# The Identification of Salivary Biomarkers of Perfectionistic Stress in Teachers

Emma Louise Thomas

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School of Health Sciences

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The candidate confirms that the work submitted is their own and that appropriate credit has been given where reference has been made to the work of others.

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## Abstract

This study examined the relationship between dimensions of perfectionism and stress levels in teachers and teacher trainees. Perceived (self-report) stress was measured as were biomarkers of stress in the form of salivary concentrations of cortisol, α-amylase, Dehydroepiandrosterone (DHEA) and Immunoglobulin-A (IgA). Sixty-five participants consisting of teacher trainees and fully qualified teachers completed questionnaires to assess trait perfectionism, perfectionistic self-presentation (PSP), perfectionistic cognitions, stress appraisal and perceived stress. Key findings were (a) Socially Prescribed Perfectionism (SPP)($p<.01$), perfectionistic self-presentation($p<.01$), and perfectionistic cognitions ($p<.05$) were positively related to perceived stress, and self-oriented perfectionism was negatively related to salivary amylase concentration ($p<.05$), (b) non-disclosure of imperfection ($p<.01$)and perfectionistic cognitions ($p<.05$) were unique positive predictors of perceived stress, and (c) tentative evidence that self-oriented perfectionism (SOP) and perfectionistic self-promotion (PSP) may also be unique negative predictors of salivary amylase concentration as those displaying SOP ($p<.05$) and PSP ($p<.05$)had lower salivary amylase concentrations than the test group average. From these findings it can be inferred that perfectionistic teachers experience more stress and that the non-disclosure of imperfection is a contributory factor.

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## 1. Introduction

### *1.1. Stress in the Education Sector*

In the modern era, stress is primarily caused psychologically; occurring when the individual concerned perceives that they can no longer adapt to the environmental and psychological demands (Cohen, Kessler & Gordon, 1995). The human body, however, is unable to discern between anticipation of physical danger and the worry of social conflict and failure to meet expectations (Selye, 1987). Long standing psychological theory has identified that the inability to differentiate results in psychological stimuli with physiological effects, as chronic stress initiates changes in the physiological systems that maintain homeostasis and health (McEwen & Stellar, 1993).

A major cause of stress in modern society originates from the pressures of work which affects approximately 1,800 in every 100,000 workers (Health and Safety Executive, 2018), with 72% of teachers reporting stress (Education Support, 2019). Teaching in particular is commonly identified as a high stress career due to high job demand, pupil misbehaviour, role ambiguity, organisational climate, career development barriers and time constraints (Harmsen et al., 2018). Government guidelines regarding the education system in the United Kingdom tightly regulate the teaching profession regarding curriculum, finance, governance and behavioural measures, and therefore restricts the individual's ability to cope with these potential stressors (Department for Education, 2017). The resulting stress has been identified as having serious implications on health and wellbeing, with the 2019 Teacher Wellbeing Index by the Education Support charity reporting that 34% of teachers experienced a mental health issue in the past academic year (Education Support, 2019). In addition to detrimental effects on physical and

mental health, high levels of stress in teachers can have significant organisational consequences, with high rates of absenteeism, poor work performance, poor relationships between co-workers and high turnover all negatively affecting the educational institution and therefore compounding many of the issues faced by teachers (Hansen & Sullivan, 2003).

According to the Teacher Wellbeing Index, 2019, the most frequently cited reasons for becoming a teacher are student interaction, helping young people achieve their potential and making a difference. However, identified issues such as poor student behaviour, high workload, long hours and unnecessary paperwork highlight the contrast between the teachers' aspirations and the reality of the job (Education Support, 2019). Although commonly expected by those entering the teaching profession these issues often lead to feelings of disillusionment, causing talented teachers to leave the profession due to the strain inflicted on their health (Milstein & Golaszewski, 1985). Kavita and Hassen, 2018, also identified higher levels of stress in secondary school teachers than primary school teachers due to the requirement of a higher level of subject expertise often paired with less academic experience, in an academic environment.

An increased ratio of pupils to qualified teachers from 17:8 to 18:7 further contributes to the high workload of teachers, and is likely to increase further with secondary school pupil numbers expected to rise by 15% to 3.3 million between 2018 and 2025 (Foster, 2018). Nearly 10 percent (9.9%) of full time educators leave the system permanently per year resulting in fewer teachers remaining in the profession until retirement age(Worth, 2018). This loss in teachers is further compounded by high levels of sick leave as a result of mental illness; with 50% of those with mental health symptoms requiring sick leave for greater than one

month (Education Support, 2019). Additionally, recruitment levels of teachers in their first year post qualification, i.e. Newly Qualified Teachers (NQTs), has continued to fall below recruitment targets in England every year since 2011(Foster, 2018). Current numbers suggest that targets are unrealistic with certain subject areas recruiting fewer than 65% of the required teachers, e.g. physics, mathematics and foreign languages (Department for Education, 2019). The retention rate of NQTs has also dropped considerably over the past 6 years, with fewer than 70% remaining in teaching after the first five years which results in an net deficit of full time teachers(Worth, 2018). An increased number (84%) of teachers in a senior position reported feeling stressed, suggesting that the teachers' increase in responsibility as they progress through their career is at least partly responsible for the drop-out rate at the 5 year mark (Education Support, 2019).

The degree of stress experienced has large implications on whether or not an NQT will remain in teaching after the first 5 years with approximately 57% of teachers considering leaving due to pressures on their health and mental wellbeing (Education Support, 2019). The first five years of a teacher's career are deemed critical in determining its longevity with correct support, opportunities and development being decisive factors that encourage teachers to stay in the profession (Worth, 2018). This finding is supported by a 2014 study which identified that lack of support, high workload and lack of future prospects greatly influenced an individual's desire to remain in teaching (Struyven & Vanthournout, 2014). Schools with poor working conditions and insufficient support networks create an environment in which new teachers are unable to develop the skills and confidence required to cope with the demands of teaching, leading to further turnover (Sims & Allen, 2018).

Stress is difficult to quantify as it often relies on self-diagnosis through questionnaires. This can therefore lead to variation in results and the potential for bias. However, government data has shown the rate of self-reported, work-related stress, depression and anxiety has increased in recent years (Health and Safety Executive, 2018). Unions have attempted to link the effects of stress with negative physical wellbeing. The 2018 Big Question survey of over 7,000 teachers in England by NASUWT (National Association of Schoolmasters and Union of Women Teachers) found that 53% of teachers claimed stress had affected their physical health in the past 12 months (NASUWT, 2019). The study also identified that over three quarters of teachers surveyed suffered from loss of sleep, low energy levels and anxiety. Additionally, the results of the survey infer a link between the stress of teaching and a rise in harmful behaviours such as smoking, drinking alcohol and self-harm.

Despite a high proportion of teachers reporting stress-related symptoms, teaching is still perceived as rewarding. This is theorised to be due to a division between the causes of stress and satisfaction; with satisfaction being gained from working with the children and seeing them learn and develop, and stress being caused by school-based issues (Skaalvik and Skaalvik, 2015), such as greater responsibility being imposed on teachers by the community for educational-wellbeing, lack of community support, the lack of status in terms of salary and career progression, and workload burden (Travers & Cooper, 2016). The 2019 NASUWT report claimed that 66% of teachers do not feel that they have enough family time due to work commitments, whilst 9% of teachers claimed their career was integral in the breakdown of a romantic relationship, supporting the hypothesis that there is a positive correlation between occupational stress and marital stress (Bromet et al., 1988; NASUWT, 2019). The ability to meet the demands of teaching depends

on the skills and strategies NQTs learn during their training, with the nature of the training received, and the background and experiences affecting their professional competence, academic expertise and ability to cope under pressure (Cains & Brown, 1998).

*1.2 Models of Work Stress*

Work stress is known to have negative effects on both physical and mental health of employees, and many different models have been designed to measure the levels of stress in the work place and their causes. There are four models that have garnered most attention in occupational medicine; Effort Reward Imbalance, Over-commitment, Job Demand Control, and Organisational Injustice (Schmidt et al., 2019). Effort Reward Imbalance estimates job stress from the perceived effort required by the employee and the rewards (Seigrist, 1996) whereas Over-Commitment focusses on the individuals behavioural pattern whilst coping with the demands of the role (Joksimovic et al., 2002). Job Demand Control concentrates on the psychological demands on the employee in relationship to the amount of control the employee has over their role (Theorell & Karasek, 1996) whilst Organisational Injustice looks at relationships between employees and their superiors (Colquitt et al. 2001).

The aspects of Effort Reward Imbalance and Job Demand Control are both visible in the teaching profession. As previously mentioned, teaching requires a lot of effort with very little reward whilst national guidelines restrict the control teachers have in their scheduling. Additionally, over-commitment to the job is often seen, with teachers feeling a sense of duty towards their students. The Over-Commitment model of work stress supports the hypothesis that

perfectionism in teachers can contribute to the levels of stress they experience, which could potentially have biological and physiological consequences.

### *1.3.1 Conceptual Overview of Stress*

Stress is an ambiguous term that encompasses the non-specific response of the body to any demand made upon it which includes both physical and psychological stimuli as well as positive and negative stimuli (Selye, 1976). The term was later redefined as disruption to the homeostasis of the body; stimulating neural, hormonal and behavioural activity in order to restore the physiological balance (Chrousos & Gold, 1992). Stress is an integral factor in the survival of humans when faced with threats (Segerstrom & Miller, 2004), with the stress response being advantageous in natural selection due to the ability of an individual to anticipate and react quickly to physical threats, for example avoiding a predator, defending territory, and coping with environmental threats (Goldstein, 1987). In response to a stressor, the central nervous system induces major chemical changes as hormones and neurotransmitters are released to make homeostatic adjustments (Jansen et al., 1995). This maintains stability in the function of the body by making corrective changes in a process termed allostasis. These allostatic mediators include adrenaline from the adrenal medulla, glucocorticoids, such as cortisol from the adrenal cortex and cytokines from the immune system (McEwen, 2002)

### *1.3.2 SAM System*

In addition to theHypothalmic Pituitary Adrenal (HPA) axis, stress induces adaptational responses in the Sympathetic Adrenal Medullary (SAM) System, a component of the autonomic nervous system (Schommer, Hellhammer & Kirschbaum, 2003). The SAM system has a less complex role in the stress response

and is associated with immediate “fight or flight” response (Wetherell et al., 2006). The primary purpose of the SAM System in response to stress is to release adrenaline and noradrenaline, in response to stress, to facilitate immediate escape or the ability to overcome danger. This hormonal response promotes an increased heart rate and increased blood pressure preparing the body to take immediate action (Konarska, Stewart & McCarty, 1989). The SAM System is optimised for an acute stress response and therefore chronic stress has been observed to cause the SAM pathway to induce health issues. Chronic stress has been observed to either cause attenuation of the SAM response, potentially contributing to weight gain, or increase adrenal hormone concentrations long-term, increasing the risk of chronic high blood pressure and heart disease (McCarty, Horwatt & Konarska, 1988; Konarska, Stewart & McCarty, 1989).

*1.3.3 HPA Axis*

The hypothalamus is located in the brain and is responsible for the control of homeostasis which is essential for basic functions such as food and water intake, body temperature regulation and pituitary hormone secretion as part of the Hypothalamic-Pituitary-Adrenal (HPA) Axis (Keller et al., 2006). Hypophysiotropic neurons in the paraventricular nucleus of the hypothalamus synthesise corticotrophin releasing hormone (CRH) in response to stress. CRH binds to the corticotropes of the Anterior Pituitary Gland and induces the release of adrenocorticotrophic hormone (ACTH). The ACTH is carried by peripheral circulation of the brain to the Adrenal Cortex where it stimulates the release of cortisol (Smith and Vale, 2006). The inhibitory, negative feedback effect of cortisol on the HPA Axis limits the exposure of effector tissue and organs to cortisol and

therefore minimises the duration of its immunosuppressive and catabolic effects, preventing damage to the body (Tsigos & Chrousos, 2002).

Although termed a stress hormone due to its increased secretion during stressful situations, cortisol is an omnipresent regulator of all homeostatic responses. During non-stressful events, CRH is secreted in 2-3 pulsatile releases per hour, following a circadian rhythm with amplified secretions in the early hours of the morning (Tsigos & Chrousos, 2002). The total amount of cortisol produced per day under normal conditions is approximately 20µg, of which 80% is bound to Corticosteroid Binding Globulins, 10% is bound to serum albumin and 10% remains as free cortisol (Brien, 1980). It is generally accepted that it is the unbound cortisol that is metabolically active and thus responsible for the allostatic stress response (Brien, 1980).

