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Resilience, Health and Stress: Using an Ecological System Model

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Abstract

This thesis reports on five studies which examine whether an ecological system model of resilience, as includes adaptive, engineering and ecological aspects, can be examined within the context of health, stress and emotional regulation. Despite the well-documented application of other models of resilience in health and stress contexts, little is known about the ecological system model of resilience. This thesis therefore provides a novel investigation of the ecological system model of resilience in various settings. The findings of Study 1 indicate that aspects of the ecological system model of resilience are significantly associated with aspects of health-related quality of life and health-specific self-efficacy. Study 2 fails to offer evidence as to the relationship between resilience and physiological responses given to emotional picture stimuli by using skin conductance responses measurements. Study 3 reveals that the aspects of trait resilience are positively related with both positive and negative sound and video stimuli, with the effect size varying from small to large when using skin conductance responses measurements. Study 4 suggests that aspects of resilience are positively related with heart rate variability during an exposure to affective videos. Finally, Study 5 shows that engineering resilience is positively related with skin conductance responses and negatively related with anxiety. Furthermore, Study 5 indicates that engineering resilience uniquely predicts anxiety after controlling for baseline scores. Overall, these studies have improved our understanding held as to the ecological system model of resilience in relation to health and emotional regulation and With regard to the capacity of ecological model of resilience (EEA) for predicting quality of life (health-related) for people in their positive functioning as well as the manner in which physiological alterations in cardiovascular and electro-dermal activity, this model of resilience and provides empirical evidence about the forecasting role of resilience in general. These findings highlight key areas for development in both future studies and in relation to the resilience within the health and emotional regulation system.

Declaration

I hereby declare that this thesis has been composed by myself and that the research reported herein has been conducted by myself.

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Zainab Alanazi

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Chapter 1

General Introduction

This chapter reviews the literature as relates to the definition held towards resilience, biomarkers and resilient functioning, emotions and stress reactivity, the measurement of resilience, the ecological model of resilience, the application of Holling's model to the measurement of psychological trait resilience, the ecological model and biomarkers, the trauma analogue paradigm, skin conductance responses and heart rate. The chapter also conveys the aims and outline of this thesis. This chapter further discusses the importance of the biomarkers of resilience in understanding resilience and reviews the evidence which relates to resilience in general as well as to the associated physiological and psychological processes explored in resilience investigations. Finally, the limited evidence which corresponds to the ecological model of resilience is considered. While it is noted that there are limited studies associated with the emotion regulation system and resilience, the ecological model of resilience is here reviewed and then discussed as to how this model can be applied to measuring psychological trait resilience. A further review is then presented as to the limited research relating to the ecological model and biomarkers, whereby detail is given as to the three factors that make up this model and how they can be applied to the measurement of resilience. This is undertaken to add new knowledge to the overall study of resilience. Furthermore, in the trauma analogue paradigm, two of the most commonly-used physiological measures are reviewed – heart rate and skin conductance response. By drawing a conclusion from the review's findings, the aims and outline of the thesis are provided at the end of the chapter in light of the gaps identified.

Definition of Resilience

In general, resilience has been defined as a process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of stress — such as family and relationship problems, serious health problems, work place issues and financial stressors. That is, resilience is the ability to *bounce back* from difficult experiences or adversities (Tugade & Fredrickson, 2004). Existing literature typically characterises resilience as either a process or a personality trait (e.g., Masten, 2009). The process approach defines resilience as a dynamic process of adaptation undertaken as to a risk and is an interaction between risk and protective factors (Luthar *et al.,* 2000; Masten, 2007; Olsson *et al.,* 2003). The personality trait approach considers resilience as the ability to resist psychological stresses associated with unpleasant or traumatic experiences (Tugade & Fredrickson, 2004). According to Benard (1991), resilience as a trait includes social competence, problem solving, autonomy and a sense of purpose. Nakaya *et al.* (2006) suggest that personality traits are significant correlates of resilience, whereas Neelarambam (2015) stresses the importance of mindfulness for resilience. Cognitive adaptability, spirituality, resourcefulness and adaptability (Joseph & Linley, 2006), genetic factors (Cichetti & Curtis, 2006) and environmental factors (Luther *et al.,* 2000) have all been found to be related with resilience.

In defining resilience as a process, Southwick et al. (2014), argued that it is a process of moving forward without going back. It is an individual conscious effort to progress in an insightful positive way which is a result of past adverse experiences. The authors recognize that some people may have had severe traumatic disorders which they have been struggling with every day. However, their active decision and the sobriety to keep moving forward that is frequently reconfirmed define resilience as a process (Southwick et al., 2014). Lee, Cheung, and Kwong (2011) and Richardson (2002) confirms this by arguing that resilience as a process is the reintegration process and a fall back to an individual's positive functioning through enabling factors after having been through severe stressors (Lee, Cheung, & Kwong, 2011; Richardson, 2002). On the other hand, resilience as a trait is associated with personality traits (Eley et al., 2013). The combination of personal traits and an individual's environment influence resilience. However, since the environment keeps on changing, it follows that resilience and behaviour are a result of adapting to life challenges (Cloninger, salloum & Mezzich, 2012; Josefsson et al., 2013). Other literatures have also supported that resilience is a trait because it results from an individual's genes and environment (Feder, Nestler & Charney, 2009).

Resilience is a concept that does not have one overriding definition. As noted above, resilience is a broad concept and has been characterised differently. Accordingly, it is important to adapt a definition which underpins the present thesis. For this thesis, we have adapted a definition which refers to 'resilient functioning'. Resilient functioning centres on a biological and cognitive framework at the core of which is the brain. Within this framework, the brain is constantly adapting and accommodating to maintain functional equilibrium as it makes sense of experiences. In doing so, positive health and psychological outcomes are facilitated (Cicchetti & Curtis, 2006). It is within this context that resilience can be understood as a central biological and cognitive process (Franklin, Saab & Mansuy, 2012; Waugh, Wager, Fredrickson, Noll & Taylor, 2010) that has an executive functioning capability within resilience (Cicchetti & Curtis, 2006). Executive functioning is, however, a broad term that encapsulates a range of interacting high-level cognitive, emotional and behavioural processes that are involved in complex, goal-orientated or task-directed thoughts and behaviours. Processes such as planning, flexibility, organisation, attention, problem solving, decision-making, working memory and response inhibition are all important in explaining resilient functioning (Cicchetti & Curtis, 2006).

Measurement of Resilience

Literature regarding the measurement of resilience suggests that there are various theoretical and measurement conceptualisations that arise in relation to the way that individuals respond stressful events experienced (Maltby *et al.*, 2016). Typically, no consensus exists among researchers as to the theoretical and empirical approaches which should be used when measuring resilience. Measurements of trait resilience have been very wide-ranging and therefore are not as clear as they might be. This lack of clarity as to measuring trait resilience means that confusion can arise as different measures may be measuring just specific aspects of resilience (Windle *et al.*, 2011).

Resilience has typically been measured using self-report questionnaires within the extant literature. Here, self-report questionnaires of resilience are applied to assess the effectiveness of interventions and policies developed to promote resilience. These questionnaires are also extensively used in research in order to understand the correlates, predictors and causes of resilience (Windle *et al.*, 2011). However, to obtain robust results in research and practice, it is vital to employ reliable and valid questionnaires to ensure the accuracy and quality of the data gained.

There are a number of self-reported resilience measures found in the literature. Some are widely used in research and practice while others have been questioned in regards to their reliability and validity. In a systematic literature review in which nineteen resilience measures were reviewed in terms of their psychometric properties, Windle *et al.* (2011) highlighted that, conceptually and theoretically, all of the self-reported measures lacked evidence in terms of their psychometric properties. In that review, it was highlighted that among resilience measures, only a limited number (such as the Connor-Davidson Resilience Scale, the Resilience Scale for Adults and the Brief Resilience Scale) had strong psychometric properties. Similar issues have been noted when reviewing the resilience measures employed in relation to adolescents. For example, in a review of six measurements employed in assessing resilience among adolescents, Ahern, Kiehl, Lou Sole & Byers (2006) found that these resilience measures lacked evidence as to their application in different age groups (including adolescence). An example of these is the Baruth Protective Factors Inventory and Brief-Resilient Coping Scale. Among the six reviewed measures, only one (the Resilience Scale) was found to possess psychometric properties.

Given that resilience is an important construct for policy, practice and research, it is necessary to have reliable and valid measures that assess resilience from a wide perspective and that provide solid information which underpins effective intervention, policies and research. As the extant literature details that the instruments of resilience suffer from reliability and validity issues, Maltby *et al.* (2015) constructed a parsimonious measure of resilience and thus a useful approach through which to measure trait resilience. This was achieved by investigating and incorporating a wide range of theoretical and empirical approaches currently employed to assess resilience. The EEA measure of psychological trait resilience is thus proposed as a reliable and valid measure by Maltby *et al.* (2015) to address the issues pertaining to the currently used resilience measures. The EEA resilience scale measures resilience from multiple aspects, as includes engineering, ecological and adaptive capacity, while its reliability and validity have been established across different samples and cultures (Maltby *et al.*, 2015, 2016). This measure refers to the biological and ecological aspects of resilience. Having biological measures included in the psychological research paradigm will give a stronger understanding of the underlying processes involved in resilience. It is suggested that the neglect of biological measures may be related to an individual not having the requisite biological characteristics, with this being regarded as the cause of his or her own misfortune in not being able to function resiliently.

Biological resilience is described as the ability to recover after an initial stressor. This incorporates measure like anabolic hormones, stress levels, the ability to concentrate and stress levels, which can be used in evaluations. Neurobiological studies of resilience have ben mediated by some key molecules occurring in susceptible animals being absent and impairing their coping abilities, and the distinct mechanisms of adaptation being present in resilient individuals promoting normal behaviours (Friedman et al., 2016). The ventromedial prefrontal cortex (vmPFC) and the amygdala are representations of human resilience where they are activated during stress. Through homeostasis, there are biological changes that occur with increases in hormones like noradrenalin, adrenalin, neuropeptide Y, gamma-Aminobutyric acid, and Cortisol to allow for reaction to stimuli. Biochemical changes attributed to resilience need to be examined without assumptions that there is sufficient awareness to activate protective factors, derived from the complex interactions of the environment and the person. With rapid changes in structural and functional control, biologic resilience involves having the flexibility and adaptability of coping with any changes. With improvements in resilience in humans occurring due to cognitive and psychological therapies, developing more stable, faster and general effective interventions will ensure that the current realm of resilience research covers the active adaptive and maladaptive mechanisms that can facilitate better outcomes. Thus, in the current thesis, we have adapted the model and measurement of EEA ecological system in understanding resilience and have examined its relevance within wider psychology.

Applying Holling's Model to the Measurement of Psychological Trait Resilience

To date, there is no available research that integrates engineering, ecological and adaptive aspects of psychological trait resilience into a framework that allows research related to resilience to be examined in a more systematic way, with this being true despite the common usage of these three aspects of resilience within other disciplines. Although Holling's (2016) model is robust and useful in regard to it shedding light on biological, psychological and social systems in the ecological literature, the model lacks evidence in terms of it providing a solid framework through which to comprehensively understand resilience. To address this, Maltby *et al.* (2015) proposed a framework, as employed by Holling and colleagues (Holling, 1973, 2006), in the ecological literature. This framework includes ecology and systems theory to present psychological trait resilience. According to the Holling approach, resilience includes three general systems; engineering resilience, ecological resilience and adaptive capacity. Maltby *et al.* (2015) operationalised this model by employing psychometric theories – such as exploratory and confirmatory factors analysis. To operationalise this model, they utilised five of the most widely-used scales – the Ego Resiliency Scale, the Hardiness Scale, the Psychological Resilience Scale, the Connor-Davidson Resilience Scale and the Brief Resilience Scale. By refining these frequently-used resilience scales by using factor analytics techniques, a 3-factor structure for the resilience measure was yielded that explicitly includes engineering, ecological and adaptive capacity Here, Maltby *et al.* (2015) introduced a 12-item trait resilience scale consisting of four items per component.

There have been no scales through which to measure Holling's three dimensions in psychology, yet the implications of this new model are exciting. In this sense, Maltby *et al.* (2015) developed a 12-item measure that reflects the key aspects of the three resilience measurements by taking a dual approach with these items. Here, engineering resilience is measured via the ability to recover as well as the speed of this recovery. Ecological resilience is measured via the ability to maintain stability as well as the processes employed in resisting the traumatic experience. Finally, adaptive capacity is measured via the willingness to adapt as well as the willingness to undergo key functions. The new scale also uses a unique combination of items from well-established scales, with these carefully selected items thereby measuring the dynamics that are key to resilience. This not only makes the scale more user-friendly, as only 12 items are used, but it also ensures that these items measure the key dynamics and traits that are relatively stable. Reliability and validity studies have produced good evidence as to reliability and validity of this newly-proposed model and measurement of resilience. Overall, the scale consists of two negative and ten positive items. Example items on the scale include: "I usually come through difficult times with little trouble" (engineering resilience), "I believe I can achieve my goals, even if there are obstacles" (ecological resilience) and "I like it when things are uncertain or unpredictable" (adaptive capacity). Each item is scored on a 4-point Likert scale ranging from 1 (*strongly agree*) to 4 (*strongly disagree*). The overall score for each of the subscale's ranges from 4 to 16, whereby a higher score indicates a higher level of resilience. The initial development of the scale was carried out on students and older adults, whereby the scale demonstrated a good degree of reliability and validity. In the study conducted here, Cronbach's alpha for the subscales of resilience were .90 for engineering, .82 for ecological and .87 for adaptive.

In the psychological realm, there is acknowledgement given as to the presence and usefulness of these three components, although they have not been systematically operationalised in terms of them manifesting as a measurement model. The American Psychological Association (2015) gives practical advice on strategies which encompass these three aspects of resilience. Lim *et al.* (2014) and Masten (2009) have provided evidence of engineering resilience, while Anthony (1987), Rutter (2008) and Golubovich *et al.* (2014) have shown where ecological resilience has been used. Braniecka *et al.* (2014) and Yuen *et al.* (2014) have indicated the use of adaptive capacity within the psychological dimension.

Ecological Model of Resilience

Holling (1973), with colleagues, has introduced and developed a theory which holds that any system could return to or recover equilibrium after a disturbance (Folke *et al.,* 2004) and could absorb such a disturbance before realigning and returning to a stable state (Pedersen *et al.,* 2006). Holling (1978) further argued that systems could adapt to accommodate change. This is understood in an ecological context, as combines systems theory and ecology to convey how resilience could be described across a variety of ecological systems.

There are three aspects to this theory as to resilience – engineering resilience, ecological resilience and adaptive capacity – with this being known as the EEA approach. Engineering resilience is the ability to recover quickly or easily following a disturbance, ecological resilience is the ability to absorb and resist change and maintain a stable state after a disturbance while adaptive capacity is the ability to restructure after a disturbance. These all reflect key aspects about systems and can be identified across a number of disciplines (such as political systems and the environment, among others). In biological literature, Shade *et al.* (2011) have shown how bacterial communities resist, recover and exhibit resilience after a water column disturbance, while Chaumot *et al*. (2012) have demonstrated how the molecular protein in insects has the capacity to restore functionality after an event, with this suggesting the occurrence of a resilience process. Ecological resilience is also evident in the robustness of networks, as provide stability within financial markets (Ulanowicz *et al.,* 2009), while Bach and Dahllof (2011) have shown how arctic marine amphipods have the ability to adapt to survive in contaminated water. Adaptive capacity has also been demonstrated by Lorenz (2013) in regard to the way that social system structures can withstand or avoid disaster, mainly via modification. The three aspects of resilience can therefore be shown across a diverse range of disciplines.

Maltby *et al.*, (2015, 2016) have shown that the position of the ecological model of resilience has been tested within wider psychology. The components of this model have been successfully situated within the adaptive aspects of wider trait and well-being psychology. Here, the Big Five personality traits have been found to be significantly associated with the components of trait resilience. Lower neuroticism explains the unique variance in engineering resilience, while lower neuroticism and higher extraversion and conscientiousness explain the unique variance in ecological resilience. Finally, lower neuroticism and higher extraversion, openness to new experiences and conscientiousness explain the unique variance in adaptive capacity. Furthermore, ecological resilience significantly predicts the indices of well-being (i.e., subjective well-being, psychological well-being and physical health) after removing the effect of demographic information (e.g., age and gender), personality and coping strategies. However, it is important to note that this evidence has been documented using UK samples. Therefore, the examination of the ecological model of resilience within different contexts and via the use of different samples (as may include the general public) would be meaningful in strengthening its position within wider psychology. Indeed, recent attempts have been made to understand whether the ecological model of resilience is applicable across cultures and samples.

Notably, a number of studies have provided support for the replicability of the structure and usefulness of the ecological model and its measurement of resilience. For instance, in using three different samples (US adults alongside Japanese and Polish undergraduate students), Maltby *et al.* (2016) found that a higher-order bifactor model produced the best fit of data across their different samples. They also reported that after removing the effect of the socio-demographic information and personality of the sample, engineering and adaptive capacity negatively predicted depression and adaptive capacity negatively predicted anxiety among the US adults. These results suggest that the factor structure of the measurement of ecological resilience and its ability to predict health-related outcomes (e.g. depression and anxiety) are replicable across cultures.

Biomarkers and Resilient Functioning

Traditionally, the assessment of resilience rests on self-reported measurement tools which measure resilience via the subjective ratings of psychological factors. Although there are no perfect psychometric tools through which to measure psychological resilience, psychometric instruments are useful in providing initial findings as to the levels of resilience held among individuals. However, these instruments carry some inherent problems due to their subjective nature. Thus, the results obtained via such measurement tools could be affected by various intentional and non-intentional factors. Self-reporting has been regarded as a popular measure of resilience based on its cheaper way of data collection, easy implementation, and its ability of measuring behavioural and psychological measures. However, there is an issue of reliability and validity of the data collected in this type of measurement. Reliance on self-report for measurement of independent and dependent variables raises concerns about the validity of causal conclusions for various reasons like method variance and monomethod bias, systematic response distortions, and the psychometric properties of questionnaire scales (Razavi, 2001). Through such psychological perspectives of resilience, it becomes important to understand the interactions of resilience with environmental stress, and the biological influences on the behaviour of individuals. With a range of measures of resilience like questionnaires and interviews, self-evaluations of functioning, physiological measures, epigenetic analyses and psychological and behavioural phenotypes, there are still some difficulties in adequate measurements. For instance, psychological functioning and psychiatric symptoms cannot be regularly measured using clinical interviews and questionnaires particularly capturing the fluctuations that occur.

On the other hand, objective measurements of resilience address the problems associated with such subjective measurements and are favourable in terms of complementing the self-reported measurement of resilience with objectively measurable biomarkers (Walker *et al.*, 2017). At this point, biomarkers of resilience come to prominence to provide an important context in which resilience can be approached via its biomarkers and indices.

Biological markers (or ‘biomarkers’) are a useful indicator of general health and include physical parameters that can be linked to a disease or class of diseases. Thus, such markers can be used to identify an individual’s health status and risk (Schmidt, 2006). Biological markers can also be used to assess specific responses to certain stimuli. Notably, there can be neurochemical, physiological and immune biomarkers of resilience. Biomarkers can be used to evaluate both the physical and mental health of an individual. This is because the nervous system activates glands and organs for defending the body from threat. Here, bodily reactions (such as increased heart rate, rapid blood flow, sweating and rapid breathing) are indicators of physiological changes (Kurniawan *et al.,* 2013). Various methods are used by medical experts to assess health conditions based on such biomarkers, with these including the checking of blood pressure, heart rate, weight and body mass index. The biomarkers of resilience are thereby indices in identifying vulnerable individuals. Examining resilience via its biomarkers can advance the knowledge held which relates to the diagnosis and treatment of vulnerable individuals towards psychological and physiological problems. In the wider field of psychopathology, advances have been made in incorporating findings from neuroscience and normal brain development. One of the areas in which investigations have been made is in examining biological markers for resilient functioning. This is to provide a greater understanding as to why some people develop psychopathological tendencies whereas others do not, even though they face the same level of risk. It is therefore important to understand the processes through which vulnerable individuals do not develop psychopathology, namely so that this can inform the theories held as to maladjustment and pathology.

In recent years, significant technological and scientific advances have started to make it easier to decipher the underlying biological mechanisms that are linked to resilient phenotypes.

According to recent studies' findings, the process of assessing stress responses at several phenotypic levels, that not only include psychological and behavioural measurements, but also those of neural, neurochemical and neuroendocrine, thus potentially helping in explicating an integrative resilience model. (Southwick et al., 2005) In this context, animal studies remain a vital element when it comes to the biological constituents of resilience, as a result of which they are starting to identify molecular pathways as well as neural circuits which end up mediating resilient phenotypes. This review is aimed at integrating recent developments in the field of resilience from the standpoint of neurobiology, development, genetics, and psychology (Shields et al., 2015).

Charney, 2004 outlined several potential neurobiological elements of resilience. The author considered three classical monoamine neurotransmitters (dopamine, noradrenaline, and serotonin) and neuropeptides, in addition to concentrating on resilience's physiological biomarkers— heart rate variability and cardiovascular reactivity and recovery. According to him, several neurobiological factors responsible for psychological resilience have not yet been identified.

When taking the theories of resilience into account, previous studies have focused on the behaviour and psychosocial correlates of resilience (Curtis & Cicchetti, 2003; Luthar *et al.,* 2000) while others (e.g., Cicchetti & Cohen, 2003) have focused on major human biological systems with strong links to human behaviour and their relationships with resilient functioning. This has contributed a strong amount of information to the field of psychopathology, but there has not been much exploration of the biological mechanisms that may contribute to behavioural differences (Nelson *et al.,* 2002). Examining resilience within the context of biological mechanisms would provide further information in understanding why some people develop psychopathology and others do not. Thus, incorporating the study of biomarkers into the theoretical framework held as to resilience is important as it provides a more complete understanding of resilience. Consequently, this also contributes to the knowledge possessed in other fields – such as psychopathology. Cicchetti and Cohen (2003) have focused on major human biological systems with strong links to human behaviour and considered relationships with resilient functioning.

Part of the problem in resilience investigations has been that researchers have generally not possessed training in either psychological or physiological processes. Those focusing on behaviour usually do not have a background in biology and thus resilience has remained in the psychological domain. However, combining resilience with biology could allow us to understand the ecological impacts on resilience, its transactional nature and organisational perspective. This will enable us to analyse resilience from multiple levels (Cicchetti & Tucker, 1994). Here, it is important that biological mechanisms are not given priority over psychological phenomena when working to achieve positive outcomes in the field of resilience. Resilience is not purely a biological process. The biological aspect of resilience is only one part that enables us to further understand resilience, but there are also psychological and physiological aspects of resilience which are important to understand when elucidating the mechanism(s) underlying resilience. Accordingly, to produce a complete picture of resilience and its underlying mechanism(s), it is fruitful to take all aspects of resilience into consideration.

The common and diverse pathways connecting risk and preventative factors to adaptive and maladaptive outcomes are noted as phenomena known as multifocality and equifinality. These act as a lens through which the significant processes in the development of psychopathology can be better understood and observed. There should be recognition given as to the diverse conditions which may lead to the same outcomes, with this being known as equifinality. In the description by Cichectti and Rogosch (1996), equifinality is the understanding that many different risk factors o pathways can lead to the same result. In studying psychological disorders, this involves understanding how different causes like the different early life experiences, may cause the same patterns of abnormal behaviour. Unlike the popular belief that for each psychological disorder there is a distinct cause, Cicchetti and Toth (1996) indicated that there are various pathways that lead to a specific disorder creating interactivity and diversity. This means that in order to understand the development of conduct disorder in a child there is need to investigate the experiences and traits of that child from varying perspectives. Nonetheless, in the diagnosis and treatment of psychological disorders, there are some implications of equifinality. The suggestion of the principle is that there is no clear cause-and-effect relationship that exists for a specific disorder (Mash & Wolfe, 2010) and that there are various contributing factors among individuals with similar disorders. It is also possible that the same cause results in different outcomes despite it starting at the same point in time, with this being known as multifocality. Thus, it is the understanding that a particular risk factor can lead to a variety of developmental outcomes (Cichetti & Rogosch, 1996). In this case, different individuals can have the same histories or experiences like the death of a parent, child sexual abuse, or a secure attachment history, yet they turn out to have significantly different outcomes in their lives. It is likely that both biological and psychological factors will contribute to the same outcomes. From this, it can be concluded that individuals can show different patterns of adjustment or maladjustment and that their ability to exhibit resilience or psychopathology may be influenced by a number of factors that may include, but are not limited to, past experience, social context, biological, physiological and psychological factors. However, research has concentrated on the general risk factors of psychopathology (Lengua, Honorado & Bush, 2007), but it has ignored an understanding of the particular processes used in determining the maladaptive or adaptive outcomes, or even the processes differentiating the development of these particular pathologies.

In the Biological Sciences, new advances in technology are being made all the time and these can be applied to the study of psychopathology (Cicchetti & Cohen, 2003). Applying the principles of biology to psychology is important when studying the link between resilience and biological and physiological factors that have the potential to affect resilience as a psychological factor. It is useful to have a comprehensive understanding of theories that elucidate how resilience is related to physiological and biological factors here. This can be achieved by means of the proper usage of recent technology and its application within Psychological Science if the link between resilience and physiology is to be understood. Even if no explicit theory exists through which to explain this link at this stage, hypothesises can be generated to form a framework which ultimately leads to the accumulation of scientific evidence which underpins a theory. However, new technologies should be used as useful tools, but not in being applied as an exclusive way of studying resilience as its scope may be relatively limited. The ideal and more effective way of achieving this aim is to incorporate technology and psychological measures to study psychological constructs (such as resilience).

Within the scope of this section, it impossible to cover all of the areas of physiological and biological functioning that might potentially contribute to resilient functioning. We limit this thesis by focusing on several broad areas that directly and/or indirectly reflect the functioning of major human biological systems that have clear links to human resiliency behaviour. Thus, this thesis will consider the possible links and contributions of emotion, health and some other psychological factors of resilience and resilient functioning. As emotions, health and psychological factors encompass a wide range of behavioural and biological processes that play a vital role in many aspects of human development and adaptation, we restrict this thesis to study only some aspects of these areas and their relationships with resilience. There is evidence to suggest that psychological and physiological factors may exert an impact on these areas, thus potentially playing a role in resilient functioning.

Emotion, Stress Reactivity and Resilience

Emotion regulation is characterised as the intra- and extra-organismic processes by which emotional arousal is redirected, controlled, modulated and modified to enable an individual to function adaptively in emotionally-arousing situations. The ability to regulate emotion allows individuals to adapt in emotionally-charged situations (Cicchetti *et al.,* 1995; Gross, 1998). In the face of adversity, an individual's appraisal style can have detrimental effects upon their psychological and physical well-being (Folkman & Lazarus, 1985). There are particular characteristics that arise within the context of emotion regulation and these include emotion and stress reactivity, temperament and positive and negative emotionality (Davidson, 2000; Masten, 2001). These all work together to adapt the way in which an individual respond to emotional stressors. Although, little research has been conducted as to the possible link between emotional regulation and resilience, it is believed that emotion regulation may be a protective factor in resilience. It is not adequately understood as to whether resilient individuals are unaffected by stress or whether they have a unique ability to react to stress in an adaptive way, nor has it been determined how such individuals show adaptation at a biological level when facing stress or adversity.

One particular area to focus on is the way in which individuals are able to recover rapidly and effectively from negative affective events, with this potentially being a significant component of resilient functioning. Although theory shows that resilient people bounce back from adverse situations in an effective and quick manner, evidence is limited to support this theory. According to a study in which the characteristics of resilient people were examined in terms of using more positive emotions in an attempt to recover from unpleasant emotional experience, resilient people are able to use positive emotions to bounce back from, and find positive meaning in, stressful situations (Tugade & Fredrickson, 2004). Other research has found that resilient individuals maintain a high level of positive psychological characteristics (such as positive affect and well-being) when faced with adversity and that this is the reason as to why negative affect does not last long among such figures (Davidson, 2000). The experiencing of positive feelings was found to partially contribute to the resiliency ability of individuals towards regulating emotions efficiently, with this being produced by increased cardiovascular recovery from unpleasant emotional arousal (Tugade & Fredrickson, 2004). Additionally, psychological resilience and positive emotions have been found to play an important role here.

The relationships that arise between emotions, stress reactivity and resilience have been studied in various ways, with one approach being the employment of psychophysiological methods in order to investigate the emotion regulatory processes which correspond with psychological resilience. Testing the differences in the reactions given to emotional stimuli is also measured through the methodological instrument of the startle reflex – this being an involuntary response to a sudden stimulus, one that is manifested by twitching and the contraction of various muscles (most often eye blinking). The startle reflex is greater when negative emotional stimuli is faced and this may indicate the effect of environmental stressors on the brain's systems. The startle reflex tool could thus be used to gain a better understanding as to the relationship between emotional regulation and resilience.

Trauma Analogue Paradigm

In psychology, the trauma analogue paradigm (TAP) is a frequently used method that has been successfully applied to incorporate the biological and psychological dimensions of resilience. It is a useful approach to apply to resilience examination as trauma is an emotional reaction to an unpleasant incident (such as an accident, natural disaster or death) in which individuals respond differently depending on their levels of resilience. This is characterised by denial and shock immediately after the traumatic incident, with victims showing unpredictable emotions, flashbacks, nausea or headaches (State University of New York at Buffalo, 2006).

Moreover, victims of trauma find, at times, that it is difficult to lead normal lives. In essence, trauma is a condition which occurs when an individual fail to cope with a negative occurrence. It is assumed that the affective response experienced during a traumatic event affects how the event is later re-experienced. Research regarding emotional reactivity has predominantly stressed pre-traumatic levels of fear or anxiety and its ability to predict PTSD (Regambal & Alden, 2009).

