The Role of Lower-Order Big Five Personality Constructs in Affective Disorder Symptoms: Associations and Mediating Mechanisms

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List of Abbreviations

5-HTTLPR	Serotonin-transporter-linked promoter region gene
ACC	Anterior cingulate cortex
ADHD	Attention deficit hyperactivity disorders
ALSPAC	Avon Longitudinal study of Parents and Children
APA	American Psychological Association
AST-D	Ambiguous Scenarios Test for Depression
BAS	Behavioural Activation System
BDI	Beck Depression Inventory
BDI-II/BDI-2	Beck Depression Inventory – Second Edition
BES	Best evidence synthesis
BFAS	Big Five Aspect Scale
BFI-2	Big Five Inventory - 2
BFI-44	Big Five Inventory - 44
BIS	Behavioural Inhibition System
BSI-DEP	Brief symptom inventory - depression
CAS	Clinical Anxiety Scale
CB5T	Cybernetic Big Five Theory
CBT	Cognitive Behavioural Therapy
CFI	Comparative fit index
COPE Inventory	Coping Orientations to Problems Experienced Inventory
COVID-19	Coronavirus disease
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, 5th Edition
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4th Edition
FFFS	Fight-Flight-Freeze System
FI-FFM	Faceted Inventory of the Five-Factor Model
fMRI	Functional magnetic resonance imaging
GAD	Generalised anxiety disorder
GAD-7	Generalised Anxiety Disorder - 7
HamD	Hamilton Rating Scale for Depression
HEXACO	Honesty-humility Emotionality Extroversion Agreeableness Conscientiousness Openness model of personality
HiTOP	Hierarchical Taxonomy of Psychopathology
HPA axis	Hypothalamic–pituitary–adrenal axis
HTR2A	5-Hydroxytryptamine Receptor 2A (a gene associated with serotonin reuptake)
IAD	Illness anxiety disorder
IAS	Illness Anxiety Scale
ICD-11	International Classification of Diseases, 11th Revision
IDD	Inventory to Diagnose Depression
KDEF	Karolinska Directed Emotional Faces
MADRS	Montgomery–Åsberg Depression Rating Scale
MDD	Major depressive disorder
NewMood	New Molecules in Mood Disorder dataset
MINI	Mini International Neuropsychiatric Interview

MLR	Maximum likelihood estimation
MSCEIT	Mayer-Salovey-Caruso Emotional Intelligence Test
NEO-IPIP	Neuroticism Extroversion Openness - International Personality Item Pool
NEO-PI	Neuroticism Extroversion Openness - Personality Inventory
NEO-PI-3FH	Neuroticism Extroversion Openness - Personality Inventory - 3 First Half
NEO-PI-R	Neuroticism Extroversion Openness - Personality Inventory - Revised
NESDA	Netherlands Study of Depression and Anxiety
OCD	Obsessive compulsive disorder
ODD	Oppositional defiance disorder
OFC	Orbitofrontal cortex
PDD	Persistent depressive disorder
PFC	Prefrontal cortex
PHQ-9	Patient Health Questionnaire - depression module - 9
PID-5	Personality Inventory for the DSM-5
PTSD	Post-traumatic stress disorder
RMSEA	Root Mean Square Error of Approximation
RRS	Ruminative Response Scale
SARS	Severe acute respiratory syndrome
SCID	Structured Clinical Interview for DSM-IV
SEM	Structural equation modelling
SNRI	Serotonin–norepinephrine reuptake inhibitor
SPS	Social Phobia Scale
SRMR	Standardized Root Mean Square Residual
S-SAIS	Straightforward Social Interaction Anxiety Scale
SSRI	Selective serotonin reuptake inhibitor
STAI-S	State Trait Anxiety Inventory - State
STDY	Standardised by the standard deviation of the predictor variable
STDYX	Standardised by the standard deviations of the predictor variable and outcome variable
SUD	Substance use disorder
TLI	Tucker-Lewis index
VIF	Variance inflation factor
vmPFC	Ventromedial prefrontal cortex

Abstract

Introduction

Big Five personality traits are transdiagnostic factors in affective disorders. These traits can be split into narrow lower-order personality constructs, such as personality aspects and facets. This PhD aimed to identify lower-order personality constructs explaining variance in affective disorders, and to identify mediators through with personality constructs predict affective disorders.

Methods

Five studies are presented. Paper One investigated whether rumination facets mediated the effects of Big Five traits on depressive symptoms. Paper Two presents a systematic review of 15 studies investigating associations between lower-order personality constructs and affective disorder scores. Using multiple regression, Paper Three investigated which personality facets uniquely explained variance in affective disorder scores. Papers One and Three used existing data from the "NewMood" dataset. Papers Four and Five investigated the mediating effects of emotion regulation; additionally, Paper Five investigated the mediating role of affective cognition. In Papers One, Four and Five, data were analysed using structural equation modelling; Papers Four and Five used online samples from the University of Manchester.

Results

Paper One found that the effects of most Big Five traits on depressive symptoms were mediated by rumination facets. Papers Two and Three found that affective disorders were best explained by the personality facets depression (referring to sadness and demotivation, not clinical depression), gregariousness, assertiveness, positive emotion, and competence. Papers Four and Five added that several of these relationships were mediated by emotion regulation and affective cognition.

Conclusions

This PhD has contributed to the literature by identifying which lower-order personality constructs contribute to affective disorder scores, and the mediators of emotion regulation and affective cognition. These findings may improve understanding of the development of affective disorders, and benefit personality-informed interventions, such as treatment-matching by personality.

Lay Abstract

Introduction

Someone's personality can affect their likelihood of getting anxiety and depression. Personality can be measured using general measures, such as extroversion, and specific measures, such as assertiveness. This PhD aimed to find out which specific measures of personality predicted symptoms of anxiety and depression, and through which mediating mechanisms.

Methods

This PhD included five studies. Paper One investigated whether general personality measures affected depression through repetitive, negative thinking. Paper Two reviewed existing studies investigating which specific personality measures predicted anxiety and depression. In Paper Three, participants were tested on all thirty specific personality measures, to investigate which of these explained anxiety and depression. Paper Four investigated whether these specific personality measures affected COVID-related anxiety and depression through coping strategies. Paper Five investigated whether personality measures affected anxiety and depression through coping strategies and thinking about emotional information. Papers One and Three used data from a community sample; Papers Four and Five used online data from participants at the University of Manchester.

Results

Paper One found that broad personality measures affected depression through repetitive, negative thinking. Papers Two and Three found that people who were more motivated, and believed in their ability to cope, tended to have lower anxiety and depression. Papers Four and Five found that personality affected anxiety and depression scores through coping and thinking about emotional information.

Conclusions

This PhD increased understanding of which specific measures of personality affect anxiety and depression, and identified two of the mediating mechanisms. These findings can help to improve screening for anxiety and depression and help therapists to plan treatments for people based on their personality scores.

Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Copyright statement

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Chapter One

Introduction

1.1 **Introduction**

Affective disorders, such as anxiety and depressive disorders, are defined as disorders of emotion (International Society for Affective Disorders, 2021). Affective disorders are the most prevalent class of mental illnesses, with anxiety disorders having a lifetime prevalence of 25-30%, while depressive disorders have a lifetime prevalence of 17% (Clark & Beck, 2010). Anxiety and depressive disorders are frequently comorbid, with 10-15% of children and adolescents with an anxiety disorder also having a diagnosis of a depressive disorder, while 15-75% of children and adolescents with a depressive disorder also have an anxiety disorder diagnosis (Hankin et al, 2016). Additionally, depression contributes to the global disease burden more than any other illness (Wittchen et al, 2011). Importantly, affective disorders also have a large individual cost, in terms of reduced quality of life and increased risk of suicide (McLean et al, 2008), along with large social and economic costs, including treatment costs and loss of workdays (McManus et al, 2016).

Personality traits are transdiagnostic risk and resilience factors in affective disorders (Hankin et al, 2016), with longitudinal studies suggesting that high neuroticism, and low extroversion and conscientious (all traits of the Big Five model of personality; Costa & McCrea, 2008), causally predict anxiety and depression (Klein et al, 2011; Spinhoven et al, 2016; Struijs et al, 2018). Investigating such personality differences may improve understanding of the development of affective disorders. Researching the influence of personality on affective disorders can also directly inform treatment: firstly, by informing treatment matching by personality, whereby individuals are given treatments which are more effective for their personality configuration (Bagby et al, 2016); and secondly, by informing personality-targeted interventions, targeting personality risk factors of affective

disorders (Newton et al, 2016), such as neuroticism, and their mediators, such as avoidance (Barlow et al, 2017). The latter class of intervention requires understanding of both which personality constructs contribute to affective disorders, and the mediating mechanisms in these relationships.

Existing research into associations between personality constructs and affective disorders is mainly limited to broad personality traits; these traits can be split into narrower lower-order personality constructs, such as personality aspects and facets (Costa & McCrea, 2008; DeYoung et al, 2007). For example, trait extroversion comprises facets such as gregariousness, assertiveness, and positive emotion (Costa & McCrea, 1985). As most research into associations between personality constructs and affective disorders has focused on broad personality traits, the contribution of individual facets is relatively unknown. For example, the personality traits of extroversion and conscientiousness protect from affective disorders (Klein et al, 2011; Kotov et al, 2010). However, it is not clear which constructs within these traits provide this protection.

Research into associations between personality and psychopathology research has largely been limited to simple correlations, meaning that the mediating mechanisms are largely unknown (Durbin & Hicks, 2014). While several mediators between personality traits and affective disorders, such as coping style and affective cognition (Elliott et al, 2011; Mirnics et al, 2013) have been suggested, these associations are either hypothetical, or supported by provisional evidence, and this research has not been integrated into a theoretical framework. This PhD aims to build on previous research: firstly, by investigating how lower-order personality constructs contribute to affective disorders; and, secondly, by investigating possible mediating mechanisms.

1.2 **Aim**

This PhD has two aims: firstly, to determine which lower-order personality constructs contribute to affective disorders; and secondly, to identify the mediating mechanisms in these relationships. The first aim will be addressed by using correlations and multiple regression analyses to determine which lower-order personality constructs, such as Big Five Aspect Scale (BFAS; DeYoung et al, 2007) aspects and Neuroticism Extroversion Openness – Personality Inventory – Revised (NEO-PI-R; Costa & McCrea, 2008) facets are associated with, and explain variance in, affective disorders. The second aim will be addressed by using structural equation modelling of cognitive tasks and questionnaire data to investigate whether these effects are mediated by emotion regulation strategies or affective cognition.

1.3 **Thesis Overview**

This PhD thesis aims to investigate which personality constructs contribute to affective disorders, and to investigate the possible mediating effects of emotion regulation strategies and affective cognitive biases. Following an in-depth review of the relevant literature (Chapter Two), this PhD proceeds in journal format, consisting of five academic papers:

Paper One (Chapter Three) investigates the mediating effects of facets of rumination, an emotion regulation strategy, on the relationships between Big Five personality traits and depressive symptoms. This paper uses secondary analysis of an existing dataset of 3,143 participants from Greater Manchester and Budapest (the "NewMood" sample). Paper One has been published in the *International Journal of Psychology* (Lyon et al, 2020a).

Papers Two and Three (Chapters Four and Five) focus on determining which lower-order personality constructs explain variance in affective disorders. Paper Two (Chapter Four) describes a systematic review of studies investigating associations between lower-order personality traits and affective disorder scores. An article based on this review has been published in the *Journal of Affective Disorders* (Lyon et al, 2021). Paper Three (Chapter Five) then describes a secondary analysis of a subset of 264 participants from the "NewMood" sample. This study reports a simultaneous multiple regression to investigate which personality facets uniquely explained variance in anxiety and depression scores. Paper Three has also been published in the *Journal of Affective Disorders* (Lyon et al, 2020b). The results of Papers Two and Three were used to select the personality facets for investigation in the final two papers.

Using online questionnaires, Papers Four and Five (Chapters Six and Seven) collected primary data from non-clinical samples, to investigate mediating mechanisms explaining the relationships between personality constructs and affective disorder scores. Paper Four (Chapter Six) investigated which emotion regulation strategies mediated the relationships between narrow personality facets (identified from Papers Two and Three), and anxiety and depression scores associated with the COVID-19 pandemic. Paper Five (Chapter Seven) used structural equation modelling to investigate whether both affective cognitive biases and emotion regulation strategies mediated the relationships between personality constructs (broad Big Five traits, and the narrow facets identified from Papers Two and Three) and anxiety and depression scores. Papers Four and Five are in preparation for submission to the *Journal of Affective Disorders.*

These papers, and their contributions to the existing literature, are explored in the general discussion (Chapter Eight). This chapter proposes the Motivation Competence Model of Personality and Affective Disorders, which is original to this thesis, being based on the findings of this PhD. This model proposes that the contribution of personality to affective disorders is primarily explained by constructs relating to motivation, such as facets depression (referring to demotivation and sadness, rather than clinical depression), assertiveness and positive emotion; and constructs relating to competence, i.e., facet competence. Additionally, this model proposes that the relationships between personality constructs and affective disorders are mediated by both interpretation of emotional information and emotion regulation, whereby personality constructs predict interpretation of emotional information, in turn predicting emotion regulation, in turn predicting affective disorders (see Figure 8.1).

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Chapter Two

Literature Review

2.1 **Personality**

Personality is defined as patterns of thought, behaviour, and interactions with the environment, which are relatively consistent across time and situations (Bleidorn et al, 2021; Costa & McCrea, 1985; Vukasović, & Bratko, 2015). Personality is generally studied through personality traits, defined as enduring patterns of thoughts, motivation, and behaviour, on which individuals differ (Bieidorn et al, 2012). Broad personality traits denote dimensions of personality. For example, if a theoretical model includes five broad personality traits, the model proposes that the personality of individuals vary in five ways, across five dimensions (Costa & McCrae, 1985; 2008; Soto & John, 2017; Vukasović & Bratko, 2015). For example, Eysenck's model of personality includes three broad personality traits (Eysenck & Eysenck, 1993), whereas the HEXACO model includes six broad personality traits (Lee & Ashton, 2004). The leading model of personality is the Big Five model (Church, 1994; DeYoung et al, 2015; Vukasović & Bratko, 2015; Xie & Cobb, 2020), which posits that individual differences vary across five broad traits (Costa & McCrea, 2008).

2.1.1 The Big Five Model

Costa and McCrea's (1985; 2008) Big Five model proposes that the majority of individual differences are explained by five personality traits: neuroticism, extroversion, conscientiousness, agreeableness and openness to new experiences (here shortened to openness; Costa & McCrea, 1985; 2008). Neuroticism primarily refers to negative emotion and threat response, with people high in neuroticism experiencing more sadness and nervousness (Church et al, 1994; Komulainen et al, 2014). Extroversion refers to positive emotion, assertiveness, and sociability

(Church et al, 1994; DeYoung et al, 2007; Komulainen et al, 2014). Trait conscientiousness is associated with organisation and dependability in working toward long-term goals (Roberts et al, 2014). Agreeableness refers to benevolence and conflict-aversion (DeYoung et al, 2007; Soto & John, 2017), and openness refers to creativity, intellect, and aesthetic appreciation (DeYoung et al, 2007; Soto & John, 2017).

Big Five personality traits are arranged hierarchically, with structures above and below the trait level (DeYoung et al, 2007; Soto & John, 2017; Table 2.1). Rather than being completely orthogonal, there are weak-to-moderate correlations between Big Five traits, with an average correlation of r = 0.26 (Digman, 1997). Because of these significant correlations, traits can be factor analysed into two higher-level meta-traits: stability (or alpha), encompassing conscientiousness, agreeableness, and reverse neuroticism; and plasticity (or beta), encompassing extroversion and openness (Allen & DeYoung, 2017; Digman, 1997).

Table 2.1
The Big Five Personality Hierarchy

General Factor of Personality (Rushton & Irwing, 2011)	General Factor of Personality				
Meta-traits (Allen & DeYoung, 2017; Digman, 1997)	Stability / Alpha			Plasticity / Beta	
Big Five traits (Costa & McCrae, 2008)	Agreeableness	Conscientiousness	Neuroticism	Extroversion	Openness
10 Big Five Aspects (De Young et al, 2007)	Compassion Politeness	Industriousness Orderliness	Withdrawal Volatility	Enthusiasm Assertiveness	Intellect Openness
BFI-2 facets (Soto & John, 2017)	Compassion Respectfulness Trust	Organisation Productiveness Responsibility	Anxiety Depression Emotional volatility	Sociability Assertiveness Energy	Aesthetic sensitivity Intellectual curiosity Creative imagination
NEO-PI-R facets (Costa & McCrae, 2008)	Trust Straightforwardness Altruism Modesty Tendermindedness Compliance	Competence Order Dutifulness Achievement-striving Self-discipline Deliberation	Anxiety Angry hostility Depression Self-consciousness Impulsiveness Vulnerability to stress	Warmth Gregariousness Assertiveness Activity Excitement seeking Positive emotion	Fantasy Aesthetics Feelings Actions Values Ideas

Note. Hierarchy of personality traits, from the General Factor of Personality (Rushton & Inwing, 2011) to NEO-PI-R facets (Costa & McCrae, 2008)

A General Factor of Personality has also been proposed, associated with high scores on both meta-traits, and referring to effectiveness social interactions (Rushton & Irwing, 2011). However, the General Factor of Personality is not universally accepted as a meaningful construct, with some researchers suggesting that it is a statistical artifact of positive correlations between Big Five traits (Revelle & Wilt, 2013). Below the trait level, personality traits can be split into two aspects per trait in the Big Five Aspect Scale (BFAS; DeYoung et al, 2007; 2016), three facets per trait in the Big Five Inventory - 2 (BFI-2; Soto & John, 2017), and six facets per trait in the Neuroticism Extroversion Openness – Personality Inventory – Revised (NEO-PI-R; Costa & McCrea, 2008), with moderate-to-strong correlations between each lower-order construct within the same trait.

2.1.2 Development of the Big Five Model

Critiques of the Big Five model refer to its development (Block, 1995), therefore it is necessary to explain the development of this model for it to be evaluated. Five factor models of personality started to become the dominant models of personality in the 1980s; however, their developed can be traced back to the work of Cattell in the 1930s (Digman, 1996). Cattell grounded his personality research in the lexical hypothesis, which posits that all descriptions of individual differences between people are already encoded in language, as people must develop adjectives to describe each other's thoughts and behaviour (Cattell, 1943). Factor analysis of adjective scores of samples of male college students revealed sixteen personality factors (Cattell, 1943). However, Cattell frequently over-extracted factors, under the supposition that over-extraction would not negatively affect the results (Davis & Panksepp, 2018, p. 157-168; Digman, 1996); re-analysis revealed a five-factor solution, corresponding to the current Big Five (Tupes & Christal, 1992). This five-

factor solution was later replicated using three different sets of adjectives (Goldberg, 1990). Several five-factor models have been proposed, however they inhabit the same personality space, with relatively small variations (Digman, 1996). Of these, the dominant model of personality is the Big Five model proposed by Costa & McCrea (1985, 2008).

2.1.3 Evaluation of the Big Five Model

The Big Five model has been criticized on the basis that the factor analysis through which it was derived may have been biased or subjective (Block, 1995). For example, Cattell selected adjectives based on his personal judgement, meaning his results, and those of Tupes and Christal (1961) are limited to Cattell's personal decisions. Furthermore, study 1 in Goldberg (1990) was limited to adjectives which had been selected to relate to Tupes and Christal's (1961) five factor solution (Block, 1995). On this basis, critics of the Big Five suggest that researchers may have biased the sample of adjectives to produce a five-factor solution (Block, 1995). Nevertheless, studies 2 and 3 in Goldberg (1990) found a five-factor solution when using terms chosen by independent lexicographers, who were not biased in favour of the Big Five. Furthermore, the Big Five model of personality has replicated in over fifty-six nations and numerous languages (Schmitt et al 2007), meaning it is unlikely to be explained by biases in the analysis procedure.

The Big Five model has also been criticized due to its basis on the lexical hypothesis (Block, 1995). Even Costa & McCrea (1985) showed scepticism toward the lexical hypothesis, reasoning that lay terms for body parts cannot provide a basis for the science of anatomy, therefore lay terms for personality cannot provide a basis for the science of personality. This is arguably an unfair comparison, as individuals

must describe others' personality, but not their internal anatomy, for day-to-day interactions. Nevertheless, evidence for Big Five traits is not limited to factor analysis based on the lexical hypothesis. For example, Big Five neuroticism and extroversion conceptually overlap with Eysenck's traits of the same name, which he based on individual differences in the excitation and inhibition of the autonomic nervous system (Church, 1994; Dreycott & Kline, 1995); furthermore, Eysenck's trait of psychoticism is conceptually similar to a blend of conscientiousness and agreeableness (both reversed; Church, 1994; Dreycott & Kline, 1995). fMRI studies have revealed that neuroticism is associated with volume in the amygdala and hypothalamic-pituitary-adrenal (HPA) axis (Shiner & DeYoung, 2013); extroversion with the mesolimbic dopamine system and medial orbitofrontal cortex (DeYoung et al, 2010; Shiner & DeYoung, 2013); conscientiousness with the dorsolateral prefrontal cortex (Allen & DeYoung, 2017); agreeableness with the oxytocin system in the medial prefrontal cortex (Shiner & DeYoung et al, 2013); and openness with the "salience coding" neurons in the substantia nigra, which are associated with dopamine release during perception of novel stimuli (DeYoung, 2013). Taken together, Big Five personality traits have been derived without relying on the lexical hypothesis, with these traits being grounded in underlying neurobiology, rather than merely being linguistic artifacts.