*1.4 Stress and Disease*

Long term activation of the HPA axis in response to stress has a detrimental effect on the body as the basic requirements of homeostasis, such as regulation of body temperature and metabolism, require a set expenditure of energy. Additional pressures imposed on the body's ability to maintain homeostasis when faced with stressful events require additional energy expenditure either from immediate nutritional input or from endogenous stores of fat, glycogen and protein (McEwen and Wingfield, 2003). The stress response regulation of homeostasis involves reactions from multiple organ systems, however, inappropriate regulation can lead to a range of pathologies and disorders (Smith & Vale, 2006). Chronic stress or "allostatic overload" occurs when the allostatic mediators required for short term adaptation in response to acute stress, remain switched on when no longer

required causing desensitisation of glucocorticoid receptors and tissue damage, and potentially leading to disease (McEwen, 2002).

The primary function of cortisol is to initiate catabolic processes within the body; causing the breakdown of stored energy in order to achieve the required energy to cope with stressors. Hepatic gluconeogenesis and lipolysis are induced, and protein degradation of muscle is promoted in order to increase the concentration of circulating glucose for immediate use (Kyrou & Tsigos, 2009). In this catabolic process the cortisol prevents anabolic processes due to the antagonism of growth and thyroid hormones, insulin and sex hormones (Kyrou & Tsigos, 2009). The short term effect of these processes on multiple organ systems have immediate evolutionary benefits, however, long term exposure can have harmful effects on health .

**Table 1: The purpose of the Acute Stress Response in Organ Systems in Mammalian Survival and the adverse consequences of Chronic Stress (Allostatic Overload) adapted from (McEwen & Stellar, 1993; McEwen, 2004)**

| System | Acute Stress Response | Chronic Stress Consequence | Disease |
|---|---|---|---|
| Metabolism | Glucocorticoid release; maintenance of homeostasis to manage energy use | Increased appetite, increase in insulin levels, increased deposition of fat | Obesity, Diabetes, Hypertension |
| Cardiovascular System | Increased blood pressure to prepare for "fight or flight" response | Repeatedly elevates blood pressure leading to the development of atherosclerotic plaques | Coronary Heart Disease, Myocardial Infarction |
| Immune System | Promotes immune cell mobilisation to fight pathogens | Supresses immune function | Metastasis of cancer, viral infections, colitis, ulcers, asthma |
| Nervous System | To regulate appropriate coping responses whilst forming memories of the stressful event for utilisation in future events | The amygdala becomes hyperactive and the hippocampus becomes damaged due to chronic use leading to atrophy | Cognitive impairment, Post-Traumatic Stress Disorder, Depression |

The acute responses of the various organ systems are pivotal for adaptation and survival, but the overuse of these systems leads to long term pathophysiological consequences. The release of cortisol has the physiological purpose of offering an energy boost; it promotes gluconeogenesis (McEwen, 2004) as well as an increase in appetite (Anandt & Brobeck, 1951). Those suffering from chronic stress have been observed exhibiting food seeking behaviour during sedentary periods, resulting in an increase in insulin secretion and therefore the deposition of fat (McEwen, 2004). Visceral fat in particular leads to an obesity-related inflammatory state which increases the risk of Type II Diabetes amongst those who suffer from chronic stress (Kyrou & Tsigos, 2009).

Perhaps the most well-known disease associated with chronic stress is cardiovascular disease as stress induced changes in behaviour including sedentary lifestyle, poor diet, alcohol and drug consumption which all increase the risk of cardiac events (McEwen and Stellar, 1993; Kyrou and Tsigos, 2009).These responses to psychological strain affect lipid and glucose metabolism, as well as increase fat accumulation, blood pressure and heart rate, and the formation of atherosclerotic plaques (McEwen & Stellar, 1993; McEwen & Wingfield, 2003; Kyrou & Tsigos, 2009). Damage and disease accrued by the cardiovascular system decreases the operational range of the heart meaning the strain of repeated changes in allostatic load increases the likelihood of overexertion and myocardial infarction(McEwen & Stellar, 1993).

Long term stress also reduces the efficiency of the immune system as cortisol release due to acute stress dampens cellular immunity by decreasing the production of many types of cytokines and inflammation mediators causing the redistribution of lymphocytes and macrophages from the blood to the skin, lymph

nodes and bone marrow to await an acute immunological challenge (McEwen, 1998; Reiche, Nunes & Morimoto, 2004). It has also been observed that chronic stress can result in an overall weaker immune system due to HPA Axis -induced cortisol secretion inhibiting the immune system, leading to an increase in susceptibility to viral infections (Davis, 1998). For example one study showed an increase in infection rate of the common cold by approximately 16% in those experiencing chronic stress (McEwen & Stellar, 1993). Additionally, weakened immune systems due to chronic stress have been linked to tumour metastasis, in particular those caused by viruses (Cohen, Kessler & Gordon, 1995; Reiche, Nunes & Morimoto, 2004).

Allostatic overload can also impair the limbic system as it contains the HPA axis, resulting in a reduction in function such as memory loss and loss of physical coordination (Herman et al., 2005). The hippocampus, which contains a high concentration of mineralocorticoid receptors and glucocorticoid receptors, allows the formation and contextualisation of long-term memory in response to stress in order to provide "emotional bias" for future stressful events (McEwen, 1998). Prolonged exposure to cortisol, however, has been observed to accelerate neuronal loss as well as cause atrophy of the hippocampus (Sapolsky et al., 1990), with structural changes resulting in an accelerated aging process and the development of diseases including depression and Alzheimer's Disease (Umegaki et al., 2000; McEwen, 2002). Sustained hippocampal activation by chronically elevated glucocorticoid concentrations has been shown to impair hippocampal function due to long term activation of receptors resulting in inhibition of the HPA axis and dysregulated homeostasis (Sapolsky & Pulsnelli, 1985).

*1.5.1 Stress and Personality*

Due to the frequent observation of a low yet significant correlation between the occurrence of stressful events and negative psychological and physiological responses, research into personality variables has been conducted in order to identify the traits responsible for determining the intensity of the stress response in individuals (Kobasa & Puccetti, 1983). A framework set out by Bolger and Zuckerman (1995) specified that personality traits may influence both the frequency in which individuals expose themselves to stressful events and the reactivity to those events (Bolger & Zuckerman, 1995). This would therefore suggest that individuals with particular personality traits experience a stronger and more negative stress response.

Factors considered important in determining the strength of stress response are the quality of emotional response and the effectiveness of defence mechanisms (Pruessner et al., 1997). An individual who displays the characteristics associated with the hardiness trait, which is characterised by resilience and the ability to cope with stress, has a source of resistance against the negative health effects associated with stress (Kobasa & Puccetti, 1983). By contrast, other personality traits are less effective at coping with stress. Specifically, Type D (distressed) personalities are defined by their tendency to experience negative emotions and therefore are more likely to suffer anxiety, have a negative view of themselves and focus on adverse situations, and are consequently at a higher risk of cardiac events and other stress related illnesses (Sher, 2005). A 2005 study into the effect of Type D personalities, suggested that certain individuals may have alterations within their HPA axis which increase their cortisol output and consequently their stress response (Sher, 2005).Therefore personality traits have the potential to

greatly influence the level of stress an individual perceives in response to work-related stressors.

A 2006 study into the long-term effects of personality traits on stress revealed that those with certain traits are prone to experience downregulated HPA axis activity due to prior prolonged HPA axis activity. Specifically, women higher in neuroticism and men higher in introversion have been observed to have blunted cortisol responses, associated with depression and anxiety, due to the body's attempt to adapt to long term hyper-arousal of the HPA axis (Oswald et al., 2006; Ruttle et al., 2011). In the current study, perfectionism is focused upon as a personality trait that via self-criticism, concern over achievements, and self-doubt, negatively impact stress experiences, the HPA axis and health in teachers.

*1.5.2 Perfectionism and Stress*

Perfectionism is a personality factor in which one's approach to life makes stressors and failures more distressing and more likely to occur. Pursuing extreme and unrealistic requirements or having extreme or unrealistic requirements imposed on oneself are strongly linked to increased feelings of stress (Hewitt, Flett & Mikail, 2017). Perfectionism is broadly defined as the tendency to hold and pursue unrealistically high goals, either from oneself or others (Pacht, 1984). Perfectionists strive for the impossible whilst still attempting to achieve perfection in their endeavours and this is potentially extremely relevant in the teaching profession, where educational targets are increased yearly. The stress caused by the failure to attain unrealistic goals and the inability to recognise and celebrate accomplishments when they do manifest, has been linked to a 50% increase in mortality rate for those over the age of 65 (Fry & Debats, 2009).

The link between perfectionism, stress and depression is evident and the potential health problems that can arise are significant. The ability to assess and manage perfectionism can prevent both psychological and physiological disease. By identifying the individuals most at risk of suffering from perfectionism related stress whilst going about everyday life, and allowing for psychotherapeutic treatment to treat the underlying causes of perfectionistic behaviour, it may be possible to reduce the negative symptoms associated (Hewitt, Flett & Mikail, 2017). Identifying and studying the relationship between perfectionism and stress in teachers could allow for the development of novel methods of tackling the stress crisis.

Hewitt and Flett have designed a number of psychometric tests over the years to diagnose and assess the different levels and manifestations of perfectionism. The *Multidimensional Perfectionism Scale(MPS)* (Hewitt & Flett, 1991)*,The Perfectionistic Self-Presentation Scale(PSPS)* (Paul L. Hewitt et al., 2003) and *The Perfectionism Cognitions Inventory(PCI)* (Flett et al., 1998) were developed to measure the components of perfectionistic behaviour in adults. The use of these scales can determine the extremity of an individual's perfectionism, their perfectionistic traits and the ways in which it is expressed, and therefore highlight the differences between the different dimensions of perfectionism (Hewitt, Flett & Mikail, 2017).

*1.5.3 Perfectionistic Personality Traits*

Perfectionism is divided into three trait dimensions in a Comprehensive Model of Perfectionistic Behaviour ; self-oriented perfectionism (SOP), other-oriented perfectionism (OOP) and socially prescribed perfectionism (SPP) (see **Table**

**2)**(Hewitt, Flett & Mikail, 2017). The different dimensions influence the motivation, behaviour and ability to cope of perfectionistic individuals.

*Self-oriented perfectionists* generate unrealistic expectations, over concern about mistakes, and self-critical evaluations for themselves (Cheek et al., 2018). The motivational component of SOP drives the individual to not only achieve perfection, but also to avoid imperfection. The definitions of success and failure are set by the individual and therefore do not necessarily adhere to the typical criteria, often being driven by not just the desire to do well but to outperform all others and be the best (Hewitt, Flett & Mikail, 2017). Due to this constant self-comparison to others, self-oriented perfectionists are often self-conscious and self-doubting. The fear of failure, and the shame and self-hatred experienced when imperfection occurs often leads to the avoidance of situations where the imperfections may be on show, hindering the individual's ability to achieve their true potential (Hewitt, Flett & Mikail, 2017; Cheek et al., 2018).

*Socially prescribed perfectionists* believe that others demand perfection of them, whether or not this is actually the case (Hewitt, Flett & Mikail, 2017). The demands for perfectionism may be perceived to be from those close to them (parents, family, friends), or from society as a whole (Cheek et al., 2018). Although the socially prescribed perfectionists often have similar behaviour and symptoms to self-oriented perfectionists, they differ in their motivation. Socially prescribed perfectionists are motivated to attain perfectionism due to the belief that it will allow them to gain acceptance and love, and avoid rejection and abandonment. As with SOP, the desired level of perfection is never achieved, with every level of accomplishment achieved becoming the new baseline (Hewitt, Flett & Mikail, 2017).

**Table 2: The three dimensions of perfectionism and the associated components, adapted from (Hewitt, Flett & Mikail, 2017).**

| **Trait Dimension** | **Trait Components** |
|---|---|
| Self-Oriented Perfectionism | The drive to be perfect<br>Excessively stringent self-evaluation<br>Requirement to be perfect |
| Socially Prescribed Perfectionism | Belief or perception that others require you to be perfect |
| Other-Oriented Perfectionism | Requirement for others to be perfect<br>Stringent and critical evaluation |

*Other-oriented perfectionists* hold others to high standards of perfection and are highly critical of those who fail to achieve these standards(Stoeber, 2014). OOP is often linked to narcissism, and individuals who score highly on the OOP scale are often found to be hostile, anti-social, passive-aggressive, narcissistic and controlling (Stoeber, 2014). Despite this desire for others to succeed there is a tendency for other-oriented perfectionists to be hypercompetitive, with individuals feeling threatened when out-performed. This narcissistic injury often leads to anger (Hewitt, Flett & Mikail, 2017), which is commonly viewed as a reaction to stress (Kendall and Hollon, 1979).

The mechanisms and processes associated with perfectionism can be contributors to distress, a decrease in wellbeing, and disease. A maladaptive cycle of stress can be linked to perfectionism with stress enhancement, perpetuation, anticipation and generation being caused by the perceived experience of failure (See **Table 3**)(Hewitt, Flett & Mikail, 2017).

