when a word was presented to participants in a word association test, they were required by Nelson et al. to write down the first word they immediately thought of. The use of independently measured association norms to create stimuli for this experiment provided the opportunity to examine transfer of fear and avoidance functions along semantic categories without the need for any explicit associative training. All stimuli were presented on a standard 15" computer monitor in uppercase size 72 bold font, in red and made up both the aversive and appetitive cues assigned to participants. For the purposes of good experimental control, different real word sets were assigned to the roles of CS+, CS-, DSC+ and DCS-. The three word sets are listed in Table 3.1.

Table 3.1.

Different words assigned to each of three cohorts of participants as CS+, CS-, DCS+ and DCS- stimuli.

	P1-P8	**P9-P20**	**P21-P27**
CS+	broth	fib	weep
CS-	assist	ill	brawl
DCS+	soup	lie	cry
DCS-	help	sick	fight

After the conclusion of the computer-based phase of the experiment, participants completed a written *Expectancy Rating Questionnaire* which examined their expectancy of a shock for all eight possible configurations of stimuli and responses (i.e., four stimuli, each with two possible responses). Participants also completed a self-evaluation questionnaire consisting of 40 questions taken from the State – Trait Anxiety Inventory (Spielberger, 1983). Also provided was a brief (9 questions) *Likert* type scale examining whether the experimental procedure the participant had just completed was viewed by them as a positive or negative experience.

3.2.3 Ethics

Prior to research commencing ethical approval forms were made to both the N.U.I. Maynooth Biomedical Sciences and the Social Research Ethics Sub-committees for approval. These committees granted a joint approval. Volunteers were carefully briefed before participation. The briefing document contained a detailed summary of the procedure involved. The aversive nature of the images and sounds that the participants would encounter during the experiment was highlighted, as well as the individual's ability to withdraw from the experiment at any time. Confidentiality was assured and the name and location of the supervisor responsible was provided. Comprehensive contact details of both the N.U.I. Counselling Service and other publicly accessible counselling services (e.g., AWARE) were provided on the briefing document, should any participant experience any post experimental distress. Briefing documents were provided a minimum of 24 hours before any testing took place, to provide a sufficient period of notice.

At the beginning of the experiment, a consent form was considered and signed by each participant with regard to their understanding of the issues addressed in the briefing document and also the reaffirmation of their right to withdraw at any stage during the experiment. After a cooling off period of at least 24 hours candidates who expressed an interest in partaking were contacted and offered a selection of available laboratory times. A debriefing form was supplied at the end of the experiment, providing a brief overview of the experiment as well as contact details for the research supervisor for any subsequent enquiries that the participant may have. All documentation complied with the British Psychological Society's code of professional ethics.

3.2.4 Experimental Design

In Experiment 2, commonly used words and their synonyms were used as stimuli in fear and avoidance learning trials as well as probes for derived avoidance. Initially, conditioned stimuli (CS+ and CS-) were presented during an aversive conditioning procedure. They were then presented later during a probe phase which also provided an avoidance response to cancel the receipt of a shock. The original CS+ and CS- were used, along with their categorically related class counterparts (referred to here as DCS+ and DCS-), to examine for any evidence of "derived" avoidance between the stimuli. Self- reported expectancy ratings regarding the appearance of aversive stimuli subsequent to each individual cue were also taken after the probes phase. All participants were exposed to the same procedure and a within subjects analysis was undertaken using planned comparisons, to examine differences in responding and self-reported expectancies between conditioned CS+ and CS- stimuli and also between the two novel derived avoidance probes, as well as the level of transfer of avoidance between the conditioned and probe stimuli. Expectancy ratings were also of interest as potential predictors (i.e., correlates) of avoidance rates. The study was also interested in correlations between avoidance and expectancy ratings as well as individual differences highlighted using the STAI, so the design is also partly correlational in nature.

The primary hypothesis was that conditioned and inferred threat cues would produce greater avoidance than conditioned and inferred safety cues. The dependent measure was the mean percentage of trials in which avoidance occurred for each cue.

A related hypothesis was that the appearance of threat stimuli, both conditioned and derived, would correspond with a greater threat appreciation on the part of the participant, as indicated by the psycho-physiological measurements provided by the polygraph. The dependent measure was the mean measured increase in skin conductance within 5 seconds from the appearance of each conditioned and derived stimulus.

It was also expected that ratings of the impending shock would be greater for the learned and inferred threat cues than for the learned and inferred safety cues, in the circumstance that an avoidance response was not emitted. A related hypothesis was that there would be no differences in reported expectancies between conditioned threat and safety or between inferred threat and safety cues if an avoidance response was made. The dependent measure used to test these hypotheses, was the mean expectancy rating for each stimulus. The study also sought to examine any correlation between trait anxiety scores and avoidance response rates. Finally, this study examined the hypothesis that the self-reported expectancy ratings for the occurrence of the aversive stimuli by the participants would correlate positively with rates of avoidance.

3.2.5 Procedure.

Once approval from the University Ethics Committee had been received, acquaintances of the experimenter were invited by email to take part in the study. Included in the email was a copy of the briefing document with an instruction that they read the briefing and indicate by replying if they were interested in participating. After a period of a minimum of 24 hours, candidates who agreed to participate were contacted and offered a selection of available laboratory times.

Participants were tested individually in the N.U.I. Maynooth Psychology Department experimental laboratories (see Figure 3.2). Upon arrival, the participants confirmed that they had been given in excess of 24 hours in which they could opt out of participation. They also confirmed that they had been advised of the nature of the aversive stimuli (i.e. mild electric shock) and had consented to take part. After they had read the study briefing sheet for the second time and confirmed their understanding of the task, the participant was seated in front of a standard 15" computer monitor and a keyboard which were connected to the primary experimental laptop. Participants were reassured regarding their ability to cease the experiment at any time if they felt uncomfortable and advised to begin whenever they felt comfortable.

Initially the participant identified their non-dominant hand and they were informed that this was to reduce the level of interference to the polygraph from involuntary movement of the arm. To the dorsal area of the forearm two medical grade *E.E.G. pads* were affixed approximately 5cm apart. The two connecting wires from the Square Wave Stimulator were attached with the machine in an OFF position and with the *Amplitude - Volts* dial set to its lowest level. With the machine turned ON, by depressing the *Initiate* button on the Stimulator (when set to *Single* mode) delivered a single shock to the participant's arm. The wave amplitude level (i.e. shock level) was manipulated by the participant from an indiscernible shock level set by the experimenter to the highest they deemed acceptable. They were instructed to set the final level to one which delivered a brief shock that they would describe as "uncomfortable but not painful" was achieved. This level, usually somewhere between 4.5 and 6 (of a possible maximum level 10) on the amplitude level dial, was then fixed and maintained throughout the experiment.

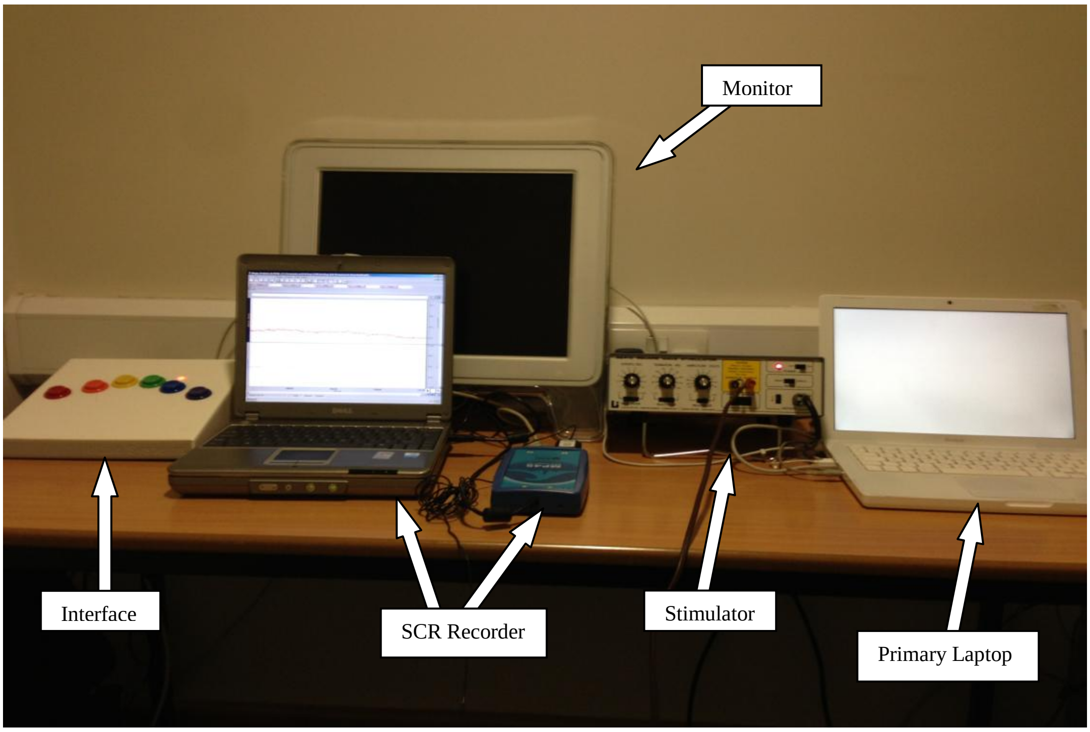

Figure 3.2. Laboratory set up for Experiment 2 using an SCR Recorder and a Square Wave Stimulator. During testing the computer monitor and keyboard were relocated to an adjacent table, away from the rest of the apparatus.

The *SCR Recorder* was then attached to the index and middle finger of the participant's non-dominant hand of using Velcro cuffs and the application of signal boosting SCR gel. The recording software was initiated on the SCR laptop and this provided a visual graphic of the participant's real-time level of skin conductance.

Once all systems were working correctly the participant was advised to begin.

Phase 1: Fear conditioning

In Phase 1 participants were presented with stimuli which were or were not followed by a short (200ms) electric shock applied to their forearm through two E.E.G. pads. The procedure, as highlighted in Figure 3.3, exposed the participant to 20 trials, only 10 of which involved their receiving a shock. For the remaining 10 trials, presented pseudo-randomly, no unconditioned stimulus was provided. The following instructions were provided for them to read and then repeated aloud by the experimenter prior to the commencement of the phase:

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.