As with most models of personality, the Big Five is descriptive rather than explanatory, being unable to make causal claims regarding the origin or development of personality traits (Davis & Panksepp, 2018, p. 169-184; DeYoung, 2015). For example, it is not logical to claim that someone is talkative because they are extroverted, as "talkative" is part of the definition of extroversion (Davis & Panksepp, 2018, p. 171). However, this is an unfair criticism as the Big Five does

not aim to provide an explanatory model of personality (for such a model, please refer to the discussion of Cybernetic Big Five Theory, in section 2.4.1.4). As a descriptive model of personality, the Big Five is highly robust, replicating across cultures and languages (Schmitt et al, 2007). Even critics of the Big Five agree that its adoption has helped to solve the "Tower of Babel" problem, in which different groups of researchers studied separate personality constructs, without a unifying framework (Block, 1995). Furthermore, the utility of the Big Five is evidenced by its predictive validity, explaining variance in a wide array of outcomes such as income (Jonason et al, 2018), values and political ideology (Carney et al, 2008), and mental and physical health (Bogg & Roberts, 2004; Kotov et al, 2010; Sutin et al, 2010).

2.2 **Mental illness**

Mental illness, or psychopathology, denotes disorders of thought and behaviour, which cause distress and impair functioning (Wakefield, 2007). Mental illnesses are a pervasive issue, as a meta-analysis of population studies across 27 European countries found that 38.2% of the population had a mental illness each year, while less than a third of this number received treatment (Wittchen et al, 2011). Mental illnesses are associated with an increased risk of suicide, with around 90% of suicides being related to mental illnesses, specifically depression, substance dependence, and schizophrenia (McLean et al, 2008). Mental illnesses also have high social and economic costs, accounting for over 70 million days of sick leave in England in 2007 and costing the UK around £70 billion (4.5% of national GPD) per

year (McManus et al, 2016). It is therefore important to understand risk and resilience factors in mental illnesses, including personality variables.

2.2.1 Taxonomy of mental illnesses

Mental illnesses are described in both the DSM-5 and the ICD-11 as categorically discrete disorders, although there is high comorbidity between mental illnesses (Kotov et al, 2017). For example, at least 15% of adolescents with anxiety disorders also suffer from a depressive disorder, and vice versa (Hankin et al, 2016). Using factor analysis, Andrews et al (2009) concluded that mental illnesses were ordered in three clusters: internalising (affective), externalising (behavioural), and psychotic (thought) disorders. Internalising disorders include affective disorders such as anxiety, depression, and phobias; externalising disorders include disorders of behaviour such as substance use disorder (SUD), conduct disorder, oppositional defiant disorder (ODD), and attention deficit hyperactive disorder (ADHD); and thought disorders include primary psychotic disorders such as schizophrenia and bipolar disorder. Research into affective disorders is particularly important, as anxiety and depressive disorders and are the most prevalent classes of mental illness (Wittchen et al, 2011), and depression contributes more to the global disease burden than any other mental illness (Wittchen et al, 2011).

2.2.2 Affective Disorders

The International Society for Affective Disorders defines affective disorders as disorders of emotion, including both anxiety and depressive disorders (International Society for Affective Disorders, 2021). While affective disorders are sometimes referred to as mood disorders, denoting only depressive disorders

(VandenBos & American Psychological Association, 2007), affective disorders here include both anxiety and depressive disorders.

Anxiety disorders are a group of mental illnesses characterised by chronic and excessive fear, anticipation, and worry, and include disorders such as generalised anxiety disorder (GAD), panic disorder, social anxiety (sometimes called social phobia), specific phobias (VandenBos & American Psychological Association, 2007), obsessive compulsive disorder (OCD), and post-traumatic stress disorder (PTSD; Wittchen et al, 2011). Anxiety disorders are the most common class of mental illnesses, with a 12-month prevalence rate of 14% (Wittchen et al, 2011), and a lifetime prevalence rate of 25-30% (Clark & Beck, 2010). Within anxiety disorders, specific phobia is the most common, with a 12-month prevalence rate of 6.4% (Wittchen et al, 2011).

Depressive disorders are a class of mental illnesses characterised by pervasive sadness (VandenBos & American Psychological Association, 2007), and are the second most prevalent class of mental illness, with a 12-month prevalence rate of 7.8% (Wittchen et al, 2011), and a lifetime prevalence rate of 17% (Clark & Beck, 2010). Major depressive disorder (MDD) is the most common depressive disorder, with a 12-month prevalence rate of 6.8% (Wittchen et al, 2011), with symptoms including loss of pleasure and energy, feelings of guilt and worthlessness, and suicide ideation (American Psychiatric Association, 2013). As affective disorders are best explained by multidimensional models (Clark & Beck, 2010), the following sections will expand upon biological and cognitive factors in affective disorders. As a comprehensive discussion of these factors is beyond the scope of this review, the following sections are limited to highlighting several relevant findings.

2.2.2.1 *Biological factors in Affective Disorders*

Affective disorders have a genetic component, with GAD, panic disorder and MDD having moderate heritability estimates of 0.32, 0.43 and 0.37, respectively (Hettema et al, 2001; Sullivan et al, 2000). Affective disorders are also associated with abnormalities in endocrine and neurotransmitter functioning, compared to healthy participants. For example, both anxiety and depressive disorders are associated with increased activation of the HPA axis, along with decreased serotonergic functioning, which mediates HPA activity (Elliott et al, 2011; Wu et al, 2013). The role of serotonin is further evidenced by the effectiveness of selective serotonin reuptake inhibitors (SSRI's) in reducing affective disorder symptoms (Ballenger, 2000).

Affective disorders are associated with altered brain structure and functioning. For example, both anxiety and depressive disorders are associated with altered activity in both limbic brain regions, involved in the emotional processes, and frontal brain regions, involved in the inhibition of emotional processes (Kaltenboeck & Harmer, 2018; Shin & Liberzon, 2010). To give an example, GAD, PTSD, social anxiety, and specific phobia are associated with both higher resting state activity, and activity in response to threatening stimuli, in limbic structures such as the amygdala and insula (Shin & Liberzon, 2010). PTSD, social anxiety, and panic disorder are associated with reduced activity in ventromedial prefrontal cortex (vmPFC; Shin & Liberzon, 2010). Depression is associated with increased activity in various limbic and frontal brain regions, such as the amygdala, anterior cingulate cortex (ACC), and orbitofrontal cortex (OFC) in response to negative words (Elliott et al, 2011), and decreased volume in various brain regions, such as the hippocampus, OFC, subgenual ACC and basal ganglia (Kaltenboeck & Harmer, 2018). Anxiety and

depression also show differential changes in brain functioning. For example, MDD, but not anxiety disorders, is associated with reduced longevity of activation in the ventral striatum, within the dopaminergic reward circuit, thus contributing to avolition (Johnstone & Walter, 2014; Treadway & Zald, 2011). The importance of the dopaminergic reward in depression is evidenced by the effectiveness of Behavioural Activation, a psychological therapy focusing on goal setting and engagement with rewarding stimuli (Martínez-Vispo et al, 2018), in increasing striatal activity (Dichter et al, 2009).

2.2.2.2 *Cognitive factors in Affective Disorders*

Affective disorders are associated with alterations in non-emotional ("cold") cognition. For example, both anxiety and depressive disorders are characterised by executive dysfunction, such as deficits in attention and memory, with both MDD and PTSD being associated with overgeneral memory bias, referring to difficulty in recalling specific autobiographical memories (Elliott et al, 2011; Ferreri et al, 2011). Affective disorders are also characterised by abnormalities in affective ("hot") cognition. For example, anxiety disorders are associated with attentional biases toward threatening stimuli, whereby individuals with anxiety disorders detect threatening stimuli more quickly that neutral stimuli, and experience difficulty in disengaging attention from threatening stimuli (Cisler & Koster 2010). Additionally, anxiety disorders are associated with memory biases toward threatening stimuli, such as greater autobiographic memory of social threats in social anxiety, and interpretation biases toward threat, whereby ambiguous stimuli are interpreted as threatening (Ferreri et al, 2011). While depressed individuals also evidence attentional biases toward socially threatening words, depression appears to be more broadly associated with attentional, memory and interpretation biases toward

negatively-valanced information, along with reduced attentional, memory and interpretational biases toward positively-valanced information (Elliott et al, 2011; Platt et al, 2017). For example, depression is associated with memory biases toward negative self-referent words (Miskowiac et al, 2018), and negative interpretations of ambiguous stimuli (Hirsch et al, 2016). Research into affective cognitive biases has inspired a new line of treatment, Cognitive Bias Modification, which trains individuals on cognitive tasks to either attend to neutral rather than emotional stimuli, or to interpret ambiguous stimuli as neutral (Cristea et al, 2015; Mogg et al, 2017).

Affective disorders are associated with unhealthy thoughts, at the levels of automatic thoughts, intermediate thoughts (implicit ideas leading to distress) and global core beliefs (Beck & Beck, 1995, p. 18). As with affective cognitive biases, the content of these beliefs differs between affective disorders, with anxiety disorders being associated with core beliefs regarding potentially threatening stimuli, whereas depressive disorders are associated with beliefs regarding loss, failure, and inadequacy (Beck & Haigh, 2014). For example, an individual with GAD may enter, and respond to, situations based on the unhealthy belief "Something bad will happen," whereas an individual with MDD may do so under the unhealthy belief that "Everything I do is wrong." These biases in thinking and beliefs lead to biases in an individual's schemas, referring to their underlying cognitive model of the world, thus contributing to mental illness such as affective disorders (Beck & Haigh, 2014; Roiser et al, 2012). The importance of unhealthy core beliefs is supported by the efficacy of cognitive therapies, focusing on reality-checking, and adjusting unhealthy core beliefs, in treating affective disorders (Beck & Beck, 1995, p. 1-12; Clark & Beck, 2010).

Metacognitive biases, defined as beliefs about cognition, are another factor in both anxiety and depressive disorders (Hankin et al, 2016). Affective disorders are associated with both positive metacognitive beliefs, defined as beliefs that unhealthy cognitive strategies such as focusing on threatening stimuli and worry, are adaptive; and negative metacognitive beliefs, defined as beliefs that thoughts are dangerous and uncontrollable (Wells, 2011, p. 223-246). Investigation of metacognitive biases has led to the development of metacognitive therapy, which effectively reduces both anxiety and depressive symptoms (Wells & King, 2006; Wells et al, 2009).

To summarize the above examples, affective disorders are associated with structural and functional abnormalities in various brain regions, such as regions involved in emotional processing (Kaltenboeck & Harmer, 2018; Shin & Liberzon, 2010). Affective disorders are also associated with deficits in executive functioning, biases in affective cognition, and unhealthy beliefs (Beck & Haigh, 2014; Elliott et al, 2011; Ferreri et al, 2011; Hankin et al, 2016), although the content of these biases and beliefs may differ between disorders. Briefly summarising this literature, anxiety disorders tend to be associated with increased processing of threat, whereas depressive disorders tend to be associated with increased processing of negative information, such as loss, and reduced processing of reward (Elliott et al, 2011; Johnstone & Walter, 2014).

2.3 **Associations between Big Five Constructs and Affective Disorders**

2.3.1 Associations between Big Five Traits and Affective Disorders

Correlational studies consistently suggest that Big Five traits, especially neuroticism, extroversion, and conscientiousness, relate to a variety of affective

disorders. For example, a meta-analysis of 175 correlational studies, investigating associations between personality traits and affective disorders, concluded that affective disorders are generally positively correlated with trait neuroticism, and negatively correlated with traits extroversion and conscientiousness (Kotov et al, 2010; Table 2.2). Conscientiousness was correlated with most affective disorders, but not social phobia. Agreeableness and openness did not significantly correlate with any affective disorder. Furthermore, traits neuroticism, extroversion and conscientiousness uniquely explain variance in both MDD and PTSD (Naragon-Gainey & Simms, 2017). These findings suggest that effects of the Big Five on affective disorders are limited to the traits of neuroticism, extroversion, and conscientiousness.

As Big Five traits are broad measures of personality, derived from factor analysis of adjectives (Digman et al, 1996; Goldberg et al, 1990), these traits are statistical common factors across narrower personality constructs. This is reflected in questionnaire measures of personality, where traits are calculated as either the sum, or the average, of lower-order personality constructs (Costa & McCrea, 2008; DeYoung et al, 2007). Big Five traits therefore provide less precision compared to lower-order constructs in predicting outcomes and may obscure associations at lower levels of the personality hierarchy. Firstly, different facets in the same trait may predict an outcome through different mechanisms. For example, extroversion includes constructs related to positive emotion, assertiveness, and sociability (DeYoung, 2015; Soto & John, 2017), which may contribute to affective disorders via different mediating mechanisms. Secondly, different facets within the same trait may have opposite effects on mental illnesses.

Table 2.2
Correlations between Big Five traits and Affective Disorders

Affective disorders		Neuroticism	Extroversion	Conscientiousness	Agreeableness	Openness
Depressive disorders	MDD	0.47*	-0.25*	-0.36*	-0.06	-0.08
	Unipolar depression	0.42*	-0.28*	-0.35*	0.06	-0.04
	Dysthymic disorder	0.36*	-0.29*	-0.33*	0.07	-0.14
Anxiety disorders	GAD	0.32*	-0.18	-0.29*	0.05	-0.09
	PTSD	0.49*	-0.25	-0.27*	-0.19	-0.07
	Panic disorder	0.45*	-0.28*	-0.27*	0.02	-0.11
	Agoraphobia	0.34*	-0.23*	-0.25*	0.14	-0.16
	Social phobia	0.41*	-0.37*	-0.34*	0.11	-0.15
	Specific phobia	0.28*	-0.07	-0.16	0.00	-0.03
	OCD	0.35*	-0.27*	-0.21*	-0.01	-0.03

Note. * significant at $p<0.05$. Univariate Pearson correlations between Big Five traits and various affective disorders, adapted from Kotov et al (2010, p. 800, Table 5)

For example, conscientiousness is associated with both self-efficacy, which protects from various mental illnesses (Bandura, 1997, p. 319-362) and perfectionism (Stoeber et al, 2009), which is a risk factor for depression (Eccles et al, 2014). Thirdly, the significant effect of one facet may be masked by the non-significant effects of other facets within the trait. For example, facet trust in agreeableness significantly negatively correlates with various affective disorders (Cox et al, 1999; Friesen, 2008; Jourdy & Petot, 2017; Quilty et al, 2013) however the effect of trait agreeableness on affective disorders is non-significant (Kotov et al, 2010). Limiting research to the trait level would therefore overlook this protective factor. In reflection of these limitations, personality research should also investigate associations between lower-order personality constructs and affective disorders.

2.3.2 Associations between Lower-Order Big Five Constructs and Affective Disorders

The existing research investigating associations between lower-order personality constructs and affective disorders suffers from several methodological limitations. Such studies often use heterogenous measures, for both affective disorders (Naragon-Gainey & Simms, 2017; Rees et al, 2005; Wolfenstein & Trull, 1997) and personality facets (Allen et al, 2018; Friesen et al, 2008; Naragon-Gainey et al, 2009), meaning it is difficult to determine whether results for a given measure

are generalisable, and that it is not possible for perform a meta-analysis to determine the average effect size for a given association. Several studies have also used novel statistically derived personality facets using factor analysis of both Big Five and non-Big Five measures. (Naragon-Gainey et al, 2009; Naragon-Gainey, 2011; Watson et al, 2015), meaning the results are difficulty to integrate with results based on the different levels of the Big Five personality hierarchy. Such studies also tend to derive these novel personality facets from individual samples, therefore it is unclear whether these factors replicate or are limited to the individual sample.

Studies at the facet level also over-rely on simple correlations between personality facets and affective disorders (Jourdy & Petot, 2017; Khoo & Simms, 2018; Osma et al, 2016). However, as all facets within a trait significantly correlate with each-other, the effects of one facet may be explained that that of other facets. For example, Cox et al (1999) found that all six facets of neuroticism significantly correlated with OCD, however only facets anxiety and vulnerability explained variance in OCD (controlling for anxiety sensitivity). This means that it is not clear which lower-order personality constructs uniquely explain variance in affective disorders.

2.3.3 Models of associations between Big Five Constructs and Affective Disorders

Most studies investigating the relationship between personality constructs and affective disorders use cross-sectional studies and are therefore unable to determine temporality or causation (Ormel et al, 2013; Watson et al, 2015). More recently, longitudinal studies, such as those using the NESDA (Netherlands Study of Depression and Anxiety) and IMAGEN cohorts (Castellanos-Ryan et al, 2016; Spinhoven et al, 2013; 2016), have used cross-lagged effects to study causation

between personality traits and affective disorder scores. While several theoretical models have been put forward to explain the associations between personality constructs and affective disorders, these models are not mutually exclusive, and no individual model is sufficient to explain this relationship (Ormel et al, 2013). The following three sub-sections will introduce and evaluate the evidence base for three such models explaining associations between personality constructs and mental illnesses.

2.3.3.1 *The Spectrum model*

The spectrum model, also called the continuum model, of personality and mental illness posits that dimensions of personality and dimensions of mental illness refer to the same underlying continuums, whereby differences in personality are sub-clinical manifestations of mental illnesses (Durbin & Hicks, 2014; Watson et al, 2006; Klein et al, 2011). Stated alternatively, the spectrum model posits that mental illnesses are extremes in the normal distribution of personality (Ormel et al, 2013). Echoing this model, Costa & McCrea (1992, p. 9, para. 4) suggested that "most dimensions of psychopathology have parallels in dimensions of individual differences in the normal range." This model proposes that associations between personality and mental illness psychopathology will be "fairly specific" (Klein et al, 2011, pp. 272, Table 2.1), such as a one-to-one mapping between dimensions of personality and dimensions of mental illness.

Supporting the spectrum model, personality disorder severity differs across five dimensions, described in the Personality Inventory for the DSM-5 (PID-5; Krueger et al, 2012), most of which conceptually map onto and correlate with Big Five traits (Griffin et al, 2014; Table 2.3). Furthermore, using factor analysis based

on comorbidity between mental illnesses, Kotov et al (2017) introduced the Hierarchical Taxonomy of Psychopathology (HiTOP), suggesting that mental illness scores differ across five dimensions, called psychopathology spectra (Hopwood et al, 2018; Kotov et al, 2017), some of which also conceptually relate to Big Five traits (Table 2.3). Based on the spectrum model, the HiTOP model proposes a one-to-one mapping between personality dimensions and psychopathology spectra, such as neuroticism mapping the internalising spectrum, and conscientiousness mapping onto the disinhibited externalising spectrum (Table 2.3).

While there is some important overlap between personality dimensions and psychopathology spectra, the spectrum model makes several unsupported predictions. Firstly, not all psychopathology spectra map onto personality dimensions. For example, the spectrum model suggests that openness maps onto the psychoticism/thought disorder spectra. However, Griffin et al (2014) found that openness mapped onto the PID-5 less robustly than other traits. Furthermore, a meta-analysis of 48 correlational studies of personality and trait psychoticism found no significant correlation between trait psychoticism and openness ($r = 0$; Knežević et al, 2016). Secondly, associations between personality traits and psychopathology spectra do not adhere to the one-to-one mapping proposed by the HiTOP model.

Table 2.3.

Personality traits and spectra of psychopathology

Big Five	PID-5	HiTOP
Neuroticism	Negative affect	Internalizing
Extroversion	Detachment	Detachment
Conscientiousness	Disinhibition	Externalizing (disinhibited)
Agreeableness	Antagonism	Externalizing (antagonistic)
Openness	Psychoticism[1]	Thought disorder[1]

Note. Dimensions of psychopathology across various dimensional models, and their conceptual mapping onto Big Five personality traits.

1 - The literature on the relationship between openness and the PID-5 psychoticism dimension, and the HiTOP thought dimension, has yielded mixed results.

For example, rather than strongly associating with all internalizing disorders, neuroticism most strongly associates with disorders characterised by pervasive distress, such as GAD and MDD, and has weaker associations between disorders where distress is limited to specific situations, such as social anxiety and specific phobias (Watson et al, 2006).

Additionally, neuroticism significantly positively correlates with various psychotic and externalising disorders with high distress, such as schizophrenia and substance use disorders. Therefore, neuroticism appears to refer to subjective distress, rather than merely internalising (Watson et al, 2006). Additionally, traits such as extroversion and conscientiousness significantly explain variance in affective disorders such as MDD (Naragon-Gainey & Simms, 2017), again challenging the one-to-one mapping of personality dimensions and psychopathology spectra.

Rather than being theoretically meaningful, the overlap between personality traits and psychopathology spectra may instead be an artifact of how the HiTOP was developed. The HiTOP was derived using factor analysis of diagnoses of mental illnesses, with diagnoses being based on verbal descriptions of symptoms, through self-reports and semi-structured interviews (Kotov et al, 2017). This is very similar to the factor analyses through which the Big Five was derived (Davis & Panksepp, 2018, pp. 169-184). Therefore, the HiTOP may refer to a five-factor model of personality, which happens to have been derived using clinical terms, rather than a model of mental illness. Personality and psychopathology are often measured using self-reports, which may have overlapping items. For examples, measures of both neuroticism and depression include items regarding feelings of guilt and worthlessness (Jang et al, 2006). Therefore, the overlap between dimensions of personality and psychopathology may be exaggerated by overlapping item content in

measuring both constructs (Ormel et al, 2013). While personality constructs conceptually overlap with some psychopathology spectra, these associations appear to be more complicated than a simple one-to-one mapping and may be explained using additional models (Ormel et al, 2013).

2.3.3.2 *The Vulnerability model*

The vulnerability model, or predispositional model, postulates that personality traits causally impact mental illnesses such as affective disorders (Hengartner et al, 2016; Klein et al, 2011; Ormel et al, 2013; Watson et al, 2006). Of the Big Five traits, neuroticism is the most consistent causal predictor of affective disorders (Watson et al, 2006). For example, analysis of the Zurich Cohort Study (N = 591) found that trait neuroticism in 1988 significantly predicted anxiety disorder and MDD severity between 1993and 2008, controlling for mental health at baseline (odds ratios of 1.32 and 1.41, respectively; Hengartner et al, 2016).