**Table 3: The elements of the cycle of stress due to maladjustment in perfectionism, adapted from** (Hewitt & Flett, 2002)**:**

| Element of Stress Cycle | Description |
|---|---|
| Stress Enhancement | Distress is magnified due to perfectionistic behaviour |
| Stress Perpetuation | Distress is maintained or amplified due to maladaptive coping mechanisms, e.g. failure to seek support |
| Stress Anticipation | Worry over possible future stressors leads to distress due to reflection on past setbacks and failures |
| Stress Generation | The redefining of failure and distortion of one's own experience, e.g. despite succeeding at a task defining it as a failure because the individual was not the best |

Table 3 includes the various ways perfectionism contributes to stress. Firstly, perfectionism influences the level of exposure to stress through generation, anticipation and perpetuation. Secondly, perfectionism influences the reaction to the exposure. Stress perpetuation increases the likelihood of experiencing a variety of stressors in a variety of forms, due to the constant pressure to achieve high standards (Hewitt & Flett, 2002). Individuals with perfectionistic traits are more likely to experience stress due to certain ingrained stress mechanisms. These include the tendency to engage in behaviour that generates stress, the prolonging of stressful experiences due to the failure to cope and adapt, worrying about potential stressors, and interpreting minor mistakes to be of greater importance (Hewitt & Flett, 2002).

The coping responses of perfectionists to stress can be divided into adaptive and maladaptive strategies (Dunkely & Blankstein, 2000). Perfectionists commonly set themselves high standards and have moderate external expectations placed upon them. The tendency to be highly organised allows the individual to cope with and assess stressors in a relatively proactive way. In contrast, those who have high levels of external expectations placed upon them tend to be anxious about mistakes, doubt their own ability and are therefore handicapped by the anxiety surrounding their own pursuit for perfection (Lapsley, 2001). As it appears to be external pressures that determine an individual's coping ability, those who score highly for socially prescribed perfectionism are found to be particularly at risk of having poor coping strategies and therefore are likely to display negative problem solving orientation, a lack of constructive thinking, and an emotionally oriented way of coping (Dunkely & Blankstein, 2000).

The stress caused by perfectionism and maladaptive coping strategies makes individuals vulnerable to a variety of psychological diseases including anxiety, depression and eating disorders (Cheek et al., 2018). A series of age-adjusted studies into the mortality rate and perfectionism have shown that those with a high perfectionism score are at a greater risk of death by 51% than those who scored low (Fry & Debats, 2009). It was found that SOP and SPP predict early mortality, even once other personality factors that are linked to detrimental health (e.g. neuroticism) were taken into account (Hewitt, Flett & Mikail, 2017).

It has been suggested that not only does perfectionism contribute to physical ill-health, it also hinders the individuals ability to cope and recover from health issues (Cheek et al., 2018). This is evident in numerous studies conducted into the association between perfectionism and the recovery from cardiac illness (Parker et al., 2006; Stafford, Jackson and Berk, 2009; Dunkley, Berg and Zuroff, 2012). The studies showed that perfectionists who are self-critical were more likely to suffer depression during the recovery process and were at a higher risk of death, likely due to their all-or-nothing approach to succeeding and failing (Hewitt, Flett & Mikail, 2017).

As well as physiological health related mortality, perfectionism has also been linked to suicidal behaviour, with socially-prescribed perfectionism most strongly and consistently associated in studies of both clinical and non-clinical adult populations (Hewitt, Flett & Mikail, 2017). In particular, perfectionists who allow their perfectionism to impede their actions due to fear of failure are predisposed to depression and suicidal preoccupation (Adkins & Parker, 1996).

*1.5.4 Perfectionistic Self-Presentation*

In order to understand the implications perfectionism can have on the mental wellbeing of an individual a distinction between the level of trait perfectionism and the public expression of the trait must be made (Paul L Hewitt et al., 2003). Perfectionists may attempt to create a desired image of themselves either to serve their own interpersonal needs or to protect themselves from criticism and hide their vulnerabilities by using Perfectionistic Self-Presentation (Sherry *et al.*, 2007). Perfectionistic Self-Presentation is conceptualised as three distinct interpersonal dimensions of perfectionism which have the aim of creating the illusion of perfection in oneself to others (Sherry et al.,2007). Perfectionistic Self-Promotion (PSP) involves the active promotion of a perfect image of oneself whilst Non-Disclosure of Imperfection (NDC) and Non-Display of Imperfection (NDP) comprises of the avoidance of verbally and physically showing imperfection respectively.

Perfectionistic self-presentation has previously been found to strongly correlate with SPP. For example, Besser, Flett and Hewitt (2007) identified strong correlation between all aspects of perfectionistic self-presentation and SPP in both men (PSP, $r$ =.61, $p$ < .01; NDC, $r$ = .51, $p$ < .01; NDP, $r$ = .41, $p$ < .01) and women (PSP, $r$ =.67, $p$ < .01; NDC, $r$ = .56, $p$ < .01; NDP, $r$ = .65, $p$ < .01). This suggests that perfectionistic self-presentation is a personality variable found in socially prescribed perfectionists and could therefore be contributory to perceived stress (Besser, Flett & Hewitt, 2010). There are also several other theoretical reasons to expect perfectionistic self-presentation is related to stress. First, those high in perfectionistic self-presentation may be more likely to perpetuate feelings of stress due to their maladaptive coping responses. Secondly, an inability to

express vulnerability due to the fear of being viewed as less than perfect may prevent those with high perfectionistic self-presentation from seeking appropriate help and professional intervention (Hewitt et al., 2008). As such, because willingness to disclose personally distressing information is linked with lower levels of stress (Kahn, Achter and Shambaugh, 2001), those who present with perfectionistic self-presentation tendencies are more inclined to experience high levels of stress.

There is also some empirical work that supports these theoretical propositions. For example, Hewitt et al. (2008) found that those with a high desire to conceal imperfection experienced higher levels of distress in a job interview situation ($r$ =.42, $p < .01$), and were more likely to perceive others comments as negative (Hewitt *et al.*, 2008). Additionally, a 1995 study highlighted the impact perfectionistic self-presentation can have on an individual's personal life; those with the need to hide their flaws and imperfections were found to be more at risk of harmful behaviours (e.g. eating disorders) and theorised that this is due in part to the unwillingness to admit problems and shortcomings (Hewitt, Flett & Edgier, 1995). The vulnerability caused in an individual by perfectionistic self-presentation has been demonstrated to severely affect their mental wellbeing, with all three facets being positively correlated with feelings of social hopelessness (PSP, $r$ =.29, $p < .001$; NDP, $r$ =.26, $p < .01$; NDC, $r$ =.30, $p < .001$) and those with a high level of non-disclosure of imperfection more likely to commit suicide ($r$ =.17, $p < .05$) (Roxborough *et al.*, 2012). The severity of the mental health implications of perfectionistic self-presentation highlights the importance of identifying the link between the three facets and stress in teachers.

*1.5.5 Perfectionistic Cognitions Inventory*

Another way to measure an individual's level of perfectionism is to assess the automatic thoughts that arise from their predisposition for the need to be perfect. The Perfectionistic Cognitions Inventory (PCI) was developed to analyse an individual's reflection of imperfections and mistakes (Flett et al., 1998). It is suggested, that in addition to perfectionistic personality traits and self-presentational styles,

perfectionism should be characterised by the frequency of thoughts that pertain to achieving perfectionism and high standards(Frost & Henderson, 1991). The PCI was created to assess cognitive aspects of perfectionism independently of external dysfunctional attitudes and personality vulnerabilities, by measuring the frequency of such perfectionistic thoughts (e.g. "I should never make the same mistake twice" and "I should be perfect"). Although this method is believed to offer an insight into the surface-level responses of perfectionism, the scores are more likely to fluctuate in response to current concerns and experiences than other facets such as perfectionistic personality traits and perfectionistic self-presentation (Flett et al., 2007).

Perfectionistic cognitions have been shown to be positively linked with failure and self-criticism, and arise from self-criticism and self-punishment due to concerns over failure to meet perfectionistic standards (Flett et al., 1998). Hill and Appleton (2011) identified the predictive ability of the frequency of perfectionistic cognitions to identify psychological distress. Perfectionistic cognitions were found to account for variance in burnout symptoms, suggesting that the frequency of perfectionistic cognitions has an effect on the ability of an individual to cope with

psychological pressure (Hill and Appleton, 2011). Furthermore, Downey et al. (2014) observed that high frequency perfectionistic cognitions are more likely to lead to participation in self-destructive behaviours

As discussed, concerns over failure and mistakes have been found to have a negative impact on individuals as frequent thoughts pertaining to perfectionism are associated with lack of emotional regulation due to self-blame, rumination and lack of self-praise (Rudolph, Flett & Hewitt, 2007). Consequently, it is unsurprising that the PCI has shown strong associations with psychological distress. PCI has been found to correlate significantly with psychological distress and this relationship is particularly apparent when the individual is undergoing social evaluation (Flett et al., 2016). The heightened stress reactivity is thought to be a consequence of the individual perpetuating stress as a response to negative perfectionistic cognitions (Flett et al., 2016). This suggests that a high frequency of perfectionistic cognitions would be indicative of increased levels of stress (Hewitt & Flett, 2004) and therefore be particularly relevant when assessing the link between perfectionism and stress in teachers due to the evaluative nature of the job.

*1.5.6 Studies of Perfectionism in Teachers*

There currently exist very few studies into the prevalence of perfectionism and its effect on stress in teachers. A study by Flett, Hewitt and Hallett (1995) first looked into the possible implications on perfectionistic personality factors and stress for teachers. It found that SPP was the only perfectionistic trait dimension to correlate significantly with negative outcomes regarding teacher stress ($r$ = -.35, $p$ < .01). The study theorised that SPP was associated with higher levels of stress among teachers due to lack of recognition for their work, the

perceived pressure of others and lack of control (Flett, Hewitt & Hallett, 1995). In depth analysis of the influence of perfectionistic self-presentation and perfectionistic cognitions in teachers does not exist, to the best of our knowledge. Due to the shortage of studies into the effects of perfectionism on stress, this study aims to further examine the effect of perfectionism on stress in teachers.

The link between perfectionism and self-reported stress by individuals has been examined frequently (see above), however, this study has the unique opportunity to examine the physiological effects of both stress and perfectionism. As mentioned previously, stress induces a series of physiological changes in the body; however, the extent to which perfectionism influences these changes is as yet unknown. This study hopes to measure the stress induced physiological changes in the human body as well as identify the potential difference in change experienced by teachers who have high levels of perfectionism and those without.

### *1.6 Measuring the Biomarkers of Stress*

To date, research has examined stress in teachers using self-reporting measures which are useful because it is a relatively stress-free method of ascertaining stress levels. Results can be obtained and analysed quickly and cheaply making them popular among large studies, and are useful at diagnosing sub-clinical psychological symptoms (Tang & Tang, 2020). Additionally, self-report is relatively inexpensive, does not require specialist training to implement and can be used in a wide variety of situations. Despite these advantages, self-report measures of stress require complete honesty from the participant; participants may be unwilling to fully share personal issues despite confidentiality promises, and may have a tendency to over or under estimate their own qualities (Tang & Tang, 2020). Additionally, self-report does not disclose the physiological effects that the

stress is having on the participant. With this in mind, other means of assessing stress are required to better understand the relationship between perfectionism and stress in teachers. The effect stress has physiologically on the body presents the possibility of measuring these changes biologically through the use of biomarker quantification. In addition to potentially offering a more reliable method of assessing stress levels, biomarker measurement allows an insight into the physiological changes caused by psychological stress (Dhama et al., 2019). The potential to measure the changes invoked by stress could present the opportunity to predict impending negative health effects. The analysis of salivary biomarkers allows for a non-invasive and non-stressful study into the physiological workings of the body in relation to stress.

Salivary cortisol is frequently used to measure as a biomarker for psychological stress (hellhammer, Wüst & Kudielka, 2009), however, unlike some stress hormones (e.g. catecholamines), changes in cortisol levels are only indicative of negative stress, making it a popular biomarker to measure negative psychological distress (Melamed et al., 1999). Cortisol is the main glucocorticoid hormone produced by the adrenal cortex and salivary cortisol correlates well with serum cortisol (Takai et al., 2004) and therefore offers an accurate representation of HPA axis activity, one of the two primary systems (HPA Axis and Autonomic Nervous System) which determines stress response (Takai et al., 2004). Furthermore, changes in salivary cortisol levels occur quickly in response to HPA axis activation, saliva flow has no impact on salivary cortisol levels and saliva can be obtained non-invasively thus avoiding unnecessary stress (Melamed et al., 1999). However, several studies have found limitations and variations in the efficacy of using salivary cortisol as the sole biomarker for psychological stress (Vedhara et al., 2003:; Hellhammer, Wüst & Kudielka, 2009). Various factors

including caffeine, steroids, quality of sleep and cortisol diurnal variation have been identified as causes of variance in cortisol concentration, thus creating disparity between studies as to the efficacy of cortisol as a biomarker of stress (Vedhara *et al.*, 2003; Van Uum *et al.*, 2008; Hellhammer, Wüst and Kudielka, 2009).

