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Eating Disorder Risk: Distress Tolerance and Its Relation to Interoceptive Accuracy

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Dedication

This research is dedicated to my beloved parents who fostered hope in tough times and encouraged me to continue, to my fiancé who struggled with me during times of breakdown but proudly stood by myside throughout this journey and to my two best friends who always know how to lift me up.

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Lastly, a big thank you goes to all those who took the time to participate in the study. This research would not have been possible without their contribution.

Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Nicosia. This thesis has been composed solely by myself except where stated otherwise by reference or acknowledgment. It has not been previously submitted, in whole or in part, to this or any other institution for a degree, diploma or other qualifications.

Signed: Eleni Iasonidou Date: 10/3/2022

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Note to reviewers:

Adhering to the Department's guidelines, the present thesis was structured as three separate papers. Each paper tests a different research hypothesis. However, all studies have the same methodology and used the same sample of participants. We decided to present the Methods section (albeit the same) in all Study Chapters, to make reading more cohesive and aid potential publication process.

CHAPTER 1
GENERAL INTRODUCTION

1.0 Introduction

Based on the American Psychiatric Association (APA, 2013) eating disorders (EDs), including anorexia nervosa (AN), bulimia nervosa (BN), binge eating disorder (BED), and other specified and unspecified EDs constitute a group of serious and potentially life-threatening psychiatric conditions. They are characterised by a range of abnormal eating behaviours accompanied by an overvaluation of body, shape and weight that significantly impair a person's physical and psychological functioning (Fairburn, 2008). The serious consequences of ED symptoms are not limited to those presenting with full syndromes (Pearson et al., 2002). In other words, being at risk for developing an ED does not preclude a person from experiencing the adverse effects of these disorders (e.g., nutritional deficiencies; Neumark-Sztainer et al., 1998, reduced quality of life; Herpertz-Dahlmann et al., 2008, etc.). Therefore, efforts to identify individuals at risk as well as the factors that contribute to disordered eating behaviours are of paramount importance.

Contemporary theories of ED pathology support that EDs exist on a continuum, ranging from healthy eating attitudes and behaviours to diagnosable EDs (Shisslak et al., 1995), and that high-risk eating behaviour differs from subclinical eating behaviour only in terms of symptom frequency and/or intensity (e.g., frequency and intensity of caloric restriction) (Dancyger & Garfinkel, 1995; Fairburn & Beglin 1990; Lowe et al., 1996). "High risk" refers to individuals who present with body shape/weight concerns and unhealthy weight control behaviours but do not currently meet the criteria for an ED diagnosis (Jacobi, Abascal, et al., 2004).

Among the most potent risk factors associated with ED development is gender, weight/shape concerns and unhealthy weight regulation methods (Taylor et al., 2003; Jacobi et al., 2011; Taylor et al., 2006; Stice, 2002; Jacobi, Hayward, et al., 2004). Although individuals of all ages and genders may present with disordered eating, EDs are particularly more common among high school and college female students (Liechty & Lee, 2013; Striegel-Moore & Bulik, 2007). In fact, 10-30% of college age women are at risk for EDs (Franko et al., 2005). ED attitudes and behaviours as seen in individuals at high risk - even at a lower frequency and intensity - can have serious psychological and physical consequences. More specifically, ED attitudes and behaviours are associated with low confidence and self-esteem, shame (Killen et al., 1994; Taylor et al., 1998; Stice et al., 1998), and alcohol abuse and anxiety problems (Fisher et al., 1991). Unhealthy weight control methods, including self-induced vomiting and laxative use, can cause a variety of serious physical consequences, such as enamel erosion, esophageal irritation and/or tear and other medical complications (Roerig

et al., 2002) and also constitute risk factors for developing EDs (Jacobi, Hayward, et al., 2004).

Emotion Dysregulation, Distress Intolerance and ED risk

Empirical research on ED risk factors has focused on dysregulated emotions for quite some time now, highlighting the role of emotion dysregulation in both the cause and maintenance of EDs (e.g., Brockmeyer et al., 2014; Ruscitti et. al., 2016; Mallorquí-Bagué et al., 2018). In recent years, the focus of ED research has narrowed somewhat to investigate more closely specific factors related to the broader construct of emotion regulation. Some of these factors gaining consistent support are distress tolerance (DT; Zvolensky et al., 2010) and interoceptive accuracy (IAcc; Merwin, Zucker, et al., 2010; Pollatos et al., 2008).

DT refers to "the capacity to experience and withstand negative psychological states" (Simons & Gaher, 2005). Individuals low in DT perceive distress as unbearable, exhibit great efforts to avoid negative emotions and use any means to escape these (Simons & Gaher, 2005). Substantial evidence exists supporting that individuals who present with ED symptoms experience difficulties coping with negative affect in an adaptive way (Zvolensky et al., 2010). In fact, dysregulated eating behaviours have been found to act as an escape mechanism helping to soothe distress in the absence of other effective strategies (Anestis et al., 2007; Corstorphine et al., 2007; Haynos & Fruzzetti, 2011). Disordered eating behaviours, such as binge eating and extreme dietary restriction, temporarily relieve the aversive emotional state (Linehan & Chen, 2005; Chen et al., 2015). Over time, these behaviours, acting as escape responses, become reinforced, especially in the absence of other more adaptive skills of coping with negative affect (Linehan & Chen, 2005).

Despite the wealth of cross-sectional studies dedicated to the investigation of cognitive-affective factors underlying risk and maintenance of eating pathology (e.g., Brockmeyer et al., 2014; Ruscitti et. al., 2016; Mallorquí-Bagué et al., 2018), experimental studies focusing on reactivity to, and tolerance of, distressing stimuli in individuals with eating pathology are scarce (Merwin, 2011). Previous studies have over-relied on self-report measures to quantify DT, a method which is often subject to recall bias. Laboratory tasks aimed to elicit frustration and examine persistence on a task may serve as a proxy for psychological DT (Daughters et al., 2005; Holdwick, & Wingenfeld, 1999) and thus might be particularly useful in the investigation of DT in EDs. One of the most frequently used behavioural tasks to assess psychological DT is the "Paced Auditory Serial Addition Task-Computerized" (PASAT-C) (Lejuez et al., 2003) – a cognitive stress task which has been shown to induce negative affect. Despite their utility, as with all assessment methods, these tasks do not present without limitations. Various task-related behaviours, such as early task

termination, are interpreted as a proxy for DT. However, early task termination may also reflect boredom and/or fatigue. Thus, it is important to evaluate such behaviours in light of additional assessment measures (e.g., physiological, self-report) to ensure that the task did indeed elicit distress. Incorporation of multiple methods of assessment is also important and needed to gain a comprehensive understanding of emotional responses when in distress, since an emotional response involves not only subjective experience, but also physiology and behaviour (Gross, 2013). Nevertheless, behavioural paradigms are still important since they are less affected by social desirability response bias and can be used as complementary to self-report measures.

The Breath-Holding Task (BHT; Hajek et al., 1987) is another behavioural paradigm used to assess tolerance to physical distress. During the task, the participant is asked to hold his/her breath for as long as possible aiming at inducing *physical* discomfort. Hajek and colleagues (Hajek, 1989; Hajek et al., 1987) developed the BHT procedure to examine breath-hold endurance among smokers and assess their ability to tolerate uncomfortable physical sensations. To our knowledge, no previous study has investigated the ability to tolerate negative physical sensations in ED populations.

The present study aims to examine reactivity to a performance-based challenge task (i.e., the PASAT-C) and a physical-based challenge task (i.e., the BHT), reflecting DT, in a sample of young females at high vs. low risk for EDs. In addition, performance in the two tasks will be compared between and within groups.

Somatic-Affective Experience, Interoceptive Abilities and ED risk

Overall, individuals with ED symptoms seem to experience difficulties tolerating negative affect, exhibit a tendency to avoid negative internal states and further engage in dysfunctional behaviours to alleviate the negative emotions they do experience (Zvolensky et al., 2010; Merwin, Zucker, et al., 2010; Wildes et al., 2010). However, little is known about the underlying mechanisms that might explain this dysregulated response to negative affect. Emotions are complex experiences that include somatic sensations, and the intensity of these is considered to be associated with emotional intensity (James, 1884; Damasio 1994; Damasio 1999). In fact, several studies identified that individuals who perceive bodily signals with higher degree of accuracy experience more intense emotions and vice versa (Critchley et al., 2004; Wiens et al., 2000; Katkin et al., 2001; Pollatos et al., 2005). Based on this premise, Merwin (2011) proposes that in the early stages of EDs, individuals present with a hypersensitivity to somatosensory experience which may intensify the unpleasantness of internal states and thus account for the maladaptive attempts to avoid or escape these experiences. In a study investigating emotional reactivity to affective experience individuals

at high risk for EDs demonstrated heightened emotionality to negative affect (Koushiou et al., 2019), providing support for the assumption of hypersensitivity to negative affect at the pre-morbid stages of the disorder. This is to be contrasted with hyposensitivity to somatosensory experience which manifests in the later stages of EDs, due to prolonged self-imposed starvation and strengthening of avoidant behavrious, that might impair one's ability to detect and adaptively respond to bodily signals.

A number of studies have used multiple methodologies to examine individuals' with EDs ability to perceive and integrate internal body sensations (i.e., sensitivity to somatosensory experience). This ability is broadly referred to as *interoception* (Craig, 2002). Interoception is comprised of multiple processes, both sensory and belief based (Garfinkel et al., 2015). These include (1) interoceptive accuracy (i.e., the extent to which an individual's perception of bodily signals aligns with physiological assessments of these signals [Garfinkel et al., 2015; Khalsa et al., 2018]; as measured by performance on objective measures of interoception, e.g., the Heartbeat Perception Task [HBPT; Schandry, 1981]), (2) interoceptive sensibility (i.e., self-reported beliefs of the extent to which an individual is able to detect internal sensations; measured using questionnaires) and, (3) interoceptive awareness (i.e., correspondence between interoceptive accuracy and interoceptive sensibility). Previous research has provided a link between these various aspects of interoception and eating pathology (see Martin et al., 2019 for a review).

Behavioural assessments of interoception, reflecting interoceptive accuracy (IAcc) abilities, have been widely employed in the context of ED research. A commonly used method of assessing IAcc is a heartbeat counting task, such as the HBPT developed by Schandry (1981). Several studies demonstrated a link between low cardiac IAcc and eating pathology (Herbert & Pollatos, 2014; Klabunde et al., 2013; Fischer et al., 2016; Pollatos et al. 2008). Nevertheless, the existing empirical research on IAcc and disordered eating has yielded inconsistent and/or null results (e.g., Lutz et al., 2019; Pollatos & Georgiou, 2016; Kinnaird et al., 2020; Richard et al., 2019). Studies to date have been mainly conducted in clinical ED samples thus intervening factors (e.g., treatment progress) might contribute to such inconsistencies (Richard et al., 2019). Although research on clinical populations often provides valuable information, it also poses challenges in result interpretation as it hinders our ability to discern whether sensitivities and/or disruptions constitute state phenomena secondary to the effects of the disorder or individual trait-characteristics that precede illness onset and increase vulnerability. Overall, it is often assumed that individuals with EDs (especially AN) are hyposensitive to somatosensory experience because of the lack of responsivity to bodily signals (e.g., hunger or fatigue) and their non-accepting stance in response to difficult emotions (Merwin et al., 2013). However, to our knowledge, no studies

to date have investigated IAcc in individuals who are at risk for EDs but do not currently present with a clinical ED diagnosis and therefore their emotional processing is expected to be unaffected by the various physical effects seen in clinical cases.

In conclusion, evidence for the hypothesis of hypo or hypersensitivity to somatic-affective cues is inconsistent and its role in the development of eating pathology remains unclear. Therefore, the second aim of the present study is to examine IAcc in individuals at high vs. low ED risk using the HBPT as an objective method of measuring perception of bodily signals (IAcc), under well-controlled laboratory conditions.

IAcc, DT and ED risk: is there an association?

Beyond the individual significance of IAcc and DT in terms of EDs, it is important to understand the interplay between these factors. Based on Damasio's somatic marker hypothesis (1994; 1999) the extent of an individual's sensitivity to bodily signals is thought to be an essential variable of emotional experience. Thus, individual differences in sensitivity (i.e., IAcc) may play a pivotal role in the way emotions are experienced and ultimately regulated (Merwin, Zucker, et al., 2010). If individuals at high ED risk are hypersensitive to bodily signals, then it is expected that they experience emotions with greater intensity. Experiencing emotions with greater intensity may in turn lead to emotions felt or experienced as a lot more intolerable (Merwin, Timko, et al., 2010). As a result, disordered eating behaviours may be employed to relieve the experience of negative, aversive emotions.

An understanding of the relationship between interoceptive processing and ED risk remains poor. The current literature lacks research on the possible mediators of this relationship (Martin et al., 2019). To the best of our knowledge, no study to date has examined the role of DT as a mediator of the relationship between IAcc and ED risk. Therefore, the third aim of the current study is to extend understanding of the relationship between IAcc and ED risk by examining DT as a possible mediator. We propose that lower DT is a significant mediator in the relationship between IAcc and ED risk.

1.1 Present Thesis

The aim of the present thesis is to examine emotional reactivity in response to two distress tasks – a psychological stress task (PASAT-C) and a physical stress task (BHT) in young female adults at high vs. low risk for EDs, in order to assess and compare the two groups in terms of DT. Cardiac activity was recorded during the two tasks while subjective emotional ratings were collected after completion of the tasks. Behavioural reactions to the tasks (i.e., duration spent on each task) were also examined. Reactions to the tasks (physiological, self-reported and behavioural) were compared between high and low risk

participants. Moreover, participants' affective experience was compared between the two tasks. We expected that compared to the low-risk group, participants at high ED risk would present greater reactivity to the two stress tasks. This is expected to be evident in their physiological responses (higher heart rate [HR]), behavioural responses (shorter time spend on the tasks), and self-reports of affect. We further expected that the difference would be more prominent for the BHT – the task aimed at inducing physical distress.

In addition, the current study examined IAcc in individuals at high vs. low risk for EDs. IAcc was measured using the Heartbeat Perception Task (HBPT; Schandry, 1981). It was expected that individuals at high ED risk would be more accurate at perceiving bodily signals (i.e., their heartbeat), signifying higher IAcc.

Lastly, two mediation models were examined. The first model assessed whether DT, as reflected by behavioural responding to the two stress tasks (i.e., latency to quit), acts as a significant mediator in the relationship between IAcc and ED risk. The second model assessed whether emotional reactivity, as reflected in physiological responding (HR) to the two stress tasks, is a significant mediator in the aforementioned relationship.

A sample of individuals assessed to be at high risk of developing ED were selected in order to avoid the confounding effects associated with illness progression (e.g., fasting, purging, excessive exercise, laxative/diuretics misuse). This constitutes a limitation of previous studies which limits our understanding of factors that contribute to the development of EDs. Moreover, young female adults were selected as an appropriate age group to participate in this study since young adulthood and being a female are two factors which have both been associated with an increased risk for ED development (Striegel-Moore et al., 2009; Soet & Sevig, 2006).

The present thesis integrates multiple methods of assessment (physiological, subjective experience, and behaviour) in order to provide a more comprehensive understanding of the affective response to stress of individuals at high vs. low ED risk. The findings of the present thesis:

i) highlight the role of distress intolerance as a characteristic of individuals at risk for developing EDs;

ii) provide a better understanding of the mechanism underlying ED onset by demonstrating that the capacity to tolerate cognitive frustration is a significant mediator in the relationship between IAcc and ED risk and,

iii) inform efforts aimed at preventing EDs in young female adults and highlight the significance of Dialectical Behavioural Therapy and treatments that use somatic

experiencing as the core element of therapy, such biofeedback, mindfulness, mentalization and acceptance-based treatments, in preventing the development of EDs.

1.2 Overview of Studies

Study 1

The first study (Chapter 2) aimed to firstly assess the efficacy of two distress tasks (i.e., a psychological stress task – PASAT-C – and a physical stress task – BHT) in inducing negative affect and secondly to investigate the physiological (HR), subjective (self-reported emotions) and behavioural (latency to quit the task) responses of young female adults at high vs. low ED risk in response to the two distress tasks. Reactions to the two stress tasks were considered to reflect participants' ability to tolerate distress. On a preliminary basis, we aimed to identify the specificity of disturbances of high-risk individuals (i.e., physical vs. cognitive level) by comparing the affective experience (physiological, subjective, behavioural) on the physical stress task (BHT) vs. the psychological/cognitive stress task (PASAT-C; Lejuez et al., 2003). Prior to the experiment, participants completed a battery of self-reported questionnaires assessing their height and weight (to determine BMI), perceived DT, levels of depression, anxiety, stress and potential confounding factors for BHT assessment (like physical activity involvement and knowledge of a musical instrument).

Study 2

The second study (Chapter 3) aimed to examine IAcc among young females at high vs. low ED risk, using the HBPT (Schandry, 1981) as an objective method of measuring perception of bodily signals (reflecting IAcc), under well-controlled laboratory conditions. Furthermore, on a preliminary basis, we aimed to investigate the mediating effect of DT, as reflected by behavioural responding (i.e., latency to quit the PASAT-C), in the relationship between IAcc and ED risk, integrating results from our prior research (Chapter 2).

Study 3

For the third study (Chapter 4) we incorporated results from our prior experimental research (Chapter 2 & 3) to examine a second mediation model. In this model, physiological manifestation of distress (i.e., physiological responses to the two stress tasks) was assessed as a possible mediator in the relationship between IAcc and ED risk.

CHAPTER 2

STUDY 1

Investigating distress tolerance in females at high vs. low risk for eating disorders across self-report, behavioural and physiological domains in response to a physical vs. a cognitive stress task.

Abstract

Objective: Disordered eating has long been theorised to function as a maladaptive way of coping with negative affect and/or aversive psychological states (Haynos & Fruzzetti, 2011). The aim of the current study was to: i) assess the effectiveness of two distress tolerance tasks in inducing negative affect, and ii) investigate emotional reactivity in young females at high vs. low eating disorder (ED) risk in response to the two distress tasks by utilizing physiological (heart rate [HR]), behavioural (i.e., time spent on the task) and self-report measures.

Method: Females (18-25 years of age) at high (N=56) vs. low (N=58) ED risk completed the Breath-Holding Task (BHT) and the "Paced Auditory Serial Addition Task-Computerized" (PASAT-C) and provided their affective ratings upon completion of the tasks. Physiological measurements (HR) were recorded during the two distress tasks and were then averaged for each time period.

Results: Both tasks were successful in inducing negative affect. High risk participants demonstrated greater cardiac reactivity in response to both tasks compared to their low-risk counterparts. The cognitive distress task produced greater emotional reactivity across all modalities (i.e., physiological, behavioural and self-reported) in the high-risk group, as compared to the physical distress task.

Conclusions: Individuals at high ED risk exhibit greater physiological and subjective arousal to distressful stimuli, suggesting hypersensitivity to negative affect. Greater arousal to stress may point to a trait-like feature that exists prior to illness and increases vulnerability, either by making emotions difficult to tolerate or by generating a hyperawareness of the body.

Keywords: eating disorder risk, distress tolerance, negative affect, physiology, PASAT-C, BHT

2.0 Introduction

Eating disorders (EDs) constitute a serious public health concern due to their severe and long-lasting effects on physical, psychological and social functioning (Smink et al., 2012). Although EDs are classified into distinct categories in DSM-V (APA, 2013), research demonstrates that patients with EDs often migrate between ED diagnoses over the course of illness (Milos et al., 2005; Eddy et al., 2008; Castellini et al., 2011; Ekeroth et al., 2013). Exploring this phenomenon, Fairburn and colleagues (2003) suggest that the main maintaining process of ED psychopathology are likely to be largely the same across different ED diagnoses, with over evaluation of weight and shape identified as the core characteristic underlying a range of diagnostic categories (APA, 2013). This has led to a transdiagnostic view of EDs (Fairburn et al., 2003), putting an emphasis on identifying factors associated with EDs transdiagnostically, rather than isolating factors relating specifically to one diagnostic group.

Disordered eating has long been theorised to function as a maladaptive way of coping with negative affect and/or aversive psychological states (Anestis et al., 2007; Corstorphine et al., 2007; Haynos & Fruzzetti, 2011). Several studies examine the capacity of individuals with EDs to withstand negative psychological states, termed as *distress tolerance* (DT; Simons & Gaher, 2005). Empirical evidence suggests that individuals with EDs are more distress intolerant and as a result engage in dysregulated eating behaviours to attenuate the experience of negative emotions. In their study, Corstorphine and colleagues (2007), observed a general pattern associating avoidance of affect with unhealthy eating behaviours. They additionally observed that women in the ED clinical group showed higher levels of avoidance of affect compared to the non-clinical group, suggesting that dysregulated eating behaviours may constitute a maladaptive outcome of those presenting with low tolerance for negative affect and are thus actively trying to avoid the experience of it. In another study DT was found to significantly predict bulimic symptoms, even after controlling for several covariates, including depressive and anxiety symptoms (Anestis et al., 2007). Additionally, the authors observed an interaction between DT and urgency – acting in a rushed manner in the face of intense negative emotion to achieve immediate reduction of that affective state – in predicting symptoms of bulimia nervosa (BN). Specifically, individuals who were less able to tolerate negative affect and tend to act rashly to ameliorate this sensation were more likely to report bulimic symptoms. Based on the aforementioned findings, it seems that the degree to which an individual perceives negative affect to be intolerable plays a pivotal role in predicting behavioural and emotional dysregulation. As such, what might be evaluated as minimally discomforting to some, unlikely to trigger a response, may be perceived as intolerable to

others and thus lead to the engagement of ill-matched responses to escape that overwhelming emotional experience.

Further evidence for the link between DT and eating symptomatology comes from treatment studies. Individuals with BN and binge eating disorder (BED) who received training on DT and other emotion regulation skills, as part of a Dialectical Behaviour Therapy (DBT) protocol, reported no engagement in binge eating as compared to a waitlist control group (Safer et al., 2001; Telch et al., 2001). Despite these findings confirming the potential utility of DBT for EDs, an increase in DT may constitute a mediating factor in the treatment's efficacy, achieved through both mindfulness and emotion regulation strategies.

Although there is growing base of studies investigating the relationship between DT and EDs, almost all studies to date have relied on self-report measures to examine this association. Therefore, findings may be influenced by problems inherent in such methodology (e.g., self-report bias). A multimethod approach toward measurement would increase confidence in results. To our knowledge, only one study to date has utilised an experimental paradigm to assess DT in an ED population, incorporating multiple methods of assessment (Yiu et al., 2018). Specifically, individuals with EDs and HCs were compared on their behavioural (i.e., termination of task, latency to quit task), physiological (respiratory sinus arrhythmia, skin and tonic conductance responses) and self-reported responses to a mental arithmetic stress task, namely the "Paced Auditory Serial Addition Task-Computerized" (PASAT-C) (Lejuez et al., 2003) – a cognitive stress task which has been shown to induce negative affect. Individuals in the clinical group reported significantly higher levels of negative emotions but similar physiological and behavioural manifestations of distress, compared to HCs, after completion of the task. Based on this finding, individuals with EDs exhibit similar DT levels under experimental investigation as HCs, as they experienced significantly higher subjective distress relative to HCs when presented with the same stimuli but did not stop or avoid the task. This may be the case due to the type of task used which focuses on tolerance of cognitive distress.

To our knowledge, no previous study has investigated the ability to tolerate physical sensations in ED populations, using an experimental paradigm. Previous research focusing on self-reports suggests that individuals with AN experience higher sensitivity to sensations and attempts to avoid sensory experience compared to individuals with a past history of AN (weight restored) and healthy controls with no ED history (Zucker et al., 2013). Sensitivity to sensation may enhance awareness of the physiological correlates of emotional experience (e.g., the churning in the gut that may accompany anxiety). This hyperawareness of visceral sensations may be experienced as aversive or intolerable and may, thus, lead to maladaptive

interpretations of the meaning of these visceral sensations. In this study we sought to examine tolerance to physical distress using an experimental paradigm, namely the Breath-Holding Task (BHT; Hajek et al., 1987) and compare it to tolerance of cognitive distress (i.e., responses to the PASAT-C). More specifically, we aimed to examine subjective (behavioural & affect self-reports) and physiological (HR) responses to the two types of distress in a sample of young females at high vs. low risk for EDs.

Employing individuals who do not currently meet criteria for an ED to assess physiological reactivity (HR) to unpleasant stimuli is expected to address another gap in the literature, since studies to date investigating autonomic function present mixed results (e.g., see review by Giel et al., 2011). For example, individuals with BN exhibited decelerated HR when negative affect was induced via food stimuli (Laberg et al., 1991), while in another study there were no HR changes observed when women with high self-reported body dissatisfaction were presented with body-related words (Herbert et al., 2013). These inconsistencies in results might be partly due to the use of clinical populations who often present with a number of medical problems that can impact physiological responding (e.g., Mitchell & Crow, 2006). Moreover, studies to date have almost exclusively relied on pathology-specific stimuli (e.g., food and body related words, images etc.), compromising our ability to understand emotional reactivity uncomplicated by features of the illness. Preliminary evidence from a study comparing emotional responsiveness to general vs. ED pathology-specific affective film clips showed that individuals at high ED risk exhibit greater physiological reactivity in both affective contexts (Koushiou et al., 2019). In a more general context, Yiu et al. (2018) found that when exposed to the PASAT-C, participants with EDs and controls exhibited similar levels of autonomic response.

Interpretation of the mixed results becomes difficult due to the variations in methodology employed in these studies, thus not allowing for a clear account as to the specificity of the physiological disturbances in this population. For example, it cannot be concluded whether disturbances are due to hyper-sensitivity to negative affect, associated with sympathetic dominance, or hypo-sensitivity related to the dominance of the parasympathetic nervous system and a diminished sympathetic modulation). Moreover, findings are mainly the product of clinical samples that present with several physical complications, including arrhythmias, bradycardia etc. (e.g., see Mitchell & Crow, 2006), associated with illness progression and are expected to impact physiological responding. To address this gap, the current research aims to investigate the physiological responses (HR) to unpleasant stimuli in individuals who are at high ED risk but do not currently exhibit ED clinical symptoms to control for the confounding effects associated with illness chronicity. Moreover, on a preliminary basis, the current study also aims to identify the specificity of

disturbances in this population (i.e., physical vs. cognitive level) by comparing the affective experience (both physiological and subjective) on a physical stress task (BHT) vs. a psychological/cognitive stress task (PASAT-C; Lejuez et al., 2003).

2.0.1 Study Aims

The present study aims to firstly assess the effectiveness of a cognitive – the PASAT-C – and a physical stress task – the BHT – in inducing negative affect. The second aim of the current study is to examine emotional reactivity and DT of young females at high vs. low ED risk in response to the two stress tasks by integrating physiological (HR), behavioural (i.e., time spent on the task) and self-report measures. Behavioural and self-report responses to the two stress tasks are expected to reflect participants' DT. DT of the two groups will also be assessed via a self-report measure. Lastly, correspondence between physiological and self-reported responses to negative affect will be examined.