Recent studies suggest that multiple Big Five traits causally impact mental illnesses. Using the NESDA cohort, Spinhoven et al (2016) found that a statistically derived maladaptive personality type, characterised by high neuroticism, and low extroversion, conscientiousness, and agreeableness, longitudinally predicted psychological distress, and increase in psychological distress over time. Further analysis of this dataset revealed that traits neuroticism and extroversion causally predicted anxiety and depression (Struijs et al, 2018). Vulnerability effects have also been observed in early childhood, as high trait negative emotion and low trait effortful control (conceptually similar to conscientiousness) at ages 6-7 significant predicted internalising and externalising 4 years later (Eisenberg et al, 2008). Along with the direct effects of personality traits on mental illness, the vulnerability model

also suggests that personality may influence how individuals construct or modify their environment, impacting their risk of developing affective disorders (Jang et al, 2006; Ormel et al, 2013).

2.3.3.3 *The Scar model*

Mental illness may also causally affect personality, known as the scar or consequences model (Klein et al, 2011; Ormel et al, 2013). Supporting this model, longitudinal studies suggest that both psychological distress (Ormel et al, 2013) and affective disorders (Karsten et al, 2012) increase trait neuroticism. An eight-year longitudinal study (N = 2,470; Karsten et al, 2012) suggested that the longer a participant had an anxiety disorder, the greater their level of neuroticism increased over time, and the greater their level of extroversion and conscientiousness decreased. However, it is also possible that these changes may be limited to the duration of affective disorders, called the state or concomitants model (Klein et al, 2011; Ormel et al, 2013). For example, a meta-analysis of 207 studies found that treatments for mental illnesses lead to a reduction in neuroticism and increases all other Big Five traits, meaning that interventions targeting personality risk and resilience factors may be useful in treating mental illnesses (Roberts et al, 2017). Therefore, affective disorder scores also temporally affect personality traits.

2.3.3.4 *Causal Reciprocity between Scar and Vulnerability effects*

As personality traits predict affective disorders, and vice versa, it is possible that the two constructs have a reciprocal relationship: while anxiety and depression increase neuroticism, high neuroticism also increases the risk of developing such disorders (Karsten et al, 2012). This unhealthy cycle may be mediated by emotion regulation strategies. For example, both affective disorders and high trait

neuroticism are associated with avoidance of stressors (Connor-Smith & Flachsbart, 2007; Visted et al, 2018), which unintentionally increases exposure to stressful life events (Bolger & Zuckerman, 1995). This creates a positive feedback loop where vulnerable personality traits, stress exposure and affective disorder severity exacerbate each other. As personality traits and affective disorders causally affect each-other (Karsten et al, 2012), it is important to understand the mediating mechanisms in this relation, to better understand and prevent such unhealthy cycles.

2.4 **Mediating Mechanisms**

As stated in section 2.3.3, most of the literature regarding personality-affective disorders associations focuses on simple correlations (Durbin & Hicks, 2014; Ormel et al, 2013; Watson et al, 2006). Mediators such as coping styles (Mirnics et al, 2013) and affective cognition (Elliott et al 2011) have been proposed at the trait level. However, this research has not yet been combined into a cohesive theoretical framework. Both emotion regulation strategies and affective cognitive biases significantly correlate with both personality constructs and affective disorder scores (Connor-Smith & Flachsbart, 2007; Elliott et al, 2011; Beck & Haigh, 2014; Smith et al, 2018; Visted et al, 2018). Therefore, it is statistically possible that both emotion regulation strategies and affective cognitive bias may mediate the relationship between personality constructs and affective disorders (Fairchild & McDaniel, 2017); however, we are not aware of any study which has directed tested this pathway. The following two sub-sections will focus on these potential mediators, and their associations with both personality and affective disorders.

2.4.1 Emotion regulation strategies

Emotions, along with other motivations, are adaptive neurobiological systems which have evolved to track progress toward, and attain, goals (Ellis & Toronchuk, 2013; Lazarus & Lazarus, 1994, p. 141; Montag & Davis, 2018). For example, fear has evolved to motivate individuals toward behaviour which promotes safety (Ellis & Toronchuk, 2013). Positive emotion is generated when an individual perceives that they are moving toward a goal faster than expected, and briefly upon the attainment of a goal (Carver, 2006; Carver & Scheier, 2001, p. 121); negative emotion is generated when an individual perceives that they are moving toward a goal slower than expected, that they are not moving toward a goal, or when an individual perceives an obstacle or threat which increases their relative distance to the goal (Carver, 2006; Carver & Scheier, 2001, p. 121).

Emotion regulation is defined as all attempts to alter the intensity or duration of any emotion, positive or negative (McRae & Gross, 2020). Emotion regulation can be measured using narrow strategies, including reappraisal (alternatively referred to as positive reinterpretation or cognitive restructuring), acceptance, problem-solving (alternatively referred to as active coping), social support, suppression, avoidance, and rumination (see Table 2.4 for definitions of these strategies; Connor-Smith & Flachsbart, 2007; Gross & Levenson, 1993; Nolen-Hoeksema & Harrell, 2002). The terms coping strategies and emotion regulation strategies are often used interchangeably (Visted et al, 2018; Naragon-Gainey et al, 2017). While this review focuses on the use of emotion regulation strategies, emotion regulation is also understood through emotional competence, referring to skills involved in emotion regulation (John & Eng, 2014).

Table 2.4
Definitions of select emotion regulation strategies

Emotion regulation strategy		Definition
Adaptive	Reappraisal[1]	Finding a more positive or realistic way to think about a bad situation, looking on the bright side, identifying benefits arising from a situation (e.g., personal growth), or finding a humorous side to the stressor
	Acceptance[1]	Coming to terms with aspects of the stressor that can't be changed, learning to live with the stressor or one's limitations, developing a sense of understanding
	Problem solving[1]	Active attempts to resolve a stressor through planning, generation of possible solutions, logical analysis and evaluation of options, implementing solutions, and staying organised and on task
	Instrumental social support[1]	Problem-focused social support, including seeking help, resources, or advice about possible solutions to problems
	Emotional social support[1]	Emotion-focused social support, including seeking comfort, empathy, and closeness with others
Maladaptive	Emotional suppression[2]	The conscious inhibition of emotional expressive behaviour while emotionally aroused
	Avoidance[1]	Attempts to avoid the problem, reminders of the problem, thoughts of the problem, or emotions related to the problem
	Rumination[3]	Engaging in behaviours and thoughts that passively focus your attention on your symptoms of distress and on all the possible causes and consequences of these symptoms

Note. 1 Definitions from Connor-Smith & Flachsbart (2007, p. 1082, Table 2.1)
2 Definition from Gross & Levenson (1997, p. 970, para. 1)
3 Definition from Nolen-Hoeksema & Harrell (2002; p. 391, para. 2)

These competences include attention toward and awareness of emotions; emotion identification; emotional self-efficacy, denoting an individual's belief in their ability to regulate their emotions (John & Eng, 2014) and emotion intelligence, defined as the use of abstract thinking and problem-solved within the context of emotions (Mayer et al, 2016).

2.4.1.1 *Emotion regulation and mental illnesses*

Difficulties in emotion regulation are a transdiagnostic factor across various mental illnesses, including affective disorders, eating disorders, and psychotic disorders (Aldao et al, 2016). Patterns of associations between emotion regulation strategies and disorder severity are consistent across affective disorders, in which severity positively correlates with suppression, avoidance, and rumination; and negatively correlates with reappraisal, acceptance, social support and problem-solving (Cisler et al, 2010; Garnefski et al, 2002; Sawhney et al, 2018; Schäfer et al, 2017; Visted et al, 2018). Due to these general associations, emotion regulation strategies are often grouped into adaptive strategies (which negatively correlate with affective disorders) and maladaptive strategies (which positively correlate with affective disorders; Schäfer et al, 2017; Visted et al, 2018). Naragon-Gainey et al (2017) performed an exploratory factor analysis of emotion regulation strategies, revealing one factor of adaptive strategies, and two factors of maladaptive factors, referring to maladaptive cognitive and behavioural strategies, respectively. These finding suggest that the distinction between adaptive strategies and maladaptive strategies is statistically meaningful.

Although strategies may be referred to as adaptive or maladaptive, this does not mean that a given strategy is healthy or unhealthy in all circumstances (Cisler et

al, 2010; Kobylińska & Kusev, 2019). Rather than merely investigating the adaptiveness or maladaptiveness of strategies, research into emotion regulation also considers strategy effectiveness, referred to whether a strategy effectively regulates the target emotion in a certain context (Sheppes, 2014). Furthermore, the effectiveness of a given emotion regulation strategy depends on the emotion being regulated, the situation, and the level of emotional intensity (Doré et al, 2016; Troy et al, 2018).

2.4.1.2 *Emotion regulation strategies and personality*

Emotion regulation strategies significantly associate with personality constructs. In a systematic review of over 30,000 participants across 165 studies investigating associations between emotion personality traits and emotion regulation strategies, Connor-Smith & Flachsbart (2007) found that trait neuroticism positively correlated with maladaptive strategies and negatively correlated with adaptive strategies; the opposite pattern was observed for traits extroversion and conscientiousness. Agreeableness and openness also positively correlated with problem solving, social coping, and religious coping (Table 2.5). While this area of research is limited to broad personality traits, researchers appreciate the importance of investigated narrower personality constructs: A review by Carver and Connor-Smith (2010) recommending further research into narrow personality facets, speculating that facets within the same trait may have different relationships with emotion regulation strategies. For example, the positive associations between extroversion and social coping may not be explained at the broad trait level but instead by the facets of warmth and gregariousness (Carver & Connor-Smith, 2010).

Table 2.5
Correlations between Big Five traits and emotion regulation strategies

Emotion regulation strategy	Neuroticism	Extroversion	Conscientiousness	Agreeableness	Openness
Problem solving	-0.13*	0.20*	0.30*	0.09*	0.14*
Instrumental social support	0.03	0.22*	0.08*	0.08*	0.06*
Emotional social support	0.11*	0.25*	0.06	0.12*	0.08*
Mixed social support	-0.01	0.24*	0.09	0.11*	0.06*
Emotion regulation	0.00	0.03	0.08*	0.01	0.06*
Distraction	0.17*	0.09*	-0.07	-0.05	0.05
Cognitive restructuring	-0.16*	0.22*	0.20*	0.14*	0.15*
Acceptance	-0.10*	0.02	0.07	0.08*	0.07
Avoidance (narrow)	0.13	-0.04			-0.05
Denial	0.18*	-0.02	-0.17*	-0.12*	-0.07
Wishful thinking	0.35*	-0.03			0.11
Withdrawal	0.29*	-0.05	0.01	0.08	0.10*
Mixed emotion focus	0.22*	0.08	-0.13*	-0.09*	0.10
Negative emotion focus	0.41*	-0.05	-0.14*	-0.09*	0.03
Religious coping	0.01	0.02	0.09*	0.12*	-0.12*
Substance use	0.28*	-0.04	-0.18*	-0.18*	0.04

Note. * significant at $p<0.05$. Blank if association is not reported.
Univariate Pearson correlations between Big Five traits and various emotion regulation strategies, adapted from the meta-analysis by Connor-Smith & Flachsbart (2007, p. 1096-1076, Table 7).

As emotion regulation strategies significantly correlate with both personality constructs (Connor-Smith & Flachsbart, 2007) and affective disorders (Schäfer et al, 2017; Visted et al, 2018), it is statistically possible that emotion regulation mediates the relationship between personality constructs and affective disorders (Fairchild & McDaniel, 2017). To explain the role of personality in emotion generation and regulation, the following two section briefly summarise the processes through which emotions are generated and regulated.

2.4.1.3 *The Extended Process Model of Emotion Regulation*

The leading model of emotion regulation is Gross's (2015) Extended Process model of Emotion Regulation (summarised in Figure 2.1). This model integrates the Transactional Model of Coping (Folkman, 1984), wherein emotion generation depends upon attention and appraisal; and models based on cybernetics, defined as the study of goal-directed systems, which posit that motivation is the result of goal-direct feedback loops (Carver & Scheier, 2001).

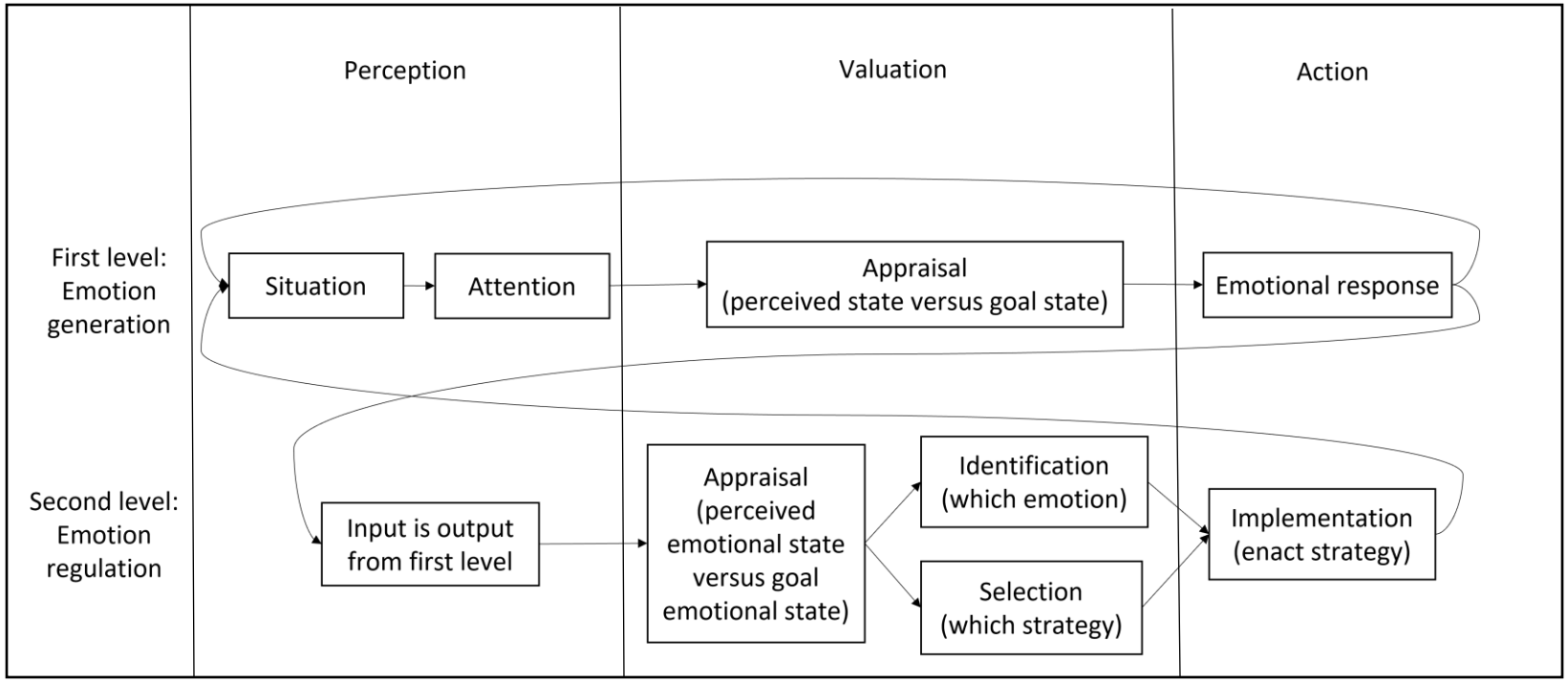

Figure 2.1. Summary of the Extended Process Model of Emotion Regulation

Adapted from theoretical descriptions across Gross (2014; 2015) and Ochsner & Gross (2014). This figure is original to this thesis.

In the Extended Process model, emotions are generated by an automatic "first level" system, through a cycle of perception, valuation, and action, associated with activity in the amygdala, insula, and ventral striatum (Ochsner & Gross, 2014). Firstly, an individual's sensory input is processed through attention and is interpreted with the individual's expectations and schemas (Gross, 2014). The individual thereby generates a cognitive model (the perceived state) of the environment. Secondly, the perceived state is constantly being compared to the goal state; when there is a discrepancy between two models, the emotional state associated with that goal is generated, to motivate behaviour to attain the goal state. The Extended Process Model therefore posits that the neurobiological systems associated with emotion generated are not "emotion systems" but are better described as "valuation systems," taking in information from the perceived model to "decide" when emotions should be generated (Gross, 2015). Thirdly, the individual then behaves in accordance with these motivations, and the results of this behaviour feed into the sensory input in the next iteration of this cycle.

The Extended Process Model (Gross, 2015) also proposes a conscious "second-level" system, associated with activity in the dorsolateral and dorsal posterior medial prefrontal cortex (Ochsner & Gross, 2014). This "second-level" system tracks discrepancies between the perceived emotional state and the goal emotional state, through another cycle of perception, valuation, and action (Gross, 2015). This system generates emotion regulation strategies through identification of the emotion requiring regulation, selection of an emotion regulation strategy, and implementation of that strategy (Gross, 2015). These stages conceptually overlap with the three statistical sub-factors of the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT; Legree et

al, 2014; Mayer et al, 2016): emotion perception (perception), understand emotions (valuation), and managing emotions (action). Therefore, research into both emotion regulation and emotional intelligence can be integrated into the Extended Process model.

In the Extended Process model, emotions are both generated and regulated in reference to an individual's cognitive model (the perceived state), rather than in reference to the objective world (Gross, 2015). This model therefore implies that cognitive biases may contribute to both unhealthy emotion generation and regulation. For example, an individual may not perceive than an emotion requires regulation or may select unhealthy strategies. This may in turn result in the generation of maladaptive emotional states and contribute to affective disorders. Therefore, emotion regulation may mediate the relationship between cognitive biases and affective disorders.

2.4.1.4 *Cybernetic models of personality and emotion*

The cybernetic model discussed above presupposes a neurobiological Behavioural Activation System (BAS) for goal approach and positive emotion, and a neurobiological Behavioural Inhibition System (BIS) for threat avoidance and negative emotion (Carver & Scheier, 2001). More recently, the BIS has been renamed as the Fight-Flight-Freeze-System, while the term BIS refers to a separate anxiety circuit (Corr et al, 2013); here, the term BIS is used to refer to the threat avoidance and negative emotion system.

Various models of personality, such as Reinforcement Sensitivity Theory (Corr et al, 2013) and Cybernetic Big Five Theory (CB5T; DeYoung, 2015) propose that

extroversion and neuroticism represent the cognitive and behavioural manifestations of individual differences in the sensitivity of the BAS and BIS, respectively (Carver & Scheier, 2001, p. 139; Carver et al, 2000; DeYoung, 2015; Figure 2.2). This claim is supported by the growing field of personality neuroscience, which has consistently found that extroversion is positively associated with volume in the reward circuitry, such as the mesolimbic dopamine system and the medial PFC, and neuroticism is positively associated with the volume of the brain regions associated with threat reactivity, such as the amygdala (Allen & DeYoung, 2017; DeYoung et al, 2010; Shiner & DeYoung, 2013). Furthermore, a series of questionnaire studies (with a combined sample of N = 1,108) suggest that BAS and extroversion load onto a single factor; and that BIS and neuroticism load onto another factor (Quilty et al, 2014).

Cybernetic Big Five Theory (DeYoung, 2015) further hypothesises that all Big Five traits, and their lower-order constructs, refer to sensitivity to goal-directed processes. For example, CB5T speculates that agreeableness refers to sensitivity to cooperative goals, and openness to sensitivity to the exploration of novel goals (Figure 2.2). However, many of these associations are speculative, and it is not theoretically necessary for all personality constructs to refer to cybernetic processes. Due to the significant associations between conscientiousness and affective disorders (Klein et al, 2011; Kotov et al, 2010), it is important to discuss the role of conscientiousness in CB5T.

Once a goal has been attained, an individual must pursue another, more challenging goal, to generate positive emotion and reduce negative emotion (Bandura & Locke, 2003).