The disparity between studies on the use of salivary cortisol as an indicator of psychological stress has prompted research into alternative salivary biomarkers. Salivary Alpha Amylase (SAA) is viewed as a viable candidate as a biomarker of stress due to its relation to the SAM stress system; the second system to determine the stress response (Nater et al., 2005). Multiple studies have combined the analysis of both SAA and salivary cortisol in an attempt to biologically characterise the stress reaction (Takai et al., 2004; Gordis et al., 2006; Wolf Nicholis & Chen, 2008).

The activation of the SAM system in response to stress, results in the release of the catecholamines adrenaline and noradrenaline from the adrenal medulla and norepinephrine from the nerve terminals of the sympathetic nervous system (Wolf, Nicholis & Chen, 2008). SAA has been identified as an accurate indicator of SAM activity and catecholamine release due to its secretion in response to the activation of the salivary glands by sympathetic stimulation (Rohleder et al., 2004). Sympathetic neurotransmitters, in response to stress, exert activity on parotid gland cell membranes, which in turn promote intracellular messengers which stimulate salivary protein secretion. SAA concentrations have been observed to increase and recover quickly with concentrations peaking immediately following a stressor and returning to basal levels within 10 minutes (Gordis et al., 2006). This allows for a snapshot view of the effect stressors have

on the SAM system. Whilst stress activates the sympathetic nervous system, it inhibits the parasympathetic nervous system, resulting in the decreased production of saliva. It is therefore common practice to measure salivary flow rate alongside SAA secretion to account for the parallel decrease in salivary volume and achieve an accurate SAA concentration (Rohleder, et al., 2004).

Although salivary cortisol and SAA are the most analysed biomarkers of the stress response, research into the validity of salivary Dehydroepiandrosterone (DHEA) and salivary Immunoglobulin A (IgA) has been conducted. DHEA has anti-glucocorticoid properties and has been shown to have neuroprotective, antioxidative and anti-inflammatory effects, suggesting DHEA may have a significant role in the protection against the negative consequences of stress (Lennartsson et al., 2012). Numerous studies have highlighted the link between DHEA synthesis and stress (Oderbeck et al., 1998; Shirotsuki et al., 2009; Lennartsson et al., 2012), with particular focus on the relationship between cortisol and DHEA. The ratio between DHEA and cortisol secretion in response to stress differentiates between chronic and acute stress. High levels of DHEA secretion have been observed in response to acute stress, resulting in a high DHEA to cortisol ratio (Oberbeck et al., 1998), whereas a high cortisol to DHEA ratio is often indicative of chronic stress (Lennartsson et al., 2012). Age, however, can influence these ratios as DHEA is a precursor to oestrogen and testosterone in females and males, and therefore DHEA production peaks between the ages of 20 and 30 and declines progressively with age (Heaney, Caroll & Phillips, 2014).

Salivary immunoglobulin A (salivary IgA) is reported to be a potential biomarker of chronic stress due to the negative impact stress has on the humoral immune response (Mouton *et al.*, 1989). Salivary IgA is an antibody produced in the B

lymphocyte plasma cells of the stroma of the salivary glands (Brandtzaeg, 2013), and is often chosen as a measure of immunocompetence due to the ease of collection (Tsujita & Morimoto, 1999). The immune system is often acknowledged to be negatively influenced by long-term stress, with susceptibility to infection increasing among those who self-report psychological stress (McEwen & Stellar, 1993). Similarly to SAA, salivary IgA is released in response to sympathetic nervous system innervation of the salivary glands, however, long-term cortisol secretion resulting from HPA axis activation has a blunting effect on IgA concentrations due to a resulting decrease in B-lymphocytes (Viena et al., 2012). Samples taken immediately after a stressful event have shown an increase in salivary IgA levels whereas studies that measured concentrations days or weeks after a stressful event showed a decrease when compared to pre-stress levels (Tsujita & Morimoto, 1999). This finding correlates with the hypothesis that the effect of chronic and acute stress on salivary IgA secretion differs; with chronic stress resulting in reduced IgA concentrations and acute stress resulting in increased IgA concentrations (Brandtzaeg, 2013). The variation in IgA concentrations between chronic and acute stress offer the potential to differentiate between the two on a biological level, however the effect participant health may have on studies can cause significant variation in concentrations.

### *1.7 Aim of Study*

The aim of this study is to examine the relationship between perfectionism (trait perfectionism, perfectionistic self-presentation, and perfectionistic cognitions) and stress in qualified teachers and trainee teachers. In doing so, whether perfectionism predicted self-reported stress and salivary biomarkers of stress (salivary concentrations of cortisol, amylase, IgA and DHEA) was assessed. Based

on previous research, it was hypothesised that perfectionism would predict higher levels of both self-reported stress and biomarkers of stress.

## 2. Method

### *2.1 Ethical Approval*

Ethical approval for this study was gained from the York St John Research Ethics Committee (code: Thomas_04/03/2019). Informed consent was gained from 65 individuals.

### *2.2 Participants*

There were 65 participants, all of whom were on an education career path. The participants consisted of 45 Postgraduate Certificate in Education (PGCE) students and 20 Fully Qualified Teachers (FQTs). Each participant was given a unique and anonymous numerical ID. Of the PGCE students, 34 were female and 11 were male. The age of the PGCE students ranged from 23 years to 46 years with a mean age of 28.1 years with a standard deviation (SD) of 7.63 years. 31 of the PGCE students were training to teach primary school pupils whilst 14 were training to teach secondary school pupils.

17 of the FQTs were female and 3 were male. They had an age ranger of 24-62 years with a mean age of 42.7 years (SD 11.05). The FQTs had experience in teaching ranging from 3-29 years with the mean years of experience being 14.6 years (SD 9.34). 7 of the FQTs taught in primary schools, whilst 13 taught in secondary schools.

**Table 4: Demographic Breakdown of Participants**

| | | | |
|---|---|---|---|
| ***Level of training required*** | | | |
| *Post Gradute Certificate of Education (PGCE)* | *45 participants (69.2%)* | *Fully Qualified Teacher FQT* | *20 participants (30.8%)* |
| ***Gender*** | | | |
| *Male* | *14* | *Female* | *51* |
| ***Age*** | | | |
| *Range* | *23-62 years* | *Mean* | *32.8 years (+/- SD 11.2)* |
| ***Taught Level*** | | | |
| *Primary* | *38* | *Secondary* | *27* |

*2.3.1 Multidimensional Perfectionism Scale (MPS)*

To measure trait perfectionism, the Multidimensional Perfectionism Scale (MPS) was used (Hewitt et al., 1991). The MPS uses a Likert Scale to assign scores by offering a range of answer options from one extreme to another and assigning each a numerical value. Five items were used to measure Self Oriented Perfectionism ("I strive to be as perfect as I can be"), and Socially Prescribed Perfectionism ("I feel that people are too demanding of me"), whilst 8 items were used to measure Other Oriented Perfectionism ("I think less of people I know if they make mistakes"). Responses were measured on a 7-point Likert Scale ranging from 1 ("strongly disagree") to 7 ("strongly agree") to measure the three dimensions of perfectionism.

Previous studies have provided evidence for the validity and reliability of this measure (e.g. Hewitt et al., 1991; Dunn et al., 2006; Madigan, Stoeber and Passfield, 2016).

*2.3.2 Perfectionistic Self Presentation Scale (PSPS)*

To measure Perfectionistic Self Presentation the 27 item Perfectionistic Self Presentation Scale was used (Hewitt et al., 2003). 10 items were used to measure Perfectionistic Self Promotion (PSP)("I try always to present a picture of perfection"), and Non-display of Imperfection (NDP) ("I will do almost anything to cover up a mistake"), whilst 7 items were used to measure Non-disclosure of Imperfection (NDC) ("I never let others know how hard I work on things"). Responses were measured on a 7-point Likert Scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"), with items 1, 11, 16, 18 and 22 reverse scored.

Previous studies have provided evidence for the validity and reliability of this measure (e.g. Hewitt et al., 2003).

*2.3.3 Perfectionistic Cognitions Inventory (PCI)*

To measure the participants' Perfectionistic Cognitions, the 10 item version of the Perfectionistic Cognitions Inventory (PCI) was used (Flett et al., 1998). The items alluded to perfectionistic thoughts that may have been experienced in the previous week ("I should be perfect"). The frequency of these thoughts were scored on a 5-point Likert Scale ranging from 0 ("Not at all") to 4 ("All of the time"). Previous studies have provided evidence for the validity and reliability of this measure (e.g.Donachie, Hill & Hall, 2018).

*2.3.4 Primary and Secondary Appraisal Scale (PASA)*

To measure the participants' cognitive appraisal and coping processes in relation to Challenge and Threat, the 8 item version of the Primary and Secondary Appraisal Scale (PASA) was used (Gaab et al., 2005). Four items were used to measure Challenge ("This situation is important to me") and Threat ("This situation scares me"). Responses were measured on a 6 point Likert Scale from 1 ("strongly disagree") to 6 ("strongly agree"). Previous studies have provided evidence for the validity and reliability of this measure (e.g. Gaab et al., 2005).

*2.3.5 Perceived Stress Scale (PSS-10)*

To measure perceived stress, the 10 item version of the Perceived Stress Scale(PSS) was used (Cohen, Kamarck and Mermelstein, 1983). Items measured the perception of stress in the previous week ("Last week, how often have you felt that you were on top of things?"). Responses were measured on a 5-point Likert

Scale from 0 (“Never”) to 4 (“Very Often”). Previous studies have provided evidence for the validity and reliability of this measure (e.g. Yokokura et al., 2017).

*2.4.1 Collection and processing of Saliva*

Data collection took place on three occasions at York St John University and once at Huntington School, York during 2019. In order to account for circadian rhythm of the salivary biomarkers, the participants, were asked to provide 2 saliva samples alongside their questionnaires, between 2pm and 4pm, using the unstimulated saliva “passive drool” collection technique (Bosch, 2014). Participants were instructed to provide a 1 minute sample to practice technique and a 3 minute sample 15 minutes later. Saliva was collected in 2mL polypropylene cryovials (Eppendorf, UK) and the volume of saliva was recorded. On the same day, samples were centrifuged for 5 minutes at 18,000xG to remove bacteria and mucins and the supernatants were removed and stored at -80˚C until use.

*2.4.2 Salivary Cortisol*

All samples were analysed in duplicate using commercial Enzyme Linked Immunosorbent Assay (ELISA) kits (Stratech Uk) with a sensitivity <0.0007µg/dL. The assay is a competitive ELISA in which samples containing cortisol competed with cortisol conjugated to Horseradish peroxidase for antibody binding sites on a pre-coated 96 well plate. Unbound conjugated cortisol was washed away and bound cortisol conjugate enzyme was measured by the reaction of horseradish peroxidase to the provided highly sensitive chromogenic substrate tetramethylbenzidine (TMB). This reaction produced a blue colour. The reaction was stopped with an acidic stop solution, which turned the reaction yellow. This allowed the optical density of the plate to be read at 450nm on a standard plate

reader. The cortisol conjugate detected is inversely proportional to the amount of sample cortisol.

There is a strong correlation between saliva and serum with the kit (*r*=.91, *p*=<.0001) and the intra-assay and inter-assay coefficients of variations of <11% and <7%, respectively. Cross reactivity of the antibody to closely related steroid hormones is low (<1%) apart from Dexamethasone (19.2%). Consequently an excluding factor for participants was the use of steroid based medication. High and low controls were used to validate the ELISA (see Table 5) and the results were measured against standard curve concentrations (3.0, 1.0, 0.333, 0.111, 0.037, 0.012µg/dL). Stratech UK provides a normal reference range for adults based on their assay; between 0.094µg/dL and 0.359µg/dL dependent on time of day.

Briefly, 25µl of saliva was added to an antibody-coated well with 200µl of an assay diluent solution containing 1:1600 enzyme conjugate containing phosphate buffer and pH indicator. After an incubation period of one hour at room temperature (22◦C) they were washed thoroughly using the provided wash buffer. 200µl of TMB was added to each well and the plate was left for a further 30minutes in a dark room. The colourgenic reaction was stopped with 50µl of Stop Solution. The samples were read within 5minutes at a wavelength of 490nm, then a further reading was read at a wavelength of 450nm. If the samples gave an optical density greater than the linear range they were diluted further and reanalysed.