2.0.2 Study Hypotheses

We expect that the two distress tasks will be successful in negative emotion induction. Moreover, it is expected that individuals of the high-risk group will exhibit greater reactivity to the two stress tasks, and this will be evident in their physiological responses (i.e., higher HR), behavioural responses (i.e., shorter time spent on the tasks), and self-reported affect (i.e., greater negative affect after the tasks) than individuals of the low-risk group. Shorter time spent on the tasks and greater self-reported negative affect after completion of the tasks are expected to be indicative of lower DT in the high-risk group. High risk participants are also expected to demonstrate lower DT compared to the low-risk participants as evident from the self-report measure of DT used in the study. We expected that the BHT– the task aimed at inducing physical distress would be more distressing for high ED risk individuals – compared to the PASAT-C, aimed at inducing cognitive distress. Based on Merwin's (2011) and Haynos and Fruzzeti's (2011) conceptualization of EDs suggesting that in the premorbid stages of the illness individuals experience hypersensitivity to somatic sensations, we expect that high-risk individuals will demonstrate good correspondence between physiological and self-reported responses.

2.1 Methods

2.1.1 Participants

The sample consisted of 114 female participants (M_{age}= 21.46, SD= 2.01). Young female adults were selected as an appropriate age group to participate in this study since young adulthood and being a female are two factors which have both been associated with a greater risk for developing an ED (Striegel-Moore et al., 2009; Soet & Sevig, 2006).

Eligible participants were females, 18-25 years of age, with a good working knowledge of the English language. Individuals who scored above 52 on the Weight Concerns Scale (see self-report measures; Killen et al., 1994) were assigned to the high ED risk group (N=56), while those who scored below the above-mentioned threshold were assigned to the low-risk group (N=58). Individuals (N=3) who met diagnostic criteria for an ED based on the Eating Disorder Diagnostic Scale (EDDS; Stice et al., 2000) were not eligible to participate in the study and were referred for further assessment. As expected, there were significant differences between the two groups on WCS scores with high-risk participants reporting significantly more weight concerns (M = 66.96, SD = 7.60) than their low-risk cohorts [(M = 30.86, SD = 15.18), t (84.56) = 16.14, $p < .001$]. The majority of the participants were Cypriots (84.2%) while the rest were Greek (12.3%) or other (3.5%).

2.1.2 Materials and measures

Physiological measures and apparatus

The experiment was built and run on the OpenSesame software (Mathôt et al., 2012). For the acquisition and processing of physiological data BIOPAC MP150 for Windows and AcqKnowledge 5.0.2 data acquisition software (Biopac Systems Inc, Santa Barbara, CA) were used. HR data was collected using Ag/ AgCl shielded electrodes that were placed on the participants' inner forearms following skin preparation following standard procedures (Fridlund & Cacioppo, 1986). A BIOPAC ECG100C bioamplifier was used to filter raw ECG. The bioamplifier was set to record beats per minute (BPM) in milliseconds.

Mean scores for HR were computed for the 5-min baseline period, for the BHT and for PASAT-C separately.

Self-report measures (Appendix A)

Demographic data questionnaire: Participants were asked to complete a personal questionnaire pertaining to demographic and personal data including; gender, age, year and level of studies, height, weight (current, highest, lowest, ideal and disappointing), involvement in sports or knowledge of a musical instrument, and whether they suffer from any chronic illness.

Eating disorder risk

The Eating Disorder Diagnostic Scale (EDDS; Stice et al., 2000) is a brief self-report scale consisting of 22 items for measuring AN, BN and BED and eating pathology based on the DSM-IV (American Psychiatric Association [APA], 1994) criteria. Responses can be used to generate a possible DSM-IV diagnosis for the three EDs and can also provide an overall eating disorder symptom composite. The symptom composite score is used to indicate

participants' overall eating pathology. This scale was used in the current study to detect individuals who currently meet the criteria for an ED diagnosis for exclusion purposes. An SPSS computer algorithm is provided by Stice et al. (2000) to determine diagnoses. The scale has shown high internal consistency (α= 0.89) and test-retest reliability (r=.87) in previous studies (Stice et al., 2000) within adolescent and adult samples. The EDDS demonstrated satisfactory internal consistency in this sample (α= 0.74).

The Weight Concerns Scale (WCS; Killen et al., 1994) is a 5-item self-report questionnaire that assesses worry about weight and shape, fear of weight gain, diet history, importance of weight, and perceived fatness. This scale was used in the proposed study to determine high-risk status with a threshold score of 52 and above to be indicative of higher risk for developing ED. The WCS has shown good test–retest reliability (r=0.85) and good predictive validity for ED caseness in previous studies (Killen et al., 1994; Killen et al., 1996; Jacobi et al., 2004). It has also shown satisfactory internal consistency in a Greek-Cypriot sample of university students (α= 0.75) and high and middle school students (α= 0.80; Koushiou et al., 2019). Satisfactory internal consistency has been shown in this sample as well (α= 0.76).

Self-report Distress Tolerance

Distress Tolerance Scale (DTS; Simons & Gaher, 2005) is a 15-item questionnaire assessing the degree to which individuals can withstand negative emotion. Four aspects of DT (perceived ability to tolerate emotional distress, subjective appraisal of distress, attention absorbed by distress, and emotional regulation efforts to alleviate distress) are measured on a 5-point Likert Scale ranging from *1= strongly agree* to *5= strongly disagree*. Items are summed to yield a total *DT* score, with higher scores reflecting greater tolerance for negative emotional experience. The scale demonstrates excellent internal consistency (α= 0.91) and criterion validity (Simons & Gaher, 2005). The scale demonstrated excellent internal consistency in this sample as well (α= 0.90).

Distress tasks

(i) Physical Stress Task

The Breath-Holding Task (BHT; Hajek et al., 1987) is a behavioural index of physical DT. The task requires participants to hold their breath after a full, normal expiration. To maximise experienced distress during the task, participants were asked to hold their breath for as long as they can, even if they felt the urge to breathe again. The same procedure was then repeated after a 60-second rest period. Similar to previous work (Zvolensky et al., 2010), the longer duration of the two trials was used as the index of maximum breath-holding duration. Higher breath-hold durations reflect greater ability to tolerate physical discomfort. The BHT

has shown good test-retest reliability (r = 0.67; Sütterlin et al., 2013). The task has demonstrated good test-retest reliability in this study as well (r = 0.87).

(ii) Cognitive Stress Task

The "Paced Auditory Serial Addition Task – Computerized" (PASAT-C; Lejuez et al., 2003) is a mental arithmetic stress task which has been shown to induce negative affect (Daughters et al., 2005; Holdwick, & Wingenfeld, 1999). During the task single-digit numbers are sequentially presented on a computer screen and the participant is required to add the presented number to the previously presented number before the next one appears on the screen. There are three levels to the task; Level 1-low difficulty (3 minutes); Level 2-medium difficulty (3 minutes); and Level 3-high difficulty (3 minutes). Numbers are presented more quickly with each level, with Level 1 providing a 3-s latency between number presentations, a 2-s latency during the second level, and a 1-s latency during the final level. Level 3 is considered to be the DT phase of the task as the latency between digit presentations exceeds the participant's skill level, thus inducing distress. Before starting Level 3 participants are informed that once the final level begins, they can terminate exposure to the task by pressing the QUIT button. Participants are notified that they will win one point for each correct response, while incorrect scores or not responding will not impact their score. DT is indexed as latency in seconds to terminate level 3 of the task.

Affect ratings (Appendix B)

The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) is a self-report measure made up of two scales; the Positive Affect (PA) and the Negative Affect (NA) Scales. The PA scale consists of 10 positive adjectives (e.g., excited) and the NA scale of 10 negative adjectives (e.g., upset). Respondents are asked to rate each item on a 5-point Likert Scale, ranging from *very slightly* to *very much*, reflecting how they feel at the moment. Only the Negative Affect subscale was used in the current study to capture participants' emotional reactions to the physical and the psychological stress tasks (the Breath-Holding Task and PASAT-C). The scale was administered to the participants immediately prior to and following the completion of the BHT and the PASAT-C. Both scales of the PANAS have shown high internal consistency (a= .89 for the PA scale, and a= 0.85 for the NA scale (Watson et al., 1988). Good internal consistency has been also shown for the PANAS-NA subscale in this sample (α= 0.83).

The Self-Assessment Manikin (SAM; Bradley & Lang, 1994) is a non-verbal picture-oriented instrument developed to assess momentary feelings of pleasure, arousal, and dominance in response to an event. The SAM was used in the current study to assess participants' emotional response to the Breath-Holding Task and the PASAT-C along the

principal affective dimensions of valence, arousal and dominance. Each dimension on the SAM contains five graphical figures defining a 9-point scale. The pleasure dimension of SAM ranges from a frowning, unhappy figure (1= unpleasant) to a happy, smiling figure (9= pleasant). The arousal dimension ranges from a relaxed, calm figure (1= calm) to an excited, wide-eyed figure (9= aroused). Lastly, the dominance dimension (ranging from 1= without control, to 9= in control) represents changes in control reflected in changes in the size of the figure with the large figure indicating maximum control over the situation. Participants are asked to place an 'x' on any of the figures of each dimension, or between any two figures, which results in a 9-point rating scale for each dimension. The SAM was administered to participants immediately after completion of the BHT and the PASAT-C.

Confounding variables (Appendix A)

Depression and anxiety have been found to affect affective experience (Stice, Marti, & Durant, 2011) and thus were assessed as possible confounders. The Depression Anxiety Stress Scales-21 (DASS-21; Brown et al., 1997) is the short form of the DASS-42 (Lovibond & Lovibond, 1995), a measure of depression, anxiety, and stress or psychological distress. The DASS-21 contains three self-report scales, each containing 7 items of similar content. The DASS-21 shows good internal consistency with Cronbach alpha of .88 for depression, .82 for anxiety, .90 for stress, and .93 for the entire scale. The DASS-21 subscales demonstrated satisfactory internal consistency in the present study (α= 0.76 for depression, α= 0.70 for anxiety, α= 0.74 for stress) and good internal consistency for the entire scale (α= 0.85).

Body Mass Index (BMI) has been found to affect physiological reactions in ED populations (e.g., see Dapelo et al., 2015), thus was assessed as a possible confound. Body Mass Index (BMI) was calculated based on the participants' subjective measures of height and weight. BMI was calculated based on the following transformation: (weight(kg)/height^2(m)).

Physical activity level was assessed as a possible confound for differences in physiological reactions between individuals at high and low ED risk (Klaperski et al., 2013). Participants' activity level was measured using the Stanford Brief Activity Survey (SBAS; Taylor-Piliae et al., 2006), a short 2-item, self-report survey which assesses the usual amount and intensity of physical activity. The first item describes different kinds of at-work activities (i.e., item C – "I spent most of the day sitting or standing. When I was at work, I did such things as writing, typing, talking on the telephone, assembling parts, or operating a machine that takes very little exertion or strength. If I drove a car or truck while at work, I did not lift or carry anything for more than a few minutes each day") and the second item describes leisure-time activities (i.e., item G – "Weekdays, when I got home from work, I did few active

things, but most weekends I was able to get outdoors for some light exercise- going for walks, playing a round of gold (without motorized carts), or doing some active chores around the house"). There are five response items for each item. Responders are asked to select one response to describe their at-work activity and one to describe their leisure-time activity. Based on responses on the two items, respondents' overall physical activity intensity is classified as follows: (1) inactive, (2) light, (3) moderate, (4) hard, and (5) very hard. It was originally developed and validated in a sample of English-speaking older adults (Taylor-Piliae et al., 2006) and was later validated in middle-aged individuals (Taylor-Piliae et al., 2007) and young adults (Joseph et al., 2014).

2.1.3 Procedure

Screening phase

Potential participants were identified and invited to take part in the study from a sample recruited during a wider campaign ("UNIC Mental Health Screening Days 2019: Eating Attitudes and Behaviours"), that took place at the University of Nicosia between the 7th and the 18th of October 2019. Individuals were contacted via email only in case they provided their consent to be contacted for participation in future studies (see Appendix C for the email that was sent to students). Further participants were recruited based on opportunistic sampling by online and on campus advertisement of the study (see Appendix D). Participation in the study was voluntary. Prior to participation, individuals were asked to respond to the Eating Disorder Diagnostic Scale (EDDS; Stice et al., 2000) in order to detect individuals with a current ED diagnosis for exclusion purposes. In addition, if participants came from the aforementioned campaign, they were asked to verify their responses on the Weight Concerns Scale (WCS; Killen et al., 1994), or if they were part of the opportunistic sampling then were asked to complete the WCS.

Eligible participants completed a battery of self-report questionnaires prior to their visit at the lab.

Experimental phase

During the experimental phase of the study, participants were asked to complete a physical and a cognitive stress task which aimed to examine their ability to tolerate psychological and physical stress. The order of the two tasks was counterbalanced among participants to control for carry over effects. Upon informed consent, participants completed a battery of questionnaires including a general demographic/ historical data questionnaire, the DTS, and the DASS-21 and were then provided with instructions about the tasks they had to complete.

At first, participants were seated on a chair and asked to complete a set of affect ratings using the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). Then they were fitted with physiological monitors. There was a 5-minute baseline period before beginning the tasks to stabilise physiological signals. Then, participants went on to complete either the BHT or the PASAT-C. Physiological measurements of HR were collected during both tasks. Self-report affect ratings using the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) and the Self-Assessment Manikin (SAM; Bradley & Lang, 1994) were collected post-BHT and post-PASAT-C. All participants received debriefing at the end of the study.

The current study received ethical approval from the Cyprus National Bioethics Committee (ref. number: ΕΕΒΚ/ΕΠ/2020/13) and written informed consent was obtained from all participants prior to participation.

Data analysis plan

All statistical analyses were conducted using SPSS 25.0. The mean HR was computed for each time period (baseline, BHT, PASAT-C).

Descriptive statistics for each variable were calculated and are presented in Tables 2.1, 2.2. The chi-square test was used to explore the distribution of frequencies for categorical variables (i.e., activity level and level of studies). The Likelihood Ratio was used when the expected values were less than five for RxC tables. Before performing the statistical analysis for continuous variables, data were checked using the absolute values of skewness and kurtosis for normality and the Levene's test for homogeneity of variances as parametric test assumptions. For continuous measurements that were not normally distributed (depression, anxiety, stress, BMI, weight concerns, DT [self-reported], DT [as measured by performance on the two distress tasks]) bootstrapping with 1,000 re-samples was performed in analysis.

Firstly, to examine whether the BHT and the PASAT-C were successful in inducing unpleasant emotion, participants' PANAS-negative affect (NA) score at baseline was compared against PANAS-NA scores after each task. Repeated-Measures ANOVAs were conducted with Time (baseline, post-BHT, post-PASAT-C) as the within-subjects variable and the PANAS-NA as the dependent variable.

Following, Repeated Measures Factorial ANOVAs were conducted for analysis involving the physiological index of HR and the self-reported emotions with Time (baseline, BHT, PASAT-C) as the within-subjects variable and ED risk group (high vs. low) as the between-subject variable. More specifically, five repeated measures Time x ED risk group ANOVAs were conducted with HR, PANAS-NA score, SAM-valence, SAM-arousal and SAM-control as dependent variables. Simple effect analysis with Bonferroni adjustment was

used to break down significant interactions. The same analysis was run with physical activity level as a covariate as it has been found to influence autonomic reactivity (Klaperski et al., 2013).

Two independent samples t-tests were conducted to examine group differences in PASAT-C latency to quit and BHT duration. One more independent samples t-test was conducted to examine group differences in DTS scores.

Finally, Pearson's r correlations were conducted on an exploratory basis between the physiological measure (HR), recorded during the BHT and the PASAT-C and the affect ratings PANAS-NA, SAM-valence, SAM- arousal, SAM-control as recorded after the tasks. The analysis was conducted for the high and low risk participants separately to investigate correspondence between physiological reactions and self-report affect ratings.

Partial η^2 was used to report effect sizes for repeated measures ANOVAs, using the commonly used guidelines proposed by Cohen (1988, pp. 284–7): .01=small effect, .06=moderate effect, .14=large effect. A probability value of less than .05 was considered significant.

2.2 Results

2.2.1 Descriptive Statistics

Participants' characteristics, behaviours and attitudes based on the self-report questionnaires.

Tables 2.1, 2.2 present the Means and Standard Deviations for the self-report questionnaires used in the study, as well as the t statistic for comparisons between the two groups on each of these variables.

Table 2.1

Sample Characteristics and t-test Comparisons among the High and Low ED Risk Groups.

	Total Sample N=114	High risk n=56	Low risk n=58	Between-group comparisons t(df)
	M (SD)	*M (SD)*	*M (SD)*	
Age (years)	21.46 (2.01)	21.57 (1.99)	21.34 (2.04)	.60 (112)[1]
BMI (kg/m^2)	22.10 (3.54)	22.62 (4.02)	21.59 (2.95)	.51 (112)[1]
	N (%)	N (%)	N (%)	χ^2(df)
Ethnicity				
Cypriot	96 (84.2)	46 (82.1)	50 (86.2)	
Greek	14 (12.3)	8 (14.3)	6 (10.3)	
Other	4 (3.5)	2 (3.6)	2 (3.4)	
Level of Studies[1]				4.09 (1)[2*]
Undergraduate	63 (55.3)	36 (64.3)	27 (46.6)	
Graduate	50 (43.9)	19 (33.9)	31 (53.4)	
Physical Activity Intensity				11.82 (4)[3*]
Inactive	12 (10.5)	2 (3.6)	10 (17.2)	
Light	55 (48.2)	31 (55.4)	24 (41.4)	
Moderate	35 (30.7)	20 (35.7)	15 (25.9)	
Hard	10 (8.8)	3 (5.4)	7 (12.1)	
Very hard	2 (1.8)	-	2 (3.4)	

Note. *M* = mean; *SD* = standard deviation; *BMI* = Body Mass Index.
[1] = Independent Samples t-test with bootstrapping (1,000 re-samples); [2] = Chi-Square test (Pearson Chi-Square); [3] = Chi Square test (Likelihood Ratio)
*$p \leq 0.05$

Table 2.2

Participants' Behaviours and Attitudes across ED Risk Groups.

	Total Sample N=114	High risk n=56	Low risk n=58	Between-group comparisons t(df)
	M (SD)	*M (SD)*	*M (SD)*	
WCS	48.60 (21.75)	66.96 (7.60)	30.86 (15.18)	16.14 (84.56) *
DTS total	2.94 (.78)	2.63 (.74)	3.23 (.70)	-4.40 (112) *[2]
Tolerance	2.92 (.99)	2.59 (.91)	3.25 (.95)	-3.76 (112) *[2]
Appraisal	3.25 (.81)	2.91 (.77)	3.58 (.70)	-4.89 (112) *[2]
Regulation	2.62 (.87)	2.49 (.86)	2.75 (.88)	-1.56 (112)[2]
Absorption	2.95 (1.00)	2.55 (.94)	3.34 (.91)	-4.58 (112) *[2]
DASS-21[1] -Depression subscale	6.04 (5.94)	5.61 (5.49)	6.45 (6.37)	-.75 (112)
DASS-21[1] - Anxiety subscale	5.82 (5.85)	4.79 (4.76)	6.83 (6.62)	-1.90 (103.604)
DASS-21[1] - Stress subscale	10.79 (6.56)	10.82 (6.12)	10.76 (7.01)	-.05 (112)

Note. *M* = mean; *SD* = standard deviation; N = Number; WCS = Weight Concerns Scale; DTS = Distress Tolerance Scale; DASS-21 = Depression Anxiety Stress Scale-21.
[1] = analysis for this variable included 113 cases, high risk = 55, low risk = 58, [2] = Independent samples t-test with bootstrapping (1,000 re-samples)
*$p \leq 0.001$

2.2.2 Preliminary Analyses

Results showed that there were no significant differences on depression BCa 95% CI [-2.95, 1.30], t (112) = -.75, p = .45, anxiety, BCa 95% CI [-4.15, 0.17], t (103.60) = -1.90, p = .06, stress, BCa 95% CI [-2.22, 2.34], t (112) = -.05, p = .96, or BMI, BCa 95% CI [-0.26, 2.30], t (112) = .51, p = .12, among the high and low ED risk groups. It is thus concluded that differences in physiological and emotional reactivity between the high and the low ED risk groups are not confounded by depressive and anxiety symptoms, or BMI. Among the high-risk group 14.7% of participants reported mild to extremely severe depression, 23.3% mild to extremely severe anxiety and 21.4% mild to severe stress. Among the low ED risk participants, 24.1% reported mild to severe depression, 36.3% mild to extremely severe anxiety, 29.7% mild to severe stress.

As for weight concerns, high risk participants reported significantly more weight concerns (BCa 95% CI [31.63, 40.47], t (84.56) = 16.14, $p < .001$; M = 66.96, SD = 7.60) than their low-risk counterparts (M = 30.86, SD = 15.18).

Self-reported distress tolerance

The two risk groups significantly differed on their ability to tolerate distress based on their self-report responses on the DTS, (BCa 95% CI [-.86, -.32], t (112) = -4.40, $p < .001$). More specifically, high risk participants were found to be significantly less distress tolerant (M = 2.63, SD = .74) than their low-risk counterparts (M = 3.23, SD = .70). When comparing the two groups on the four aspects as examined by the DTS (distress tolerance; distress appraisal; distress regulation; distress absorption), results indicate that, firstly, participants at high risk for EDs report significantly greater difficulties (BCa 95% CI [-.983, -.330], t (112) = -3.76, $p < .001$) in handling being distressed or upset (M = 2.59, SD = .91) than low risk participants (M = 3.25, SD = .95). Secondly, their appraisal of being distressed reflects a significantly greater lack of acceptance of distress (BCa 95% CI [-.926, -.383], t (112) = -4.89, $p < .001$; M = 2.91, SD = .77) as compared to low-risk participants (M = 3.58, SD = .70). Thirdly, high and low risk participants exhibit a similar pattern of efforts to avoid negative emotions (p = .12). Fourthly, high risk participants reported being significantly more consumed by the presence of distressing emotions (BCa 95% CI [-1.133, -.448], t (112) = -4.58, $p < .001$; M = 2.55, SD = .94) as compared to low-risk participants (M = 3.34, SD = .91).

2.2.3 Manipulation Checks

Following the procedure employed by previous experimental studies in the field (e.g., Koushiou et al., 2018) PANAS-NA score was used to assess whether the physical (BHT) and the cognitive (PASAT-C) stress tasks successfully induced unpleasant affect. To do so, participants' PANAS-NA score at baseline was compared to PANAS-NA score completed after each task. The SAM was administered only after completion of each task and therefore was not incorporated in the manipulation check analyses. A Repeated-Measures ANOVA was conducted with Time (PANAS-NA score at baseline [time1], post-BHT [time2], post-PASAT-C [time3]) as the within-subject factor and PANAS-NA score as the dependent variable. Mauchly's test of sphericity indicates that the assumption of sphericity had been violated $\chi^2(2) = 20.84$, $p < .001$, therefore degrees of freedom were corrected with Huynh-Feldt estimates of sphericity ($\varepsilon = .87$). The results indicate that there was a significant effect of time, $F_{(1.73,\ 195.87)} = 80.14$, $p < .001$, $\eta_p^2 = .42$. Pairwise comparisons showed that participants reported significantly lower negative affect at baseline than after the BHT (M_{DIFF} = -.83, $p < .05$, 95% CI [-1.54, -.11]) and after the PASAT-C (M_{DIFF} = -5.32, $p < .001$, 95% CI [-6.36, -4.28]).

Overall, participants' affect ratings after the two stress tasks significantly differed from baseline, suggesting that the two tasks were successful in emotion induction.

2.2.4 Main Analyses

Table 2.3 shows the means and standards deviations of participants' physiological and affect responses to the BHT and the PASAT-C. To investigate each groups' reactivity to each task, separate Repeated Measures ANOVAs were conducted for each of the following dependent variables: HR, PANAS-NA score, SAM-valence, SAM-arousal, SAM-control. Time was added as a within-subjects variable with three levels for the HR and PANAS-NA, and two levels for the SAM variables. The assumption of sphericity was violated for HR and PANAS-NA score and thus Huynh-Feldt corrected degrees of freedom were used to assess the significance of the corresponding F-ratio. To follow up the main effects Bonferroni-corrected pairwise comparisons were conducted.

Table 2.3

Means and SDs for the Physiological and Self-report Affect Measures for each ED Risk Group across the two Distress Tasks.

	High risk (n=56)			Low risk (n=58)			p values (between-group)[1]
	Baseline	BHT	PASAT-C	Baseline	BHT	PASAT-C	
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	
HR	79.82 (7.43)	81.90 (11.08)	88.96 (11.10)	80.99 (8.97)	76.70 (10.05)	79.41 (9.52)	*
PANAS-NA	11.95 (3.43)	13.30 (3.56)	18.29 (4.76)	11.40 (2.58)	11.71 (2.30)	15.72 (5.44)	*
SAM valence	-	5.98 (1.21)	4.54 (1.51)	-	6.41 (1.16)	6.01 (1.43)	*
SAM arousal	-	5.46 (1.75)	6.52 (1.54)	-	5.12 (1.81)	5.76 (1.82)	*
SAM control	-	6.61 (1.43)	3.46 (1.75)	-	6.69 (1.66)	5.33 (1.59)	**

Note. *M* = mean; *SD* = standard deviation; HR = Heart Rate; PANAS-NA = Positive and Negative Affect Scale, Negative Affect Score; SAM = Self-Assessment Manikin

[1] = significance of group main effect across conditions

*$p \leq 0.05$; **$p \leq 0.001$

Reactivity in response to BHT and PASAT-C across physiological, behavioural and self-report domains between participants at high vs. low ED risk

1. Heart Rate

Mauchly's test of sphericity indicates that the assumption of sphericity was violated $\chi^2(2) = 6.54$, $p = .038$, therefore degrees of freedom were corrected with Huynh-Feldt estimates of sphericity ($\varepsilon = .97$). Results suggested a significant main effect for time, $F_{(1.94,217.34)} = 30.41$, $p < .001$, $\eta_p^2 = .21$, indicating that participants' HR significantly differed over the three time periods (baseline, during BHT and during PASAT-C). Bonferroni corrected post hoc tests indicated that overall, participants' mean HR during baseline (M= 80.41, SD= 8.24) and during the BHT (M= 79.30, SD= 10.84) did not significantly differ (p = .24), but HR during PASAT-C (M= 84.19, SD= 11.34) was significantly higher compared to baseline ($p < .001$) and BHT ($p < .001$). In addition, results revealed a significant main effect of ED risk group, $F_{(1,112)} = 7.37$, $p < .01$, $\eta_p^2 = .06$. Bonferroni corrected post hoc tests indicated that overall, high-risk participants presented higher mean HR ($M = 83.56$, $SE = 1.19$) than low risk participants ($M = 79.04$, $SE = 1.17$).