The TAP is an experimental procedure that measures the decreased flashback frequency of victims of trauma. In this method, a victim of trauma is exposed to a simulation or 'analogue trauma' task and their response is observed. The TAP method involves exposing victims of trauma to a series of analogue trauma tasks. It relies on the induction of stress or unpleasant feelings which do not approximate the intensity or threat of the direct experience of trauma. The response of the individual or victim is monitored post-exposure to unpleasant feelings which have the capacity to induce stress. For instance, post-trauma victims may be asked to watch a film or to view pictures which have episodes that provoke negative emotions. The assumption is that trauma poses particular problems for memory (Beck & Sloan, 2012). As such, the post-trauma victim may respond to the analogue trauma tasks by making utterances that require a deep understanding of the connection between trauma and memory functioning. Largely, knowledge of the victim's experience is critical in a related analogue trauma task that may evoke similar emotions to the past trauma (Deprince & Cromer, 2013). The main assumption in this method is that the stressor must evoke intense emotions (such as horror, fear or helplessness). The analogue method is useful in capturing the relationship between emotional responses and coping alongside their relationship with resilience. The process of capturing emotions involves exposing the post-trauma victim to a stressor and recording the response. The behaviour of the individual towards the analogue trauma stressor then displays whether the victim is able to cope or not (Deprince & Cromer, 2013). Importantly, the psychologist should note the responses of the post-trauma victim.

When examining the relationship between emotional response to the analogue trauma stressor and resilience, the behaviour of the post-trauma victim plays a critical role. It is expected that post-trauma victims which are able to adapt well will not show any signs of fear, horror or helplessness. This means that the analogue stressor would not evoke emotions that are reminiscent of the trauma. On the other hand, victims that are unable to cope with the analogue trauma tasks may show signs such as feelings of helplessness, fear or horror (Luckhurst, 2013).

Traumatic stress is one area which can be measured by the effects it has upon biological processes. Two of the biomarkers that are useful for measuring trauma are heart rate and skin conductance response (SCR), namely as both are relatively easy to carry out, are accessible and can be followed up. Effective biomarkers need to be accurate and consistent and, furthermore, should ideally be linked to a specific disease or therapy identified in previous research. Both heart rate and SCR are well-established and have been linked to various conditions, although significant research continues to be carried out to establish further links.

Skin Conductance Responses

Skin conductance response (SCR) indicates the continuous variation in the electrical characteristics of skin in response to certain stimuli (Boucsein, 1992). This is particularly related to the amount of sweat produced under the skin. The measurement of SCR is based upon reduced or increased responses to presented stimuli. Skin is an insulator but sweat conducts electricity, with this resulting in increased skin conductivity. SCR has been used as a measure of stress (Boucsein, 1992), with the most reactive parts of the body for testing purposes being the palm of a hand or the sole of a foot (Boucsein, 1992). Skin conductance is relatively cheap to examine and is closely related to psychological processes, however it is mainly used as an indicator of affective processes (Figner & Murphy, 2011). SCR is closely linked to the emotional reactions given to different kinds of stimuli. When an event occurs, the sympathetic nervous system is activated. This activation can manifest itself as an increase in sweat gland secretions (Boucsein, 1992; Dawson *et al.*, 2007). By resettling the emotions caused by the event, tension in the sympathetic nervous system decreases and parasympathetic activity increases. However, there are factors that contribute to making the skin less reactive to stimuli. For instance, alcoholism has been found to numb the skin and to make it far less reactive than the skin of a non-alcoholic person. SCR as a biomarker is, therefore, one which also needs to take into account the impact of other factors which can cause variations between individuals. Due to the extent of these variations, SCR may not be quite as reliable as other biomarkers (Harrison *et al.,* 2006) and it is often used alongside heart rate rather than as a primary biomarker. By applying SCR measurements within resilience research, reliable and valid results can be obtained to understand the physiological mechanism underlying psychological trait resilience.

Heart Rate

An individual's cardiovascular system produces reactivity which prepares the body for particular action. As part of the cardiovascular system, heart rate is measured in terms of the number of beats per minute, with this being one of the most commonly-used biomarkers in research. Notably, heart rate reflects stress responsiveness in psychosocial and cognitive situations (Karpyak *et al.,* 2014; Starcke *et al.,* 2013) and can be used to detect emotional changes as well as physical changes in the body. Emotional changes are detected when the individual is faced with certain stimuli, as may cause the heart rate to increase or, in some cases, to decrease. Reactions to specific cues are important for noting these changes and one of the reasons as to why this biomarker is frequently used is its ability to measure stress.

According to Mandal (2014), an ideal biomarker is safe and easy to measure, cost efficient to follow up, modifiable with treatment and consistent across gender and ethnic groups. Heart rate measurements score highly in these areas and thus is an appropriate biomarker for use within such research. The measurement of heart rate is easy and cost-effective, while it provides consistent results in various contexts. This makes heart rate the most accessible and used biomarker among researchers. The ways in which heart rate can be measured include finger pulse, ECG and blood pressure techniques.

There are various physiological processes that lie behind heart rate. For instance, any intense exercise can lead to an acceleration of heart rate. However, it is the physiological processes linked to emotion that can be more readily identified, a result of the measurable changes which take place. Emotional experiences (such as fear and anxiety) can raise one's heartbeat. As well as changes to heart rate, such experiences are also noted through an individual's sweat level, muscle tension, breathing rate and facial expression. A number of previous studies have focused on the biological responses given to stress, whereby people have been subjected to traumatic situations and researchers have measured this by the evidence of increased cardiac activity (Regehr *et al.,* 2007). The effect of certain psychological factors on the cardiovascular system has been previously established. Psychological factors (such as stress, depression, anxiety, maladaptive personality traits and other behavioural disorders) have been found to be linked with heat rate (Sher, 1999). The biomarkers used in experiments not only include heart rate measurements but, on occasion, cortisol levels (which are evidenced through measures of saliva). However, heart rate remains the most widely used biomarker for measuring stress, with heart rate variability being a non-invasive approach through which to measure changes in heart rate.

Heart rate variability can be measured through time domain methods, where the heart rate is measured at a given point in time or at intervals between specified times. Alternatively, this can be measured by frequency domain methods, with both time and frequency domain methods providing evidence of an increase or decrease in heart rate. The difference between heart rate and heart rate variability is that an individual's heart rate is a vital sign whereas heart rate variability is a quantitative measure of cardiac activity used to diagnose diseases affecting the nervous system (Barbieri *et al.,* 2005). Changes in heart rate may indicate fear (Levenson, 1992), panic or anger (Levenson, 1992).

Considering the importance of skin conductance and heart rate as biomarkers in the measurement of emotional regulation, it would be beneficial to apply these two important aspects in examining the relationships that arise between emotions, emotional regulation, arousal and psychological trait resilience within the experimental settings. Evidence produced via heart rate and skin conductance response measurements shall thus be more reliable, valid and objective due to the nature of the biomarkers. The emerging evidence from experimental designs which have used those biomarkers is also useful in terms of it being easily testable by future research. However, it would also be useful to extend the work from its physiological nature, which is experimental in this context, to the wider population by transferring the work outside of the laboratory. This can be achieved by means of the survey method. As resilience plays a vital role in health, focusing on the relationship that arises between psychological trait resilience and health-related quality of life would be beneficial in gaining a better understanding of the effect of psychological trait resilience in wider contexts. Therefore, there are two main aspects of this thesis; (I) examining psychological trait resilience within the context of emotional regulation by using physiological theories and (ii) translating psychological trait resilience into a relatively wider context (e.g., health) by using the survey methodology.

EEA Model of Resilience and Emotional Biomarkers

The EEA model of resilience, has been proposed by Maltby, Day and Hall (2015), with its usefulness having been established particularly within the discipline of psychology. The proposed model witnesses' systems and ecological theory being incorporated to present resilience across several ecological systems. The model proposes three important components of resilience for human functioning –engineering resilience, ecological resilience and adaptive capacity. This framework is derived from Holling's ecological systems theory of resilience. In the proposal of this model, the authors have reviewed evidence from a wide range of systems that include biological, environmental and socially resilient systems. The definition of each component of this framework would be useful to hold in understanding what is meant by ecological systems resilience.

Engineering resilience is characterised in psychological literature as the ability to bounce back after a traumatic or stressful event. It is defined by the speed in which a system can return or recover stability following any disturbance. Holling (1973) has suggested that it is the ability to return to its former stable state that differentiates engineering resilience from ecological resilience when change is involved. It is argued by Hollnagel *et al.* (2006) that this stable state should be maintained or regained after trauma, with this indicating that the system may already be prepared to withstand trauma. This then leads to the theory that, within a system, there may be biological processes that are already in existence long before any disturbance occurs. The challenge faced here pertains to being able to identify the specific biomarkers which indicate that a system can speedily return to its stable state. Gunderson (2000) has argued that engineering resilience is the return of a system to a single equilibrium, as indicates that no change takes place and that stability is restored. As Holling (1996) has suggested, engineering resilience has its foundation in efficiency, constancy and predictability. These attributes point to a system in which there is little diversity and biological processes may reflect this lack of variability, however these would need to be measured over a period of time. Oken *et al*. (2015) have pointed out that any trauma or perturbation may cause changes in an individual's physiological state and it is how a system responds to these changes that show how much the system may be affected.

Ecological resilience is defined as the ability to be confident, strong and robust. Gunderson (2000) has argued that ecological resilience is determined by how much disturbance a system can absorb before it changes stability. Oken *et al.* (2015) have highlighted that stress levels may help with resilience but only in the short term. For example, an increase in blood pressure or heart rate may provide the physiological changes that precipitate action, but sustained or repeated increases may damage the system. Biomarkers can help to detect ecological effects and prevent the collapse of a system, as may otherwise prove too difficult to recover from (Colin *et al.*, 2015). Ecological resistance is also defined by a system's ability to keep going after a trauma (Scheffer *et al.*, 2015). Changes may occur after the disturbance but these may not affect the system's stability. However, Sheffer *et al.* (2015) found that the recovery time after a trauma could indicate the amount of disturbance a system could absorb and, furthermore, could be used as a warning. Here, it was noted that the system's slowing down could be an indicator of potential collapse.

Adaptive capacity is where a system learns from some unpredictable event and, in consequence, adapts to it. This has been recognised in psychological literature as a capacity to adapt well, adjust and be flexible. Not all systems are able to make this change and thus biomarkers may be able to differentiate between the systems that can adapt and those that do not have this same resilience. This is how a system can adapt to unpredictable change, whereby biological processes may here be able to indicate the ability to withstand change. Gunderson (2000) has argued that adaptive capacity is how robust a system is to changes in the environment when these are caused by a disturbance. Oken *et al*. (2015) have suggested there may be some benefits to the stress caused by a sudden disturbance, with this relating to the increased immunity gained. However, this would only be applicable if the disturbance was repeated. Additionally, Masten (2014) has argued that the cost of adaption may lead to long-term issues. Masten (2014) has also advised that such adaptation may be defined in different ways and value judgements may have to be made as to the degree of adaptation witnessed.

There is an area that has not yet been fully explored and that may lead to indications that certain biological processes are associated with the EEA model of resilience. There have been a number of biomarkers used to measure stress responses – including muscle activity, heart rate, voice characteristics, posture and cognitive function (Oken *et al.*, 2015). As suggested by Oken *et al.* (2015), other biomarkers which affect some people include headaches and stomach disorders. Behavioural biomarkers relate to an individual's personality and can increase the understanding held as to why individuals respond to trauma in different ways. Stress-related biomarkers may also be influenced by an individual's genetic make-up, age, education level or environment (Oken *et al.*, 2015). It is clear that a number of factors may affect the use of accurate biomarkers when measuring resilience as these may vary from individual to individual. Colin *et al.* (2015) support this assertion by suggesting that biomarkers can be difficult to interpret, although they further suggest the use of biomarkers to sign potential issues. It may therefore be possible to observe a pattern that could provide more information as to how biological processes may be linked more strongly to resilience. This pattern may be more closely observed if a succession of tests is carried out over a period of time.

EEA model of resilience and Health-related quality of life (HRQOL):

According to Maltby et al., (2015, 2016) this model of resilience has been tested within wider psychology, and this model of resilience significantly predicts the indices of well-being (i.e., subjective well-being, psychological well-being and physical health) which is the resources that protect and promote quality of life. Since resilience is an important correlate and predictor of health-related quality of life for individuals in their positive functioning, it could be useful to establish the link between the components of EEA resilience and health-related quality of life.

Health-related quality of life (HRQOL) is defined a perception of the impact of physical and mental health on her/her life (Spieth & Harris, 1996). The perceived physical and mental health may be related with, for example, illness, injury, medical treatment, health care policy etc. HRQOL is a multidimensional concept that comprises of multiple domains pertaining to physical, mental, and psychosocial functioning and any other associated constructs (Varni, Burwinkle, Seid & Skarr, 2003). It is a concept that is directly related to the impact of individuals health conditions on their quality of life. Neglecting related quality of life may result in maladaptive outcomes on everyday functioning across different life domains. HRQOL is generally studied within clinical context and it has been found to be related with different variables. Higher psychological problems such as anxiety and depression were significantly related with reduced HRQOL (Drexel et al., 2019). The poorer HRQOL also related with unmet needs, especially physical, psychological, and health system and information needs (Sodergren et al., 2019). Furthermore, it has been associated with measures of obesity, screen anxiety-related disorders and paediatric quality-of-life (Kızılay et al., 2019). Resilience is found to be not only a correlate of HRQOL but also as a predictor. For example, Maatouk et al., (2018) demonstrated that patients who have a high level of resilience had a better HRQOL in terms of physical and mental health quality of life. It was also found to assist reduced depressive symptoms. Thus, translating resilience into HRQOL context would be useful for us to understand how it is associated with HRQOL among normal population.

Thesis Aims and Outline

Having reviewed the theoretical and empirical evidence held as to resilience, the measurement and biomarkers of resilience and the EEA model of resilience in Chapter 1, this thesis consequently focuses primarily on the relationships that arise between the EEA model of psychological trait resilience, health and emotional regulation within different contexts. This it to be achieved by incorporating pertinent biomarkers into the theoretical framework of resilience in order to gain a more complete understanding of resilience in terms of the physiological and psychological basis of resilient functioning. As the EEA model of resilience is newly presented into the literature, it would be useful to show its usefulness to health-related quality of life. This would not only help to strengthen the theoretical and empirical underpinnings of the model but also its usefulness with health of individuals. Measuring individuals' physiological response to stressors could help us to determine the ability of resilient people or those at risk to stressors. Thus, investigating EEA model of resilience under different experimental conditions by exposing people to various stress-induced or happiness-induced stimuli such as picture, audio, video or combination of pairs of stimuli could help us to prepare tailoring training to individual needs to cope with stressors. Furthermore, to obtain valid results, it is important to measure individuals' responses to stressors using various physiological measures such as heart rate and skin conductance. In the light of these arguments, we respectively tested the EEA model of resilience under different experimental conditions using different physiological measures (one at a time or pairs of two at a time).

There are two main aims of this thesis: (a) to examine the contribution of psychological trait resilience into health quality of life after controlling for the effect of health-specific self-efficacy and (b) to experimentally investigate the relationship between psychological trait resilience, emotional regulation and physiological arousal using various emotionally-loaded stimuli.

Based on the above research aims, specific objectives have been set for each chapter of this thesis. In Chapter 2, review is given to a study we conducted with a cross-sectional design. In that study, the relationship that arises between psychological trait resilience and health quality of life was investigated. Here, an intention was held to examine the role of psychological trait resilience components in predicting health quality of life domains after controlling for health-specific self-efficacy. In Chapter 3, an overview is given to an experiment we produced which used emotionally-loaded picture stimuli to elicit arousal in the body via the skin conductance response methodology. In that chapter, we examine the relationship between psychological trait resilience and physiological responses toward picture stimuli as produced though skin conductance responses. In Chapter 4, we detail how the repertoires of stimuli was expanded within the experiments undertaken by including both sound and video stimuli, with this being shown to have more effects in eliciting physiological responses. In that chapter, it is outlined how the goal in the experiment produced was to explore how psychological trait resilience is related to the physiological responses resulting from sound and picture stimuli. In Chapter 5, it is conveyed how in the experiment conducted, we changed the biomarker from skin conductance to heart rate as well as limiting the stimuli. In that chapter, it shown how, at this point, we only used video stimuli as it had been found to be more effective when compared to sound and picture stimuli in inducing physiological and emotional responses. With that new design, we sought to investigate how psychological trait resilience relates to changes in heart rate as triggered by positive and negative video stimuli. In Chapter 6, it is noted how the type of stimuli employed in the experiment was changed from picture, sound and video stimuli to the cold pressor task in order to stimulate skin conductance responses and heart rate changes. In using the cold pressor task here, we aimed to experimentally induce pain which would trigger changes in skin conductance and heart rate. With that aim, the relationship that arises between EEA resilience and changes in skin conductance and heart rate were examined. The studies presented in Chapter 3, Chapter 4, Chapter 5 and Chapter 6 were undertaken with experimental designs with student samples collected from UK universities, while the study reported in Chapter 2 was conducted with a survey method using the general public of the USA. Finally, in Chapter 7, discussion is given to the main findings of this thesis and their possible implications upon the theory and research of this area. In that chapter, the limitations and future directions of the thesis are also highlighted.

Chapter 2

Investigating the Relationship between Trait Resilience and Health-Related Quality of Life

Abstract

The aim of this study was to examine the relationship that arises between trait psychological resilience and health-related quality of life and, furthermore, to examine to what extent trait resilience predicts health-related quality of life after controlling for health-specific self-efficacy. The study utilised a sample of 148 USA adults ranging in age between 18 and 45 years old (mean age = 33.1). Here, the participants filled in the EEA psychological trait resilience, EQ-5D-5L (for health-related quality of life) and health-specific self-efficacy scales. The results of the correlational analysis undertaken reveal that engineering, ecological and adaptive capacity were positively related with nutrition efficacy and physical exercise efficacy. In contrast, engineering and ecological resilience were found to be negatively correlated with mobility, self-care, usual activities, pain discomfort and anxiety/depression. The results of the hierarchical regression analysis produced reveal that engineering resilience significantly predicted mobility, self-care, usual activities and anxiety/depression after controlling for health-specific self-efficacy. These results suggest that EEA trait resilience is an important correlate of health-related quality of life.

Introduction

Recently, growing attention has been given to measuring health-related quality of life both in the general population and among clinical populations (e.g., individuals with chronic conditions) because of its importance in offering information regarding health-specific outcomes, patient management alongside policy decisions and evaluations (Morris, Devlin & Parkin, 2007). Health-related quality of life (HRQOL) is typically characterised as one's health status in relation to how a given health-related condition affects their physical ability to function effectively in a variety of roles – including physical, emotional, social and mental well-being (Ware & Sherbourne, 1992). To put it differently, HRQOL is a multi-dimensional construct that assesses the life of an individual from their own perspective in terms of the physiological, psychological and functional aspects of their well-being (Ravens-Sieberer & Bullinger, 1998).

In the relevant literature, researchers have determined a variety of factors that are implicitly or explicitly associated with HRQOL. Wilson and Cleary (1995) have proposed a conceptual model that explains the relationships that arise between the determinants of health status and health-related quality of life. According to this model, there are six fundamental factors that are directly or indirectly associated with general HRQOL. These factors include biological and physiological factors, symptoms, functional status, general health perceptions, individual differences characteristics and overall quality of life. These factors fall on a continuum, with one end of the continuum including biological and physiological factors while the other end of the continuum includes overall quality of life factors. According to Wilson and Cleary (1995), irrespective of how psychological factors as individual differences characteristics are characterised, these factors can have causal relationships with factors that are associated with HRQOL in the conceptual model. As seen, individual differences characteristics play an important role in explaining HRQOL.

Some studies have investigated the relationships that arise between HRQOL and other relevant constructs within different contexts. Studies have shown that obese children have reported lower levels of HRQOL in comparison with normal-weight children in terms of their physical, social and school activities (Pinhas-Hamiel *et al.*, 2006). Studies have also shown that HRQOL is related to resiliency in different populations – such as rheumatoid arthritis patients (Liu *et al.*, 2017) and family caregivers of vascular dementia and Alzheimer's disease patients (Kuo *et al.*, 2014). Higher levels of health-related quality of life were also found to be significantly associated with higher levels of happiness and lower levels of anxiety and depression (Vinaccia-Alpi *et al.*, 2017). Furthermore, longitudinal studies have suggested that HRQOL is significantly associated with self-efficacy and enjoyment and leisure-time physical activity over time (Herens *et al.*, 2016). Moreover, higher neuroticism has been found to be related to lower HRQOL, whereas higher conscientiousness has been shown to relate to higher HRQOL (Chapman, Duberstein & Lyness, 2007). Due to the extreme importance of HRQOL in human life, researchers have made significant attempts to identify the correlates and predictors of different components of HRQOL in different populations and cultures. Resilience appears to be an important variable for the health, quality of life and well-being of individuals.

In using the EEA resilience measure, studies have suggested that engineering and adaptive trait resilience significantly predicts depression while adaptive capacity significantly predicts anxiety after statistically controlling for demographic information (e.g., sex, age, income, education and employment) and personality characteristics (Maltby *et al.*, 2016). In another study, Maltby *et al.* (2015) showed that ecological resilience can predict subjective well-being, psychological well-being and physical health while adaptive capacity can predict physical health. Here, higher resilience is positively associated with better subjective and psychological well-being and physical health. In that study, it was also demonstrated that engineering and ecological resilience could positively predict physical health over time. In using different measures of resilience via a cross-sectional study in which Chinese patients with rheumatoid arthritis were investigated in terms of the levels of disease reactivity, resilience and health-related quality of life witnessed, Liu *et al.* (2017) found that resilience is significantly positively related to mental health-related quality of life. In that study, resilience was also found to mediate the relationships that arise between disease activity and mental health-related quality of life by decreasing disease activity. In Turkish samples, resilience was associated with positive affect, negative affect, affect balance, satisfaction with life, and flourishing (Yildirim, 2019a; Yildirim & Belen, 2019). Resilience was also found to predict academic efficacy. Furthermore, studies suggest that individuals who have greater levels of resilience experience a smaller reduction in their levels of HRQOL as the levels of depressive symptoms increase (Kirby *et al.*, 2017). Thus, resilience appears to play an important role in relation to different life domains.

The concept of health-specific self-efficacy seems to be important in research when health-related quality of life is investigated. Health-specific self-efficacy represents an individual’s optimistic self-belief as to their ability to resist temptations and to adopt a healthy lifestyle (Schwarzer & Renner, 2009). Health-specific self-efficacy refers to a person’s health-related behaviours from multiple aspects, with this including nutrition self-efficacy, physical exercise self-efficacy and alcohol resistance self-efficacy (Schwarzer & Renner, 2009). According to Schwarzer and Renner (2009), nutrition self-efficacy refers to the capability held as to dieting, weight control and preventive nutrition towards having a healthy diet. Physical exercise self-efficacy is defined as the ability to motivate individuals to initiate, perform and maintain regular physical exercise based on a number of factors (e.g., the optimistic self-beliefs held as to being able to do this appropriately). Alcohol resistance self-efficacy is the ability to resist or overcome addictive behaviours – such as alcohol consumption.

Previous research has found that those who have higher levels of alcohol resistance self-efficacy are better equipped to regulate their drinking beliefs and behaviours (Matley & Davies, 2018). Studies using the health-specific self-efficacy measure have shown that the dimensions of health-specific self-efficacy are significantly correlated with the motivation held as to adapting or maintaining health behaviour intentions (such as to consuming a healthy diet, undertaking physical exercise and employing a healthy lifestyle) as well as health behaviours such as nutrition behaviour, exercise behaviour and alcohol drinking over time (Schwarzer & Renner, 2009). Furthermore, meta-analytical studies have suggested that self-efficacy interventions can have significant effects upon an individual's behaviours. That is, higher levels of self-efficacy can play a protective role as to behaviours (Sheeran *et al.*, 2016). According to Bandura (1997), self-efficacy may mediate the relationships that arise between stress, negative health and well-being outcomes alongside having direct positive relationships with various health outcomes.

Although some studies suggest that there is a positive relationship between resilience and quality of life, different models of resilience have been employed to establish these relationships. For example, Salimi, Pakpour and Ghafourifard (2017) and Vizoso-Gómez and Arias-Gundín (2018) used Connor-Davidson's (2013) resilience model, while Liu *et al.*, (2017) used Block and Kremen's (1996) ego-resiliency model. However, in the present study, we used a newly-proposed model of EEA trait resilience (Maltby *et al.*, 2015) to investigate the relationships that arise between resilience and health-related quality of life. Since it possesses multi-dimensional properties, the EEA trait resilience model seems to be advantageous when compared to some of the commonly-used models of resilience (e.g., the ego-resiliency model) where resilience is generally considered as uni-dimensional. By using the EEA trait resilience model, it is possible to gain more information as to how different aspects of resilience are related with health-related quality of life. In the study conducted here, we sought to explore the extent to which there are relationships that arise among EEA psychological trait resilience, health-related quality of life and health-specific self-efficacy among USA adults by using the cross-sectional survey method. We gave specific attention to exploring to what extent EEA trait resilience can predict the dimensions of health-related quality of life after controlling for health-specific self-efficacy. Exploring these relationships is potentially useful for the clinical and non-clinical assessment of interventions targeted at increasing the levels of resilience in order to increase health-related quality of life.

Method

Participants

The participants of this study comprised of 148 USA adults. The age of the participants ranged between 18 and 45 years old, while the mean age of the participants was 33.09 with a standard deviation of 7.06. In regards to the marital status of the participants, 43.9% were single, 42.6% were married, 9.5% were divorced and 4.1% were separated. Among the participants, 47.3% were male and 52.7% were female. With respect to ethnicity, the majority of the participants (77.7%) were Caucasian (e.g., White European), 7.4% were Black (e.g., African-American), 6.1% were East Asian (e.g., Chinese), 3.4% were Mixed, 0.7% were South Asian (e.g., Indian) and 4.7% were Other. Most of the participants (56.1%) were university graduates. A completed informed consent form was obtained from all of the participants. The sample of the study consists of adults from various socio-demographic backgrounds who volunteered to take part in the study. The common characteristic of the participants is their residence in the USA.

Measures

EEA Psychological Trait Resilience Scale (Maltby, Day & Hall, 2015). This scale has been constructed to measure trait resilience from three different but related aspects of resilience – Engineering, Ecological and Adaptive Capacity – as is known as the EEA trait resilience scale. This scale comprises of 12 items in three subscales as to trait resilience; engineering (e.g., "I tend to take a long time to get over set-backs in my life"), ecological (e.g., "I work to attain my goals no matter what roadblocks I encounter along the way") and adaptive (e.g., "I enjoy dealing with new and unusual situations"). Each subscale is measured by four items. Each item is scored on a 5-point Likert-type scale ranging between 1 (*strongly disagree*) and 5 (*strongly agree*). After reversing negatively-worded items, a total score can be created by adding up all of the items on the respective subscales. Here, higher scores imply higher levels of engineering, ecological and adaptive trait resilience being possessed. Maltby *et al.*, (2015) have provided good reliability and validity evidence in terms of the measure's internal consistency reliability, convergent validity, predictive validity and construct validity. In the study conducted here, Cronbach's alpha for the subscales of resilience were .90 for engineering, .82 for ecological and .87 for adaptive.

The EQ-5D-5L (Cheung *et al.*, 2009). This instrument is a standardised measure of health status developed by the EuroQol Group in order to provide a simple and generic measure of health via a cost-effective assessment. The EQ-5D-5L is a descriptive system that describes and values health in terms of five dimensions; mobility (e.g., "I have no problems in walking about"), self-care (e.g., "I have no problems washing or dressing myself"), usual activities (e.g., "I have no problems doing my usual activities"), pain discomfort (e.g., "I have no pain or discomfort"") and anxiety/depression (e.g., "I am not anxious or depressed"). Each dimension is measured via five levels, while the participants are asked to describe their health status by selecting only one option under each of the dimensions on the day on which the questionnaire is conducted. The five levels range from 1 (*no problem*) to 5 (*extreme problems*). Higher responses being given to a dimension reflects extreme problems with that dimension while lower responses being given to a dimension reflects that no problems are encountered with that dimension. Apart from that, the EQ-5D-5L also includes a self-rating vertical scale in which participants are asked to describe their health status based on a 20-cm vertical visual analogue scale, with the highest point, “the best health you imagine”, being set at 100 while the lowest point, “the worst health you imagine”, is set at 0. However, due to the design of this study, we did not use the 20-cm vertical sale. Concerning validity of the scale, the EQ-5D-5L scale was found to be related with health-related quality of life and had a high test-retest reliability (r > 0.7, Li *et al.,* 2019).

Health-Specific Self-Efficacy Scale (Schwarzer & Renner, 2009). This is a self-report scale that was developed to measure health-related behaviours from multiple aspects. The scale includes three dimensions; nutrition self-efficacy (e.g., “I can manage to stick to healthful foods, even if I need a long time to develop the necessary routines”), physical exercise self-efficacy (e.g., “I can manage to carry out my exercise intentions, even when I have worries and problems”) and alcohol resistance self-efficacy (e.g., “I am certain that I can control myself to reduce my alcohol consumption”). Each item on the scale is rated on a 4-point Likert-type scale ranging from 1 (*very uncertain*) to 4 (*very certain*). In the original article, Schwarzer and Renner (2009) reported that the scale has good psychometric properties as well as an ability to show that all of the dimensions are related (but differently) from each other. In this study, Cronbach’s alpha for the subscales of health-specific self-efficacy were .93 for nutrition self-efficacy, .90 for physical exercise self-efficacy and .90 for alcohol resistance self-efficacy.