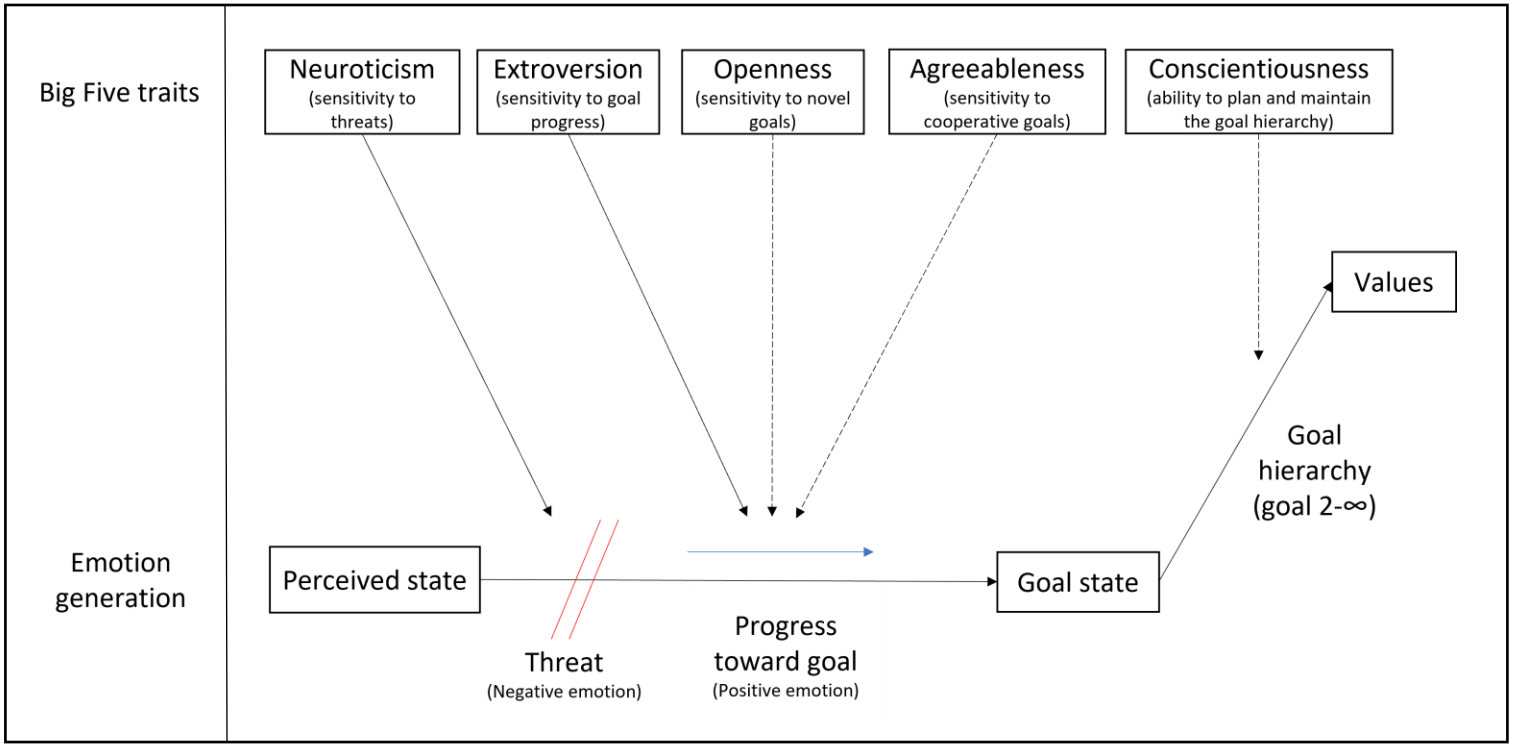

Figure 2.2. Summary of Cybernetic Big Five Theory

Adapted from theoretical descriptions form DeYoung (2015). Dashed lines represent speculative associations. This figure is original to this thesis.

Furthermore, instrumental goals are necessary to motivate emotion regulation (Gross, 2014). Individuals therefore generate a hierarchy of progressively more difficult goals, aligned with personal values, for healthy emotion generation and regulation (Johnson et al, 2010). CB5T proposes that conscientiousness refers to the ability to construct and maintain a goal hierarchy, as individuals high in conscientiousness are more able to prioritise goals and are motivated to adhere to long-term goals (DeYoung, 2015; Figure 2.2). Additionally, facet competence (within conscientiousness) is often a prerequisite for goal setting and goal pursuit (Bandura, 1994; 1997, p. 1-35). Conscientiousness may therefore refer to the common factor across personality variables associated with planning and maintaining a goal structure, which facilitates adaptive emotion generation and regulation.

Cybernetic models of personality and emotion, such as CB5T, propose that traits such as extroversion and neuroticism refer to the cognitive and behavioural manifestations of underlying sensitivities to environmental signals of goal progress (Corr et al, 2013; DeYoung, 2015). The Extended Process Model adds that emotions are generated and regulated in reference to an individual's cognitive model, which relies on attention and interpretation (Gross, 2015). It therefore follows that personality constructs may affect emotion generation and regulation by biasing an individual's cognitive model. Therefore, the relationship between personality and emotion regulation, and between personality and affective disorders, may be mediated by affective cognitive biases.

2.4.2 Affective cognitive biases

2.4.2.1 *Affective cognition and affective disorders*

As with personality constructs and emotion regulation, affective cognitive biases are transdiagnostic factors in affective disorders (Beck & Haigh, 2014; Hankin et al, 2016). Depressive disorders are consistently associated with three types of affective cognitive biases: biases in attention toward negative information, such as isolation or loss; memory biases, whereby depressed individuals are more likely to remember negatively-valenced words; and interpretation biases, in which ambiguous situations are interpreted as negative (Elliott et al, 2011; Platt et al, 2017). Furthermore, these three affective cognitive biases have been consistently observed in anxiety disorders (Lichtenstein-Vidne et al, 2017; Smith et al, 2018). However, the target of these biases differs between these disorders, with anxiety disorders being associated with biases toward threatening information, while depressive disorders are associated with toward biases toward loss (Cisler & Koster, 2010; Clark & Beck, 2010; Beck & Haigh, 2014).

Changes in affective cognitive biases temporally impact affective disorders. While antidepressants often take up to three weeks to reduce affective disorder symptoms, a single dose of an SSRI or SNRI significantly reduces negative biases in attention, memory, and interpretation (Harmer et al, 2004; Miskowiak et al, 2007). Therefore, one potential mechanism of action in antidepressants may be a reduction in affective cognitive biases. Furthermore, attentional bias modification, in which participants are trained to attend to and remember neutral over neutrally valanced information, is effective in reducing clinical anxiety (Mogg et al, 2017). While existing studies of cognitive bias modification have small samples and heterogenous

methods, such interventions nevertheless lead to a significant reduction in anxiety and depression, compared to experimental control (Cristea et al, 2015).

2.4.2.2 *The Generic Cognitive Model of Mental Illness*

Research into the role of affective cognition in clinical depression led to the development of the Cognitive Neuropsychological Model of Depression (Roiser et al, 2012), which posits that affective cognitive biases causally predict negative schemas, and the resulting interpretation biases, which in turn causally predict clinical depression. This framework was then expanded into the Generic Cognitive Model of Mental Illness, which proposes causal relationships between affective cognitive biases and various mental illnesses (Beck & Haigh, 2014; Figure 2.3). In the Generic Cognitive Model, environmental stressors, along with genetic risk factors, contribute to the generation of affective cognitive biases in attention, such as biases toward threats and loss, and away from positive information. Sensory input must be attended to for it to enter working memory, therefore biases in attention contribute to biases in memory. Furthermore, memories contribute to the construction of schemas, which function as both the cognitive model of the world and as perceptual filters (Beck & Haigh, 2014; Clark & Beck, 2010), and thus determine beliefs about novel situations. Therefore, biases in attention and memory contribute to biases in interpretation.

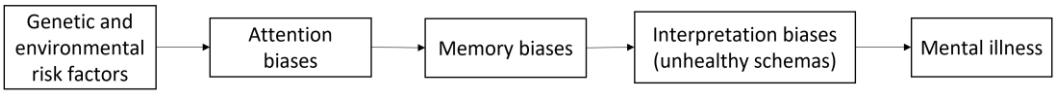

Figure 2.3. The Generic Cognitive Model of Mental Illness

Adapted from Beck & Haigh (2014, p. 5, Figure 1).

As emotion generation and regulation is dependent upon accurate information from the perceived state (Folkman 1984; Gross, 2014; 2015), cognitive biases may therefore contribute to emotion dysregulation and affective disorders (Beck & Haigh, 2014; Clark & Beck, 2010).

2.4.2.3 *Affective cognition and personality traits*

Correlational studies also suggest significant associations between personality traits and affective cognitive biases. For example, neuroticism is associated with attentional and memory biases toward threatening and negative emotional stimuli (Chitsazi et al, 2016; Lonigan & Vasey, 2007; Rusting et al, 1999). Furthermore, extroversion is significantly associated with both positive biases in memory (Rusting et al, 1999) and reduced negative biases in attention (Amin et al, 2004). As personality traits, and affective disorder scores, significantly correlate with affective cognitive biases, it is statistically feasible that affective cognitive biases may mediate the relationship between personality constructs and affective disorders (Fairchild & McDaniel, 2017). Furthermore, given that personality traits also significantly correlate with emotion regulation strategies (Connor-Smith & Flachsbart, 2007), affective cognitive biases may mediate the relationship between personality constructs and emotion regulation strategies, which may in turn impact affective disorders (Fairchild & McDaniel, 2017). However, the existing literature has not investigated these possible mediating pathways.

2.5 **Conclusion**

Big Five personality constructs are transdiagnostic risk and protective factors in affective disorders (Hankin et al, 2016). An extensive correlational literature

suggests that trait neuroticism positively correlates with various affective disorders, while traits extroversion and conscientiousness negatively correlate with various affective disorders (Klein et al, 2011; Kotov et al, 2010). Furthermore, longitudinal studies support the vulnerability model, that personality traits causally predict affective disorders (Ormel et al, 2013; Klein et al, 2011; Spinhoven et al, 2016; Struijs et al, 2018). Investigating associations between personality constructs and affective disorders can improve the current understanding of the development of affective disorders, and may inform treatments, such as treatment-matching by personality (Bagby et al, 2016) and personality-targeted interventions, which focus on personality-related risk factors (Newton et al, 2016; Barlow et al, 2017). However, two major questions are currently unanswered in the literature:

Firstly, it is unclear which lower-order personality constructs contribute to affective disorders. Most of the research into personality and affective disorders focuses on personality traits and has not investigated lower-order Big Five personality constructs. The few studies which have investigated personality facets often use heterogenous measures of both personality and affective disorders, meaning it is difficult to determine whether results are generalisable (Allen et al, 2018; Friesen et al, 2008; Naragon-Gainey et al, 2009). Additionally, studies investigating personality at the trait level over-rely on simple correlations (Jourdy & Petot, 2017; Khoo & Simms, 2018; Osma et al, 2016). As all personality facets within the same trait correlate with each other (Costa & McCrea, 1985; Soto & John, 2017), the significant correlation between a personality facet and an affective disorder may not be meaningful; but may instead be explained its correlation with another facet, which in fact explains variance in an affective disorder (Cox et al, 1999). Future research investigating the impact of lower-order personality

constructs on affective disorders should control for associations between personality facets, using statistical techniques such as multiple regression and structural equation modelling.

Secondly, it is unclear which processes mediate the relationships between personality constructs and affective disorders. Most studies investigating the associations between personality constructs and affective disorders focus on simple correlations and have not investigated possible mediators (Durbin & Hicks, 2014; Ormel et al, 2013; Watson et al, 2006). Two potential mediators include emotion regulation strategies and affective cognition, both of which are transdiagnostic factors in affective disorders (Aldao et al, 2016; Hankin et al, 2016). As both emotion regulation strategies and affective cognition significantly correlate with both personality constructs and affective disorders (Connor-Smith & Flachsbart, 2007; Elliott et al, 2011; Beck & Haigh, 2014; Smith et al, 2018; Visted et al, 2018), these mediating effects are statistically possible (Fairchild & McDaniel, 2017). As personality traits refer to individual differences in sensitivity to threats and goal progress (Corr et al, 2013; DeYoung, 2015), personality traits may influence processing of emotion information, along with emotion regulation strategies used in response to stressors. Furthermore, emotions are generated and regulated in reference to an individual's cognitive model (Gross et al, 2015; Ochsner & Gross, 2014), which may be altered by cognitive biases. Therefore, the relationship between affective cognition and affective disorders may be mediated by emotion regulation. Taken together, there is a strong theoretical and statistical argument that affective cognitive biases and emotion regulation strategies may mediate the relationships between personality constructs and affective cognition.

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Chapter Three

Paper One

Complex mediating effects of Rumination Facets between Personality Traits and Depressive Symptoms

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Abstract

Aim

This study investigates whether facets of rumination statistically mediate the relationships between Big Five personality traits and depressive symptoms.

Method

Self-reported personality traits and rumination were investigated as predictors of depressive symptoms in a cross-sectional sample of 3,043 participants aged 18-60 years (68.8% female). Multiple regression analysis investigated which personality traits and rumination facets best explained variance in depressive symptoms. Structural equation modelling was used to determine whether facts of rumination mediated the relationships between personality traits and depressive symptoms.

Results

Multiple regression analysis found that variance in depressive symptoms was best explained by the personality traits neuroticism, extroversion, conscientiousness; and both facets of rumination, brooding and reflection. Structural equation modelling added that the effects of neuroticism, extroversion, conscientiousness and openness on depressive symptoms were statistically mediated by brooding; the effects of neuroticism, extroversion and openness to depressive symptoms were statistically mediated by reflection.

Conclusions

Rumination facets statistically mediate the effects of various personality traits on depressive symptoms. These results provide insights into which individuals may be best suited to treatments for depression targeting rumination.

Highlights

- Neuroticism, extroversion and conscientiousness explain depressive symptoms
- Facets of rumination statistically mediate relationships between personality traits and depressive symptoms
- Personality traits and rumination explain 50.40% of variance in depressive symptoms

3.1 **Introduction**

Major depressive disorder is one of the most common mental illnesses, associated with an increased risk of suicide, with suicide being the leading cause of death in men below the age of 50 (McManus et al, 2016). Depression also has economic costs, being one of the most common causes of sick leave (McManus et al, 2016). It is therefore important to study the mechanisms explaining depression in order to inform treatment.

Personality traits have consistently been shown to correlate with depression. For instance, a meta-analysis of 175 correlational studies measuring personality traits and common mental illnesses found that depression consistently related to high trait neuroticism, low extroversion and low conscientiousness (Kotov et al, 2010). More recently, a multiple regression study by Quilty et al (2013) found that neuroticism and extroversion explain variance in depression; studies regarding conscientiousness have yielded mixed results. Studies measuring dimensions of temperament also suggest that negative emotionality (related to neuroticism), positive emotionality (related to extroversion) and effortful control (related to conscientiousness) all contribute towards explaining variance in depression (Vasey et al, 2013). Naragon-Gainey & Simms (2017) found that conscientiousness explained variance in depression above neuroticism and extroversion, although this effect depended on the measure used. When administering the PID-5 measure of abnormal personality (Krueger et al, 2012), depression was best explained by neuroticism, extroversion, and conscientiousness. However, the effect of conscientiousness was not significant when measuring personality using the NEO-PI-3FH (Naragon-Gainey & Simms, 2017). Taken together, these studies suggest that depression has clear relationships

with both neuroticism and extroversion, whereas the link between conscientiousness and depression may be limited to one or more facets of conscientiousness.

The literature on personality and depression has been criticised for not proposing clear mechanisms to account for these relationships (Durbin & Hicks, 2014). One potential mediating mechanism is rumination (Roelofs et al, 2008), a maladaptive emotion regulation strategy characterized by unconstructive persistent thoughts (Olatunji et al, 2013). Rumination is one of the strongest vulnerability factors in the development of internalising disorders, predicting both depression and anxiety (Aldao et al, 2016; Michl et al, 2013), and is associated with additional risk factors of depression, such as alcohol use, avoidant coping (Nolen-Hoeksema & Harrell, 2002), and attentional biases to negative information (Platt et al, 2017). Rumination has been described as a process which "transforms normative distress, especially sadness, to depression" (Burnwell & Shirk, 2007, p. 56). On average, women report higher use of rumination compared to men (Nolen-Hoeksema & Harrell, 2002), which could also help to explain why depression is twice as common in women as in men (McManus et al, 2016).

Rumination can be split into two facets, each of which represent separate emotion regulation strategies: brooding (focus on negative emotions and comparisons to an unachieved standard) and reflection (analysis of past events for problem-solving), which differentially relate to depression (Olatunji et al, 2013). While both reflection and brooding positively correlate with depression, brooding shows stronger correlations with depression (Roelofs et al, 2008). In addition, high reflection is related to reduced depression severity over time, while brooding relates to increased depression severity over time (Olatunji et al, 2013; Treynor et al, 2003). These results suggest that reflection is an adaptive strategy, whereas brooding is a

maladaptive strategy (Burnwell & Shirk, 2007). As reflection and brooding refer to separate emotion regulation strategies, which differentially affect depression, researchers into personality and depression should investigate both strategies, rather than combining them into a broad measure of rumination.

There is emerging evidence that rumination mediates the relationship between neuroticism and depression (Olatunji et al, 2013; Roelofs et al 2008), with studies focusing on rumination facets suggesting that this mediating effect is limited to brooding (Verstraeten et al, 2011). However, previous research has not investigated whether rumination mediates the relationships between other personality traits and depression, despite the theoretical links between these traits and ruminative behaviour. For instance, conscientiousness relates to greater cognitive control, including effortful control (Vasey et al, 2013), which protects from negative cognitive biases (Lonigan & Vasey, 2007). Therefore, individuals low in conscientiousness may be more likely to ruminate, increasing their risk of depression. Similarly, extroversion positively correlates with support seeking and positive reframing (Connor-Smith & Flachsbart, 2007), which may provide alternative cognitive strategies to rumination.

The current study uses multiple regression and structural equation modelling to examine relationships between personality traits, facets of rumination, and depressive symptoms. We predicted that variance in depressive symptoms will be explained by the personality traits of neuroticism, extroversion, and conscientiousness. Along with mediating the relationship between neuroticism and depressive symptoms (Olatunji et al, 2013; Roelofs et al, 2008), we also predicted that rumination facets will mediate both the relationship between extroversion and

depressive symptoms, and the relationship between conscientiousness and depressive symptoms.

3.2 **Methodology**

3.2.1 Participants

This study used data provided from the pre-existing "NewMood" dataset, which collected data between 2004 and 2009 (Freeborough & Kimpton, 2011). Participants in the "NewMood" study were recruited from general practices and through a dedicated study website, and comprised residents from both Greater Manchester, United Kingdom and Budapest, Hungary. Only participants between the age of 18 and 60 were included; there were no additional inclusion or exclusion criteria. The study did not target individuals with a mental illness. However, the study was advertised as a study about depression, meaning that individuals with depression, or a family history of depression, may have been more likely to respond. Data were collected with the approval of the respective institutional ethics committees, and in line with the Declaration of Helsinki, with all participants giving written consent prior to taking part.

Missing data points were replaced with the participant mean for that variable. Participants were excluded if they did not provide any data for any of the following variables: sex, population (Manchester or Budapest), age, Big Five traits, RRS facets or BSI-DEP. On this basis, 100 participants were excluded from all structural equation modelling. This ensured that all regressions within structural equation modelling were tested on the same sample. Excluded participants were less likely to have a history of depression, compared to included participants (Pearson $\chi^2 = 12.183$;

df = 1; $p<0.001$). The remaining 3,043 participants were involved in all analyses except for Cronbach's alpha calculations: 1,052 from Budapest and 1,991 from Manchester. The sample was 68.8% female and comprised 2,093 females and 950 males. The age range was 18-60 years old, with a mean of 32.77 years (SD: 10.365 years). 94.8% of the sample reported their ethnicity as white; 1.7% were Asian-Indian; 1.4% were Asian-oriental; 1% were mixed race; 0.6% were black; 0.4% identified as "other". 74.1% of the sample reported having either an A-level or a degree. 50.5% of the sample worked full-time; 28.1% were students; 9.7% worked part-time; 4.3% were unemployed; 4% were housewives or househusbands; and 1.2% were retired. A history of depression was reported by 41.4% of the sample, and a history of anxiety, panic or phobia by 26.4% of the sample. History of a suicide attempt or self-harm was reported by 12.7% of the sample. A small percentage of participants also reported histories of various other mental illnesses, including schizophrenia, eating disorder, and substance use disorder. 28.5% of the sample reported a history of taking antidepressant medication.

3.2.2 Measures

Participants completed a battery of self-report questionnaires. These included the BFI-44 (John et al, 1991), which measures each of the Big Five personality traits: neuroticism (referring to negative emotion and avoidance), extroversion (referring to positive emotion and sociability), conscientiousness (referring to persistence and orderliness), agreeableness (referring to compassion and politeness), and openness (referring to novelty-seeking and creativity). Neuroticism and extroversion are measured with 8 items; conscientiousness and agreeableness are each measured with 9 items, and openness is measured with 10 items.

Participants also completed the Brief Symptom Inventory (BSI: Derogatis, 1993). For this study, only items related to depressive symptoms, and related aspects of depression (such as guilt, loss of appetite, difficulty in sleeping, and thoughts of death and dying), were used to create a composite score. Scores for these 10 items were added together and divided by the number of items answered to provide a depression score (BSI-DEP) that could range from 0 to 4, with higher scores indicating higher levels of depressive symptoms. This questionnaire was chosen as it captures both the psychological and physical symptoms of depression, while maintaining strong internal consistency (Table 3.1).

Rumination was measured using the "brooding" and "reflection" scales from the Ruminative Response Scale (RRS; Nolen-Hoeksema et al, 1999). "Brooding" and "reflection" were each measured using five items. Similar to the scales above, item scores were added together and divided by the number of responded items, yielding a range between 1 and 4 for both brooding and reflection facets, with higher scores indicating higher levels of each facet. Participants are asked how frequently they engage in these strategies when experiencing sadness or depression. For example, the brooding subscale asks participants how often they "Think 'what am I doing to deserve this?'", while the reflection subscale asked participants how often they "Analyse your personality to try to understand your feelings." This study measures facets of rumination, rather than broad trait rumination, for two reasons: firstly, reflection and brooding refer to conceptually separate emotion regulation strategies; secondly, the full RRS includes a subscale of 12 "depression-related" items. Measuring total RRS scores would therefore lead to conceptual overlap between rumination and depression (Treynor et al, 2003). For descriptive statistics of these questionnaires, please see Table 3.1.

Table 3.1
Means, standard deviations and Cronbach's alphas for BFI-44 personality traits, RRS facets and BSI depression

		Mean	Standard deviation	Cronbach's alpha
Personality trait	Neuroticism	3.15	0.91	0.86 (n=2,975)
	Extroversion	3.29	0.90	0.87 (n=2,978)
	Conscientiousness	3.67	0.71	0.82 (n=2,967)
	Agreeableness	3.76	0.62	0.73 (n=2,968)
	Openness	3.74	0.64	0.79 (n=2,959)
Rumination facet	Reflection	2.09	0.67	0.78 (n=3,020)
	Brooding	2.15	0.68	0.79 (n=3,024)
BSI-DEP		0.88	0.92	0.92 (n=3,007)

Note. All figures are to 2 decimal places. BFI: Big Five Inventory. RRS: Rumination Response Scale. BSI: Brief Symptom Inventory. Sample sizes denote the number of participants having data on all items of the particular scale.