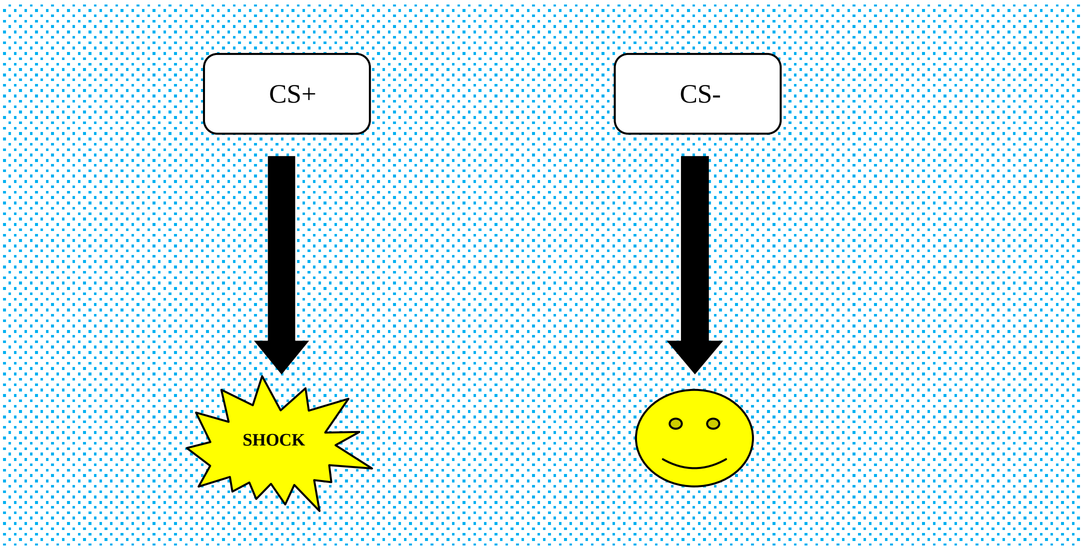

Figure 3.3. Diagrammatic representation of the respondent conditioning phase (Phase 1).

When the participant proceeded with Phase 1, a blank screen appeared for 20 seconds, followed by either the CS+ or CS- word for 4 seconds. The CS+ word provided the cue for the subsequent delivery of a small static shock delivered at the previously set level for a period of a maximum of 50 microseconds. After the completion of 20 trials (10 x CS+, 10 x CS-) 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…

Phase 2 began after the participant had read the onscreen instructions detailed above, which were, as in the previous phase, also read aloud by the experimenter to ensure the procedure was understood.

Phase 2: Avoidance conditioning and probes

During the early part of Phase 2 the participant had the ability to cancel the production of a shock by pressing the spacebar when the CS+ cue appeared on-screen, as demonstrated by Figure 3.4. Avoidance behaviour (pressing the spacebar) subsequent to the appearance of the CS+ cancelled the production of the shock in all trials. No feedback was given regarding any cancellation of shock for any of the conditions. There was 100% contingency between the CS- cue with or without avoidance and the absence of shock. The CS+ was followed by a shock on all trials in which an avoidance response was not produced. In the conditioning phase, 10 CS+ and 10 CS- cues were presented pseudo-randomly.

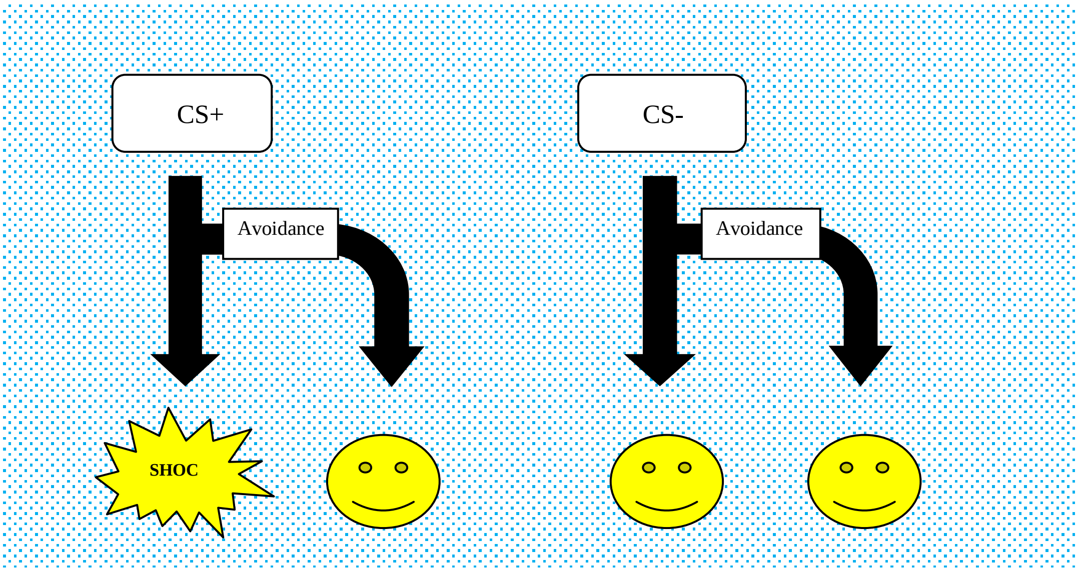

Figure 3.4. Diagrammatic representation of the early operant conditioning part of Phase 2, in which avoidance responses were established for the CS+ and CS-.

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Initially in Phase 2, six each of the CS+ and CS- cues were presented pseudorandomly, duplicating the conditioning protocol already undertaken in Phase 1. However after these 12 trials the relevant synonyms for both the CS+ and CS- cues were introduced, also pseudorandomly but without any previous warning. These stimuli were intended to funciton as derived CS+ (DCS+) and derived CS- (DCS-) cues, respectively. Figure 3.5 demonstrates the consequences of respeonding or not to the presented cues (CS+, CS-, DCS+ and DCS-) during the latter part of the operant conditioning phase, which examined for derived avoidance responding to the novel cues.

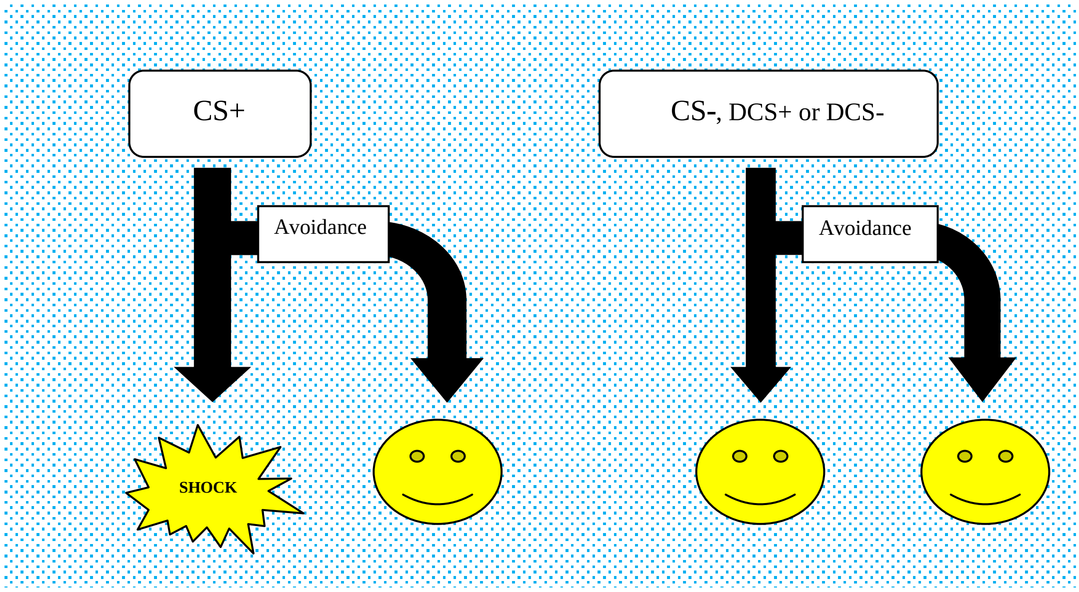

Figure 3.5. Diagrammatic representation of the latter portion of the operant conditioning phase (Phase 2) when the DCS+ and DCS were introduced to probe for any transfer of function between conditioned stimuli words and their novel synonyms.

As with Phase 1, a blank screen presented for 12s was followed by a stimulus (i.e., CS+ or CS-) and the delivery of either a shock or not, depending on the cue provided. Pressing the spacebar constituted an avoidance response for all cues, but only in the case of the CS+ was the delivery of a shock to the participant's forearm contingent upon the subject's non-response. Probes for derived avoidance consisted of a block of 16 trials containing four each of CS+, CS-, DCS+ and DCS-. Upon completion of all trails, participants were informed that the experiment was complete and they were to contact the experimenter.

Previous to any further briefing, participants provided expectancy ratings for the production of a shock for the eight stimulus-response configurations (i.e., CS+, CS-, DCS+ and DCS- with either press or no press of the spacebar) using a graduated scale for each one individually. Participants then completed the State – Trait Anxiety Inventory (Spielberger, 1983), as well as the brief experimental experience questionnaire. A debriefing sheet was then provided and participants were given the opportunity to ask any questions relating to the experiment, before the experiment was fully brought to a close.

Results

All 28 participants progressed from the initial operant conditioning phase (Phase 1) to the probes trials of Phase 2. Progression to the second phase did not require the satisfaction of any established criteria. However, two participants were excluded from the final data analysis. One participant (P8) was omitted due to a hardware malfunction during the phase. Another participant (P18) was excluded due to their use of the avoidance function for all cues during Phase 2 probes.

3.3.1 Avoidance

Figure 3.6 shows the mean percentage of trials in which participants avoided the learned threat (CS+) and learned safety cues (CS-) and also the inferred threat (DCS+) and inferred safety (DCS-) cues during probes for avoidance (Phase 2). During the critical probes, rates for avoidance were higher for conditioned and inferred threat cues than for conditioned and inferred safety cues.