Procedure

The participants filled out the online version of the questionnaires, as was disseminated by means of the Amazon Mechanical Turk platform (MTurk). The MTurk is an online marketplace where researchers across the world can disseminate their studies to those who reside in the United States in exchange for the participant receiving payment (Buhrmester, Kwang & Gosling, 2011). It is a valuable source of data collection for researchers, particularly those who want to see cross-cultural comparisons in relation to any results gained. Prior to responding to the questions, the research participants were informed that they were taking part in an online study corresponding to resilience and health-related behaviours. They were also given information regarding the anonymity and confidentiality provisions held as to the obtained responses. Furthermore, the participants were informed that they were required to complete the study in a single sitting without taking a long break. The amount of time it took to complete the online survey was about 10 minutes. Due to the design of the survey, the online version of the questionnaire was presented to the participants in the same order. The study protocol was reviewed and approved by the Institutional Review Board at the University of Leicester.

Data Analysis

Prior to the main analysis, the data were checked as to whether it was suitable for the analysis that was to be undertaken. No missing data was identified. Any univariate outliers were explored by means of Z scores (Tabachnick & Fidell, 2001). According to the Z score test, if the values found do not fall between +3.29 and -3.29, they are considered as univariate outliers. Twelve values were found to be univariate outliers for health-related quality of life and health specific self-efficacy, whereby these were subsequently deleted from the data set. Multivariate outliers were explored using Mahalanobis distance. Three values were found to be multivariate outliers and were also deleted from the dataset. To improve the validity of statistical inferences and reproduce the investigated study, we removed these outliers due to ambiguity with the validity of observations of the employed population (Leys *et al.,* 2019). After deleting those values, the remaining sample included 148 cases. The relationships that arise between the components of resilience, EQ-5D-5L and the health-specific self-efficacy variables were examined using the Pearson-moment correlation coefficients. The internal consistency reliabilities were examined using the Cronbach alpha coefficient (see description of the scales above). Here, a coefficient of greater than .70 is acknowledged as possessing satisfactory internal reliability (Kline, 2005). Hierarchical regression analysis was also performed to examine if resilience predicted the dimensions of EQ-5D-5L after controlling for the dimensions of the health-specific self-efficacy scale. Descriptive statistics were also reported. An a-priori sample size calculator (G*Power) was employed to identify the minimum required sample size for a multiple regression analysis. Here, a desired *p* value was set to 0.05, the number of predictors in the model being 6, the desired statistical power level of .90, and the anticipated effect size being medium (0.15). The analysis produced the minimum required sample size as n = 125 suggesting that the sample size of n = 148 recruited for this analysis were above the minimum sample size.

Results

Table 1 shows the means, standard deviations and correlations that arose among each of the variables used in the study. The Pearson product-moment correlation coefficients were identified to explore the relationships that arise between the dimensions of psychological trait resilience, health specific self-efficacy and EQ-5D-5L. As can be seen from Table 1, all of the dimensions of resilience engineering were found to be significantly positively correlated with nutrition efficacy and physical exercise. However, the dimensions of resilience were not found to be significantly correlated with alcohol resistance efficacy, although the pattern was in the expected direction. The engineering dimension of resilience was found to be significantly negatively correlated with all of the health behaviours dimensions (mobility, self-care, usual activities, pain discomfort and anxiety/depression), while adaptive capacity was not found to be significantly correlated with those dimensions. Ecological resilience was found to be significantly negatively correlated with all health behaviours dimensions except for self-care behaviour.

An array of standard regression analysis and hierarchical regression analyses were performed to determine the effects of resilience and health-specific self-efficacy on health-related quality of life as measured by means of EQ-5D-5L. We first ran a number of standard regression analyses to investigate whether each dimension of resilience significantly predicted health-related quality of life. In these regression models, the resilience domains were considered as independent variables, while the domains of health-related quality of life were considered as dependent variables. As shown in Table 2, engineering resilience significantly predicted all dimensions of health-related quality of life whereby mobility was ($\beta = -0.25$, $r^2 = 12$), self-care was ($\beta = -0.23$, $r^2 = 05$), usual activities was ($\beta = -0.30$, $r^2 = 14$), pain discomfort was ($\beta = -0.24$, $r^2 = 07$) and anxiety/depression was ($\beta = -0.55$, $r^2 = 34$). Ecological and adaptive capacity did not significantly predict any of the domains of health-related quality of life.

After performing the standard regression, we then conducted a series of hierarchical regressions to determine the unique effect of resilience on health-related quality of life after controlling for health-specific self-efficacy. In the hierarchical regression analyses undertaken, the health-related quality of life domains was considered as dependent variables, while resilience and health-specific self-efficacy were considered as independent variables. In the regression models employed, while health-specific self-efficacy domains were entered into Step 1, resilience domains were entered into Step 2. The results of the hierarchical regression analysis are presented in Table 3.

The results of the hierarchical regression analysis produced, as shown in Step 1, witnessed physical exercise efficacy significantly predict usual activities [F (3, 47) = 5.38, $r^2 = .10$, $p < .01$)] and pain discomfort [F (3, 47) = 3.93, $r^2 = .08$, $p < .05$)]. The inclusion of the resilience domains into Step 2 led to a statistically-significant change in the model for usual activities, F (6, 47) = 4.82, $r^2 = .17$, r^2 change = .07, $p < .01$)]. In addition, engineering resilience was found to uniquely negatively predict the usual activities domain of health-related quality of life. Furthermore, in Step 1, physical exercise efficacy and nutrition efficacy was found to significantly predict anxiety/depression [F (3, 47) = 10.32, $r^2 = .18$, $p < .001$)]. The inclusion of the resilience domains into Step 2 led to a statistically-significant change in the model [*F* (3, 47) = 13.33, $r^2 = .36$, $p < .001$)], while engineering resilience was found to uniquely negatively predict the anxiety/depression domain of health-related quality of life.

Table 1. The relationships among dimensions of resilience, health specific self-efficacy, and EQ-5D-5L

	Mean	*SD*	1	2	3	4	5	6	7	8	9	10	11
Resilience													
1. Engineering	10.84	2.69	1										
2. Ecological	13.00	1.99	.41**	1									
3. Adaptive	10.57	2.77	.27**	.30**	1								
Health-specific self-efficacy													
4. Nutrition efficacy	15.32	3.48	.39**	.44**	.19*	1							
5. Physical exercise efficacy	13.70	3.78	.47**	.35**	.19*	.45**	1						
6. Alcohol resistance efficacy	10.45	2.35	0.16	0.05	0.02	0.16	0.14	1					
The EQ-5D-5L													
7. Mobility	1.15	0.43	-.31**	-.26**	-0.11	-0.12	-.21*	-0.09	1				
8. Self-care	1.01	0.08	-.21*	-0.08	0.01	-0.15	-0.15	0.05	.36**	1			
9. Usual activities	1.15	0.41	-.35**	-.27**	-0.08	-0.15	-.32**	-0.04	.77**	.37**	1		
10. Pain discomfort	1.53	0.69	-.27**	-.16*	-0.09	-0.14	-.26**	0.04	.49**	.18*	.46**	1	
11. Anxiety/depression	1.75	1.00	-.58**	-.29**	-0.15	-.31**	-.39**	-0.01	.28**	.27**	.31**	.36**	1

Note. **. $p < 0.01$; *. $p < 0.05$; SD = standard deviation

Table 2. Standard regression analysis for resilience predicting health-related quality of life

	B	*SE*	β	t	*p*
Mobility					
Engineering	-0.04	0.01	-0.25	-2.82	**0.01**
Ecological	-0.04	0.02	-0.17	-1.88	0.06
Adaptive	0.00	0.01	0.01	0.12	0.90
Self-care					
Engineering	-0.01	0.00	-0.23	-2.50	**0.01**
Ecological	0.00	0.00	-0.01	-0.15	0.88
Adaptive	0.00	0.00	0.08	0.90	0.37
Usual activities					
Engineering	-0.05	0.01	-0.30	-3.44	**0.00**
Ecological	-0.03	0.02	-0.16	-1.82	0.07
Adaptive	0.01	0.01	0.05	0.57	0.57
Pain discomfort					
Engineering	-0.06	0.02	-0.24	-2.66	**0.01**
Ecological	-0.02	0.03	-0.06	-0.69	0.49
Adaptive	0.00	0.02	0.00	-0.06	0.96
Anxiety depression					
Engineering	-0.20	0.03	-0.55	-7.31	**0.00**
Ecological	-0.04	0.04	-0.07	-0.92	0.36
Adaptive	0.01	0.03	0.03	0.35	0.73

Table 3. Hierarchical regression analysis for resilience predicting health-related quality of life after controlling for health-specific self-efficacy

	B	SD	β	t	*p*
Mobility					
Step 1					
Nutrition efficacy	0.00	0.01	-0.03	-0.34	0.73
Physical exercise efficacy	-0.02	0.01	-0.19	-2.03	**0.04**
Alcohol resistance efficacy	-0.01	0.01	-0.06	-0.68	0.49
Step 2					
Nutrition efficacy	0.01	0.01	0.08	0.86	0.39
Physical exercise efficacy	-0.01	0.01	-0.07	-0.70	0.49
Alcohol resistance efficacy	-0.01	0.01	-0.05	-0.57	0.57
Engineering	-0.04	0.02	-0.23	-2.43	**0.02**
Ecological	-0.04	0.02	-0.18	-1.92	0.06
Adaptive	0.00	0.01	0.01	0.11	0.91
Self-care					
Step 1					
Nutrition efficacy	0.00	0.00	-0.12	-1.26	0.21
Physical exercise efficacy	0.00	0.00	-0.11	-1.16	0.25
Alcohol resistance efficacy	0.00	0.00	0.09	1.06	0.29
Step 2					
Nutrition efficacy	0.00	0.00	-0.09	-0.97	0.34
Physical exercise efficacy	0.00	0.00	-0.05	-0.51	0.61
Alcohol resistance efficacy	0.00	0.00	0.10	1.26	0.21

Engineering	-0.01	0.00	-0.20	-2.03	**0.04**
Ecological	0.00	0.00	0.03	0.30	0.77
Adaptive	0.00	0.00	0.08	0.97	0.34
Usual activities					
Step 1					
Nutrition efficacy	0.00	0.01	-0.01	-0.15	0.88
Physical exercise efficacy	-0.03	0.01	-0.31	-3.52	**0.00**
Alcohol resistance efficacy	0.00	0.01	0.01	0.15	0.88
Step 2					
Nutrition efficacy	0.01	0.01	0.08	0.91	0.36
Physical exercise efficacy	-0.02	0.01	-0.20	-2.17	**0.03**
Alcohol resistance efficacy	0.00	0.01	0.03	0.32	0.75
Engineering	-0.04	0.01	-0.24	-2.60	**0.01**
Ecological	-0.03	0.02	-0.15	-1.63	0.11
Adaptive	0.01	0.01	0.05	0.64	0.52
Pain discomfort					
Step 1					
Nutrition efficacy	-0.01	0.02	-0.04	-0.47	0.64
Physical exercise efficacy	-0.05	0.02	-0.25	-2.83	**0.01**
Alcohol resistance efficacy	0.02	0.02	0.08	1.00	0.32
Step 2					
Nutrition efficacy	0.00	0.02	0.01	0.08	0.94
Physical exercise efficacy	-0.03	0.02	-0.18	-1.88	**0.06**
Alcohol resistance efficacy	0.03	0.02	0.09	1.15	0.25

Engineering	-0.05	0.02	-0.18	-1.91	0.06
Ecological	-0.01	0.03	-0.03	-0.33	0.75
Adaptive	0.00	0.02	0.00	0.03	0.97
Anxiety/depression					
Step 1					
Nutrition efficacy	-0.05	0.02	-0.18	-2.09	**0.04**
Physical exercise efficacy	-0.08	0.02	-0.32	-3.72	**0.00**
Alcohol resistance efficacy	0.03	0.03	0.06	0.83	0.41
Step 2					
Nutrition efficacy	-0.02	0.02	-0.07	-0.86	0.39
Physical exercise efficacy	-0.03	0.02	-0.13	-1.62	0.11
Alcohol resistance efficacy	0.04	0.03	0.10	1.44	0.15
Engineering	-0.19	0.03	-0.50	-6.13	**0.00**
Ecological	-0.01	0.04	-0.02	-0.27	0.79
Adaptive	0.01	0.03	0.03	0.46	0.65

Discussion

The aim of this study was to examine the relationships that arise between EEA psychological trait resilience (as proposed by Maltby *et al.* (2015)), health-related quality of life and health-specific self-efficacy among a USA adult sample. In regards to the relationships that arise among the variables, all aspects of EEA resilience were found to be positively correlated with nutrition efficacy and physical exercise efficacy. People with higher levels of engineering, ecological and adaptive capacity tend to have higher levels of nutrition and physical self-efficacy. Engineering and ecological resilience were found to be negatively correlated with all of the domains of health-related quality of life. That is, individuals who have higher levels of resilience reported less problems with mobility, self-care, usual activities, pain discomfort and anxiety/depression. The results of the standard regression analysis undertaken have shown that higher engineering resilience directly predicts less problems being encountered with mobility, self-care, usual activities, pain discomfort and anxiety/depression. The results of the multiple regression analysis produced indicate that engineering resilience is able to predict mobility, self-care, usual activities and anxiety/depression after controlling for health-specific self-efficacy. Interestingly, although engineering resilience directly predicted pain discomfort, it did not predict pain discomfort when health-specific self-efficacy was controlled for. These results suggest that engineering resilience is an essential correlate of HRQOL. Indeed, the correlation between engineering resilience and HRQOL is plausible because engineering resilience refers to an ability to recover quickly or easily following a disturbance. It also refers to the ability and capability of an individual to return to equilibrium following any disturbance as quickly as possible. Perhaps, this plays an overwhelming role in the aspects of HRQOL and has a direct positive effect on HRQOL and may protect individuals with high levels of anxiety/depression against emotional burden (Herens *et al.*, 2016). The findings of this study demonstrate how domain of engineering resilience predicted all domains of HRQOL. This is because resilience has a distinct pattern, thus indicating that certain forms of resilience could have assumed significance for certain situation where the engineering resilience is the most important psychological resource when the disturbances related to a system that needs speed and ease of the system to recover to a stable equilibrium. In particular, if there are threats or disturbances to the system in terms of mobility (e.g. problems with move or be moved freely and easily) or self-care (e.g. problems to take care of mental, emotional, and physical health, or with usual activities, or with discomfort). Furthermore, when the disturbances are related to depressive symptoms, that is need speed to recover from the depressive symptoms, and this finding is consistent with the study of Yez et al. (2016). In this study, it was reached that recovering quickly from any disturbances or problems (engineering resilience), may be a predictor of several positive life outcome in terms of HRQOL. (Herens *et al.*, 2016).

The findings of this study as to the relationships that arise between resilience and health-related quality of life are consistent with those of previous studies in which a positive significant relationship between resilience and health-related quality of life has been reported (e.g., Kirby *et al.*, 2017; Liu *et al.*, 2017). The present findings as to the relationships that arise between health-related quality of life and self-efficacy are in line with prior research showing that self-efficacy is a correlate of health-related quality of life (e.g., Herens *et al.*, 2016). Furthermore, by using general psychological trait resilience scale, the present study expanded the previous findings and its association with health-related quality of life. Similar findings have been reported using domain-specific resilient system scale, as is derived from the same theory, ecological systems model of resilience theory. For example, using a domain-specific resilient system scale, Maltby, Day, Hall & Chivers (2017) demonstrated that ecological systems model of resilience could predict unique variance in job satisfaction, lower job burnout, quality-of-life following illness, marriage commitment and educational engagement after removing the effects of sex, age, personality, cognitive ability and trait resilience. This is important in terms of showing the applicability of the ecological systems model of resilience into general and specific life domains.

An important area to consider in the future study undertaken as to this area is the role of other variables (e.g., self-esteem, optimism, hope and coping strategies) in predicting health-related quality of life. As engineering and ecological components of EEA resilience have a significant relationship with almost all of the health-related quality of life domains, it is important for those who study resilience and health-related quality of life to pay closer attention to these two components. This is particularly true for engineering resilience as it also significantly predicts health-related quality of life dimensions. It is further important to give closer attention to resilience and health-specific self-efficacy as they are significantly related with each other.

There are practical implications for the results of this study. The results suggest that EEA trait resilience, in predicting health-related quality of life, is particularly useful in regards to public health. As EEA trait resilience is a multi-dimensional model of resilience, it is able to offer more information through which practitioners can better meet the needs of clients in terms of resilience and its relationship with health-specific quality of life. For example, individuals cope with various health-related stressful life situations in their day-to-day life. The large intake of stressful health-related problems being experienced means that individuals are likely to show an inability to deal with such problems. Practitioners can set up EEA resilience-based programmes through which to help individuals deal with health-related quality of life problems. If this can be achieved, they would report low levels of health-related quality of life problems. This means that designing such programmes could help to boost the health-related quality of life of individuals. Thus, a multi-dimensional approach of resilience to health-related quality of life allows practitioners to tailor systematic resilience approaches to the developmental needs of clients in relation to their health-specific quality of life.

Although the results of this study are important in terms of understanding the relationships that arise between trait resilience, health-related quality of life and health-specific self-efficacy, the study has encountered several limitations that need to be addressed in future studies. One such limitation was that the study was designed based on a cross-sectional design, whereby all of the variables in the study were measured at a single point of time by using the same questionnaire. Using a longitudinal design in which all of the variables in a study are measured at least twice over a given period of time would be quite useful in understanding how the relationships that arise between the variables change over time. Another limitation was that the participants used in this study consisted of USA adults. It is not very clear as to how well the obtained findings can be generalised to other samples (such as young adults, adolescents and clinical samples), because individual differences arise across samples. Thus, the replication of these findings via different samples is needed if the present findings are to be confirmed. Furthermore, data was collected using self-report measures which are subject to bias and limitations such as social desirability. Despite these limitations, this study has contributed to the understanding held as to the relationships that arise among trait resilience, health-related quality of life and health-specific self-efficacy among USA adults.

Chapter 3

The Relationship between Trait Resilience and Affective Pictures Stimuli

Abstract

This study aimed at investigating the relationship between individual differences in self-reported psychological trait resilience and physiological and self-reported responses to affective pictures among a UK sample. 36 undergraduate and postgraduate students (9 males, 27 females) participated in this study. Their age ranged between 19 and 40 years old (mean age = 22.50 years, standard deviation = 3.83 years). The data were collected using a resilience scale, skin conductance responses (SCR) and self-reported responses to emotional pictures. The SCR of the participants was continuously recorded both at its baseline and during the viewing of the pictures. The results gained show that the selected picture stimuli were found to measure what they intended to measure in terms of these images being pleasant and unpleasant (valance). Pleasant pictures were found to be approached, while unpleasant pictures were found to be aversive. The self-reported responses to the stimuli were not found to invoke arousal as expected. However, the results of the paired sample *t*-test demonstrate that the picture stimuli were largely effective in inducing physiological responses recorded via SCR with effect sizes ranging from small to large. This study failed to provide evidence as to the relationship that arises between trait psychological resilience and the physiological responses given to emotional picture stimuli. A number of possible explanations as to the results, the limitations and the implication of the study are also discussed here.

Introduction

Emotions are universal and an essential part of an individual's personal experience. Scientific experiments as to emotions have been found to be useful for both research and practice. Within laboratory experiments, pictures are one of the most frequently applied stimuli when seeking to induce emotion (Dhaka & Kashyap, 2017). Emotional responses can be measured in a variety of ways, including via affective reports, physiological reactivity and overt behavioural acts (Lang, 1969).

In psychophysiology, electro-dermal activity, as is also known as skin conductance response, is a commonly-applied technique in measuring physiological changes in one of the main branches of the autonomic nervous system (ANS), the sympathetic nervous system (Boucsein, 2012). Typically, the measuring of skin conductance responses, as are a form of electro-dermal activity, includes placing electrodes upon the surface of the skin – such as on the participant's fingers, palms, forehead and/or neck (Boucsein, 2012). Skin conductance has become a fruitful physiological measure in examining emotional processes because both emotion regulation and motivation are found to be closely associated with this branch of ANS (Figner & Murphy, 2011). Psychological processes are closely associated with the changes which occur under the skin, with this having the feature of holding electrics that fluctuate within short time intervals (of seconds) and being associated with the psychological processes of emotion (Figner & Murphy, 2011).

It has been important for researchers to employ appropriate types of emotion for the activation of ANS. Here, a variety of models of emotion have been introduced into the literature as to this area. These models have been largely categorised into two main theoretical frameworks, as have pioneered extensive research through which emotion is studied. The first model is the dimensional model of emotion, while the second model is the discrete model of emotions (Eerola & Vuoskoski, 2010; Ekman, 1992). The dimensional model assumes that emotions are distinguished within two general affective dimensions; arousal and valance. The valance dimension varies from pleasantness to unpleasantness, while the arousal dimension ranges from activated to deactivated (e.g., Barrett, 1998; Russell, 2003; Russell, 1980). However, the discrete emotion model hypotheses that there are universal basic emotions which are genetically-based. According to this model, these emotions can be better understood within six basic emotions; happiness, sadness, anger, fear, joy and surprise. These emotions are innate and have a universal facial expression (Ekman & Oster, 1979; Ekman, 1992). In a study in which the discrete and dimensional models of emotion were compared, Eerola and Vuoskoski (2010) found that the dimensional model of emotion is more reliable and suitable for representing emotions when auditory and visual stimuli are employed. To put it differently, the dimensional model can measure emotional states better in terms of arousal and valance. Based on this evidence, the present study thus employed the dimensional model of emotion in order to examine the relationships that arise between emotions and psychological trait resilience.

Resilience is an important positive psychological variable that allows individuals to cope with stressful situations and to effectively recover from that stressful situation (Smith *et al.*, 2008). The importance of resilience, particularly the EEA model of resilience as proposed by Maltby, Day and Hall (2015), has been established within different life domains including health, social relationships, marriage, education and work. Research has shown that those who are resilient have better mental health than their counterparts (Wagnild 2003), experience less depression (Mehta *et al.,* 2008) and age successfully and more healthily (Lamond *et al.,* 2008). Resilience has also been found to be positively related to better health outcomes (Smith, 2006). For example, resilience significantly predicts personal characteristics, social relations, coping and health. Furthermore, significant associations have been observed between resilience and anxiety, depression, negative affect and physical symptoms after controlling for resilience measures and optimism, social support and the Type D personality (Smith, 2008). Some studies have also focused on the link between emotional responsiveness and trait resilience. Research has shown that emotional flexibility, defined as the ability to react flexibly to dynamic affective situations, is a fundamental element of resilience. For example, Waugh, Thompson and Gotlib (2011) have investigated whether resilience is related to the exhibition of emotional flexibility in terms of frequently-changing emotional stimuli and across multiple types of emotional response by using physiological measures (such as skin conductance response (SCR).

SCR, as is also known as galvanic skin response (GSR), is a measure of autonomic changes which occur in the body and that offer conveniently-accessible autonomic physiological markers as to the body, namely as it is largely controlled by the sympathetic branch of the nervous system. SCR refers to the changes in skin conductance caused by rapid, phasic and rigid fluctuations in eccrine sweat gland activity under the skin (Boucsein, 1992; Dawson, Schell & Filion, 2007). SCR is closely linked to emotional reactions given to different kinds of stimuli. When an event occurs, the sympathetic nervous system is activated. This activation can manifest itself as an increase in sweat gland secretions (Boucsein, 1992; Dawson *et al.*, 2007). By resettling the emotions caused by an event, tension in the sympathetic nervous system decreases and parasympathetic activity increases. As a result of this, the sweat gland secretion, as acts as an index of SCR, decreases. This regulation process is profoundly complicated and varies based on affective states (Yang & Liu, 2014). Valance, arousal and dominance are considered to be three fundamental elements in the grouping of emotions. While higher levels of arousal are typically found to be related to greater levels of stimulation and actions that require more effort, lower levels of arousal are found to be related to lower levels of stimulation and actions that require less effort (Belavkin, 2004).

There are a variety of stimuli forms used within laboratory settings to elicit physiological reactions and arousals. Over the past few decades, picture, video and sound stimuli have been extensively used to induce physiological and emotional arousal. The International Affective Picture System (IAPS; Lang *et al.*, 2005) and the Nencki Affective Picture System (NAPS; Marchewka, ŻurawskiJednoróg & Grabowska, 2014) are two systems that provide researchers with standard affective pictures that can be used within scientific studies. These systems include a wide range of images of real objects which aim to trigger positive, negative and neutral feelings. These pictures have been widely used and are considered as a standard way of triggering feelings in psychological research (Courtney, Dawson, Schell, Iyer & Parsons, 2010). To measure emotional arousal, researchers typically use various physiological techniques. Galvanic skin response (GSR), as is also known as skin conductance response, is one of the techniques used to assess emotional states. GSR reflects upon the changes witnessed in sweat gland activity, as is an indicator of the intensity of an individual's emotional arousal (Boucsein, 2012). This is a useful technique through which to measure and quantify the intensity of arousal resulting from emotionally-loaded stimuli (both positive and negative) as manifests through an increase in skin conductance.

There is a wealth of evidence which shows the usefulness of SRC in measuring the potential nature of emotional and cognitive variables. Studies have shown that the psychophysiological responses measured via SCR are related to mindfulness and emotional processing (Lawrence, 2014), mindfulness meditation and reaction times as to affective stimuli (Ortner, Kilner & Zelazo, 2007), the judgement of affective arousal as to both pleasant and unpleasant image stimuli (Cuthbert *et al.*, 2000), consumer preferences for cosmetic products (Ohira & Hirao, 2015) and increased attention and orienting that is not affected by its context of presentation (Pastor *et al.*, 2008). The results of the analysis presented in (Christian, et.al. 2012) that after the participants viewed a series of emotional pictures, they assessed their self-reported affect, facial muscle activity, and startle reflexes. the study has demonstrated that Higher trait resilience predicted more divergent affective and facial responses (corrugator and zygomatic) to positive versus negative pictures. Thus, compared with their low resilient counterparts, resilient people appear to be able to more flexibly match their emotional responses to the frequently changing emotional stimuli. This suggests that those who possess high levels of resilience are more likely to flexibly modify their affective and physiological responses to meet the demands of the dynamic environment.

Present Study

Given that emotional events increase the physiological and emotional arousal and activation encountered (Yang & Liu, 2014), it would be useful to investigate how different affective states (e.g., positive and negative states) invoke physiological arousal and how this arousal is related to psychological variables. In this current study, we thus focused on how affective stimuli triggers arousal and how the resultant arousal is associated with psychological trait resilience. Accordingly, the main purpose of this study was to examine the effect of resilience in the regulation of arousal. To achieve this, we manipulated the arousal induced by the emotionally-loaded image stimuli in a laboratory setting. Emotional responses typically consist of three main dimensions; valance, arousal and dominance. Different arousal states (such as positive and negative arousal) were employed. While the images with unpleasant content are likely to trigger negative emotions, the images with pleasant content are more likely to elicit positive emotions. To elicit corresponding emotional states, positive and negative stimuli was presented on a computer screen. In the present study, we thus expected that positive image stimuli would invoke positive emotional responses, while negative image stimuli would invoke negative emotional responses. This study simultaneously used both a physiological measure (SCR) and self-reported questionnaires to gain a better understanding of different emotional states and their relationships with resilience. Indeed, this refers to the trauma analogue paradigm, as usefully links the biological and the psychological aspects in measuring resilience.

Method

Participants

The participants for this study initially comprised of 38 healthy undergraduate and postgraduate students with normal vision (or vision that was corrected to a normal level by glasses or contact lenses). Here, there were 9 males and 29 females that participated in the research. The average age for the entire sample was 22.42 years, whereby the sample ranged from 19 to 40 years old with a standard deviation of 3.75. However, after checking the suitability of the data, two cases were deleted as being univariate outliers (as described in the preliminary analysis section). Following this cleansing operation, the average age for the remaining sample was 22.50 years (as ranged from 19 to 40), with a standard deviation of 3.83. For this adjusted sample, 9 were male and 27 were female. The participants were recruited through the Experimental Participation System offered by the Psychology Department at the University of Leicester. The study was administered to those who volunteered to participate in the study. All participants were given course credit to compensate their participation.

Measures

Trait Psychological Resilience. The scale is a 12-item self-report resilience scale developed to measure three core positive aspects of trait psychological resilience; engineering, ecological and adaptive (Maltby *et al.*, 2015). The scale is known via the acronym of EEA whereby each letter refers respectively to the first letter of each resilience aspect. Each aspect includes 4 items and the items are scored using a 4-point Likert scale ranging from 4 (*strongly agree*) to 1 (*strongly disagree*). A total score can be created by adding items on each aspect. Here, a higher score demonstrates higher levels of resilience. Sample items includes “I usually come through difficult times with little trouble” (engineering resilience), “I believe I can achieve my goals, even if there are obstacles” (ecological resilience) and “I like it when things are uncertain or unpredictable” (adaptive capacity). In the current study, the internal consistency reliabilities for each aspect were as follows; engineering was .77, ecological was .80, and adaptive was .68.

Picture Rating Scale. This scale is a three-continuous semantic scale designed to assess a stimulus in terms of valance, avoidance (or direction) and arousal (Marchewka, ŻurawskiJednoróg & Grabowska, 2014). Here, the participants indicate their rating on a bipolar horizontal rating scale by using a paper-pencil approach. The instruction for each scale is different. For the valance scale, the instruction was given with a sentence as "You are judging this image as ..." (from 1 = *very negative* to 9 = *very positive*, with 5 = *neutral*). For the avoidance scale, the instruction was given with a sentence as "My reaction to this image is ..." (from 1 = *to avoid* to 9 = *to approach*, with 5 = *neutral*). For the arousal scale, the instruction was given with a sentence as "Confronted with this image, you are feeling: …" (from 1 = *relaxed* to 9 = *aroused*, with 5 = *neutral*). Higher scores being found on the directional and arousal scales respectively indicate higher levels of avoidance and arousal while higher scores as to the valance scale shows that the image is assessed as being positive.