3.2.3 Analysis

Mplus v7.4 (https://www.statmodel.com/) was used to run a multiple regression model with population (coded as 1 = Budapest and 2 = Manchester), sex (coded as 1 = male and 2 = female), age, Big Five traits, and RRS facets as predictors. As none of these variables showed a normal distribution, MLR method (maximum likelihood estimation with robust standard errors) was used with default settings.

An MLR method in Mplus v7.4 (also with default settings) was used for structural equation modelling, testing the direct effects of Big Five traits on BSI-DEP; and the indirect effects of Big Five traits on BSI-DEP, mediated by RRS facets. All variables were entered simultaneously into the same model (shown in supplementary Figure 3.1). Big Five traits and RRS facets were tested as predictors of BSI-DEP. Big Five traits were tested as predictors of RRS facets. Population, sex, and age were included as predictors of all five personality traits, RRS facets and BSI-DEP. The model also controlled for the correlation between RRS facets. Based on prior testing and modification indices, the correlations between all pairs of Big

Five traits (as also reported in Allen & DeYoung, 2017) were also included to improve model fit indices, thus yielding a fully saturated model (supplementary Figure 3.1), with a perfect match ($\chi^2 = 0$ with df = 0 and p = 0; RMSEA = 0, Pclose = 0; CFI = 1; TLI = 1). Supplementary structural equation modelling was stratified by sex, in which sex was not included as a variable.

In Mplus analyses, for dichotomous predictors (population and sex) we report regression coefficients standardised (divided) only by the standard deviation of the particular outcome variable ("STDY"). For continuous predictors, we show regression coefficients standardised by standard deviations of both the predictor variable (by multiplication) and the outcome variable (by division; "STDYX").

3.3 **Results**

3.3.1 Multiple regression

Variance in BSI-DEP was significantly explained by the personality traits neuroticism, extraversion, and conscientiousness, along with both brooding and reflection, as well as population ($R^2 = 0.504$; $p<0.001$; Table 3.2).

Table 3.2
Personality traits and rumination facets explaining variance in BSI depression

Predictor variable		Estimate	95% confidence interval
Personality trait	Neuroticism	0.28***	0.25-0.32
	Extroversion	-0.12***	-0.15- (-0.08)
	Conscientiousness	-0.10***	-0.13- (-0.07)
	Agreeableness	<0.01	-0.03-0.03
	Openness	-0.02	-0.05-0.01
Rumination facet	Brooding	0.32***	0.29- 0.36
	Reflection	0.09***	0.07-0.13
Other predictors	Population	0.11***	0.06-0.16
	Sex	-0.05	-0.11-0.00
	Age	0.02	-0.01-0.04

Note. * significant at p<0.05; ** significant at p<0.01; *** significant at p<0.001.
The multiple regression also controlled for population (1 = Budapest and 2 = Manchester), sex (1 = male and 2 = female), and age. All figures are given to 2 decimal places. Standardised results are shown

3.3.2 Structural equation modelling

3,043 participants with non-missing values could be entered into the Mplus path analysis. After fitting this saturated model, BSI-DEP had a residual variance of 0.496. Significant ($p \leq 0.05$) regression paths are displayed in Figure 3.1, with 95% confidence intervals detailed in Table 3.3.

Neuroticism, extroversion, and conscientiousness directed predicted BSI-DEP Table 3.3). Brooding mediated the effects of neuroticism, extroversion, conscientiousness, and openness on BSI-DEP. Reflection mediated the effects of neuroticism, extroversion, and openness on BSI-DEP (Table 3.4)

Table 3.3
Significant ($p \leq 0.05$) regression paths displayed in figure 1, with 95% confidence intervals of the estimate

Predictor	Outcome	Estimate	Lower 2.5%	Upper 2.5%
Neuroticism	Brooding	0.55	0.51	0.58
	Reflection	0.25	0.21	0.29
	BSI depression	0.29	0.25	0.32
Extroversion	Brooding	-0.05	-0.08	-0.01
	Reflection	-0.13	-0.17	-0.09
	BSI depression	-0.12	-0.15	-0.08
Conscientiousness	Brooding	-0.07	-0.11	-0.04
	BSI depression	-0.10	-0.13	-0.07
Openness	Brooding	0.05	0.02	0.08
	Reflection	0.27	0.23	0.30
Brooding	BSI depression	0.32	0.29	0.36
Reflection	BSI depression	0.10	0.07	0.13

Note. Standardisation is according to both the predictor and the outcome variable. Non-significant paths are not shown, neither are the coefficients of population, sex or age. BSI: Brief Symptom Inventory.

Table 3.4
Significant ($p \leq 0.05$) standardised estimates of indirect effects on BSI depression. Indirect effects are reported at 95% confidence intervals

Predictor	Mediator	Estimate	Lower 2.5%	Upper 2.5%
Neuroticism	Brooding	0.18	0.15	0.20
Neuroticism	Reflection	0.03	0.02	0.03
Extroversion	Brooding	-0.02	-0.03	-0.00
Extroversion	Reflection	-0.01	-0.02	-0.00
Conscientiousness	Brooding	-0.02	-0.04	-0.01
Openness	Brooding	0.02	0.01	0.03
Openness	Reflection	0.03	0.02	0.04

Note. Standardisation is according to both the mediator and the outcome variable. BSI = Brief Symptoms Inventory.

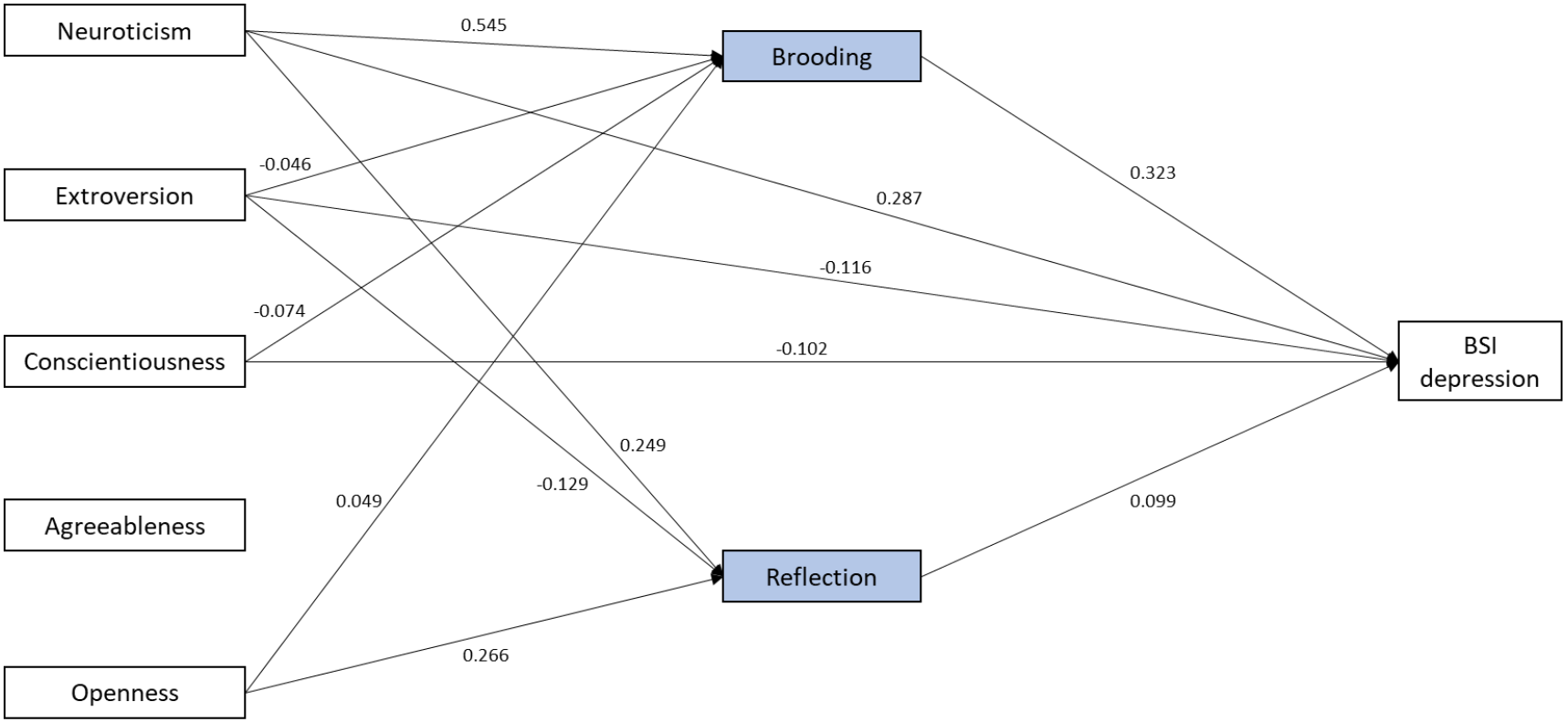

Figure 3.1. Significant regression (path) coefficients between Big Five personality traits, rumination facets and depressive symptoms

Only significant ($p \leq 0.05$) standardised path coefficients are displayed. Standardisation is according to both the predictor and the outcome variable. Non-significant paths are not shown, neither the coefficients of population, sex or age. BSI: Brief Symptom Inventory. Significant mediators are shaded.

3.3.3 Structural equation modelling by sex

When only including women in the model, results revealed the same significant pathways as when including both sexes. When only including men in the model, the effect of extroversion on brooding was non-significant, and the effect of agreeableness on brooding was statistically significant. Therefore, brooding mediated the relationship between extroversion and BSI-DEP in women but not men; and brooding mediated the relationship between agreeableness and BSI-DEP in men but not in women (Supplementary tables 3.1-3.4; Supplementary figures 3.2-3.3). Thus, analyses stratified by sex revealed only minor differences compared to the whole sample.

3.4 **Discussion**

This study aimed to investigate whether facets of rumination mediate the relationship between personality traits and depressive symptoms. In line with much previous research, variance in depressive symptoms was best explained by the personality traits of neuroticism, extroversion, and conscientiousness (Kotov et al, 2010; Naragon-Gainey & Simms, 2017). In addition, the effects all of personality traits explaining variance in depressive symptoms were at least partly mediated by facets of rumination. Specifically, the effects of neuroticism, extroversion and conscientiousness on depressive symptoms were mediated by brooding. The effects of neuroticism and extroversion on depression were mediated by reflection. Openness did not significantly explain variance in depressive symptoms; however, brooding and reflection significantly mediated the pathway from openness to depressive symptoms. Extroversion may protect from depressive symptoms due to

higher levels of social support and positive emotion (Costa & McCrea, 1992). Conscientiousness may protect from depressive symptoms due to problem-focused coping (Connor-Smith & Flachsbart, 2007) and greater self-regulation (Eisenberg et al, 2014).

Previous research suggests that facets of rumination mediate the relationship between neuroticism and depressive symptoms (Roelofs et al, 2008; Verstraeten et al, 2011). The current study adds that facets of rumination also mediate the effects of extroversion, conscientiousness and openness on depressive symptoms. Openness did not have a direct effect on depression. However, as previous research suggests that openness is associated with openness to treatment (Costa & McCrea, 1992), it is possible that this effect may have been masked in the current study by adherence to treatment associated with conscientiousness (Costa & McCrea, 1992). Furthermore, openness had an indirect effect on depressive symptoms via reflection. Overall, the relationships between various personality traits and depressive symptoms were mediated by both facets of rumination: brooding and reflection. This is only partly in line with previous research, which has suggested that brooding, but not reflection, mediates the relationship between neuroticism and depression. One possible explanation for this discrepancy is that previous studies were underpowered for mediation analysis, having fewer than 200 participants (Verstraeten et al, 2011) and therefore did not observe the smaller mediating effect of reflection.

A novel finding from this study is that the mediating effects of rumination also extend to the traits of extroversion, conscientiousness and openness. Brooding most strongly related to neuroticism, and less strongly to extroversion, conscientiousness and openness, implying that brooding is primarily a cognitive manifestation of neuroticism. In fact, common genes, such as *5-HTTLPR* and

HTR2A, explain variance in neuroticism (Gonda et al, 2018), brooding, and depressive symptoms (Eszlari et al, 2019), suggesting that brooding may be a cognitive style resulting from high trait neuroticism. Reflection has a contradictory role in depression. This may be explained by the fact that both neuroticism and openness explain variance in reflection: neuroticism may explain maladaptive cognitions about to negative information, whereas openness may explain adaptive cognitive problem-solving (Connor-Smith & Flachsbart, 2007).

Another novel finding of this study is that both brooding and reflection mediated the pathways between extroversion and openness on depressive symptoms. Openness conceptually relates to cognitive exploration (Allen & DeYoung, 2017), which may explain why individuals high in openness are more likely to engage in brooding and reflection. Extroversion relates to positive biases in memory (Rusting et al, 1999), meaning that individuals high in extroversion may be less likely to reflect on negative memories, thus reducing depressive symptoms. Extroversion also relates to coping strategies such as positive reappraisal and support seeking (Connor-Smith & Flachsbart, 2007), which may provide more adaptive alternatives to brooding and reflection.

Another novel finding of this study is that brooding mediated the relationship between conscientiousness and depressive symptoms. Conscientiousness relates to effortful control (Vasey et al, 2013), and individuals with high effortful control are less likely to show attentional biases to negative information (Lonigan & Vasey, 2007). This decreases the likelihood of experiencing negative biases in memory (Platt et al, 2017), which may reduce brooding. Conscientiousness also protects from cognitive styles associated with depression as it is associated with the perception of personal competence (Costa & McCrea, 1992), reducing hopelessness,

and may also reduce brooding via problem-focused coping, including strategies such as planning and positive reappraisal (Chwaszcz et al, 2018). Individuals high in conscientiousness may therefore have alternative cognitive and behavioural strategies, reducing the use of brooding.

The results of this study may inform clinical practice through treatment-matching. As variance in depression is explained by personality traits (Naragon-Gainey & Simms, 2017; Quilty et al, 2013), treatments should be tailored toward the patients' personality (Bagby et al, 2016). This study found that the pathways from neuroticism, extroversion, conscientiousness and openness to depression are mediated by rumination. These traits may be screened to inform the suitability of psychotherapies targeting rumination, such as rumination based cognitive behavioural therapy (Michl et al, 2013).

This study has some limitations. Firstly, by using a cross-sectional design, this study is unable to determine causation. For example, it is possible that depression caused higher rumination, rather than rumination causing depression. While this study reports statistical mediation, further longitudinal research is needed to investigate causation between personality traits, facets of rumination, and depression. Secondly, this study is limited to broad personality traits, whereas it is possible that the relationships between personality, rumination and depression are explained by a smaller number of personality facets.

3.5 **Conclusion**

Personality traits and rumination facets explained 50.40% of variance in depressive symptoms. When personality traits and facets of rumination were

considered together, variance in depressive symptoms was best explained by neuroticism, extroversion and conscientiousness, and the rumination facets brooding and reflection. Brooding mediated the relationships between neuroticism, extroversion, conscientiousness, and openness on depressive symptoms. Reflection mediated the relationships between neuroticism, extroversion, and openness on depressive symptoms. The effectiveness of interventions targeting rumination may therefore depend on personality traits, which can be used for treatment-matching.

3.6 **Ethical Compliance Section**

3.6.1 Funding

This study was carried out as part of a self-funded Ph.D., administered by the UK's Student Loans Company. As part of "NewMood", this study was supported by the Sixth Framework Program of the European Union (LSHM-CT-2004-503474). Gabriella Juhasz was supported by the Hungarian Brain Research Program, Semmelweis University (Grants: 2017-1.2.1-NKP-2017-00002), by the Thematic Excellence Programme (2020-4.1.1.-TKP2020) of the Ministry for Innovation and Technology in Hungary, within the framework of the Neurology and Translational Biotechnology thematic programs of the Semmelweis University. Nora Eszlari was supported by the Hungarian Brain Research Program (Grants: 2017-1.2.1-NKP-2017-00002) and by the New National Excellence Program of The Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund (ÚNKP-20-4-II-SE-9). No funding organization was involved in the conceptualizing, planning, analysis or writing of this study.

3.6.2 Compliance with Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

3.6.3 Conflicts of Interest

The authors declare that they have no conflict of interest.

3.6.4 Informed consent

Informed consent was obtained from all individual adult participants included in the study.

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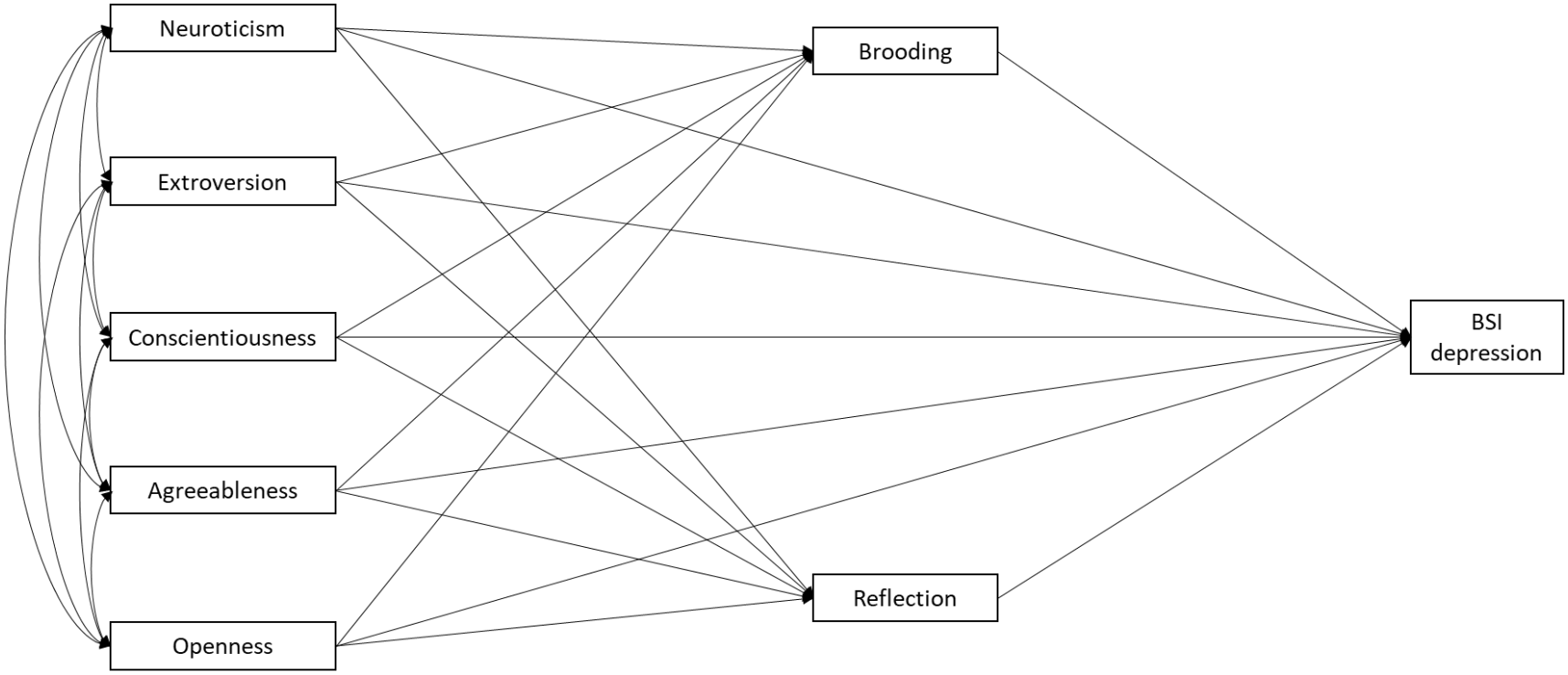
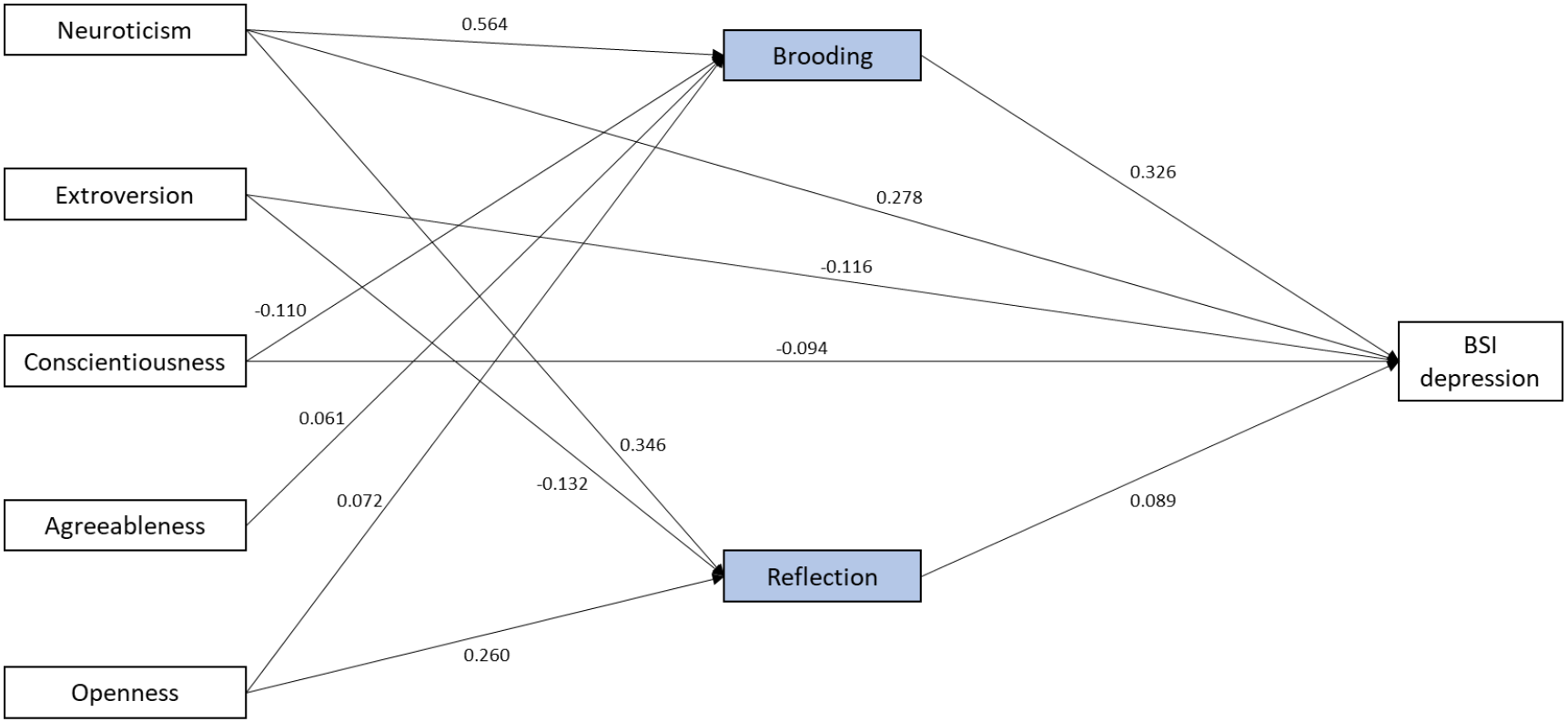


Supplementary Figure 3.1. Tested pathways between Big Five personality traits, rumination facets and depressive symptoms

Double-ended arrows stand for covariances, and single-ended arrows for regression (path) coefficients. Population, sex and age were predictors of all five personality traits, both rumination facets and BSI depression in regression models (not shown). BSI: Brief Symptom Inventory.