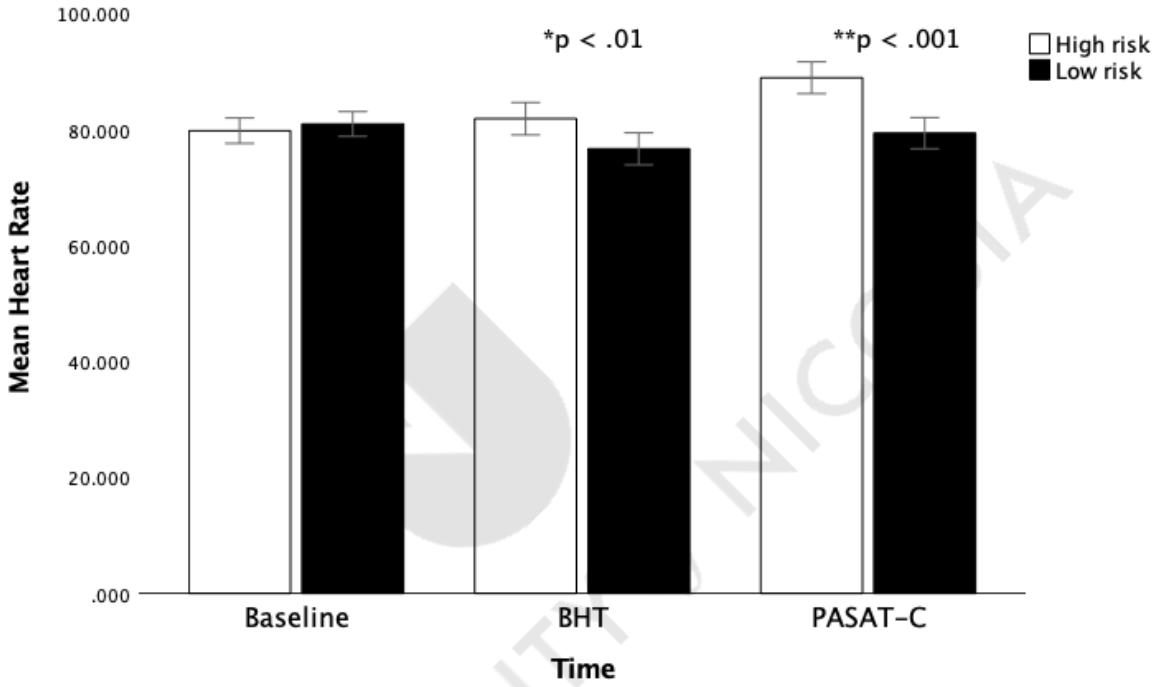
There was also a significant ED risk x Time interaction, $F_{(1.94,217.34)} = 33.60$, $p < .001$, $\eta_p^2 = .23$. To break down this interaction, follow-up Repeated Measures ANOVA were computed for each ED risk group separately with Time (baseline, during BHT, during PASAT-C) as a within subject variable. Mauchly's test of sphericity indicates that the assumption of sphericity had been violated for the high risk group, $\chi^2(2) = 15.34$, $p < .001$, therefore degrees of freedom were corrected with Huynh-Feldt estimates of sphericity ($\varepsilon = .82$). A significant main effect of Time was found for both the high ED risk group, $F_{(1.64, 90.43)} = 42.90$, $p < .001$, $\eta_p^2 = .44$, as well as for the low risk group, $F_{(2, 114)} = 14.03$, $p < .001$, $\eta_p^2 = .20$. Low risk participants presented significantly lower HR during the BHT ($M = 76.70$, $SD = 10.05$) than at baseline ($M = 80.99$, $SD = 8.97$) and during the PASAT-C ($M = 79.41$, $SD = 9.52$). There was no significant difference in the HR of low risk participants at baseline and during the PASAT-C ($p = .16$). On the other hand, high risk participants' mean HR during the PASAT-C was significantly higher ($M = 88.96$, $SD = 11.10$) than at baseline ($M = 79.82$, $SD = 7.43$) and during the BHT ($M = 81.90$, $SD = 11.08$). No significant differences were observed for the HR of high-risk participants during the baseline and during the BHT ($p = .15$). Furthermore, we examined Bonferroni corrected pairwise comparisons between the two groups at each time point (HR: at baseline, during BHT, during PASAT-C). Results showed significant group differences only for mean HR during the two distress tasks (BHT [$F_{(1, 112)} = 6.89$, $p < .01$]; PASAT-C [$F_{(1, 112)} = 24.32$, p

< .001]; see Figure 2.1, with the high risk group exhibiting significantly higher mean HR during both tasks (BHT: *M* = 81.90, *SD* = 11.08, PASAT-C: *M* = 88.96, *SD* = 11.10) compared to the low risk group (BHT: *M* = 76.70, *SD* = 10.05, PASAT-C: *M* = 79.41, *SD* = 9.52).

It is important to note that including physical activity level as a covariate did not change the main findings for the HR.

Figure 2.1

Interaction Time x Group on Mean Heart Rate.



Note. Error bars: 95% CI

2. Self-reported emotions

i. PANAS Negative Affect Score

Mauchly's test of sphericity indicates that the assumption of sphericity was violated $\chi^2(2) = 19.69$, $p < .001$, therefore degrees of freedom were corrected with Huynh-Feldt estimates of sphericity ($\varepsilon = .88$). The ED risk x Time interaction did not reach significance ($p = .09$) but there was a significant main effect of Time, $F_{(1.76,197.16)} = 81.65$, $p < .001$, $\eta_p^2 = .42$, indicating that participants' PANAS-NA score significantly differed over the three time periods (baseline, post-BHT and post-PASAT-C). Post hoc tests indicated that overall, self-reported negative affect after the two distress tasks was significantly different from baseline. In particular, participants reported significantly higher negative affect after the BHT (*M* = 12.51, *SD* = 3.08) and after the PASAT-C (*M* = 17.01, *SD* = 5.26) compared

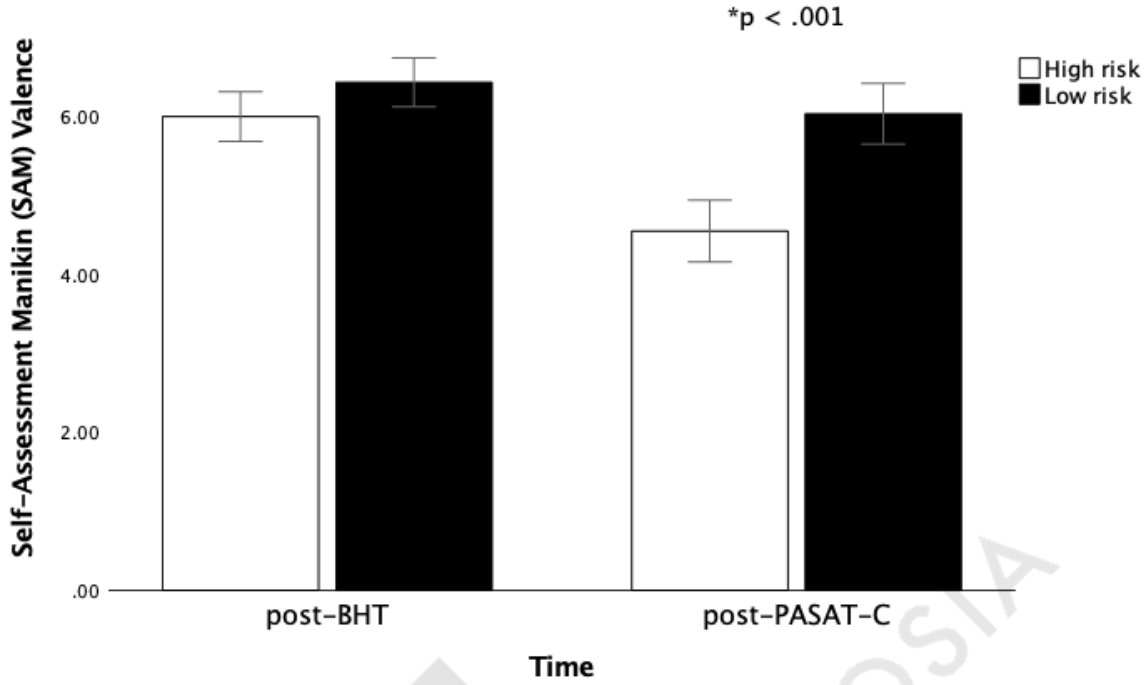
to baseline (M = 11.67, SD = 3.03; $p < .001$). Moreover, there was a significant difference between the two distress tasks in terms of negative affect reported by participants, such that negative affect reported after the PASAT-C (M = 17.01, SD = 5.26) was significantly higher compared to negative affect reported after the BHT ($p < .001$). There was also a significant main effect for ED risk group, $F_{(1,112)} = 9.87$, $p < .005$, $\eta_p^2 = .08$. Bonferroni corrected post hoc tests indicate that overall, high-risk participants reported higher negative affect (M = 14.51, SE = .36) than their low-risk counterparts (M = 12.94, SE = .35).

ii. SAM-Valence

Results indicated a significant main effect for time, $F_{(1,112)} = 48.45$, $p < .001$, $\eta_p^2 = .30$. Bonferroni pairwise comparisons showed that overall participants assessed the cognitive stress task – PASAT-C – as more unpleasant (M = 5.28, SD =1.64) than the physical stress task – BHT (M = 6.20, SD =1.20). A significant main effect of ED risk group, $F_{(1,112)} = 20.27$, $p < .05$, $\eta_p^2 = .15$, was also observed, with high-risk participants reporting higher overall unpleasantness (M = 5.26, SE = .15) than low risk participants (M= 6.22, SE =.15). A significant ED risk x Time interaction, $F_{(1,112)} = 15.72$, $p < .001$, $\eta_p^2 = .12$, was also observed. Following up the interaction effect, two paired samples t-tests and two independent t-test were computed using the Bonferroni correction (adjusted p = .05/4 = .0125). These analyses suggested that high-risk participants reported significantly more unpleasantness following the PASAT-C (M = 4.54, SD =1.51) than following the BHT (M = 5.98, SD =1.21, t (55) = 7.80, $p < .001$). However, among low-risk participants, there is no significant difference between the unpleasantness reported after the BHT and after the PASAT-C (p = .04). Furthermore, we compared the two ED risk groups' valence scores at each time (post-BHT and post-PASAT-C). Results showed that there was no significant difference between high and low risk participants in the pleasantness/unpleasantness reported after the BHT (p = .05), however, high risk participants reported feeling significantly more unpleasant after the PASAT-C (M = 4.54, SD =1.51) as compared to their low-risk cohorts (M = 6.02, SD =1.43; t (112) = 5.37, $p < .001$; see Figure 2.2).

Figure 2.2

Interaction Time x Group on SAM – Valence.



Note. Error bars: 95% CI

iii. SAM-Arousal

The ED risk x Time interaction did not reach significance (p = .20), but there was a significant main effect for time, $F_{(1,112)} = 27.99$, $p < .001$, $\eta_p^2 = .20$. Bonferroni pairwise comparisons showed that overall participants assessed PASAT-C as more arousing (M = 6.14, SD =1.72) than the physical stress task – BHT (M = 5.29, SD =1.78). There was also a significant main effect of ED risk group, $F_{(1,112)} = 3.81$, $p \leq .05$, $\eta_p^2 = .15$, with high-risk participants reporting higher overall arousal (M = 5.99, SE = .20) than low risk participants (M= 5.44, SE =.20).

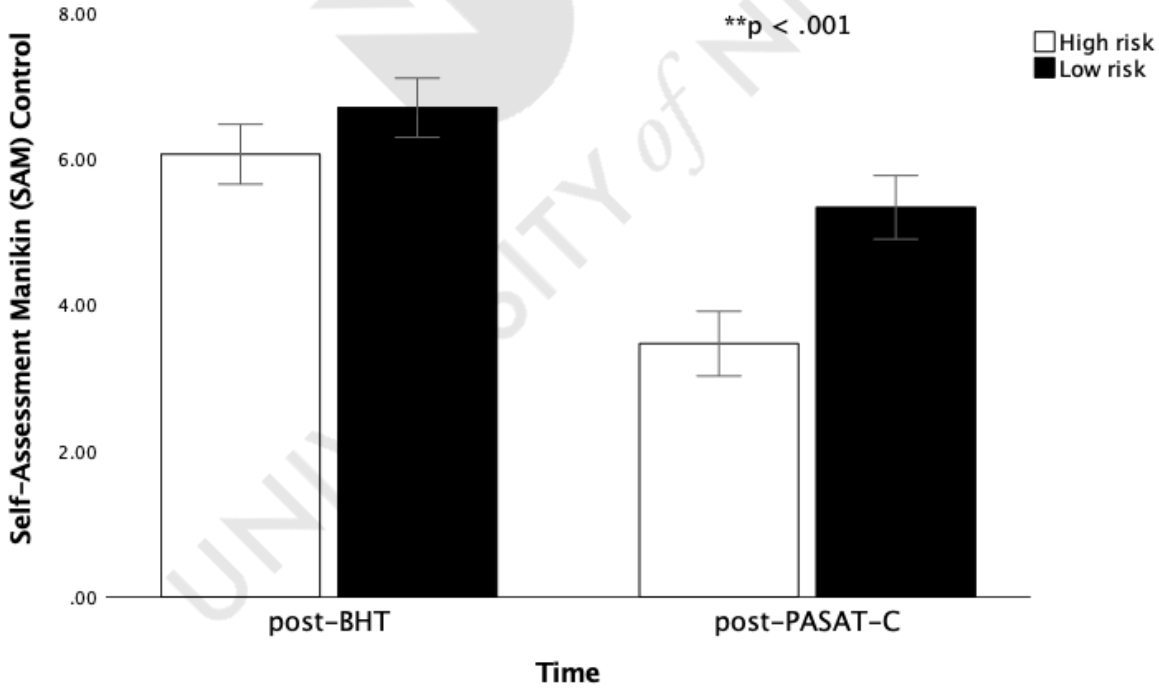
iv. SAM-Control

Results indicated a significant main effect for time, $F_{(1,112)} = 118.36$, $p < .001$, $\eta_p^2 = .51$. Bonferroni pairwise comparisons showed that overall participants reported feeling greater control over the situation after the physical stress task – BHT – (M = 6.37, SD =1.58) than after the cognitive stress task – PASAT-C – (M = 4.40, SD =1.91). A significant main effect of ED risk group was also observed, $F_{(1,112)} = 26.83$, $p < .001$, $\eta_p^2 = .19$. Bonferroni pairwise comparisons revealed that low-risk participants reported feeling higher overall control over the situation (M = 6.01, SE = .17) than high-risk participants (M= 4.76, SE =.17).

Results also revealed a significant ED risk x Time interaction, $F_{(1,112)} = 11.42$, $p \leq .001$, $\eta_p^2 = .09$. To examine the interaction effect, two paired samples t-tests and two independent t-test were computed using the Bonferroni correction (adjusted $p = .05/4 = .0125$). The results suggested that low risk participants reported significantly less control over the situation after the PASAT-C ($M = 5.33$, $SD = 1.59$) than after the BHT ($M = 6.69$, $SD = 1.66$). High risk participants presented a similar pattern of results, reporting lower emotional control after the PASAT-C ($M = 3.46$, $SD = 1.75$) than after the BHT ($M = 6.05$, $SD = 1.43$). In addition, we compared the two ED risk groups' scores of control over the situation at each time point (post-BHT and post-PASAT-C). Results showed that there was no significant difference between high and low risk participants in the feelings of control over the situation reported after the BHT ($p = .03$), however, high risk participants reported feeling significantly less control over the situation after the PASAT-C ($M = 3.46$, $SD = 1.74$) as compared to their low-risk cohorts ($M = 5.33$, $SD = 1.59$; $t(112) = 5.95$, $p < .001$; see Figure 2.3).

Figure 2.3

Interaction Time x Group on SAM – Control.



Note. Error bars: 95% CI

3. Behavioural reactions (PASAT-C & BHT duration)

An independent samples t-test showed that there was a significant difference between high vs. low-risk groups in the duration they stayed on the PASAT-C, BCa 95%

CI [-62.25, -13.55], t (107.73) = -3.05, $p < .005$. High risk participants stayed on the task significantly less time (M = 88.30, SD = 71.46) than low risk participants (M = 126.22, SD = 60.55). A second univariate ANOVA showed that breath-hold duration, during the BHT, did not significantly differ between the two groups (p = .26). See Table 2.4 for Means and Standard Deviations and comparisons between the two groups on the behavioural variables.

Table 2.4

Means and SDs for the Behavioural Responses among the High and Low ED Risk Groups.

	High risk (n=56)	Low risk (n=58)	p values (between-group)
	M (SD)	*M (SD)*	
PASAT-C- Latency to Quit (seconds)	88.30 (71.46)	126.22 (60.55)	*
BHT- Latency to quit (seconds)	28.35 (13.73)	31.10 (12.37)	

*$p \leq 0.005$

Correlations between physiological and self-report affect responses

Spearman's rho correlations were conducted on an exploratory basis, between the physiological measure (HR) recorded during the BHT and the PASAT-C, and the affect ratings PANAS-NA, SAM-valence, SAM- arousal, SAM-control reported post tasks. The analysis was conducted for the high (N = 56) and low (N = 58) risk participants separately to investigate correspondence between physiological reactions and self-reported affect ratings. Results revealed that high risk participants showed a good correspondence between physiological responding and self-reported affect ratings. In particular, high risk participants' HR during the BHT correlated positively with self-reported PANAS-NA, r_s (54) = .33, $p < .05$, and arousal, r_s = .29, $p < .05$. During the PASAT-C, high risk participants' HR correlated positively with arousal, r_s = .40, p = < .005, and negatively with valence, r_s = -.45, $p < .001$ and control, r_s = -.50, $p < .001$. No significant correlations were found for the low-risk group in any of the two tasks.

2.3 Discussion

The aim of the present study was to firstly assess the effectiveness of a cognitive and a physical stress task in inducing negative affect. A second aim was to assess emotional responses to the two stress tasks between participants at high vs. low risk for developing EDs, integrating physiological, behavioural, and self-report measures of emotional experience. Furthermore, differences in the ability to tolerate distress between

the two groups were assessed via self-report measures. The present study extends the current literature on affective response in EDs by comparing affect response to a cognitive stress task vs. a physical stress task and further by employing individuals who do not currently meet criteria for an ED diagnosis, expecting to grasp the actual emotional experience of individuals, without the confounding effects associated with illness progression.

Hypothesis 1: Emotional reactivity to the physical vs. the cognitive induced stress in young female adults at high vs. low risk for EDs

Both the physical, as well as the cognitive stress task, appeared to be successful in emotion induction, as negative affect reported after each of the two tasks was significantly higher compared to negative affect reported at baseline.

High risk participants exhibited greater physiological arousal (i.e., higher HR response) during both tasks compared to low-risk participants. This finding is in line with previous research in the field (Koushiou et al., 2019), suggesting that higher physiological arousal may point to a trait-like feature that exists prior to illness onset and increases vulnerability. This hyperarousal to somatosensory experience may in turn act as an ED risk factor either by making emotions difficult to tolerate or by generating a hyperawareness of the body (Merwin, 2011). This result of hyperarousal also points to poor emotion regulation in the high ED risk group. An inability to regulate emotions adaptively then leads to avoidance of negative psychological states or situations that might evoke emotions that are difficult to tolerate. This finding confirms the Haynos and Fruzzeti (2011) model of emotion regulation suggesting that individuals at the premorbid stages of the illness demonstrate heightened emotionality. Later in the course of illness, as observed in studies using ED clinical samples (Herbert et al., 2013; Laberg et al., 1991) prolonged exposure to starvation and neglect of hunger cues, lead to a strengthening of avoidant behaviours thus making these same individuals less reactive to emotional cues. Although the Haynos and Fruzzeti (2011) conceptualization focuses more on AN features, with research suggesting a temporal shift between ED diagnoses over time, we could propose that this conceptualization can be extended to other ED diagnoses as well. In fact, emotion dysregulation has been established as a transdiagnostic risk factor for the development of all EDs (Danner et al., 2014; Donofry et al., 2016; Fairburn et al., 2003; Monell et al., 2015).

Evidence from participants' subjective emotional experience (i.e., self-report affect responses) to the two stress tasks showed that individuals at high ED risk reported greater

unpleasantness and less control over the situations, compared to individuals at low ED risk. This was the case only after the cognitive stress task (i.e., the PASAT-C).

Previous research suggests that clinical and subclinical populations of ED (Merwin, Timko, et al., 2010; Zucker et al., 2013) experience higher levels of sensitivity to sensation and attempts to avoid sensory sensations suggesting a hypersensitivity to somatic sensations. Based on these findings, we hypothesised that high risk participants would exhibit a differential pattern of emotional responding in response to the physical vs. the cognitive stress task, with higher emotional reactivity and being less distress tolerant in response to the task aimed at inducing physical distress. Nevertheless, results indicate the exact opposite pattern of results, with high-risk participants exhibiting higher emotional reactivity and distress tolerance (higher physiological and self-report responses), to the task aimed at inducing cognitive distress. As far as the subjective response to the tasks is concerned, high-risk participants reported greater unpleasantness and less control over the situation compared to low-risk participants, only after the cognitive stress task (i.e., the PASAT-C).

This observation, albeit preliminary, suggests that this population experiences more difficulties when encountered with cognitive distress. Nevertheless, it should be noted that our results may in part be influenced by the use of two experimental paradigms that are very different in nature. The PASAT-C requires greater (intellectual) capacity (Brooks et al., 2011) compared to the BHT. The PASAT has been found to be a very difficult task for the general population, even under ideal circumstances (Brooks et al., 2011). Moreover, the BHT gives participants a sense of control over task termination since they are instructed to "hold their breath for as long as they can", and thus may not produce the same degree of distress as that created by the PASAT-C which is more restrictive and gives less freedom to the participant over task termination (i.e., able to quit only on Level 3).

Hypothesis 2: Ability to tolerate distress as indicated via behavioural reactions to the distress tasks and the self-report responses to the DTS

There is growing evidence for the role of DT, defined as the ability to withstand negative affect, in both the cause and maintenance of dysregulated eating behaviours. Empirical evidence suggests that individuals with EDs present reduced ability to tolerate distress (Zvolensky et. al., 2010; Corstorphine et al., 2007; Anestis et al., 2007; Safer et al., 2001; Telch et al., 2001; Chen et al., 2015). However, studies to date have not examined DT in subclinical populations. Based on the behavioural reactions to the two distress tasks (i.e., time spent on the tasks) used in the current study, it was observed that high and low

risk participants spent a similar amount of time on the BHT – the physical stress task, while significant differences were observed for the duration they stayed on the PASAT-C – the cognitive stress task. Specifically, high risk participants stayed on the PASAT-C for a significantly shorter time compared to their low-risk counterparts, similar to the findings of another study (Eichen et al., 2007). This outcome provides support to one of our previous findings showing heightened physiological reactivity in high ED risk individuals in response to the cognitive stress task compared to the physical stress task. Taken together, these findings indicate that females at high ED risk assessed the cognitive stress task as more distressful compared to the physical stress task.

In addition, based on the participants' self-reported responses on the DTS (Simons & Gaher, 2005), individuals at high ED risk demonstrated a reduced ability to withstand negative affect (i.e., poorer DT) – the same impairment as that seen in clinical populations – compared to their low-risk counterparts. When comparing the two groups on the four aspects as examined by the DTS (i.e., tolerance, appraisal, regulation, absorption) results indicate that firstly, participants at high risk for ED portray an impaired ability handling being distressed or upset, reporting that distress is unbearable to them. Secondly, high risk participants' individual appraisal of being distressed reflects a lack of acceptance of distress, that they are ashamed of their feelings of distress, and perceive their coping abilities to distress as inferior to others. Examining the third aspect of the DTS, high risk participants are found to be relatively consumed by the presence of distressing emotions, with their functioning being significantly disrupted when experiencing negative emotions. Findings concerning the fourth and final aspect of the DTS (regulation) have been somewhat unexpected, with the two groups exhibiting a similar pattern, that fell into the medium levels of efforts to avoid negative emotions. Although this finding may seem unexpected, it may actually signify the increased desire of ED populations to conform with societal standards to minimise threat of social rejection (Merwin, Timko, et al., 2010). There is a link between ED symptoms and perfectionistic self-presentation (i.e., striving to create an image of flawlessness to others) (McGee et al., 2005) and fears of negative evaluations by others (Gilbert & Meyer, 2005; Trompeter et al., 2019). In this case, by providing a socially acceptable response (or a response that one deems to be more socially acceptable), increases the likelihood of being perceived as "normal" and minimizes the risk of being negatively evaluated by others.

The aforementioned result from the self-report measure of DT contradicts with the behavioural response of high-risk participants to the PASAT-C, in which they

demonstrated a significantly shorter duration compared to low-risk participants, indicating avoidance of negative affect. This discrepancy between behavioural and self-reported efforts of emotional avoidance suggests that there are differences between their *perceived* and *actual* tolerance of distress.

Overall, even in the absence of a clinical diagnosis, high risk participants seem to portray various difficulties in emotional responding, and more specifically an impaired ability to tolerate distress and accept their feelings of distress and are getting absorbed by these feelings.

Hypothesis 3: Correspondence between objective (physiological) and subjective reactions to the two stress tasks

An examination of the correspondence between the physiological and self-reported reactions of high vs. low-risk participants to the two distress tasks points to a hyperawareness of the body among high-risk participants. More specifically, high risk participants' HR was related with PANAS-NA, arousal, valence, and ability to control reactions over the situation. Such results may indicate that high risk individuals experienced distress in high intensity (higher intensity leads to more correspondence; Hollenstein & Lanteigne, 2014) and also a stronger network of negative emotions in this group. However, considering their diminished ability to tolerate distress, they seem to lack the necessary skills to effectively respond to negative emotional states and thus rely on maladaptive ways to achieve a reduction of that affective sensation. Nevertheless, this finding remains on a speculative level and future studies are needed to explore how individuals in the premorbid stages of the disorder experience their body.

It is important to note that there was no significant correspondence between physiological and self-report reactions to the two tasks for the low-risk group. In fact, emotional correspondence has been difficult to empirically assess even in non-clinical populations (Hollenstein & Lanteigne, 2014).