Visual Stimuli. We used 20 pictures (10 positive and 10 negative) to elicit positive and negative emotional states. The pictures were drawn from the Nencki Affective Picture System (NAPS; Marchewka, ŻurawskiJednoróg & Grabowska, 2014) which are freely available to researchers. All of the pictures were standardised affective stimulus with high quality realistic images. These images are set to represent five categories – people, faces, animals, objects and landscapes. Using bipolar scales, each picture is scored in terms of valance, arousal and the approach-avoidance dimensions. It is found that the physical properties of these pictures are satisfactory as they have been assessed in terms of luminance, contrast and entropy. The pictures and their ratings have been successfully validated by comparing these with other available standardised pictures as used in scientific research (i.e., those of the Self-Assessment

Manikin and the International Affective Picture System). The pictures were presented through a PowerPoint slideshow.

Physiological Measures. Skin conductance was continuously recorded to measure emotional reactivity throughout the experiment, with this being achieved by using NeuLog Skin Conductance Response (SCR) equipment. The SCR is a sensitive index used to determine autonomic changes in the sweat glands. Units of SCR are presented in microsiemens (μS). This sensor is related to psychophysiological activity, as manifests in sweat gland activity, through the sympathetic nervous system. Here, SCR was monitored with the use of two logger sensor electrodes attached on the surface of the distal phalanges of the index and middle fingers on the non-dominant hand of the participant. Before the electrodes were placed upon the participant, it was ensured that the fingers were clean in order to obtain a continuous connection between the skin and the electrodes, namely as dirt can interfere with the connectivity between the skin and electrodes. The mean scores of a window of 6 seconds, whereupon the stimuli were presented, were considered to be the SCR. A difference score between the mean score of the baseline for each of the stimuli and each score obtained during the presentation of the stimuli was computed.

Procedure

for this experiment 20 pictures stimuli were used including 10 positive and 10 negatives, the pictures were presented to each of the participants. the presentation was organized in PowerPoint, the positive pictures were numbered and the negative pictures as well, the pictures were undertaken randomly so that the positive image was presented then negative image, the participants of this study were recruited via a convenience sampling method. The students were recruited from psychology courses in return for receiving course credit. The researcher met with the participants in the designated laboratory. The participants undertook the experiment individually by sitting in front of a computer in the lab. Participants were informed of their rights during and after the experiment, while a clear and brief explanation of the research procedure was given. Written consent was obtained from each of the participants. After providing this written consent, the participants completed a paper and pencil version of the questionnaires listed above without a time constraint being imposed. After they had completed the questionnaires, SCR sensors were placed on their non-dominant hand. Following this, the participants underwent a two-minute baseline period, whereupon they were relaxing in a comfortable chair without doing anything – with this seeking to neutralise their feelings. Subsequently, the presentation of the stimuli procedure was clearly explained to the participants. The participants were informed that they were to view each stimulus for the complete time as it appeared on the computer screen. Immediately afterwards, the participants went through the emotional arousal induction session. Each stimulus was presented in a full-screen view for six seconds, after that they were asked to rate each of the picture in term of three domains (valence, arousal and dominance) then a twenty-five second blank screen being presented between the slides. The pictures were automatically shown to the participants for the whole session. The presentation order of the pictures was maintained for all of the participants. The study procedure received ethical approval, with the 3354-cp341 code, from the Department of Neuroscience, Psychology and Behaviour's Ethics Committee at the University of Leicester. and this ethics covered multiple experiments in this thesis.

Data Analysis

The obtained data were analysed in four phases. In the first step, a data cleansing operation was carried out to ensure that the data met the assumptions required for the analysis to be produced (such as normality). In the second phase of the analysis, the descriptive statistics were reported as to the picture rating scale, undertaken in order to assess the degree of valance, avoidance and arousal for each of the positive and negative picture stimulus. In the third phase of the analysis, an array of paired sample *t*-tests were conducted to compare the baseline recorded and the measurements taken during the picture stimuli. Finally, the Pearson product-moment correlation was conducted to explore the relationships that arise among the dimension of resilience and positive and negative picture stimuli during the test. All analyses were carried out using SPSS Version 24.0. Using G*Power (Erdfelder, Faul & Buchner, 1996), the total sample size was estimated as being 109, with an alpha level of p=0.05 and a power of 0.90 for correlation analysis. The number of participants (n = 38) in the present study was significantly lower than the recommended sample size. Thus, one of the possible explanations for the result may be that the sample size used in this study was not large enough to offer a statistically significant difference among the variables of this research.

Results

Preliminary Analysis

Preliminary analysis was performed to identify any missing scores and to test the assumptions underlying the paired sample t-test and correlation analysis. In screening the data, no missing values were found. We used the Z score to find any extremely high and extremely low univariate values. According to Tabachnick and Fidell (2001), Z scores, as can be used to test univariate outliers in a given data set, range from -3.29 to +3.29. While scores that fall within that range are treated as normal values, scores that fall outside of that range are treated as outliers. By adapting this approach, two scores were found to be outliers and eliminated from the analysis.

As for normality, skewness and kurtosis indices were utilised to test the assumption of normality. According to researchers, skewness and kurtosis statistics can be considered as two statistics through which to check for univariate normality. Curran, West and Finch, (1996) and George and Mallery (2010) have set out rules designed to determine skewness and kurtosis. These rules propose that values that fall within ±1 indicate “very good” symmetry and values, while those that fall within ±2 indicate “acceptable” symmetry. Finally, skewness > 2 and kurtosis > 7 indicates a “concern” regarding symmetry. In taking this into consideration, the skewness (0.92 to 1.86) and kurtosis (-0.1 to 3.42) values for each of the stimuli pictures largely fell within the acceptable criteria for a normal distribution. This suggests that the data is suitable for conducting a parametric test. Thus, a paired-sample *t*-test was selected for the analysis.

Testing the Effectiveness of Picture Stimuli in Eliciting Arousal

After ensuring that the data was appropriate for the analysis to be undertaken, we performed descriptive statistics to assess each of the positive and negative picture stimuli in terms of valance, avoidance and arousal. Table 4 presents the results of the self-assessment of the picture stimuli in terms of valance, avoidance and arousal. The results of the analysis as to valance indicates that the mean scores for the positive pictures were above the midpoint of 4.5, while the mean scores for the negative pictures were below the midpoint of 4.5. This suggests that the selected stimuli measured what it was intended to measure. As for avoidance, the analysis shows that the mean scores for the positive picture stimuli were below the midpoint of 4.5, while the mean scores for the negative picture stimuli were above the midpoint of 4.5, with this suggesting that the participants tended to approach the positive stimuli while they tended to avoid the negative stimuli. In regards to the self-reported arousal, the analysis reveals that the mean scores for both the positive and negative picture stimuli were below the midpoint of 4.5, as suggests that the selected picture stimuli were not strong enough to elicit the targeted emotions.

Following the assessment of the picture stimuli, we conducted analysis as to detecting whether the selected picture stimuli were effective in eliciting emotions. To achieve this goal, we ran a series of paired-sample *t*-tests, as is a test that can be used when the data are obtained at two time points (e.g., pre-test and post-test).

In this regard, we first carried out a series of paired sample *t*-tests to investigate whether there were any statistically significant mean differences between the positive picture stimuli at the baseline period and during the viewing of the stimuli. Overall, the findings gained from these paired sample *t*-tests demonstrate the statistically significant mean differences between the baseline period and during the viewing of the stimuli, with the effect sizes here ranging from small to medium (see Table 5). We then performed another series of paired sample *t*-tests to explore if there were any statistically significant mean differences between the negative picture stimuli at the baseline period and during the viewing of the stimuli. Overall, the results of the analysis indicate that other than two picture stimuli (burring house and football player), the majority of the picture stimuli showed significantly higher mean scores in the during-viewing period than during the associated baseline period, with the effect size here ranging from small to large (see Table 5). These results suggest that the viewing of the pictures triggered the emotional regulation of the participants.

Table 4. Assessment of picture stimuli in terms of valance, avoidance, and arousal

	Valance		Avoidance		Arousal	
	Mean	SD	Mean	SD	Mean	SD
Positive Pictures						
Zoo	8.06	0.79	2.56	1.58	2.83	1.81
Peacock	7.58	1.00	2.25	1.42	1.89	1.12
Diver	8.03	1.59	1.89	1.55	2.39	1.99
Woman	7.00	1.55	2.83	1.80	3.56	2.27
Window	7.33	1.82	3.00	1.85	3.00	1.80
Dolphin	7.58	1.36	2.11	1.39	3.00	2.06
Sculpture	7.89	1.53	2.11	1.82	2.44	1.96
Woman-man	8.31	1.51	1.47	1.03	2.00	1.91
Hand worker	7.58	1.71	2.53	1.70	2.69	1.67
Beach	7.89	1.30	2.39	1.96	2.64	2.13
Negative Pictures						
Butcher	1.94	1.12	7.58	2.13	6.64	1.71
Broken leg	2.14	1.48	7.44	2.30	6.75	1.99
Waste	2.25	1.57	7.72	1.97	6.03	1.93
Toilet 1	2.36	0.96	7.58	2.12	6.39	2.07
Sick man	2.64	1.55	6.17	2.55	6.19	2.24
Burring house	1.89	1.12	7.08	2.61	6.44	1.89
Football player	3.17	1.48	5.00	2.38	5.36	2.26
Crashed motorcycle	2.53	1.11	6.33	2.37	5.94	1.71
Toilet 2	1.33	0.68	8.61	1.40	7.61	1.54
Car accident	2.00	1.26	6.94	2.25	6.44	1.90

Following the assurance as to the effectiveness of the positive and negative picture stimuli measured during the viewing period as compared to the baseline period, we finally conducted a Pearson product-moment correlation to explore the possible relationship that arises between the components of EEA trait resilience and the positive and negative affective stimuli.

Table 6 and Table 7 present the results of the correlations found among the variables of this research. Overall, the results of the correlations demonstrate that although the components of resilience (engineering, ecological and adaptive), positive pictures and negative pictures were internally related with each other in the expected direction, the components of resilience were not found to be significantly related with either the positive pictures or negative pictures.

Table 5. Paired samples t-test to evaluate picture stimuli

Stimuli	Types	Period	Mean	*SD*	t	*p*	Cohen's d	Cohen's d label
Zoo	Positive	Baseline	1.14	1.13	-2.58	.01	0.43	Small
		Stimuli	1.16	1.16				
Peacock	Positive	Baseline	1.27	1.35	-1.32	.20	0.22	Small
		Stimuli	1.29	1.37				
Diver	Positive	Baseline	0.93	0.77	-1.98	.06	0.33	Small
		Stimuli	0.94	0.79				
Woman	Positive	Baseline	1.25	1.04	-3.80	.00	0.63	Medium
		Stimuli	1.29	1.04				
Window	Positive	Baseline	1.05	0.89	-3.02	.00	0.50	Medium
		Stimuli	1.07	0.90				
Dolphin	Positive	Baseline	1.01	0.86	-4.13	.00	0.69	Medium
		Stimuli	1.03	0.87				
Sculpture	Positive	Baseline	0.95	0.78	-2.96	.01	0.49	Small
		Stimuli	0.96	0.79				
Woman-man	Positive	Baseline	0.98	0.94	-2.07	.05	0.35	Small
		Stimuli	0.99	0.94				
Hand worker	Positive	Baseline	1.01	0.92	-2.09	.04	0.35	Small
		Stimuli	1.01	0.92				
Beach	Positive	Baseline	1.13	1.13	-2.45	.02	0.41	Small
		Stimuli	1.13	1.13				
Butcher	Negative	Baseline	1.12	0.94	-4.43	.00	0.74	Medium
		Stimuli	1.15	0.95				
Broken leg	Negative	Baseline	1.02	0.88	-3.70	.00	0.62	Medium
		Stimuli	1.04	0.89				
Waste	Negative	Baseline	0.96	0.78	-3.09	.00	0.52	Medium
		Stimuli	0.98	0.80				
Toilet 1	Negative	Baseline	0.91	0.80	-7.51	.00	1.25	Large
		Stimuli	0.95	0.80				
Sick man	Negative	Baseline	0.90	0.84	-2.40	.02	0.40	Small
		Stimuli	0.97	0.84				
Burring house	Negative	Baseline	0.93	0.85	0.06	.96	0.01	N/A
		Stimuli	0.93	0.84				
Football player	Negative	Baseline	1.00	0.99	-0.24	.81	0.04	N/A
		Stimuli	1.01	0.93				
	Negative	Baseline	1.07	1.12	-3.69	.00	0.62	Medium

Crashed motorcycle		Stimuli	1.11	1.16				
Toilet 2	Negative	Baseline	1.02	1.04	-2.16	.04	0.36	Small
		Stimuli	1.11	1.12				
Car accident	Negative	Baseline	1.13	1.16	-2.05	.05	0.34	Small
		Stimuli	1.17	1.18				

Table 6. Correlations among aspects of resilience and positive picture stimuli using SCR

	1	2	3	4	5	6	7	8	9	10	11	12	13
Resilience													
1.Engineering	1												
2.Ecological	.51**	1											
3.Adaptive	.59**	.38*	1										
Positive stimuli													
4.Zoo	-0.12	-0.08	-0.08	1									
5.Peacock	-0.09	-0.05	-0.08	.97**	1								
6.Diver	-0.04	0.02	-0.19	.78**	.75**	1							
7.Women	-0.13	-0.1	-0.25	.69**	.68**	.86**	1						
8.Window	-0.03	-0.05	-0.22	.64**	.61**	.91**	.96**	1					
9.Dolphin	-0.04	-0.05	-0.26	.77**	.73**	.96**	.88**	.94**	1				
10.Sculpture	-0.03	-0.02	-0.24	.75**	.71**	.98**	.89**	.95**	.99**	1			
11.Women Man	-0.04	0.09	-0.09	.82**	.78**	.94**	.77**	.82**	.91**	.92**	1		
12.Handworker	-0.04	0.08	-0.07	.84**	.79**	.93**	.77**	.81**	.92**	.91**	.99**	1	
13.Beach	-0.09	0.09	-0.08	.87**	.84**	.88**	.70**	.72**	.86**	.86**	.96**	.95**	1

*. $p < 0.05$, ** $p < 0.01$

Table 7. Correlations among aspects of resilience and negative picture stimuli using SCR

	1	2	3	4	5	6	7	8	9	10	11	12	13
Resilience													
1.Engineering	1												
2.Ecological	.51**	1											
3.Adaptive	.59**	.38*	1										
Negative stimuli													
4.Butcher	-0.05	-0.06	-0.22	1									
5.Broken leg	-0.02	-0.05	-0.21	.96**	1								
6.Waste	-0.03	-0.04	-0.26	.95**	.98**	1							
7.Toilet 1	-0.02	0.01	-0.2	.90**	.97**	.96**	1						
8.Sick man	-0.02	0.11	-0.12	.84**	.92**	.91**	.97**	1					
9.Buring house	0.01	0.11	-0.06	.84**	.92**	.91**	.97**	.98**	1				
10.Football player	-0.04	0.08	-0.07	.82**	.89**	.90**	.91**	.95**	.96**	1			
11.Crashed motorcycle	-0.07	0.1	-0.06	.71**	.81**	.83**	.88**	.91**	.93**	.94**	1		
12.Toilet 2	-0.02	0.03	-0.05	.75**	.80**	.81**	.84**	.86**	.88**	.88**	.91**	1	
13.Car accident	-0.1	-0.08	-0.12	.66**	.72**	.75**	.75**	.76**	.78**	.83**	.86**	.93**	1

*. $p < 0.05$, ** $p < 0.01$

Discussion

A picture is one of the most important stimuli for inducing a momentary effect that has the potential to arouse various emotions while also increasing the emotional activities that facilitate the understanding held as to psychological variables (such as resilience). The purpose of this study was to investigate the relationship that arises between EEA psychological trait resilience and affective picture stimuli among university students in the United Kingdom. For the purpose of this study, we set out some expectations. We expected that the selected positive and negative picture stimuli could indeed measure what they intended to measure in terms of valence.

In line with our expectations, the results show that the selected positive pictures were measuring positive affect by exceeding the average midpoint of 4.5, while the selected negative picture stimuli were measuring negative affect by remaining under the average midpoint of 4.5. We then expected that positive pictures could be considered as stimuli to be approached while negative picture stimuli could be considered as aversive. The results verified this expectation. We also expected that the selected affective stimuli could adequately arouse positive and negative feelings. However, the results failed to offer evidence as to that expectation by significantly remaining under the average midpoint of 4.5. In addition, concerning the effectiveness of the stimuli as compared to the baseline measurement, we expected that the mean scores of the viewing-period for both the positive and negative stimuli could be significantly higher than the mean scores of their associated baseline measurement. The results of the analysis indicate that the mean scores of most of the stimuli during the viewing period were greater than their associated baseline measurement, with the effect size ranging between small to large except for two pictures (burning house and football player). These results are similar to the expectations we held. Finally, we expected that the components of EEA psychological resilience could significantly correlate with each of the affective positive and negative stimuli during the viewing period. However, the analysis fails to provide evidence to support that expectation. one of the possible explanations for this result may be that the sample size used in this study was not large enough to offer a statistically significant difference among the variables of this research (see the method section P. 71)

Previous studies have shown that the emotional events which elicit SCR differ in their levels of arousal but not valence (Yang & Liu, 2014). that's mean the SCR is quick to detect or respond to slight changes of emotional reactions to the emotional arousal rather than to valence. In this study, however, it was found that the affective stimuli varied on valence but not on arousal. The explanations for this result that resilient persons tend to not appraise affective stimuli, rather they are likely to accept it and not avoid it, they absorb it, their emotion reactivity may be decreased. From this perspective, this might have influenced their physiological reactions toward emotional stimuli (Koelsch, 2014). It is essential for balancing their emotional reactivity and it's essential for adaptive (Lindsay et al., 2018; Watford & Stafford, 2011) and the acceptance may play a key role in diminishing emotional reactivity for the stimuli (Feldman et al., 2016; Lindsay & Creswell, 2017; Lindsay et al., 2018). Also, the explanations for this result may be related to the clear content of the selected picture stimuli, namely in regards to the fact that they were clearly distinguished as being positive or negative. Although the content of the stimuli could have been clear, this could not have been strong enough to induce arousal. In general, the effect sizes witnessed as to each of the stimuli used in this present study were small. This can be explained in regards to the fact that the changes seen in the physiological activities (such as skin conductance and heart rate) are higher when dynamic picture stimuli (e.g., moving pictures) are presented than when static picture stimuli are shown (Detenber, Simons & Bennett, 1998). Dynamic picture stimuli may be more physiologically arousing because people show a genetic tendency to respond more to moving stimuli, with this potentially requiring immediate action, whereby such a need does not arise in relation to stationary or static stimuli (Courtney *et al.,* 2010). Thus, future research is needed to investigate the effect of dynamic stimuli (such as video and sound) on physiological reactions and their relationship with resilience. Notably, the present findings are not in accordance with the previous findings in which resilience has been found to be related to affective picture stimuli (e.g., Waugh, Thompson & Gotlib, 2011). the explanation of this result is the components of resilience in this model (EEA) are focus on the ability of individual to maintain stable, recovery and adapt to the disturbance, however in this study the pictures stimuli were not eliciting the emotional or disturbance situation.

Although this investigation has been limited by the small convenience sample used, the findings have some important implications. For example, to the best of our knowledge, this was the first study to have examined the EEA psychological trait resilience model (Maltby *et al.*, 2015) within the context of arousal by using affective picture stimuli. Although the study has failed to provide evidence as to the link between EEA resilience and affective pictures, it would be useful to know that there is no link between the variables of this research in the current sample whereupon the resilience of students as to the arousal encountered towards the affective pictures was the focus of interest. This study is important in terms of it employing two different methods (e.g., the physiological measure of SCR and a self-reported questionnaire) in its study of resilience and arousal.

The relevance of the study's findings should be assessed by considering several possible limitations. Firstly, the number of females and males included in this study were not equally distributed, with females being substantially more than males. The sample included undergraduate students studying psychology courses at the University of Leicester. As such, they were quite similar in terms of some demographic characteristics such as age, gender and socioeconomic background. Males and females may have different physiological reactions toward affective stimuli, with females being more sensitive in some cases. Thus, it would be useful to investigate gender differences in emotional reactivity with approximately equal numbers of males and females to understand to what extent they differ in emotional reactivity using different physiological measures such as SCR and heart rate. Secondly, in the present study, we only employed picture stimuli which was static and may have a relatively low degree of power in eliciting emotional arousal when compared to dynamic stimuli (video and sound). It would be useful to employ different stimuli and to examine their relationship with psychological trait resilience in future studies. In terms of the physiological biomarkers of resilience, we only selected skin conductance response through which to monitor physiological changes in the skin as derived from emotionally-loaded stimuli. Using different biomarkers (e.g., SCR heart rate) would provide richer information to understand how resilience is related to the human physiological function. Because different biomarkers give different information about human physiology. According to Mandal (2014), the heart rate is an ideal biomarker, safe and easy to apply, efficient to follow up, modifiable with treatment and gives consistent results across gender and ethnic groups. It is the most accessible biomarker that is used conveniently by health professionals and ordinary people to measure heart rate (e.g., Brumbaugh et al., 2013; Kreibig, 2008; Sokhadze, 2007). Other psychophysiological related measures can also be used to evaluate emotional reactivity such as respiration rate and facial action (Xie & Zhang, 2016).

Finally, although using self-report measures are advantageous in terms of being convenient and inexpensive, applying self-report measures for data collection tends to be biased and results obtained via self-report measures may not reflect the accurate picture of participants.

In summary, the current study has investigated the relationship between trait resilience and affective picture stimuli by using SCR within a laboratory setting. The results gained suggest that the selected affective picture stimuli effected changes in the physiological reactions of the participants, with the effect size ranging from small to large, however the psychological trait resilience domains were not found to correlate with the affective stimuli.

Chapter 4

Investigation of the Relationship between Trait Resilience and Emotional Regulation Using Affective Sound and Video Stimuli

Abstract

The purpose of this experiment was to examine the relationship between psychological trait resilience and emotional regulation via the use of affective sound and video stimuli. A convenience sample of 40 university students – as comprised of 22 (55%) females and 18 (45%) males – was recruited from a university in Leicester, United Kingdom. The participants' ages ranged between 18 and 33 years old, with an average age of 20.08 years old (SD = 2.88). Engineering, Ecological and Adaptive (EEA) resilience, stimuli rating scale and sound and video stimuli were used for the data collection. The skin conductance activities of the participants were continuously measured during the experiment. The results have shown that the positive and negative sound and video stimuli employed were quite effective in eliciting physiological reactions among the participants. More importantly, the results demonstrate that each aspect of EEA resilience was significantly positively related with both the positive and negative sound and video stimuli, with the effect size varying from small to large. The results suggest that EEA psychological trait resilience is important in respect of understanding the physiological activities which arise in response to emotionally-loaded stimuli.

Introduction

In our previous study, whereby psychological trait resilience was examined within the context of emotional regulation via the use of picture stimuli, we failed to provide support in terms of the relationship that arises between psychological trait resilience and emotional arousal. This failure could be related to the types of employed stimuli, in which dynamic stimuli may be more physiologically arousing as people show a tendency to respond to moving stimuli as opposed to stationary or static stimuli (Courtney *et al.,* 2010). This may indicate that arousal may require different stimuli. Therefore, in this study, we develop our previous study by expanding the array of stimuli by employing both video and sound stimuli.

Reliable and valid measurements of emotional arousal are necessary in measuring the degree to which a person experiences arousal. Such measurements may derive from self-report measures that refer to the self-evaluation of an individual's emotional arousal after confronting stimuli (such as by listening to or watching stimuli). Measurements can also manifest as objective measures of physiological arousal that are associated with the direct measure of ANS (see chapter 3), with this being very sensitive to physiological changes – including changes in skin conductance responses, heart rate and respiratory rate. In this regard, visual and auditory stimuli have been extensively used in the studies of emotions in eliciting emotional and physiological arousal. Affective auditory and visual stimuli result in the strong arousal, feelings and emotional experiences of listeners (Hanser & Mark, 2013). In this study, we also adopted auditory and visual stimuli to examine the relationships that arise between arousal and resilience. As previously established, the use of static stimuli may not be the most appropriate route through which to examine resilience and its relationship with emotional arousal. Thus, employing auditory and visual stimuli, as are more dynamic in nature, can provide richer information through which to understand psychological trait resilience.

Resilience has been found to be important for positive functioning across different life domains – including in relation to health (Taylor & Distelberg, 2016), social relationships (Graber, Turner & Madill, 2016) and marriage (Neff & Broady, 2011). The research shows that individuals who state that they have the ability to effectively recover themselves from any stressful situations also display the ability physiologically. The finding says that they have the physiological ability to get back to the base levels of physiological after encountering a difficult or negative emotional situation or development. It indicates that resilience cannot be considered as a psychological phenomenon. An individual's perception of resilience can be found in a person's physical response towards a stressful situation that allows a strong reason to research it in the field of health psychology. To predict or understand one's physiological reaction towards stress or negative situation, health researchers could conduct research and examine the reports of psychological resilience (Michele et al, 2004). However, evidence as to the implementation of resilience towards emotional regulation within experimental contexts is limited. Indeed, there is lack of evidence as to how resilience is related to the physiological changes witnessed in the body. Consequently, the introducing of empirical evidence pertinent to uncovering the relationship between resilience and arousal in the body is important as it could provide the basis of work designed to help understand the mechanism(s) of resilience. At this point, it is important to examine resilience on the basis of a model in which its examination with emotional regulation could shed light on physiological arousal. In this regard, the application of Maltby, Day and Hall's (2015) EEA model of resilience comes into prominence in understanding emotional regulation. There is thus a need to employ psychological trait resilience alongside emotional regulation under experimental settings to understand the relationship that arises between resilience and arousal.

Present Study

The central goal of this study was to examine the relationships that arise between psychological trait resilience and emotions by using the physiological responses witnessed towards emotionally-loaded stimuli. In other words, this study sought to uncover how resilient individuals respond to emotional stimuli. We also sought to investigate whether the stimuli used in this study were effective enough to elicit physiological responses. In accordance with this purpose, we used a self-report measure of resilience to assess resilience and used video and sound stimuli to induce emotions. We utilised skin conductance responses as a measure of physiological responses. By using this physiological measure, we sought to obtain clear and solid evidence in respect of the association between resilience and emotional activity which arises towards emotionally-loaded stimulus. Within this context, we stated a number of hypotheses. We firstly assumed that the selected sound and video stimulus (both positive and negative) would be effective in eliciting emotional activities and thus we expected that the physiological activities of individuals while watching the videos and listening to the sounds selected would be greater than their corresponding baseline measurement. Most importantly, we expected that psychological trait resilience would be positively related with both the positive and negative sound and video stimuli. This expectation was based on the notion that as a higher value being found in relation to skin conductance responses refers to higher physiological activities in the body being encountered, we expected that when individuals watched the selected videos and listened to the chosen sounds they would experience greater arousal towards both the positive and negative stimuli. Thus, expecting a positive correlation between resilience and emotional activities is tenable.

Method

Participants

The participants of the present study comprised of forty university students enrolled in psychology courses at the University of Leicester. In respect of the demographic information, we only collected information as to age and gender. There were 22 (55%) females and 18 (45%) males, while the ages of the participants ranged from 18 to 33 years old (M = 20.08 years*; SD* = 2.88). All of the participants voluntarily took part in the study and were given course credit in return for their participation. The administration of the experiment was the same for all of the participants.

Psychological Trait Resilience Scale. (see description of the scales above).

Stimuli Rating Scale. This scale is a self-report scale and includes a three-continuous semantic scale to measure a stimulus in terms of its valance, avoidance and arousal (Marchewka, ŻurawskiJednoróg & Grabowska, 2014). (see description of the scales above).

Video Stimuli. A set of affectively-loaded video stimuli were drawn from YouTube and prepared for use within this study. This set included five positive (e.g., twins with mom, baby playing with dog) and five negative (e.g., baby crying on song, spider) video stimuli. The main inclusion criterion employed during the selection of the videos was that the stimuli should not induce more than one emotion. The videos were categorised into two broad groups in regards to their ability to elicit one of two different emotional states; positive and negative. The selected videos were cropped using an online cutter program, with each video being cut down to about thirty second for time-frame consistency.

Sound Stimuli. Ten affectively-loaded sound stimuli were drawn from the International Affective Digitized Sounds (IADS-2; Soares *et al.*, 2013). The content of those stimuli was both positive (five sounds) and negative (five sounds), whereby a variety of sounds was included – such as baby laughing, vomit and screaming. All of these sounds were standardised affective stimuli and provided high-quality realistic sounds. The sound stimuli available in the IADS-2 were found to be valid digitised sounds for the study of emotions in different cultures – such as in Portuguese culture (Soares *et al.*, 2013).

Physiological Measure. We measured skin conductance responses as an index of physiological changes in the body. Skin conductance was continuously monitored to measure physiological reactivity during the experiment. NeuLog GSR sensor equipment was utilised as the apparatus through which to record SCR. SCR is quite a sensitive measure in recording autonomic changes in the sweat glands. The presentation of SCR manifests via the microsiemens (µS) unit. SCR is associated with psychophysiological activity, as manifests in sweat gland activity, via the sympathetic nervous system. In this experiment, the recording of SCR was monitored via the use of two logger sensors electrodes attached on the surface of the distal phalanges of the index and middle fingers on the non-dominant hand of the participants. The electrodes were placed on the non-dominant hand as the participants needed to use their dominant hand to assess each of the stimuli after watching or listening to it. Prior to the placement of the electrodes, it was ensured that the fingers were cleaned to minimise the contamination of the data and to maximise the gaining of a continuous connection between the skin and the electrodes (as dirt can interfere with this connectivity). SCR is estimated by considering the mean scores of a window of 6 seconds wherein the stimuli were presented.