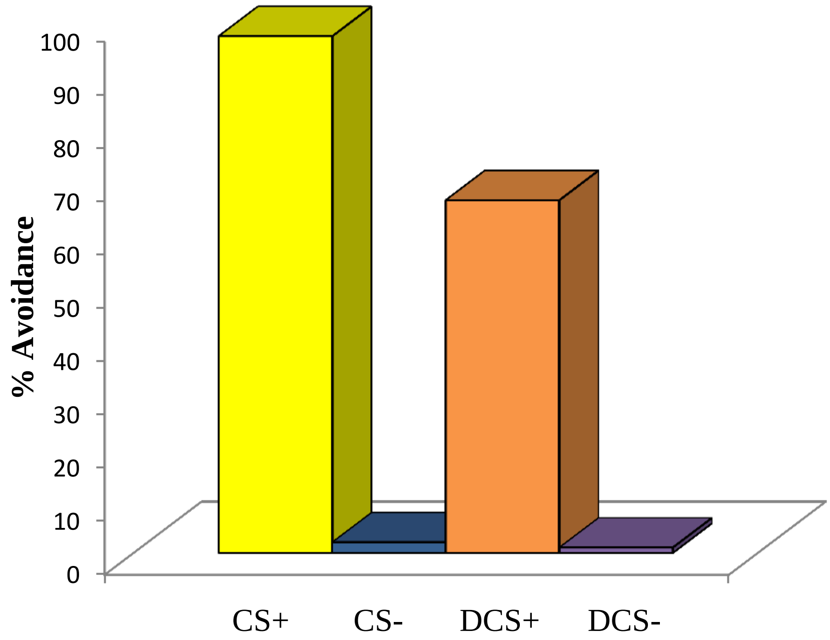

*Figure 3.6***.** Percentage of avoidance responses to learned threat and safety cues (CS+ & CS-) and also to inferred threat and safety cues (DCS+ & DCS-) during Phase 2 (Probes) of Experiment 2.

A one-way repeated measures analysis of variance (ANOVA) was conducted comparing the level of avoidance responding for all four cues during the probe trials. There was a statistically significant main effect for stimulus type, Wilks' Lambda = .011, F (1, 23) = 662.20, $p<.005$. That effect was very large (eta squared = 0.989).

Post hoc analysis showed that there was a significant difference during the probe trials between the rate of avoidance to the CS+ and the CS-, ($t[25] = 34.240$, $p< .005$). This indicates that the directly established avoidance and non-avoidance functions conditioned in Phase 1 maintained across the extinction conditions of Phase 2. Table 3.2 shows that during the probe trials there was a very high rate of avoidance to the learned and derived threat cues and considerably less to the learned and derived safety cues. The difference in avoidance rates between the DCS+ and the DCS- novel synonyms was statistically significant (t[25] = 7.543, p< .005).

Table 3.2.

Mean and standard deviation for the avoidance response rates for all stimuli during the probes phase of Experiment 2.

Phase	Stimulus	Mean % of trials on which there was avoidance	SD
2: Probes	CS+: Learned Threat	97.12	10.786
	CS-: Learned Safety	1.92	9.806
	DCS+: Inferred Threat	66.35	44.126
	DCS-: Inferred Safety	0.96	4.903

3.3.2 Skin Conductance Responses

Figure 3.9 shows the mean increases of phasic SCR demonstrated by participants in response to the presentation of learned and derived threat cues (CS+ & DCS+) and learned and derived safety cues (CS- & DCS-) during probes for avoidance (Phase 2). During the critical probes, increases in measured SCR were higher for conditioned and inferred threat cues than for conditioned and inferred safety cues. The calculation of phasic SCR increases involved the identification of the SCR level at the time of presentation of the onscreen cue and then calculating the difference between this level and the subsequent peak in amplitude of SCR measured in microsiemens (*u*S) within 5s of stimulus onset. Negative responses and zero responses are included in all calculations as zero responses. These differences in *u*S were then Log (Ln) transformed to reduce skew and Kurtosis in the data set.

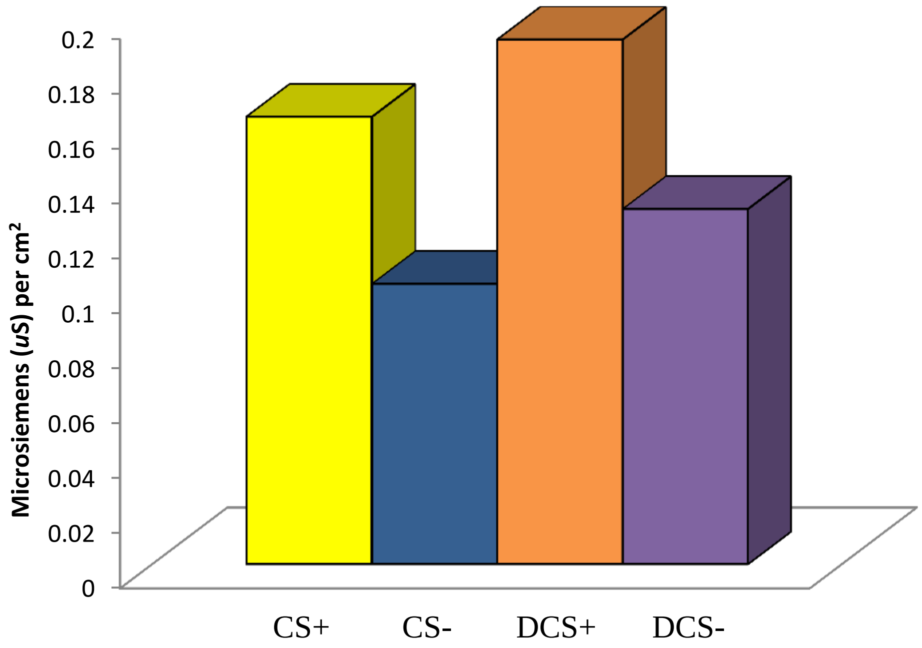

Figure 3.9. Mean increases in SCR (measured in *u*S microsiemens per cm^2) for learned threat and safety cues (CS+ & CS-) and also inferred threat and safety cues (DCS+ & DCS-) during Phase 2 (Probes) of Experiment 2.

A one-way repeated measures ANOVA was conducted comparing differences in the increases in SCR for all four cues during the probe trials. There was a statistically significant main effect for stimulus type, Wilks' Lambda = .577, F (1,23) = 5.614, p < .005. That effect was large (eta squared = .423). Post hoc analysis showed that there was a significant difference, during the probe trials, between SCR levels recorded during the presentation of the CS+ cue than for the CS-, t(25) = 2.593, p< .05. There was also a significant difference between SCRs recorded during the presentation of the DCS+ cue than for the DCS-, t(25) = 3.098, p< .005. Table 3.3 shows that the mean skin conductance responses were substantially greater for the learned and inferred threat cues than they were for the learned and inferred safety cues (CS+/CS).

Table 3.3.

Mean and standard deviation for SCR for all stimuli during the probes phase of Experiment 2.

Phase	**Stimulus**	**Differences in SCR (*u*S per cm^2)**	**SD**
2: Probes	CS+ Learned Threat	0.16300	0.05030
	CS- Learned Safety	0.10233	0.29257
	DCS+ Inferred Threat	0.19112	0.04321
	DCS- Inferred Safety	0.12946	0.27131

Correlation analysis provided evidence of a strong positive correlation (rho = .487, n = 26, p < 0.05) between CS+ and DCS+ for recorded SCR suggesting that a significant portion of the derived fear response observed for synonym probes during

Phase 2 was generalised from the conditioned responses established for the CS+ and CS- stimuli. Taken together these findings suggest that fear and avoidance responses readily generalized from the conditioned to the derived probe stimuli.

3.3.3 Self-reported expectancies

Figures 3.8 and 3.9 show the differences in mean reported expectancies of shock following each stimulus, in the event of an avoidance response not being made. As predicted, if no avoidance response was made (Figure 3.9), expectancies of the receipt of shock were substantially raised for the CS+ cue in comparison to the CS- cue. The results of a one-way repeated measures ANOVA (Wilks' Lambda = .075, F [1,23] = 94.80, $p < .005$) produced an eta squared value of .925 which describes a very large effect size. Post hoc analysis showed that there was a significant difference during the probe trials regarding the expectancy level of receiving a shock if no response was made to the CS+ and the CS- cues $t(25)= 16.158$, $p<0.005$. The difference between the reported mean expectancy for the DCS+ and DCS- cues if no avoidance response was made was also significant, $t(25) = 5.027$, $p < .005$.

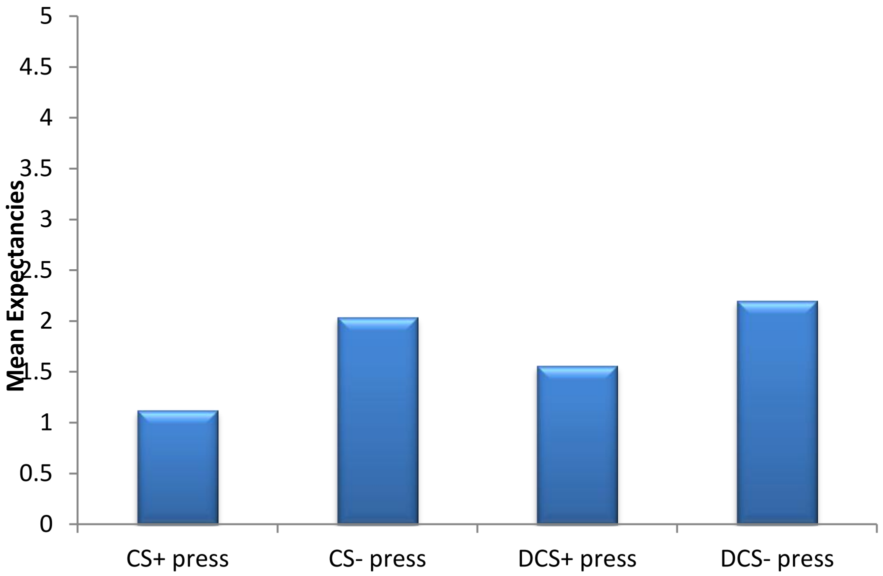

Figure 3.8. Mean expectancy ratings for the receipt of an electric shock, if an avoidance response was made during Phase 2 probes.