2.3.1 Limitations

The current study has a number of limitations. The sample used in the current study was homogenous in that most participants were of Cypriot nationality and were educated either at an undergraduate or graduate level. A more diverse sample in terms of culture, age and educational background may help increase generalizability of results. Secondly, the use of a cross-sectional design in the present research makes it difficult to ascertain whether low perceived DT is a correlate of the development or maintenance of ED

pathology. Although the current study provides initial understanding of the potential role of DT in ED risk, it is necessary for further empirical work in this area to utilise longitudinal designs to examine the role of DT in the onset and maintenance of ED symptoms and psychopathology. Thirdly, investigation of autonomic response to distressful stimuli in the current study was limited to just one physiological index (i.e., HR). Future research would benefit from the addition of more valence-specific physiological indices, such as corrugator and eye blink startle reflex, to systematically explore autonomic responses in samples with subthreshold and threshold manifestations of ED. Fourth, it is possible that breath-holding duration, as a behavioural index of physical DT, is affected by individual differences in lung capacity. Future research utilizing a variety of physical DT tasks is recommended. In spite of these limitations, the current study is one of the few to have used a well-controlled experimental design to investigate the affective experience of females at risk for EDs in two contexts (physical vs. cognitive), across multiple domains of emotional responding (physiological, behavioural, self-reported).

2.3.2 Conclusions

The current study contributes to the literature as it is one of the few to have used a well-controlled experimental design to investigate the emotional experience of females at risk for ED development across physiological, subjective and behavioural domains, in response to a psychological and a physical stress task. Results suggest that females at high risk exhibit an overall hyper-reactivity (physiological [higher HR] & subjective) to distressful stimuli. This was true for both the physical and the cognitive stress tasks. Data from the physiological responding and self-reported emotional experience indicate that individuals at high ED risk experience significantly greater physiological reactivity (i.e., higher HR) which is also accurately reflected in their subjective responses compared to low ED risk individuals, when presented with the same stimuli. This heightened reactivity to distressful stimuli in individuals at high ED risk, suggesting hypersensitivity to negative affect, may point to a dispositional trait, evident prior to illness development, which sets the individual at risk for an ED. Future intervention for EDs may focus on empowering individuals to manage situations that involve strong, negative affect. Albeit significant findings, suggesting an overall hypersensitivity to negative affect in individuals at high ED risk, future research is needed to explore this populations' autonomic responses to negative affect adding more physiological indices.

Exploring reactivity to emotional distress could also be added in future research and compared to reactivity to cognitive and physical distress. Also, the use of a clinical population could help examine whether heightened emotionality is hindered with illness progression. Using a clinical population, future research could diagnostically separate participants into specific ED categories to verify that IAcc and DT constitute transdiagnostic features for maintaining eating pathology. Longitudinal research designs can prove helpful in examining whether emotional reactivity to negative affect is changing with illness progression and whether it contributes to symptom development. This line of prospective study can be helpful in shedding light on the potent and significant risk factors that increase the likelihood of ED and lead to novel directions regarding clinical interventions that relate to emotional reactivity to prevent ED development.

A particular pattern of results seems to emerge for the high ED risk group when comparing emotional responsivity to the physical vs. the cognitive stress task. More specifically, females at high ED risk exhibit greater objective and subjective reactivity to the cognitive stress task than the physical stress task. Based on this finding, it can be suggested that individuals at high ED risk may become overwhelmed by a variety of strong emotions (i.e., poor DT) but may be somewhat better at tolerating physical discomfort (i.e., persist long periods of non-eating, engage in purge activities). Although this outcome provides only initial empirical evidence and future studies are needed to replicate these findings to identify the specificity of emotional disruptions in ED populations, important treatment implications can be derived. Clinical interventions for EDs may distinguish between tolerance related to emotions and tolerance related to physical cues and sensations. Individuals at clinical or subclinical levels of EDs may benefit from treatments and techniques that tackle each aspect of DT alone.

CHAPTER 3

STUDY 2

Interoceptive accuracy and eating disorder risk in young female adults:

The mediating role of distress tolerance

Abstract

Objective: Previous research suggests that eating disorder (ED) populations have difficulties in perceiving bodily signals. However, findings may be compromised by the physical effects of the disorder (i.e., bradycardia). Thus, the first aim of the present study was to examine interoceptive accuracy (IAcc) among young females at high vs. low ED risk, using the Heartbeat Perception Task. If individuals vulnerable to EDs, who are not affected by the physical effects seen at the later stages of the disorder, are more interoceptive accurate, then it is expected that they will experience emotions with greater intensity. Experiencing emotions with greater intensity may, in turn, lead to emotions felt or experienced as a lot more intolerable. Therefore, the second aim of the current study was to examine behavioural reactivity to two distress tasks (i.e., time spent on the tasks), expected to be indicative of distress tolerance (DT), in high vs. low ED risk individuals. Finally, DT was assessed as a possible mediator in the relationship between IAcc and ED risk.

Method: We assessed IAcc and DT in 114 females aged 18-25 years old, either at high (N=56) or low (N=58) risk for EDs.

Results: High risk participants demonstrated higher IAcc and lower DT compared to their low-risk cohorts. DT to cognitive frustration was a significant mediator in the relationship between IAcc and ED risk.

Conclusions: Individuals at high ED risk exhibited higher IAcc and lower DT. Results demonstrate that tolerance to cognitive frustration is an important cognitive-affective mechanism underlying the IAcc-ED risk association.

Keywords: eating disorder risk, interoceptive accuracy, distress tolerance

3.0 Introduction

Eating disorders (EDs) constitute a major public health concern with increasing prevalence rates among young females (Smink et al., 2012). Although risk factors for EDs have been extensively studied in the empirical literature, the mechanisms underlying ED development still remain inconclusive. There is a plethora of research dedicated to the relationship between dysregulated emotions and EDs, however only recently has there been a focus on several specific factors relevant to the broader construct of emotion regulation. Such factors gaining consistent support are *interoceptive accuracy (IAcc)* (Merwin, Zucker, et al., 2010; Pollatos et al., 2008) and *distress tolerance (DT)* (Zvolensky et al., 2010).

IAcc, Emotional Experience and EDs

Many theories of emotion posit that *interoception*, conceptualised as the ability to perceive bodily signals accurately, is a crucial element of emotional experience (James, 1884; Damasio, 1994). A core idea of these theories posits that we feel emotions because we perceive bodily signals, suggesting that individuals who perceive bodily signals with a high degree of accuracy experience emotions with greater intensity and vice versa (i.e., decreased interoceptive abilities predict reduced perceived intensity of emotional experience) (James, 1884; Damasio 1994; Damasio, 1999). This positive association is confirmed in several empirical studies, utilizing either questionnaires (e.g., Mandler et al., 1958) or laboratory tasks (Critchley et al., 2004; Wiens et al., 2000; Katkin et al., 2001; Pollatos et al., 2005) to measure interoceptive abilities.

As early as 1962, Bruch observed that AN-patients exhibit deficits in their ability to identify and respond to internal bodily sensations. Recent empirical research supports Bruch's (1962) early observations and provide evidence for diminished interoceptive abilities in eating disorder (ED) patients (Fassino et al., 2004; Matsumoto et al., 2006; Pollatos et al., 2008; Klabunde et al., 2013; Khalsa et al., 2015, for a review see Martin et al., 2019). Interoceptive abilities in these population has been mostly assessed using self-report measures, thus resulting in the measurement of a subjective, self-evaluated trait, termed as *interoceptive sensibility*. To move beyond one's perception of interoceptive abilities (i.e., interoceptive sensibility), it is important to examine performance on objective measures of interoception, referred to as *interoceptive accuracy*.

A commonly used objective method of assessing IAcc is the Heartbeat Perception Task (HBPT; Schandry, 1981). Pollatos and colleagues (2008) used this method to assess

IAcc in a sample of anorexia nervosa (AN) patients. Despite Pollatos et al. (2008) findings demonstrating an impaired ability in AN-patients to accurately perceive their own heartbeat, results were confounded by the participants' low body mass index (BMI). Thus, results may be influenced by the physical problems observed in the acute or chronic stages of the disorder (i.e., bradycardia associated with low weight; Mitchell & Crow, 2006) and not reflect a true decrease in visceral sensitivity. This BMI and visceral under-sensitivity association may, in fact, point to the potential utility of ED symptomatology as a maladaptive strategy to attenuate emotional experience by muting somatic correlates. A more recent study by Klabunde and colleagues (2013), also utilizing the HBPT, tried to control for the confounding effects associated with illness progression by utilizing a sample of women recovered from BN. Results showed that deficits in IAcc are still present after recovery. A justification of the persistence of these deficits after recovery may be that a biological trait and/or a history of self-regulation difficulties resulting from environmental failures are present prior to the development of BN symptoms. Otherwise, it may be that the observed hyposensitivity to bodily signals, that persists after recovery, constitutes a biological adaptation in response to the disorder which has not regressed with clinical improvement and still affects the individuals' ability to accurately perceive bodily signals.

Thus, it is often assumed that sensation is muted in individuals with EDs and that hyposensitivity to somatic-affective cues reinforces symptom development by motivating patients to depend more on external cues to guide their behaviour (e.g., food intake), rather than internal sensations (e.g., satiation) and/or emotions (Merwin et al., 2013). However, contradictory findings have been observed showing that individuals with AN exhibit greater perceived sensitivity to sensation compared to healthy controls (HCs) (Merwin et al., 2013). Thus, it can be suggested that individuals with EDs are *hypersensitive* to somatosensory experience but have difficulty interpreting or tolerating these sensations, and therefore are unable to use these signals to respond in an adaptive way. Even though these findings may seem contradictory (i.e., pointing to either hyposensitivity or hypersensitivity to somatosensory experience), they signify the complex interaction between basic affective mechanisms and symptoms of ED. Haynos and Fruzzeti (2011) hypothesise that in the early stages of the disorder, patients (especially AN) experience *hypersensitivity* to somatic-affective cues. Supporting this theoretical account, a study examining reactivity in individuals at risk for EDs found an overall hypersensitivity to negative affect (Koushiou et al., 2019). Due to this hypersensitivity, emotions may be experienced as intolerable thus reinforcing the employment of ill-matched responses (i.e.,

avoiding and/or limiting food intake) to attenuate or escape these experiences. Later in the course of the illness, and especially in the absence of healthy strategies to regulate arousal, prolonged neglect of hunger cues and exposure to starvation, not only strengthen avoidant behaviours but eventually result in hyposensitivity to somatic-affective cues and a muting of sensations (Haynos & Fruzzetti, 2011).

In conclusion, evidence for the hypothesis of *hypo* or *hypersensitivity* to somatic-affective experience and its etiological role in the development of EDs is inconsistent. Studies to date have been conducted with clinical ED populations posing challenges as it is unclear whether sensitivities and/or disruptions are state phenomena secondary to the effects of the disorder or individual trait-characteristics that precede illness onset and increase vulnerability. To our knowledge, no studies to date have investigated IAcc in individuals who are at high risk for EDs but do not currently meet the criteria for an ED diagnosis. The current study aims to address this gap and assess ability to perceive visceral signals, and more specifically heartbeat - considered to reflect IAcc - of individuals at ED high risk, thus controlling for the confounding effects of ED symptoms found at the acute or chronic stages of the illness.

Distress Tolerance and Eating Disorders

DT, conceptualised as the capacity to withstand distress related to affective, cognitive and/or physical states (e.g., negative affect, physical discomfort; Simons & Gaher, 2005), has been gaining prominence as an important mechanism in the development and maintenance of EDs (Zvolensky et al., 2010). Several studies suggest that individuals with EDs are more distress intolerant and as a result engage in dysregulated eating behaviours to attenuate the experience of negative emotions. For example, a study comparing women presenting with an ED diagnosis to women with no prior history of EDs showed that women in the clinical group scored higher in the "avoidance of affect" and lower on the "accept and manage" subscales of the self-report scale used in the study compared to the non-clinical group (Corstorphine et al., 2007). This finding supports previous theoretical accounts (e.g., Heatherton & Baumeister, 1991) suggesting that individuals with EDs exhibit difficulties in tolerating negative affect and use disordered eating behaviours to attenuate the experience of it (Corstorphine et al., 2007). The same study also demonstrated a positive association between avoidance of affect and unhealthy eating attitudes (Corstorphine et al., 2007). Therefore, it is not the presence of negative affect itself that gives rise to ED symptomatology, but rather how one experiences and responds to negative emotional states. In fact, in their study Anestis and colleagues (2007)

not only found that DT significantly predicted bulimic symptoms, but also demonstrated that DT mediates the relationship between anxiety sensitivity and bulimic symptoms. This finding suggests that it is not anxiety sensitivity itself that is responsible for the development and maintenance of eating symptomatology, but rather the reduced ability to tolerate negative affect that may be caused by heightened fear of the physical symptoms of anxiety (Anesis, 2007).

The link between DT and eating disorder symptoms is also evident in treatment studies. Women with bulimia nervosa (BN) and binge eating disorder (BED) assigned to a Dialectical Behaviour Therapy (DBT) treatment group, offering training on various emotion regulation skills, such as DT skills, evidenced significant reduction in eating pathology compared to the control group. Nevertheless, enhancing DT skills is only a part of DBT protocols, therefore change may be a result of other aspects of the treatment alone (i.e., mindfulness, interpersonal effectiveness) or a combination of them.

While previous research provides evidence for the importance of the ability to tolerate negative affect in the development and maintenance of eating pathology, there has been an over-reliance on self-report measures which are subject to various limitations (e.g., response bias, interpretation of questions etc.). In fact, only one study has utilised an experimental paradigm to assess DT in an ED population (Yiu et al., 2018). Individuals with EDs and HCs were compared on three aspects of emotional responding (behavioural, physiological, self-report responses) to a mental arithmetic stress task. The behavioural distress tolerance measure used in this study was the "Paced Auditory Serial Addition Task-Computerized" (PASAT-C) (Lejuez et al., 2003) which has been demonstrated as a successful task to induce negative affect. Individuals in the clinical group reported significantly higher levels of negative emotions but similar physiological and behavioural manifestations of distress, compared to controls, after completion of the task. This lack of convergence between objective (physiological and behavioural) and subjective reactions to the cognitive stress task indicates that ED populations exhibit significantly higher subjective distress compared to HCs when presented with the same stimuli. Based on this observation, the authors concluded that the interpretation of experiences is what best distinguishes between ED patients and HCs.

In addition to the PASAT-C, which aims to induce *psychological* discomfort and assess one's ability to withstand it, there are other assessment procedures used to assess one's ability to tolerate other types of discomfort, such as *physical discomfort*. It is important to assess tolerance to physical sensations as well since EDs are primarily

characterised by a distortion in the way the body is experienced - not only *cognitively* but also *physically* (i.e., distortions in the perception of bodily signals) (Merwin, Zucker, et al., 2010). The present study aims to address a key gap in the literature by comparing performance on a cognitive (i.e., the PASAT-C) vs. a physical stress task, namely the Breath-Holding Task (BHT; Hajek et al., 1987) to assess DT to cognitive and physical discomfort in a sample of individuals at high risk for EDs. The use of a subclinical sample is expected to be indicative of the actual emotional experience of individuals at risk without the confounding effects associated with illness progression.

A Link between IAcc and Distress Tolerance (DT)?

Given the proposed role of IAcc in emotional experiencing, if individuals vulnerable to EDs are hypersensitive to somatic sensation (i.e., are high IAcc), then it is expected that they would experience emotions with greater intensity. Experiencing emotions with greater intensity may in turn lead to emotions felt or experienced as a lot more intolerable (Merwin, Timko, et al., 2010). While evidence exists supporting that tolerating aversive emotional states is particularly difficult for ED-patients, studies to date have not yet provided evidence for the somatic-affective mechanisms that might explain the association between DT and EDs. Given that emotions are complex experiences that include somatic correlates (e.g., Damasio 1999), individual differences in IAcc could have implications for the way emotions are experienced and ultimately regulated (Merwin, Zucker, et al., 2010). To the best of our knowledge, no study to date has examined the role of DT as a mediator of the relationship between IAcc and ED risk. Therefore, the last aim of the current study is to extend understanding of the relationship between IAcc and ED risk by examining DT as a possible mediator. Understanding the possible role of DT in the relationship between IAcc and ED risk has important implications for informing both prevention and intervention programs.

3.0.1 Study Aims

The first aim of the present study is to examine IAcc among young females at high vs. low ED risk, using the HBPT (Schandry, 1981). A second aim is to examine behavioural response (i.e., time spent on the task) of high vs. low ED risk individuals to two distress tasks: 1) the BHT aimed at inducing physical distress and assessing capacity to withstand it and, 2) the PASAT-C aimed at inducing cognitive distress and assessing capacity to withstand it. The duration participants stay on the task is expected to reflect DT. The third aim of the current study is to investigate whether DT, as reflected in

behavioural reaction to the two stress tasks, is a significant mediator in the relationship between IAcc and ED risk.

3.0.2 Study Hypotheses

Based on previous research and theoretical models we expected individuals at high ED risk to be more interoceptive accurate than their low-risk counterparts. In addition, individuals at high ED risk were expected to exhibit greater avoidance of negative affect as reflected in their behavioural response (i.e., spend less time on the task) to the BHT (aimed at examining tolerance to physical distress) and PASAT-C (aimed at examining tolerance to cognitive distress) when compared to low-risk participants, thus indicating that high ED risk individuals are less DT. Finally, we expected that DT would mediate the relationship between IAcc and ED risk.

3.1 Methods

3.1.1 Participants

The participants of the current study were the same as those recruited for *Study 1*. Young female adults were selected as an appropriate age group to participate in this study since young adulthood and being a female are two factors which have both been associated with a greater risk for developing an ED (Striegel-Moore et al., 2009; Soet & Sevig, 2006).

Eligible participants were females, 18-25 years of age, with a good working knowledge of the English language. Individuals who scored above 52 on the Weight Concerns Scale (see self-report measures; Killen et al., 1994) were assigned to the high ED risk group (N=56), while those who scored below the above-mentioned threshold were assigned to the low-risk group (N=58). Individuals (N=3) who met diagnostic criteria for an ED based on the EDDS (Stice et al., 2000) were not eligible to participate in the study and were referred for further assessment. As expected, there were significant differences between the two groups on WCS scores with high-risk participants reporting significantly more weight concerns (M = 66.96, SD = 7.60) than their low-risk cohorts [(M = 30.86, SD = 15.18), t (84.56) = 16.14, p < .001].

3.1.2 Materials and measures

Physiological measures and apparatus

The experiment was built and run on the OpenSesame software (Mathôt et al., 2012). For the acquisition and processing of physiological data BIOPAC MP150 for Windows and AcqKnowledge 5.0.2 data acquisition software (Biopac Systems Inc, Santa

Barbara, CA) were used. Heart rate (HR) data was collected using Ag/ AgCl shielded electrodes that were placed on the participants' inner forearms following skin preparation following standard procedures (Fridlund & Cacioppo, 1986). A BIOPAC ECG100C bioamplifier was used to filter raw ECG. The bioamplifier was set to record beats per minute (BPM) in milliseconds.

Mean scores for HR were computed for the 5-min baseline period, for the BHT and for PASAT-C separately. HR was also recorded during the HBPT to have an objective measurement of the participants' heartbeats.

Self-report measures (Appendix A)

Demographic data questionnaire: Participants were asked to complete a personal questionnaire pertaining to demographic and personal data including; gender, age, year and level of studies, height, weight (current, highest, lowest, ideal and disappointing), involvement in sports or knowledge of a musical instrument, and whether they suffer from any chronic illness.

Eating disorder risk

The Eating Disorder Diagnostic Scale (EDDS; Stice et al., 2000) is a brief self-report scale consisting of 22 items for measuring AN, BN and BED and eating pathology based on the DSM-IV (American Psychiatric Association [APA], 1994) criteria. Responses can be used to generate a possible DSM-IV diagnoses for the three EDs and can also provide an overall eating disorder symptom composite. The symptom composite score is used to indicate participants' overall eating pathology. This scale was used in the current study to detect individuals who currently meet the criteria for an ED diagnosis for exclusion purposes. An SPSS computer algorithm is provided by Stice et al. (2000) to determine diagnoses. The scale has shown high internal consistency (a= 0.89) and test-retest reliability (r=.87) in previous studies (Stice et al., 2000) within adolescent and adult samples. The EDDS demonstrated satisfactory internal consistency in this sample (α= 0.74).

The Weight Concerns Scale (WCS; Killen et al., 1994) is a 5-item self-report questionnaire that assesses worry about weight and shape, fear of weight gain, diet history, importance of weight, and perceived fatness. This scale was used in the proposed study to determine high-risk status with a threshold score of 52 and above to be indicative of higher risk for developing ED. The WCS has shown good test–retest reliability (r=0.85) and good predictive validity for ED caseness in previous studies (Killen et al., 1994; Killen et al.,

1996; Jacobi et al., 2004). It has also shown satisfactory internal consistency in a Greek-Cypriot sample of university students (α= 0.75) and high and middle school students (α= 0.80; Koushiou et al., 2019). Satisfactory internal consistency has been shown in this sample as well (α = 0.76).

Distress tasks

(i) Physical Stress Task

The Breath-Holding Task (BTH; Hajek et al., 1987) is a behavioural index of physical DT. The task requires participants to hold their breath after a full, normal expiration. To maximise experienced distress during the task, participants were asked to hold their breath for as long as they can, even if they felt the urge to breathe again. This procedure was then repeated after a 60-second rest period. Similar to previous work (Zvolensky et al., 2001), the longer duration of the two trials was used as the index of maximum breath-holding duration. Higher breath-hold durations reflect greater ability to tolerate physical discomfort. The BTH has shown good test-retest reliability (r = 0.67; Sütterlin et al., 2013). The task has demonstrated good test-retest reliability in this study as well (r = 0.87).

(ii) Cognitive Stress Task

The "Paced Auditory Serial Addition Task – Computerized" (PASAT-C; Lejuez et al., 2003) is a mental arithmetic stress task which has been shown to induce negative affect (Daughters et al., 2005; Holdwick, & Wingenfeld, 1999). During the task single- digit numbers are sequentially presented on a computer screen and participant is required to add the presented number to the previously presented number before the next one appears on the screen. There are three levels to the task; Level 1-low difficulty (3 minutes); Level 2-medium difficulty (3 minutes); and Level 3-high difficulty (3 minutes). Numbers are presented more quickly with each level, with Level 1 providing a 3-s latency between number presentations, a 2-s latency during the second level, and a 1-s latency during the final level. Level 3 is considered to be the DT phase of the task as the latency between digit presentations exceeds the participant's skill level, thus inducing distress. Before starting Level 3 participants are informed that once the final level begins, they can terminate exposure to the task by pressing the QUIT button. Participants are notified that they will win one point for each correct response, while incorrect scores or not responding will not impact their score. DT is indexed as latency in seconds to terminate level 3 of the task.

Interoceptive Accuracy

The Heartbeat Perception Task (HBPT; Schandry, 1981) is used to assess individuals' ability to accurately perceive their own heartbeat reflecting IAcc. Participants are asked to silently count their heartbeat over four counting phases (duration: 25s, 35s, 45s, 100s). The task was administered following the procedure used in previous studies (Pollatos et al., 2006, Pollatos et al., 2008, Young et al., 2017). A start and a stop verbal cue signal the beginning and end of the counting phases. During heartbeat counting, participants were not permitted to use any method to aid their counting (i.e., taking one's pulse). At the end of each time interval, participants were asked to verbally report the number of counted heartbeats. Participants were not given feedback about their performance or the length of the counting phases. Heartbeat perception is calculated as the mean score of four heartbeat perception intervals based on the following transformation:

1⁄4 Σ (1 – (|recorded heartbeats – counted heartbeats|)/recorded heartbeats)

Based on this calculation, the heartbeat perception score can vary between 0 and 1 with higher scores indicating better IAcc. The HBPT has good test–retest reliability (up to .81; Jones, 1994; Wildman & Jones, 1982) and has been found to correlate highly with other heartbeat detection tasks (Knoll & Hodapp, 1992).

Confounding variables (Appendix A)

IAcc has been found to differ due to levels of anxiety, depression, stress, BMI, and participation in physical activity (Cameron, 2001; Dunn et al., 2007; Ehlers et al., 2000; Pollatos et al., 2006). Addressing these potential confounders, participants were asked to complete the following self-report measures:

The Depression Anxiety Stress Scales-21 (DASS-21; Brown et al., 1997) is the short form of the DASS-42 (Lovibond & Lovibond, 1995), a measure of depression, anxiety, and stress or psychological distress. The DASS-21 contains three self-report scales, each containing 7 items of similar content. The DASS-21 shows good internal consistency with Cronbach alpha of .88 for depression, .82 for anxiety, .90 for stress, and .93 for the entire scale. The DASS-21 subscales demonstrated satisfactory internal consistency in the present study (α= 0.76 for depression, α= 0.70 for anxiety, α= 0.74 for stress) and good internal consistency for the entire scale (α= 0.85).

Participants' activity level was measured using the Stanford Brief Activity Survey (SBAS; Taylor-Piliae et al., 2006), a short 2-item, self-report survey which assess the usual amount and intensity of physical activity. The first item describes different kinds of at-

work activities (i.e., item C – "I spent most of the day sitting or standing. When I was at work, I did such things as writing, typing, talking on the telephone, assembling parts, or operating a machine that takes very little exertion or strength. If I drove a car or truck while at work, I did not lift or carry anything for more than a few minutes each day") and the second item describes leisure-time activities (i.e., item G – "Weekdays, when I got home from work, I did few active things, but most weekends I was able to get outdoors for some light exercise- going for walks, playing a round of gold (without motorized carts), or doing some active chores around the house"). There are five response items for each item. Responders are asked to select one response to describe their at-work activity and one to describe their leisure-time activity. Based on responses on the two items, respondents' overall physical activity intensity is classified as follows: (1) inactive, (2) light, (3) moderate, (4) hard, and (5) very hard. It was originally developed and validated in a sample of English-speaking older adults (Taylor-Piliae et al., 2006) and was later validated in middle-aged individuals (Taylor-Piliae et al., 2007) and young adults (Joseph et al., 2014).

Body Mass Index (BMI) has also been found to affect physiological reactions in ED populations (e.g., see Dapelo et al., 2015), thus was assessed as a possible confound. Body Mass Index (BMI) was calculated based on the participants' subjective measures of height and weight. BMI was calculated based on the following transformation: (weight(kg)/height^2(m)).

2.1.3 Procedure

Screening phase

Potential participants were identified and invited to take part in the study from a sample recruited during a wider campaign ("UNIC Mental Health Screening Days 2019: Eating Attitudes and Behaviours"), that took place at the University of Nicosia between the 7th and the 18th of October 2019. Individuals were be contacted via email, only in case, they provided their consent to be contacted for participation in future studies (see Appendix A for the email that was sent to students). Further participants were recruited based on opportunistic sampling by online and on campus advertisement of the study (see Appendix B). Participation in the study was voluntary. Prior to participation, individuals were asked to respond to the Eating Disorder Diagnostic Scale (EDDS; Stice et al., 2000) in order to detect individuals with a current ED diagnosis for exclusion purposes. In addition, if participants came from the aforementioned campaign, they were asked to verify

their responses on the Weight Concerns Scale (WCS; Killen et al., 1994), or if they were part of the opportunistic sampling then were asked to complete the WCS.