Procedure

Each participant individually took part in the experiment in a comfortable laboratory room. They were requested to give their consent prior to taking part in the experiment. After providing a written consent form, the participants were requested to provide their name and student number in order to receive course credit. However, they were assured that their identifying information would not be used for any purpose other than those related to this specific research. After consent was obtained, the participants completed the psychological trait resilience scale. Prior to its administration, participants were informed about the procedure of the experiment and brief information as to the purpose of the study was provided. In regards to the self-report scales, the participants were instructed that there were no right or wrong answers for any of the questions, with this being conveyed so that as accurate responses as possible were obtained. Furthermore, the participants were advised that if they experienced any disturbances during the experiment, they could immediately report it to the researchers so that they could withdraw from the study.

Physiological data were recorded using conductive electrodes. Here, two skin conductance responses sensors were placed on the ring and index fingers on the non-dominant hand of the participants in order to detect the electro-dermal activity occurring under their skin. For this, we collected data using Lab Quest equipment. Video and sound stimuli were used for inducing physiological reactions. Ten video (five positives, five negative) and ten sound (five positives, five negative) stimuli were presented to each of the participants. A PowerPoint presentation was used to create the audio and video stimuli presentation. To avoid order effects impacting upon the elicitation of emotions, the presentation of the video clips was undertaken randomly. A standard computer was used for the stimuli presentation in the experiment. The participants started with an instructional session prior to the actual experiment session. In that session, two sound (one positive, one negative) and two video (one positive, one negative) consecutive trail stimuli were presented in order for the participants to be familiar with the experiment. In the experiment sessions, the participants listened to each of the sound stimulus on the computer screen for about 6 seconds. After that, they were asked to rate each of the sounds in terms of three domains – for valence ranging between 1 (*very negative*) and 9 (*very positiv*e), for arousal ranging between 1 (*approach*) and 9 (*avoidance*) and for dominance ranging between 1 (*relaxed*) and 9 (*aroused*). This rating procedure was repeated for each of the stimulus. The sound and rating scale remained available to the subjects until they had completed all of the ratings and had moved to the next sound. For this procedure, the participants had a constant 20-second period in which to complete the ratings scale (including the time available in which their emotions were to be neutralised). After the participants had completed the ratings, they needed to wait until the next sound was presented. The same procedure was applied for the video stimuli with some exceptions. In the video session, each of the videos was presented on a computer screen for 30 seconds (rather than 6 seconds) and the participants had 60 seconds to complete the rating (including the time available in which their emotions were to be neutralised). A 10-minute optional break was able to be taken in the middle of the experiment. Skin conductance responses were continuously recorded while the audio and video stimuli were presented. The participants were then thanked for their participation and received course credits upon the completion of the experiment.

The study procedure received ethical approval, with the 3354-cp341 code, from the Department of Neuroscience, Psychology and Behaviour Ethics Committee at the University of Leicester and this ethics covered multiple experiments in this thesis. The participants were assured that the data would only be used for the purpose of the research being published and presented at scientific conferences. They were also assured as to the confidentiality and anonymity of the data.

Data Analysis

All of the statistical analyses undertaken were carried out via SPSS for Windows Version 24.0. The significance level for the statistical test was set at $p < 0.05$. The descriptive statistics of the stimuli were presented with a mean and standard deviation. Paired samples *t*-tests were used to compare the differences in the mean scores of the baseline period and the period of experiencing the video and sound stimuli. Pearson's correlation was used to explore the correlations identified among the components of resilience and the video and sound stimuli.

Results

Preliminary Analysis

Preliminary analyses were carried out prior to the main analysis in order to see whether the data fitted with the analysis. Initially, we had fifty cases. Nine cases were deleted from the data set due to an error arising in the physiological data recording. One further case was also deleted due to it demonstrating an extremely high score. After deleting these cases, forty cases remained and the main analysis was conducted on those cases. All of the target variables were normally distributed as determined by skewness and kurtosis statistics, with all of these values being found to fall within the range of ±2 (George & Mallery, 2010). We used the mean scores to determine whether the sound and video stimuli changed the emotional states of the participants. Thus, we calculated each of the participants' mean scores as to the sound and video stimuli both at the baseline period (pre-test) and during the experiencing of the stimuli.

Evaluation of the Stimuli

Following the cleansing operation undertaken as to the data, as was produced to ensure the suitability of the data for analysis, we firstly analysed the results of the self-report questionnaire responses as corresponded to the evaluation of each video and sound stimuli. The evaluation of the stimuli was made in terms of valance, avoidance and arousal. The results of the descriptive statistics in respect of this analysis are shown in Table 8. The positive and negative video and sound stimuli are separately presented. Figure 2 provides a list of the video stimuli used in this study.

In terms of the video stimuli, all five positive videos were rated as being positive and as invoking arousal by exceeding the midpoint of 4.5 on the scale, while they were viewed as instigating less avoidance with the mean scores falling below the midpoint of 4.5. In the same vein, all five negative videos were rated as invoking avoidance and arousal by exceeding the midpoint of 4.5 on the scale. These negative videos were also seen as negative, with the mean scores falling below the midpoint of 4.5.

The results gained in regards to the positive and negative video stimuli suggest that the selected stimuli measured what they supposed to measure in terms of eliciting emotions. The results also suggested that participants tended to approach the positive stimuli, whereas they tended to avoid the negative stimuli. In terms of the sound stimuli, similar results were obtained. The positive sound stimuli were rated as being positive and arousing by exceeding the midpoint of 4.5 on the self-report scale, whereas they were viewed as invoking less avoidance with the mean scores falling below the midpoint of 4.5. Similarly, the negative sound stimuli were rated as invoking avoidance and arousal by exceeding the midpoint of 4.5 on the scale alongside being negative with the mean scores falling below the midpoint of 4.5. These results suggest that the sound stimuli measured what they intended to measure as to eliciting emotion. Furthermore, the results suggest that participants tended to approach the positive sounds, whereas they tended to avoid the negative sounds

Table 8. Descriptive statistics as to the assessment of positive and negative video and sound stimuli in terms of valance, avoidance, and arousal

	Valance		**Avoidance**		**Arousal**	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
Positive videos						
Playing dog	7.63	1.19	2.48	1.36	6.33	2.16
Baby laughing	7.78	1.42	2.73	1.97	6.68	2.16
Baby playing on water	8.08	1.31	2.00	1.24	7.55	1.45
Twins with mom	7.65	1.14	1.65	0.74	7.88	1.09
Baby playing with dog	7.43	1.52	2.80	1.54	7.60	1.63
Negative videos						
Spider	1.38	0.59	8.48	0.93	7.03	1.86
Snake	1.23	0.53	7.10	2.63	7.95	1.50
Baby crying on song	2.93	2.02	6.30	2.68	6.53	2.06

Man, with crocodile	1.95	0.93	8.05	1.68	7.30	1.45
Snake attacking	2.80	1.02	7.18	1.43	6.18	1.38
Positive sounds						
Applause	6.93	1.91	3.43	1.97	5.95	2.18
Music1	7.60	1.24	2.68	2.02	6.35	2.42
Music2	7.73	1.69	2.73	1.97	6.80	2.16
Baby laughing	8.38	0.90	1.95	1.13	7.78	1.12
Bird	7.50	1.38	2.65	1.41	6.68	1.76
Negative sounds						
Vomit	1.53	0.82	8.48	0.93	7.28	1.40
Screaming	1.33	0.80	7.40	2.34	7.85	1.51
Baby crying	2.40	1.22	6.63	2.48	6.85	1.73
Traffic	2.00	0.91	8.08	1.51	7.08	1.80
Drill	3.30	1.20	7.38	1.27	6.13	1.51

Testing the Effectiveness of Video and Sound Stimuli in Eliciting Arousal

After evaluating the video and sound stimuli in terms of valance, avoidance and arousal, we then performed analysis through which to identify if the selected video and sound stimuli were effective in inducing emotions. As we collected physiological data both at the baseline period and during the watching and listening to the stimuli, we were able to compare the values obtained at the baseline (pre-test) and during-test periods. To this end, we performed a series of paired-sample *t*-tests (noting that a paired-sample *t*-test is used when data are obtained at two time points (e.g., pre-test and post-test) from the same participants. It is useful to report the effect size when the results gained are interpreted. Cohen (1988) has proposed a guideline for the interpretation of effect size, with this being known as Cohen's d values. Here, an effect size near 0.2 signifies a small effect, an effect size near 0.5 signifies a medium effect and an effect size near 0.8 signifies a large effect.

The results of the paired sample *t*-tests are presented in Table 9. According to Table 9, all of the positive videos had $p < .05$, so generally there were significant mean differences between the pre-test and during-test measurements. All of the videos had a medium effect size except one video (baby playing on water) as had a small effect size. These results suggest that the positive videos were effective in eliciting physiological responses. As for the negative videos, the results show that all of the negative videos except one (man with crocodile, $p > .05$) had $p < .05$ and so generally there were significant mean differences between the pre-test and during-test measurements. Two negative videos had a medium effect, while the remaining two had a small effect. These results suggest that the negative videos were generally effective in eliciting physiological responses.

A separate dependent sample *t*-test was conducted to compare the participants' mean scores as to the sound stimuli obtained at the pre-test and during-test periods. These results are presented in Table 10. As seen in Table 10, all of the positive sound stimuli had $p < .05$, with this meaning that there were significant mean differences between the pre-test and during-test measurements. Other than one sound stimuli (applause), as showed a medium effect size, the remaining four sound stimuli had a small effect. These results suggest that the positive sounds had a significant effect upon the physiological reactions witnessed. For the negative sound stimuli, the results indicate that all of the negative videos had $p < .05$, with this meaning that there were significant mean differences between the pre-test and during-test measurements. Four negative sounds had a medium effect, while one sound had a large effect. These results suggest that the negative sound stimuli had significant effects upon the eliciting of physiological reactions.

Correlation among the Study Variables

The Pearson correlation analysis undertaken among the components of resilience and positive and negative video stimuli is presented in Table 11. The results of this correlational analysis indicate that all of the variables were significantly correlated with each other and those correlations were in the expected direction. Here, the components of resilience were positively correlated with each other with correlations ranging between r = .69 and r = .73. The positive video stimuli were also positively correlated with each other with correlations ranging between r = .90 and r = .98. Furthermore, the negative video stimuli were positively correlated with each other with correlations ranging between r = .93 and r = .97. More importantly, the components of resilience were significantly positively correlated with both the positive and negative video stimuli. The correlations found between the components of resilience and positive video stimuli ranged between r = .36 and r = .50, while the correlation between the components of resilience and the negative video stimuli ranged between r = .38 and r = .50.

The correlations identified among the components of resilience and the positive and negative sound stimuli were also investigated. These correlations are presented in Table 11. As seen in Table 11, all of the variables were significantly correlated with each other and those correlations were in the expected direction.

Table 9. Paired samples t-test to evaluate the significance of sound stimuli

Stimuli	Period	Mean	*SD*	t	*p*	Cohen's d	Cohen's d label
			Positive sound				
Applause	Stimuli	1.99	1.79	3.20	0.00	0.51	Medium
	Baseline	1.86	1.73				
Music 1	Stimuli	1.70	1.62	2.09	0.04	0.33	Small
	Baseline	1.64	1.54				
Music 2	Stimuli	1.86	1.87	1.99	0.05	0.31	Small
	Baseline	1.78	1.81				
Baby laughing	Stimuli	1.88	1.94	2.73	0.01	0.43	Small
	Baseline	1.78	1.85				
Bird sound	Stimuli	1.90	1.88	2.66	0.01	0.42	Small
	Baseline	1.85	1.83				

		Negative sound					
Vomit	Stimuli	1.97	1.79	4.25	0.00	0.67	Medium
	Baseline	1.85	1.71				
Screaming	Stimuli	1.85	1.85	3.53	0.00	0.56	Medium
	Baseline	1.73	1.77				
Baby crying	Stimuli	1.95	1.88	5.42	0.00	0.86	Large
	Baseline	1.80	1.84				
Traffic	Stimuli	1.91	1.90	4.51	0.00	0.71	Medium
	Baseline	1.77	1.81				
Drill	Stimuli	1.95	1.88	3.31	0.00	0.52	Medium
	Baseline	1.85	1.84				

The correlation found between resilience and the positive and negative sound stimuli is presented in Table 12. The positive sound stimuli were positively correlated with each other with correlations ranging between r = .91 and r = .98. The negative sound stimuli were also positively correlated with each other with correlations ranging between r = .91 and r = .99. Most importantly, the components of resilience were significantly positively correlated with both the positive and negative sound stimuli. The correlations found between the components of resilience and the positive sound stimuli ranged between r = .33 and r = .47, while the correlation between the components of resilience and the negative sound stimuli ranged between r = .33 and r = .47.

Table 10. Correlations among components of resilience and positive and negative video stimuli

	1	2	3	4	5	6	7	8	9	10	11	12	13
Resilience													
1. Engineering	1												
2. Ecological	.69**	1											
3. Adaptive	.73**	.73**	1										
Positive videos													
4. Playing dog	.46**	.39*	.39*	1									
5. Baby laughing	.50**	.41**	.46**	.94**	1								
6. Baby playing on water	.45**	.42**	.42**	.90**	.94**	1							
7. Twins with mom	.38*	.36*	.44**	.94**	.94**	.93**	1						
8. Baby playing with dog	.37*	.37*	.42**	.93**	.93**	.93**	.98**	1					
Negative videos													
9. Spider	.43**	.44**	.41**	.97**	.92**	.89**	.93**	.92**	1				
10. Snake	.47**	.38*	.42**	.97**	.95**	.94**	.95**	.93**	.94**	1			
11. Baby crying on song	.50**	.43**	.47**	.96**	.97**	.94**	.94**	.93**	.95**	.97**	1		
12. Man with crocodile	.42**	.41**	.42**	.93**	.94**	.97**	.97**	.97**	.93**	.95**	.95**	1	
13. Snake attacking	.42**	.39*	.44**	.95**	.95**	.94**	.98**	.97**	.93**	.96**	.95**	.96**	1

*. $p < 0.05$, ** $p < 0.01$

Table 11. Correlations among components of resilience and positive and negative sound stimuli

	1	2	3	4	5	6	7	8	9	10	11	12	13
Resilience													
1. Engineering	1												
2. Ecological	.69**	1											
3. Adaptive	.73**	.73**	1										
Positive sounds													
4. Applause	.37*	.40*	.47**	1									
5. Music1	.33*	.37*	.46**	.96**	1								
6. Music2	.34*	.35*	.45**	.93**	.97**	1							
7. Baby laughing	.35*	.34*	.43**	.91**	.95**	.99**	1						
8. Bird	.36*	.35*	.47**	.93**	.96**	.98**	.98**	1					
Negative sounds													
9. Vomit	.33*	.38*	.44**	.98**	.97**	.93**	.91**	.93**	1				
10. Screaming	.33*	.39*	.46**	.93**	.97**	.98**	.96**	.97**	.94**	1			
11. Baby crying	.33*	.38*	.45**	.92**	.96**	.98**	.97**	.96**	.93**	.99**	1		
12. Traffic	.36*	.33*	.44**	.92**	.96**	.99**	.99**	.98**	.92**	.96**	.96**	1	
13.Drill	.33*	.33*	.45**	.90**	.95**	.98**	.97**	.98**	.91**	.97**	.97**	.97**	1

*. $p < 0.05$, ** $p < 0.01$

Discussion

The aim of this study was to examine the relationship that arises between psychological trait resilience and emotional regulation via the use of emotionally-loaded sound and video stimuli. The results of this study found that the evaluation of the auditory and visual stimuli was in the expected direction. The positive and negative sound stimuli were rated to be highly invocative as to arousal and avoidance alongside being what they intended to measure in terms of valance. Furthermore, the positive and negative video stimuli were rated as being highly invocative as to arousal and being approached as well as being what they intended to measure as to valance.

This study has found significant mean differences when subtracting the baseline skin conductance responses mean scores skin conductance responses mean scores recorded when experiencing the stimuli. These results suggest that the selected auditory and visual stimuli were quite effective in causing arousal and in invoking physiological changes in the body. The effect size as to the effectiveness of the stimuli ranged between small and large, with this mainly being found to manifest a medium effect size. Previous studies have also found that auditory and visual stimuli elicit strong arousal, feelings and emotional experiences among individuals (Hanser & Mark, 2013; Soares *et al.*, 2013).

The present study has found evidence to support our main hypothesis that the components of resilience are positively correlated with the physiological changes in the body as indicated via arousal. To put it differently, individuals with high levels of skill in relation to engineering, ecological and adaptive capacity would show significant increases in the physiological changes in their body towards auditory and visual stimuli, while individuals with a low level of skills in relation to engineering, ecological and adaptive capacity would show a significant reduction in physiological changes and arousal in their body. These findings are in line with the results of prior research whereby resilience has been found to be associated with emotions (Philippe, Lecours & Beaulieu-Pelletier, 2009). According to the broaden-and-build theory (Fredrickson, 2001), positive emotions widen individuals' momentary thought-action repertoires, which in turn helps to build their long-lasting personal resources, varying from physical and mental resources to social and psychological resources. Within the context of this theory, resilience, which is considered as a long-lasting personal resource, has found to allow individuals to experience positive feelings in the face of adversity. This theory also postulates that it is also possible that positive emotions may stimulate psychological resilience. That is, resilience may allow individuals to thrive and benefit from positive feelings and also positive emotions may facilitate individuals to be resilient. This may ultimately result in an enhanced emotional well-being. In general, it has actually found to be related with positive feelings which is vital for effective functioning in a wide range of life domains (Klohnen, 1996).

This experiment's results are important for several reasons. The study suggests the importance of psychological trait resilience on emotional regulation. Resilience seems to be a variable, which is highly related to physiological arousal. To the best of our knowledge, this is the first study that examines the relationship between EEA model of resilience and emotional regulation via positive-negative stimuli experimental induction. The emergent link between resilience and emotional regulation may have important clinical implications. For example, these results may be important for designing programs that aims to help patients with high resilience levels and self-generated positive emotions to cope with stressors better. Patients can be equipped with resilience ability to effectively regulate adaptive emotions. Research findings suggest that positive emotions can improve physical health while negative emotions can increase cardiovascular diseases (e.g., coronary heart disease). As showed here, resilience can be used to better understand emotional regulation. The findings are also important to the relevant literature. Studies in the literature as to the relationships that arise between EEA psychological trait resilience and other psychological and physiological variables are very limited. Having established the relationship between resilience and physiological activities, researchers can be encouraged to conduct more systematic research as to resilience and other possible variables via the use of different study designs (such as experimental designs and survey designs).

An important limitation of this study was that we only had the experimental group and thus no control group was employed, which can be used as a baseline to compare groups and to assess the effect the intervention of the video and sound That is, the same participants underwent both the video and sound stimuli experiment. In future studies, it would be beneficial to design studies in which both experimental and control groups were employed to minimise the effects of other variables on the independent variable. Another limitation of this study pertains to the inclusion criteria of selecting video stimuli. The video stimuli used here were largely retrieved from YouTube, an international video-sharing website. It is probable that the participants of this study could have watched the videos before the experiment. Those who had watched the videos beforehand could have possessed some familiarity with the content, as may have impacted upon the physiological arousal demonstrated. Future research is needed to ensure that such an effect can really occur. In addition, a small convenience sample of university students took part in this study and this thus poses a limitation as to the generalisability of the present findings Therefore, there is a need for research to be conducted with a large and diverse population comprising of various ages and cultural groups (Yildirim, Alshehri & Aziz, 2019). Finally, resilience was measured using a self-report measure. Information provided through self-report measures may be incorrect as participants could have tended to answer questions in a manner that could be viewed favourably by others. Measuring resilience in a different way (e.g., peer reports) may be useful for more accurate results.

Chapter 5

The Association between the EEA Model of Resilience and Physiological Emotional Responses Using Heart Rate as a Marker of Emotional Responses.

Abstract

Resilience has been widely acknowledged to be an adaptive characteristic which arises during the exposure of an individual to stressful life events. However, a limited number of studies have focused on how resilience is related to physiological changes in the body. The purpose of this study was to investigate the relationship between psychological trait resilience and heart rate variability whereupon a person is exposed to affectively-loaded stimuli. Here, the respondents were university students aged between aged 18 to 36 years old, with a mean age of 20.20 years old (*SD* = 3.4). A sample of 45 respondents (5 males, 40 females) completed the self-report measure of psychological trait resilience and the visual stimuli rating scale. The participants undertook to watch a series of affectively-loaded video stimuli in an experimental setting. Their heart rate changes were recorded throughout their watching of the video stimuli. The results of the analysis show that the employed positive and negative videos stimuli were highly effective in causing changes in heart rate, whereby heart rate variability during the watching of the videos was significantly greater than the heart rate variability witnessed before the watching of the videos. The results of the correlational analysis demonstrate that engineering, ecological and adaptive capacity, as components of psychological resilience, were significantly positively related with heart rate variability during the exposure of the participants to the affective videos. The overall findings suggest that it may be fruitful for researchers and practitioners alike to explore how psychological trait resilience is related to heart rate variability.

Introduction

To further expand upon the findings as to the link between physiological responses and the EEA model of resilience, there is a need to examine resilience within the context of physiological arousal by using a different biomarker of resilience (e.g. heart rate). Such an investigation can elaborate upon our held understanding as to the physiological aspects that underlie resilience and their relationship with emotional arousal resulting from emotionally-loaded stimuli.

Emotions are characterised as coordinated sets of responses given to internal or external events that may have a particular significance for the organism (Lazarus, 1993). These response sets may vary and involve cognitive, behavioural, psychological, physiological and neural mechanisms aimed at orchestrating the best possible response to significant events. According to physiological theories, intense emotions are distinct from normal emotions in terms of quantification. The intensity of emotions is determined by a person's level of arousal (James, 1894). Here, the more aroused a person is, the more intense the emotions they shall experience. When a stimulus is perceived as significant, an increase in physiological arousal occurs and this arousal triggers the preparing of the body for action against that stimuli. Common physiological responses include the activation of the sympathetic nervous system (as results in an increased heart rate, blood pressure, respiration rate and muscle tension, alongside a decreased skin temperature) and the release of arousal hormones (such as noradrenaline and cortisol) from the adrenal glands (Boucsein, 2012).

Emotional arousal has an impact on the heart rate of an individual. If a person is exposed to positive stimuli, their heart rate shall increase. Heart rate increases with exposure to positive stimulus because of its outcome, as is usually pleasant (Segerstrom and Nes, 2007). In the same way, negative stimulus also increases the heart rate. When exposed to a negative stimulus for an extended period of time, this behaviour is invoked by negative results being brought about by the negative stimuli. Once the stimuli are averted, the body returns to homeostasis by activating the relaxation response, with this being characterised by, among other aspects, a reduction of heart rate, decreased production of stress hormones, slower breathing and vasodilation (Medicine, B. 2011).

Heart rate is typically measured in terms of the number of beats per minute and this is one of the most commonly-used biomarkers. It reflects stress responsiveness in psychosocial and cognitive situations (Karpyak *et al.,* 2014; Starcke *et al.,* 2013) and can be used to detect emotional changes as well as physical changes. Emotional changes are detected when the individual is faced with certain stimuli, as may cause the heart rate to increase (or, in some cases, to decrease). Reactions to specific cues are important for noting these changes and this is one of the reasons as to why this biomarker is often used to measure stress. According to Mandal (2014), an ideal biomarker is safe and easy to measure, cost efficient to follow up, modifiable with treatment and consistent across gender and ethnic groups. All of these ideals position heart rate as being highly useful as a biomarker. The ease with which a health specialist, or just an ordinary person, can measure an individual's heart rate makes this the most accessible biomarker. The ways in which heart rate can be generally measured include ECG and blood pressure techniques.

There are various physiological processes that lie behind heart rate. For instance, any intense exercise can lead to a higher heart rate. However, it is the physiological processes linked to emotion that can be more readily identified, as measurable changes take place. Emotional experiences (such as fear and anxiety) can increase an individual's heartbeat. As well as changes to heart rate, such experiences are also noted through a person's sweat level, muscle tension, breathing rate and facial expressions. A number of previous studies have focused on the biological responses given to stress, whereby participants have been subjected to traumatic situations and researchers have measured these by the evidence of increased cardiac activity

(Regehr *et al.,* 2007). The biomarkers used in such experiments are often heart rate measurements, but they can also include cortisol levels which are evidenced through measures of saliva. However, heart rate remains the most widely-used biomarker for measuring stress, with heart rate variability being a non-invasive approach that measures changes in heart rate.

Heart rate variability can be measured through time domain methods, whereby the heart rate is measured at a given point in time or at intervals between specified times. Alternatively, it can be measured by frequency domain methods. Here, both time and frequency domain methods provide evidence of increases or decreases in the heart rate. The difference between heart rate and heart rate variability is that heart rate is a vital sign whereas heart rate variability is a quantitative measure of cardiac activity used to diagnose diseases affecting the nervous system (Barbieri *et al.,* 2005). Changes in heart rate may indicate fear (Levenson, 1992), panic or anger (Levenson, 1992). Although emotions are a primary factor affecting heart rate, other factors may have an impact. These include age and physical activity and thus these also need to be taken into consideration when carrying out heart rate measurements.

Since the definition of resilience that has been adopted in this thesis is 'resilient functioning', as centres on a biological and cognitive framework at the core of which is the brain (Cicchetti & Curtis, 2006), it is therefore required that a number of biological factors are identified and linked with the psychological variables. In this regard, the measuring of heart rate plays an important role in investigating resilience. This means that both the biological and psychological domains are needed in order to understand the complexity of resilience. Within this context, emotion is one area of biological functioning that might potentially contribute to resilient functioning, as directly and/or indirectly reflects the functioning of major human biological systems which have clear links to human behaviour. This is because emotion encompasses a wide range of behavioural expressions and associated biological processes that play a vital role in many aspects of human development and adaptation. Emotion regulation is conceived of as the intra- and extra-organismic processes by which emotional arousal is redirected, controlled, modulated and modified to enable an individual to function adaptively in emotionally-arousing situations.

To investigate the link between physiological responses and the EEA model of resilience within a laboratory setting, the employment of the trauma analogue paradigm (as links the biological and the psychological aspects in measuring resilience) would be useful. There has been some research which indicates that heart rate and heart rate variability may be useful for measuring the valence of emotion – whether it is a positive emotion like joy or a negative emotion like sadness or fear (Hamdi *et al.,* 2012). However, there have been limited studies undertaken as to the relationship between trait resilience and the biological correlates and sensory-affective responses in a laboratory setting. Many of the existing studies have relied on self-reporting. There are a number of ways through which to measure heart rate, with the most common being the use of electrocardiography (ECG) and photoplethysmography (PPG). ECG can measure the electrical activity of the heart and enables distinctive features of an individual's heart beats to be detected via the use of a common signal processing technique. PPG involves the measurement of blood volume in the blood vessels by using light transmitters and receptors just below the skin's surface (Fleureau, J., 2012).

Resilience is the capacity of individuals to enact positive adjustments regardless of the challenging or threatening circumstances faced. It is, in other words, an ability to recover quickly after exposure to a stressor (Keye and Pigeon, 2013). It could be further defined as a sort of learning process whereby, through challenging and threatening situations, individuals gain knowledge through which to actively cope with comparable situations (Ahern *et al.,* 2006). It has been stated that resilience is a psychological capacity to adequately react towards change. One of the main factors associated with resilience is healthy emotion regulation. Thus, emotional response exhibits the individual reactions given to daily life situations and illustrates the ability of a person to positively adjust and recover from negative incidents. This study concentrates on examining the relationship that arises between physiological emotional responses and resilience by performing an experiment which includes exposing the sample to various types of videos and then recording the participants' responses.

Present Study

Evidence as to the relationship between resilience and biological correlates and sensory-affective responses in a laboratory setting is scarce. This is especially evident when considering the EEA model of resilience as proposed by Maltby *et al.* (2015). This is because the theory has only recently been presented in the literature as to this area. It would thus be fruitful to provide empirical evidence in respect of this newly introduced model of resilience if researchers are to fully understand how psychological trait resilience is associated with physiological changes (particularly heart rate variability) in the body. Thus, the aim of this study was to explore psychological trait resilience and physiological arousal as indicated by heart rate variability. This was sought to be accomplished via the use of video stimuli to elicit intense emotions. This study had two objectives. The first objective was to replicate the validity of the emotional positive and negative video stimuli created and used in our previous experimental study, achieved here by using heart rate as a marker of emotional reaction. The second and most important objective of this study was to examine the relationship between psychological trait resilience and heart rate variability during the exposure of an individual to affective positive and negative video stimuli. In this study, we expected that the video stimuli would be valid in eliciting changes in heart rate. We also expected that psychological trait resilience would be significantly positively correlated with heart rate variability in the course of the exposure undertaken to the emotionally-loaded stimuli.

Method

Participants

The sample of this experiment comprised of 45 respondents (5 men, 40 women), aged between 18 and 36 years old (M = 20.20 years, SD = 3.4). In terms of ethnicity, 23 participants characterised themselves as White, 9 as Black, 6 as Asian, 3 as East Asian, 2 as being of Mixed Race and 2 as falling into the "Other" category. The sample comprised of participants studying at the University of Leicester. The Experimental Participation Requirement platform employed within the university was utilised in recruiting the participants. There were no particular inclusion or exclusion criteria as to the specific characteristics of the participants in regards to them partaking in the study. Both undergraduate and postgraduate students took part in the study. Participation in this study was voluntary and the participants were awarded with course credit in exchange for their involvement. This study was conducted with a relatively small sample size as G*Power recommended a required sample size of 109, with an alpha level of p=.05, medium effect of .30, and a power of .90 for correlation analysis.

Measures

This experiment used an analogue laboratory design to test the eliciting of emotional responses in laboratory conditions. The experiment used both subjective and objective measures through which to deeply understand the relationship between psychological trait resilience and changes in the heart rate resultant from watching stimuli. The measures employed are as follows.