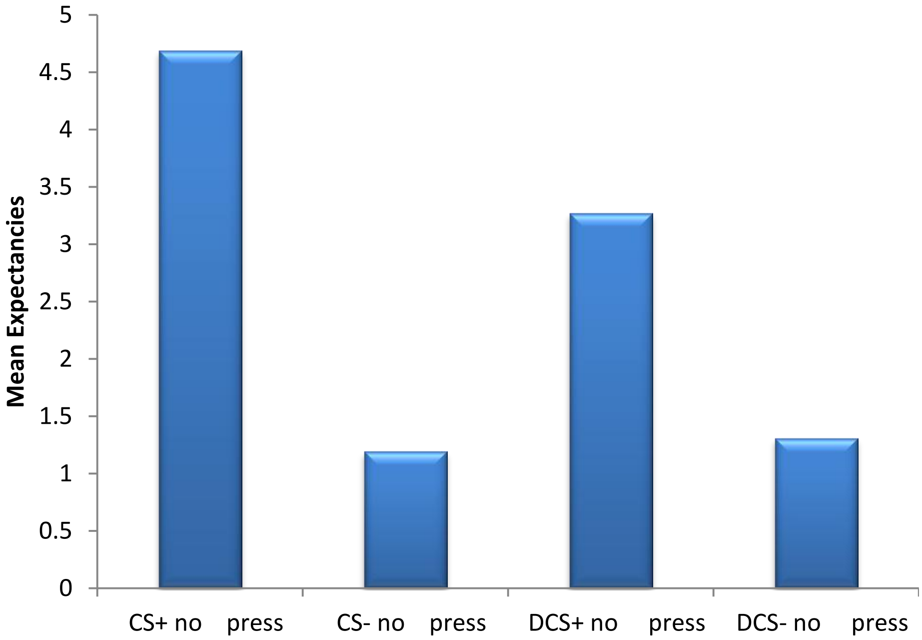

Figure 3.9. Mean expectancy ratings for the receipt of an electric shock, if an avoidance response was not made during Phase 2 probes.

Table 3.4 shows that lower expectancy of receiving an electric shock was reported in the event of an avoidance response being made for threat cues compared to expectancies reported if a response was not made. The transfer of safety cue functions between the learned and derived safety cues was also supported by the comparatively low mean expectancy ratings reported for these stimuli whether avoidance responses were or were not made.

Table 3.4.

Mean and standard deviation for the expectancy ratings for all stimulus response configurations.

Response	Stimulus	Mean Expectancy rating	SD
Avoidance			
	CS+ Learned Threat	1.12	0.326
	CS- Learned Safety	2.04	1.183
	DCS+ Inferred Threat	1.54	0.859
	DCS- Inferred Safety	2.15	1.156
No Avoidance			
	CS+ Learned Threat	4.69	0.838
	CS- Learned Safety	1.19	0.801
	DCS+ Inferred Threat	3.27	1.756
	DCS- Inferred Safety	1.31	0.679

In the probe trials of Phase 2, however, significant differences were observed between the expectancies of shock for safety cues (CS- & DCS-) if avoidance was or was not engaged in. Expectancies of shock following avoidance were rated significantly higher for the learned safety cues than for not pressing the spacebar (*t* [25] = 2.80, p < .05). Expectancies of shock were also paradoxically rated significantly higher for the derived safety cue following avoidance than for not responding (*t* [25] = 3.275, p < 0.005). Figure 3.10 shows that expectancies regarding the receipt of a shock if avoidance was produced provided an increased level of reported threat appreciation than if no avoidance was used.

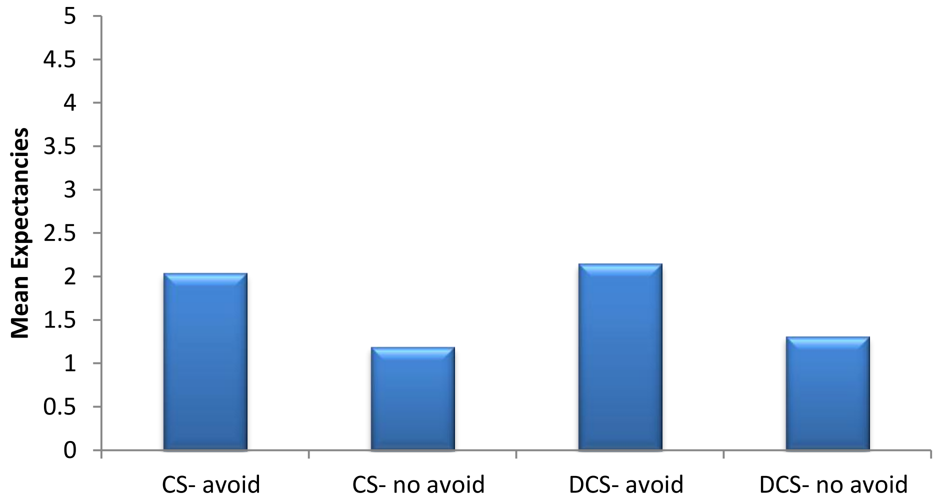

Figure 3.10. Mean expectancy ratings for the receipt of an electric shock following the appearance of the safety cue, if an avoidance response was or was not made during Phase 2 probes.

As expected expectancy ratings appear to track avoidance levels for each participant. Measures of expectancy and avoidance responding for the CS+ and

DCS+ stimuli were generally high. Expectancy and avoidance for the safety cues (CS- and DCS-) were lower than for both threat stimuli.

Table 3.5 shows that the CS+ cue was associated with increased SCR and also provides for greater levels of avoidance. This accounts for the lower expectancy of receiving shock if the spacebar (avoidance) is pressed. The expectancy level, if avoidance is not engaged in, reaches almost maximum value for the CS+ cue and is also matched by low levels of non-avoidance responding and increased SCR levels. The significantly lower mean levels of avoidance and expectancy reported for the CS- and DCS- cues were also supported by lower mean SCRs.

Table 3.5.

Comparison of mean avoidance response levels, SCR and expectancies recorded for all cues during the probes phase of Experiment 2.

Response	Stimulus	% trials on which avoidance was/was not produced	SCR (*u*S per cm^2)	Shock Expectancy
Avoidance				
	Learned Threat (CS+)	97	0.163	1.12
	Learned Safety (CS-)	2	0.102	2.04
	Inferred Threat (DCS+)	66	0.191	1.56
	Inferred Safety (DCS-)	1	0.129	2.20
No Avoidance				
	Learned Threat (CS+)	3	0.163	4.69
	Learned Safety (CS+)	98	0.102	1.19
	Inferred Threat (CS+)	34	0.191	3.27
	Inferred Safety (CS+)	99	0.129	1.31

3.3.4 Correlation analysis

A correlational analysis was conducted to examine the relation between overt avoidance, SCR differences and the reported expectancy of shock for all cues during Phase 2. Preliminary analyses indicated that the assumption of normality had been violated for the range of percentage avoidance responses and the range of expectancy ratings (for non-avoidance). Thus, a non-parametric correlational analysis was employed. The relationship between percentage of avoidance responses on DCS+ trials and participant's expectancy rating of a subsequent shock following no avoidance response to this cue was significant and positive (rho = .862, n = 26, p <.005). The relationship between percentage avoidance to the DCS- safety cues and participant's expectancy rating of a subsequent shock following no avoidance response also provided evidence of a significant positive correlation (rho = .446, n = 26, p < .05). In other words, if a participant avoided either of these stimuli, they also tended to report a high expectancy of shock for failing to produce that avoidance response.

Expectancies of shock following the CS+ were positively but not significantly correlated with avoidance rates observed for that stimulus (rho = .259, n = 26, p > .05). Interestingly this correlation was not evident for the CS- cue (rho = -.058, n = 26, p > .05). This analysis confirms that while avoidance rates to both learned and inferred threat stimuli were significantly greater than avoidance of learned and inferred safety stimuli, there was not a particularly strong relationship between the more reliable avoidance rates and self-reported expectancies.

Comparisons between mean avoidance levels and SCRs during Phase 2 for CS+, CS-, DCS+ and DCS- cues also found only a small to medium correlation (rho values = -.274, -.174, .264 & -.307 respectively), none of the which achieved significance. There was a strong correlation between mean SCRs to CS+ and DCS+ cues (rho = .487, n = 26, p <.05). SCRs to the CS- and DCS- cues did not correlate (rho = .105, n = 26, p >.05).

Individual trial analysis appears to indicate a trend towards larger SCRs on the initial Phase 2 trials, regardless of the stimulus. This can most certainly be taken as evidence of a common orienting response. Due to the randomised nature of the stimulus sequence, this is unlikely to have confounded effects here. When the initial novel response was omitted from the analysis, the difference between SCRs to the DCS+ and DCS-was still significant, t(25) = 1.881, p < .05. Figure 3.11 provides a sample of real time phasic increases of SCRs for two participants (P9 & P24) to presentation of each cue during the probes phase. Clearly evident from the initial trial in each is the large increase in SCR recorded for initial presentation of a novel stimulus.

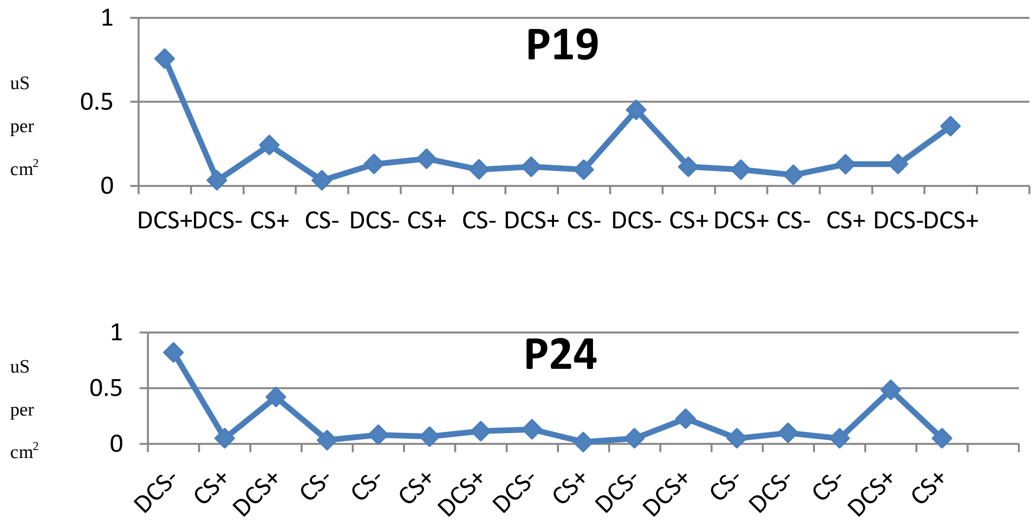

Figure 3.11. Sample trial by trial phasic SCRs measured in *u*S per cm^2 for each presentation of the CS+, CS-, DCS+ and DCS- cues during Phase 2 probe trials for participants P19 and P24.

Trial by trial analysis of tonic skin conductance levels (SCL) undertaken on the chronological continuous graph recorded for each participant also highlighted an emergent pattern of responding which appears to indicate the possible reinvigoration of fear to stimuli later in Phase 2. Phasic SCRs mask this effect to some extent due to the fact that all responses are recorded relative to a shifting baseline. However absolute SCL data, as highlighted in samples included in Figure 3.12, revealed trends in the shifting baseline arousal itself across trials. Analysis of the SCL data uncovered that 63% (17/27) participants produced a single unusual and sudden increase in SCL during the latter half of trials, which was comparable to or greater than the initial rise in skin conductance level for the original appearance of the derived stimulus.