Eligible participants completed a battery of self-report questionnaires prior to their visit at the lab.

Experimental phase

During the experimental phase of the study, participants were asked to complete a physical and a cognitive stress task which aimed to examine their ability to tolerate psychological and physical stress. The order of the two tasks was counterbalanced among different administrations to avoid carry over effects. Upon informed consent, participants completed a battery of questionnaires including a general demographic/ historical data questionnaire, the DASS-21 and SBAS were then provided with instructions about the tasks they had to complete.

At first, participants were seated on a chair and were fitted with physiological monitors. There was a 5-minute baseline period before beginning the tasks to stabilise physiological signals.

Next, participants went on to complete the HBPT at four different duration intervals (25 s, 35 s, 45 s and 100 s) following the directions of Schandry (1981) for the Mental Tracking Method. For all four intervals, participants were provided with the verbal instructions to silently count their heartbeats without using any kind of exteroceptive aid (such as taking one's pulse). Participants were notified when to start and stop counting by a verbal cue. At the end of each time interval, participants were asked to verbally report the number of counted heartbeats. During the task, ECG measurements were taken. The experimenter did not provide feedback on the participants' performance or the length of the counting phases.

Following the HBPT, participants went on to complete the BHT and the PASAT-C in a counterbalanced order. At the end of the experiment, debriefing was provided.

The current study received ethical approval from the Cyprus National Bioethics Committee (ref. number: ΕΕΒΚ/ΕΠ/2020/13) and written informed consent was obtained from all participants prior to participation.

Data analyses plan

All statistical analyses were conducted using SPSS 25.0. Descriptive statistics for each variable were calculated and are presented in Tables 2.1 and 2.2. The chi-square test

was used to explore the distribution of frequencies for categorical variables (i.e., activity level and level of studies). The Likelihood Ratio was used when the expected values were less than five for RxC tables. Before performing the statistical analysis for continuous variables, data were checked using the absolute values of skewness and kurtosis for normality and the Levene's test for homogeneity of variances as parametric test assumptions. In cases where the assumption of homogeneity of variances was violated, corrected values were used. For continuous measurements that were not normally distributed (depression, anxiety, stress, BMI, weight concerns, DT [as measured by performance on the two distress tasks] and IAcc) bootstrapping with 1,000 re-samples was performed in analysis. Independent samples t-tests were conducted to examine differences between high and low risk participants in depression, anxiety, stress, BMI, weight concerns, DT (i.e., time spent on each stress task) and IAcc.

Lastly, mediation analyses were conducted using Model 4 of the PROCESS macro (v3.4, model 1, Hayes, 2017) for SPSS to investigate whether DT is a significant mediator in the relationship between IAcc and ED risk. The PROCESS macro mediation model uses a bootstrapping resampling strategy to examine the significance of the model and the effect of the mediator. For the current analysis, the 95% bias-corrected bootstrapped confidence intervals of indirect effects were performed with 5,000 re-samples. Since significant differences between the two groups were found only on the ability to tolerate cognitive distress, only one mediation model was run, testing whether DT (cognitive) significantly mediates the relationship between IAcc and ED risk (independent variable = IAcc, dependent variable = ED risk, mediator = tolerance to cognitive distress, as reflected in the behavioural reaction to the PASAT-C).

3.2 Results

3.2.1 Descriptive Statistics

Participants' characteristics, behaviours and attitudes based on the self-report questionnaires.

The sample of the current study consisted of 114 female participants (M_{age}= 22.78, *SD*= 1.990). The majority of the participants were Cypriots (84.2%) while the rest were Greek (12.3%) or other (3.5%). Based on their self-report responses on the WCS, from the 114 participants, 56 were found to be at high risk for developing an ED, while the rest 58 were classified as low risk for EDs.

Tables 2.1, 2.2 presented in Chapter 2, Study 1 show the Means and Standard Deviations of the sample's characteristics, behaviours and attitudes and t-test comparisons among the high and low risk groups.

3.2.2 Preliminary Analyses

Results showed that the two groups did not differ significantly on levels of depression, BCa 95% CI [-2.95, 1.30], t (112) = -.75, p = .45, anxiety, BCa 95% CI [-4.15, 0.17], t (103.60) = -1.90, p = .06, stress, BCa 95% CI [-2.22, 2.34], t (112) = -.05, p = .96, and BMI, BCa 95% CI [-0.26, 2.30], t (112) = .51, p = .12.

As for the Weight Concerns Scale, high risk participants reported significantly more weight concerns, BCa 95% CI [31.63, 40.47], t (84.56) = 16.14, p < .001; M = 66.96, SD = 7.60) than their low-risk counterparts (M = 30.86, SD = 15.18).

Results from the chi square test indicate that there is a significant association between ED risk group and physical activity levels, $\chi^2(4) = 11.82$, $p < .05$, and a significant association between ED risk group and level of studies, $\chi^2(1) = 4.09$, $p < .05$. There were significantly more undergraduate students in the high ED risk group (N = 36) than in the low ED risk group (N = 27) and significantly fewer graduate students in the high ED risk group (N = 19) as compared to the low ED risk group (N = 31).

Moreover, there was a significant difference between the high and the low-risk groups in the duration they stayed on the PASAT-C, BCa 95% CI [-62.25, -13.55], t (112) = -3.06, p < .005. High risk participants stayed on the task significantly less time indicating a decreased ability to tolerate cognitive frustration. The two groups did not significantly differ on their ability to tolerate physical distress, as measured by the BHT duration (p = .26). See Table 3.1 for means and standard deviations. Since significant differences between the two groups were found only on the ability to tolerate cognitive distress, we decided to investigate whether tolerance to cognitive distress mediates the relationship between IAcc and ED risk.

Table 3.1

Latency to quit (Means and SDs) on the PASAT-C and the BHT among the high and low ED risk groups.

	High risk (n=56)	Low risk (n=58)	p values (between-group)
	M (SD)	*M (SD)*	
PASAT-C- Latency to quit (seconds)	88.30 (71.46)	126.22 (60.55)	**
BHT- Latency to quit (seconds)	28.35 (13.73)	31.10 (12.37)	

Note. M = mean; *SD* = standard deviation; PASAT-C = "Paced Auditory Serial Addition Task – Computerized"; BHT = Breath-holding Task

**$p \leq 0.005$

IAcc between ED risk groups as measured by the Heartbeat Perception Task.

Participants in the two risk groups significantly differed on IAcc based on their performance on the HBPT, (BCa 95% CI [.005, .142], t (112) = 2.05, $p < .05$). More specifically, high risk participants were found to be significantly more IAcc (M = .68, SD = .19) than their low-risk counterparts (M = .60, SD = .19).

3.2.3 Mediation Analyses

The mediating effect of tolerance to cognitive distress on the association between IAcc and ED risk.

A mediation analysis was performed to investigate the assumption that impaired tolerance to cognitive distress mediates the relationship between IAcc and ED risk. Findings are depicted in Figure 3.1 and Table 3.2. Analysis of the model indicated that the association between IAcc and DT was negative and significant, B = -130.51, SE = 30.94, 95% CI [-191.81, -69.21], β = -.37, p < .001, as was the association between DT and ED risk, B = -.08, SE = .03, 95% CI [-.14, -.02], β = -.26, p < .05. These results support the mediational hypothesis. IAcc significantly predicted ED risk when performing a linear regression analysis independent of DT, B = 25.66, SE = 10.29, 95% CI [5.28, 46.04], β = .23, p < .05. IAcc was no longer a significant predictor of ED risk after controlling for the mediator, DT, B = 15.08, SE = 10.79, 95% CI [-6.30, 36.45], β = .13, p = .17, consistent with full mediation. Approximately 11% of the variance in ED risk was accounted for by the predictors (R^2 = .11). Thus, findings revealed a statistically significant total effect, B = 25.66, SE = 10.29, 95% CI (5.28, 46.04), but a non-significant direct effect, B = 15.08, SE = 10.79, 95% CI (−6.30, 36.45), of IAcc on ED risk. The indirect effect was tested using a percentile bootstrap estimation approach with 5,000 samples (Shrout & Bolger, 2002),

implemented with the PROCESS macro Version 3 (Hayes, 2017). These results indicated the indirect coefficient was significant, B = 10.58, SE = 4.82, 95% CI [2.33, 21.38], completely standardised β = .09.

Figure 3.1

Mediation Model for the Effect of Interoceptive Accuracy (IAcc) on ED risk Mediated by Distress Tolerance (DT).

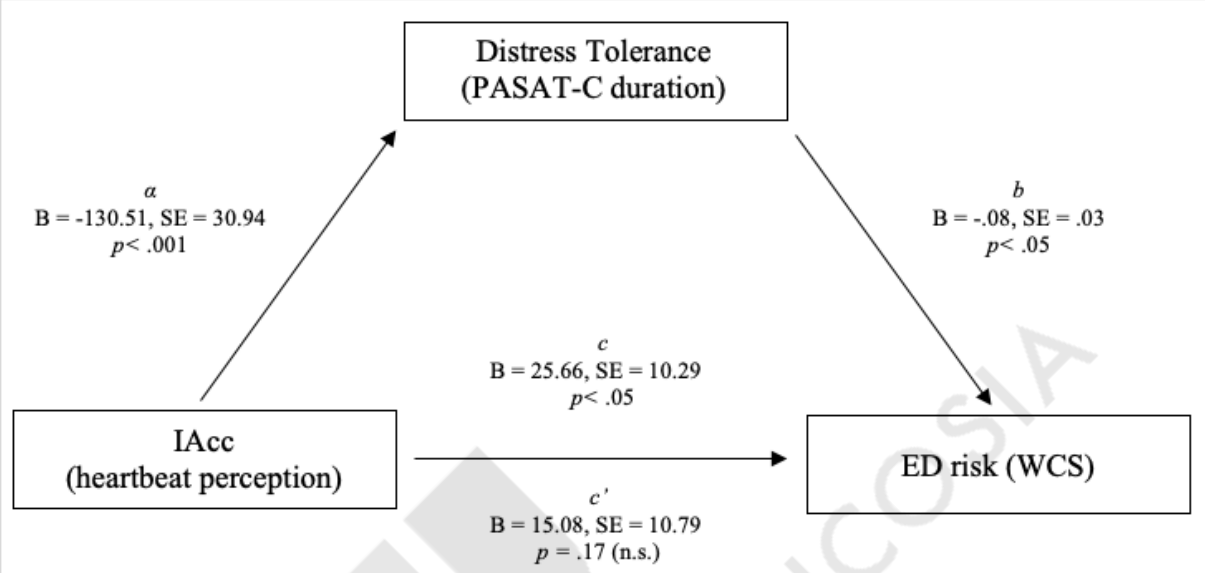


Table 3.2

Mediation Analyses for the Effect of IAcc on ED risk Mediated by DT.

Variable	*B*	95% CI	*SE B*	β	R^2
Step 1					.05
Constant	32.19**	18.58, 45.81	6.87		
IAcc	25.66*	5.28, 46.04	10.29	.23*	
Step 2					.11
Constant	47.68**	30.07, 65.29	8.89		
IAcc	15.08	-6.30, 36.45	10.79	.13	
DT (PASAT-C)	-.08*	-.14, -.02	.03	-.26*	

Note. CI = confidence interval; IAcc = Interoceptive accuracy; DT = distress tolerance; PASAT-C = "Paced Auditory Serial Addition Task – Computerized"
* $p \leq 0.05$; ** $p \leq 0.001$.

Since high vs. low-risk participants were found to have significant differences in physical activity, the mediation model was re-run including physical activity as a covariate. Results showed that the model was still significant after including physical activity as a covariate. Findings are depicted in Figure 3.2 and Table 3.3.

Figure 3.2

Mediation Model for the Effect of Interoceptive Accuracy (IAcc) on ED risk Mediated by Distress Tolerance (DT), including Physical Activity as a Covariate.

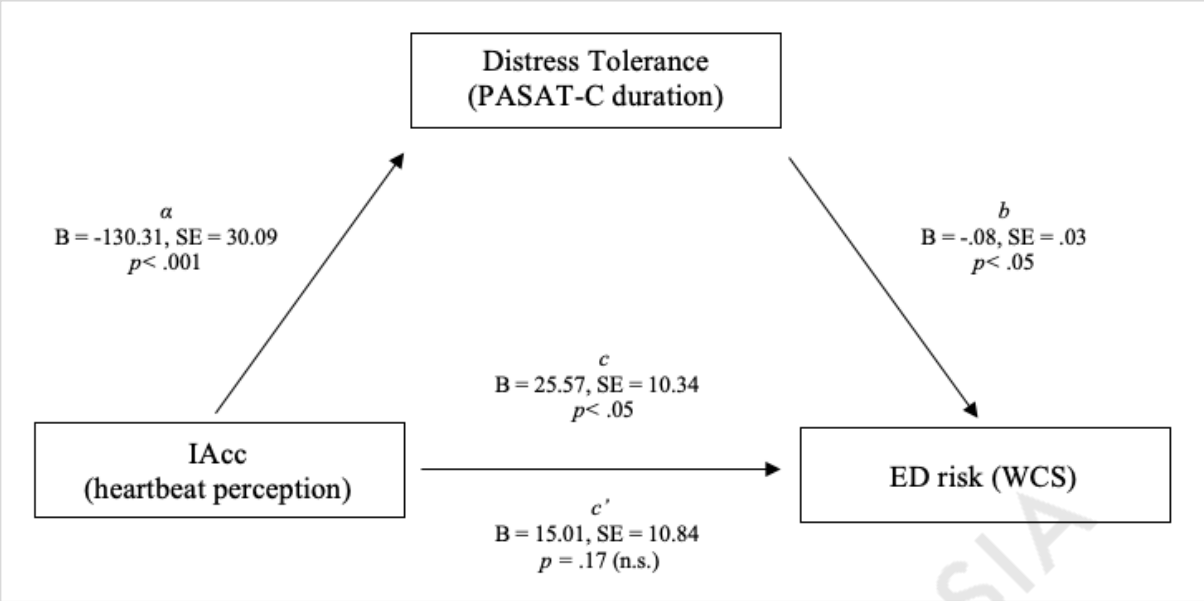


Table 3.3

Mediation Analyses for the Effect of IAcc on ED risk Mediated by DT, including Physical Activity as a Covariate.

Variable	*B*	95% CI	*SE B*	β	R^2
Step 1					.05
Constant	33.68**	15.70, 51.66	9.07		
IAcc	25.57*	5.09, 46.05	10.34	.23*	
SBAS	-.59	-5.21, 4.03	2.33	-.02	
Step 2					.11
Constant	48.89**	27.96, 69.80	10.56		
IAcc	15.02	-6.46, 36.49	10.84	.13	
DT (PASAT-C)	-.08*	-.14, -.02	.03	-.26*	
SBAS	-.48	-4.99, 4.02	2.27	-.02	

Note. CI = confidence interval; IAcc = Interoceptive accuracy; DT = distress tolerance; PASAT-C = "Paced Auditory Serial Addition Task – Computerized"
* $p \leq 0.05$; ** $p \leq 0.001$.

3.3 Discussion

The purpose of the current research was to examine IAcc among young females at high vs. low risk for EDs, using the HBPT as an objective method of measuring perception of bodily signals (IAcc), under well-controlled laboratory conditions. Furthermore, the

current study aimed to assess performance on two stress tasks (i.e., a physical stress task – BHT & a cognitive stress task – PASAT-C). Finally, the present study aimed to investigate on a preliminary basis the mediating effect of tolerance to cognitive distress in the relationship between IAcc and ED risk.

Based on the Haynos and Fruzzeti (2011) model, it was assumed that individuals at high ED risk would be more accurate in perceiving signals from their body as measured by the HBPT. In accordance with this model participants at high ED risk were found to be more interoceptive accurate than their low-risk counterparts. Results of the current study add to the findings of current research studies investigating the, thus far, inconsistent picture of the relationship of EDs and interoceptive abilities (Merwin, 2011). Heightened IAcc means that even minor visceral changes are detected. Given the complexity of the body which precludes precise prediction, even minor bodily changes detected may be misinterpreted and experienced as threatening, feared or undesirable. The result may be the employment of extreme behaviours to control experience. Merwin, Timko, Moskovich, Ingle, Bulik, and Zucker (2010) have proposed a model of EDs as an illness of psychological inflexibility, explained as an inability to behave flexibly in the face of difficult thoughts, feelings and bodily sensations. Psychological inflexibility is expressed via desperate attempts to control the experience of the body, in order to minimise ambiguity and achieve a sense of control (Merwin, Timko, et al., 2010).

Moreover, high risk participants demonstrated a lower capacity of tolerating cognitive distress as evidenced by the duration they stayed on the cognitive tolerance task, PASAT-C, while no significant differences were observed in their ability to tolerate physical distress as evidenced by BHT duration. Based on Damasio's somatic marker hypothesis (1994, 1999), emotional situations are associated with bodily changes, known as somatic markers. These somatic markers are important for guiding behaviour by marking significant body changes. Based on this hypothesis, one can assume that individuals high in IAcc have a processing advantage in emotional situations due to their heightened precision in detecting visceral signals. For the majority of people, bodily changes are often expected phenomena. For example, for most people, increased hunger will simply lead to eating more to achieve homeostasis. The enhanced awareness of visceral signals found in individuals at high ED risk in addition to their reduced ability to tolerate cognitive distress, may lead to this somatic variability experienced as intolerable, which in turn, may lead to the employment of dysfunctional behaviours to achieve homeostasis, in the absence of other more adaptive ways of responding to negative affect

(Merwin, Timko, et al., 2010). In fact, a growing base of evidence exists supporting the relationship between ED symptoms and non-acceptance of emotional experience and/or experiential avoidance (i.e., attempts to avoid aversive emotional states via dysfunctional behaviours) (Merwin, Zucker, et al., 2010; Wildes et al., 2010).

Focusing on the aforementioned hypothesis, we aimed to investigate on a preliminary basis the mediating effect of DT in the relationship between IAcc and ED risk. Since significant differences between the two groups were only observed on their ability to tolerate cognitive distress, we included only tolerance to cognitive distress in our mediating model. We assumed that tolerance to cognitive distress would be a significant mediator in the relationship between IAcc and ED risk. As predicted, results indicated that there was a full mediation when DT was introduced into the model, supporting our hypothesis. This finding is in line with a previous study which found DT to be a significant mediator in the relationship between anxiety sensitivity and bulimic symptoms (Anestis et al., 2007). In light of such results, it appears that capacity to tolerate cognitive frustration may be an important cognitive-affective mechanism underlying the IAcc-ED risk association. Based on the current findings, we can assume that individuals at high ED risk lack emotion regulation skills to help them act flexibly in the face of cognitive distress. As this is the first study to examine the association between DT, IAcc and ED risk, these results should be interpreted as preliminary support for the proposed mediational model (see Figure 3.1). In addition, given the novelty of the finding, it would be valuable for future studies to replicate this association. Also, future research should aim to examine this association using more robust ways of measurement (i.e., tolerance to negative affect as indicated by physiological data).

3.3.1 Limitations

The results of the study should be considered in light of some notable limitations. Firstly, the sample used in the current study was homogenous in that most participants were of Cypriot nationality and were educated either at an undergraduate or graduate level, thus results cannot be generalised to other populations. Future research would benefit from replicating these findings with other samples from other cultural contexts, ages, and educational backgrounds. Secondly, potential weaknesses must be considered with regards to the use of the HBPT. Despite its widespread use as a measure of interoceptive accuracy in several research studies (Pollatos et al., 2008; Ehlers et al., 2000), there are authors suggesting that performance in these kind of tracing tasks can be affected by participants' beliefs and expectations about their heart rates (Ring et al., 2015; Knapp-Kline & Kline,

2005; Wiens & Palmer, 2001). In addition, other factors like attention or motivation may also affect performance on any heartbeat perception task. Nevertheless, and despite the aforementioned methodological problems, a convincing body of research exists supporting the validity of the HBPTs in detecting processes associated with interoception (Critchley et al., 2004; Wiens, 2005). Moreover, the extent to which interoception is modality specific is not yet clear, thus future studies would benefit from the use of interoceptive measures that focus on the gastric tract. In fact, gastric interoception would be particularly relevant in individuals with eating related issues. Nevertheless, some evidence exists demonstrating that cardiac awareness is related to greater sensitivity for gastric functions, thus pointing to a general sensitivity for interoceptive processes across different visceral bodily modalities (Herbert et al., 2012), however more research is needed to confirm this link. Another potential limitation of the current study is the use of a cross-sectional design, which does not allow for the examination of the temporal ordering of the variables studied. Therefore, it is important for future studies to replicate the associations found in the current study using prospective designs.

3.3.2 Conclusions

In summary, the present study found that when compared to individuals at low risk for EDs, individuals at high-risk exhibit higher IAcc, as indexed via the HBPT, and lower DT as indexed in their behavioural responses in the PASAT-C, a behavioural task aimed at investigating tolerance to cognitive distress. To our knowledge, the present study is the first empirical work to show that IAcc, as measured by a HBPT, is heightened in individuals who are at high ED risk but do not currently meet criteria for an ED clinical diagnosis. The finding provides preliminary evidence for the Haynos and Fruzzeti model (2011) postulating that in sub-clinical stages of the illness, individuals present with hypersensitivity to somatic affective experience which in turn leads to the engagement of pathology-related behaviours in an attempt to attenuate negative experience. This highlights the potential role of IAcc in the development of EDs and provides important clinical implications. Heightened IAcc could be seen as a useful therapeutic tool for individuals at risk for EDs. Therapies that use somatic experiencing and interoception as core elements of therapy (e.g., biofeedback, mindfulness, mentalization-based therapy and acceptance and commitment therapy [ACT]; Hayes et al., 2009) to reduce symptomatology may prove helpful by providing guidance on more effective ways of responding to painful or negative internal experiences (i.e., observation and acceptance of negative internal events).

The present study also demonstrated novel findings regarding the association between IAcc, DT and ED risk. More specifically, results indicated a full mediation model by DT. Based on this finding, we can suggest that tolerance to cognitive frustration plays a significant role in the association between IAcc and ED risk. This preliminary investigation is intended to stimulate future work examining the cognitive-affective mechanisms underlying IAcc and ED risk and further provides several important clinical implications. Firstly, the assessment of DT could be integrated within clinical assessments of individuals who present with weight concerns to possibly establish the risk of developing an ED. Secondly, since DT is a cognitive-affective mechanism related to both IAcc and ED risk, it could be promising to incorporate elements of teaching or enhancing DT in ED prevention programs. For example, Dialectical Behaviour Therapy (DBT), a form of cognitive-behaviour therapy developed by Linehan (1993), focuses on teaching and improving DT skills to deal with low levels of DT found in borderline personality disorder. In fact, there is research supporting the efficacy of DBT in treating individuals with bulimia nervosa and binge eating disorder (Chen et al., 2008). Similarly, ACT- based interventions may also prove helpful in addressing DT deficits in individuals at risk for EDs by promoting greater degrees of emotional acceptance, mindfulness, and self-awareness thus changing one's maladaptive responses to aversive stimuli (Hayes et al., 2009).

CHAPTER 4

STUDY 3

Interoceptive Accuracy and Eating Disorder Risk in Young Female Adults: The Mediating Role of Physiological Reactivity to Distress

Abstract

Objective: Many theories of emotion posit that the perception of visceral signals, termed as interoception, is a crucial element of emotional experience (James, 1884; Damasio, 1994), suggesting that individuals who perceive bodily changes with a higher degree of accuracy, have a correspondingly enhanced experience of emotions (Critchley et al., 2004; Pollatos et al., 2005). Following this theoretical model, previous research demonstrated that good heartbeat perceivers exhibit stronger heart rate response (i.e., enhanced physiological reactivity) to emotional stimuli compared to poor heartbeat perceivers (Pollatos et al., 2007). The present study aims to investigate whether emotional reactivity to two stress tasks (cognitive – PASAT-C, physical – BHT), as indicated via physiological responding (i.e., heart rate response) mediates the relationship between IAcc and ED risk.

Method: IAcc was assessed in 114 females aged 18-25 years old who were either at high (N=56) or low (N=58) risk for EDs, using the Heartbeat Perception Task (HBPT). They went on to complete: 1) the Breath-Holding Task; aimed at inducing physical distress and, 2) the "Paced Auditory Serial Addition Task-Computerized"; aimed at inducing cognitive distress.

Results: High risk participants demonstrated higher IAcc compared to their low-risk cohorts. Hyper-reactivity to negative affect, as indicated by increased cardiac response to the PASAT-C, was a significant mediator in the relationship between IAcc and ED risk.

Conclusions: Individuals at high ED risk experience greater physiological reactivity to negative affect, especially to cognitive distress, which may influence how they perceive and respond to signals from their bodies.

Keywords: interoceptive accuracy, HBPT, negative affect, BHT, PASAT-C, eating disorder risk

4.0 Introduction

Eating disorders (EDs) are characterized by cognitive distortions concerning body shape and weight that lead to severe disturbances in eating behaviours and body weight (Schmidt et al., 2016). EDs often have serious negative outcomes on physical health (O'Brien et al., 2017), longstanding psychological difficulties (Richard, 2005), poor treatment outcomes (Keel & Brown, 2010) and high mortality rates (Arcelus et al., 2011). Therefore, an understanding of the factors that may contribute to the development of clinically significant EDs is imperative. Besides emotional functioning, including emotional experiencing and responding, which has been found to play an important role in the development and maintenance of EDs, (Harrison et al., 2009, Harrison et al., 2010), *interoceptive accuracy (IAcc),* a more specific factor related to the broader construct of emotional processing, has been gaining consistent support. (Merwin, Zucker, et al., 2010; Pollatos et al., 2008).

Interoceptive Accuracy and EDs

Interoception is defined as the ability to perceive bodily signals (James, 1884; Damasio, 1994). Previous studies suggest that individuals with EDs have difficulties perceiving internal bodily signals (Fassino et al., 2004, Thompson et al., 1987; Matsumoto et al., 2006), mostly assessed using self-report measures, thus resulting in the measurement of a subjective, self-evaluated trait, termed as *interoceptive sensibility*. Relying on questionnaire data to measure interoception (i.e., interoceptive sensibility) means we are unable to discriminate *perception* of perceiving bodily signals from *actual* ability, termed as *interoceptive accuracy* (IAcc). Thus, it is important to explore the ability to perceive bodily signals using experimental approaches.