Supplementary figure 3.2. Supplementary figure 3.2. Significant regression (path) coefficients between Big Five personality traits, rumination facets and depressive symptoms, in men

Only significant ($p \leq 0.05$) standardised path coefficients are displayed. Standardisation is according to both the predictor and the outcome variable. Non-significant correlations are not shown, neither are the coefficients of population or age. BSI: Brief Symptom Inventory.

Supplementary table 3.1
Significant (p≤0.05) regression paths displayed in supplementary figure 2, with 95% confidence intervals of the estimate, in men

Predictor	Outcome	Estimate	Lower 2.5%	Upper 2.5%
Neuroticism	Brooding	0.564	0.505	0.622
	Reflection	0.346	0.278	0.414
	BSI depression	0.278	0.210	0.346
Extroversion	Brooding	*	*	*
	Reflection	-0.132	-0.201	-0.063
	BSI depression	-0.116	-0.173	-0.060
Conscientiousness	Brooding	-0.110	-0.170	-0.050
	BSI depression	-0.094	-0.147	-0.040
Agreeableness	Brooding	0.061**	0.000**	0.122**
Openness	Brooding	0.072	0.020	0.123
	Reflection	0.260	0.204	0.315
Brooding	BSI depression	0.326	0.260	0.392
Reflection	BSI depression	0.089	0.033	0.145

Note. Standardisation is according to both the predictor and the outcome variable. Non-significant correlations are not shown, neither are the coefficients of population or age. Differences in significance of particular pathways compared to the whole sample (table 3.3) are indicated with * (a path becoming non-significant in men) or ** (a path becoming significant in men), respectively. BSI: Brief Symptom Inventory.

Supplementary table 3.2
Significant (p≤0.05) standardised estimates of indirect effects on BSI depression in men

Predictor	Mediator	Outcome	Estimate	Lower 2.5%	Upper 2.5%
Extroversion	Brooding	BSI depression	*	*	*
Extroversion	Reflection	BSI depression	-0.012	-0.021	-0.003
Neuroticism	Brooding	BSI depression	0.184	0.143	0.225
Neuroticism	Reflection	BSI depression	0.031	0.010	0.051
Conscientiousness	Brooding	BSI depression	-0.036	-0.057	-0.015
Openness	Brooding	BSI depression	0.023	0.006	0.041
Openness	Reflection	BSI depression	0.023	0.008	0.038

Note. Indirect effects are reported at 95% confidence intervals. Standardisation is according to both the mediator and the outcome variable. A difference in significance of particular pathways compared to the whole sample (table 4) is indicated with * (a path becoming non-significant in men). BSI: Brief Symptom Inventory.

Supplementary table 3.3
Significant (p≤0.05) path (regression) coefficients displayed in supplementary figure 3, with 95% confidence intervals of the estimate, in women

Predictor	Outcome	Estimate	Lower 2.5%	Upper 2.5%
Neuroticism	Brooding	0.536	0.498	0.575
	Reflection	0.204	0.155	0.254
	BSI depression	0.284	0.242	0.327
Extroversion	Brooding	-0.049	-0.090	-0.008
	Reflection	-0.132	-0.182	-0.083
	BSI depression	-0.119	-0.158	-0.080
Conscientiousness	Brooding	-0.062	-0.101	-0.023
	BSI depression	-0.106	-0.141	-0.070
Openness	Brooding	0.047	0.009	0.085
	Reflection	0.275	0.230	0.319
Brooding	BSI depression	0.310	0.264	0.356
Reflection	BSI depression	0.102	0.065	0.140

Note. Standardisation is according to both the predictor and the outcome variable. Non-significant correlations are not shown, neither are the coefficients of population or age. BSI: Brief Symptom Inventory.

Supplementary table 3.4
Significant (p≤0.05) standardised estimates of indirect effects on BSI depression in women

Predictor	Mediator	Outcome	Estimate	Lower 2.5%	Upper 2.5%
Neuroticism	Brooding	BSI depression	0.166	0.138	0.194
Neuroticism	Reflection	BSI depression	0.021	0.012	0.030
Extroversion	Brooding	BSI depression	-0.015	-0.028	-0.002
Extroversion	Reflection	BSI depression	-0.014	-0.021	-0.006
Conscientiousness	Brooding	BSI depression	-0.019	-0.032	-0.007
Openness	Brooding	BSI depression	0.015	0.003	0.027
Openness	Reflection	BSI depression	0.028	0.017	0.039

Note. Indirect effects are reported at 95% confidence intervals. Standardisation is according to both the mediator and the outcome variable. BSI: Brief Symptom Inventory.

Chapter Four

Paper Two

Associations between Facets and Aspects of Big Five Personality and Affective Disorders: A Systematic Review and Best Evidence Synthesis

Lyon, KA[1]; Elliott, R[1]; Ware, K[2]; Juhasz, G[34]; Brown, LJE[2]

Kieran Lyon decided on eligibility criteria and databases to be searched, screened all articles, assessed study eligibility and quality, conducted data extraction, interpretated findings, wrote the manuscript, and completed all revisions following review by the co-authors.

An article based on this chapter has been published in the *Journal of Affective Disorders*:

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This published version of this article included several errors, due to mistakes in extracting data from Friesen (2008) and Jourdy & Petot (2017). These errors are addressed in a published corrigendum:

Lyon, K. A.; Elliott, R.; Ware, K.; Juhasz, G.; & Brown, L. J. E. (2021). Correction to Lyon, K. A.; Elliott, R.; Ware, K.; Juhasz, G.; & Brown, L. J. E. (2021). *Journal of Affective Disorders*, 294, 115. DOI: 10.1016/j.jad.2021.07.003

The following is the corrected version of the article.

Abstract

Background

Big Five personality traits correlate with affective disorders, with neuroticism considered a risk factor, and conscientiousness and extroversion considered protective factors. However, the relationships between affective disorders and lower-order personality facets and aspects are less clear.

Method

A systematic review was carried out to identify studies measuring associations between lower-order personality constructs and affective disorders. Big Five facets were measured using the NEO-PI-R, and aspects using the BFAS. PsycINFO, EMBASE, MedLine and OpenGrey were searched from January 1st, 1985, to June 30th, 2020. Fifteen studies met criteria and reported a total of 416 associations. Data were analysed using best evidence synthesis.

Results

Most facets of neuroticism were positively associated with affective disorders. Positive emotion in extroversion, and competence and self-discipline in conscientiousness, were negatively associated with affective disorders. Trust in agreeableness, and actions in openness, were negatively associated with anxiety disorders, whereas fantasy in openness was positively associated with anxiety disorders. At the aspect level, withdrawal in neuroticism was positively associated with MDD, whereas industriousness in conscientiousness was negatively associated with MDD.

Limitations

Due to the use the heterogenous measures between studies, a meta-analysis could not be performed. Only Big Five personality constructs were investigated, limited to BFAS personality aspects, and NEO-PI-R personality facets.

Conclusions

Neuroticism, positive emotion, competence and self-discipline correlate with various anxiety and depressive disorders. These facets may be endophenotypes for affective disorders in general. Future research is needed to investigate mediating pathways between personality facets and affective disorders.

Highlights

- Most facets of neuroticism were positively associated with affective disorders
- Positive emotion was negatively correlated with affective disorders
- Competence and self-discipline negatively correlated with affective disorders

4.1 Introduction

Affective disorders are among the most common mental illnesses, with anxiety disorders being the most prevalent mental illnesses, followed by depressive disorders (Stansfeld et al, 2016; Steel et al, 2014; Wittchen et al, 2011). For instance, a review of mental health population studies across thirty European countries found that anxiety disorders have a 12-month prevalence rate of 14%, whereas mood disorders have a 12-month prevalence rate of 7.8% (Wittchen et al, 2011). Affective disorders also have high economic costs. For example, mental illnesses are the third most common cause of sick leave in the UK, accounting for between £70- and £100 billion per year, much of which is accounted for by affective disorders (McManus et al, 2016). Due to their high prevalence and health cost, it is important to assess possible risk factors of affective disorders.

Within the diathesis-stress model, personality constructs can be conceptualized as diathesis, or vulnerability, factors in the development of affective disorders (Ormel et al, 2013; Watson et al, 2006). Associations between personality constructs and affective disorders may be mediated by behavioural and neurocognitive correlates of personality, such as stressful life events (Kendler et al, 2004), attentional biases (Elliott et al, 2011; Amin et al, 2004) and emotion regulation strategies (Connor-Smith & Flachsbart, 2007). Personality constructs have also been conceptualized as endophenotypes of mental illnesses (Bearden & Friemer, 2006), as they are moderately heritable (Vukasović & Bratko, 2015), and causally predict the development of affective disorders (Spinhoven et al, 2013; Struijs et al, 2018). Overall, investigating personality constructs associated with affective disorders can help to identify possible endophenotypes for affective disorders. Furthermore, affective disorders can also causally affect personality traits,

such as scar effects, in which anxiety and depression increase trait neuroticism (Ormel et al, 2013; Watson et al, 2006).

Studies of personality using factor analysis have converged on five personality traits (Davis & Panksepp, 2018; Goldberg et al, 1990). A dominant model of personality is the Big Five (DeYoung et al, 2007; Allen & DeYoung, 2016), which proposes that personality can be described across five broad personality traits: neuroticism (referring to negative emotion and avoidance), extroversion (referring to positive emotion and sociability), conscientiousness (referring to persistence and orderliness), agreeableness (referring to compassion and politeness), and openness (referring to novelty-seeking and creativity; Costa & McCrea, 1992; Goldberg et al, 1990). A meta-analysis of 175 correlational studies of personality traits and common mental illnesses found that neuroticism positively correlates with affective disorders such as generalised anxiety, depression and panic disorder, whereas extroversion and conscientiousness negatively correlate with these affective disorders (Kotov et al, 2010). For this reason, the personality configuration of high neuroticism, low extroversion and low consciousness has been referred to as the "vulnerable personality" (Wardenaar et al, 2014, p. 918, para. 2) and the "misery triad" (Miller, 1991, p. 430, para. 1).

Big Five personality constructs exist within a personality hierarchy, from broad traits to narrow facets (DeYoung et al, 2016), allowing personality to be considered at different levels of specificity (DeYoung et al, 2016). Various measures of lower-order personality constructs have been developed. In the Big Five Aspect Scale (BFAS), each trait is split into its two most statistically robust components (DeYoung et al, 2007); for example, trait agreeableness is split into the aspects compassion and politeness. The Big Five Inventory – 2 (BFI-2) splits each

trait into three facets; for example, trait conscientiousness is split into order, productiveness and responsibility (Soto & John, 2017). The NEO-PI-R separates each trait into six narrow facets: for instance, extroversion is separated into the facets of warmth, gregariousness, assertiveness, activity, excitement-seeking and positive emotion (Costa & McCrea, 2008).

Studying these lower-order personality constructs can provide more specific information about which components of a personality trait best explain its predictive power. For example, trait agreeableness has a non-significant relationship with MDD (Kotov et al, 2010), whereas the agreeableness facet trust moderately negatively correlates with MDD ($r = -0.30$, Quilty et al, 2013), indicating a specific role of this facet within the trait. Conversely, trait conscientiousness significantly negatively correlates with various affective disorders, whereas the conscientiousness facet deliberation does not (Friesen, 2008), indicating that this facet does not play an important role in this relationship.

Investigating lower-order personality constructs can therefore help to understand how personality constructs and affective disorders impact each other and can help to identify narrower endophenotypes for affective disorders. It may also help to better understand the mechanisms underlying these associations. For instance, trait extroversion negatively correlates with various affective disorders (Kotov et al, 2010). However, extroversion includes conceptually distinct personality facets that could relate to separate mediating mechanisms: If the effect of extroversion is explained by facet positive emotion, extroversion may protect from affective disorders via positive attentional and memory biases (Amin et al, 2004; Canli et al, 2004) and goal-directed behaviour (Carver & Scheier, 2013; Wilt et al, 2018). However, if the effect of extroversion is explained by facet sociability,

the mediating mechanism may relate to social factors, such as social support. If the effect of extroversion is explained by facet assertiveness, one mediating mechanism may be negotiating skills to attain competitive goals. Therefore, investigating associations between facets and affective disorders can help to understand how personality risk factors influence the development of affective disorders.

The aim of the current study is therefore to systematically review the literature investigating associations between lower-order personality constructs and affective disorders.

4.2 **Methodology**

The systematic review protocol was pre-registered on Prospero (ID: CRD42019126874).

4.2.1 Inclusion and exclusion criteria

To be included in the review, studies had to report statistical tests of relationships between personality facets or aspects and affective disorder measures. This could be simple associations between the personality and affective disorder scores, or tests of difference in which mean personality scores were compared between groups that differed in the presence or severity of a given affective disorder. Affective disorders could be coded using affective disorder status, such as a clinical diagnosis (as defined by the DSM-IV (APA, 2000) and onwards); by affective disorder severity, measured with a standardised quantitative tool, including questionnaires; or quantitatively coded interviews such as the Mini International Neuropsychiatric Interview (MINI: Sheehan et al, 1998).

Both cross-sectional and longitudinal study designs were included. Studies using correlations were only included if they reported both correlation coefficients and p-values; studies using tests of difference were only included if they reported both effect sizes and p-values. If these statistics were not provided in an otherwise eligible study, then the primary author was contacted, and these data requested. If associations between lower-order personality constructs and affective disorder scores were reported in a subsample of a larger study, only the data from the relevant subsample was extracted.

To ensure consistency of constructs across studies, studies were only included if they measured personality aspects using the Big Five Aspect Scale (BFAS; DeYoung et al, 2007) or personality facets with the NEO-PI (Costa & McCrea, 1985) or variations of this questionnaire, such as the NEO-PI-R (Costa & McCrea, 2008). These questionnaires were chosen as they represent the predominant models of aspects and facets in the existing literature, and therefore provided the greatest body of literature for review (Soto & John, 2017; Xie & Cobb, 2020). Studies that derived personality aspects or facets from a factor analysis of one or more of the above scales, plus additional scales of both Big Five and non-Big Five measures, were excluded due to a lack of direct comparability between the resultant measures and those captured by the BFAS and NEO-PI-R.

Studies testing both clinical and non-clinical populations were included. As personality is more flexible in adolescence than adulthood (Srivastava et al, 2003), studies were excluded if any participants were younger than 18 years old.

4.2.2 Literature search

The databases PsycINFO, EMBASE and MedLine were initially searched from January 1st, 1985 (the year that the first questionnaire to measure Big Five facets, the Neuroticism Extroversion Openness – Personality Inventory (NEO-PI; Costa & McCrea, 1985) was published) to February 28th, 2019. This search was then updated to include literature published until June 30th, 2020. Searches were performed using the following search strategy applied to the OVID platform: *(Personality OR NEO-PI* OR BFI* OR BFAS OR big five) AND (facet* OR primary trait OR aspect*) AND ((affect* AND disorder*) OR (mental AND disorder*) OR (mental AND health) OR (mental AND condition) OR anx* OR depress* OR obsessive-compulsive OR agoraphobia OR phobia) AND (assoc* OR correlate* OR regress* OR predict*).*

To combat publication bias, literature was also search in OpenGrey from January 1st, 1985, to February 28th, 2019, then extended to June 30th, 2020. As OpenGrey only allowed access to the first 2,000 search results, the total number of hits could not be displayed. To reduce the number of hits below 2,000, results were limited to the "psychology" domain, and a new search strategy was developed: *("Personality" OR "big five" OR "NEO-PI*") AND ("facet*" OR "primary trait" OR "aspect") AND (("affect*" AND "disorder*") OR ("mental" AND "health")) AND ("correlate*" OR "regress*").* All 2,000 results were screened in the initial search. OpenGrey allows searches to be specified by year, but not by date, therefore the extended search included studies from January 1st, 2019, to June 30th, 2020. The extended search did not produce any hits, therefore all results from OpenGrey were from the original search.

The combined search of PsycINFO, EMBASE, MedLine, and OpenGrey produced a total of 12,722 records. After de-duplication, 11,289 records remained. These studies were first screened by titles and abstracts. For this, two reviewers independently screened a subset comprising 1,200 records by title and abstract, with any discrepancies between reviewers resolved by discussion. One reviewer included 13 studies while another included 9 studies, meaning a consistency rate of 67.8%. However, the resolution of discrepancies revealed that all disagreements were cases in which the second reviewer had retained a study that it was subsequently agreed could have been excluded at this stage. There were no cases where the primary reviewer had incorrectly excluded a relevant study, suggesting a high level of screening accuracy by the primary reviewer. The remainder of the records were therefore screened by title and abstract by the primary reviewer. After screening by title and abstract, the search was reduced to 61 records (Figure 4.1).

Of these 61 records, three were French doctoral theses, for which full texts were unavailable in English (Bresson, 2006; Jourdy, 2013; Kim, 2012). The method sections of these theses were therefore translated into English by an experienced translator, fluent in French. The full text of three records (Leong et al, 2003; Moghanloo & Aguilar-Vafaie, 2009; Sells et al, 2012) were not available, and so were excluded at this stage. The full texts of the remaining 58 records were then independently assessed against the inclusion and exclusion criteria by two reviewers, with 100% agreement. Through this process, the search was reduced to thirteen publications, one of which described two separate studies (Kaplan et al, 2015). The most common reason for exclusion at this stage was that studies did not correlate personality facets with affective disorders ($k = 20$). In addition, several papers used novel measures of personality facets ($k = 7$), meaning their results could not be

mapped onto existing research or the personality hierarchy. Five papers did not measure affective disorders, and five papers did not measure Big Five facets or aspects (Figure 4.1).

The reference lists of all included publications were then hand-searched for relevant studies, from which one additional article (describing one study) was identified as meeting the inclusion criteria (Wolfenstein & Trull, 1997). This led to a final sample of fifteen studies, described within fourteen publications (Allen et al, 2018; Bagby et al, 1995; Cox et al, 2000; Friesen, 2008; Hayward et al, 2013; Jourdy & Petot, 2017; Kaplan et al, 2015; Khoo & Simms, 2018; Osma et al, 2016; Naragon-Gainey & Simms, 2017; Newby et al, 2017; Quilty et al, 2013; Rees et al, 2005; Wolfenstein & Trull, 1997; Figure 4.1).

4.2.3 Quality assessment

Quality assessment of studies was performed using the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (NIH, 2019). This tool assesses fourteen study characteristics, including the clarity of the research question, sample size and sample details, appropriateness of measures, and analysis of potential confounding variables. Rather than simply rating the studies according to the number of criteria met, reviewers assess the strengths and limitations of each study according to these characteristics, and then use their reflections on these ratings to make a global judgment of study quality as “good,” “fair” or “poor.” For this review, quality assessment was performed by two reviewers, who each came to an independent judgement of overall study quality, and then met to compare their ratings. The two reviewers initially agreed on the ratings awarded to eleven of the fifteen studies (73.3% agreement).