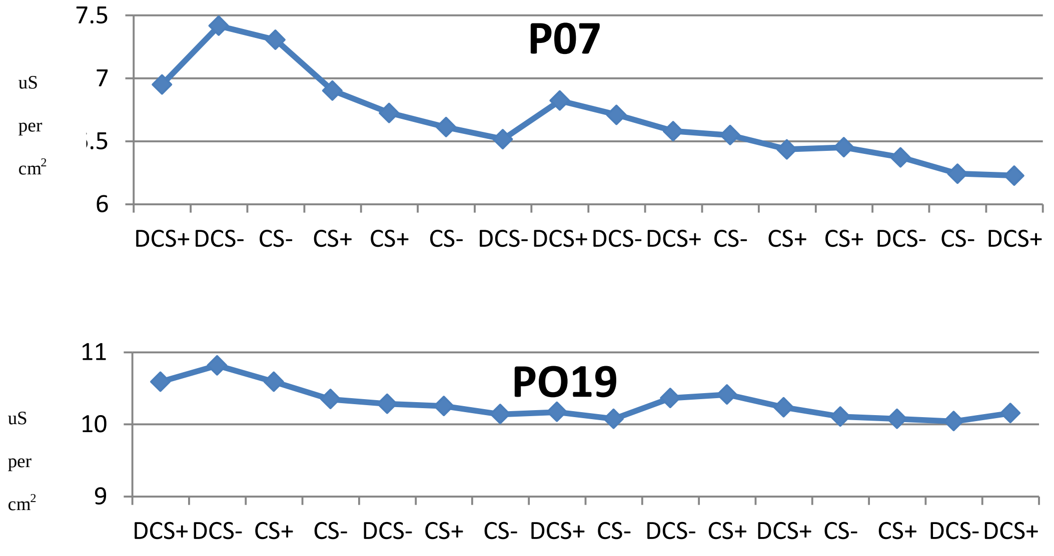

Figure 3.12. Sample trial by trial maximum recorded tonal SCL measured in *u*S per cm^2 for each presentation of the CS+, CS-, DCS+ and DCS- cues during Phase 2 probe trials for participants P07 and P19.

Trait anxiety statistics taken from the STAI questionnaires completed by the participants were also analysed in relation to avoidance responding and SCRs levels. There was no evidence of a strong correlation between response frequencies to any of the cues and levels of trait anxiety as measured by the questionnaire. Any influence provided by differing trait anxiety levels, with sex and age being adjusted for, was unrelated to any increase in either avoidance responding levels or threat appreciation as indicated by SCR.

In summary, differences in levels of avoidance, SCR and self-reported expectancies of shock were all significant across the CS+ and CS- stimuli, as well as across the DCS+ and DCS- stimuli. Higher levels of avoidance responding were associated with higher levels of SCR and reported expectancies regarding the receipt of shock if an avoidance response was not produced. Lower levels of avoidance were associated with lower levels of SCR and expectancy. Significant large correlations were observed between avoidance frequencies and expectancy ratings for the DCS+ and DCS- cues in contrast to the small or indeterminate correlations recorded for the CS+ and CS- cues. Small to medium but non-significant correlations were observed between avoidance levels and SCRs for all cues. No relationship was observed between trait anxiety levels and any of the responses measured.

Discussion

In contrast to Experiment 1, the central hypothesis regarding the transfer of function between two semantically related words was supported by a significant amount of derived avoidance demonstrated in the presence of the DCS+ cue. This large effect was also supported by increased SCR as well higher level expectancy of the US in the case that an avoidance response was not made to the DCS+. Avoidance responding to the DCS+ in Experiment 1 was only demonstrated during 25% of probe trials compared to 63% for Experiment 2. Given that no further avoidance conditioning trials were given during Experiment 2, each of the methodological change made after Experiment 1will be reconsidered individually.

3.4.1 The use of synonyms over "categorically related words".

Historically, semantic generalisation research involving synonyms and antonyms has proved especially fruitful. As previously discussed in chapter 1, Razran in 1939 provided evidence of superior generalisation to synonyms in comparison to homophones when using salivatory volume as the dependent measure. During the 1940s, Razran's success in demonstrating generalisation using synonyms prompted Reiss (1940, 1946), as well as Cofer and Foley (1942), to use the same paradigm to demonstrate semantic generalisation but using SCR as a dependent measure. Throughout the 1950's (e.g., Branca, 1957; Luria & Vinogradova, 1959) and 1960's (e.g., Peatral, 1961; Mink, 1963) generalisation of responses between synonyms provided a reliable experimental paradigm to examine for differences among clinical populations, other semantic relations or to provide evidence of generalisation gradients. Much like Experiment 2, stimuli were selected based on the associative strength between words as described by association norm resources.

The evidence regarding the influence of associative strengths of word pairs of synonyms on generalisation gradients remains unclear. However, synonyms were selected for use in this experiment based on their very high level of association frequency as detailed in the *University of South Florida Word Association, Rhyme and Word Fragmentation Norm* indices. The results obtained showed a marked increase in derived avoidance over Experiment 1 with almost 100% avoidance responding to the CS+ and 66% to the DCS+ cue. Avoidance responding to the safety cues (i.e., CS- and DCS-) was at a rate of less than 2%. Without any previous training to establish word-relations, this experiment provided comparable levels of avoidance to the CS+, CS- and DCS- as the Dymond et al. (2011) study, which employed laboratory created stimuli and stimulus relations.

3.4.2 Skin conductance

As previously highlighted (see Table 3.5), a predictable relationship between avoidance response frequencies and SCR was evident during Experiment 2. Greater rises in skin conductance were associated with higher levels of avoidance to the CS+ and the DCS+. While no baseline SCL was recorded for neutral stimuli previous to the probe phase, the low SCR coupled with almost non-existent avoidance response levels for the CS- and the DCS- cues provides supporting evidence for the transfer of function effect between stimuli. The reason for the inclusion of SCR measurement in the experimental design was to provide a measure of threat appreciation in the event that derived avoidance responding should not be evident. However, comparisons between SCR and frequency of avoidance provided low or medium levels of correlation, none of which were significant. This is an important observation in itself because it indicates a decoupling of fear and avoidance behaviour and makes it more untenable to argue that one is the cause of the other, a situation that is acceptable to experimental analysts of behaviour.

At first glance, given the corresponding high levels of avoidance and SCR, the lack of correlation may appear unusual. However, while SCRs are a highly accurate indication of imminent threat appreciation, Szpiler & Epstein (1976) proposed that rather than the increase in tonal conductance level being the indicator of response, the rate of increase may be a better measure of the physiological response. Also, there is a paradoxical effect at work here in which the possibility of emitting an avoidance response likely reduced anticipatory arousal in participants (Thompson, 1981). Examination of trial-by-trial SCRs appears to support the reduced level of physiological response for all participants after the first presentation of the novel DCS+. More importantly, there was a significant correlation between SCRs for the CS+ and the DCS+, supporting the case further for derived avoidance being generalised from the conditioned responses established for the CS+ and CS- stimuli.

The SCR did highlight one other interesting effect visible during the trial-by-trial examination of SCL fluctuations across participants. For the majority of participants (63%) a singular, sudden and unusual increase in arousal level occurred which was not specific to the cue being presented at the time (i.e., the increase occurred whether it was a threat cue or not). Figure 3.1.1 demonstrates the phenomenon for two selected participants, one of which is in response to the DCS+ and the other to the DCS-. Typically occurring during the middle of the probe phase and without any obvious interference from either experimental procedure or environmental factors, this pattern might lead one to speculate about the possible role of private verbal behaviour once the initial response pattern has been established. It may well be that some ruminative processes are working to alter the function of stimuli, once a pattern of responding has been well established enough for concurrent verbal behaviour to occur. This is highly speculative at this point of course, but it is tempting to think that this pattern would not be observed in non-verbal populations, whose behaviour is typically much more clearly under the control of the immediate contingencies.

3.4.3 Expectancies

In line with the results from Dymond et al. (2011) and Declercq and De Houwer (2009), expectancy ratings were significantly higher for the receipt of shock subsequent to the appearance of the threat cues (CS+ & DCS+) than for the safety cues (CS- & DCS-) in the event that a response wasn't made. Comparatively low shock expectancy was also evident for all cues if an avoidance response was made. Expectancy levels, as previously reported, seem to be broadly associated with the significant amount of derived avoidance demonstrated to the DCs+ cue, as well as greater levels of SCR to both threat cues (i.e., CS+ & DCS+). This appears to support Lovibond's expectancy model (2006) which claimed that avoidance is based on a number of propositional assumptions that can be measured as expectancies. High levels of avoidance during the early conditioning trials support the proposition that an aversive stimulus will follow a particular cue and secondly, that avoidance behaviour will extinguish this relation. The expectancy ratings for the CS+ and CS- cues with and without avoidance taken at the end of the experiment appeared to also support the establishment of both propositions.

According to Lovibond, avoidance learning provides for the transfer of the expectancy between equivalent stimuli as well as the function. In other words, learning to avoid at the presentation of the CS+ cue creates the expectancy of the imminent appearance of the US in a related stimulus unless an avoidance response is made. Based on this expectancy, avoidance behaviour will be used to prevent the possible appearance of the US upon encountering a novel stimulus which is similar to one previously conditioned. This proposition appears also to be supported by the recorded expectancies taken during Experiment 2. Ratings for the receipt of a shock if an avoidance response was not made to the CS+ synonym (i.e., DCS+) were twice the recorded level if a response was made. Mean expectancies for the CS- cue, with or without avoidance, were almost identical to those recorded for the DCS- cue. This would appear to support the role of expectancies in derived avoidance.