A commonly used experimental method of assessing IAcc is the Heartbeat Perception Task (HBPT; Schandry, 1981). Pollatos and colleagues (2008) used this method to assess IAcc in a sample of anorexia nervosa (AN) patients. Despite Pollatos et al.'s (2008) findings demonstrating an impaired ability in AN patients to detect their own heartbeat, results were confounded by the participants' low body mass index (BMI). Thus, results were influenced by the physical problems associated with the acute or chronic stages of the disorder (i.e., bradycardia associated with low weight; Mitchell & Crow, 2006) and do not reflect a true decrease in visceral sensitivity. This BMI and visceral under-sensitivity association may in fact, point to the potential utility of ED symptomatology as a maladaptive strategy to attenuate emotional experience by muting somatic correlates (Merwin et al., 2013). Klabunde and colleagues (2013) used the HBPT

in women recovered from bulimia nervosa (BN) in order to control for the confounding effects of ED symptoms seen in the chronic stages of the illness. Based on their data deficits in IAcc were still present after recovery. Such a finding points to either a biological trait that is present prior BN symptoms or a consequence of the disorder.

Based on the aforementioned results, it is often assumed that sensation is muted in ED populations and that hyposensitivity to somatic-affective cues reinforces symptom development by motivating patients to depend more on external cues to guide their behaviour (e.g., food intake), rather than internal sensations (e.g., satiation) and/or emotions (Merwin et al., 2013). However, contradictory findings have been observed in another study in which AN-patients reported greater perceived sensitivity to sensation compared to healthy controls (HCs) (Merwin et al., 2013). Therefore, it is equally plausible that individuals with EDs are *hypersensitive* to somatosensory experience but have difficulty interpreting or tolerating these sensations, and therefore are unable to use these signals to guide behaviour adaptively. In fact, it is hypothesised that hyper-sensitivity (e.g., heightened emotional reactivity), is present in the early stages of the disorder and is eventually diminished resulting to hypo-sensitivity due to prolonged starvation and other physical effects associated with illness progression (Haynos & Fruzzetti, 2011). Supporting this claim, preliminary evidence exists suggesting an overall hypersensitivity to negative affect in individuals at risk for EDs (Koushiou et al., 2019).

Although impaired IAcc has been found to play an important role in ED maintenance and illness symptomatology in clinical populations, studies to date have not yet examined this factor in individuals at risk for EDs. Thus, the first aim of the current study is to examine IAcc using the HBPT as an objective method of measuring perception of bodily signals (IAcc), under well-controlled laboratory conditions in individuals at high ED risk - who are still unaffected from the physical effects of the illness - vs. low ED risk individuals. We hypothesise that individuals at high ED risk will present an enhanced ability to perceive bodily signals (i.e., higher IAcc; suggesting hypersensitivity) as reflected in their performance during the HBPT compared to their low ED risk cohorts.

Emotional processing and Eating Pathology

Disordered eating has been conceptualised to serve as a maladaptive way of coping with negative affect (Heatherton & Baumeister, 1991, Fairburn et al., 2003, Haynos & Fruzzetti, 2011). Despite the growing evidence base demonstrating difficulties with emotional experiencing in ED populations, in both clinical and non-clinical samples, there is a dearth of experimental studies investigating emotional responding to aversive

psychological states, such as distress, in individuals at high ED risk. To date, we are aware of only one study (i.e., Yiu et al., 2018) that utilised an experimental paradigm to assess emotional responding to distress in an ED population. The authors assessed the emotional experience of a clinical sample of ED patients and a group of HCs in response to a mental arithmetic stress task, namely the "Paced Auditory Serial Addition Task-Computerized" (PASAT-C) (Lejuez et al., 2003) – a cognitive stress task which has been shown to induce negative affect. Individuals in the clinical group reported significantly higher levels of negative emotions while demonstrating similar physiological and behavioural responding to the stress task as compared to controls. This lack of convergence between objective (physiological and behavioural) and subjective reactions to the cognitive stress task indicates that ED populations exhibit significantly higher subjective distress compared to HCs when presented with the same stimuli. Based on this observation, the authors concluded that the interpretation of experiences is what best distinguishes between ED patients and HCs.

PASAT-C aims to assess reactions to induced *psychological* distress. Other tasks, for example physical tasks, are used to assess reactions to *physical* distress. Physical tasks primarily measure responding to physiological discomfort (Glassman et al., 2016). One of the most commonly used physical tasks is the Breath-Holding Task (BHT; Hajek et al., 1987). In this task participants hold their breath for as long as possible with the aim of inducing *physical* discomfort. The BHT was firstly developed to predict treatment outcome of smokers who entered a Smokers Clinic (Hajek et al., 1987) and has since been widely used in the research of smoking cessation and relapse (e.g., Brandon et al., 2003; Brown et al., 2002). Hajek and colleagues (Hajek, 1989; Hajek et al., 1987) used the BHT to examine BH endurance among smokers in order to assess emotional responding to uncomfortable physical sensations. To our knowledge, no previous study has investigated emotional reactivity to negative physical sensation in an ED population. Individuals presenting with ED symptoms are primarily characterised by a distortion in the way the body is experienced - not only *cognitively* but also *physically* (i.e., distortions in the perception of bodily signals) (Merwin, Timko, et al., 2010), therefore an examination of their emotional responding to uncomfortable physical sensations is imperative.

The present study aims to examine emotional responding of individuals at high vs. low ED risk to two distress tasks (i.e., the PASAT-C & BHT) using the physiological index of heart rate (HR). To our knowledge this is the first study to compare physiological reactivity to a cognitive vs. a physical tolerance task in individuals at high vs. low risk for

EDs. A non-clinical sample of high-risk individuals was employed to avoid the physical effects (i.e., bradycardia) observed in clinical ED cases that might impact physiological responding. Thus, results are expected to be indicative of the participants' actual emotional experience.

Interoceptive Accuracy and the Experience of Emotions

Damasio's somatic marker hypothesis proposes that the ability to perceive bodily signals constitutes the basis of our emotional experience, suggesting that we feel emotions because we perceive changes in bodily states (Damasio, 1994; 1999). Therefore, individuals with an enhanced ability to perceive bodily changes (i.e., higher IAcc) should have a correspondingly enhanced experience of emotions (Critchley et al., 2004; Pollatos et al., 2005). Based on this hypothesis, one can assume that individuals high in IAcc should have a processing advantage in emotional situations due to their heightened precision in detecting such somatic markers. For the majority of people, changes in bodily experience are expected phenomena. For example, in a situation of increased hunger most people will simply eat more to achieve homeostasis. However, if individuals at high ED risk exhibit an enhanced ability to perceive bodily signals, along with a hyper-reactivity to distress, disordered eating behaviours may act as a maladaptive response to escape the experience of negative affect.

Merwin, Timko, Moskovich, Ingle, Bulik, and Zucker (2010) have proposed a model of EDs as an illness of psychological inflexibility, explained as an inability to behave flexibly in the face of difficult thoughts, feelings, and bodily sensations. Psychological inflexibility is expressed via desperate attempts to control the experience of the body in order to minimise ambiguity and achieve a sense of control (Merwin, Timko, et al., 2010). Heightened IAcc means that even minor visceral changes are detected, and due to the complexity of the body which precludes precise prediction, these minor bodily changes can be misinterpreted and thus experienced as threatening, feared or undesirable. The result may be the employment of extreme behaviours to control experience.

An understanding of the relationship between interoceptive processing and ED risk remains poor. The current literature lacks research on the possible mediators of this relationship (Martin et al., 2019). Previous research demonstrated that good heartbeat perceivers exhibit stronger HR response (i.e., enhanced physiological reactivity) to emotional stimuli compared to poor heartbeat perceivers (Pollatos et al., 2007). In the current study, individuals at high ED risk are expected to be better at perceiving their own heartbeat and thus exhibit stronger physiological reactivity in response to the two distress

tasks, compared to low-risk individuals. Further, we aim to investigate whether emotional reactivity to the two distress tasks, as indicated by physiological reactivity (i.e., HR) mediates the relationship between IAcc and ED risk. Specifically, we propose that heightened physiological reactivity to negative affect will mediate the relationship between IAcc and ED risk.

4.0.1 Study Aims

The first aim of present study is to examine IAcc among young females at high vs. low ED risk, using the HBPT (Schandry, 1981). A second aim is to examine physiological reactivity (i.e., HR) of high vs. low ED risk individuals to two distress tasks: 1) the BHT aimed at inducing physical distress and, 2) the PASAT-C aimed at inducing cognitive distress, and further to investigate whether IAcc correlation with HR reactivity during the two tasks. The third aim of the current study is to investigate whether heightened emotional reactivity, as reflected in increased physiological responding (HR) to the two stress tasks, is a significant mediator in the relationship between IAcc and ED risk.

4.0.2 Study Hypotheses

Based on previous research and theoretical models we expected individuals at high ED risk to be more interoceptive accurate than their low-risk counterparts. In addition, individuals at high ED risk were expected to exhibit a hyper-reactivity to negative affect, as reflected in greater physiological reactivity in response to the BHT (aimed at inducing physical distress) and the PASAT-C (aimed at inducing cognitive distress) as compared to low-risk participants. We also expected that the degree of IAcc is positively correlated with HR responses. Finally, we expected that heightened emotional reactivity would mediate the relationship between IAcc and ED risk.

4.1 Methods

4.1.1 Participants

The current study utilised data from the same participants as in *Study 1* and *Study 2.* The sample consisted of 114 female participants (M_{age}= 21.46, *SD*= 2.01). Young female adults were selected as an appropriate age group to participate in this study since young adulthood and being a female are two factors which have both been associated with a greater risk for developing an ED (Striegel-Moore et al., 2009; Soet & Sevig, 2006).

Eligible participants were females, 18-25 years of age, with a good working knowledge of the English language. Individuals who scored above 52 on the Weight

Concerns Scale (see self-report measures; Killen et al., 1994) were assigned to the high ED risk group (N=56), while those who scored below the above-mentioned threshold were assigned to the low-risk group (N=58). Individuals (N=3) who met diagnostic criteria for an ED based on the EDDS (Stice et al., 2000) were not eligible to participate in the study and were referred for further assessment. As expected, there were significant differences between the two groups on WCS scores with high-risk participants reporting significantly more weight concerns (M = 66.96, SD = 7.60) than their low-risk cohorts [(M = 30.86, SD = 15.18), t (84.56) = 16.14, $p < .001$]. The majority of the participants were Cypriots (84.2%) while the rest were Greek (12.3%) or other (3.5%).

4.1.2 Materials and measures

Physiological measures and apparatus

The experiment was built and run on the OpenSesame software (Mathôt et al., 2012). For the acquisition and processing of physiological data BIOPAC MP150 for Windows and AcqKnowledge 5.0.2 data acquisition software (Biopac Systems Inc, Santa Barbara, CA) were used. HR data was collected using Ag/ AgCl shielded electrodes that were placed on the participants' inner forearms following skin preparation following standard procedures (Fridlund & Cacioppo, 1986). A BIOPAC ECG100C bioamplifier was used to filter raw ECG. The bioamplifier was set to record beats per minute (BPM) in milliseconds.

Mean scores for HR were computed for the 5-min baseline period, for the BHT and for PASAT-C separately.

Self-report measures (Appendix A)

Demographic data questionnaire: Participants were asked to complete a personal questionnaire pertaining to demographic and personal data including; gender, age, year and level of studies, height, weight (current, highest, lowest, ideal and disappointing), involvement in sports or knowledge of a musical instrument, and whether they suffer from any chronic illness.

Eating disorder risk

The Eating Disorder Diagnostic Scale (EDDS; Stice et al., 2000) is a brief self-report scale consisting of 22 items for measuring AN, BN and BED and eating pathology based on the DSM-IV (American Psychiatric Association [APA], 1994) criteria. Responses can be used to generate a possible DSM-IV diagnoses for the three EDs and can also provide an overall eating disorder symptom composite. The symptom composite score is

used to indicate participants' overall eating pathology. This scale was used in the current study detect individuals who currently meet the criteria for an ED diagnosis for exclusion purposes. An SPSS computer algorithm is provided by Stice et al. (2000) to determine diagnoses. The scale has shown high internal consistency (a= 0.89) and test-retest reliability (r=.87) in previous studies (Stice, Telch, & Rizvi, 2000) within adolescent and adult samples. The EDDS demonstrated satisfactory internal consistency in this sample (α= 0.74).

The Weight Concerns Scale (WCS; Killen et al., 1994) is a 5-item self-report questionnaire that assesses worry about weight and shape, fear of weight gain, diet history, importance of weight, and perceived fatness. This scale was used in the proposed study to determine high-risk status with a threshold score of 52 and above to be indicative of higher risk for developing ED. The WCS has shown good test–retest reliability (r=0.85) and good predictive validity for ED caseness in previous studies (Killen et al., 1994; Killen et al., 1996; Jacobi et al., 2004). It has also shown satisfactory internal consistency in a Greek-Cypriot sample of university students (α= 0.75) and high and middle school students (α= 0.80; Koushiou et al., 2019). Satisfactory internal consistency has been shown in this sample as well (α= 0.76).

Distress tasks

(i) Physical Stress Task

The Breath-Holding Task (BTH; Hajek et al., 1987) is a behavioural index of physical DT. The task requires participants to hold their breath after a full, normal expiration. To maximise experienced distress during the task, participants were asked to hold their breath for as long as they can, even if they felt the urge to breathe again. This procedure was then repeated after a 60-second rest period. Similar to previous work (Zvolensky et al., 2010), the longer duration of the two trials was used as the index of maximum breath-holding duration. Higher breath-hold durations reflect greater ability to tolerate physical discomfort. The BTH has shown good test-retest reliability (r = 0.67; Sütterlin et al., 2013). The task has demonstrated good test-retest reliability in this study as well (r = 0.87).

(ii) Cognitive Stress Task

The "Paced Auditory Serial Addition Task – Computerized" (PASAT-C; Lejuez et al., 2003) is a mental arithmetic stress task which has been shown to induce negative affect (Daughters et al., 2005; Holdwick, & Wingenfeld, 1999). During the task single- digit

numbers are sequentially presented on a computer screen and participant is required to add the presented number to the previously presented number before the next one appears on the screen. There are three levels to the task; Level 1-low difficulty (3 minutes); Level 2-medium difficulty (3 minutes); and Level 3-high difficulty (3 minutes). Numbers are presented more quickly with each level, with Level 1 providing a 3-s latency between number presentations, a 2-s latency during the second level, and a 1-s latency during the final level. Level 3 is considered to be the DT phase of the task as the latency between digit presentations exceeds the participant's skill level, thus inducing distress. Before starting Level 3 participants are informed that once the final level begins, they can terminate exposure to the task by pressing the QUIT button. Participants are notified that they will win one point for each correct response, while incorrect scores or not responding will not impact their score. DT is indexed as latency in seconds to terminate level 3 of the task.

Interoceptive Accuracy

Heartbeat Perception Task (HBPT; Schandry, 1981) is used to assess ability to accurately perceive their own heartbeat reflecting IAcc. Participants are asked to silently count their heartbeat over four counting phases (duration: 25s, 35s, 45s, 100s). The task was administered following the procedure used in previous studies (Pollatos et al., 2006, Pollatos et al., 2008, Young et al., 2017). A start and a stop verbal cue signal the beginning and end of the counting phases. During heartbeat counting, participants were not permitted to use any method to aid their counting (i.e., taking one's pulse). At the end of each time interval, participants were asked to verbally report the number of counted heartbeats. Participants were not given feedback about their performance or the length of the counting phases. Heartbeat perception is calculated as the mean score of four heartbeat perception intervals based on the following transformation:

1⁄4 Σ (1 – (|recorded heartbeats – counted heartbeats|)/recorded heartbeats)

Based on this calculation, the heartbeat perception score can vary between 0 and 1 with higher scores indicating better IAcc. The HBPT has good test–retest reliability (up to .81; Jones, 1994; Wildman & Jones, 1982) and has been found to correlate highly with other heartbeat detection tasks (Knoll & Hodapp, 1992).

Confounding variables (Appendix A)

A number of variables (depression, anxiety, BMI and physical activity level) have been found to affect physiological reactivity (Stice, Marti, & Durant, 2011; Dapelo et al.,

2015). In addition, IAcc has been found to differ due to levels of anxiety, depression, stress, BMI, and physical activity level (Cameron, 2001; Dunn et al., 2007; Ehlers et al., 2000; Pollatos et al., 2006). Addressing these potential confounders, participants were asked to complete the following self-report measures:

The Depression Anxiety Stress Scales-21 (DASS-21; Brown et al., 1997) is the short form of the DASS-42 (Lovibond & Lovibond, 1995), a measure of depression, anxiety, and stress or psychological distress. The DASS-21 contains three self-report scales, each containing 7 items of similar content. The DASS-21 shows good internal consistency with Cronbach alpha of .88 for depression, .82 for anxiety, .90 for stress, and .93 for the entire scale. The DASS-21 subscales demonstrated satisfactory internal consistency in the present study (α= 0.76 for depression, α= 0.70 for anxiety, α= 0.74 for stress) and good internal consistency for the entire scale (α= 0.85).

Body Mass Index (BMI) was calculated based on the participants' subjective measures of height and weight. BMI was calculated based on the following transformation: (weight(kg)/height^2(m)).

Participants' activity level was measured using the Stanford Brief Activity Survey (SBAS; Taylor-Piliae et al., 2006), a short 2-item, self-report survey which assess the usual amount and intensity of physical activity. The first item describes different kinds of at-work activities (i.e., item C – "I spent most of the day sitting or standing. When I was at work, I did such things as writing, typing, talking on the telephone, assembling parts, or operating a machine that takes very little exertion or strength. If I drove a car or truck while at work, I did not lift or carry anything for more than a few minutes each day") and the second item describes leisure-time activities (i.e., item G – "Weekdays, when I got home from work, I did few active things, but most weekends I was able to get outdoors for some light exercise- going for walks, playing a round of gold (without motorized carts), or doing some active chores around the house"). There are five response items for each item. Responders are asked to select one response to describe their at-work activity and one to describe their leisure-time activity. Based on responses on the two items, respondents' overall physical activity intensity is classified as follows: (1) inactive, (2) light, (3) moderate, (4) hard, and (5) very hard. It was originally developed and validated in a sample of English-speaking older adults (Taylor-Piliae et al., 2006) and was later validated in middle-aged individuals (Taylor-Piliae et al., 2007) and young adults (Joseph et al., 2014).

4.1.3. Procedure

Screening phase

Potential participants were identified and invited to take part in the study from a sample recruited during a wider campaign ("UNIC Mental Health Screening Days 2019: Eating Attitudes and Behaviours") that has been approved by the Cyprus National Bioethics Committee (ref number: ΕΕΒΚ/ΕΠ/2018/28) and took place at the University of Nicosia between the 7th and the 18th of October 2019. Individuals were be contacted via email, only in case, they provided their consent to be contacted for participation in future studies (see Appendix C for the email that was sent to students). Further participants were recruited based on opportunistic sampling by online and on campus advertisement of the study (see Appendix D). Participation in the study was voluntary. Prior to participation, individuals were asked to respond to the Eating Disorder Diagnostic Scale (EDDS; Stice et al., 2000) in order to detect individuals with a current ED diagnosis for exclusion purposes. In addition, if participants came from the aforementioned campaign, they were asked to verify their responses on the Weight Concerns Scale (WCS; Killen et al., 1994), or if they were part of the opportunistic sampling then were asked to complete the WCS.

Eligible participants completed a battery of self-report questionnaires prior to their visit at the lab.

Experimental phase

During the experimental phase of the study, participants were asked to complete a physical and a cognitive stress task aimed at inducing physical and cognitive frustration, respectively. The order of the two tasks was counterbalanced among different administrations to avoid carry over effects. Upon informed consent, participants completed a battery of questionnaires including a general demographic/ historical data questionnaire, the DASS-21 and SBAS were then provided with instructions about the tasks they had to complete.

At first, participants were seated on a chair and were fitted with physiological monitors. There was a 5-minute baseline period before beginning the tasks to stabilise physiological signals.

Next, participants went on to complete the HBPT at four different duration intervals (25 s, 35 s, 45 s and 100 s) following the directions of Schandry (1981) for the Mental Tracking Method. For all four intervals, participants were provided with the verbal instructions to silently count their heartbeats without using any kind of exteroceptive aid

(such as taking one's pulse). Participants were notified when to start and stop counting by a verbal cue. At the end of each time interval, participants were asked to verbally report the number of counted heartbeats. During the task, ECG measurements were taken. The experimenter did not provide feedback on the participants' performance or the length of the counting phases.

Following the HBPT, participants went on to complete the BHT and the PASAT-C in a counterbalanced order. At the end of the experiment, debriefing was provided.

The current study received ethical approval from the Cyprus National Bioethics Committee (ref. number: ΕΕΒΚ/ΕΠ/2020/13) and written informed consent was obtained from all participants prior to participation.

Data analysis plan

Statistical analyses were conducted using SPSS 25.0. Descriptive statistics for each variable were calculated and are presented in Tables 2.1 and 2.2. The chi-square test was used to explore the distribution of frequencies for categorical variables (i.e., activity level and level of studies). The Likelihood Ratio was used when the expected values were less than five for RxC tables. Before performing the statistical analysis for continuous variables, data were checked using the absolute values of skewness and kurtosis for normality and the Levene's test for homogeneity of variances as parametric test assumptions. In cases where the assumption of homogeneity of variances was violated, corrected values were used. For continuous measurements that were not normally distributed (depression, anxiety, stress, BMI and weight concerns) bootstrapping with 1,000 re-samples was performed in analysis. An independent samples t-test was performed to analyze differences between high and low risk participants with regards to IAcc.

To examine group differences in physiological reactivity to the two stress tasks (BHT and PASAT-C) a Repeated Measures Factorial ANOVAs was conducted with Time (baseline, BHT, PASAT-C) as the within-subjects variable and ED risk group (high vs. low) as the between-subjects variable. More specifically, a repeated measures Time x ED risk group ANOVA was conducted with HR as dependent variables. Simple effect analysis with Bonferroni adjustment was used to break down significant interactions. Following, correlation analyses for each group were carried out between the heartbeat perception score and the mean HR response during each task.

Lastly, mediation analyses were conducted using Model 4 of the PROCESS macro (v3.4, model 1, Hayes, 2017) for SPSS to investigate whether emotional reactivity, as

indicated by physiological responses, is a significant mediator in the relationship between IAcc on ED risk. The PROCESS macro mediation model uses a bootstrapping resampling strategy to examine the significance of the model and the effect of the mediator. For the current analysis, the 95% bias-corrected bootstrapped confidence intervals of indirect effects were performed with 5,000 re-samples. Two mediation models were tested. The first mediation model hypothesised in the current study tested IAcc as the independent variable, ED risk as the dependent variable and physiological reactivity to physical distress as the mediator, while the second model included physiological reactivity to cognitive distress as the mediator. The second model, which was the only model that yielded significant results, was also run with physical activity level as a covariate as it has been found to impact physiological responding (Klaperski et al., 2013).

4.2 Results

4.2.1 Descriptive Statistics

Participants' characteristics.

The sample of the current study consisted of 114 female participants (M_{age}= 22.78, *SD*= 1.990). The majority of the participants were Cypriots (84.2%) while the rest were Greek (12.3%) or other (3.5%).

Tables 2.1, 2.2 presented in Chapter 2, Study 1 shows the Means and Standard Deviations of the sample's characteristics, behaviours and attitudes and t-test comparisons among the high and low risk groups.

4.2.2 Preliminary Analyses

Results showed that the two groups did not differ significantly on levels of depression, BCa 95% CI [-2.95, 1.30], t (112) = -.75, p = .45, anxiety, BCa 95% CI [-4.15, 0.17], t (103.60) = -1.90, p = .06, stress, BCa 95% CI [-2.22, 2.34], t (112) = -.05, p = .96, and BMI, BCa 95% CI [-0.26, 2.30], t (112) = .51, p = .12.

As for the Weight Concerns Scale, high risk participants reported significantly more weight concerns, BCa 95% CI [31.63, 40.47], t (84.56) = 16.14, p < .001; M = 66.96, SD = 7.60) than their low-risk counterparts (M = 30.86, SD = 15.18).

Results from the chi square test indicate that there is a significant association between ED risk group and physical activity levels, $\chi^2(4) = 11.82$, $p < .05$ (for differences in frequencies see Table 2.1), and a significant association between ED risk group and level of studies, $\chi^2(1) = 4.09$, $p < .05$. There were significantly more undergraduate

students in the high-risk group (N = 36) than in the low-risk group (N = 27) and significantly fewer graduate students in the high-risk group (N = 19) as compared to the low-risk group (N = 31).

IAcc between ED risk groups as measured by the Heartbeat Perception Task.

Participants in the two risk groups significantly differed on IAcc based on their performance on the HBPT, (BCa 95% CI [.005, .142], t (112) = 2.05, $p < .05$). More specifically, high risk participants were found to be significantly more IAcc (M = .68, SD = .19) than their low-risk counterparts (M = .60, SD = .19). Since depression, anxiety, stress, and physical activity have been found to be related to differences in IAcc (Cameron, 2001; Dunn et al., 2007; Ehlers et al., 2000; Pollatos et al., 2006), a further ANOVA was conducted controlling for these covariates. This analysis confirmed better heartbeat perception in high-risk individuals as compared to their low-risk counterparts, $F_{(1,107)}$ = 4.16, $p < .05$, η_p^2= .04, when controlling for the possible confounders.

Physiological reactivity to the BHT and PASAT-C among participants at high vs. low risk for EDs.

To examine the physiological reactivity (HR) of the two groups in response to the two distress tasks a Repeated Measures Factorial ANOVA was conducted with Time (mean HR during baseline[time1], BHT [time2] and PASAT-C (level 3) [time3]) as the within-subjects variable and ED risk group (high vs. low) as the between-subjects variable. Mauchly's test of sphericity indicates that the assumption of sphericity had been violated $\chi^2(2) = 6.54$, $p = .038$, therefore degrees of freedom were corrected with Huynh-Feldt estimates of sphericity ($\varepsilon = .97$). Results suggested a significant main effect for time, $F_{(1.94,217.34)} = 30.41$, $p < .001$, η_p^2= .21, indicating that participants' HR significantly differed over the three time periods (baseline, during BHT and during PASAT-C). Bonferroni corrected post hoc tests indicated that overall, participants' mean HR during baseline (M= 80.41, SD= 8.24) and during the BHT (M= 79.30, SD= 10.84) did not significantly differ (p = .24), but HR during PASAT-C (M= 84.19, SD= 11.34) was significantly higher compared to baseline ($p < .001$) and BHT ($p < .001$). In addition, results revealed a significant main effect of ED risk group, $F_{(1,112)} = 7.37$, $p < .01$, η_p^2= .06. Bonferroni corrected post hoc tests indicated that overall, high-risk participants presented higher mean HR (M = 83.56, SE = 1.19) than low risk participants (M = 79.04, SE = 1.17).