*2.4.3 Salivary Amylase*

All samples were analysed in duplicate using a commercial Kinetic Enzyme Kit(Salimetrics, State College, PA, USA) with a sensitivity of 2.0U/ml. The intra-assay and inter-assay precision of the kit is <7.2% and <5.8% respectively. Briefly,

8µl of sample (diluted 1 in 200 using the provided amylase diluent) was added to 320µl preheated (37˚C) amylase substrate. The plate was then read after 1 minute at 405nm, then again after 3 minutes. The procedure was followed as specified, with a salivary dilution of 1 in 200 used. The Units (U)/ml of α-amylase activity per sample was determined using the following equation:

$$\frac{\delta Abs./\min x\ Total\ Assay\ Volume\ x\ Dilution\ Factor}{Milimolar\ Absorptivity\ of\ 2-chlor-p-nitrophenol\ x\ Sample\ Volume\ x\ Light\ Path}$$

The α-amylase activity per ml of saliva was then determined in relation to salivary flow rate by accounting for the volume of saliva produced by the participant in the specified collection time at collection. The activity was extrapolated as activity per ml per minute. This was determined by dividing the α-amylase activity by the volume of saliva produced during a known time frame (e.g. 3 minutes).

*2.4.4 Protein Concentration Determination*

The total protein concentration of the saliva was determined using a Pierce Bicinchoninic (BCA) Protein Assay Reagent Kit (Pierce Biotechnology, Rockford, IL, USA). Briefly, a Bovine Serum Albumin (BSA) standard concentration range (2000, 1500, 1000, 750, 500, 250, 125, 50µg/ml) was used, using Phosphate Buffered Saline (PBS) as a diluent, to create a standard curve. 25µl of non-diluted saliva was added alongside the standard curve. 200µl of the provided working reagent was added to each well and the plate was incubated for 30 minutes at 37◦C. The plate was then cooled and the absorbance was read at 562nm in a standard plate reader.

*2.4.5 Salivary IgA*

An in-house ELISA was developed to determine the concentration of Salivary IgA per sample and all volumes used were 100µl unless stated otherwise. A 96-well High Binding Corning plate (Sigma-Aldrich, Dorset, UK) was coated with 1.25µg/ml monoclonal antibody (mAb) capture IgA in 0.05M sodium carbonate-bicarbonate pH 9.6 and incubated overnight at 37˚C. The plate was patted dry and blocked with 150µl 1% BSA (Tocris Bioscience, Bristol, UK) in pH 7.4 10mM PBSfor 1 hour at 37˚C. The plate was washed: the wells were filled with wash solution (0.15M sodium chloride (NaCl), 0.05% Tween-20 Surfact-Amps Solution) emptied and patted dry 4 times. Purified human IgA (Bio-rad, California, USA) was used to construct a standard curve (1.0, 0.1, 0.01 and 0.001µg/ml concentrations). Saliva samples were diluted (1/10,000) in Optimal saliva dilutions (1/10,000) in diluent provided in the salivary amylase commercial kinetic enzyme kit (see above). The plate was incubated for 2 hours at room temperature and the wash step repeated. The polyclonal detector biotin-labelled goat anti-human IgA antibody(Bio-rad, California, USA) was added to each well and incubated for 1 hour at 37˚C. The wells were washed and 1/32000 streptavidin-Horseradish peroxidase (Bio-rad, California, USA) was added to each well and the plate was incubated for 1 hour at room temperature. Following washing the colorimetric reaction was initiated by addition of Tetra-methylbenzidene (TMB) for 5 minutes then stopped by adding an equal volume of 0.1M Sulfuric Acid ($H_2SO_4$).The absorbances were read at 490nm within 20 minutes of stopping the reaction. The IgA concentration was normalised against total protein concentration as a percentage.

*2.4.6 Salivary DHEA*

All samples were run in duplicate using commercial Enzyme Linked Immunosorbent Assay (ELISA) kits (Salimetrics, State College, PA, USA) with a sensitivity of <43pg/ml. The assay is a competitive ELISA in which saliva samples containing DHEA competed with DHEA conjugated to Horseradish peroxidase for antibody binding sites on a pre-coated 96 well plate. Unbound conjugated DHEA was washed away and bound DHEA conjugate enzyme was measured by the reaction of horseradish peroxidase to the provided TMB. This reaction produced a blue colour. The reaction was stopped with an acidic stop solution, which turned the reaction yellow. This allowed the optical density of the plate to be read at 450nm on a standard plate reader. The DHEA conjugate detected is inversely proportional to the amount of sample DHEA.

The intra-assay and inter-assay precision of the kit is <8.8% and <7.7% respectively. Antibody cross-reactivity is low (<0.1%). Due to limited saliva samples the 1 in 200 dilution from the salivary amylase assay was used. Briefly, 100µl of standards (15,300, 5,100, 1,700,566.7, 188.9pg/ml), controls and samples were added to the appropriate wells. 150µl of 1:225 provided enzyme conjugate/diluent solution was added to each well. The plate was then incubated at room temperature on a mixer at 500rpm for 1 hour. The plate was then washed using the provided wash buffer. 200µl of TMB was added for 25minutes then 50µl of the provided stop solution was added. The samples were read at 450nm within 10 minutes.

*2.5 Data Analysis*

Salivary cortisol, salivary IgA, salivary DHEA, and protein concentrations were extrapolated using four parameter logistics curves (*myassay.com).*

Psychometric data and salivary biomarker concentrations were analysed using IBM SPSS statistics 25 (ref). Pearson's Bivariate correlation and Multiple Linear Regression were statistical tests used to analyse the data. Preliminary analysis involved removal of univariate outliers (Zscores greater than 3.29) and multivariate outliers (Mahalanobis Distance greater than 32.09; (Huberty, 2014)). This resulted in the removal of two univariate outliers and one multivariate outlier. The primary analysis included examination of bivariate correlations and a series of multiple regressions. Predictor variables were perfectionism (Trait perfectionism, Perfectionistic Self Presentation and Perfectionistic cognitions) and the criterion variables were biomarkers of stress (salivary cortisol, IgA, α-amylase and DHEA) and self-report stress.

## 3. Results

*3.1 Assay Quality Control*

The high and low control values provided in the respective assay kits were within the expected range provided by the manufacturers. Consequently, the measured values for the standards and unknown saliva samples in each assay format were accepted as valid.

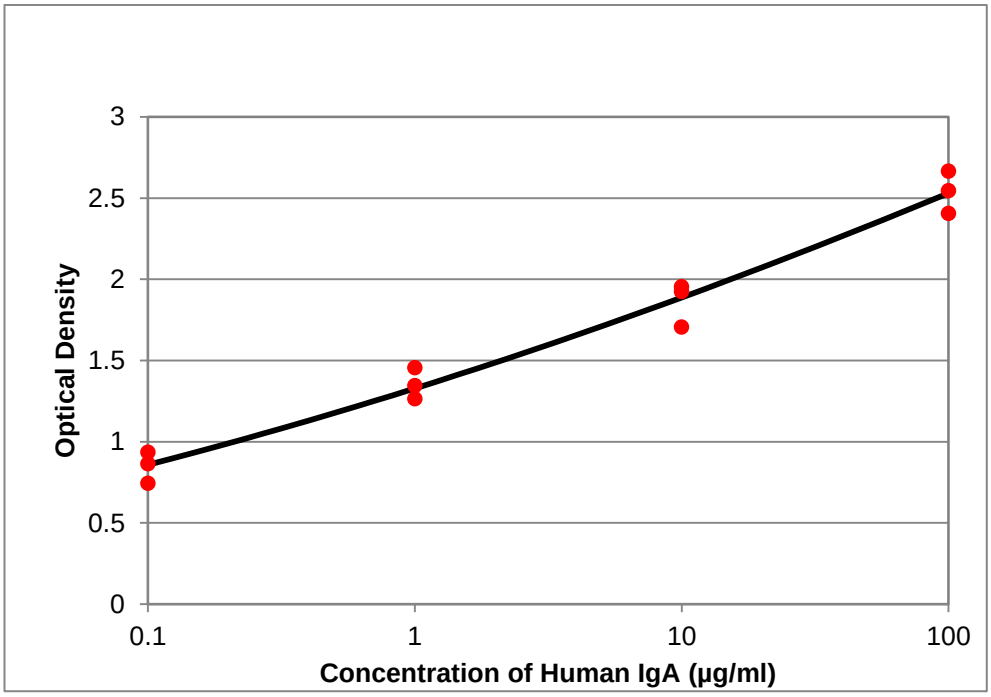
**Table 5: The expected control values of each analyte provided by the commercial assay kits against the mean measured control values seen across all assays**

| ***Biomarker*** | ***Expected Control Value*** | | ***Mean Measured Control Value*** | |
|---|---|---|---|---|
| | ***High*** | ***Low*** | ***High*** | ***Low*** |
| ***Cortisol(µg/ml)*** | *0.962 +/- 0.241* | *0.097 +/- 0.024* | *1.103 SD +/-0.022* | *0.1083 SD +/- 0.023* |
| ***Amylase (U/ml)*** | *261.98 +/- 65.5* | *27.26 +/- 10.90* | *213.01 SD +/- 0.18* | *17.84 SD +/- 0.05* |
| ***DHEA (pg/ml)*** | *510.81 +/- 127.7* | *30.85 +/- 12.34* | *483.62 SD +/- 3.8* | *22.74 SD +/- 0.5* |

*3.2 IgA Standard Curve*

IgA ELISA optimisation identified 1.25µg/ml capture monoclonal antibody in conjunction with 1 in 32K Streptavidin-HRP solution as the optimum combination of solutions. From this a standard curve of Human IgA was created using known concentrations of Human IgA (0.1, 1, 10, 100µg/ml) against the optical density at 490nm. The standard curve was run alongside the saliva samples in each plate. The mean optical density of the standard curve from all 3 plates run can be seen in Figure 1.

**Figure 1: The mean optical density of 4 purified Human IgA samples provided by Biorad used to determine salivary IgA concentrations in participants' samples. The standards were run in triplicate on all 3 plates, resulting in 9 repeats per sample. 0.1µg/ml = 0.865 (SD 0.0384), 1µg/ml= 1.345 (SD 0.0762), 10µg/ml= 1.925 (SD 0.0788), 100µg/ml = 2.545 (SD 0.0751).**



*3.3 Salivary Biomarker Concentrations*

**Table 6: Average Cortisol Concentration, IgA Concentration, Salivary Amylase Activity and DHEA concentration per participant. Cortisol, IgA and Salivary Amylase were run in triplicate. DHEA was run in duplicate due to insufficient saliva samples.**

| Participant ID | Cortisol concentration (ug/ml) | IgA concentration (ug/ml) | Salivary Amylase activity (U/ml) | DHEA concentration (ug/ml) |
|---|---|---|---|---|
| 5 | 0.1529 | 49.74 | Insufficient Saliva | Insufficient Saliva |
| 7 | 0.1454 | 15.51 | 7.8277 | 0.196 |
| 8 | 0.1155 | 151.3 | 75.70775 | 0.203 |
| 18 | 0.07369 | 38.86 | 19.466845 | Insufficient Saliva |
| 22 | 0.08529 | 13.55 | 6.817645 | 0.482 |
| 24 | 0.1985 | 48.14 | 24.16925 | 0.345 |
| 27 | 0.548 | 25.47 | 13.009 | 0.827 |
| 28 | 0.2851 | 55.22 | 27.75255 | 0.427 |
| 29 | 0.1824 | 142.9 | 71.5412 | Insufficient Saliva |
| 30 | 0.2553 | 106.5 | 53.37765 | 0.674 |
| 31 | 0.2116 | 57.26 | 28.7358 | 0.123 |
| 33 | 0.3221 | 37.01 | 18.66605 | Insufficient Saliva |
| 36 | 0.5466 | 17.04 | 8.7933 | Insufficient Saliva |
| 42 | 0.1492 | 44.72 | 22.4346 | 0.652 |
| 49 | 0.1459 | 56.72 | 28.43295 | 0.59 |
| 50 | 0.1919 | 66.28 | 33.23595 | 0.157 |
| 51 | 0.3271 | 12.96 | 6.64355 | 0.103 |
| 57 | 0.2872 | 39.13 | 19.7086 | 0.164 |
| 58 | 0.2705 | 27.03 | 13.65025 | 0.854 |
| 59 | 0.7727 | 59.57 | 30.17135 | 0.698 |
| 61 | 0.2625 | 4.787 | 2.52475 | 0.362 |
| 62 | 0.2528 | 16.02 | 8.1364 | 0.126 |
| 63 | 0.2109 | 33.3 | 16.75545 | 0.214 |
| 64 | 0.5129 | 32.36 | 16.43645 | 0.837 |
| 65 | 0.2275 | 42 | 21.11375 | 0.237 |
| 67 | 0.2298 | 21.86 | 11.0449 | 0.196 |
| 72 | 0.1282 | 51.2 | 25.6641 | 0.102 |
| 75 | 0.1645 | 70.51 | 35.33725 | 0.156 |
| 82 | 0.4395 | 18.34 | 9.38975 | 0.354 |
| 83 | 0.318 | 60.21 | 30.264 | 0.328 |
| 89 | 0.1747 | 35.5 | 17.83735 | 0.562 |
| 90 | 0.1516 | 36.36 | 18.2558 | 0.632 |
| 91 | 0.6992 | 56.78 | 28.7396 | 0.467 |
| 92 | 0.1174 | 35.07 | 17.5937 | 0.104 |
| 94 | 0.4399 | 15.47 | 7.95495 | 0.154 |
| 95 | 0.2301 | 47.08 | 23.65505 | 0.823 |
| 96 | 0.2553 | 17.72 | 8.98765 | Insufficient Saliva |
| 97 | 0.3292 | 32.71 | 16.5196 | Insufficient Saliva |

4 of the 37 participants who supplied saliva produced cortisol levels above the Stratech UK supplied average adult range of 0.094µg/mL and 0.359µg/mL. Salivary amylase activity was consistently low. All participants Salivary Amylase Activity were below average (<93U/ml) according to Stratech UK. Salivary IgA concentrations were all below the average adult ranges provided by the National Health Service; 800ug/ml to 3000ug/ml (NHS Foundation trust, 2021). Participant samples provided DHEA concetrations within and below the average range of 0.45ug/ml and 6.5ug/ml according to Stratech UK.