Lovibond's expectancy model provided a causal role for expectancy in the transfer of function between trained and similar stimuli. He claimed that future avoidance to novel stimuli was based on the expectancy formed by historical precedent. However, from a behaviour analytic perspective, this relationship between expectancies and avoidance is purely speculative. Causal is itself explained in terms of the derived transformation of avoidance functions which is controlled by the private verbal behaviour of the individual. In other words, the same process is used to explain why expectancies might control avoidance behaviour as is used to explain how the conditioning contingencies and history of derived relational responding came to control the expectancies in the first instance. Dymond et al. (2009) claimed that rather than the expectancies providing such a mediational role in the derived avoidance, a more parsimonious model would involve both the avoidance and that expectancy being transferred as part of the same relational process involved in learning. In this way expectancy can function as a discriminatory process and also the outcome of a relational learning process (Dymond et al, 2009). Neither of the experiments in the current research provided an indication of directionality in the relationship between expectancy and avoidance (i.e., with regards to causation). Analysis only provided a strong positive correlation between avoidance and expectancy levels for the DCS+ and the DCS-, indicating the existence of a relationship. Surprisingly, a medium but not significant correlation was present between avoidance and expectancy for the CS+ and none whatsoever for the CS-.

Most surprising of all, however, was the relationship between the CS- and DCS- expectancy ratings in the event if avoidance responses were produced. Participants provided a medium level expectancy rating for the receipt of a shock if avoidance responses were produced. This would be contrary to the conditioned safety function attributed to the CS-. It may have been the case that because the CS+ was salient and had clearly established response functions, participants did not discriminate the contingency between the CS- and shock very well. In other words, they may simply be reporting that they did sometimes wonder if shock might be delivered following the CS- or DCS-. By definition then, the CS- stimuli exerted S- control rather than S+ control and this does not produce well-controlled discriminations of S- stimuli from each other. Of course, the expectancy ratings were all delivered offline rather than inline during probe trials, and this makes their use as reliable sources of information on contingency discrimination questionable.

3.4.4 Trait anxiety

Trait anxiety refers to the “relatively stable individual differences in anxiety-proneness” while State anxiety is the reaction to a process at that time Spielberger (1983). Neither measure correlated with avoidance frequency. However, a high level of anxiousness may not be required to demonstrate the conditioning and transfer effects. Perhaps derived avoidance, as demonstrated here and as claimed by Dymond et al. (2011), is merely a by-product of normal language and intellectual development and not an indicator of dysfunction. Of course, if derived avoidance were to be produced excessively and to generalise particularly rapidly and across remotely related continua, it may be indicative of dysfunction. Levels of avoidance required in this experiment, and given the relatively innocuous nature of the US stimuli involved, would not lend themselves to be used as analogues of dysfunctional behaviour that should correlate with sub clinical tests for anxiety proneness.

Despite the lack of relational training during Experiment 2, participants demonstrated high levels of derived avoidance, SCRs and expectancy of shock for the trained threat cues and their synonyms. This research sought to provide a real world analogy of an often employed behavioural experimental design, which has been used to demonstrate the transfer of function and derived avoidance between arbitrary pairs of nonsense words using relational training. The dependent measures used here provided sufficient evidence to demonstrate that fear and avoidance can generalise without the need for training by using readily available and naturally occurring semantic relations. The lack of correlation between the effect and trait or state anxiety levels prompts speculation that the phenomenon, at least as measured here, is not any kind of indicator or psychopathology.

Chapter 4

General Discussion

This research project comprised of two experiments and provided a novel demonstration of the transfer of function, without previous relational training, between a conditioned stimulus (i.e., a commonly used word) and its synonym. Although the first experiment failed to do so, evidence of a generalisation of fear effect between stimuli was provided by levels of overt avoidance, skin conductance and self-reported expectancies during Experiment 2. High level avoidance to the conditioned and derived CS+ was supported by large mean SCRs and high ratings of expectancy with regards to the receipt of a shock should an avoidance response not be made. Lower levels of avoidance to the safety cues (CS- & DCS-) corresponded with lower SCRs and lower reported expectancies. The level of avoidance of the threat stimuli (CS+ & DCs+) was significantly greater than that observed for the safety stimuli. The mean SCRs for the threat cues were significantly greater than for the safety cues and expectancy levels for a shock by not responding to the threat cues were significantly greater than for not responding to the safety cues. The evidence provided by these measures clearly indicates that the transfer of function between words and their synonyms was successfully demonstrated in Experiment 2.

The experimental design of the second experiment had benefitted from procedural changes in response to a number of possible confounds identified subsequent to the failure of Experiment 1. For example, in the first experiment and despite a high level of avoidance to the CS+, participants failed to provide significant levels of derived avoidance between categorically related word pairs (i.e., words describing either fruit or furniture). Both Keller (1943) and Dunsmoor et al. (2012) had successfully demonstrated the generalisation effect between images of different categorical class members. By using object names rather than images, Experiment 1 was restricted to semantically related associations between cues to provide for any transfer of fear effect. A major confound was discovered by research into the strength of association between the word pairs used as CSs in the first experiment. By examining word association frequencies provided by *The University of South Florida Word Association, Rhyme and Word Fragmentation Norms* (Nelson, McEvoy & Schreiber, 1998) it was discovered that the selected cues were weakly related and this could have contributed to the lack of derived avoidance between class members. As one of the main rationales of this research was to provide a real world analogy of the transfer of function, the use of naturally occurring but weakly associated word pairs would have interfered with any generalisation between the stimuli during Experiment 1. Indeed, according to the semantic association literature (Hutchinson, 2003), using words associated by artificial categories, rather than the stronger related synonyms and antonyms, was always bound to reduce the probability of derived transfer effects. As a result, cues from the second experiment consisted of strongly associated synonyms which successfully led to a large generalisation of fear effect and high levels of derived avoidance responding.

The use of synonyms in the sematic generalisation of fear has a long and fruitful history. One of the aims of the current research was to link the analysis of derived avoidance to the paradigms developed by early pioneers such as Razran (1939), Reiss (1940) or Keller (1943). Their research successfully and repeatedly demonstrated the generalisation of fear using synonyms and developed novel techniques including electric shocks and SCR. By combining their traditional paradigms with modern experimental techniques, results from Experiment 2 supported their original findings with significant SCR and expectancy levels and also bolstered that support with novel findings relating to the significant level of derived transfer of avoidance.

Modern paradigms have become more and more complex since Augustson and Dougher (1997) successfully demonstrated derived avoidance. The use of synonyms, SCR and shock as the US in Experiment 2, allowed this research to fill in the procedural gaps between early basic paradigms and their modern complex counterparts. The application of modern behavioural paradigm to the analysis of this phenomenon, also bridges the gap between the semantic generalisation literature, which seems to now fall under a cognitive and associationist rubric.

4.2 The Analysis of Avoidance

Results from Experiment 1 raised doubt regarding the semantic generalisation of fear and avoidance along verbal continua represented by weakly related words. While the high level of avoidance to the CS+ during Experiment 1 indicated successful conditioning, transfer of function was supported only by low levels of derived avoidance. In contrast, Experiment 2 provided significantly high levels of avoidance for both conditioned and derived threat cues when synonyms were used as conditioned and derived stimuli in the place of weakly related categorical stimuli. This effect was also supported by SCRs and expectancy ratings for avoidance to the DCS+ (derived threat) stimuli. Differences between avoidance rates to the DCS+ cues and the DCS- (derived safety) cues were also significant. Indeed, the level of avoidance demonstrated during Experiment 2 appeared to be comparable to the high levels of transfer of function found in previous studies.

This research extends upon the semantic generalisation research and makes a start at identifying the conditions and boundary conditions of the generalisation effect. The most important advance in this regard is the introduction of an avoidance response into the paradigm. This is important because the core problem in anxiety is not necessarily fear but avoidance (Augustson et al., 1997) and avoidance has been implicated as a core process in many pathological forms of anxiety (Freeman, Garety, Kuipers, Fowler, Bebbington, & Dunn, 2007). Indeed, anxiety inducing avoidance is a fundamental part of human adaptive behaviour (Hayes, Strohl and Wilson, 1999). The high levels of avoidance demonstrated in this and other research indicates the prevalence and utility of avoidance in dealing with the appearance of a potential threat stimulus.

The level of derived avoidance demonstrated during Experiment 2 was slightly less than, but still broadly in line with, that demonstrated in other research. In their 2011 study, for example, Dymond et al. claimed that participants showed derived avoidance for 90% of probe trials after training arbitrarily related cues using two 3 member equivalence relations and examining for any transfer of function between the conditioned and previously but indirectly related cues. As previously highlighted, in Declercq and DeHouwer (2009) 75% of their participants generated 100% derived avoidance responses. Dymond et al. (2013), while not providing mean avoidance data, described the derived avoidance response levels demonstrated by their groups as “substantial” with significant differences between derived avoidance to threat and safety cues. Hooper, Saunders and McHugh in 2010 highlighted high levels of avoidance for words that participants had been trained to avoid in their examination of the underlying generalisation processes involved in thought suppression. In their typical equivalence related experimental paradigm, during the transfer probe phase participants demonstrated avoidance to stimuli previously related to the CS+ for 80% of trials. The cumulative evidence in favour of the ease in which a function can transfer between related stimuli would indeed appear convincing. However, while Experiment 2 of this current project provided comparatively high (66%) levels of derived avoidance, evidence from Experiment 1 showed a quite a weak effect.

As discussed in Chapter 2, the low level of derived avoidance observed during Experiment 1 may have possibly been explained by the low strength of association because the class members were from an "artificial category", as described by Hutchinson (2003). The word pairs also may have been naturally low with regard to their associative strength. If so, this finding may support the idea that there exists a semantic generalisation gradient comparable to the gradient demonstrated by Guttman et al. (1956) for topographically related stimuli. As previously reported, semantic generalisation gradients were initially proposed by Reiss (1946) and were a popular topic of study during the 1950s and 1960s, with a number of experiments using SCR to demonstrate successfully the graduated generalisation effect (e.g., Lipton & Blanton,1957; Phillips, 1958). Mink (1963) was the first to use empirically measured word pair responses from the *Minnesota Word Association Response Norms* (Russell & Jenkins, 1954) to identify such a gradient. However at the time, other research cast doubt on the graduated effect (e.g. Lang, Greer & Hnatiow, 1963) or failed support generalisation between synonyms altogether (Staats, Staats & Crawford, 1962). Convincing support came from a study by Cramer in 1970 using Electromyogram (EMG) results that highlighted a linear graph of generalised responding in relation to the associative strength of the semantically related words. The evidence from Experiment 1 would appear at first glance to accept the possibility that word association strength of the cues was a contributory factor in the low derived avoidance levels recorded. However, it does not follow from this that intermediate levels of association strength up to those existing between the conditioned and probe stimuli employed in Experiment 2 would yield intermediate levels of avoidance (i.e., illustrate a smooth generalisation gradient).