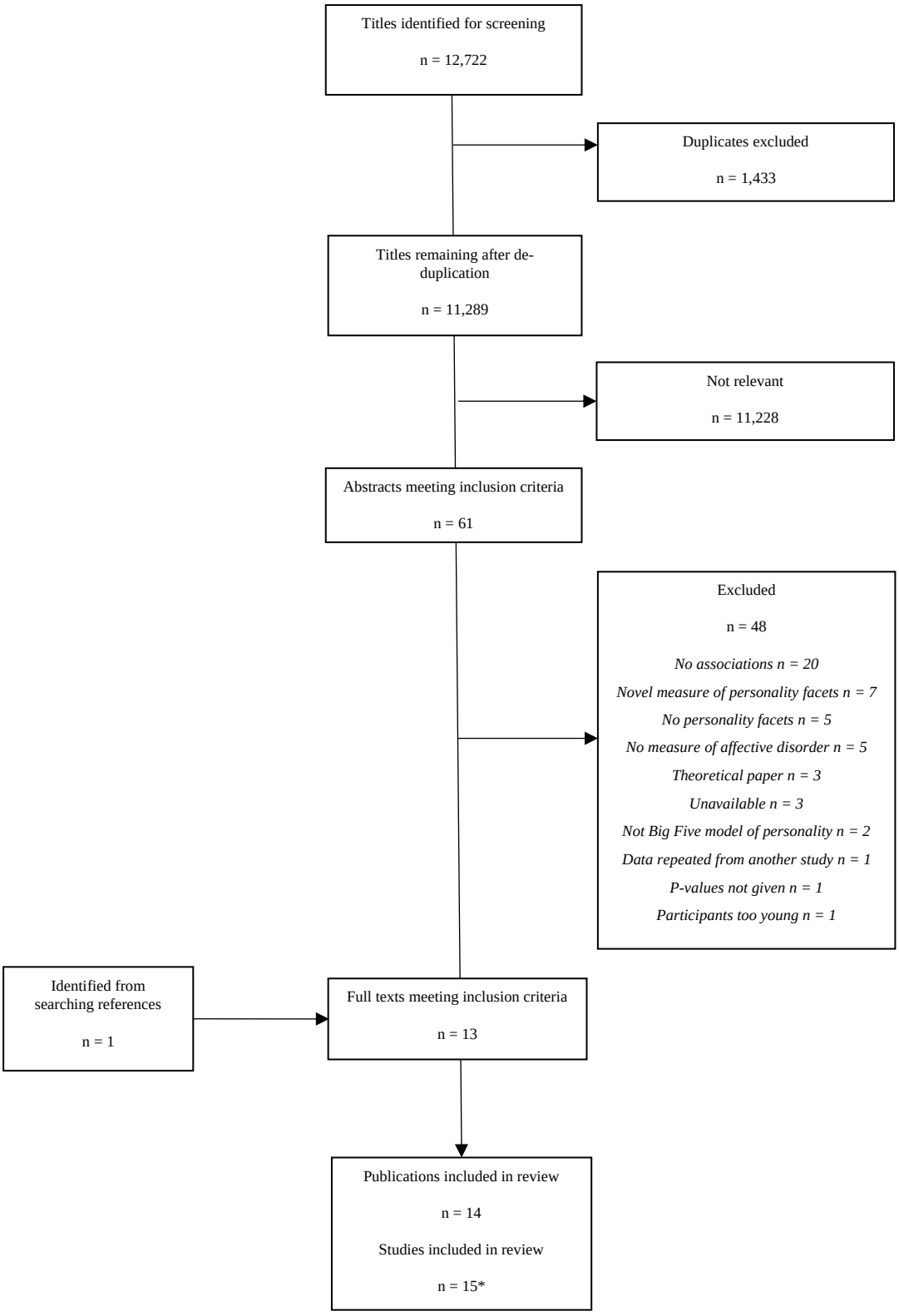

Figure 4.1. Flow chart of the study selection process

*One publication consisted of two correlational studies (Kaplan et al, 2015).

All disagreements were resolved through discussion.

4.2.4 Best evidence synthesis

After all included studies were quality assessed, results were synthesized using a best evidence synthesis process adapted from Terwee et al (2007) and Faudzi et al (2019). In best evidence synthesis, each association (in this case, each association between a specific aspect/facet and a specific affective disorder) is assigned an overall value based on the quality, number, and consistency of studies reporting a correlation co-efficient for this association (Slavin et al, 1986). Specifically, if a result for an association was reported in one study of good quality, or consistently in multiple studies of fair quality, the association was considered to have "strong evidence" and coded as "++" for positive associations, "--" for negative correlations and "00" for non-significant associations at $p<0.05$. If a result for an association was reported in one study of fair quality or consistently in multiple studies of poor quality, the association was reported to have "weak evidence," coded as "+" for positive associations, "-" for negative associations and "0" for non-significant associations at $p<0.05$. If a result for an association was only reported in one study of poor quality or otherwise not investigated, the result was reported to have "absence of evidence," and left blank. All instances in in which results for an association conflicted between studies were reported as "conflicting evidence" and coded as "±". As aspects and facets refer to different levels of specificity within the personality hierarchy, associations between facets and affective disorders, and between aspects and affective disorders, were synthesized in separate best evidence syntheses. Several poor-quality studies were statistically underpowered (Jourdy & Petot, 2017; Osma et al, 2016), which may have led to false negative results, which may in turn unduly affect the results of the best evidence synthesis. Therefore,

where a best evidence synthesis included one or more studies of poor quality, an additional best evidence synthesis was performed of only those studies of good or fair quality, so that any undue impact of the poor-quality studies could be determined. All evidence synthesis ratings were made by one author (KL).

4.3 **Results**

Eleven studies used a sample of current or recovering psychiatric patients; four studies used a sample of undergraduate students. The sample size ranged from fourteen (Rees et al, 2005) to 1,079 (Friesen, 2008), with a mean sample size of 303.60 (SD = 281.03). Across the fifteen studies, the total sample comprised 4,554 participants. Four studies were rated as being of "good" quality; eight of "fair" quality; and three studies of poor quality (Table 4.1).

Several studies did not provide details regarding the age range of their sample (Bagby et al, 1995; Cox et al, 2000; Hayward et al, 2013; Kaplan et al, 2015; Newby et al, 2017; Osma et al, 2016; Quilty et al, 2013; Rees et al, 2005; Wolfenstein & Trull, 1997) or the proportions of male and female participants (Hayward et al, 2013; Khoo & Simms, 2018). In addition, three studies only provided this information for their total sample, but not for smaller subsets used in the analyses reported here (Friesen et al, 2008; Naragon-Gainey & Simms, 2017; Rees et al, 2005). Age and gender characteristics that were reported for studies are displayed in Table 4.1.

The most common disorder investigated was MDD, which was investigated in ten of the studies making up the final sample. The second most common disorder studied was social anxiety, investigated by five studies across four articles.

Table 4.1
Included studies by participant characteristics, affective disorder measures, personality measures and quality

Article	Country	Sample size	Participant characteristics	Affective disorder(s) studied	Affective disorder measures	Personality measure used	Lower-order personality construct measures	Results summary	Quality rating
Allen et al (2018)	Canada	354	Psychiatric outpatients, from three randomized controlled trials. Mean age = 38.09 (SD = 12.08) 63.60% female	MDD	BDI	BFAS Administered 100 items: compete questionnaire. Only performed correlations for neuroticism, extroversion and conscientiousness aspects	2 neuroticism aspects: withdrawal and volatility 2 extroversion aspects: enthusiasm and assertiveness 2 conscientiousness aspects: industriousness and orderliness	Withdrawal positively correlated with MDD Industriousness negatively correlated with MDD	Fair
Bagby et al (1995)	Canada	57	Psychiatric outpatients. Mean age = 40.10 (SD = 10.02) 64.91% female	MDD	HamD BDI	NEO-PI Administered 144: neuroticism, extroversion and conscientiousness	6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress 6 extroversion facets: warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotion 6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	All facets of neuroticism positively correlated with MDD. Positive emotion negatively correlated with MDD. Fantasy, aesthetics and feelings positively correlated with MDD	Fair
Cox et al (2000)	Canada	309	Undergraduates from the University of Manitoba Mean age = 19.84 (SD = 3.52) 61.49% female	IAD	IAS	NEO-PI-R Administered 240 items: complete questionnaire	6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress 6 extroversion facets: warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotion 6 conscientiousness facets: competence, order, dutifulness, achievement striving, self-discipline, deliberation 6 agreeableness facets: trust, straightforwardness, altruism, compliance, modesty, tendermindedness 6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	All facets of neuroticism positively correlated with IAD. Assertiveness, activity, positive emotion, competence, dutifulness, achievement striving, self-discipline, trust, modesty, tendermindedness and ideas negatively correlated with IAD	Fair
Friesen (2008)	Canada	1,079	Psychiatric outpatients Major depressive disorders = 803 (MDD: 788; PDD = 12; major depression not otherwise specified = 3); GAD = 23; panic disorder = 62; social anxiety = 60; PTSD = 78; OCD = 53 Mean and standard deviation of age, and with proportions of sexes, not reported	MDD[1] GAD Panic disorder Social anxiety PTSD OCD	SCID-I/P	NEO-PI-R. Administered 240 items: complete questionnaire. Personality scores of clinical groups were compared with normative personality scores provided from Costa & McCrea (1992)	6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress 6 extroversion facets: warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotion 6 conscientiousness facets: competence, order, dutifulness, achievement striving, self-discipline, deliberation 6 agreeableness facets: trust, straightforwardness, altruism, compliance, modesty, tendermindedness 6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	MDD, GAD, PTSD, social anxiety, panic disorder, and OCD patients scored higher on all facets of neuroticism. MDD patients scored lower on all facets of extroversion. GAD and OCD patients scored lower on facets warmth, gregariousness, assertiveness, and positive emotion. Social anxiety patients scored lower on all facets of extroversion except excitement-seeking. Panic disorder patients scores lower on all facets of extroversion except activity. PTSD patients scores lower on all facets of extroversion except assertiveness. MDD patients scored lower on all facets of conscientiousness. GAD, social anxiety and panic disorder patients scores lower on all facets of conscientiousness except deliberation. PTSD patients scored lower on the conscientiousness facets competence, order, self-discipline, and scored higher in deliberation. OCD patients scored lower on conscientiousness facets competence, dutifulness, achievement striving and self-discipline. MDD patients scored lower on trust, straightforwardness, altruism and compliance, and higher on modesty and tender-mindedness. GAD patients scored lower on trust, altruism, and compliance. Social anxiety patients scored lower	Fair

								on trust and altruism and scored higher on modesty and tender-mindedness. Panic disorder patients scored lower on trust and compliance and scored higher on tender-mindedness. PTSD patients scored lower on trust, and higher on straightforwardness, modesty, and tender-mindedness. OCD patients scores lower on trust, altruism, compliance, and higher on tender-mindedness. MDD patients scored lower on actions, and higher on fantasy, aesthetics, feelings and values. GAD, social anxiety and panic disorder patients scores higher on fantasy and lower on actions. PTSD patients scores lower on fantasy, aesthetics, actions, and ideas. OCD patients scored higher on fantasy, aesthetics and feelings, and lower on actions.	
Hayward et al (2013)	USA	216	112 psychiatric outpatients with MDD; 104 healthy controls. Mean age = 70.41 (SD = 5.94)	MDD	MADRS	NEO-PI-R. Administered 240 items: complete questionnaire	6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress 6 extroversion facets: warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotion 6 conscientiousness facets: competence, order, dutifulness, achievement striving, self-discipline, deliberation 6 agreeableness facets: trust, straightforwardness, altruism, compliance, modesty, tendermindedness 6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	MDD patients scores higher on all facets of neuroticism MDD patients scores lower on facets assertiveness, activity and positive emotion MDD patients scored lower on facets competence, order, dutifulness and self-discipline	Fair
Jourdy & Petot (2017)	France	58	All diagnosed with major depression without psychotic features Mean age = 41.79 (SD = 11.26) 60.34% female	MDD	BDI-II	NEO-PI-R Administered 240 items: complete questionnaire	6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress 6 extroversion facets: warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotion 6 conscientiousness facets: competence, order, dutifulness, achievement striving, self-discipline, deliberation 6 agreeableness facets: trust, straightforwardness, altruism, compliance, modesty, tendermindedness 6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	Facets angry hostility, depression, self-conscientiousness and vulnerability positively correlated with MDD Facets competence and self-discipline negatively correlated with MDD	Poor
Kaplan et al (2015)[2]	USA	Study 1: 502 Study 2: 698	Undergraduate students. Study 1: Mean age = 19.04 (SD = 1.04) 69.50% female Study 2: Mean age = 19.03 (SD = 1.58) 64.30% female	Social anxiety	Study 1: S-SAIS Study 2: SPS	NEO-IPIP Administered 10 items: facet trust	1 agreeableness facet: trust	Trust negatively correlated with social anxiety	Study 1: Good Study 2: Good
Khoo & Simms (2018)	USA	260	Current or past outpatients' psychiatric clinic in the past 2 years Mean age = 37.70 (SD = 11.90) Proportion of sexes not reported	MDD	MINI	NEO-PI-3 Administered 48 items: openness	6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	Actions, ideas, and values negatively correlated with MDD	Good

Naragon-Gainey & Simms (2017)	USA	266	Sample of psychiatric patients, part of a larger dataset for which demographic information is reported. Mean and standard deviation of age, and proportions of sexes, not reported	MDD PDD GAD Social anxiety Panic disorder OCD PTSD Agoraphobia	MINI	NEO-PI-3HF Administered 24 items: conscientiousness	6 conscientiousness facets: competence, order, dutifulness, achievement striving, self-discipline, deliberation	All conscientiousness facets except order negatively correlated with MDD, PDD, social anxiety and PTSD. Competence, dutifulness, achievement-striving and self-discipline negatively correlated with GAD. Competence and deliberation negatively correlated with OCD. No facet of conscientiousness significantly correlated with panic disorder or agoraphobia.	Good
Newby et al (2017)	Canada	271	208 undergraduates; 63 from the community Mean age = 24.25 (SD = 9.19) 79.70% female	Social anxiety	SPS	NEO-PI-R Administered 48 items: neuroticism	6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress	All facets of neuroticism positively correlated with social anxiety	Fair
Osma et al (2016)	Spain	52	Participants meeting criteria for panic disorder using the Anxiety Disorders Interview Schedule, Lifetime Version Mean age = 32.02 (SD = 10.39) 50.00% female	Panic disorder	PDSS	NEO-PI-R Administered 96 items: neuroticism and extroversion	6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress 6 extroversion facets: warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotion	Only the neuroticism facet anxiety positively correlated with panic disorder	Poor
Quilty et al (2013)	Canada	275	All participants were diagnosed with a mood disorder using the Structured Clinical Interview for DSM-IV, Axis I Disorders, Patient Version (SCID-I/P). Major depressive disorder = 119; dysthymic disorder = 18; depressive disorder not otherwise specified = 1; bipolar I disorder = 110; bipolar II disorder = 21; bipolar disorder not otherwise specified = 6 Mean age = 43.02 (SD = 11.58) 63.64% female	MDD	HamD	BFAS Administered 100 items: complete questionnaire NEO-PI-R Administered 240 items: complete questionnaire	2 neuroticism aspects: withdrawal and volatility 2 extroversion aspects: enthusiasm and assertiveness 2 conscientiousness aspects: industriousness and orderliness 2 agreeableness aspect: compassion and politeness 2 openness aspects: openness (aspect) and intellect 6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress 6 extroversion facets: warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotion 6 conscientiousness facets: competence, order, dutifulness, achievement striving, self-discipline, deliberation 6 agreeableness facets: trust, straightforwardness, altruism, compliance, modesty, tendermindedness 6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	Both aspects of neuroticism positively correlated with MDD. Both aspects of extroversion, and both aspects of conscientiousness, negatively correlated with MDD. Compassion in agreeableness and intellect in openness negatively correlated with MDD. All facets of neuroticism positively correlated with MDD. All facets of extroversion, and all facets of conscientiousness except order, negatively correlated with MDD. Trust, straightforwardness, altruism, modesty, actions and values also negatively correlated with MDD	Fair
Rees et al (2005)	Australia	14	Psychiatric outpatients with a diagnosis of a non-OCD affective disorder Mean age = 38.59 (SD = 10.21) Proportions of sexes are not reported for the correlational analysis	MDD	BDI	NEO-PI-R Administered 240 items: complete questionnaire. Only performed correlations for facets competence and self-discipline	6 neuroticism facets: anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability to stress 6 extroversion facets: warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotion 6 conscientiousness facets: competence, order, dutifulness, achievement striving, self-discipline, deliberation 6 agreeableness facets: trust, straightforwardness, altruism, compliance, modesty, tendermindedness 6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	Competence and self-discipline negatively correlated with MDD	Poor

Wolfenstein & Trull (1997)	USA	143	Current depression = 46; past depression = 50; never-depressed control = 47. Correlations performed on the entire sample. Mean and standard deviation of age not reported 51.05% female	MDD	IDD BDI	NEO-PI-R Administered 48 of 240 items: openness	6 openness facets: fantasy, aesthetics, feelings, actions, ideas, values	Aesthetics positively correlated with MDD	Fair

Note. BDI = Beck Depression Inventory. BDI-II = Beck Depression Inventory – Second Edition. HamD = Hamilton Rating Scale for Depression. IAS = Illness Anxiety Scale. IDD = Inventory to Diagnose Depression. MINI = Mini-international Neuropsychiatric Interview. SCID = Structured Clinical Interview for DSM-IV. SPS = Social Phobia Scale. S-SAIS = Straightforward Social Interaction Anxiety Scale.
Personality measures: BFAS: Big Five Aspect Scale. NEO-IPIP = Neuroticism Extroversion Openness - International Personality Item Pool. NEO-PI = Neuroticism Extroversion Openness – Personality Inventory. NEO-PI-R = Neuroticism Extroversion Openness – Personality Inventory – Revised.
[1] This study compared the personality scores of the "major depressive disorders" group with population norms described by Costa & McCrea (1992). The vast majority of participants in this group had a diagnosis of MDD (788 out of 803 participants), therefore the results for this group are reported as associations between personality facets and MDD status.
[2] Kaplan et al (2015) consisted of two correlational studies

The other disorders investigated included persistent depressive disorder (PDD; k = 1), generalized anxiety disorder (GAD; k = 2), panic disorder (k = 3), obsessive-compulsive disorder (OCD; k = 2), post-traumatic stress disorder (PTSD; k = 2), illness anxiety disorder (IAD; k = 1) and agoraphobia (k = 1). As see in Table 1, there was low consistency across the outcome measures used for affective disorders. For example, the most common measure of depression was the Beck Depression Inventory, which was only used in five of the ten studies investigating MDD.

Two studies investigated the associations between personality aspects and MDD (Allen et al, 2018; Quilty et al, 2013), consisting of 16 extracted associations. Fourteen studies measured personality facets using variations of the NEO-PI-R, with a total of 400 extracted associations between personality facets and affective disorder measures. Associations between facets of conscientiousness and affective disorder measures were reported most often, making up 110 of the extracted associations (27.50%).

4.3.1 Best evidence synthesis: personality aspects

Best evidence synthesis at the aspect level found strong evidence that the neuroticism aspect withdrawal was positively associated with MDD; associations between volatility and MDD found conflicting results (Table 4.2). Studies into extroversion aspects and MDD also yielded conflicting results. There was strong evidence that the conscientiousness aspect industriousness was negatively associated with MDD; tests of association between orderliness and MDD yielded conflicting results. There was weak evidence that the agreeableness aspect compassion was negatively associated with MDD, and weak evidence that politeness was not significantly associated with MDD.

Table 4.2
Best evidence synthesis of personality aspects and MDD

	Personality aspect	MDD
Neuroticism	Withdrawal	++
	Volatility	±
Extroversion	Enthusiasm	±
	Assertiveness	±
Conscientiousness	Industriousness	--
	Orderliness	±
Agreeableness	Compassion	-
	Politeness	0
Openness	Openness (aspect)	0
	Intellect	-

Note. MDD: Major Depressive Disorder
++ or – or 00: Strong evidence of a positive correlation (++), negative correlation (- -) or no correlation (00) i.e., consistent findings in multiple studies "fair" methodological quality or in one study of "good" methodological quality
+ or – or 0: Weak evidence of a positive correlation (+), negative correlation (-) or no correlation (0) i.e., in reported in one study of "fair" methodological quality, or consistently in multiple studies of poor quality
±: Conflicting evidence

There was weak evidence that the aspect openness (relating to creativity) was not significantly associated with MDD, however there was weak evidence that the openness aspect intellect was negatively associated with MDD. As neither of the studies investigating associations between personality aspects and affective disorder scores had poor quality, a subsequent best evidence synthesis excluding poor-quality studies was not performed.

4.3.2 Best evidence synthesis: personality facets

Two poor-quality studies investigated associations between all personality facets and MDD (Jourdy & Petot, 2017; Rees et al, 2005), and one poor-quality study investigated associations between personality all facets and panic disorder (Osma et al, 2016). Therefore, two best evidence syntheses were performed: one in which all studies of personality facets were included; and one in which poor-quality studies were excluded. When poor-quality studies were included in the best evidence synthesis, there was conflicting evidence regarding the associations

between most facets of neuroticism and extroversion and panic disorder. When poor-quality studies were excluded, there was weak evidence that all facets of neuroticism positively correlated with panic disorder, and that all facets of extroversion, except activity, negatively correlated with panic disorder. When poor-quality studies were included, there was also conflicting evidence regarding the associations between MDD and facets anxiety, positive emotion, and dutifulness. When poor-quality studies were excluded, there was strong evidence of a positive association between facet anxiety and MDD, strong evidence of a negative association between positive emotion and MDD, and strong evidence on a negative association between dutifulness and MDD (Table 4.3).

4.3.2.1 *Neuroticism*

There was strong evidence that most facets of neuroticism were positively correlated with MDD and social anxiety, and weak evidence that most facets of neuroticism positively associated with GAD, OCD, PTSD and IAD; these results were not affected by excluding poor-quality studies. When including poor-quality studies, there was conflicting evidence regarding associations between most facets of neuroticism and panic disorder; when excluding poor-quality studies, there was weak evidence that all facets of neuroticism positively correlated with panic disorder.

4.3.2.2 *Extroversion*

Studies of facets of extroversion and MDD mostly yielded conflicting results. Nevertheless, there was weak evidence that positive emotion negatively associated with various distress disorders such as GAD, social anxiety, OCD, PTSD and IAD.