### *3.4 Reliability of Psychometric Instruments*

Cronbach's alpha was used to determine the internal consistency of the psychometric instruments. For social science measures, the minimum accepted reliability coefficient is 0.70 (Cortina, 1993), which was met by all instruments (Table 7).

**Table 7: The internal consistency of the psychometric instruments using Cronbach's Alpha reliability coefficient scores. Cronbach's alpha interprets the reliability of a test by assessing the correlation of the test with itself, expressing the correlation on a scale of 0 – 1 (Tavakol & Dennick, 2011). For social science measures, the minimum accepted reliability coefficient is .70 (Cortina, 1993)**

| Measure | Reliability Coefficient |
|---|---|
| Self-Oriented Perfectionism | .84 |
| Socially Prescribed Perfectionism | .71 |
| Other Oriented Perfectionism | .81 |
| Perfectionistic Self Promotion | .87 |
| Non-Display of Imperfection | .82 |
| Non-Disclosure of Imperfection | .86 |
| Perfectionistic Cognitions Inventory | .89 |
| Challenge | .75 |
| Threat | .79 |
| Perceived Stress | .84 |

*3.5 Descriptive Statistics*

Based on the Likert scale format, the participant group reported moderately high levels of self-oriented perfectionism, moderate levels of socially prescribed perfectionism, and moderately low levels of other oriented perfectionism. In addition, the participant group also reported moderate levels of perfectionistic self-promotion, non-disclosure of perfectionism and non-display of perfectionism.

The participants reported perceived stress levels ranging from low to high. Based on example ranges provided by the relevant commercial assay kits, saliva samples contained concentrations of cortisol, amylase, IgA and DHEA ranging from low to high.

*3.6 Bivariate Correlations*

The relationships between trait perfectionism, perfectionistic self-presentation, perfectionistic cognitions, primary appraisal of stress, perceived stress and biomarkers of stress were assessed using bivariate correlations (Table 8).

Bivariate correlations for perceived stress indicated a positive relationship between perceived stress and multiple aspects of perfectionism. Specifically, there was a moderate positive correlation between perceived stress and Non-Display of Imperfection (NDP) and Non-Disclosure of Imperfection (NDC) (NDP, $r$ = .35, $p$ <.01; NDC, $r$ = .32, $p$ < .01). There was also a small positive correlation between perceived stress and socially prescribed perfectionism , perfectionistic self-promotion (PSP), perfectionistic cognitions (PCI) and Threat (SPP, $r$ = .28, $p$ < .01, PSP, $r$ = .27, $p$ < .05; PCI, $r$ = .27, $p$ < 0.05; Threat, $r$ = .29, $p$ < 0.05). Finally, there was a small positive correlation between threat appraisal and other oriented perfectionism ($r$ = .26, $p$ < .05) and NDC ($r$= .27, $p$ < .05).

Bivariate correlation for biomarkers of stress indicated only one significant correlation between aspects of perfectionism and biomarkers of stress. Specifically, there was a negative moderate correlation between self-oriented perfectionism and salivary amylase ($r$ = .31, $p$ < .01). However, bivariate correlations indicated moderate positive correlation between the concentration of salivary DHEA and the challenge perception of primary appraisal ($r$ = .29, $p$ < .05).

*3.7 Multiple Regression Analyses*

A series of multiple regression analyses were conducted to determine whether perfectionism predicts self-report measures of stress and biomarkers of stress. In each case, self-report stress and biomarkers of stress were the dependent variable and trait perfectionism (regression set 1), perfectionistic self-presentation (regression set 2), and perfectionistic cognitions (regression set 3) were the predictor variables. The results of the analyses are reported in Table 9.

*3.8.1 Trait Perfectionism*

Trait perfectionism did not significantly predict any biomarker of stress, challenge or threat appraisal, or perceived stress; amylase, $F$(3,55)= 1.92; cortisol, $F$ (3, 55) = 1.4; IgA, $F$ (3,55) = 1.05; DHEA, $F$ (3, 55) = 2.16; challenge, $F$ (3,59) =.89; threat, $F$ ( 3,59) = 2.15; perceived stress, $F$ (3,59) = 1.74. However, individual traits were identified as unique predictors of salivary amylase, salivary DHEA and threat appraisal. Specifically, self-oriented perfectionism was a unique negative predictor (β = -.319, $p$ < .05) of salivary amylase, whilst other-oriented perfectionism was a unique positive predictor of DHEA (β = .338, $p$ < .05) and threat appraisal (β = .321, $p$ < .05).

*3.8.2 Perfectionistic Self-Presentation*

Perfectionistic self-presentation dimensions significantly predicted perceived stress and accounted for 20.2% in perceived stress; $F$ (3, 59) = 4.97, $p$ < .01). Non-disclosure of imperfection was the only unique positive predictor of perceived stress (β = .338, $p$ < .05). This indicated that as non-disclosure of imperfection increases so does the level of reported stress.

Perfectionistic self-presentation did not significantly predict any biomarkers of stress, or challenge or threat appraisal; amylase, $F$ (3,55) =1.93; cortisol, $F$ (3,55) = .51; IgA, $F$ (3,55) = .29; DHEA, $F$ (3,55) = .19, challenge, $F$ (3,59) = 1.65, threat, $F$ (3,59) = 1.74. However, there was some evidence that perfectionistic self-promotion was a unique negative predictor of salivary amylase. As perfectionistic self-promotion increases, salivary amylase concentration decreases (β = -.388, $p$ < .05). Additionally, non-display of imperfection was identified as a unique positive predictor (β = .319, $p$ < .05) of challenge, despite perfectionistic self-presentation as a whole not predicting challenge. In this case, as non-display of imperfection increases, so does appraisal of challenge.

*3.8.3 Perfectionistic Cognitions*

Perfectionistic cognitions were found to significantly predict perceived stress. Perfectionistic cognitions accounted for 7.4% of variance in perceived stress; $F$ (1,61) = 4.863, $p$ <.05; β = .272, $p$ < .05. However, Perfectionistic cognitions did not significantly predict any of the salivary biomarkers, or threat or challenge.

**Table 8. Descriptive Statistics and Bivariate Correlations between aspects of perfectionism and Salivary Biomarkers. Note: *$p < .05$. **$p < .01$. ***$p < .001$.**

**The data suggests an association between Salivary Amylase and Self Oriented Perfectionism, and Salivary DHEA and Threat Appraisal.**

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Perfectionism** | | | | | | | | | | | | | | |
| 1. Self-Oriented Perfectionism | | | | | | | | | | | | | | |
| 2. Socially Prescribed | .35* | | | | | | | | | | | | | |
| Perfectionism | | | | | | | | | | | | | | |
| 3. Other Oriented Perfectionism | .06 | .42** | | | | | | | | | | | | |
| **Perfectionistic self-presentation** | | | | | | | | | | | | | | |
| 4. Perfectionistic Self Promotion | .59** | .31* | .19 | | | | | | | | | | | |
| 5. Non-Display of Imperfection | .23 | .52** | .43** | .50** | | | | | | | | | | |
| 6. Non-Disclosure of Imperfectio | .17 | .16 | .30* | .57** | .52** | | | | | | | | | |
| **Perfectionistic Cognitions Inventory** | | | | | | | | | | | | | | |
| **(PCI)** | | | | | | | | | | | | | | |
| 7. PCI | .56** | .39** | .32* | .65** | .34** | .44** | | | | | | | | |
| **Primary Appraisal** | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8. Challenge | .18 | .16 | .06 | -.06 | .21 | .03 | .09 | | | | | | | |
| 9. Threat | .12 | .02 | .26* | .05 | .25 | .27* | .13 | .53**. | | | | | | |
| **Perceived Stress (PSTR)** | | | | | | | | | | | | | | |
| 10. PSTR | .13 | .28* | .08 | .27* | .35** | .32** | .27* | .22 | .29* | | | | | |
| **Biomarkers** | | | | | | | | | | | | | | |
| 11. Salivary Cortisol | -.23 | -.13 | .06 | -.05 | .03 | .10 | -.03 | .06 | .24 | .09 | | | | |
| 12. Salivary IgA | .14 | -.03 | -.17 | -.02 | -.10 | .01 | -.03 | .04 | .00 | -.02 | -.20 | | | |
| 13. Salivary Amylase | -.31* | .06 | -.02 | -.23 | .01 | .03 | .03 | -.07 | -.04 | .03 | .52** | -.09 | | |
| 14. Salivary DHEA | .11 | -.04 | .23 | -.03 | -.03 | -.10 | .18 | .29* | .16 | .03 | -.23 | -.08 | -.27* | |
| *N* | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 59 | 59 | 59 | 59 |
| *M* | 5.473 | 3.770 | 2.235 | 4.031 | 4.364 | 3.188 | 1.992 | 3.546 | 2.429 | 2.066 | | | | |
| *SD* | .95 | 1.11 | .84 | .95 | .96 | 1.14 | .93 | 1.36 | 1.30 | .62 | | | | |

**Table 9. Multiple Regression Predicting the link between salivary biomarkers, stress and perfectionistic personality traits. The data suggests a negative correlation between Salivary Amylase and both Self Oriented Perfectionism and Perfectionistic Self Promotion. DHEA is shown to be increased in those who experience Other Oriented Perfectionism. Additionally perceived stress was measured higher in those who do not disclose imperfection.**

| | Salivary Cortisol | | Salivary IgA | | Salivary Amylase | | Salivary DHEA | | Challenge | | Threat | | PSTR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $R^2$ | β | $R^2$ | β | $R^2$ | β | $R^2$ | β | $R^2$ | β | $R^2$ | β | $R^2$ | β |
| | .071 | | .054 | | .095 | | .106 | | .043 | | .098 | | .081 | |
| Self Oriented Perfectionism | | .201 | | .157 | | -.319* | | .161 | | .141 | | .160 | | -.031 |
| Socially Prescribed Perfectionism | | -.131 | | .013 | | .044 | | -.260 | | .110 | | -.176 | | .289 |
| Other Oriented Perfectionism | | .1.43 | | -.190 | | .006 | | .338* | | -.002 | | .321* | | -.047 |
| | .027 | | .016 | | .095 | | .010 | | .077 | | .073 | | .202** | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Perfectionistic self promotion | -.159 | -.003 | -.388* | .026 | -.207 | -.220 | -.007 |
| Non-display of Imperfection | .007 | -.144 | .096 | .025 | .319* | .208 | .175 |
| Non-disclosure of Imperfection | .190 | .086 | .200 | -.124 | -.021 | .286 | .338* |
| | .001 | .001 | .001 | .032 | -.008 | .002 | .074* |
| Perfectionistic cognitions inventory | .006 | -.025 | .031 | .178 | .089 | .134 | .272* |

Note. *$p$ < .05. **$p$ < .01. ***$p$<.001;

## 4. Discussion

### *4.1 Overview*

The aim of this study was to examine the relationship between perfectionism (trait perfectionism, perfectionistic self-presentation, and perfectionistic cognitions) and stress in qualified teachers and trainee teachers. Based on previous research, it was hypothesised that perfectionism would predict higher levels of both self-reported stress and biomarkers of stress (salivary concentrations of cortisol, amylase, IgA and DHEA). This hypothesis was partially supported as cortisol concentrations proved to be increased among the participants, however DHEA, SAA and Salivary IgA concentrations were all low in comparison to the expected ranges provided by the Stratech UK testing kits and the NHS foundation respectively. Despite this finding, correlations were observed between salivary biomarkers and different characteristics of stress and perfectionism. Trait perfectionism, perfectionistic self-presentation, and perfectionistic cognitions were positively related to perceived stress. In addition, NDC and perfectionistic cognitions were unique positive predictors of perceived stress. However, evidence of the relationship between perfectionism and biomarkers of stress was limited, however, there was tentative evidence that SOP and PSP were unique negative predictors of salivary amylase.