The Ecological Model of Trait Resilience (EEA). The EEA model of trait resilience is measured via EEA (Engineering resilience, Ecological resilience and Adaptive capacity). In the original article, good reliability and validity was documented as to this approach (Maltby *et al.*, 2015). In this study, internal consistency reliabilities were reported as .79 for engineering, .77 ecological, and 76 adaptive capacity.

The Stimuli Rating Scale. (See chapter 4 and the appendix)

Physiological Measure. As a physiological measure, we used Edu-Logger Heart Rate sensor equipment. The sensor can be used to trace pulse rates under different conditions. There are two modes of operation of this sensor in terms of monitoring heart rate: measuring the heart rate as Bits Per Minute (BPM) and showing the analog arbitrary value of the measured signal. The electrodes placed on a finger are both plethysmograph-based and so monitor changes in blood flow. Range and operation modes of the sensors vary from 0 to 240 BPM. With a full data acquisition system, the Edu-Logger Sensors are fairly practical as it is placed on a finger of the participants and can be used with the Edu-Logger USB module. The sensors can be placed on the palmar surface of the distal phalange of the baby finger (Yildirim, 2019b). Via a computer, the data is sent in a digital form to a viewer unit.

Procedure

Upon arrival at the laboratory, the participants were informed of their rights and given a consent form to sign. The research procedures were also briefly but clearly explained to the participants. Following this, all of the self-report measures of EEA resilience were completed before starting the experiment with the exception of the valence scale (as was completed after showing each video stimuli). We requested that the participants control for a wide range of possible factors that could influence their cardiovascular parameters (such as movement, posture and any other physical activity).

In the experiment, the emotional responses were measured via measuring changes in heart rate by utilising the EDU Logger sensor equipment. 10 video clips, including both those that were positive and negative, were selected from YouTube. With regards to the number of stimuli, half of the videos were positive while the remaining half were negative. Before the actual presentation of the videos, a 2-minute baseline period was allocated to record the participants' general heart rate. Following this, two example videos (one positive, one negative) were presented to the participants so that they could gain an understanding as to the types of video that were to be presented. Immediately after watching each of the videos, they were asked to rate that video in terms of valance, arousal and approach by using the self-assessment measure. Here, the heart rates of the participants were continuously monitored during the experiment to measure their physiological reaction to the given stimuli.

The study procedure received ethical approval from the Department of Neuroscience, Psychology and Behaviour's Ethics Committee, with the code of 9035-jm148, at the University of Leicester, and this ethics covered multiple experiments in this thesis. Respondents that were selected as part of the project were required to provide written consent after clearly understanding what was involved in the experiment. Agreement being given to this understanding was required before the experiment proceeded. It was made clear that if written consent was not attained, the participant was permitted to withdraw from the study at their discretion. The consent form comprised of statements and directions regarding the nature of the study, the anonymity of the data, permission as to the participant's withdrawal both during and after their involvement, the ways in which the data would be stored in a coded form, the ways of requesting the results of the study if required and the intended use, length of storage and disposal of the data. The confidentiality of the participants was also assured here.

Data Analysis

Pearson correlation analysis was used to investigate the correlations between the variables in the study – namely the relationships which arise between psychological resilience and changes in heart rate as invoked from positive and negative stimuli. Descriptive statistics (such as the mean and standard deviation of the results) were used to explore the nature of the study variables. To test the hypothesis that was put forth to examine the mean difference between the pre-test and post-test measurements, a paired sample t-test was used. A significant probability level of 0.05 was determined to test the study's hypothesis. All of the data analysis was performed using SPSS Version 24 for Windows.

Results

The descriptive statistics employed to assess the stimuli used in this study are presented in Table 13. This descriptive statistical information primarily includes the mean and standard deviation as to the valance, avoidance and arousal witnessed in relation to each of the positive and negative stimulus used in this study. When participants were asked to assess the emotionally-loaded stimuli in terms of its valance, avoidance and arousal, they were required to indicate the extent to which the given video was considered as positive versus negative, approach versus avoidance or arousal versus relaxed on a continuum. Here, one end of the continuum referred to positive or avoid or arousal, while the other end of the continuum referred to negative or approach or relaxed. Higher scores given on the continuum indicated positive, avoidance and arousal while lower scores given on the continuum indicated negative, approach and relaxed.

According to Table 13, positive videos were rated to be positive by exceeding the threshold midpoint score of the scale, which is 4.5 in this case. In contrast, the negative videos were rated as being negative by falling below the threshold midpoint score of 4.5 on the scale. Similarly, positive videos were found to produce less avoidance by falling below the threshold midpoint value of 4.5, while negative videos were found to produce more avoidance by falling above the threshold midpoint value of 4.5 on the scale. In regards to arousal, both the positive and negative videos were found to be highly capable of instigating arousal, with all of the videos being rated above the midpoint score of 4.5. These results collectively suggest that the positive and negative videos selected for the purpose of this study achieved their goals in eliciting arousal as they measured what they intended to measure

Table 12. Descriptive statistics concerning the evaluation of positive and negative video stimuli

	Valance		**Avoidance**		**Arousal**	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
Positive videos						
Playing dog	7.71	1.62	2.73	1.99	6.24	1.90
Baby laughing	7.02	1.84	3.38	2.07	6.78	1.29
Baby playing on water	8.40	0.86	2.16	1.57	7.20	1.38
Twins with mom	7.47	1.46	2.87	1.73	5.82	2.34
Baby playing with dog	7.56	1.44	2.67	1.92	6.78	1.65
Negative videos						
Spider	1.47	0.79	8.51	0.89	7.16	1.80
Snake	1.31	0.76	7.27	2.53	7.84	1.62
Baby crying on song	2.84	1.92	6.49	2.63	6.64	2.00
Man, with crocodile	1.98	1.01	8.02	1.78	7.09	1.74
Snake attacking	3.33	1.26	7.29	1.27	5.82	1.93

Table 13. Paired samples t-test to evaluate video stimuli

Stimuli	Period	Mean	*SD*	t	*p*	Cohen's d	Cohen's d label
			Positive video				
Playing dog	Stimuli	100.76	12.41	7.78	< .001	1.16	Large
	Baseline	90.59	12.24				
Baby laughing	Stimuli	90.36	8.98	5.72	< .001	0.85	Large
	Baseline	82.37	7.09				
	Stimuli	95.49	11.09	8.86	< .001	1.32	Large

Baby playing on water	Baseline	84.79	8.08				
Twins with mom	Stimuli	95.13	12.36	8.00	< .001	1.19	Large
	Baseline	85.05	9.50				
Baby playing with dog	Stimuli	96.18	10.56	10.02	< .001	1.49	Large
	Baseline	83.90	8.88				
			Negative video				
Spider	Stimuli	94.84	11.70	8.80	< .001	1.31	Large
	Baseline	85.98	9.36				
Snake	Stimuli	97.42	10.47	8.14	< .001	1.21	Large
	Baseline	84.94	10.63				
Baby crying on song	Stimuli	92.96	11.80	6.16	< .001	0.92	Large
	Baseline	84.13	9.61				
Man, with crocodile	Stimuli	94.99	12.69	6.35	< .001	0.95	Large
	Baseline	84.34	10.00				
Snake attacking	Stimuli	94.44	11.49	7.75	< .001	1.16	Large
	Baseline	83.15	9.55				

Following the evaluation of the video stimuli via the use of a self-report questionnaire, we then moved on to analyse whether the positive and negative video stimuli were powerful enough to invoke changes in the physiological activity of the body. Here, we selected heart rate as an objective measure of detecting the physiological activity in the body as derived from the watching of affectively-loaded video stimuli. As the changes in heart rate were recorded at a baseline period (pre-test) and during the watching of the videos, a comparison was made between the two scores. Since the design of the study employed a repeated measure between subjects with two levels (pre-test and during-test), a paired sample t-test appeared to be the more suitable statistical test for this analysis. At this point, we paired the heart rate scores gained during the pre-test and during-test points. Any difference below the probability value of 0.05 was considered as statistically significant. The results of the paired sample t-tests for both the positive and negative stimuli are presented in Table 14. As seen in Table 14, significant mean differences in changes in the heart rate between the pre-test and during-test points were observed, with all differences being less than the probability value of 0.01. Table 14 also shows that all of the participants who underwent the watching of the videos were significantly aroused, with the effect sizes for all being considered to be large. This interpretation rests on the effect size rules proposed by Cohen (1998). This rule, as is known as Cohen's d, suggests that $d = 0.2$ represents a small effect size, 0.5 represents a medium effect size and 0.8 represents a large effect size.

Figure 3 presents a list of the videos used to elicit changes in heart rate in this experiment. As seen in Figure 3, the set of videos intended to elicit a variety of positive and negative emotions (such as happiness, sadness and fear). In addition, we examined the correlations found between psychological trait resilience and changes in heart rate as derived from affectively-loaded visual stimuli. Table 15 separately shows the correlation found among the psychological trait resilience components and the positive and negative video stimuli. The findings of the correlation analysis generally show that there was a significant relationship between the components of resilience and the positive and negative visual stimuli – where r ranges between .296 and .601 ($p < 0.05$). Adaptive capacity was not found to be correlated with two of the negative stimuli. Other than this, the components of resilience were significantly positively correlated with the positive and negative videos.

Figure 1. List of Video Stimuli Used in This Study

Table 14. Correlations among components of resilience and positive and negative video stimuli

	1	2	3	4	5	6	7	8	9	10	11	12	13
Resilience													
1. Engineering	1												
2. Ecological	.60**	1											
3. Adaptive	.54**	.55**	1										
Positive videos													
4. Playing dog	.42**	.52**	.37*	1									
5. Baby laughing	.38*	.61**	.49**	.45**	1								
6. Baby playing on water	.30*	.31*	.30*	.51**	.39**	1							
7. Twins with mom	.33*	.32*	.30*	.48**	.40**	.41**	1						
8. Baby playing with dog	.54**	.37*	.31*	.66**	0.27	.43**	.45**	1					
Negative videos													
9. Spider	.33*	.34*	.33*	.33*	0.22	0.27	.32*	.35*	1				
10. Snake	.32*	.37*	0.26	.45**	0.20	0.06	.30*	0.23	0.24	1			
11. Baby crying on song	.45**	.46**	.35*	.45**	.48**	.56**	.50**	.37*	.39**	0.22	1		
12. Man with crocodile	.44**	.45**	.32*	0.26	.39**	.43**	.46**	.31*	0.20	0.07	.49**	1	
13. Snake attacking	.31*	.34*	0.25	0.12	.30*	0.28	.30*	0.16	0.29	0.22	.51**	.45**	1

*. $p < 0.05$, ** $p < 0.01$

Discussion

This study aimed at investigating the relationship that arises between psychological trait resilience and changes in heart rate, which occur during the watching of affectively-loaded stimuli among students in a UK university. In line with our expectations, resilience was typically revealed to have a significant relationship with changes in heart rate. The video stimuli employed played an effective role in causing these changes. In using heart rate as a marker of physiological activity in the body, this study has successfully replicated the validity of the emotionally-loaded video stimuli used in our previous experimental study. This supports the *a priori* hypothesis that watching affective stimuli would be effective in causing changes in heart rate. The results suggest that the employed positive and negative stimuli are as valid as in our previous study. These results are consistent with the results of previous research in which the presence of affective stimuli was found to elicit an increase in heart rate. For example, Medicine (2011) found that the presence of emotional stimuli activates responses toward that stimuli via the increasing of an individual's heart rate, production of stress hormones, breathing speed and vasodilation.

In the present study, we found that each of the resilience domains was significantly positively correlated with changes in heart rate during the watching of emotionally-loaded stimuli. Those who possess high levels of engineering, ecological and adaptive capacity shall demonstrate higher rates of heart variability. This may be interpreted as denoting that individuals who possess high levels of psychological trait resilience may be more likely to be aroused towards emotionally-loaded visual positive and negative stimuli. Thus, a greater degree of arousal may trigger significant changes in heart rate. These results provide meaningful support in relation to our expectations and previous findings. In the previous study, evidence was provided that demonstrated how arousal has a significant impact on the heart rate of an individual. For example, if a person is exposed to positive stimuli, their heart rate shall increase. Here, a heart rate increases with exposure to positive stimulus because of its outcome, as is usually pleasant (Segerstrom & Nes, 2007). Similarly, negative stimulus increases the heart rate as well. When exposed to negative stimuli for an extended period of time, this behaviour is brought about by the negative results emerging from the negative stimuli. In another study, a positive relationship between psychological resilience and emotions was reported right after the induction of sadness relative to a theme of loss (Philippe, Lecours & Beaulieu-Pelletier, 2009). Negative stimuli have been found to evoke heart rate variability. For instance, unexpected scary moments that evoke a physiological startle response can be applied to increase negative emotions (e.g., fear) among viewers of scary movies, with this affecting the heart rate of individuals (Schmitz *et al.,* 2012). A greater variability in heart rate was also obtained after individuals watched a violent movie. These findings are also in line with studies wherein resilience has been found to have a shared positive correlation with positive emotions. Karampas (2016) has indicated that greater positive emotions significantly correlate with higher level of resilience and better psychosomatic health.

The students who scored highly in relation to psychological resilience demonstrated higher levels of arousal, with this resulting in higher levels of heart rate changes. In contrast, those who scored lowly in relation to psychological resilience demonstrated lower levels of arousal, with this contributing to lower levels of heart rate changes. These results suggest that intervention studies could consider heart rate as a biomarker of resilience through which to better understand the relationship. Cultivating resilience is important, not only in reducing the effect of stress on individuals but also in contributing adaptive coping strategies (Wu *et al.,* 2013) that can lead to better psychological functioning. Thus, researchers and practitioners could employ evidence-based assessments when seeking to understand psychological trait resilience and its biomarkers (e.g., heart rate).

Some of the limitations of this study should be taken into consideration when interpreting the current findings. Firstly, this is particularly evident when it comes to the proportion of male participants to female participants. It is probable that the present findings pertain more to females than to males. Thus, there is a need to replicate the obtained findings with a group of people wherein gender is approximately balanced. It would also be worthwhile to repeat the current findings with various cultural and ethnic groups in an attempt to produce a more plausible conclusion. Using a large sample size for the replication of these findings would increase the power of the statistical analysis undertaken as well as the implications of such a study (see mothed section, P.111). The second limitation pertains to the self-report questionnaire used to measure the participants' levels of resilience. Here, the participants in this study could have overestimated or underestimated their resiliency level. Thus, the collecting of data via reliance being measured through a self-report questionnaire might shed some doubt upon the objectivity of the data.

This study has shown that the components of psychological trait resilience are significantly associated with heart rate changes as derived from being exposed to emotionally-loaded stimuli among students in a UK university. These results are important in terms of understanding and extending the correlates of psychological resilience. From this, researchers, practitioners and authorities could undertake evidence-based assessments towards enhancing the levels of resilience held among students in order to promote positive human functioning.

Finally, resilience was measured using a self-report measure. Information provided through self-report measures may be incorrect as participants could have tended to answer questions in a manner that could be viewed favourably by others. Measuring resilience in a different way (e.g., peer reports) may be useful for more accurate results.

Chapter 6

The Relationships between EEA Resilience and Physiological and Psychological Changes after the Cold Pressor Test

Abstract

This study was conducted to determine how resilience was related with physiological changes occurring in the heart rate and skin conductance responses of individuals when the cold pressor test (CPT) was administered. 45 healthy participants (41 females and 4 males) underwent the CPT with a repeated measure design in which the experimental (cold water) versus control (mild water) condition was manipulated. The heart rate and skin conductance responses of the participants were recorded at the baseline period and during the cold pressor test, while their anxiety levels were measured both before and after the CPT. An independent sample *t*-test has shown that the participants were randomly assigned to either the experimental condition or to the control condition. A repeated measure mixed ANOVA has indicated that the heart rate, skin conductance responses and state anxiety of the participants during or after the CPT were significantly higher than in the baseline period for the participants undergoing the experimental condition, with this suggesting that the CPT influenced the participants' physiological changes. Correlation analysis has revealed that engineering resilience was positively related with skin conductance responses and negatively related with anxiety. Regression analysis has demonstrated that engineering resilience uniquely negatively predicted anxiety after controlling for the baseline scores. Overall, the results suggest that engineering resilience may be better considered within the context of the CPT.

Introduction

In our previous studies, we examined the EEA model of resilience within the context of emotional regulation and physiological arousal. To do this, we employed various sets of stimuli (including picture, sound and video content). This has undoubtedly expanded our understanding held as to the EEA model of resilience and its relationship with physiological arousal and emotional regulation. However, transferring the EEA model of resilience within the context of stress would also be useful in strengthening the position of the model within the wider sphere of psychology. Thus, the use of the cold pressor paradigm as a stress or pain induction procedure can shed light on the EEA mode of resilience.

The cold pressor test (CPT) is an experimental technique that usually involves the submergence of an individual's hand in ice-cold water for a certain period of time, undertaken in order to induce acute pain (Von Baeyer *et al.,* 2005). CPT is a commonly-used method in laboratory settings when seeking to elicit physical and psychological stress that affects the sympathetic activation in the body of participants. Arousal is indicative of an activation of the sympathetic nervous system. Higher arousal or changes in the body, as can be measured by means of physiological measurements such as in relation to heart rate and skin conductance, refers to the degree to which a body responds to an internal or external stressor. Psychological concepts of arousal are found to be related to the sympathetic nervous system (Dawson, Schell & Filion, 2000) as regulates the organism's resources to fulfil the internal and external demands faced (Salvia, Guillot & Collet, 2012).

The cold pressor test has been applied to a wide range of variables. There is substantial evidence that the cold pressor test is linked to a variety of variables. Vigil, Rowell, Alcock and Maestes (2014), for example, have found that the CPT influences subjective pain (such as in relation to an individual's pain threshold, pain tolerance and pain intensity). In an experimental study in which the underlying mechanism between optimism and pain was investigated among healthy university students by using the CPT, Hanssen *et al.* (2013) found a causal link between optimism and pain. Here, it was suggested that higher scores being measured in relation to optimism results in lower scores being found in pain intensity ratings during experimentally-induced acute pain.

When investigating individual differences in pain responses or arousal during experimentally-controlled CPT, several variables may play an important role. In this sense, resilience may be an important variable that needs to be examined within the context of CPT. Goubert and Trompetter (2017), in producing a systematic literature review through which to understand the science and practice of resilience in the context of pain, found that resilience is a significant psychological factor and resource that allows individuals to recover from negative outcomes. They also documented that having the ability to enact resilience is important in preventing and dealing with pain-specific problems. Some studies have investigated the impact of resilience on pain and disturbance caused by stressors. There is substantial evidence to show that a close association exists between resilience and stressors. In other words, resilient people have high coping abilities, as allow them to bounce back from adverse negative situations (Earvolino-Ramirez, 2007). Higher resilience is related to lower stress levels being encountered (Friborg *et al.*, 2006). Furthermore, resilience is found to act as a personality characteristic which moderates the effect of stress and pain and contributes to the adaptation produced (Wagnild & Young, 1993). Moreover, pain has been found to be negatively correlated with resilience. Thus, the more resilient people are, the lower pain they will experience (de Souza *et al.,* 2018). In the context of the CPT, it is plausible to argue that the possession of high levels of resilience may enable individuals to undertake high levels of physical activity and arousal in the body against any external stressor (such as the CPT) to deal with such stressors effectively.

Present Study

The aim of this study was to examine how resilience is related to physiological changes occurring in the heart rate and skin conductance responses of individuals whereupon the CPT was administered. To achieve this aim, two hypotheses were generated. Firstly, we hypothesised that the effect of the cold pressor test (using cold water) would be greater than the effect of warm water in eliciting physiological changes witnessed in the heart rate and skin conductance responses of individuals and in anxiety score changes. Secondly, we hypothesised that resilience would be significantly associated with changes in the heart rate, skin conductance responses and anxiety scores of participants measured during or after the CPT. To the best of our knowledge, this is the first study to investigate the EEA resilience model within the laboratory conditions of stress manipulation, with this being undertaken in order to understand how resilience relates to physiological changes in the body after an induction of pain.

Method

Participants

The participants for this study were 45 healthy undergraduate students as ranged in age between 18 and 47 years old (M = 20.45, *SD* = 4.53). The number of females was 41, while the number of males was 4. All of the participants were enrolled in Psychology at the University of Leicester and voluntarily participated in the study. In terms of the participants' demographic characteristics, the majority of the participants were Caucasian (46.7%), with the remainder being South Asian (22.2%), Black (22.2%), East Asian (4.4%), Mixed Race (2.2%) and Other (2.2%). The religious affiliation of the sample comprised of those who were Christian (40%), those with no religion (31.1%), Muslim (13.3%), Hindu (6.7%) and other (8.8%). The participants were fully informed as to the details of the experiment prior to them signing a consent form and were aware that they could opt out at any point during the experiment. All of the participants were given course credits for taking part in the experiment.

Measures

Resilience. Resilience was measured by the psychological trait resilience scale (EEA) developed by Maltby *et al.* (2015). The EEA consists of twelve items which measure the extent to which one has the engineering, ecological and/or adaptive ability in dealing with stressful situations. There are three dimensions of the scale; Engineering (e.g., "It does not take me long to recover from a stressful event"), ecological (e.g., "I work to attain my goals no matter what roadblocks I encounter along the way") and adaptive (e.g., "I enjoy dealing with new and unusual situations"). The participants respond to each item on a Likert scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). The scores for the EEA dimensions are calculated by summing all of the individual item scores as to a particular dimension after reverse scoring items 1 and 2 on the dimension of engineering. Thus, the possible scores for each dimension range between 4 and 16, with higher scores indicating greater resilience being possessed. In this study, internal consistency reliabilities for each of the resilience subscale (engineering, ecological and adaptive) were respectively .85, .85, and .88.

Anxiety. Anxiety was assessed by the State-Trait Anxiety Inventory (STAI) as developed by Spiegelberger, Gorsuch and Lushene (1970). The inventory includes 40 items that measure both state and trait anxiety. The STAI includes two questionnaires of 20 items each. The first questionnaire assesses state anxiety (e.g., "I feel secure") while the second questionnaire assesses trait anxiety (e.g., "I feel nervous and restless"). The inventory is frequently used to measure anxiety by giving particular attention to worry, tension, nervousness and apprehension. The participants respond to each of the items on a Likert scale ranging from 1 (*not at all*) to 4 (*very much so*). The scores for each of the questionnaires are calculated by summing all of the individual item scores after reversing the scoring items. Thus, the possible scores range from 20 to 80, with higher total scores indicating greater levels of anxiety being possessed. Participants completed both state and trait anxiety scales before the experiment while they completed state anxiety again after the experiment. As for internal consistency reliabilities in this study, Cronbach alpha coefficients for state anxiety were .90 both before and after the experiment while Cronbach alpha coefficient for trait anxiety was .86 before the experiment.

Heart Rate. Heart rate was measured using a pulse logger sensor. The Edu-Logger Heart Pulse Logger Sensor was used to monitor heart rate variability. This sensor can be used to monitor and compare pulse rates under a wide range of conditions. The sensors were attached to the distal phalange of the pinkie finger on the left hand. Values for this logger are presented as BPM (Beats per Minute), as ranges from 0 to 240. The electrodes are plethysmograph-based.

Skin Conductance Response (SCR). SCR was measured using the Galvanic Skin Response (GSR) logger sensor that measures the electrical conductivity of skin, particularly that found on our fingers. The changes witnessed in the conductivity of skin depends upon unconscious emotion effects (e.g., a sudden noise, smell, touch, pain or view). A GSR or SCR sensor is used to measure electro-dermal activity in microsiemens via a range of 0 to 10. The Neulog Galvanic Skin Response (GSR) Sensor NUL-217 was used here to measure skin conductance responses. A pair of electrodes was attached to the palmar surface of the medial phalange of the middle and ring fingers on the left non-dominant hand. A high level of SCR being found, as denotes higher sweating and higher conductance in the skin, indicates higher levels of arousal. The data as to the heart rate and skin conductance responses of the participants were recorded via NeuLog Software Version 7.56.47 for Windows PCs.

Pain Stimulus. The cold pressor test was used to induce physical pain. Pain stimulus was performed to the right hand whereby a 22-litre digital stirred stainless-steel water bath

(Clifton water bath NE4-22D series) was utilised to induce pain. A pump continuously circulated the water to keep it at a temperature of 3° Celsius. The cold pressor pain induction technique is a simple and secure method of inducing arousal. The basic idea of this procedure pertains to individuals being asked to submerge either their dominant or non-dominant hand into the cold water up to the wrist. When they can no longer tolerate the pain, they voluntarily withdraw their hand from the water (von Baeyer *et al.*, 2005).

Procedure

This study was part of a research project in which the relationships that arise between the negative side of happiness and the individual differences possessed in relation to the levels of well-being among individuals were examined (Yildirim, 2019b). In that project, the relationship between positive and negative psychological constructs and their relationships with well-being were examined. The relationship between negative psychological constructs and well-being were reported elsewhere (Yildirim, 2019b). As a positive psychological construct, we took out the resilience and examined its relationship with anxiety and physiological changes in the body.

Here, the participants took part in the experiment individually. Prior to the experimental sessions, the participants were informed that if they had any current health problems, they would not be able to participate in the experiment. For example, those who suffer from any kind of medical condition were not allowed to take part in the experiment. However, none of the participants were excluded as no health problems were found to be present. All of the instructions for the experiment were given both orally and in a written form by the experimenter during the time of the experiment. All of the participants singed an informed consent form.

The participants in this study were initially divided randomly between either the experimental condition or control condition to prevent the selection bias and ensure against any accidental bias. This was done to compare the groups and minimize the source of bias in the assignments (Suresh, 2011). For this design, we used an alternative allocation method as the experiment took too long to be completed and there was limited number of equipment that can be allocated to participants. Also, the equipment took so long to set up for each participant. (D'Arcy Hart P, 1999), though alternate allocation method is not useful for clinical trials as a randomisation method because the person recruiting trial participants knows the next treatment and may be influenced in the recruitment (Chalmers 1999). However, with the current study the individuals, or order of individuals being recruited were not determined by the research team, rather they were determined by the individuals themselves. This would allow us to minimise the variability among the participants and improve the power of statistical analysis. Prior to the experimental procedure starting, the participants were placed in a comfortable chair. Before submerging their hand into the water, the participants completed the EEA psychological trait resilience scale to assess their levels of resilience and responded to the State-Trait Anxiety Inventory to measure their levels of anxiety. After completing the questionnaire, a pulse logger sensor was attached to the pinkie finger of the participant, while two electrodes were attached to the ring finger and index finger on the left hand. Due to the design of the study, whereby the participants submerged their right hand into the water, physiological sensors were placed on their left hand as a non-dominant hand. The pulse logger sensor was then used to measure the participant's heart rate, while the two electrodes were used to measure their skin conductance response for the electro-dermal activity encountered. During the task, the participants were asked to sit quietly in the provided chair within the laboratory. The heart rate and skin conductance responses of the participants were recorded as a 3-minute baseline period (before the cold pressor test) and as a 3-minute period as the cold pressor test was being undertaken. The participants were then required to submerge their left forearm in a water bath for a maximum of 3 minutes just up to the wrist. They were informed that if the pain became intolerable, they could remove their hand from the cold water. Immediately following the removal of their hand from the cold water, the participants dried their hand. Other than the pain induction stimuli (cold water versus warm water), all of the procedures were the same for the participants in the experimental and control conditions. The experimenter was present in the laboratory during the experimental sessions. Upon the completion of the experiment, the participants were given a questionnaire in which they were asked to indicate whether they liked or disliked the experiment. By providing this questionnaire, we aimed to ensure that all of the participants were well after undergoing the cold pressor test. The total duration of the experiment was approximately 40 minutes for each participant. The study procedure received ethical approval from the Department of Neuroscience, Psychology and Behaviour's Ethics Committee, with the code of 9035-jm148, at the University of Leicester, and this ethics covered multiple experiments in this thesis.

Data Analysis

In this study, the box plots were used to determine outliers, as can be either extremely low or high scores. The box plots indicated that there were no outliers within the dataset. Skewness and kurtosis values were used to check the normality distribution of the scores for resilience, anxiety, skin conductance and heart rate. According to Curran, West and Finch (1996), if the skewness and kurtosis scores are between -2 and +2, it can be concluded that the data is normally distributed. The skewness and kurtosis scores found here showed that the score distributions for each variable was normal. Thus, parametric tests were used for the analysis. An independent sample *t*-test was used to identify the differences between the experimental and control conditions. Several repeated measure mixed ANOVA were used to determine the difference witnessed in the levels of state anxiety, skin conductance and heart rate between the conditions. Pearson product-moment correlation was carried out to explore the correlation values of all interested variables. A hierarchical regression analysis was used to examine the effect of resilience on skin conductance responses and heart rate. All of the statistical analyses were carried out using SPSS Version 24 for Windows. The significance level was set at $p < 0.05$. This study was conducted with a relatively small sample size as G*Power recommended a required sample size of 109, with an alpha level of p=.05, medium effect of .30, and a power of .90 for correlation analysis.

Results

Randomisation Check

The trait-anxiety scores obtained before the administering of the cold pressor test were used to identify whether participants were randomly allocated to the experimental or control conditions. An independent sample *t*-test was conducted to compare the trait anxiety scores for the experimental and control conditions. Table 16 presents the mean and standard deviation values before and during the cold pressor test between the experimental and control conditions. As seen from Table 16, there were no statistically-significant differences in the trait anxiety scores between the experimental and control conditions (M = 41.72 versus M = 40.10); t (43) = 0.66, p = 0.52. This result means that the participants were randomly allocated into the groups.