Evidence regarding any gradient of threat appreciation could have been provided by the word association strengths for the selected Experiment 1 CS+ stimuli (i.e., *chair- table* .31*; table – chair* .76). Given their strengths (i.e., low .31 and high .76), differences in derived avoidance levels across participants who were exposed to either CS-DCS configuration should be apparent. Even though Thompson et al. (1998) claimed that research to date had also failed to provide evidence regarding any asymmetrical priming effect between pairs of differing directional associative strengths, the choice of stimuli selected as the CS+ cue was alternated between participant cohorts. This would have accounted for any confounding directional effect and a post hoc inspection of the data revealed that there was no discernible pattern of conditioning or transfer of functions that could be related to the choice of the CS+ cue.

Attempts have been made to address any potential confounds which would explain the weak effect recorded during Experiment 1. Other proposed confounds to Experiment 1, regarding the aversiveness of the US or the lack of subtlety of the overt avoidance response compared to the measurement of SCR, have been addressed either in discussion or by being refuted by the results of Experiment 2. However, given that the research has employed avoidance as a main dependent measure and the semantic generalisation work of the 1930s and thereafter employed mainly SCR as a measure of conditioned fear, it is difficult to know if the absence of transfer of avoidance is something that would also have been observed historically had avoidance been used as the main index of stimulus function transfer during

Experiment 1. Nevertheless, the current research at least contributes the finding that mere categorical relatedness is not sufficient for the transfer of conditioned avoidance but that stimuli related through equivalence of semantic meaning (i.e., synonyms) will facilitate high rates of derived fear and avoidance functions.

4.3 Skin conductance Analysis

Along with demonstrating the transfer of function between semantically related stimuli, this research attempted to provide novel evidence regarding the positive relationship between threat appreciation as measured by SCRs and avoidance behaviour. The relationship between skin conductance levels and threat appreciation has been supported by over 100 years of research and is widely accepted as a reliable indicator of fear and threat (see Szpiler & Epstein, 1976 for review). During Experiment 2 the transfer of fear between semantically similar words was demonstrated by high levels of overt avoidance which was supported by differences in SCR levels between threat and safety cues. Analysis of SCR data revealed a strong correlation between the effects of the CS+ and DCS+ cues and suggested that a significant proportion of the fear response had been generalised from the conditioned cue. The significant difference in SCRs between the DCS+ and DCS- cues was comparable that between the CS+ and CS- cues and provided further evidence for the transfer of function between conditioned and derived stimuli. As previously highlighted, if Experiment 1 had included SCR as a dependent measure, it may possibly have revealed at least some transfer of fear that would have complimented the finding of a weak non-significant generalisation of avoidance. However, while SCRs were successfully generalised along a semantic relation in

Experiment 2, only a weak correlation was found between SCRs and avoidance rates in that experiment.

A number of possible confounds may have interfered with the relationship between SCR and avoidance levels as observed in Experiment 2. Firstly, SCR is a very sensitive indicator of physical arousal. Szpiler and Epstein (1976) claimed that fluctuations in electrodermal activity associated with anxiety could be viewed either as a measure of anxiety related physiological instability or possibly the indication of a behavioural orienting response. They proposed that the distinction between instability or orienting behaviour would only be available to the "individual's own thoughts", as the source of stimulation may not be evident. Of course, Szpiler et al. (1976) were referring to non-specific fluctuations in skin conductance levels recorded in as tonic rather than phasic conductance responses. These longer records are replete with what appear to be random or "non-specific" fluctuations in skin conductance levels. These fluctuations are in principle understandable as response to discrete stimuli in the anatomy of the individual or as a result of private events, such as thoughts. Nevertheless, the relevance of this observation for the current data is that some SCRs will undoubtedly contain some of these non-specific components, particularly early probe trials in which a large orienting response might even be expected. More specifically, individual trial analysis of Experiment 2 SCR data highlighted that at the initial presentation of a novel probe stimulus an atypically large SCR was recorded for most of the participants. This may reflect the superimposition of a normal stimulus response on top of an orienting response, and as such the "true" magnitude of the SCR for the relevant stimulus is difficult to ascertain on early trials before habituation to the stimulus novelty has occurred. Of course, the stimuli were presented in a quasi-random sequence so mean response magnitudes were affected more or less equally by any orienting response effect. Post-hoc analyses revealed that when the SCR for the first probe was omitted from the analysis, the difference in SCR magnitude to the DCS+ and DCS-was still significant, $t(25) = 1.881$, $p < .05$. Nevertheless it is important for researchers to be aware that using SCR as a determinate measure for threat appreciation may be confounded by the difficulty in teasing apart the effect of threat appreciation from a mere orienting response on a trial-by-trial basis.

A second possible reason why SCRs did not correlate more strongly with avoidance rates in Experiment 2 relates to the availability of an avoidance response. This may have interfered with the ability of SCR to provide a reliable indicator of fear appreciation because the ability to avoid the aversive US would be expected to reduce fear of the conditioned and derived stimuli (Lovibond, Saunders, Weidemann & Mitchell, 2008). Indeed, Szpiler et al (1976) provided evidence supporting the reduction in SCR levels for stimuli in which an overt avoidance response was used. This reduction in SCR over those expected for an unavoidable US, merely indicates the very fact that avoidance has been successfully conditioned rather than any decrease in the aversiveness of the US. A more accurate measure of perceived threat to the stimulus would be the level of avoidance responding. For this reason, avoidance rates provide a simpler and perhaps more reliable measure of the aversiveness of a stimulus and its potential to disrupt and control behaviour.

Finally, another possible confound to the utility of SCR as a reliable threat measure in Experiment 2 was that there was no requirement for a response to the safety stimuli during this experiment. That is, it may be that the very requirement to make a motor response, is sufficient itself to create some autonomic arousal (i.e., rather than fear itself). Szpiler et al. (1976) controlled for any influence which the action of overt responding would have on SCRs. In one study, these researchers used a control group who were required to repeatedly and rhythmically tap a response key which, they were told, would indicate any effect shock would have on their frequency of responding. By requiring these participants to produce an overt response for both the CS+ and CS- the motor response confound was eliminated from the SCR measures. Even with these controls the differential conditioning effect was still apparent using SCR measures, and so we can assume that any effect on SCRs caused by the motor activity intrinsic to avoidance itself, is negligible. Nevertheless, this is one more contributing processes to the lack of strong correlation between SCRs and overt avoidance.

One interesting artefact observed in the trial by trial SCR data was the regular occurrence in spontaneous rises in on-going (tonic) skin conductance levels at roughly the mid-point of the probes phase for most participants. The majority of participants appeared to display skin conductance levels that deviated from the direct contingency control of the cues during the mid-latter part of the probe phase. Specifically, they demonstrated a large sudden increase in SCL that was not specific to the cue being presented (i.e., the increase occurred regardless of whether a threat or safety cue was presented). In the absence of any stimulus manipulation that can explain this effect, it may be acceptable to speculate that this change was due to the private verbal behaviour of participants that may routinely emerge once habituation had occurred and a stable response pattern had been established (i.e., they were no longer learning). The reduced demand of the task at the mid-point of the probe phase may have allowed ruminative behaviours to occur (e.g., concurrent private verbal behaviour, rule formation, etc.). The re-examination of threatening stimuli previously avoided is termed *cognitive restructuring* in the cognitive related anxiety literature and is both recognised as an established behavioural process and endorsed as a coping technique by CBT. Acceptance and Commitment Therapy (ACT) is a treatment program which embraces the elements of *Relational Frame Theory,* specifically regarding the role played by language in psychopathology, contends that this private rumination over response-consequence contingencies (i.e., *cognitive restructuring*) is central to the anxiety process itself and is to be expected to some degree for every verbally-able human (Arch & Craske, 2008)

On a parallel note, Dunsmoor et al. (2012) specified an important role for memory rehearsal in the emergence and maintenance of fear. As previously described, Dunsmoor and colleagues successfully demonstrated the generalisation of fear between pictures of categorically related tools using SCR and expectancies as dependent measures. They also demonstrated increased memory recall for the aversively related stimuli, 24 hours after participation in their fear conditioning experiment. Similarly, McGaugh (2006) claimed that memory enhancement provided by arousal could result from increased attention during coding or during subsequent rehearsal or consolidation of the aversive event and related stimulus sequences. However, Dunsmoor et al. (2012) claimed that "the typical human fear conditioning experiment is ill suited to address how humans acquire and retain long term declarative memories for a range of threat related stimuli" due to the role of internal cognitive processes in memory. Thus, it is not unusual in either the associative or behavioural literature to assign some causal status to private dialogues in the control of fear and avoidance responses, whether those private activities be conceived as forms of verbal behaviour that transform the response functions of events referred to in private verbal statements or as memory rehearsal events that consolidate conditioning effects. In either case, the occurrence of private behaviour could in principle lead to a sudden and unexpected increase in skin conductance levels, even when over avoidance rates are not affected.

While this research accepts the broad validity of SCR as an indicator of arousal level, it was used in Experiment 2 only as a supporting metric to the primary measure of avoidance. The “noisiness” inherent in SCR measures however, coupled with the lack of a strong correlation between SCR measures and avoidance, should lead researchers to be cautious in their use and interpretation of this measure. The current research findings would appear to suggest that avoidance is a more reliable and parsimonious indicator of threat appreciation.

4.4 Expectancies Analysis

Recorded expectancies for Experiments 1 and 2 required a rigorous examination because of their more subjective nature in comparison to the other more traditional and objective measures used. Expectancy ratings were broadly consistent with the other recorded measures of fear appreciation for both experiments. Experiment 1 probes provided high avoidance and expectancy levels for the CS+ which contrasted with low levels of derived avoidance and expectancy being demonstrated to the DCS+ cue. This lack of transfer of expectancies was supported by the recording of comparable expectancy ratings regarding the appearance of the US for both the DCS+ and the CS- cues. In other words, the DCS+ seemed to have functioned as no more threatening than a safety stimulus (i.e., CS-). During Experiment 2, high levels of avoidance, SCR and expectancy were apparent for both the CS+ and the DCS+, thus demonstrating the transfer of fear, avoidance and expectancies. However, a number of artefacts in the patterns of expectancies recorded raised the interesting issue of the role of expectancies in the production of avoidance responses, as proposed by Lovibond (2006). For example, the equivalent and low level of US expectancies recorded for both the CS- and DCS+ cues in Experiment 1, coupled with a low but notable level of avoidance during that same experiment (25% for the DCS+, compared to 3% for the DCS-), suggests that the expectancies cannot be easily invoked as a mediator or even cause of the overt avoidance observed. Put simply, participants failed to discriminate between the DCS+ and DCS- in terms of US expectancy ratings, but discriminated to a much higher degree between these stimuli when it came to overt avoidance. In other words, derived avoidance in Experiment 1 was more easily controlled by the experimental contingencies than derived expectancies, and so the latter can hardly be invoked to explain the former. Experiment 2 on the other hand provided a strong significant correlation between expectancies and avoidance for the DCS+ and DCS- cues with very similar levels of avoidance and reported expectancy of a shock. But their relationship provided only a small non-significant correlation for the CS+ cue and none at all for the CS-. Based on these and other previously discussed anomalies, it might be more parsimonious to consider the comparable levels of avoidance and expectancies as merely outcomes of the same relational process (i.e., transformation of response functions: see Dymond et al., 2009).