### *4.2 Salivary Biomarkers of the Participants*

All participant samples contained DHEA concentrations at the lower end or below the expected range provided by the Stratech UK provided kit. Low DHEA levels are associated with tiredness and depression (Wolkowitz et al., 1997), suggesting that the challenges of a career in education affects the mental wellbeing of individuals.

This study also showed low levels of SAA activity and salivary IgA concentrations were low within the participants. SAA activity has previously been shown to be low during times of exam stress (Afrisham et al., 2016), which correlates with the fact that 69.2% of participants were PGCE students approaching final exams. Low IgA levels can be a result of blunting caused by consistently high cortisol levels (Viena et al., 2012); 4 of the participants were recorded having cortisol levels beyond the normal range provided by Stratech UK(0.094µg/mL a0.359µg/mL), suggesting that the cortisol concentrations could have caused the low levels of salivary IgA observed.

*4.3 Trait Perfectionism and Stress*

Socially prescribed perfectionism is often associated with high levels of perceived stress due to the inherent need of those with this personality trait to attain the perceived perfectionistic requirements of others (Childs & Stoeber, 2012). In the present study, a small positive correlation was found between SPP and perceived stress. These findings also support previous research (Flett, Hewitt & Hallett, 1995; Childs & Stoeber, 2012) which found positive association between SPP and higher levels of stress among those in the teaching profession ( $r = .35$, $p < .01$; $r = .48$, $p < .001$). These data are unsurprising given the nature of educational careers. Those in the teaching profession have a number of potential sources of socially perceived perfectionism including government officials, colleagues, students, and parents, whilst trainee teachers have the added pressure from university staff and fellow trainees (Montgomery and Rupp, 2005).

In addition to the positive correlation between SPP and perceived stress, our study also highlighted a small positive correlation between OOP and those who

appraise stressful situations as “threats”. To the best of our knowledge there are very few existing studies that investigate the importance of threat appraisal in relation to OOP.

OOP is based on the belief that it is important for others to strive for perfectionism, and other oriented perfectionists are highly critical of others who do not meet these expectations (Stoeber, 2014). The role of teachers and trainee teachers involves responsibility for the academic achievement of numerous students. Those with the OOP trait are therefore surrounded by others whose achievement level is determined by their ability as a teacher, creating an environment for other oriented perfectionism to manifest.

### *4.4* Perfectionistic Self-Presentation and Stress

Perfectionistic self-presentation encompasses the way in which an individual portrays themselves to the outside world; perfectionistic self-promotion (PSP) involves highlighting your best qualities, non-disclosure of imperfection (NDC) involves not verbally sharing imperfections, and non-display of imperfection(NDP) involves physically hiding your imperfection. Our study suggests that those who present with high NDC and NDP scores are more likely to self-report that they are stressed. The disclosure of flaws and imperfections has been identified as a therapeutic measure of stress relief (Norcross, 2002), however, those who present with NDC and/or NDP are less likely to express such worries, either to therapists or to friends/family. The anonymous nature of this study allowed participants to honestly report their stress levels. Those with NDC or NDP are therefore less likely to receive any form of therapeutic relief from stress and anxiety (Hewitt et al., 2008), thus presenting another possible reason for high

perceived stress amongst those who present with these perfectionistic self-presentations. It is therefore likely that teachers and trainee teachers who are unwilling to express their worries are more likely to suffer from stress.

*4.5 Perfectionistic Cognitions and Stress*

The perfectionistic cognitions inventory (PCI) analyses an individual's reflections of imperfections and mistakes, with those that score highly often more likely to experience stress (Hewitt and Flett, 2004). The present study found a small positive correlation between PCI scores and perceived stress. Perfectionistic cognitions have previously been identified as enhancers of perfectionistic stress; high PCI scores have previously been found to increase anxiety and depression and consequently contribute to distress (Flett et al., 2007). This finding therefore aligns well with previous research. Teachers are often in situations where negative thought patterns may be triggered (e.g., excessive demands) and therefore generate a high frequency of perfectionistic cognitions. The present evidence suggests that teachers who are more likely to engage in perfectionistic thinking are more likely to succumb to the consequences of the situations they face.

*4.6 Variability of Stress and Perfectionism Biomarkers in Existing studies*

Study of existing research into the effect of stress on salivary biomarkers has generated conflicting results. For example, Hill et al., 2018 reviewed and evaluated the research on Multidimensional Perfectionism on Cortisol levels and found there were studies with both supportive and null/inconclusive findings. It was found that studies that used similar population size, methodology and demographics could have opposing results due to different statistical analyses.

Due to the broad range of this present study it was not possible to follow the methodology of previous studies therefore the purpose was to identify the most promising biomarker to focus on for future research into salivary biomarkers of stress and perfectionism.

*4.7 Biomarkers of Stress and Perfectionism*

The moderate correlation between self-oriented perfectionism and salivary α-amylase production indicates reduced SAM activation, suggesting that the "fight or flight" impulse is lower in those with the SOP trait. This is contrary to the expectation that those with perfectionistic personality traits would have increased SAA concentrations due to a higher affinity to stress. In regards to contextualising these findings, a positive correlation between SAA and self-critical perfectionism had($\beta$ = .52, $p$ = <.05) previously been observed in an earlier study into the association between self-critical perfectionism and sympathetic indicators (Mcgirr & Turecki, 2009).

A possible reason for the decreased SAA levels in those with SOP and PSP is that these individuals in particular experience stressors on a daily basis so have an adapted stress response and consequently activate the HPA axis rather than the "emergency" SAM pathway. This theory was first proposed by a 2018 study which found that those with trait anxiety had lower SAA levels under stress (Altamura et al., 2018). Both trait perfectionism and perfectionistic self-presentation, of which PSP is an aspect, have previously been linked to a higher level of trait anxiety (Saboonchi & Lundh, 1997; Mackinnon et al., 2014). It is therefore possible that teachers and trainee teachers with high SOP scores have a unique affiliation towards anxiety that affects SAM activation and in turn SAA production.

*4.8 Biomarkers of Stress*

Cortisol, SAA, salivary IgA and DHEA have previously been identified as potential biomarkers of stress (Oberbeck et al., 1998; Tsujita & Morimoto, 1999; Gordis et al., 2006; Hellhammer, Wüst & Kudielka, 2009). It was expected that the strongest correlations with perceived stress would be seen with cortisol and SAA due to the common usage of these particular biomarkers as indicators of the HPA axis and SAM pathway respectively. This present study, however, did not find any correlation between perceived stress and the potential biomarkers, although moderate positive correlation was found between DHEA and the "challenge" primary appraisal. Previous research has found positive correlations between perfectionism as a whole and cortisol concentrations (Wirtz et al., 2007), however, to the best of our knowledge, there is no research into other potential biomarkers. Consequently, we hypothesised that, due to strong association between perfectionism and stress, that there would be positive correlations between the dimensions of perfectionism and the salivary biomarkers commonly associated with stress. This study found moderate negative correlation between SAA and self-oriented perfectionism; -.31*.

Previous research examined the possibility of using salivary biomarkers, including cortisol, α-amylase, IgA and Dehydroepiandrosterone (DHEA) to measure stress levels (Mouton et al., 1989; Takai et al., 2004; Lennartsson et al., 2012). Informed by this research, the objective was to identify the most effective biomarker in the context of psychometric analysis of perfectionism and stress. The present study intentionally used a diverse population sample including both men and women and a range of ages in order to identify a universal biomarker for stress identification. Correlation analyses, did not detect any significant correlation

between the putative stress biomarkers and an individual's perceived stress levels (Table 8). However, this study identified a moderate positive correlation between salivary DHEA concentration and the "challenge" appraisal of socially stressful situations.

The "challenge" appraisal of situations is made when a positive connotation of a stressful situation is perceived as opposed to a negative "threat" appraisal, and is associated with levels of perceived control, high levels of efficacy and the ability to approach goals ( Rossato et al., 2016). This suggests that those with higher DHEA concentrations are better equipped psychologically to cope with stressful situations. This finding supports the link between higher circulating DHEA concentrations and a better mental wellbeing (Valtysdottir, Wide & Hallgren, 2003). DHEA has anabolic properties and works to reduce the catabolic effects of cortisol and therefore it has been suggested that DHEA may have a protective role against the negative consequences of stress (Lennartsson et al., 2012). It is therefore possible that the anti-anxiolytic effects of DHEA (Van Niekerk, Huppert & Herbert, 2001) create a state of mental wellbeing optimised for rationalising potential threat and therefore avoiding potential stress.

This study found no correlation between perceived stress and any of the potential biomarkers. The lack of a significant correlation between the potential biomarkers and stress, suggests that a number of other factors may be influential on the salivary concentration of these molecules. A possible explanation for the poor correlation between cortisol levels and reported stress ( $r = 0.08$) is self-inhibition of the HPA axis by circulating glucocorticoids, e.g. cortisol (Smith & Vale, 2006). Glucocorticoids control the basal activity of the HPA axis and are responsible for

the termination of the stress response in order to limit the body's exposure to cortisol and minimise the catabolic and immunosuppressive affects (Kyrou & Tsigos, 2009). Chronic stress has also been observed to have a negative effect on the functionality of the HPA axis (McEwen & Stellar, 1993), with prolonged cortisol exposure inducing neuronal atrophy in the hippocampus resulting in fewer glucocorticoid receptors and the subsequent hypothalamic dysregulation with decreased cortisol production (Bremner, 1999). It is therefore possible that with further analysis into the duration of stress experienced it would be possible to identify correlations between cortisol levels and perceived stress.

As with cortisol, SAA did not show correlation with perceived stress ( $r = 0.03$). SAA has previously been identified as potential biomarker for measuring stress induced activation of the Sympathetic Adrenal Medullary (SAM) system (Rohleder et al., 2004). SAA is secreted in response to sympathetic stimulation by the SAM system; the "fight-or-flight" stress response (Nater et al., 2005). Lack of significant correlation between SAA and perceived stress could feasibly have been influenced by genetic variation among the participants. A 2010 study found positive correlation ($r = 0.5$, $p < 0.0001$) between the copy number of the AMY1 gene and SAA concentration (Mandel et al., 2010). The AMY1 gene has a high copy number variation, with individuals possessing between 2 and 15 diploid copies, therefore creating variation between individuals' "normal" range (Mandel et al., 2010).

Salivary IgA also found no correlation between IgA concentrations and perceived stress ($r = -0.02$). Although salivary IgA concentrations have previously been identified as a useful biomarker of stress due to its propensity to increase immediately following exposure to stress by approximately 15% before dropping 13% within an hour and a half (McClelland, Ross & Patel, 2010,Tsujita & Morimoto, 1999), salivary IgA secretion has also been found to vary, both

between individuals and within the same individual over long periods of time (Mouton et al., 1989). Our participant sample was intentionally diverse and therefore potentially explains the lack of correlation with perceived stress. Age has been identified as a determining factor of salivary IgA secretion, with salivary IgA levels increasing with age among healthy individuals up to the age of 60, increasing from 9.35mg/dL ± 5.80 at 21-30 years old to 11.34mg/dL ± 7.87 between 51-60 years old (Jafarzadeh et al., 2010). Several other lifestyle factors including diet, medication, and sleep have also been observed to affect salivary IgA secretion (Mouton et al., 1989).

Additionally, due to the primary function of IgA as an antibody of the mucous membrane, secretion increases in response to exposure to viruses (Butler et al., 1970). The spread of disease is increased by spending longer periods of times in a confined space with a high number of people, thus the lifestyle of teachers means they are more likely to be exposed to contagious diseases and have an enhanced immune response (Goscé, Barton & Johansson, 2014).

*4.9 Practical Applications*

The present study has confirmed the influence perfectionism can have on stress levels among teachers and has highlighted the need for recognition and support.

A positive correlation between those with high levels of SPP and perceived stress in teachers was identified. By identifying this trait in teachers, schools would be able to offer appropriate networks of support to those most in need, however a degree of anonymity would have to be enforced in order to prevent prejudice in relation to hiring and promotions. Increasing the understanding of perfectionism and perfectionistic presentation amongst teachers would allow self-recognition of

perfectionistic personalities and allow those who are struggling with stress due to their perfectionism to seek appropriate help. The correlation of NDP and NDC with stress among teachers highlights the need for support networks either within schools or independently for teachers to be able to share their worries in non-judgemental environments.