Table 15. Trait anxiety scores between the experimental and control conditions

	Conditions	N	Mean	SD	t	df	*p*
Trait anxiety	Experimental	25	41.72	7.72	0.66	43	0.52
	Control	20	40.1	8.81			

Manipulation Check

The mean and standard deviation were estimated for each participant before and after the cold pressor test via the use of the State Anxiety Inventory, skin conductance responses and heart rate measurements. Firstly, a 2 (pre-test versus during-test) x 2 (experiment versus condition) Mixed ANOVA was used to determine whether there was a significant difference between the pre-test and during-test scores as to state anxiety for the experimental and control conditions. The results showed a significant main effect of the conditions on the anxiety scores measured, F (1, 43) = 4.45, p < .05, η_p^2 = .09. The experimental condition (M = 34.01) witnessed higher anxiety scores than the control condition (M = 29.75). This analysis also revealed a significant interaction effect, F (1, 43) = 11.19, p < .01, η_p^2 = .21. Here, the experimental condition participants demonstrated greater scores than the control condition participants during the cold pressor test (35.04 vs. 27.65, p < .01) (see Figure 4).

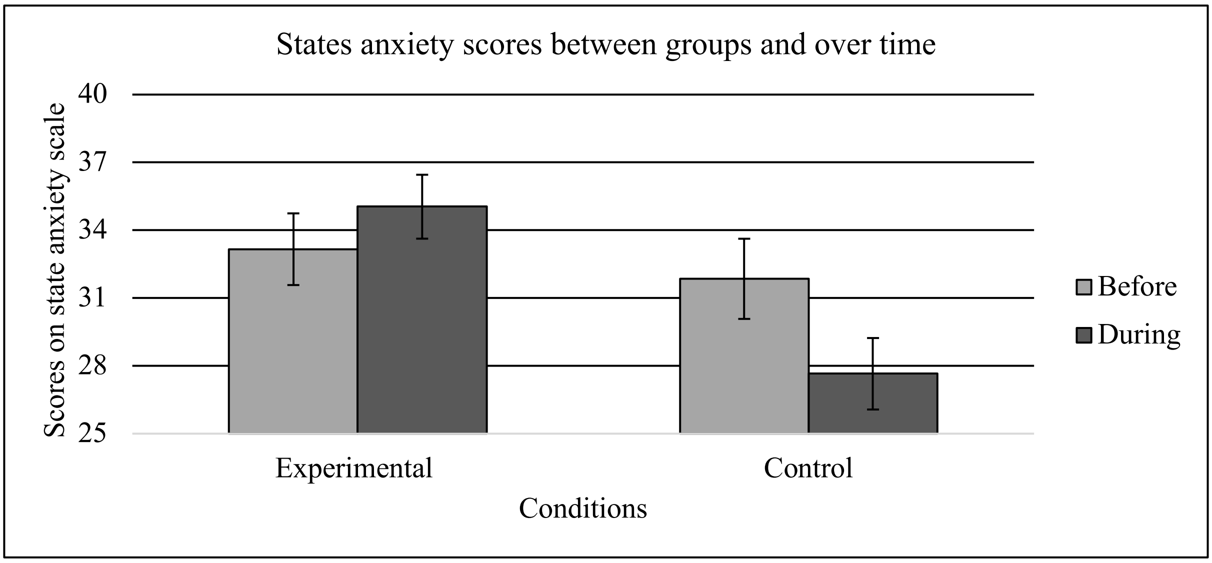
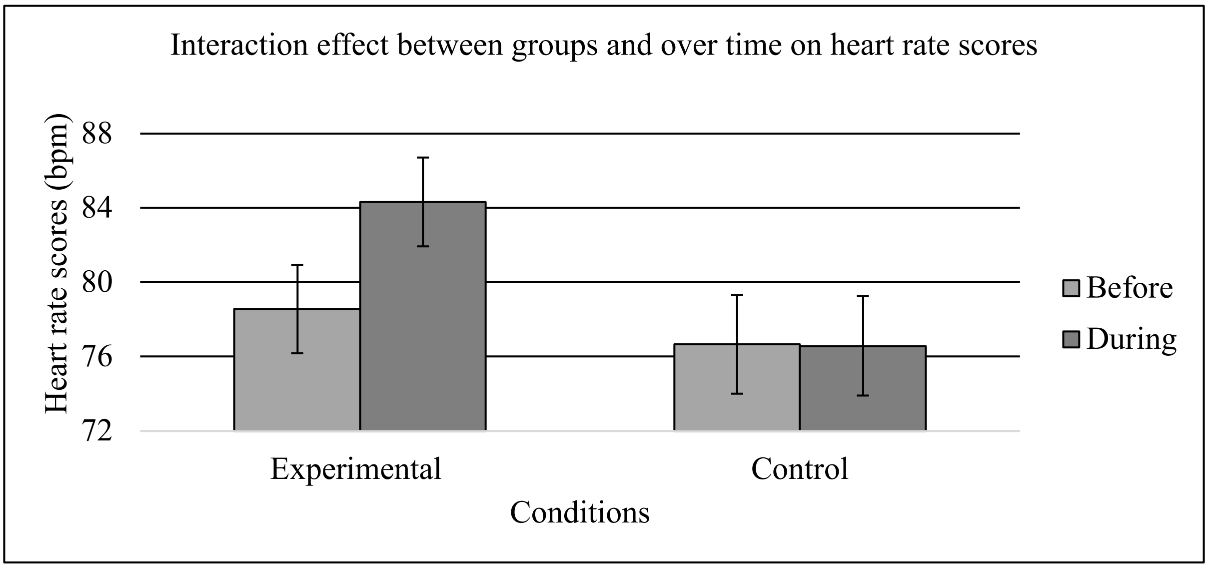


Figure 2. State Anxiety Scores between the Experimental and Control Groups - Before and During the Cold Pressor Test.

Secondly, a 2 (pre-test versus during-test) x 2 (experiment versus condition) Mixed ANOVA was used to compare the mean heart rate scores measured before and during the cold pressor test between the experimental and control conditions. As Figure 5 shows, the results indicated that there was a significant main effect of time on heart rate, F (1, 43) = 31.38, p < .001, η_p^2 = .42. It is clear that the mean heart rate scores measured during the cold pressor test were significantly greater than the mean heart rate scores measured before the test for the experimental condition. The analysis also indicated a significant interaction effect between time and conditions, F (1, 43) = 33.64, $p < .001$, $\eta_p^2 = .44$. Pairwise comparisons have revealed that the heart rate levels measured were significantly higher for the participants in the experimental condition during the cold pressor test than for the participants in the control



condition (84.32 vs. 76.58 bpm, $p < .05$).

Figure 3. Interaction Effects of Heart Rate Scores Between the Experimental and Control Groups - Before and During the Cold Pressor Test.

Thirdly, a 2 (pre-test versus during-test) x 2 (experiment versus condition) Mixed ANOVA was used to compare the mean skin conductance scores measured before and during the cold pressor test between the experimental and control conditions. As Figure 6 shows, the results indicated that there was a significant main effect of conditions on the skin conductance level measured, F (1, 43) = 7.71, $p < .001$, $\eta_p^2 = .15$. That is, the skin conductance level measured was higher in the experimental group than in the control group, (1.46 versus 1.04µS). The analysis has also revealed a significant interaction effect between time and conditions, F (1, 43) = 7.23, $p < .05$, $\eta_p^2 = .14$. Pairwise comparisons have shown that the skin conductance levels were significantly higher for the participants in the experimental condition during the cold pressor test than for the participants in the control condition (1.53 vs. 1.02 µS, $p < .05$).

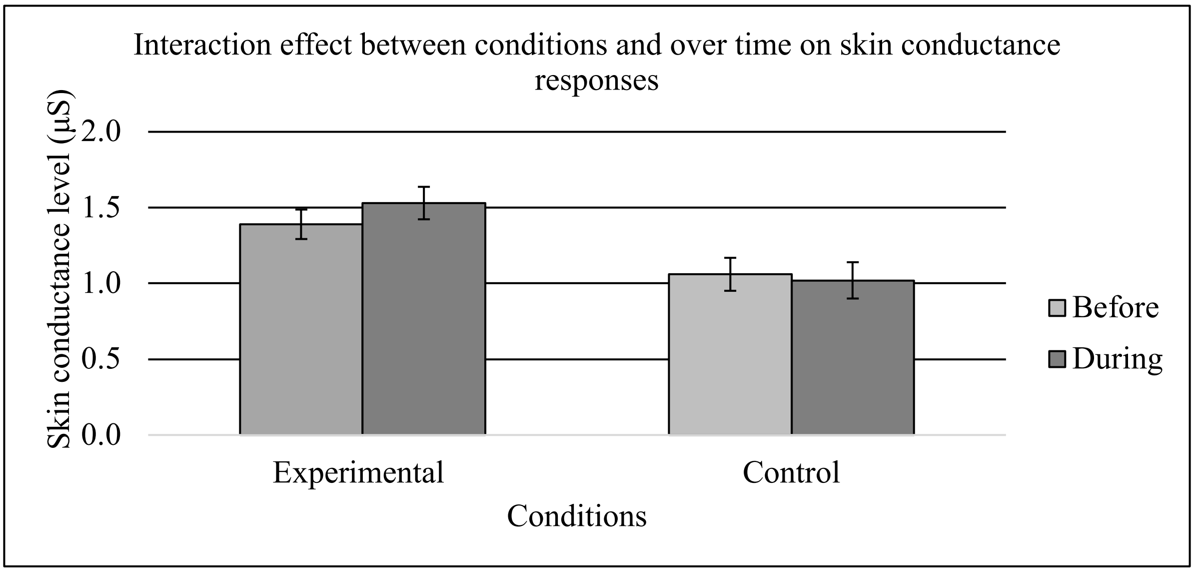


Figure 4. Interaction Effects of Skin Conductance Responses Between the Experimental and Control Groups – Before and During the Cold Pressor Test.

The Effect of Resilience on Physiological Changes

Table 17 summaries the correlations found between the dimensions of resilience as measured before the administration of the cold pressor test and the heart rate and skin conductance responses measured before and during the cold pressor test alongside the anxiety measured before and after the cold pressor test. In highlighting salient correlations, engineering resilience is seen to have significant negative correlations with the state anxiety scores both before and after the cold pressor test. Engineering resilience has also been found to have a significant positive correlation with skin conductance responses during the cold pressor test. In addition, ecological resilience is witnessed to have a significant negative correlation with the state anxiety scores measured before the cold pressor test. From Table 17, it can be seen that although the correlations between some of the resilience dimensions, physiological responses and state anxiety were in line with what was expected, they did not reach the significant probability level of 0.05.

Table 16. Correlation between dimensions of resilience and heart rate, SCR, and anxiety

	1	2	3	4	5	6	7	8	9
Before									
1. Engineering	1								
2. Ecological	.31*	1							
3. Adaptive	0.24	0.11	1						
4. Heart rate	0.04	-0.14	0.02	1					
5. SCR	0.28	-0.18	0.22	0.24	1				
6. Anxiety	-.44**	-.34*	-0.17	0.12	-0.12	1			
During									
7. Heart rate	0.04	-0.14	0.01	.93**	.37*	0.08	1		
8. SCR	.30*	-0.17	0.07	0.25	.92**	-0.05	.42**	1	
9. Anxiety	-.50**	-0.19	-0.22	-0.03	-0.11	.64**	0.04	0.01	1

*. $p < 0.05$; **. $p < 0.01$

From the correlational analysis undertaken, engineering resilience was found to be positively correlated with skin conductance responses and negatively correlated with state anxiety scores. Since linear relationships were established between the above-mentioned variables, hierarchical regression analyses were performed to examine whether engineering resilience relates to the skin conductance responses and state anxiety scores obtained during the cold pressor test. Two two-step regression analyses were performed here. Firstly, a hierarchical regression analysis was conducted to assess engineering resilience in predicting the skin conductance responses obtained during the cold pressor test after controlling for skin conductance scores obtained before the cold pressor test. With regards to the assumptions of regression analysis, no violation regarding distribution of the data was observed as it was approximately normally distributed. Multicollinearity issues among independent variables were explored using standard linear regression. No multicollinearity issue in the data set was observed as variance inflation factor was not greater than 10 and tolerance factor did not approach zero (Tabachnick & Fidell, 2001). In the first step, it was found that the skin conductance obtained before the cold pressor test was positively associated with the skin conductance obtained during the cold pressor test, F [1,44] = 240.01, r = .92, r^2 = .85, adj r^2 = .85, p < .001. However, in the second step, engineering resilience failed to predict skin conductance responses, F [2, 44] = 118.53, r = .92, r^2 = .85, adj r^2 = .84, p > .001.

Table 17. The results of hierarchical regression analysis

	B	Beta	t	*p*
Skin conductance responses				
Step 1				
SCR before	1.06	0.92	15.49	**0.00**
Step 2				
SCR before	1.05	0.91	14.58	**0.00**
Engineering resilience	0.01	0.04	0.63	0.53
Anxiety				
Step 1				
Anxiety before	0.64	0.64	5.4	**0.00**
Step 2				
Anxiety before	0.52	0.52	4.13	**0.00**
Engineering resilience	-1.00	-0.27	-2.13	**0.04**

Further hierarchical regression analysis was conducted to assess engineering resilience in predicting the state anxiety scores obtained after the cold pressor test after controlling for its associated values obtained before the cold pressor test. The results showed that, in the first step, as expected, it was found that state anxiety was positively associated with the state anxiety scores obtained after the cold pressor test, F [1,44] = 29.38, r = .64, r^2 = .41, adj r^2 = .39, p < .001. The inclusion of engineering resilience in the second step resulted in a significant change in predicting anxiety, F [2, 44] = 18.15, r = .68, r^2 = .46, adj r^2 = .44, p < .05. This result suggests that engineering resilience accounted for the unique variance in predicting anxiety after controlling for its corresponding scores obtained before the cold pressor test. Thus, higher engineering was associated with lower anxiety. The results of the regression analysis for engineering resilience are presented in Table 18.

Discussion

The aim of this study was to investigate the extent to which resilience was related with physiological changes occurring in the heart rate and skin conductance responses of the participants, alongside the anxiety levels of such individuals whereupon the CPT was performed. Upon comparing the mean of the amplitude of the skin conductance responses, heart rate and state anxiety scores of the participants before and during or after the cold pressor test, it was evident that the mean pre-scores of the variables were less than the mean during or after scores. These results indicate that the sympathetic system of each participant was activated during the cold pressor test in the studied sample. In other words, the cold pressor test (as a stressor) had an effect on the physical and psychological changes witnessed among the participants. These findings are in line with the previous findings whereby the CPT has been found to be an important stress in eliciting acute pain and when the effect of stress induced by the CPT and its relationship with psychological and physiological factors was examined both in healthy versus unhealthy individuals and children versus adults samples (e.g., Salvia *et al.,* 2012; Von Baeyer *et al.,* 2005). For example, in a study conducted by Snyder *et al.* (2005), the cold pressor test was found to have a significant effect upon the levels of hope possessed by individuals. In another study, Hanssen *et al.* (2013) found that the CPT was associated with optimism. With regard to the relationship between the induction of CPT and physiological and psychological changes, Yildirim (2019) found that the CPT was an effective method to induce physiological changes in one's body such as changes in the heart rate and skin conductance responses as well as changes in the anxiety scores. Resilience was found to be related with adaptive pain functioning through the induction of CPT that caused pain-related physiological activity (Hossain, Robinson, Fillingim & Bartley, 2018).

An important finding of this study was that engineering resilience was significantly related with the skin conductance responses measured during the CPT. Those who possess high levels of engineering resilience showed a significant increase in sweat gland activity as a result of the CPT. The present findings show similarities with the previous research as to the CPT and its relevant constructs (Friborg *et al.*, 2006; Hanssen *et al.,* 2013). A significant negative correlation was also obtained between engineering resilience and state anxiety. Individuals who possess high levels of engineering resilience thus tend to experience less anxiety after the induction of acute pain. where the engineering resilience is the most important psychological resource when the disturbances related to a system that needs speed and ease of the system to recover to a stable equilibrium. and in this study resilient persons which has highe level of engineering resilience tend to recovery in speed from the stress that elicited by cold pressor test , this result is in line with previous research which has asserted that higher levels of positive emotions and mood being possessed contributes to lower pain being encountered and to effective recovery from pain being possible (e.g., Zautra, Smith, Affleck & Tennen, 2001).

Although a significant difference was found between the experimental and control conditions in terms of heart rate changes occurring during the CPT, the present study found no evidence to support the assumption that ecological and adaptive capacity are significantly related with heart rate changes witnessed during the cold pressor test. A possible explanation for this non-significant difference may relate to the fact that each component of EEA resilience being necessary for specific situations or contexts; despite them being included in the same model of EEA resilience. Ecological resilience, which refers to the ability of the resilient system to absorb or prevent disturbance over time and maintain goals, may not be applicable to experiment. That is, descriptions of ecological resilience focus of goals and routes to goals (Maltby et al. 2015). Therefore, though a cold pressor test demands one persists in a task, it may not be a good test of a task-orientated resilience over time which requires higher levels cognitive functions such as planning and implementation of those plans. Also, adaptive capacity, which refers to the ability to incorporate new processes and adapt to change (Maltby et al., 2015), may not be relevant to the cold pressor task because the task, albeit new to most people, does not require people to change, rather than persist with the task. Therefore, the correlates of each component of resilience may be different. Furthermore, the results indicated that engineering resilience explained the unique variance in predicting anxiety. From this result, it can be concluded that individuals who possess high levels of engineering resilience would be characterised as persons who are less likely to experience anxiety when compared to their counterparts after encountering stressors. Future studies may find that individuals with higher levels of engineering resilience may be better able to cope with the physical stressors of life.

The results of this study are meaningful in terms of the findings providing an extended and expandable understanding as to the relationship between resilience and the physiological changes in the body and anxiety levels invoked in response to external stressors. These results suggest that engineering resilience is correlate of emotional reaction measuring with SCR, using cold Pressor Test that is being plausible. because Engineering resilience refers to a person's ability to recover quickly or easily following a disturbance. Also, it refers to the ability and capability of an individual to return to equilibrium following any disturbance as quickly as possible. and this plays significant effect on the level of anxiety and stress.

The findings of the current study may also be significant for health professionals when dealing with individuals experiencing stressful situations. According to Goubert and

Trompetter (2017), resilience is the ability to heal and to maintain the living of a fulfilling life in the presence of pain. Identifying how resilience is related to stressors, particularly cold pressor stressors, suggests how effective a person may respond to or recover from a stressful event (particularly physical stressors – such as cold-induced stress). This provides insight into potential areas for clinical research. Increasing resilience, as seems to be an important construct in arousal, requires a focus to given to the association between resilience and arousal. Furthermore, cultivating resilience, particularly engineering resilience, may be important in the context of pain – particularly when seeking to prevent and treat pain-specific problems.

We recognise some of the limitations of this study. Firstly, the sample of this study was relatively small and this thus restricts the generalisability of the data (see method section). It is not evident how well the present findings would be generalisable to other sample groups or cultures. Thus, future research should seek to replicate these results with a wider sample (e.g., a clinical group) with a larger number of participants. Secondly, although the study relies on both physiological (skin conductance and heart rate) and self-reported (anxiety scale) measures that are targeted to determine the changes which emerge via the autonomic nervous system during the cold pressor test, it is limited in determining all of the changes emerging in the autonomic nervous system. Other measures (e.g., blood pressor) can be used to understand the changes which occur in relation to the autonomic nervous system during the cold pressor test. It would also be useful to apply measures (e.g., EEG) that can detect changes in the brain during the cold pressor test. It would be also be important to recognise the problems with self-report measures (e.g., response bias and social desirability) and try to address the biases as to the self-report measures. Subsequent research can thereby comprise design studies in which both physiological and psychological measures are used to understand the impact of cold pressor stimulus via physiological changes. Finally, this study has focused on the EEA model of resilience and its relationship with physiological changes as occur in the autonomic nervous system due to the application of the cold pressor test. However, other models of resilience should be examined to completely understand how resilience links to the physiological changes that occur in the human body.

In conclusion, the present study has found that the cold pressor test was an effective method through which to induce pain in an attempt to invoke physiological changes via the heart rate, skin conductance and anxiety levels of the participants. Engineering resilience was found to be related to skin conductance responses and anxiety and was identified as being a unique predictor of anxiety.

Chapter 7

General Discussion

The current thesis has examined an ecological systems model of trait resilience as presented by Maltby *et al.* (2015). The overall aims of this thesis were twofold: (I) to examine psychological trait resilience within the context of emotional regulation and (ii) to identify how psychological trait resilience is associated with health-related quality of life variables after controlling for health-specific self-efficacy. The thesis has specifically used experimental approaches by employing the trauma analogue paradigm through which to explore psychological trait resilience and its relationship with emotional regulation. This has been achieved through the administration of various affectively-loaded stimuli that has included pictures, sounds and video. In using self-report questionnaires, the contribution of psychological trait resilience to health-related quality of life variables after controlling for health-specific self-efficacy has also been examined. In this regard, five empirical studies have been reported from Chapter 2 to Chapter 6. Prior to these chapters, a systematic literature review chapter that provided theoretical and empirical evidence concerning different aspects of resilience was presented. Although each of these empirical studies employed a similar procedure, resilience and its relationship with the target variables have been addressed differently each time. In this final chapter, we summarise the findings of each study reported in this thesis. We also highlight the implications of the findings in respect of both theory and practice. In addition to this, we acknowledged some of the general limitations pertaining to the studies undertaken. Finally, future directions and recommendations for subsequent studies are presented. This is followed by a conclusion section.

Summary of Findings

Chapter 2. Resilience and Health-Related Quality of Life and Health-Specific Self-Efficacy

This chapter set out to provide evidence in regards to the relationships that arise between the newly presented model of EEA resilience (Maltby *et al.*, 2015), health-related quality of life and health-specific self-efficacy. Since resilience is an important correlate and predictor of health-related quality of life for individuals in their positive functioning, it could be useful to establish the link between the components of EEA resilience and health-related quality of life. As previous research has shown a relationship between health-related quality of life and health-specific self-efficacy (e.g., Schwarzer & Renner, 2009), it could be helpful to offer empirical evidence as to the predictive role of resilience in contributing to health-related quality of life after removing the effect of health-specific self-efficacy. This would allow us to have a clear understanding towards EEA resilience being uniquely important for health-related quality of life beyond the effect of health-specific self-efficacy. As the EEA resilience model was established within the context of the UK, and largely by using student samples, offering evidence as to the usefulness of this model of resilience from another country (e.g., the USA) and a different sample (i.e., the general public) could strengthen the empirical position of this model. Thus, in the study presented in Chapter Two, we collected data from the general public of the USA. The results gained generally showed that all domains of EEA resilience were found to be positively correlated with some of the components of health-specific self-efficacy (e.g., nutrition efficacy and physical exercise efficacy). That is to say, those who possess high levels of engineering, ecological and adaptive capacity are more likely to demonstrate higher levels of health-specific self-efficacy (such as in relation to nutrition and physical self-efficacy). When it comes to health-related quality of life, other than adaptive capacity, it has been found that engineering and ecological resilience shared a negative correlation with all of the domains of health-related quality of life. The strength of the correlations ranged between -.16 and -.58. That is, individuals who possess higher levels of resilience are less likely to suffer from issues related to physical and psychological health (such as mobility, self-care, usual activities, pain discomfort and anxiety/depression). To obtain further information beyond this simple linear correlation, we performed both standard multiple regression (whereby the direct effect of resilience on health-related quality of life was investigated) and hierarchical multiple regression (whereby the predictive role of resilience on health-related quality of life beyond the effect of health-specific self-efficacy was examined). Here the results showed that the possession of a higher degree of engineering resilience directly predicted less problems with physical and psychological health (such as mobility, self-care, usual activities, pain discomfort and anxiety/depression). The results also revealed that engineering resilience predicted some of the physical health and psychological health quality of life components (e.g., mobility, self-care, usual activities and anxiety/depression) beyond the effect of health-specific self-efficacy. These results collectively suggest that EEA psychological trait resilience, particularly in regards to engineering resilience, is uniquely important in predicting and predicating health-related quality of life after removing the effect of health-specific self-efficacy. These results are important in terms of understanding the model of EEA resilience and its relationship network with health-related outcomes. However, it is important to note that the results presented here should be approached with caution, namely as we collected data using a self-report survey as may carry some participant-related bias (e.g., the exaggerating of responses) and as it is only limited to the general public of the USA.

Chapter 3. The Relationship between Resilience and Affective Picture Stimuli

This empirical study was carried out in order to understand the relationship between the components of the trait resilience system of the EEA model and affective picture stimuli via the use of an exploratory experimental research design. The reason for selecting picture stimuli in this design is that such content has been found to be effective in eliciting different short-lived emotions. In general, the findings indicated that there is no evidence as to the components of psychological trait resilience (engineering, ecological, adaptive) being related to affective positive and negative stimuli. That is, it is difficult to conclude that those who hold abilities as to engineering, ecological and adaptive capacity react differently to emotionally-loading positive and negative picture stimuli. There may be a different justification for this non-significant result. One of the salient justifications available for these results can pertain to the size of the sample used in this experiment. Here, the sample size was relatively small and mainly comprised of university students. Thus, it is possible that a statistically-significant result was not able to be found between resilience and affective picture stimuli due to the small size of the sample. It is worthwhile to note that the picture stimuli used in this particular experiment were found to be effective in invoking changes in the physiological reactions of individuals. The effect of this varied in magnitude between small and large. Furthermore, the selected positive and negative picture stimuli corresponded to the valance measure in regards to what they intended to measure, with this being demonstrated due to it exceeding the associated scale midpoint. Alongside this, the positive picture stimuli were found to be approached while the negative picture stimuli were found to be aversive. Hence, it can be concluded that although the manipulation of the experiment was successful, the experiment failed to produce evidence as to the link between the EEA model of resilience and the arousal elicited through the use of picture stimuli.

In the existing literature, there is evidence that emotional events which elicit SCR differ in the levels of arousal invoked but the valance does not vary (Yang & Liu, 2014). However, we provided results which seems to somewhat contradict previous research by showing that affective picture stimuli can vary based on valance but not arousal. This result can be explained in light of the content of the stimuli used in this study. Although the content of the stimuli employed in this study was clear enough to suggest whether each picture could be easily segregated in terms of valance, they could not have been considered strong enough to elicit arousal or they might have been seen previously by the participants (and thus they might have been familiar with these images). In returning to the effect sizes of the picture stimuli, these were typically small. This suggests that there is possibility for dynamic stimuli (e.g., video) to invoke more significant changes in the physiological reactions of individuals (e.g., skin conductance, heart rate) when compared to statistic stimuli (e.g., pictures) (Detenber, Simons & Bennett, 1998). In the literature, there is evidence which suggests that dynamic stimuli may be more physiologically arousing than statistic stimuli due to the predisposition of humans in being inclined to act towards dynamic stimuli (as may have the potential to require immediate action) than towards stationary or static stimuli (Courtney *et al.,* 2010).

Chapter 4. The Relationship between Resilience and Affective Video and Sound Stimuli

This study was built upon the evidence provided in Study 2 (Chapter 3) whereby picture stimuli were used in eliciting emotional arousal and to understand its relationship with resilience. In this study, we expanded the array of stimuli employed, namely by including dynamic stimuli rather than static stimuli, and examined how the dimensions of the EEA model of resilience are related with the emotional responses invoked when encountering dynamic stimuli. This time, we used video and sound stimuli as they are considered to have a greater effect upon the emotional responses of individuals than picture stimuli. Overall, the results of this study demonstrated that all of the domains of EEA resilience are significantly related with the physiological changes which occur in the skin of individuals. This indication was measured through changes in the skin conductance responses of the participants. These results suggest that people who possess high levels of resilience ability (e.g. engineering, ecological and adaptive ability) would significantly react to external stimuli that have a dynamic nature (such as auditory and visual stimuli). Adverse conditions can be observed from people with low levels of resilience ability in them being less aroused towards auditory and visual stimuli. In linking this with the extant literature, these findings are in accordance with the findings of Philippe, Lecours and Beaulieu-Pelletier (2009) as found that resilience is significantly related to emotional arousal.

The validation of these results can be verified via the approach that we adapted when conducting the experiment. The stimuli that we used in this study were assessed in terms of arousal, valance and dominance with the intention of showing the effectiveness of the target stimuli and their relationships with resilience. The results in this regard were in the expected direction by showing that auditory and visual stimuli were rated as being highly arousing and as strongly invoking avoidance, while it has been shown that this is what they intended to measure in terms of valance. The effectiveness of the stimuli was confirmed via the subtraction of the mean values of skin conductance from the associated mean values recorded at the baseline point. Here, the results show that the target stimuli were significantly effective in causing arousal and physiological changes in the body with a medium effect size. These findings are important and consistent with previous results whereby auditory and visual stimuli were found to elicit strong arousal, feelings and emotional experiences among individuals (Hanser & Mark, 2013; Soares *et al.*, 2013).

Chapter 5. The Association between Resilience and Emotional Responses Using Heart Rate as a Marker of Emotional Reaction

In this study, the aim was to verify some of the findings obtained from our previous studies (e.g. the study reported in Chapter 4) by using a different robust biomarker and to identify its relationship with engineering, ecological and adaptive capacity. As an indication biomarker, we particularly focused on changes in the cardiovascular system of individuals by measuring changes in their heart rate. As a stimulus, we only administered the affectively-loaded positive and negative video stimuli as presented in Chapter 4. This is because such content was shown to be very powerful in eliciting emotional responses. In accordance with our aim, the overall results indicate that all of the domains of psychological trait resilience generally manifested significant relationships with the emotional responses measured (i.e., the changes in heart rate). This suggests that individuals with high levels of psychological trait resilience – as includes engineering, ecological and adaptive capacity, have higher rates of heart variability. That is, they tend to experience more arousal towards encountering emotionally-loaded visual positive and negative stimuli. These results provide meaningful support in relation to our expectations and to previous findings.

As previously established, the video stimuli employed played an effective role in causing such changes. In using heart rate as a marker of physiological activity in the body, this study successfully replicated and verified the validity of the previously-used effectively-loaded video stimuli. This provides support for the *a priori* assumption that watching affective video stimuli would be effective in leading to changes in the cardiovascular system of individuals. This also supports the validation of effectiveness of the positive and negative stimuli employed in Chapter 4.