There was also a significant ED risk x Time interaction, $F_{(1.94,217.34)} = 33.60$, $p <$ .001, η_p^2= .23. To break down this interaction, follow-up Repeated Measures ANOVA were computed for each ED risk group separately with Time (baseline, during BHT, during

PASAT-C) as a within-subjects variable. Mauchly's test of sphericity indicates that the assumption of sphericity had been violated for the high-risk group, $\chi^2(2) = 15.34$, $p < .001$, therefore degrees of freedom were corrected with Huynh-Feldt estimates of sphericity ($\varepsilon = .82$). A significant main effect of Time was found for both the high ED risk group, $F_{(1.64, 90.43)} = 42.90$, $p < .001$, $\eta_p^2 = .44$, as well as for the low-risk group, $F_{(2, 114)} = 14.03$, $p < .001$, $\eta_p^2 = .20$. Low risk participants presented significantly lower HR during the BHT ($M = 76.70$, $SD = 10.05$) than at baseline ($M = 80.99$, $SD = 8.97$) and during the PASAT-C ($M = 79.41$, $SD = 9.52$). There was no significant difference in the HR of low risk participants at baseline and during the PASAT-C ($p = .16$). On the other hand, high risk participants' mean HR during the PASAT-C was significantly higher ($M = 88.96$, $SD = 11.10$) than at baseline ($M = 79.82$, $SD = 7.43$) and during the BHT ($M = 81.90$, $SD = 11.08$). Furthermore, we examined Bonferroni corrected pairwise comparisons between the two groups at each time point (HR: at baseline, during BHT, during PASAT-C). Results showed significant group differences only for mean HR during the two distress tasks (BHT [$F_{(1, 112)} = 6.89$, $p < .01$]; PASAT-C [$F_{(1, 112)} = 24.32$, $p < .001$]; see Figure 2.1, with the high risk group exhibiting significantly higher mean HR during both tasks (BHT: $M = 81.90$, $SD = 11.08$, PASAT-C: $M = 88.96$, $SD = 11.10$) compared to the low risk group (BHT: $M = 76.70$, $SD = 10.05$, PASAT-C: $M = 79.41$, $SD = 9.52$).

It is important to note that including physical activity level as a covariate did not change the main findings for the HR. In addition, based on t-test analyses there were no significant differences on BMI or depression and anxiety levels - as assessed via the DASS-21 (Brown et al., 1997) - between high and low ED risk participants. It is thus concluded that differences in physiological reactivity between the two groups are not confounded by BMI, depression or anxiety.

Correlation between IAcc and HR reactivity during each task.

As shown in Table 4.1, IAcc correlated positively with HR reactivity. More specifically, for the high-risk group heartbeat perception score (i.e., IAcc) was significantly positively correlated with HR reactivity during both tasks. For the low-risk group, correlation between IAcc and HR reactivity was significant only during the BHT.

Table 4.1

Correlation Analyses per ED Risk Group between IAcc and HR Reactivity during each Task.

	HR reactivity during PASAT-C		HR reactivity during BHT	
	High risk (n=56)	Low risk (n=58)	High risk (n=56)	Low risk (n=58)
Correlation with heartbeat perception score	.41	-.13	.34	-.33
Significance	**	n.s.	**	*

Note. HR = heart rate
* $p \leq 0.05$; ** $p \leq 0.001$.

4.2.3 Mediation Analyses

The mediating effect of emotional reactivity - as indicated by cardiac response to the BHT – in the association between IAcc and ED risk.

A mediation analysis was performed to examine whether hyper-reactivity to physical distress mediates the relationship between IAcc and ED risk. The findings are depicted in Figure 4.1 and Table 4.2.

The analyses conducted on the model showed that IAcc significantly predicted ED risk, both when controlling for the mediator (B = 24.20, SE = 10.13, 95% CI [4.13, 44.26], β = .22, p < .05) and when performing a linear regression analysis independent of HR (B = 25.66, SE = 10.29, 95% CI [5.28, 46.04], β = .22, p < .05). However, the association between IAcc and physiological response was not significant (B = 3.58, SE = 5.26, 95% CI [-6.84, 13.99], β = .06, p = .50). Thus, findings indicated a statistically significant total effect (B = 25.66, SE = 10.29, 95% CI [5.28, 46.04]) and direct effect (B = 24.20, SE = 10.13, 95% CI [4.13, 44.26], but no significant indirect effect of IAcc on ED risk, mediated via physiological responding to physical distress (B = 1.46, SE = 2.23, 95% CI [-2.65, 6.62].

Figure 4.1

Mediation Analysis for the effect of Interoceptive Accuracy (IAcc) on ED risk Mediated by Physiological Reactivity to the Physical Stress Task.

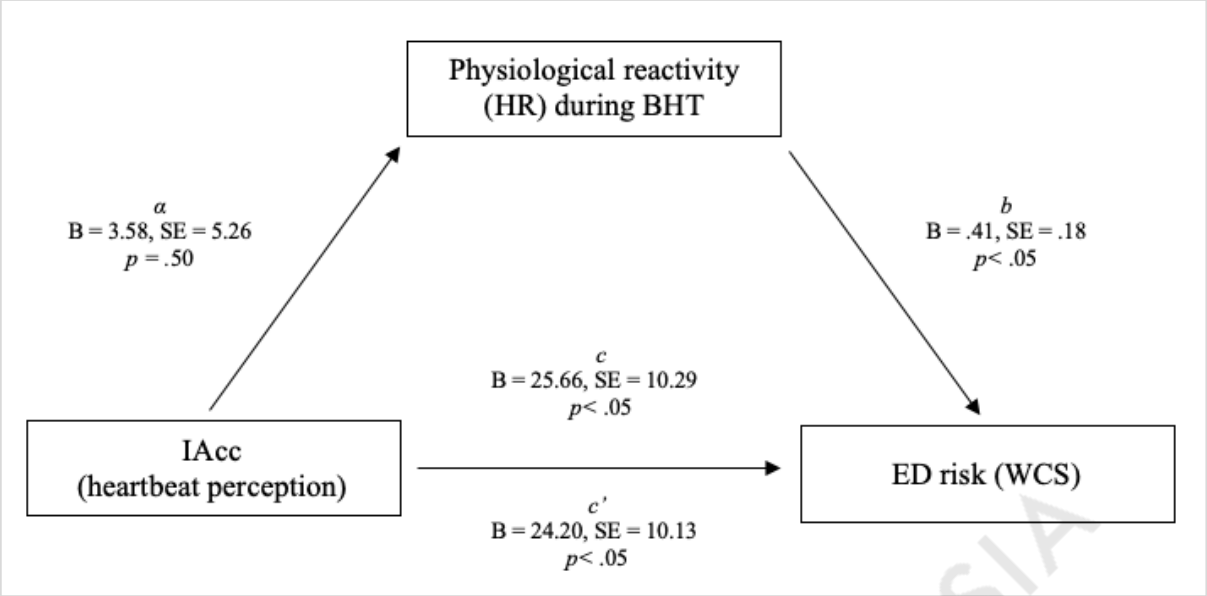


Table 4.2

Results of Mediation Analyses for the effect of IAcc on ED risk Mediated by Physiological reactivity to the *Physical Stress Task.*

Variable	*B*	95% CI	*SE B*	β	R^2
Step 1					.05
Constant	32.19**	18.58, 45.81	6.87		
IAcc	25.66*	5.28, 46.04	10.29	.23*	
Step 2					.09
Constant	.75	-30.01, 31.52	15.52		
IAcc	24.20*	4.13, 44.26	10.13	.22*	
mean HR during BHT	.41*	.18, 2.25	.18	.20*	

Note. CI = confidence interval; IAcc = Interoceptive accuracy; HR = heart rate
* $p \leq 0.05$; ** $p \leq 0.001$.

The mediating effect of emotional reactivity - as indicated by cardiac response to the PASAT-C – in the association between IAcc and ED risk.

A mediation analysis was carried out to investigate whether greater physiological reactivity to cognitive distress mediates the relationship between IAcc and ED risk. Findings are depicted in Figure 4.2 and Table 4.3.

Analysis of the model indicated that the association between IAcc and physiological responding (HR) to cognitive stress was significant, B = 12.82, SE = 5.38, 95% CI [2.16, 23.47], β = .22, p < .05, as was the association between physiological responding (HR) to cognitive stress and ED risk, B = .68, SE = .17, 95% CI [.35, 1,02], β = .36, p < .001. These results support the mediational hypothesis. IAcc significantly predicted ED risk when performing a linear regression analysis independent of physiological responding (HR) to cognitive stress, B = 25.66, SE = 10.29, 95% CI [5.28, 46.04], β = .23, p < .05. IAcc was no longer a significant predictor of ED risk after controlling for the mediator, mean HR during the cognitive stress task, B = 16.92, SE = 9.90, 95% CI [-2.69, 36.53], β = .15, p = .09, consistent with full mediation. Approximately 17% of the variance in ED risk was accounted for by the predictors (R^2 = .17). Thus, findings revealed a statistically significant total effect, B = 25.66, SE = 10.29, 95% CI [5.28, 46.04], but a non-significant direct effect, B = 16.92, SE = 9.90, 95% CI [−2.69, 36.53], of IAcc on ED risk. The indirect effect was tested using a percentile bootstrap estimation approach with 5,000 samples (Shrout & Bolger, 2002), implemented with the PROCESS macro Version 3 (Hayes, 2017). These results indicated the indirect coefficient was significant, B = 8.74, SE = 4.24, 95% CI [1.58, 18.14], completely standardised β = .08.

Since significant differences were observed between high and low-risk participants in physical activity levels, the same mediation model was run with physical activity level as a covariate. Results showed that the model was still significant after including physical activity as a covariate. Findings are depicted in Figure 4.3 and Table 4.4.

Figure 4.2

Mediation Analysis for the effect of Interoceptive Accuracy (IAcc) on ED risk Mediated by Physiological Reactivity to the Cognitive Stress Task.

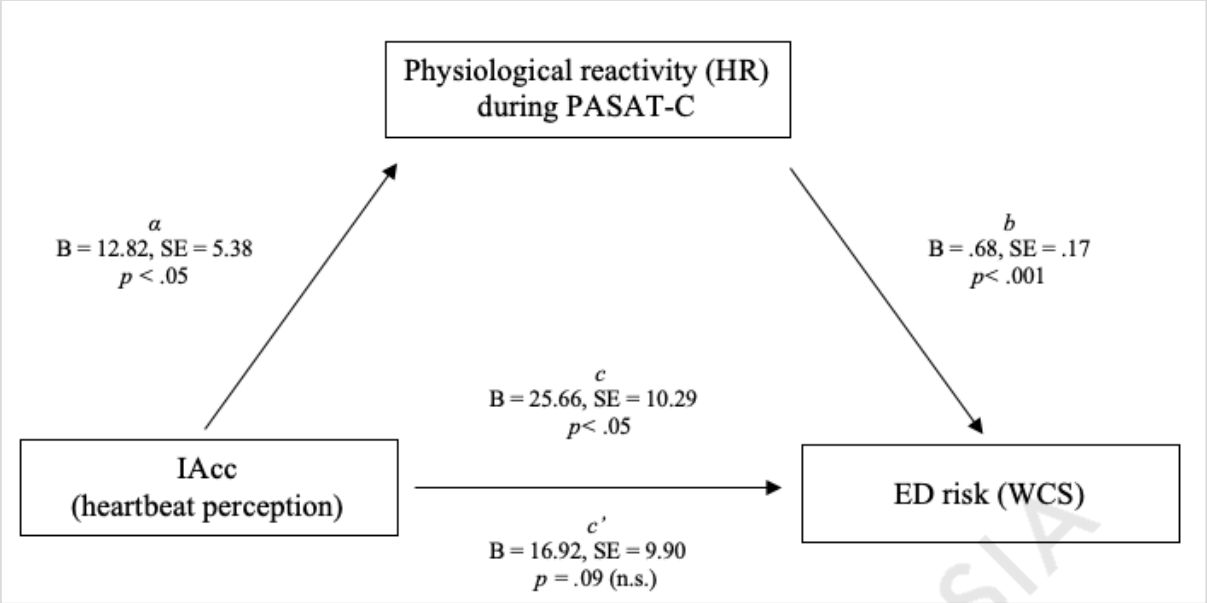


Table 4.3

Results of Mediation Analyses for the Effect of IAcc on ED Risk Mediated by Physiological Reactivity to the Cognitive Stress Task.

Variable	*B*	95% CI	*SE B*	B	R^2
Step 1					.05
Constant	32.19**	18.58, 45.81	6.87		
IAcc	25.66*	5.28, 46.04	10.29	.23*	
Step 2					.17
Constant	-19.55	-48.08, 8.99	8.89		
IAcc	16.92	-2.69, 36.53	10.79	.15	
mean HR during PASAT-C	.68**	.35, 1.02	.03	.36*	

Note. CI = confidence interval; IAcc = Interoceptive accuracy; HR = heart rate
* $p \leq 0.05$; ** $p \leq 0.001$

Figure 4.3

Mediation Analysis for the effect of Interoceptive Accuracy (IAcc) on ED risk Mediated by Physiological Reactivity to the Cognitive Stress Task, including Physical Activity as a Covariate.

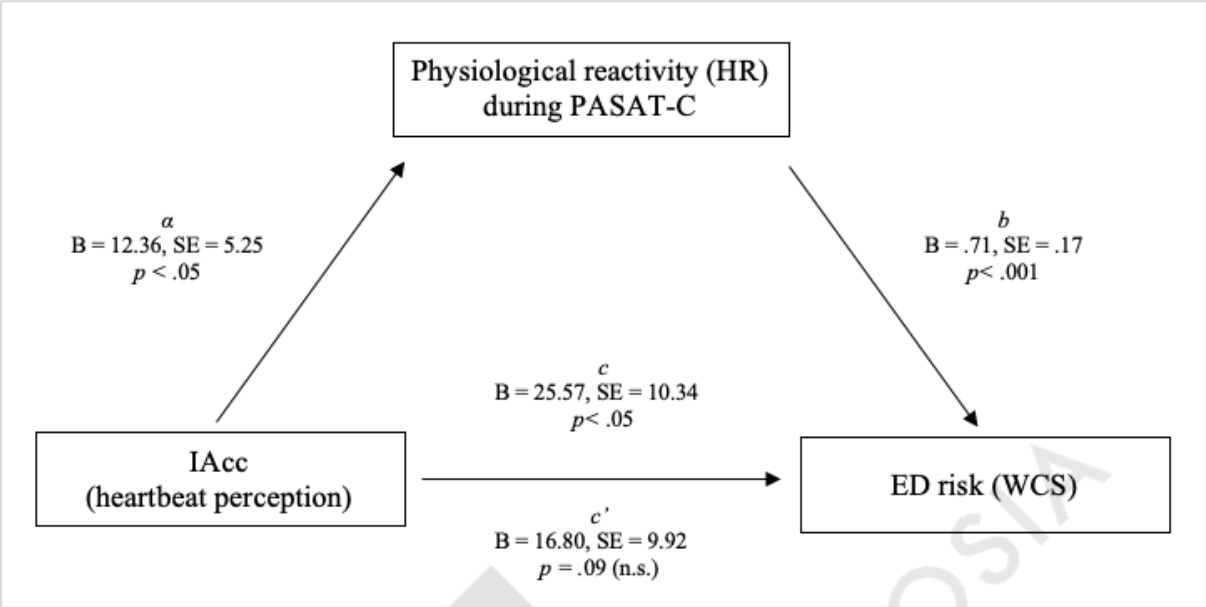


Table 4.4

Results of Mediation Analyses for the Effect of IAcc on ED Risk Mediated by Physiological Reactivity to the Cognitive Stress Task, including Physical Activity as a Covariate.

Variable	*B*	95% CI	*SE B*	B	R^2
Step 1					.05
Constant	33.68**	15.70, 51.66	9.07		
IAcc	25.57*	5.09, 46.05	10.34	.23*	
SBAS	-.59	-5.21, 4.03	2.33	-.02	
Step 2					.18
Constant	-25.60	-59.10, 7.89	8.89		
IAcc	16.80	-2.86, 36.46	10.79	.15	
mean HR during PASAT-C	.71**	.36, 1.06	.03	.37*	
SBAS	1.55	-2.91, 6.00		.06	

Note. CI = confidence interval; IAcc = Interoceptive accuracy; HR = heart rate
* $p \leq 0.05$; ** $p \leq 0.001$

4.3 Discussion

The present study aimed at examining IAcc in young female adults at high vs low risk for EDs, using the HBPT as an objective method of measuring perception of bodily signals (IAcc) under well-controlled laboratory conditions. Furthermore, we aimed to examine and compare physiological reactivity (i.e., cardiac response) to a cognitive (i.e., PASAT-C) vs. a physical stress task (i.e., BHT) in the same population and whether IAcc is correlated with HR response. Finally, the current study aimed to investigate whether hyper-reactivity to negative affect (as reflected by cardiac response) mediates the association between IAcc and ED risk.

Based on the Haynos and Fruzzeti (2011) model hypothesizing that in the premorbid stages of the illness, individuals present with hypersensitivity to somatic affective experience, it was assumed that individuals at high ED risk would be more accurate in perceiving signals from their body as measured by the HBPT. In accordance with this model participants at high ED risk were found to be more interoceptive accurate than their low-risk counterparts. Results of the current study add to the findings of current research studies investigating the, thus far, inconsistent picture of the relationship of EDs and interoceptive abilities (Merwin et al., 2011). Merwin, Timko, Moskovich, Ingle, Bulik, and Zucker (2010) have proposed a model of EDs as an illness of psychological inflexibility, explained as an inability to behave flexibly in the face of difficult thoughts, feelings and bodily sensations. Psychological inflexibility is expressed via attempts to control the experience of the body, in order to minimise ambiguity and achieve a sense of control (Merwin, Timko, et al., 2010). Heightened IAcc means that even minor visceral changes are detected. Given the complexity of the body which precludes precise prediction, even minor bodily changes detected may be misinterpreted and thus experienced as threatening, feared or undesirable. The result may be the employment of maladaptive behaviours to control experience.

In addition, high risk participants demonstrated hyper-reactivity (i.e., higher cardiac response) to both the physical and the cognitive stress tasks, as compared to their low-risk counterparts. Following the somatic marker hypothesis of Damasio (1994, 1999), emotional situations are associated with bodily changes, called somatic markers. Such somatic markers are important for guiding individual behaviour by marking significant body changes. Based on this hypothesis, one can assume that individuals high in IAcc should have a processing advantage in emotional situations due to their heightened precision in detecting such somatic markers. For the majority of people, changes in bodily

experience are identified as expected phenomena. For example, for most people, increased hunger will simply lead to eating more to achieve homeostasis. However, the enhanced awareness of visceral signals observed in our sample of individuals at high ED risk, in addition to the hyper-reactivity to negative affect, may lead to this somatic variability experienced as intolerable, and as a result, to the employment of dysfunctional behaviours to achieve homeostasis (Merwin, Timko, et al., 2010). In fact, a growing base of evidence exists supporting the relationship between ED symptoms and non-acceptance of emotional experience and/or experiential avoidance (i.e., attempts to avoid aversive emotional states via dysfunctional behaviours) (Merwin, Zucker, et al., 2010; Wildes, et al., 2010).

Further, our findings demonstrate that IAcc is associated with enhanced physiological reactivity to distress stimuli, with correlations of up $r = .41$ between the HBPT score and the mean HR reactivity during the two distress tasks. This result is in line with previous studies showing that higher levels of interoceptive abilities are associated with greater physiological reactivity to pleasant and unpleasant stimuli (Pollatos et al., 2007).

On a preliminary basis, we aimed to test the mediating effect of emotional reactivity to negative affect in the relationship between IAcc and ED risk. We assumed that physiological reactivity to both cognitive and physical distress would be significant mediators in the relationship between IAcc and ED risk. Our first model revealed that physiological reactivity to physical distress (i.e., cardiac response to BHT) did not mediate the relationship between IAcc and ED risk. However, our second model revealed a full mediation when reactivity to cognitive distress (i.e., cardiac response to PASAT-C) was introduced into the model. This finding is in line with a previous study which found tolerance of distress (self-reported) to be a significant mediator in the relationship between anxiety sensitivity and bulimic symptoms (Anestis et al., 2007). In light of such results, it appears that reactivity to cognitive frustration may be an important cognitive-affective mechanism underlying the IAcc-ED risk association. Based on the current findings, we can assume that individuals who are more interoceptive accurate - and thus experience emotion with greater intensity (James, 1884; Damasio 1994; Damasio, 1999) - rely on dysregulated eating behaviours as a fast and available comforting strategy because they lack more effective emotion regulation skills to help them act flexibly in the face of cognitive distress. Engagement in these behaviours sets them at increased risk for ED development. To illustrate, a young female who is hyperaware of her bodily signals and experiences a situation of negative affect (i.e., she is rejected at a job interview), reacts with higher

physiological arousal to the rejection. She will further experience the aversive negative affect with a greater degree of accuracy and possibly more intensely and as a result this will increase her risk of engaging in ED-related behaviours to soothe the painful internal experience. Recurrent use of such behaviours and in the absence of other more effective strategies of responding to negative affect, she may use maladaptive ED-related behaviours as a primary way of regulating distress. As this is the first study to examine the association between emotional reactivity to negative affect (as reflected in physiological data), IAcc and ED risk, results should be interpreted as preliminary evidence for the proposed mediational model (see Figure 4.2). In addition, given the novelty of the finding, it would be valuable for future studies to replicate this association. Also, future research should aim to examine this association adding more physiological indices of emotional processing, such as respiratory sinus arrhythmia and skin conductance responses.

4.3.1 Limitations

The results of the study should be considered in light of some notable limitations. Firstly, the current study employed a cross-sectional design, which permits the examination of the temporal ordering of the variables studied in the mediation model. Therefore, it is important for future studies to replicate the associations found in the current study using prospective designs. Secondly, a homogenous sample was used for the purposes of the present study in that most participants were Cypriot and with higher education. This undermines our ability to generalise our findings to other populations. Future studies could replicate results in other samples from different cultural contexts, ages, and educational backgrounds. Thirdly, despite the widespread use of the HBPT as a measure of IAcc in several research studies (Pollatos et al., 2008; Ehlers et al., 2000), some authors suggest that performance in these kind of tracing tasks can be affected by participants' beliefs and expectations about their heart rates (Ring et al., 2015; Knapp-Kline & Kline, 2005; Wiens & Palmer, 2001). In addition, other factors like attention or motivation may also affect performance on any heartbeat perception task. Nevertheless, and despite the aforementioned methodological problems, a convincing body of research exists supporting the validity of the HBPTs in detecting processes associated with interoception (Critchley et al., 2004; Wiens, 2005). Moreover, the extent to which interoception is modality specific is not yet clear, thus future studies would benefit from the use of interoceptive measures that focus on the gastric tract. In fact, gastric interoception would be particularly relevant in individuals with eating related issues. Nevertheless, some evidence exists demonstrating that cardiac awareness is related to

greater sensitivity for gastric functions, thus pointing to a general sensitivity for interoceptive processes across different visceral bodily modalities (Herbert et al., 2012), however more research is needed to confirm this link.

4.3.2 Conclusions

In summary, the present study found that when compared to individuals at low risk for EDs, individuals at high-risk exhibit higher IAcc, as indexed via the HBPT, and greater physiological reactivity to distress, as indicated by their cardiac response to a cognitive stress task - PASAT-C, and a physical stress task- BHT). To our knowledge, the present study is the first empirical work to show that interoceptive accuracy, as measured by a HBPT, is heightened in individuals who are at high ED risk but do not currently meet criteria for a clinical ED diagnosis. The finding provides preliminary evidence for the Haynos and Fruzzeti model (2011) postulating that in sub-clinical stages of the illness, individuals present with hypersensitivity to somatic affective experience which in turn leads to the engagement of pathology-related behaviours in an attempt to attenuate negative experience. This highlights the potential role of IAcc in the development of EDs and provides important clinical implications. Heightened IAcc could be seen as a useful therapeutic tool for individuals at risk for EDs. Interventions such as biofeedback, mindfulness, mentalization and acceptance-based treatments (e.g., Acceptance and Commitment Therapy [ACT]; Hayes et al., 2009) that use somatic experiencing and interoception as core elements of therapy to reduce symptomatology may prove helpful by providing guidance on more effective ways of responding to painful or negative internal experiences (i.e., observation and acceptance of negative internal events).

The present study also demonstrated novel results regarding the association between IAcc, reactivity to negative affect and ED risk. Results suggest that hyper-reactivity to negative affect mediates the association between IAcc and ED risk. Assessment of emotional reactivity to negative affect could be usefully integrated in clinical assessments of individuals who present with weight concerns to possibly establish the risk of ED development. Moreover, as hyper-reactivity to aversive emotional states has been found to be significantly related to both IAcc and ED risk, it could be promising to incorporate elements of teaching or enhancing skills of effectively managing difficult emotions in ED prevention programs. For example, mentalization-based therapy can help patients make sense of their thoughts, beliefs, wishes and feelings and link these to actions and behaviours, thus alleviating problematic responding in emotionally difficult situations.

CHAPTER 5
GENERAL DISCUSSION

5.0 Discussion

There is a plethora of studies demonstrating that ED populations, both clinical and non-clinical, exhibit difficulties in emotional processing. However, the nature of these emotional deficits remains poorly understood. In fact, studies provide contradictory findings on their severity and specificity. Some studies point to hyper-sensitivity while others suggest hypo-sensitivity in response to negative/unpleasant affect (e.g., see review by Giel et al., 2011). These findings, even though contradictory, may in fact point to the complex synergy between basic affective mechanisms that contribute to the development of ED symptoms and evolve with illness progression (Merwin, 2011). In fact, it is hypothesised that in the early stages of the disorder patients present with a hypersensitivity to somatic-affective cues which exacerbates the experience of negative affect and reinforces the use of ill-matched responses to attenuate the aversive experience (Merwin, 2011, Haynos & Fruzzeti, 2011). Over time, recurrent engagement in these behaviours leads to decreased awareness of internal cues and a muting of sensations (i.e., hyposensitivity to somatic-affective cues) (Merwin, 2011, Haynos & Fruzzeti, 2011).

The aim of the present doctoral project was to examine this assumption of hypersensitivity to somatic-affective cues at a subclinical level of ED utilizing female young adults at high vs. low ED risk. Reactivity to negative affect was examined comprehensively in two distress tolerance (DT) tasks, namely the Breath-Holding Task (BHT; Hajek et al., 1987) inducing physical distress and the "Paced Auditory Serial Addition Task-Computerized" (PASAT-C) (Lejuez et al., 2003) inducing cognitive stress, by utilizing physiological (Heart Rate [HR]), self-report (affect ratings) and behavioural measures (time spent on the tasks). Behavioural and self-reported reactions to the two tasks were indicative of DT. Ability to accurately perceive visceral signals, referred to as IAcc, was also investigated in this project in the same population using a well-controlled laboratory method.