### *4.10 Limitations and Future Research*

The present study has several limitations. First, the study utilised a relatively small participant sample (N = 65) thus limiting the power of the statistical analysis. Future research should use a larger sample size in order to detect smaller effects if they exist. Second, a larger sample would allow the examination of possible moderating factors such as sex, experience, and teaching level to help identify whether there are specific groups that are more at risk of the negative effects of stress.

Finally, the present study found no correlation between the potential salivary biomarkers and perceived stress. One explanation for this could be the fact that the present study used saliva samples obtained at one time point. However, previous research has identified many potential causes of variance in baseline biomarker concentration within individuals. As such, future research should examine changes in biomarker concentration within the individual (via repeated measurement). This could also include the collection of saliva samples at both stressed and non-stressed occasions.

### *4.11 Conclusion*

This study confirmed the influence of trait perfectionism, in particular of SPP and other OOP, on perceived stress in teachers. It also highlighted how NDC, NDP and perfectionistic cognitions can enhance the feeling of stress, suggesting the psychological need to overcome these unhealthy patterns of behaviour. The study also suggested that those with higher levels of DHEA are able to cope with stress more effectively due to their positive primary appraisal of stressful situations. Finally the study identified a link between SOP and SAA concentrations. This finding has potentially identified a new area of research into the physiological causes of, and reactions to, perfectionism.

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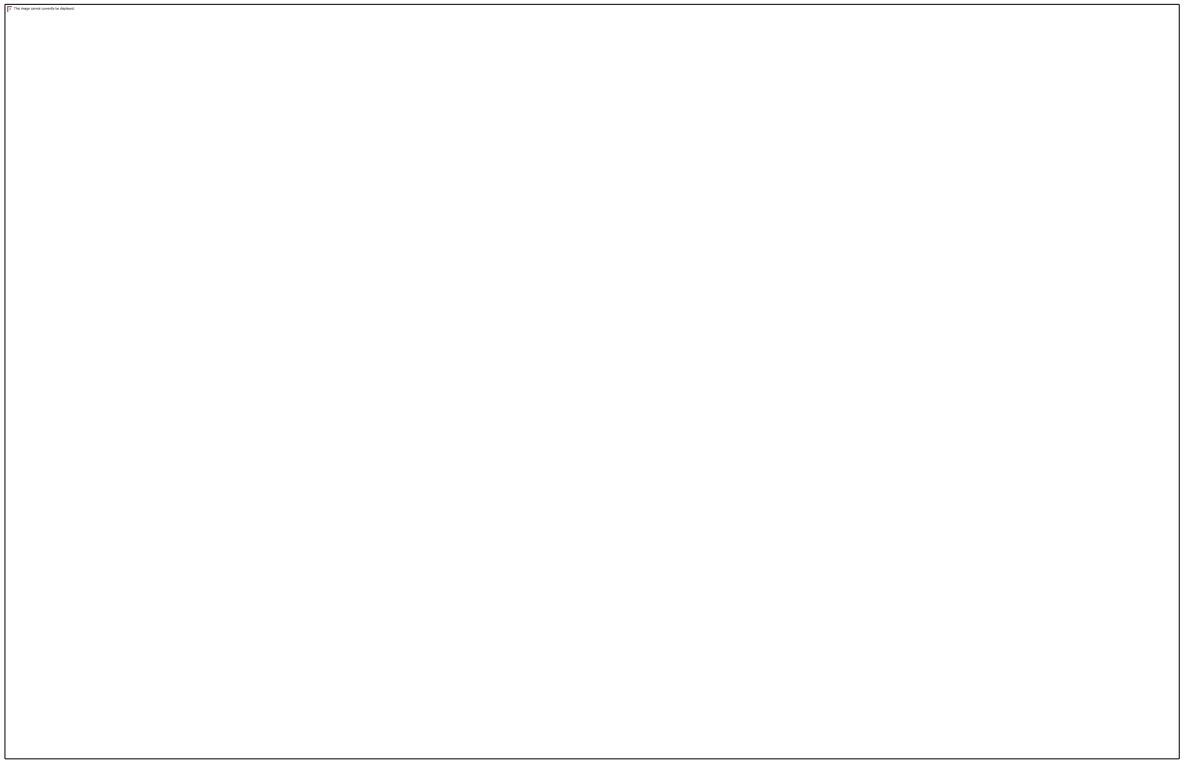
## 6. Appendix

### Interfering Medicines

**Please circle the appropriate answers b**



**Please circle the appropriate answers below and provide further information on the dotted lines if required.**

1. Are you taking any glucocorticoid medication (systemic)? Yes / no

2. Are you taking any other medications? Yes / no

If yes, please specify here

……

3.Do you have any endocrine disorders (e.g., Cushing, Addison)? Yes / No

4. Do you have any other disorders (physical or mental)?

If yes, please specify here

……

**Women only:**

Do you take the oral contraceptive pill? …….

## Questionnaire One

Listed below are a number of statements concerning personal characteristics and traits. Read each item and decide whether you agree or disagree & to what extent. **To score your responses, please read each item carefully and *circle* the appropriate number, using the scale below.**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Strongly Disagree** | | | **Neutral** | | | **Strongly Agree** |

1. One of my goals is to be perfect in everything I do..... **1 2 3 4 5 6 7**

2. Anything I do that is less than excellent will be seen as poor work by those around me..... **1 2 3 4 5 6 7**

3. I strive to be as perfect as I can be..... **1 2 3 4 5 6 7**

4. I am a perfectionist in setting my goals..... **1 2 3 4 5 6 7**

5. I feel that people are too demanding of me..... **1 2 3 4 5 6 7**

6. Although they may not say it, other people get upset with me when I slip up..... **1 2 3 4 5 6 7**

7. My family expects me to be perfect..... **1 2 3 4 5 6 7**

8. People expect nothing less than perfection from me..... **1 2 3 4 5 6 7**

9. I set very high standards for myself..... **1 2 3 4 5 6 7**

10. I must always be successful at school or work..... **1 2 3 4 5 6 7**

11. If I do not set very high standards for people I know they are likely to end up second-rate people..... **1 2 3 4 5 6 7**

12. I think less of people I know if they make mistakes..... **1 2 3 4 5 6 7**

13. If someone I know cannot do something really well, they shouldn't do it at all..... **1 2 3 4 5 6 7**

14. I cannot help getting upset if someone I know makes mistakes..... **1 2 3 4 5 6 7**

15. It is shameful for people that I know to display weakness or foolish behaviour..... **1 2 3 4 5 6 7**

16. An average performance by someone I know is unsatisfactory..... **1 2 3 4 5 6 7**

17. When someone I know fails at something important, it probably means they are less of a person..... **1 2 3 4 5 6 7**

18. If I scold others for their failure to live up to expectations, it will help them in the future..... **1 2 3 4 5 6 7**

**Questionnaire Two**

Listed below are a group of statements. Please rate your agreement with each of the statements using the following scale. If you strongly agree, circle 7; if you disagree, circle 1; if you feel somewhere in between, circle any one of the numbers between 1 and 7. If you feel neutral or undecided the midpoint is 4. Please circle only **one** number.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Strongly Disagree | | | Neutral | | | Strongly Agree |

1. It is okay to show others that I am not perfect ..... **1 2 3 4 5 6 7**
2. I judge myself based on the mistakes I make in front of other people ..... **1 2 3 4 5 6 7**
3. I will do almost anything to cover up a mistake ..... **1 2 3 4 5 6 7**
4. Errors are much worse if they are made in public rather than in private ..... **1 2 3 4 5 6 7**
5. I try always to present a picture of perfection ..... **1 2 3 4 5 6 7**
6. It would be awful if I made a fool of myself in front of others ..... **1 2 3 4 5 6 7**
7. If I seem perfect, others will see me more positively ..... **1 2 3 4 5 6 7**
8. I brood over mistakes that I have made in front of others ..... **1 2 3 4 5 6 7**
9. I never let others know how hard I work on things ..... **1 2 3 4 5 6 7**
10. I would like to appear more competent than I really am ..... **1 2 3 4 5 6 7**
11. It doesn't matter if there is a flaw in my looks ..... **1 2 3 4 5 6 7**
12. I do not want people to see me do something unless I am very good at it ..... **1 2 3 4 5 6 7**
13. I should always keep my problems to myself ..... **1 2 3 4 5 6 7**
14. I should solve my own problems rather than admit them to others ..... **1 2 3 4 5 6 7**
15. I must appear to be in control of my actions at all times ..... **1 2 3 4 5 6 7**
16. It is okay to admit mistakes to others ..... **1 2 3 4 5 6 7**
17. It is important to act perfectly in social situations ..... **1 2 3 4 5 6 7**
18. I don't really care about being perfectly groomed ..... **1 2 3 4 5 6 7**
19. Admitting failure to others is the worst possible thing ..... **1 2 3 4 5 6 7**
20. I hate to make errors in public ..... **1 2 3 4 5 6 7**
21. I try to keep my faults to myself ..... **1 2 3 4 5 6 7**
22. I do not care about making mistakes in public ..... **1 2 3 4 5 6 7**
23. I need to be seen as perfectly capable in everything I do ..... **1 2 3 4 5 6 7**
24. Failing at something is awful if other people know about it ..... **1 2 3 4 5 6 7**
25. It is very important that I always appear to be "on top of things" ..... **1 2 3 4 5 6 7**

26. I must always appear to be perfect..... **1 2 3 4 5 6 7**

27. I strive to look perfect to others..... **1 2 3 4 5 6 7**

## Questionnaire Three

Listed below are a variety of thoughts about perfectionism that sometimes pop into people's heads. Please read each thought and indicate how frequently, if at all, the thoughts occurred to you **over the last week**. Please read each item carefully and *circle* the appropriate number, using the scale below.

0 = Not At All

1 = Sometimes

2 = Moderately Often

3 = Often

4 = All of the Time

1. I should be perfect ..... **0 1 2 3 4**

2. I can't stand to make mistakes ..... **0 1 2 3 4**

3. No matter how much I do, it's never enough ..... **0 1 2 3 4**

4. I must be efficient at all times ..... **0 1 2 3 4**

5. I expect to be perfect ..... **0 1 2 3 4**

6. Why can't things be perfect? ..... **0 1 2 3 4**

7. My work has to be superior ..... **0 1 2 3 4**

8. My work should be flawless ..... **0 1 2 3 4**

9. I can't do this perfectly ..... **0 1 2 3 4**

10. I am too much of a perfectionist ..... **0 1 2 3 4**

## Questionnaire Four

*Listed below are a number of statements concerning the situation right now. Read each item and decide whether you agree or disagree & to what extent. Circle your answer. Please circle only **one** number.*

| 1 | 2 | 3 | 4 | 5 | 6 | |
|---|---|---|---|---|---|---|
| **Strongly Disagree** | | | | | **Strongly Agree** | |

| | | Strongly Disagree | | | | | Strongly Agree |
|---|---|---|---|---|---|---|---|
| 1. | I do not feel threatened by the situation ..... | **1** | **2** | **3** | **4** | **5** | **6** |
| 2. | I do not care about this situation ..... | **1** | **2** | **3** | **4** | **5** | **6** |
| 3. | I do not feel worried because this situation does not represent any threat for me ..... | **1** | **2** | **3** | **4** | **5** | **6** |
| 4. | The situation is important to me ..... | **1** | **2** | **3** | **4** | **5** | **6** |
| 5. | I find this situation very unpleasant ..... | **1** | **2** | **3** | **4** | **5** | **6** |
| 6. | This situation scares me ..... | **1** | **2** | **3** | **4** | **5** | **6** |
| 7. | This task challenges me ..... | **1** | **2** | **3** | **4** | **5** | **6** |
| 8. | The situation is not a challenge for me. ..... | **1** | **2** | **3** | **4** | **5** | **6** |

**Questionnaire Five**

The questions in this scale ask you about your feelings and thoughts **during the last week**. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

| |
|---|
| 0 = Never |
| 1 = Almost Never |
| 2 = Sometimes |

1. Last week, how often have you been upset because of something that happened unexpectedly? ..... **0 1 2 3 4**

2. Last week, how often have you felt that you were unable to control the important things in your life?..... **0 1 2 3 4**

3. Last week, how often have you felt nervous and "stressed"?..... **0 1 2 3 4**

4. Last week, how often have you felt confident about your ability to handle your personal problems?..... **0 1 2 3 4**

5. Last week, how often have you felt that things were going your way?..... **0 1 2 3 4**

6. Last week, how often have you found that you could not cope with all the things that you had to do?..... **0 1 2 3 4**

7. Last week, how often have you been able to control irritations in your life?..... **0 1 2 3 4**

8. Last week, how often have you felt that you were on top of things?..... **0 1 2 3 4**

9. Last week, how often have you been angered because of things that were outside of your control?..... **0 1 2 3 4**

10. Last week, how often have you felt difficulties were piling up so high that you could not overcome them?..... **0 1 2 3 4**

**END OF SURVEY**