In terms of the theoretical relevance of the results, the findings of this study are in line with the results of previous research whereby the presentation of affective stimuli within a controlled environment (e.g., a laboratory setting) was found to elicit increases in heart rate. In this respect, for instance, Medicine (2011) found that the presence of emotional stimuli activates responses towards that stimuli by increasing heart rate, the production of stress hormones, the breathing speed and vasodilation of individuals. Arousal as a result of encountering positive and negative stimuli is found to have a significant impact on the heart rate variability of an individual (Segerstrom & Nes, 2007). Positive relationships between psychological resilience and arousal were reported right after the induction of emotions (Karampas, 2016; Philippe, Lecours & Beaulieu-Pelletier, 2009). Negative stimuli (e.g., unexpected scary moments) have been found to evoke heart rate variability (Schmitz *et al.,* 2012). Greater variability in heart rate was also obtained after watching a violent movie.

These results suggest that intervention studies could consider heart rate variability as a biomarker of resilience to better understand the relationship between the two areas. Fostering resilience is important, not only in reducing the effect of stress on individuals but also in contributing adaptive coping strategies (Wu *et al.,* 2013) that can lead to better psychological functioning. Thus, researchers and practitioners could employ evidence-based assessment to understand psychological trait resilience and its biomarkers (e.g., heart rate).

Chapter 6. The Relationships Between Resilience and Physiological Changes After the Induction of the Cold Pressor Test

This experimental study was conducted to extend the correlates of psychological trait resilience by using a relatively different set of stimuli when compared to our previous studies. In this study, we aimed to induce short-lived stress by managing stress manipulation with a cold pressor test procedure. Through this procedure, we sought to understand how the EEA model of resilience is related with the physiological changes witnessed in the body following the induction of physical pain via the use of the cold pressor test procedure. This time, we were interested in changes in the skin, cardiovascular system and anxiety levels measured respectively via skin conductance responses, heart rate measurements and a self-reported anxiety scale. A repeated measure design was employed in this experiment whereby changes in the target variables were measured through comparing a baseline and during-test measurement. In regards to the general results which emerged from this study, the stress induction achieved through the cold pressor test was successfully employed by showing that the scores on the target variables (skin conductance responses, heart rate and anxiety level) measured during the test were significantly greater than the scores obtained at their associated baseline point. This suggests that the cold pressor test procedure, as a stressor, had a significant effect on the physical and psychological changes of the participants. These results confirm the findings as to the importance of the CPT in being a significant stressor in inducing acute pain, the effect of stress elicited by the CPT and the relationship that arises between the CPT and important psychological and physiological variables (e.g. Salvia *et al.,* 2012; Von Baeyer *et al.,* 2005).

The most important finding of this study was the establishment of the relationship between engineering resilience and skin conductance responses during the CPT. In other words, individuals who possess high levels of engineering resilience were found to experience a significant increase in their sweat gland activity as a result of the CPT. The present findings show similarities with the previous research undertaken as to CPT and its relevant constructs (Friborg *et al.*, 2006; Hanssen *et al.,* 2013). In the relevant literature, for example, the cold pressor test was found to have a significant effect on the levels of hope (Snyder *et al.,* 2005) and optimism (Hanssen *et al.,* 2013) held among individuals. As expected, a significant negative correlation was also obtained between engineering resilience and state anxiety. Here, individuals who possess high levels of engineering resilience tend to experience less anxiety after the induction of acute pain. This result is in line with previous research that has highlighted how higher levels of positive emotions, mood and resilience contribute to lower pain and to more effective recovery from pain (e.g., Holling, 1996; Maltby *et al.*, 2015; Zautra, Smith, Affleck & Tennen, 2001). We failed to report any evidence as to the relationship between ecological and adaptive capacity and heart rate variability during the CPT. A possible explanation for this non-significant difference pertains to the fact that each component of resilience mirrors different aspects of resilience (despite them being included in the same model of EEA resilience). Thus, the correlates of each component of resilience may be different. Furthermore, the results demonstrated that engineering resilience is a unique predictor of anxiety.

In summary, the studies detailed through Chapter 3, Chapter 4, Chapter 5 and Chapter 6 have documented the relationship between the domains of EEA resilience and physiological emotional responses. In conducting trauma analogue paradigm experiments, both positive and significant correlations have been revealed between each aspect of EEA resilience (engineering ecological and adaptive capacity) and emotional regulation via the use of various sets of stimuli (as includes, picture, sound and video content alongside the cold pressor test). The findings have also shown that components of EEA resilience are significantly associated with health-related quality of life after controlling for health-specific self-efficacy.

Overall Implications of This Thesis

This thesis was designed to explore the relationships that arise between psychological trait resilience, health-related quality of life and its incorporation with biomarkers, with these being related to the physiological responses elicited as a result of exposure to various physiological and emotional stimuli. We utilised two of the most commonly-used biomarkers within psychological research, heart rate and skin conductance response, and applied these to understand psychological trait resilience. Although literature exists which has explored resilience and its examination with various outcome variables corresponding with individual differences, the current thesis is unique and important for research and practice. To date, there has been no published empirical studies which have incorporated a complete integration of multiple levels of analysis (including biological) into the consideration given to resilient functioning. In terms of the EEA trait resilience system and health correlates, this thesis has provided information as to how different aspects of resilience systems, engineering resilience, ecological resilience and adaptive capacity are related to health-related quality of life in terms of mobility, self-care, usual activities, pain discomfort and anxiety/depression. In terms of resilience and the trauma analogue paradigm correlates, the studies have sought to measure the physiological emotional responses which comprise one of the core robust concepts of the developmental psychopathology framework. Here, distinctive documentation has been given as to the relationship between the components of resilience and the physiological emotional responses identified via both self-reporting and objective measures. This thesis thus contributes to the literature of this area by extensively evaluating the model of resilience and health-related quality of life and by incorporating biomarkers (as are related to physiological emotional responses). This has been achieved by examining the contributions of biological emotion reactions.

This thesis has established the relationships that arise between psychological trait resilience from the EEA model of resilience systems perspective, emotional regulation and health-related quality of life. Due to this being a new model of resilience, there is limited evidence which corresponds to the EEA model of resilience systems detailed in the literature. In contrast to the existing literature, the findings of this research provide empirical evidence as to the role of the EEA model of resilience systems on emotional regulation via the use of exploratory experimental research designs instead of solely using survey designs. The current thesis thus significantly contributes to the scientific knowledge held in terms of understanding the effect of EEA model of resilience on the emotional regulation and health-related quality of life of humans, namely as it evidences the physiological changes in the human body instead of only focusing on the self-reported changes as to human resiliency experience.

This thesis was built upon existing literature, primarily in regards to adapting Maltby *et al.*'s (2015, 2016) EEA model of resilience, and has shown both how the physiological changes in electro-dermal and cardiovascular activity are related with resilience and how resilience is associated with health-related quality of life. The main research contribution of this thesis pertains to establishing the applicability of EEA model of resilience systems, also known as the EEA model of resilience, within the context of emotional regulation and health-related quality of life. This is a model that recognises resilience as being a multi-dimensional model. This model clearly indicates that one's ability in coping with unpleasant life events can be categorised into three groups – ecological, engineering and adaptive capacity. This is important in terms of enhancing the theoretical and empirical grounds of the EEA model of resilience.

Another contribution of this thesis is that it acknowledges that individuals with high levels of EEA model of resilience (as includes ecological, engineering and adaptive capacity) can react not only to dynamic emotionally-loaded stimuli (such as sounds and videos) but also to static emotionally-loaded stimuli (such as pictures). This can be detected clearly and easily by observing the physiological changes in the cardiovascular systems (e.g., changes in the heart rate) and electro-dermal activities (e.g., changes in the skin conductance responses) of individuals. In addition to this, we have also documented that individuals with higher levels of EEA model of resilience tend to more effectively cope with physical stressors when undergoing the cold pressor task within the context of an experiment. The results are meaningful in terms of them providing an expandable understanding of the relationship between resilience and physiological changes in the body and the anxiety levels demonstrated towards external stressors. The findings from the current study may also be significant for health professionals when dealing with individuals experiencing stressful situations. Exploring how the EEA model of resilience is associated with physical stressors, particularly cold pressor stressors, has the potential to identify how a person can effectively cope with or recover from a stressful event in the case of a stressor being encountered. This thus sheds light onto potential areas of clinical research by showing that increments of resilience are important within the context of arousal and pain when preventing and/or treating pain-specific problems.

In considering that resilience is a vital characteristic for psychological health, physical health, well-being and health-related quality of life, this thesis makes a substantial contribution to the existing knowledge held as to the newly presented model of EEA model of resilience.

This advancement pertains to how the EEA model resilience are uniquely important in relation to health-related quality of life after excluding the effect of health-specific self-efficacy. Studies as to the relationships that arise between EEA psychological trait resilience and others psychological and physiological variables are very limited. Having established the relationship between resilience and other psychological variables, further research can be triggered which may produce systematic studies as to resilience and other possible variables via the use of different study designs (i.e., experimental or survey designs).

The establishment of some of the correlates of psychological resilience can have implications for researchers, practitioners and authorities in undertaking evidence-based assessments through which to enhance the levels of resilience held among students in attempting to promote positive human functioning. In general, the results presented in this thesis suggest the importance of resilience on emotional regulation and how it is related to physiological changes in the body. Thus, it appears that resilience is highly important for physiological arousal, emotional regulation and health. This is very useful in clinical research and practice in which researchers and professionals focus on determining the severity of different psychological disorders and their relationship with resilience. In measuring physiological and psychological arousal elicited as a result of emotionally-loaded stimuli or physical stressors, alongside measuring the levels of resilience of patients diagnosed with various clinical disorders (e.g., post-traumatic stress disorders), professionals can determine the level of disorder faced. By successfully determining the severity of a disorder, a professional would then be able to develop and implement effective treatments and interventions during the therapy sessions employed. Since the measuring of EEA trait resilience is undertaken via a multi-dimensional model, the use of this model of resilience allows practitioners to obtain in-depth information when seeking to address the psychological needs of their clients as to resilience and its relationship with health-related quality of life. For instance, individuals cope with various health-related stressful day-to-day life situations. The significant experiencing of stressful health-related problems means that individuals are likely to show an inability towards dealing with such problems. Practitioners can design and implement EEA resilience-based programmes which focus on enhancing the engineering, ecological and adaptive ability of individuals in an attempt to help such figures effectively cope with health-related quality of life problems. If this can be achieved, individuals would report more fulfilling emotions and low levels of health-related quality of life problems. To put it differently, setting up such programmes could help to boost the health-related quality of life of individuals. Thus, the application of a multi-dimensional approach of resilience towards health-related quality of life would allow practitioners to tailor systematic resilience approaches to meet the needs of the health-specific quality of life of their clients. It is also beneficial to measure the effectiveness of such intervention programmes with a multi-dimensional model of EEA resilience in order to gain an inclusive understanding of their effectiveness.

Overall Limitations of This Thesis

The limitations associated with each of the studies presented in this thesis have already been highlighted in the respective chapters. Here, we mention several general limitations which correspond to this thesis. One of the most important limitations raised here is that the studies reported in this thesis are exploratory in nature. In other words, we only explored to what extent the domains of EEA resilience are related with different variables in wider psychology. We have mainly established the correlates of the model of EEA resilience. Hence, the thesis is limited to providing evidence in terms of gaining a clear understanding as to what causes people to hold engineering, ecological and adaptive capacity abilities whereupon they encounter and then cope with stressful events or situations. From the findings presented in this thesis, it is difficult to conclude that one variable causes another variable due to the designs of the conducted studies. To understand the causal links that arise among the variables, it is necessary to address this by conducting research with experimental designs whereby the independent variable is manipulated to see its effect on the outcome variable(s).

Another general limitation of this thesis pertains to the number of variables that we dealt with throughout the studies. Given that resilience is vital for humans to function positively and effectively under stressful situations, the model of EEA resilience has been recently proposed into the existing literature. It would thus be helpful to examine the wider application of EEA resilience in different fields of psychology, with this being achievable by considering various psychological variables. Due to the nature of this thesis, we have only focused on a number of psychological variables and have solely examined their relationships with resilience. Undoubtedly, there are still many missing variables that need to be explored when expanding upon the correlates and predictors of the EEA model of resilience alongside the contribution of this model into the well-being sphere. For example, we did not examine the relationship that arises between resilience and well-being variables (e.g., subjective well-being, psychological well-being), with this being important as resilience is considered to be extremely important for positive well-being.

Another prominent limitation of this thesis is that the samples employed throughout the studies reported on mainly comprised of undergraduate or postgraduate students (with one sample being the general public of the USA) and all were from an English-speaking country (the United Kingdom and the United States). In considering their university-level student status, it can be concluded that all of the respondents were highly educated. The number of participants in each study was also relatively small. Accordingly, this will restrict the universality/generalisability of the results. To put it differently, the findings documented here cannot be generalised to other samples (i.e., groups with a low education level or non-English speakers). To address this issue, studies can be designed with more representative samples or that address different cultures. Here, samples can be gained that produce participants with various demographic backgrounds (such as in relation to age, education level and spoken language). It would also be useful to undertake studies with clinical samples, namely as resilience plays an important role for those who deal with health-related problems. However, some difficulties may be encountered in using clinical samples as this invokes more complex and time-consuming ethical approval processes and these figures may be unwilling to participate in such research. Nonetheless, future research needs to expand upon the universality of the results gained in this area.

Furthermore, resilience was purely measured with a means of self-report measure, whereupon participants are required to answer each question on a given scale which is generally highly structured. However, data obtained via self-report measures have been criticised. Collecting data via self-report measures may carry some problems. For example, social desirability is the most common problem associated with self-report measures. Using different methodology such as peer reports to assess resilience would be very helpful to obtain better results as to the relationship between resilience and other employed variables in this study.

Finally, most of the studies reported here have utilised a cross-sectional design in which data was collected from samples only once and thus we could only obtain information corresponding to the characteristics of the sample at that given time. To gain a broader understanding as to how the ability of individuals associated with resilience changes over time, we need to apply a longitudinal design framework. Such designs would be fruitful in terms of establishing whether the findings can offer causal or directional inferences.

Future Research Directions

This thesis has shed light on a number of important aspects of the EEA model of trait resilience as presented by Maltby *et al.* (2015). However, there is still a great deal of scope that future research must take into consideration. Here, we have only summarised a few suggestions. In this section, further suggestions for future research are considered. Considering that individuals vary strongly in terms of their levels of resilience, an in-depth examination of EEA psychological trait resilience across different groups of people may help provide a better understanding of the correlates and predictors of EEA models of resilience among individuals with different age groups. More fine-grained analyses focusing on the differences among individuals as to their levels of EEA resilience will be important in future studies. Expanding research as to the EEA model of resilience will have important theoretical and practical implications.

Most studies to date have examined EEA resilience in Western countries (e.g., in the United Kingdom). It will be important for subsequent research to consider the extent to which the EEA model of psychological trait resilience is universal. Indeed, a recent investigation recruited samples from Japan, Portugal and the US and indicated that there is great universality in the EEA trait resilience scale among individuals with different age groups across different countries (Maltby, Day, Żemojtel-Piotrowska, Piotrowski, Hitokoto, Baran & Flowe, 2016). However, providing further evidence as to the application of the EEA model of resilience and its relationship with physiological and emotional responses as well as health-related quality of life in different cultures (e.g., Eastern and Asian cultures) would strengthen both the theoretical and empirical underpinnings of this model.

Another important area for future study pertains to the role of other variables (e.g., self-esteem, optimism, hope and coping strategies) in the relationship that arises between psychological trait resilience and health-related quality of life. As engineering and ecological components of EEA resilience have a significant relationship with almost all of the health-related quality of life dimensions, it is important for those who study resilience and health-related quality of life to pay closer attention to the role of other psychological factors that may affect that relationship. Exploring the role of a third factor (such as self-esteem, optimism, hope and coping strategies) will further inform our overall understanding of the resilience process. It is also important to give closer attention to the role of third factors in the relationship that arise between resilience and health-specific self-efficacy as they have been found to be significantly related to each other.

Conclusion

This thesis has aimed at examining the application of EEA model of trait resilience within the context of emotional regulation and health-related outcomes. In this regard, five empirical studies (four experimental studies and one survey) have been reported in this thesis, all of which have tested the EEA model of resilience in different contexts. By using a survey design and in collecting data from the USA, Chapter 2 indicated that the components of EEA psychological trait resilience predict health-related quality of life after removing the effect of health-specific self-efficacy. The following chapters examined the EEA model of resilience within laboratory settings. Chapter 3 examined the relationship between psychological trait resilience and physiological changes in the skin as elicited by static picture stimuli and as measured by skin conductance responses. This study failed to produce evidence corresponding to the relationship between resilience and skin conductance responses as derived from picture stimuli. Chapter 4 expanded the sets of stimuli employed and used both auditory and visual dynamic stimuli with an intent to investigate the relationship that arises between resilience and skin conductance responses. This study provided significant evidence through which to support the positive relationship that arises between psychological trait resilience and emotional arousal as derived from emotionally-loaded positive and negative auditory and visual stimuli. Chapter 5 used only video stimuli due to its robustness in eliciting arousal and added heart rate as a biomarker alongside skin conductance responses. This study found that resilience is significantly related with changes in the cardiovascular system and skin conductance responses of individuals. Chapter 6 used a relatively different stimulus, the cold pressor test, and employed both physiological (heart rate, skin conductance) and subjective (self-reported anxiety scale) measures as indicators of arousal.

This study presented the significant relationships that arise between the components of resilience and the changes witnessed in the physiological and psychological arousal of individuals. In general, the findings suggest that the recently introduced EEA model of resilience, as is also known as EEA resilience, can be examined within the context of emotional regulation, arousal and health-related quality of life. The findings are very useful in terms of supporting the theory that the EEA model of resilience is related both to physiological changes in the cardiovascular system and electro-dermal activity of individuals and to health-related quality of life.

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Appendix:

Figure 5. A List of the Affective Picture Stimuli Used to Elicit Arousal in This Study

Positive picture stimuli

172-Peacock 186-Dolphin 252-Women 026- Zoo 178-Beach

242-Women-Man 088-Window 272-Sculpture 254-Handwork 190-Diver

Negative picture stimuli

146-Sick man 287-Football plyer 007-Waste 022-Burring house 285-Crashed Motorcycle

121-Toilet 1 125-Toilet 2 009-Car accident 019-Broken leg 058-Butcher

Figure 2 presents a list of the positive and negative pictures drawn from the NAPS to elicit the targeted emotion. In the list, there are 10 positive and 10 negative pictures.

Figure 3. Screenshot of Video Stimuli Used in This Study

The Stimuli Rating Scale. This scale is widely used in rating stimuli within experimental settings. A sample item on the scale is presented as follows.

The Valence Scale

Please circle the number that reflex your emotion toward each Video.

Video No.	Sentences										
1	**“ You are judging this video as ...”**										
	very negative	1	2	3	4	5	6	7	8	9	very positive
	“ My reaction to this video is ...”										
	to approach	1	2	3	4	5	6	7	8	9	to avoid
	“Confronted with this video, you are feeling: …”										
	relaxed	1	2	3	4	5	6	7	8	9	aroused

Video No.	Sentences										
2	**“ You are judging this video as ...”**										
	very negative	1	2	3	4	5	6	7	8	9	very positive
	“ My reaction to this video is ...”										
	to approach	1	2	3	4	5	6	7	8	9	to avoid
	“Confronted with this video, you are feeling: …”										
	relaxed	1	2	3	4	5	6	7	8	9	aroused

Video No.	Sentences										
3	**“ You are judging this video as ...”**										
	very negative	1	2	3	4	5	6	7	8	9	very positive
	“ My reaction to this video is ...”										
	to approach	1	2	3	4	5	6	7	8	9	to avoid
	“Confronted with this video, you are feeling: …”										
	relaxed	1	2	3	4	5	6	7	8	9	aroused

Video No.	Sentences										
4	**“ You are judging this video as ...”**										
	very negative	1	2	3	4	5	6	7	8	9	very positive
	“ My reaction to this video is ...”										
	to approach	1	2	3	4	5	6	7	8	9	to avoid
	“Confronted with this video, you are feeling: …”										
	relaxed	1	2	3	4	5	6	7	8	9	aroused

Participant Consent Form

BACKGROUND INFORMATION
Title: Relationships between resilience and emotional reactivity study.
Researchers: Zainab Alanazi, Dr. John Maltby, Dr. Elizabeth Maratos
Purpose of data collection: PhD Project

Details of Participation: You are invited to take part in a study that we are conducting as part of a PhD research study in Psychology at the University of Leicester. The aim is to understand the relationship between resilience and health in terms of emotional reactivity. You will complete a measure regards self-reported measures of; (EEA) trait resilience scale (Maltby Day & Hall, 2015, 12 items). And second is measure of emotional reactivity by skin conductance response (SCR) and heart rate (HR) with NeuroLog galvanic skin response logger sensor during viewing 10 video-clips and pictures.

The whole survey will take within one hour.

CONSENT STATEMENT

1. I understand that my participation is voluntary and that I may withdraw from the research at any time without giving any reason.
2. I am aware of what my participation will involve.
3. My data are to be held confidentially and only Chatwiboon Peijsel, Dr. John Maltby, and Dr. Elizabeth Maratos will have access to them.
4. My data will be kept in a locked space for a period of at least five years after the appearance of any associated publications. Any aggregate data (e.g. spreadsheets) will be kept in electronic form for up to five years after which time they will be deleted in accordance with University of Leicester waste management policy.
5. This consent forms will be kept in a separate locked filing cabinet for a period of at least five years after the appearance of any associated publications, after which time they will be deleted in accordance with University of Leicester waste management policy.
6. In accordance with the requirements of some scientific journals and organisations, my coded data may be shared with other competent researchers. My coded data may also be used in other related studies. My name and other identifying details will not be shared with anyone.
7. The overall findings may be submitted for publication in a scientific journal, or presented at scientific conferences.
8. I will be able to obtain general information about the results of this research by giving the researcher my email address now.

This study will take approximately within one hour to complete.

I am giving my consent for data to be used for the outlined purposes of the present study

All questions that I have about the research have been satisfactorily answered.

I agree to participate.
Participant's signature: ___________________________________
Participant's name (please print): ___________________________________
Date: __________

If you would like to receive a summary of the results by e-mail,
when this is available, please provide your email address: _______________________

Participant Consent Form

BACKGROUND INFORMATION
Title: Individual Differences, Affect and Cognitive Learning in relation to reactions to the Pleasant and Unpleasant Visual Stimuli.:
Name of Researcher: Zainab Alanai, Murat Yildirim,
Supervised by Dr. John Maltby, Dr. Elizabeth Maratos
Purpose of data collection: PhD Project

Details of Participation: You are invited to take part in a study that we are conducting as part of a PhD research study in Psychology at the University of Leicester. The aim is to understand the relationship between Psychological characteristics and physiological responses in terms of emotional reactivity. You will complete a number of measures, self-reported measures of (EEA) trait resilience scale (Maltby Day & Hall, 2015, 12 items), Psychological Well-being scale (PWB) (Ryff & Keyes, 1995, 18 item), Subjective Well-being Scale (SWB), self –control 10 items (SCS), (IHB) 3 items and Valuing Happiness Scale (VH) The second measure is emotional reactivity by heart rate (HR) with NeuroLog sensor during viewing video affective clips. The videos contain with emotional content that include real upsetting material derived from YouTube clips so people have a real context.
The whole experiment will take within 30 min.

CONSENT STATEMENT

1. I understand that my participation is voluntary and that I may withdraw from the research at any time without giving any reason.
2. I am aware of what my participation will involve.
3. My data are to be held confidentially and only Zainab Alanazi, Murat Yildirim, Dr. John Maltby, and Dr. Elizabeth Maratos will have access to them.
4. My data will be kept in a locked space for a period of at least five years after the appearance of any associated publications. Any aggregate data (e.g. spreadsheets) will be kept in electronic form for up to five years after which time they will be deleted in accordance with University of Leicester waste management policy.
5. This consent forms will be kept in a separate locked filing cabinet for a period of at least five years after the appearance of any associated publications, after which time they will be deleted in accordance with University of Leicester waste management policy.
6. In accordance with the requirements of some scientific journals and organisations, my coded data may be shared with other competent researchers. My coded data may also be used in other related studies. My name and other identifying details will not be shared with anyone.
7. The overall findings may be submitted for publication in a scientific journal, or presented at scientific conferences.
8. I will be able to obtain general information about the results of this research by giving the researcher my email address now.

This study will take approximately within two hours to complete.

I am giving my consent for data to be used for the outlined purposes of the present study

All questions that I have about the research have been satisfactorily answered.
I agree to participate.
Participant's signature: ____________________________________
Participant's name (please print): ____________________________________
Date: __________

If you would like to receive a summary of the results by e-mail, when this is available, please provide your email address: _______________________

Participant Debrief Sheet

Mindfulness and wellbeing: emotional reactivity study

Thank you for participating in the emotional reactivity study**.** We hope that you have found it interesting and have not been upset by any of the topics discussed. However, if you have found any part of this experience to be distressing and you wish to speak to one of the researchers, please contact John Maltby, jm148@le.ac.uk.

There are also several organisations listed below that you can contact if you feel you need particular support.

a) You can approach your personal tutor or course leader, however if they are not available then you can approach any member of the course teaching about these issues.
b) Within the Students Union there is a welfare team who are available (welfare@le.ac.uk) with a welfare Officer available 'on call' 24 hours a day, 365 days a year, in case of emergencies, who is contactable through University Security (0116 252 2023 or 0116 252 2888). They now also have a dedicated, confidential text line where you can send a message at any time of the day or night (Just text ZERO and your message to 64446).
c) You can also contact the University of Leicester Student Counselling provision on: counselling@le.ac.uk or on 0116 223 1780.

Thank you again for your time in completing this study.

Participant Debrief Sheet

Thank you for participating in the Individual Differences, Affect and Learning and Wellbeing. We hope that you have found it interesting and have not been upset by the experiment. However, if you have found any part of this experience to be distressing and you wish to speak to one of the researchers, please contact John Maltby, jm148@le.ac.uk.

There are also a number of contact available.

a) You can also contact the University of Leicester Student Counselling provision on: counselling@le.ac.uk or on 0116 223 1780.

b) Within the Students Union there is a welfare team who are available (welfare@le.ac.uk) with a welfare Officer available 'on call' 24 hours a day, 365 days a year, in case of emergencies, who is contactable through University Security (0116 252 2023 or 0116 252 2888). They now also have a dedicated, confidential text line where you can send a message at any time of the day or night (Just text ZERO and your message to 64446). The Student Welfare Service is located in the Charles Wilson Building and provides a practical service designed to meet the needs of all students, including prospective students. Welfare Officers offer both general and specialist advice on a wide range of issues including finance. These services can be contact via: studentservices@le.ac.uk

Thankyou for your time.

UNIVERSITY OF LEICESTER

University Ethics Sub-Committee for Psychology

10/10/2016

Ethics Reference: 9035-jm148-neuroscience,psychologyandbehaviour
TO:
Name of Researcher Applicant: John J. (Dr.) Maltby
Department: Psychology
Research Project Title: Individual Differences, Affect and Cognitive Learning in relation to reactions to the Cold Pressor Task and Pleasant and Unpleasant Visual Stimuli.

Dear John J. (Dr.) Maltby,

RE: Ethics review of Research Study application

The University Ethics Sub-Committee for Psychology has reviewed and discussed the above application.

1. Ethical opinion

The Sub-Committee grants ethical approval to the above research project on the basis described in the application form and supporting documentation, subject to the conditions specified below.

2. Summary of ethics review discussion

The Committee noted the following issues:
Happy to approve this application. Good luck

3. General conditions of the ethical approval

The ethics approval is subject to the following general conditions being met prior to the start of the project:
As the Principal Investigator, you are expected to deliver the research project in accordance with the University's policies and procedures, which includes the University's Research Code of Conduct and the University's Research Ethics Policy.
If relevant, management permission or approval (gate keeper role) must be obtained from host organisation prior to the start of the study at the site concerned.

4. Reporting requirements after ethical approval

You are expected to notify the Sub-Committee about:

- Significant amendments to the project
- Serious breaches of the protocol
- Annual progress reports
- Notifying the end of the study

5. Use of application information

Details from your ethics application will be stored on the University Ethics Online System. With your permission, the Sub-Committee may wish to use parts of the application in an anonymised format for training or sharing best practice. Please let me know if you do not want the application details to be used in this manner.
Best wishes for the success of this research project.
Yours sincerely,

Prof. Panos Vostanis
Chair

Measures of Resilience

Description of the Scale:

A new measure of trait resilience (EEA) derived from three common mechanisms identified in ecological theory: Engineering Resilience, Ecological Resilience and Adaptive Capacity.

Engineering resilience: This is the ability to return or recover to an equilibrium following disturbance in terms of speed or status. It is the ability to return to stability from the result of a disturbance.

Ecological resilience: The ability to be robust or persistent, and to accommodate or resist a disturbance. It is measured in terms of the magnitude of disturbance that can be absorbed.

Adaptive capacity: The ability to restructure or to manage and accommodate change and to adapt.

SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree

	The Item	SD	D	A	SA
1	I tend to take a long time to get over set-backs in my life				
2	It is hard for me to snap back when something bad happens				
3	It does not take me long to recover from a stressful event				
4	I usually come through difficult times with little trouble				
5	I give my best effort no matter what the outcome may be				
6	I am determined				
7	I work to attain my goals no matter what roadblocks I encounter along the way				
8	I believe I can achieve my goals, even if there are obstacles				
9	Changes in routine are interesting to me				
10	I enjoy dealing with new and unusual situations				
11	I like to do new and different things				
12	I like it when things are uncertain or unpredictable				