The use of expectancy ratings as a reliable measure of fear generalisation needs further consideration by researchers. The generation of accurate self-reported expectancies in an experimental design carries with it the potential from methodological confounds and conceptual confusion. For instance, depending on precisely when the expectancy ratings are taken a number of different effects may be observed. Experiment 1 recorded expectancy ratings both between phases and also after the probe phase, similar to Dymond et al. (2011; 2013). Thus, they were always retrospective rather than in line. The difference between the level of expectancy (90%) and the level of conditioned avoidance (73%) reported during Experiment 1 for the CS+ can possibly be explained by the completion of expectancy reports post-hoc. In other words, during the early stages of learning participants are merely learning to respond under the reinforcement contingencies and so it might be fair to assess the CS-US contingency as weak due to the fact that for much of the training they were in fact unable to tact that contingency at all. However, by the time the probe phase was delivered the CS-US contingency was clear and ratings may reflect this. Of course, it is questionable if participants' assessments of CS-US contingencies can be relied upon at all, especially post-hoc. Rehearsal of the CS-US relation (i.e., private verbal behaviour) between conditioning and testing phases could also, as highlighted by McGaugh (2006), provide the opportunity for participants to establish memory enhancements regarding the aversivesness of each conditioned and derived stimulus. In other words, the post-hoc memory participants have regarding the CS-US contingency, is changing over time and may well differ from in-line expectancies taken on a trial-by-trial basis (see Dunsmoor et al. (2012) for evidence of enhanced memory for contingencies post experimentation compared to that during experimentation).

In their studies, Declercq et al. (2009) and Dunsmoor et al. (2012) recorded trial-by-trail expectancy ratings. While this may enhance the reliability of the ratings, it is also likely to interfere with the conditioning process itself by upsetting the clear contingency of the CS-US relations. In addition, it may have assisted in the transfer of expectancy functions, by strongly associating them with each conditioned stimulus, and effectively "piggy-backing" the transfer of avoidance on top of a simpler transfer effect (i.e., expectancies). As previously highlighted, first establishing a transfer of one set of functions through derived relations is a well-established procedure for increasing the probability of the transfer of another set of response functions (e.g., see Roche, Barnes-Holmes, Smeets, Barnes-Holmes & McGeady 2000). In effect, the recording of in-line expectancies reduces the naturalistic format of the experiment and raises doubts regarding its ecological validity. As the current research was specifically designed to examine naturalistic transfer effects, interference caused by in-line expectancy ratings would have been highly undesirable.

Attempts to correlate subjective threat appreciation with behavioural responses in the past have not produced entirely unambiguous findings. The relationship between self-assessment and physiological measures has been repeatedly demonstrated to be unreliable, with little or no correlation evident between self-reported, physiological and behavioural responses to anxiety (Derakshan, Eysenck & Myers, 2007). There are two main suspected reasons for this poor relationship. Firstly, depending on their coping style some individuals can provide explicit threat appreciation ratings which are contradicted by both physiological and behavioural responses (Derakshan et al., 2007). More specifically, people who use a "repressive coping style" can have low trait anxiety levels but use high levels of defensive characteristics. Derakshan and colleagues claimed that people with this personality type, referred to as "*Repressers",* maintain a perception of a lower level of imminent threat than either their behaviour or physical responses would not suggest. The researchers proposed a *Vigilance- Avoidance Theory* to account for this discrepancy between measured and self-reported anxiety levels. Their theory suggested a stasis of vigilance on the part of the *Represser* which promotes an early and rapid avoidance response. Only subsequent to avoidance is an assessment of threat level then determined. Because this type of personality would possibly fail to be highlighted as highly anxious when using an anxiety trait questionnaire like the STAI, without a detailed personality assessment this behaviour would not be evident in experimental analysis.

Secondly, the utility of expectancy ratings as a measure as well as its scientific validity has been previously questioned. For example, Schwerdtfeger (2004) asked participants to assess their own level of anxiety as well as measuring heart rate and SCR taken both previous and subsequent to the delivery of a public speech. There was no correlation between self-reported levels of anxiety with either increased SCR or heart rate measured at those times. Schwerdtfeger speculated that individuals may merely be unaware of their level of arousal. He claimed that "self-reports of emotion and motivation" have consistently provided inaccurate measures of autonomic response and calls for subjective measures to be omitted from future psychophysiological research. Of course, both of the previous accounts have focussed on the awareness of physiological and emotional state rather than awareness of CS-US relations, which is all the current expectancy ratings were designed to assess. Nevertheless, the two processes (CS-US expectancy and emotional awareness) may well overlap insofar as threat expectancy is related somewhat to fear of the US, but the nature and direction of the relationship between these two variables is not well understood. Based on the foregoing, and the conflicting results regarding their relationship with avoidance, expectancies do not readily present themselves as clear mediators of the overt avoidance observed in either experiment

Interestingly, the findings of Declercq and De Houwer (2009), which they claimed provided support for Lovibond's (2006) expectancy theory, suffer from the same problem outlined here. That is, the superiority of expectancies over avoidance as a DV, was apparent only because in their analysis of the relationship they examined only the avoidance rates of those participants who had shown 100% correct expectancies. This analysis bias exemplifies the problem of approaching research with a conceptual paradigm. In fact, when their data is analysed more carefully, it becomes apparent that rather than the findings highlighted (i.e., 88% of those who reported 100% correct expectancy ratings had produced 100% avoidance responses), only 79% of participants who avoided correctly reported perfect expectancies. In other words of their sample of 56 participants, 42 successfully avoided 100% of the aversive stimuli while and only 33 correctly predicted the appearance of the US for all of the conditioned and derived threat cues. Rather than providing novel support for the role of expectancies in derived avoidance, Declercq et al. (2009) provided conflicting evidence and the causal status of expectancies is surely called in to question. In fact, the lack of reliability of the measure and also the lack of evidence regarding directionality of effect between expectancy and avoidance should also be sufficient to also question the viability of Lovibond's (2006) expectancy model.

4.5 Trait analysis

A relationship between trait anxiety and propensity for physiological arousal has been unclear for over 50 years (see Derakshan et al., 2007). In this research, no correlations were apparent between trait anxiety levels and derived avoidance, SCRs or expectancy ratings in Experiment 2. As discussed earlier, this may be because certain individuals (i.e.,"Repressers") report low levels of trait anxiety but display high levels of physiological arousal and avoidance. Another more functionally oriented explanation for this lack of correlation was provided by Dymond et al. (2011) who emphasised that fear, expectancies and avoidance are all products of the same core relational processes and so while the may correlate with each other, there is no fundamental requirement for them to do so.

Each transfer of functions represents the unique use of the same core processes, and variations in each is easily explained by variations in the presence and salience of contextual cues, whether they are intentional or not. These cues can take the form of any aspect of the procedure or physical environment that selected that particular function of interest over others, and they are known according to Relational Frame Theorists as C_{func} stimuli. It is not yet known at present why expectancies, or skin conductance responses may have transferred to novel stimuli to a greater or lesser extent than avoidance responses, but this is the real challenge for researchers, rather than the construction of intuitive accounts based on hypothetical processes and constructs (e.g., expectancies or propositions).

4.6 Conclusion

This research represented a novel attempt to produce and control the transfer of fear and avoidance, using existing semantically related everyday words and provide a more ecologically valid analogue of generalised fear and avoidance than that traditionally described in the behaviour analytic literature. It also sought to find some points of overlap between the experimental approach and nomenclature with the methods and terminology developed by early research into semantic generalisation and the more modern associative learning paradigms. Based on the methodologies explicated in this thesis, and the findings generated by the largely behavioural approach adopted, it appears that there is much methodological overlap between these approaches, even if there also exists some differences in perspective regarding the core processes involved. Despite this, however, the conscious effort to share and explore methodologies across these various research traditions is surely a worthwhile project as it will serve to foster much cross-pollination of ideas among researchers interested in broadly similar phenomena.

Results from both experiments suggest that it is possible to demonstrate the transfer of fear and avoidance between naturally occurring related pairs of words although effects are very weak when words are merely categorically related. This conclusion has to be tempered, however, by the fact that the procedures of Experiments 1 and 2 differed in relation to the US stimuli employed, and this alone may explain that difference. While research from associative researchers on avoidance is scarce, none have employed words alone as conditioned and probe stimuli for generalisation. As such, the current study represents an advance in demonstrating the relative ease with which fear and avoidance functions can transfer through verbal relations. This matter certainly would appear to merit closer investigation.

Language may well mediate the transfer of fear as it is complex and can be represented as a large network of contextually controlled interconnecting stimulus relations. It is not difficult to see how fear and avoidance (i.e., anxiety) could quickly become a clinical issue for verbally able humans once fear and avoidance have been established through direct conditioning experiences in the real world. This has long been the stance of modern behaviour analysts working in the clinical behaviour analysis field (e.g., Dougher, 2000; Torneke, 2010). While this basic process has been demonstrated in several studies, it has never been demonstrated with naturalistic words and pre-existing stimulus relations involving only real words presented in isolation from any affective images or stimuli functions in any other modality than visual.

The role of threat appreciation and complex cognitive processes to establish mentally mediated propositions has been the dominant explanation among the associative community for various measures of threat appreciation. However, it was suggested here that in their attempt to explain fear generalisation and any subsequent avoidance the Expectancy Model as proposed by Lovibond (2006) has failed to provide convincing evidence regarding any causal role for US expectancies on avoidance. Rather than expectancy, derived avoidance has been demonstrated here to be the most readily controlled function to transfer. The transfer process itself, rather than any mediating influence provided by any one of its stimulus functions, would be the preferred and most parsimonious account available to explain all of the functions transferred.

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