Our first study (Chapter 2) aimed to examine the physiological, behavioural and subjective emotional responses of participants at high vs. low risk for EDs in response to the two DT tasks. The behavioural and self-reported responses to the two stress tasks were considered to reflect participants' ability to tolerate distress (i.e., DT). Findings provide important indications as to the somatic-affective experience of individuals who are at high risk for developing EDs but have not yet developed ED clinical symptoms and their experience is not influenced by medical problems, such as bradycardia, seen at the later stages of the illness. More specifically, females at high ED risk present with an autonomic

hyper-reactivity as indicated by higher cardiac response as compared to their low-risk cohorts, evident in response to both stress tasks but being more pronounced in the cognitive stress task. Regarding the self-report affect ratings, females at high ED risk reported greater unpleasantness and less control over the situation after the cognitive stress task. An examination of the behavioural responses (i.e., time spent on the tasks) to the two distress tasks showed no significant differences between the two groups on the physical stress task, while high risk individuals stayed on the cognitive stress task for significantly less time as compared to their low-risk cohorts. The greater emotional arousal of high-risk individuals (evident in their physiological, behavioural and self-reported reactions to distress) indicates a lower capacity to tolerate distress compared to low-risk individuals and may also point to a trait-like feature that predates onset and sets the individual at risk for ED development either by making emotions difficult to tolerate or by generating a hyperawareness of the body (Merwin, 2011).

Differences in the ability to tolerate distress between the two groups were also assessed via a self-report measure, namely the Distress Tolerance Scale (DTS; Simons & Gaher, 2005) in the same study. Responses to the DTS (Simons & Gaher, 2005), which reflects the perceived capacity of individuals to tolerate distress, confirmed that participants at high ED risk demonstrate reduced DT as compared to their low-risk counterparts. A separate examination of the four aspects of DT (distress tolerance; distress appraisal; distress regulation; distress absorption), as yielded by the DT self-report measure used in the study, reveal a somewhat unexpected finding. High and low risk participants scored similarly on the distress regulation aspect of the DTS (Simons & Gaher, 2005), suggesting that the two groups use similar emotion regulation strategies to alleviate negative emotions. This however may be explained as high ED risk participants' unwillingness or reluctancy to report on their difficulties and a desire to conform with societal standards to minimise threat of social rejection (Merwin, Timko, et al., 2010).

On a preliminary basis, Study 1 also aimed to identify the specificity of disturbances of high-risk individuals (i.e., physical vs. cognitive level) by comparing the affective experience (physiological, subjective, behavioural) on the physical stress task (BHT) vs. the psychological/cognitive stress task (PASAT-C). Results indicate that young females at high ED risk exhibit higher emotional reactivity, across all modalities examined in the study (i.e., physiological, behavioural and self-reported), in response to the cognitive vs. the physical stress task. This suggests that disruptions in this population are more profound on a cognitive level. Indeed, evidence from research studies support that people

with EDs exhibit a variety of dysfunctional cognitions which play an important role in the development and maintenance of eating pathology (Fairburn et al., 2003). Nevertheless, it is important to note the methodological limitations that might influence our findings. It is possible that the distress induced by the two tasks is not comparable in terms of intensity. In fact, the PASAT has been found to be a very difficult task for the general population, even under ideal circumstances (Brooks et al., 2011), while the BHT relies more on one's own judgment as to when to quit the task as participants are instructed to "hold their breath for as long as they can". This provides a sense of control to the participants in contrast to the PASAT-C which is more restrictive and gives less freedom to the participant over task termination (i.e., able to quit only on Level 3). Therefore, the two tasks may not induce the same or even similar levels of distress.

Lastly, Study 1 aimed to examine the correspondence between physiological and self-reported responses to negative affect. Findings show that high-risk participants demonstrated good correspondence between their objective (physiological-HR) and subjective reactions (self-report-affect ratings) to the two stress tasks, suggesting that they perceive their body with relative accuracy. However, in light of their diminished ability to tolerate cognitive distress, they seem to lack the necessary skills to effectively respond to them and thus rely on maladaptive ways to alleviate negative internal experiences. Nevertheless, this is a preliminary finding and future studies are needed to replicate it.

Our second study (Chapter 3) aimed to examine IAcc among young females at high vs. low ED risk, using the HBPT as an objective method of measuring perception of bodily signals (IAcc), under well-controlled laboratory conditions. Integrating data from the previous study, demonstrating that individuals at high ED risk have a reduced ability to tolerate cognitive distress as evidenced by the duration they stayed on the cognitive-based task (PASAT-C), we also aimed to investigate the mediating effect of tolerance to cognitive distress in the relationship between IAcc and ED risk. Results demonstrate that individuals at high ED risk are more interoceptive accurate than their low-risk counterparts. This finding provides further evidence for the hypothesis that in sub-clinical stages of EDs, individuals present with hypersensitivity to somatic affective experience which, in the absence of other more effective strategies, may possibly lead to the engagement of ill-matched behaviours to attenuate the experience of negative affect. Findings from our mediation model demonstrate that tolerance to cognitive frustration, as reflected in task endurance (i.e., time spent on task), is a significant mediator in the association between IAcc and ED risk. Therefore, the capacity to tolerate cognitive

frustration seems to be an important cognitive-affective mechanism underlying the IAcc-ED risk association. Based on these findings, we can assume that individuals who exhibit higher levels of IAcc are more prone to develop EDs because they show higher cognitive distress intolerance.

The third study (Chapter 4) presented in the present doctoral project extended our research by investigating whether emotional reactivity, as reflected by cardiac responses to the cognitive and physical stress tasks, mediates the association between IAcc and ED risk. We run two separate mediation models to test this hypothesis. The first model tested whether reactivity to physical distress (i.e., cardiac response to BHT) is a significant mediator in the relationship between IAcc and ED risk. This model did not yield any significant results. The second model examining reactivity to cognitive distress (i.e., cardiac response to PASAT-C) as a possible mediator in the IAcc-ED risk association provided significant results. Thus, reactivity to cognitive distress was found to be a significant mediator in the relationship between IAcc and ED risk, confirming results from Study 1 and providing preliminary evidence that hyper-reactivity to cognitive distress plays a significant role in the IAcc-ED risk association.

Findings from the current doctoral project demonstrate that 1) high risk participants show higher physiological and subjective reactivity to induced distress as compared to their low-risk counterparts; 2) individuals at high ED risk are more interoceptive accurate than their low-risk counterparts (as indicated via their HBPT performance and correspondence between their subjective and objective reactions); 3) reduced ability to tolerate cognitive distress (i.e., lower levels of DT-cognitive) and hyper-reactivity to cognitive distress are both significant mediators in the association between IAcc and ED risk.

In light of this information, preventative and treatment models focused on DT skills may prove helpful in preventing the development of EDs. For example, mindfulness and acceptance-based interventions (e.g., Acceptance and Commitment Therapy), biofeedback and mentalization-based therapy that use somatic experiencing and interoception as core elements of therapy can provide guidance on more adaptive ways of responding to negative affect (Hayes et al., 2009). Similarly, Dialectical Behaviour Therapy can prove helpful by teaching and enhancing DT skills thus improving reactions to painful internal experiences (Chen et al., 2008). Prevention programs may benefit from these interventions by reducing maladaptive responding (i.e., disordered eating-related behaviours) in response to aversive negative affect. Although preliminary, the findings of this project as to the

association between IAcc, DT and ED risk are expected to stimulate future work to further examine the cognitive-affective mechanisms underlying ED onset.

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Appendix A

Self-report Measures

Participant no.: _____

Instructions: Please answer the following questions. Make sure you did not leave a question unanswered. There are no right or wrong answers and the questionnaire is completely confidential.

Answer the following questions with honesty by filling in or circling the answer that best represents you.

1) Gender:

a) Male ☐ b) Female ☐

2) Age**:** _____

3) Ethnicity: _____

4)Level of studies:
a) Undergraduate: 1st year ☐ 2nd year ☐ 3rd year ☐ 4th year ☐
Other:_____
b) Graduate: Master ☐ PhD ☐ 1st year ☐ 2nd year ☐ 3rd year ☐ 4th year ☐
Other: _____
c) School: _____ Department: _____

5) Height (cm): _____

6)
a) Recent Weight (Kg): _____
b) Maximum weight that you ever had was: _____
c) Lowest weight that you ever had was: _____
d) Ideal weight that you would like to have: _____
e) Which weight would be disappointing for you? _____

7) Do you suffer from one or more of the following conditions: heart or vascular disease, lung or respiratory disease (e.g. asthma), neurological disease, anxiety disorder, depression, hyperventilation?
a) Yes ☐ b) No ☐

If so, which one? _____

8) Do you have any other medical problems/health issues?

a) Yes (Diagnosis: _____) b) No ☐

9) Previous medical problems/health issues?

a) Yes (Diagnosis: _____) b) No ☐

10) Do you take medication?
a) Yes ☐ b) No ☐

If so, which one? _____

11) Do you do sports?
a) Yes ☐ b) No ☐
If so, how many hours per week: _____
Which sport? _____
12) Do you play a musical instrument?
a) Yes ☐ b) No ☐
If so, which one? _____
How many hours a week? _____
13) Do you smoke?
a) Yes ☐ b) No ☐
If yes, then it is: Daily ☐ / Weekly ☐ / Rarely ☐
14) Do you wear a smartwatch that measures your heart rate?
a) Yes ☐ b) No ☐
If yes, how many times per day do you use your smartwatch to measure your heart rate?

_____

Only for female participants:

15) When do you expect your next menstrual period?

In about _____ week / weeks.

16) Do you use hormonal contraceptives (e.g., the pill, spiral, rod, vaginal ring)?
a) Yes ☐ b) No ☐

EDDS

Over the <u>past 3 months</u>…

	Not at all (0)	(1)	Slightly (2)	(3)	Moderately (4)	(5)	Extremely (6)
1. Have you felt fat?	☐	☐	☐	☐	☐	☐	☐
2. Have you had a definite fear that you might gain weight or become fat?	☐	☐	☐	☐	☐	☐	☐
3. Has your weight influenced how you think about (judge) yourself as a person?	☐	☐	☐	☐	☐	☐	☐
4. Has your shape influenced how you think about (judge) yourself as a person?	☐	☐	☐	☐	☐	☐	☐

5. During the past **<u>6 months</u>** have there been times when you felt you have eaten what other people would regard as an unusually large amount of food (e.g., a quart of ice cream) given the circumstances?

YES ☐ NO ☐

If your answer to question 5 is "NO" please skip question 6 and move on to question 7.

6. During the times when you ate an unusually large amount of food, did you experience a loss of control (feel you couldn't stop eating or control what or how much you were eating)?

YES ☐ NO ☐

7. How many **<u>DAYS per week</u>** on average over the **<u>past 6 MONTHS</u>** have you eaten an unusually large amount of food and experienced a loss of control?

0	1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐	☐

8. How many **<u>TIMES per week</u>** on average over the **<u>past 3 MONTHS</u>** have you eaten an unusually large amount of food and experienced a loss of control?

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

If your answer to question 8 is "0" please skip questions 9-14 and move on to question 15.

During these episodes of overeating and loss of control did you…

	YES	NO
9. Eat much more rapidly than normal?	☐	☐
10. Eat until you felt uncomfortably full?	☐	☐
11. Eat large amounts of food when you didn't feel physically hungry?	☐	☐
12. Eat alone because you were embarrassed by how much you were eating?	☐	☐
13. Feel disgusted with yourself, depressed, or very guilty after overeating?	☐	☐
14. Feel very upset about your uncontrollable overeating or resulting weight gain?	☐	☐

15. How many **<u>times per week</u>** on average over the past **<u>3 months</u>** have you made yourself vomit to prevent weight gain or counteract the effects of eating?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

16. How many **times per week** on average over the past **3 months** have you used laxatives or diuretics to prevent weight gain or counteract the effects of eating?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

17. How many **times per week** on average over the past **3 months** have you fasted (skipped at least 2 meals in a row) to prevent weight gain or counteract the effects of eating?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

18. How many **times per week** on average over the past **3 months** have you engaged in excessive exercise specifically to counteract the effects of overeating episodes?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

19. How much do you weigh? If uncertain, please give your best estimate.
_____kg

20. How tall are you? _____ m

21. Over the past **3 months**, how many menstrual periods have you missed?

1 2 3 4 n/a

22. Have you been taking birth control pills during the past 3 months?

YES ☐ NO ☐

Stice, Telch, & Rizvi, 2000

WCS

For all questions below, circle only one number.

1. How much more or less do you feel you worry about your weight and body shape than other women your age?

1. I worry a lot less than other women. ☐
2. I worry a little less than other women. ☐
3. I worry about the same as other women. ☐
4. I worry a little more than other women. ☐
5. I worry a lot more than other women. ☐

2. How afraid are you of gaining 3 pounds (1.5 kg)?

(1)	(2)	(3)	(4)	(5)
Not afraid	Slightly afraid	Moderately afraid	Very afraid	Terrified
☐	☐	☐	☐	☐

3. When was the last time you went on a diet?

1. I've never been on a diet. ☐
2. I was on a diet about one year ago. ☐
3. I was on a diet about 6 months ago. ☐
4. I was on a diet about 3 months ago. ☐
5. I was on a diet about 1 month ago. ☐
6. I was on a diet less than 1 month ago. ☐
7. I'm now on a diet. ☐

4. Compared to other things in your life, how important is your weight to you?

1. My weight is not important compared to other things in my life. ☐
2. My weight is a little more important than some other things. ☐
3. My weight is more important than most, but not all, things in my life. ☐
4. My weight is the most important thing in my life. ☐

5. Do you ever feel fat?

(1)	(2)	(3)	(4)	(5)
Never	Rarely	Sometimes	Often	Always
☐	☐	☐	☐	☐

Killen et al., Int J Eat Dis , 1994
Killen et al., JCCP , 1996

DTS

Directions: Think of times that you feel distressed or upset. Select the item from the menu that best describes your beliefs about feeling distressed or upset.

	Strongly agree	Mildly agree	Agree and disagree equally	Mildly disagree	Strongly disagree
1. Feeling distressed or upset is unbearable to me.	☐	☐	☐	☐	☐
2. When I feel distressed or upset, all I can think about is how bad I feel.	☐	☐	☐	☐	☐
3. I can't handle feeling distressed or upset.	☐	☐	☐	☐	☐
4. My feelings of distress are so intense that they completely take over.	☐	☐	☐	☐	☐
5. There's nothing worse than feeling distressed or upset.	☐	☐	☐	☐	☐
6. I can tolerate being distressed or upset as well as most people.	☐	☐	☐	☐	☐
7. My feelings of distress or being upset are not acceptable.	☐	☐	☐	☐	☐
8. I'll do anything to avoid feeling distressed or upset.	☐	☐	☐	☐	☐
9. Other people seem to be able to tolerate feeling distressed or upset better than I can.	☐	☐	☐	☐	☐
10. Being distressed or upset is always a major ordeal for me.	☐	☐	☐	☐	☐
11. I am ashamed of myself when I feel distressed or upset.	☐	☐	☐	☐	☐
12. My feelings of distress or being upset scare me.	☐	☐	☐	☐	☐
13. I'll do anything to stop feeling distressed or upset.	☐	☐	☐	☐	☐
14. When I feel distressed or upset, I must do something about it immediately.	☐	☐	☐	☐	☐
15. When I feel distressed or upset, I cannot help but concentrate on how bad the distress actually feels	☐	☐	☐	☐	☐

Simons & Gaher, 2005

DASS-21

Please read each statement and tick the number which indicates how much the statement applied to you ***over the past week***. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:
0 = Did not apply to me at all
1 =Applied to me to some degree, or some of the time
2 = Applied to me to a considerable degree, or a good part of time
3 = Applied to me very much, or most of the time

		0	1	2	3
1	I found it hard to wind down	☐	☐	☐	☐
2	I was aware of dryness of my mouth	☐	☐	☐	☐
3	I couldn't seem to experience any positive feeling at all	☐	☐	☐	☐
4	I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)	☐	☐	☐	☐
5	I found it difficult to work up the initiative to do things	☐	☐	☐	☐
6	I tended to over-react to situations	☐	☐	☐	☐
7	I experienced trembling (e.g., in the hands)	☐	☐	☐	☐
8	I felt that I was using a lot of nervous energy	☐	☐	☐	☐
9	I was worried about situations in which I might panic and make a fool of myself	☐	☐	☐	☐
10	I felt that I had nothing to look forward to	☐	☐	☐	☐
11	I found myself getting agitated	☐	☐	☐	☐
12	I found it difficult to relax	☐	☐	☐	☐
13	I felt down-hearted and blue	☐	☐	☐	☐
14	I was intolerant of anything that kept me from getting on with what I was doing	☐	☐	☐	☐
15	I felt I was close to panic	☐	☐	☐	☐
16	I was unable to become enthusiastic about anything	☐	☐	☐	☐
17	I felt I wasn't worth much as a person	☐	☐	☐	☐
18	I felt that I was rather touchy	☐	☐	☐	☐
19	I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)	☐	☐	☐	☐
20	I felt scared without any good reason	☐	☐	☐	☐
21	I felt that life was meaningless	☐	☐	☐	☐

Brown, Chorpita, Korotitsch, & Barlow, 1997

SBAS

Instructions: Please read through the entire questionnaire before answering. You should select the answer that best represents your activity during the past year.

Please check the box next to the one statement that best describes the kinds of physical activity you usually performed while on the job this last year. If you are not gainfully employed outside the home but perform work around the home regularly, indicate that activity in this section.

A.	☐	If you have no job or regular work, check box A and go to Appendix table 2.
B.	☐	I spent most of the day sitting or standing. When I was at work, I did such things as writing, typing, talking on the telephone, assembling parts, or operating a machine that takes very little exertion or strength. If I drove a car or truck while at work, I did not lift or carry anything for more than a few minutes each day.
C.	☐	I spent most of the day walking or using my hands and arms in work that required moderate exertion. When I was at work, I did such things as delivering mail, patrolling on guard duty, doing mechanical work on automobiles or other large machines, house painting, or operating a machine that require some moderate-activity work of me. If I drove a truck or lift, my job required me to lift and carry things frequently.
D.	☐	I spent most of the day lifting or carrying heavy objects or moving most of my body in some other way. When I was at work, I did such things as stacking cargo or inventory, handling parts or materials, or doing work like that of a carpenter who builds structures or a gardener who does most of the work without machines.
E.	☐	I spent most of the day doing hard physical labor. When I was at work, I did such things as digging or chopping with heavy tools or carrying heavy loads (bricks, for example) to the place where they were to be used. If I drove a truck or operated equipment, my job also required me to do hard physical work most of the day with only short breaks.

Please check the box next to the one statement that best describes the way you spent your leisure time during most of the last year.

F.	☐	Most of my leisure time was spent without very much physical activity. I mostly did things like watching television, reading, or playing cards. If I did anything else, it was likely to be light chores around the house or yard or some easy-going game like bowling or catch. Only occasionally, no more than once or twice a month, did I do anything more vigorous, like jogging, playing tennis, or active gardening
G.	☐	Weekdays, when I got home from work, I did few active things, but most weekends I was able to get outdoors for some light exercise- going for walks, playing a round of gold (without motorized carts), or doing some active chores around the house.
H.	☐	Three times per week, on average, I engaged in some moderate activity, such as brisk walking or slow jogging, swimming, or riding a bike for 15-20 minutes or more, or I spent 45 minutes to an hour or more doing moderately difficult chores, such as raking or washing windows, mowing the lawn or vacuuming, or playing games such as doubles tennis or basketball.
I.	☐	During my leisure time over the past year, I engaged in a regular program of physical fitness involving some kind of heavy physical activity at least three times per week. Examples of heavy physical activity are jogging, running, or riding fast on bicycle for 30 minutes or morel heave gardening or other chores for an hour or more; active games or sports such as handball or tennis for an hour or more or a regular program involving calisthenics and jogging or the equivalent for 30 minutes or more.
J.	☐	Over the past year, I engaged in a regular program of physical fitness along the lines described in the last paragraph (I), but I did it almost *daily*-five or more times per week.

Taylor-Piliae et al., 2006

Appendix B

Affect Ratings

PANAS

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. Indicate to what extent you feel this way right now, that is, at the present moment.

1	2	3	4	5
Very slightly or Not at all	**A little bit**	**Moderately**	**Quite a lot**	**Very much**

1. Distressed _____

2. Upset _____

3. Guilty _____

4. Scared _____

5. Hostile _____

6. Irritable _____

7. Ashamed _____

8. Nervous _____

9. Jittery _____

10. Afraid _____

Watson, Clark, & Tellegen, 1988

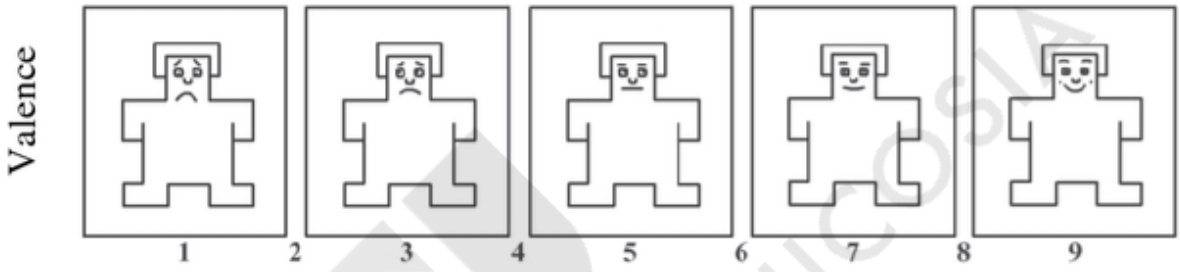
SAM

In the experiment you are participating in, we study how one would respond to a series of stressors. Using the figures below please judge your own emotional state, that is your feelings elicited by the stress task which you just completed.

There are 3 scales that you can use to indicate your feelings: pleasure, arousal, and dominance. All scales range from 1 to 9.

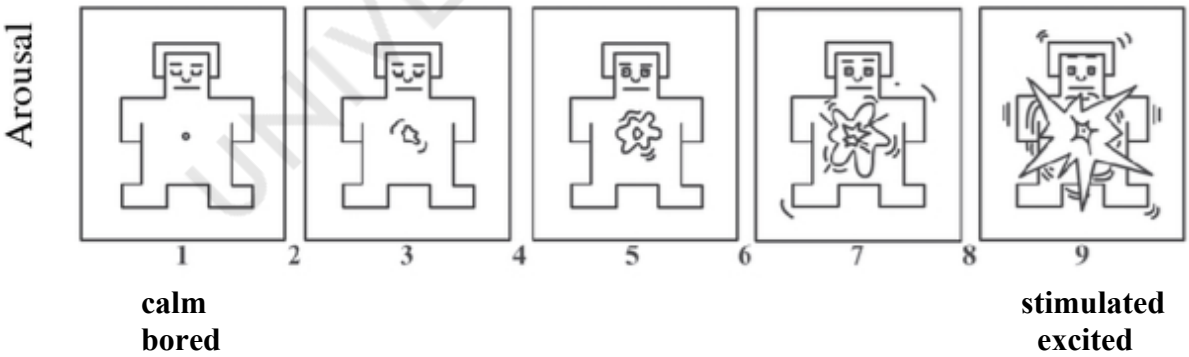
Valence scale

The scale ranges from big frown to big smile, which represents feelings that range from **unhappy** or **sad** to **happy** or **joyful**. The rating is done by choosing one among 9 options within the range, as shown below. The facial expressions of the mannequins help you find appropriate options.



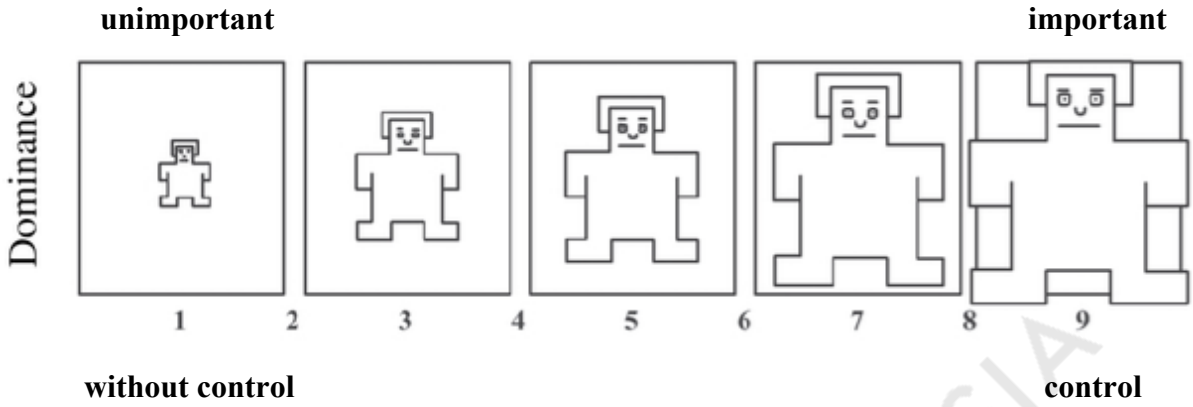
Arousal scale

The scale ranges from calm or bored to stimulated or excited. Again, you are to choose one among 9 options. You can see that the facial expression of the mannequin remains the same, but the "explosion" or grumbling in the stomach of the mannequin indicates the degree of arousal.



Dominance/Control Scale

Sometimes you feel empowered (in control of everything) when performing a task. Other times, you feel rather helpless and weak (without control). The scale ranges from submissive (or "without control") to dominant (or "in control"). A small mannequin in the left side indicates that you feel unimportant or without control, bullied, like someone else is the leader or in charge, or like you can't handle the situation. A big mannequin in the right side indicates that you feel important, very big, or like you don't need anyone's help.



Bradley & Lang, 1994

Appendix C

Invitation Email

Dear student,

We would like to thank you once again for your participation in our campaign "UNIC Mental Health Screening Days 2019: Eating Attitudes and Behaviours" that took place at the University of Nicosia on the 7-18 of October 2019.

You have received this email as you have given us your permission to contact you for participation in future studies by providing us with your email address.

We are currently carrying out a study entitled "Eating disorder risk: Distress tolerance and its relation to interoceptive accuracy" and you are kindly asked for your help. The Primary Supervisor of the study is Dr Maria Koushiou and the doctoral researcher is Mrs Eleni Iasonidou. The study has been approved by the Cyprus National Bioethics Committee (ref. number: ΕΕΒΚ/ΕΠ/2020/13).

The study that you are invited to take part is an experimental, brief study that aims to:

- Investigate the relationship between emotional experience and body-image and eating-related attitudes and behaviours

During the study, you will be asked to complete three behavioural tasks; a mental arithmetic task and two easy, short physical tasks - holding your breath and measuring your heart rate. In addition, you will be asked to answer a series of questionnaires. Some of the questions you will be asked are of a sensitive nature, including questions about your weight.

The study will be conducted at the Psychology lab of the University of Nicosia and will take approximately 30 minutes. For more information email us at unicmentalhealth@gmail.com or contact us via phone at 99862442.

If you are interested to participate in this study, please let us know via email (unicmentalhealth@gmail.com) or via phone (99862442). You will soon be contacted by the Doctoral Researcher (Eleni Iasonidou) of the program.

Appendix D

Information Leaflet

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