Table 4.3
Best evidence synthesis of personality facets and affective disorders

		Depressive disorders		Anxiety disorders						
Personality trait	Personality facet	MDD	PDD	GAD	Social anxiety	Panic disorder	OCD	PTSD	IAD	Agoraphobia
Neuroticism	Anxiety	± (++)		+	++	+	+	+	+	
	Angry hostility	++		+	++	± (+)	+	+	+	
	Depression	++		+	++	± (+)	+	+	+	
	Self-consciousness	++		+	++	± (+)	+	+	+	
	Impulsivity	± (++)		+	++	± (+)	+	-	+	
	Vulnerability to stress	++		+	++	± (+)	+	+	+	
Extroversion	Warmth	±		-	-	± (-)	-	-	0	
	Gregariousness	±		-	-	± (-)	-	-	0	
	Assertiveness	±		-	-	± (-)	-	0	-	
	Activity	±		0	-	0	0	-	-	
	Excitement-seeking	±		0	0	± (-)	0	-	0	
	Positive emotion	± (--)		-	-	± (-)	-	-	-	
Conscientiousness	Competence	--	--	--	--	±	--	--	-	00
	Order	±	00	±	±	±	00	±	0	00
	Dutifulness	± (--)	--	--	--	±	±	±	-	00
	Achievement striving	±	--	--	--	±	±	±	-	00
	Self-discipline	--	--	--	--	±	±	--	-	00
	Deliberation	±	--	00	±	00	±	±	0	00
Agreeableness	Trust	±		-	--	-	-	-	-	
	Straightforwardness	±		0	0	0	0	+	0	
	Altruism	±		-	-	0	-	0	0	
	Compliance	±		-	0	-	-	0	0	
	Modesty	±		0	+	0	0	+	-	
	Tendermindedness	±		0	+	+	+	+	-	
Openness	Fantasy	±		+	+	+	+	-	0	
	Aesthetics	±		0	0	0	+	-	0	
	Feelings	±		0	0	0	+	0	0	
	Actions	±		-	-	-	-	-	0	
	Ideas	±		0	0	0	0	-	-	
	Values	±		0	0	0	0	0	0	

Note. MDD: Major Depressive Disorder. PDD: persistent depressive disorder. GAD: generalised anxiety disorder. OCD: obsessive compulsive disorder. PTSD: post-traumatic stress disorder. IAD: illness anxiety disorder
++ or – or 00: Strong evidence of a positive correlation (++), negative correlation (- -) or no correlation (00) i.e., consistent findings in multiple studies "fair" methodological quality or in one study of "good" methodological quality
+ or – or 0: Weak evidence of a positive correlation (+), negative correlation (-) or no correlation (0) i.e., in reported in one study of "fair" methodological quality, or consistently in multiple studies of poor quality
±: Conflicting evidence
Blank cells indicate absence of evidence i.e., only studies of "poor" methodological quality, or lack of relevant information reported. Poor-quality studies investigated the associations between all personality facets and MDD, and between all personality facets and panic disorder. In cases where excluding poor-quality studies affected the results, the level of evidence when excluding poor-quality studies is shown in brackets

There was also weak evidence that warmth and gregariousness negatively associated with GAD, social anxiety, OCD and PTSD, and that assertiveness negatively associated with GAD, social anxiety, OCD and IAD. Removing poor-quality studies did not affect these results. When including poor quality studies, there was conflicting evidence regarding the association between positive emotion and MDD; when excluded poor-quality studies, there was also strong evidence of a negative association between positive emotion and MDD. When including poor-quality studies, there was conflicting evidence regarding associations between most facets of extroversion and panic disorder; when excluding poor-quality studies, there was weak evidence that that all facets of extroversion, except activity, negatively correlated with panic disorder.

4.3.2.3 *Conscientiousness*

This review found strong evidence that the conscientiousness facets competence and self-discipline negatively associated with MDD, PDD, GAD, social anxiety and PTSD. There was also strong evidence that competence negatively associated with OCD, and weak evidence that competence negatively associated with IAD. There was also strong evidence that the conscientiousness facets dutifulness and achievement-striving negatively associated with PDD, GAD and social anxiety. When including poor quality studies, there was conflicting evidence regarding the association between dutifulness and MDD; when excluded poor quality studies, there was also strong evidence of a negative association between dutifulness and MDD.

4.3.2.4 *Agreeableness*

Studies of all facets of agreeableness and MDD yielded conflicting results. There was strong evidence that trust negatively associated with social anxiety, and weak evidence that trust negatively associated with GAD, panic disorder, OCD, PTSD and IAD. There was weak evidence that straightforwardness, modesty and tendermindedness were positively associated with PTSD, and that tendermindedness also positively associated with social anxiety, panic disorder and OCD. Removing poor-quality studies did not affect these results.

4.3.2.5 *Openness*

There was conflicting evidence regarding all facets of openness and MDD. There was weak evidence that most facets of openness did not significantly associate with GAD, social anxiety, panic disorder and IAD. Best evidence synthesis found weak evidence that fantasy positively associated with GAD, social anxiety, and panic disorder; and weak evidence that actions negatively associated with GAD, social anxiety, panic disorder, OCD and PTSD. This review also found weak evidence that fantasy, aesthetics, and feelings positively associated with OCD. As with facets of agreeableness, removing poor-quality studies did not affect the results of associations between facets of openness and affective disorders.

4.4 **Discussion**

The aim of this systematic review was to determine which personality facets were significantly associated with affective disorders. Fifteen studies were identified across fourteen publications, most of which focused on MDD or social anxiety. Fifteen studies investigated personality facets, and two investigated correlations

between personality aspects and MDD. There was strong evidence that aspect withdrawal in neuroticism, and most facets of neuroticism, positively associated with various affective disorders; and that aspect industriousness, facet competence and facet self-discipline in conscientiousness, negatively associated with various affective disorders. There was weak evidence that facet positive emotion in extroversion, facet trust in agreeableness, and facet actions in openness negatively correlated with several affective disorders.

Several studies investigating the associations between personality facets and affective disorder scores had poor quality (Jourdy & Petot, 2017; Osma et al, 2016; Rees et al, 2005). As several poor-quality studies were statistically underpowered (Jourdy & Petot, 2017; Osma et al, 2016; Rees et al, 2005), their results may have been false negatives, and their inclusion may have unduly affected the final results. Therefore, a subsequent best evidence synthesis was performed in which poor-quality studies were excluded. Excluding poor-quality studies affected fourteen associations, ten of which were associations between personality facets and panic disorder: when including poor-quality studies, associations into most facets of neuroticism and extroversion and panic disorder yielded conflicting results. However, when excluding poor-quality studies, best evidence synthesis found weak evidence that all facets of neuroticism positively associated with panic disorder, and that most facets of extroversion negatively associated with panic disorder.

There was strong evidence that all facets of neuroticism were positively correlated with social anxiety, and weak evidence that all facets of neuroticism were positively correlated with GAD, OCD, panic disorder and IAD. There was also strong evidence that most neuroticism facets were positively associated with MDD. Taken together, and in line with findings that broad trait neuroticism is positively

associated with various affective disorders (Kotov et al, 2010), these findings suggest that trait neuroticism may be a transdiagnostic risk factor in affective disorders. This suggests that strategies focusing on any narrow facet of neuroticism, such as facet anxiety or facet self-consciousness, may be effective in reducing symptoms of affective disorders.

While the majority of evidence suggested that broad trait neuroticism was positively associated with affective disorder, all other traits showed a more mixed pattern, with significant associations for some facets and aspects but not for others. For example, within extroversion, there was strong evidence that positive emotion negatively correlated with MDD. This is unsurprising, as MDD is marked by high negative emotion and low positive emotion (Verstraeten et al, 2009); positive emotion also negatively associated with anxiety disorders such as GAD, social anxiety, panic disorder, OCD, PTSD and IAD. Positive emotion is maintained through movement toward goals (Carver & Scheier, 2013; Wilt et al, 2017), therefore individuals high in facet positive emotion may be more motivated to overcome challenges and engage in more active coping, thus reducing the risk of affective disorders. Positive attentional and memory biases may also mediate the relationship between positive emotion and affective disorders. Trait extroversion is associated with both active coping (Carver & Connor-Smith, 2010; Connor-Smith & Flachsbart, 2007) and positive affective cognitive biases (Amin et al, 2004; Canli et al, 2004), however we are unaware of any studies which have correlated those possible mediators with facet positive emotion.

There was weak evidence that the extroversion facets of warmth, gregariousness, and assertiveness were negatively associated with several anxiety disorders. Warmth and gregariousness refer to motivation toward socializing (Costa

& McCrea, 1992), suggesting that individuals high in these facets may receive more social support, reducing the risk of anxiety disorders. Assertiveness, defined as competitiveness and leadership (Costa & McCrea, 1992; Ellis & Torochuk, 2013), may reduce the risk of affective disorders though social interaction; furthermore, assertiveness also positively correlates with active coping (Tankamani & Jalali, 2018). Overall, various facets of extroversion, referring to positive emotion, socializing, and assertiveness were associated with lower affective disorder scores. This is confirmed by a study measuring personality using composites of FI-FFM facet scores, suggesting that both the sociability and assertiveness components of extroversion significantly negatively correlate with depression (Watson et al, 2019a).

This review found strong evidence that the conscientiousness facets of competence and self-discipline were negatively associated with various affective disorders, including MDD, PDD, GAD, social anxiety, and PTSD. Competence, also called generalised self-efficacy, is defined as an individual's perception of their ability to solve a given problem (Costa & McCrea, 1985, 1995). Competence beliefs determine whether stressors are appraised as challenges or threats (Folkman, 1984), and therefore directly downregulate negative emotion (Bandura, 1994; 1997, pp. 153) and facilitates active coping (Hahn, 2000), thus reducing the severity of affective disorders (Bjørkløf et al, 2013; Sawhney et al, 2018). Furthermore, competence is positively correlated with attentional and memory biases to positive information (Brown et al, 2012; Karademas et al, 2007), which are also negatively associated with affective disorders (Beck & Haigh, 2014). Self-discipline refers to both persistence and productivity, which may promote active coping (Eisenberg et al, 2014). Additionally, the significant effect of self-discipline may be explained by competence: perceived competence is derived from reflections of experiences of

problem-solving (Bandura 1994). Individuals with higher self-discipline are more effective problem-solvers, and therefore have higher competence (DeClerek et al, 2006). Overall, competence and self-discipline may be associated with lower affective disorder scores via active coping.

This review found strong evidence that the agreeableness facet trust negatively correlated with social anxiety, and weak evidence that trust negatively associated with GAD, panic disorder, OCD, PTSD and IAD. One possible mediator is social support seeking, as individuals high in trust use more incremental and emotional social support, which significantly reduces the severity of affective disorders (Bjørkløf et al, 2013; Sawhney et al, 2018). One study found that several facets of agreeableness positively associated with PTSD, however this study used a small sample of individuals within this patient group (Friesen, 2008; n = 78), meaning these may be anomalous results. While trust significantly correlates with various affective disorders, the correlation between broad trait agreeableness and affective disorders is non-significant (Kotov et al, 2010). This highlights the importance of investigating lower-order personality facets, as significant associations can go unobserved when only measuring personality traits.

There was weak evidence that most facets of openness did not significantly associate with anxiety disorders. Nevertheless, there was weak evidence that the openness facet actions negatively associated with GAD, social anxiety, panic disorder, OCD and PTSD. Individuals high in openness to actions are willing to carry out novel behaviours (Costa & McCrea, 1985, 1995). Therefore, it is possible that openness to actions may facilitate active coping. Conversely, there was weak evidence that openness to fantasy positively associated with various anxiety disorders. One possible explanation for this is that openness to fantasy leads to more

frequent worrying and wishful thinking, rather than effective planning, which may increase affective disorder scores. Future research into openness and affective disorders should therefore focus on the facets of actions and fantasy.

Best evidence synthesis yielded several conflicting results, especially regarding associations between facets of extroversion and neuroticism, and MDD and panic disorder. Many conflicting results were explained by study quality, as poor-quality studies used statistically underpowered samples, meaning some of their results may have been false negatives (Jourdy & Petot, 2017; Osma et al, 2016; Rees et al, 2005). While underpowered samples did not explain all conflicting results, future researchers should ensure they use statistically powered samples, to reduce the chances of false negatives and conflicting results between studies.

This review highlights some important gaps in the current literature. Firstly, three studies had poor quality due to underpowered samples (Jourdy & Petot, 2017; Osma et al, 2016; Rees et al, 2005). This resulted in conflicting results, as significant effects in statistically powered studies were often non-significant in underpowered studies. Secondly, all studies used a cross-sectional design, meaning that it is not possible to determine causation. For instance, personality traits may be vulnerability factors predicting affective disorders (Ormel et al, 2013; Watson et al, 2006). Evidence in line with this explanation comes from longitudinal studies that have found that high trait neuroticism, low extroversion, and low conscientiousness temporally precede both anxiety and depressive disorders (Spinhoven et al, 2016; Struijs et al, 2018). However, associations may also be due to scar effects, whereby affective disorders causally affect personality constructs (Ormel et al, 2013; Watson et al, 2006), as suggested by evidence showing that the onset and development of MDD is followed by an increase in trait neuroticism, and a decrease in trait

conscientiousness (Karsten et al, 2012). It is also possible that affective disorders may have state effects on personality, as trait neuroticism increases due to MDD onset but decreases during remission from MDD (Spinhoven et al, 2013). It is also possible that there are multiple causal effects, or that there are different causal effects explaining different associations. By using cross-sectional designs, the existing research into lower-order personality constructs is unable to distinguish between these models of causation. Longitudinal studies will help to distinguish between vulnerability, scar, and state effects.

This review has several limitations. Firstly, a meta-analysis could not be performed due to the use of heterogenous measures of affective disorders. Therefore, it was not possible to calculate average effect sizes of associations between personality constructs and affective disorder measures, or to weight these measures by sample size (Center for Reviews and Dissemination, 2008). Secondly, this review only included studies using the Big Five model of personality, meaning it is not clear how affective disorders correlate with facets across other models of personality. Nevertheless, limiting the review to one model of personality maintains construct validity, meaning that results can be meaningfully synthesized across studies. Thirdly, the review was limited to studies measuring personality facets with the NEO-PI-R (Costa & McCrea, 1992). While this is the predominant measure of personality facets (Xie & Cobb 2020), there are alternative validated measures of personality facets, such as the BFI-2, with three facets per trait (Soto & John, 2017) and the FI-FFM, with between three and five facets per trait (Watson et al, 2019b). Furthermore, several studies have investigated correlations between affective disorder scores and Big Five facets derived from factor analyses of various measures

of lower-order facets (Naragon-Gainey et al, 2009; Naragon-Gainey, 2011). Again, limiting this review to a single model of personality facets ensures construct validity.

There are also some strengths to this review. One strength is that this review was not limited to studies published in English, with several articles being translated by an experienced translator (Bresson, 2006; Jourdy, 2013; Kim, 2012). This ensures that the conclusions of this review reflect the wider research community, rather than just research published in English. Another strength is that this review controlled for poor-quality studies, by performing an additional best evidence synthesis excluding poor-quality studies. Therefore, the results of this review are unlikely to be unduly affected by poor-quality studies.

Future research should focus on possible mediating pathways between lower-order personality constructs and affective disorders. One possible mediator is the use of emotion regulation strategies, as neuroticism predicts avoidant coping (Carver & Connor-Smith, 2010; Connor-Smith & Flachsbart, 2007; Hahn, 2000). Another possible mediator is affective cognition, as competence is associated with positive attentional and memory biases, while neuroticism is associated with negative attentional and memory biases (Amin et al, 2004; Brown et al, 2012; Canli et al, 2004).

4.5 **Conclusion**

This systematic review reveals that a range of affective disorders are associated with high trait neuroticism, low positive emotion in extroversion, and low competence and self-discipline in conscientiousness. Furthermore, anxiety disorders are associated with low trust and low openness to actions, along with high openness

to fantasy. Investigating these personality facets may help to improve our understanding of the development of affective disorders. Future research is needed to investigate possible mediating mechanisms, such as emotion regulation strategies and affective cognition. This will improve our understanding of how personality may contribute to affective disorders, and how affective disorders may impact personality.

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4.6.2 Conflict of interest

The authors report no conflict of interest.

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Supplementary table 4.1
Summary of results: associations between personality aspects and affective disorders

	Study	Allen et al (2018)	Quilty et al (2013)
	Affective disorder	MDD	MDD
Neuroticism	Withdrawal	0.29**	0.42**
	Volatility	0.09	0.59**
Extroversion	Enthusiasm	-0.07	-0.39**
	Assertiveness	-0.04	-0.29**
Conscientiousness	Industriousness	-0.13*	-0.50**
	Orderliness	-0.02	-0.19**
Agreeableness	Compassion		-0.13**
	Politeness		-0.03
Openness	Openness (aspect)		-0.03
	Intellect		-0.24**

Note. * Significant at $p<0.05$; ** Significant at $p<0.01$

Supplementary table 4.2
Summary of results: associations between personality facets and affective disorders

	Study	Bagby et al (1995)[1]	Cox et al (2000)[2]	Friesen (2008)[3,4]						Hayward et al (2013)[6]	Jourdy & Petot (2017)[7]	Kaplan et al (2015) Study 1	Kaplan et al (2015) Study 2	Khoo & Simms (2018)	Naragon-Gainey & Simms (2017)[8]								Newby et al (2017)[9]	Osma et al (2016)[3]	Quilty et al (2013)	Rees et al (2005)[10]	Wolfestein & Trull (1997)[10]
	Affective disorder	MDD	IAD	MDD[5]	GAD	Social anxiety	Panic disorder	PTSD	OCD	MDD	MDD	Social anxiety	Social anxiety	MDD	MDD	PDD	GAD	Social anxiety	Panic disorder	OCD	PTSD	Agoraphobia	Social anxiety	Panic disorder	MDD	MDD	MDD
Neuroticism	Anxiety	0.62**	0.60**	1.21*	2.04*	1.74*	1.68*	0.80*	1.70*	1.11**	0.40												0.50**	0.41*	0.54**		
	Angry hostility	0.56**	0.37**	0.91*	1.32*	0.96*	1.02*	0.35*	1.10*	1.07**	0.44**												0.37**	0.04	0.33**		
	Depression	0.43**	0.52**	1.95*	1.80*	1.79*	1.34*	0.97*	1.59*	1.16**	0.70**												0.50**	0.16	0.56**		
	Self-consciousness	0.57**	0.46**	1.10*	1.46*	2.23*	1.05*	0.38*	1.36*	1.06**	0.47**												0.61**	0.00	0.40**		
	Impulsivity	0.43**	0.26**	0.46*	0.61*	0.33*	0.38*	-0.27*	0.73*	1.11**	0.39												0.19**	0.14	0.16**		
	Vulnerability to stress	0.40**	0.48**	1.58*	2.48*	2.00*	1.64*	0.88*	1.90*	1.12**	0.67**												0.50**	0.18	0.49**		
Extroversion	Warmth	0.14	-0.10	-0.84*	-1.27*	-1.64*	-0.70*	-0.81*	-0.97*	0.96	-0.27													0.11	-0.35**		
	Gregariousness	0.16	-0.06	-0.43*	-0.48*	-0.97*	-0.43*	-0.63*	-044*	1.00	-0.24													-0.09	-0.34**		
	Assertiveness	-0.09	-0.26**	-0.60*	-0.44*	-1.43*	-0.36*	-0.19	-0.73*	0.95*	-0.33													0.19	-0.18**		
	Activity	0.07	-0.12*	-0.62*	-0.35	-0.63*	-0.25	-0.34*	-0.11	0.93**	-0.35													0.23	-0.26**		
	Excitement-seeking	-0.04	-0.10	-0.22*	-0.23	0.02	-0.45*	-0.53*	-0.16	1.03	0.09													-0.11	-0.17**		
	Positive emotion	-0.33**	-0.12*	-1.16*	-1.47*	-1.04*	-0.87*	-0.96*	-0.13*	0.95**	-0.35													0.06	-0.37**		
Conscientiousness	Competence		-0.28**	-1.01*	-1.63*	-1.54*	-0.77*	-0.57*	-1.14*	0.94*	-0.44*				-0.43**	-0.35**	-0.25**	-0.28**	-0.10	-0.22**	-0.39**	-0.03			-0.38**	-0.69**	
	Order		-0.03	-0.58*	-0.72*	-0.74*	-0.53*	-0.40*	-0.11	0.94*	-0.26				-0.08	0.01	0.03	-0.03	-0.01	0.00	-0.01	0.01			-0.08		
	Dutifulness		-0.21**	-0.66*	-0.50*	-0.56*	-0.49*	-0.21	-0.58*	0.94*	-0.37				-0.28**	-0.24**	-0.14*	-0.16*	0.00	-0.09	-0.26**	-0.04			-0.37**		
	Achievement striving		-0.21**	-0.81*	-0.67*	-1.00*	-0.55*	-0.03	-0.66*	0.97	-0.36				-0.30**	-0.23**	-0.14*	-0.22**	-0.07	-0.09	-0.22**	-0.10			-0.31**		
	Self-discipline		-0.36**	-1.34*	-1.94*	-1.58*	-1.14*	-0.46*	-1.50*	0.93*	-0.45**				-0.34**	-0.25**	-0.21**	-0.21**	-0.09	-0.11	-0.27**	-0.05			-0.46**	-0.60*	
	Deliberation		-0.08	-0.19*	-0.13	-0.02	-0.16	0.36*	-0.09	0.96	-0.31				-0.27**	-0.22**	-0.08	-0.15*	-0.04	-0.18**	-0.30**	-0.05			-0.22**		
Agreeableness	Trust		-0.31**	-0.79*	-1.59*	-1.15*	-0.84*	-0.57*	-0.91*	0.95	-0.25	-0.20**	-0.22**												-0.30**		
	Straightforwardness		-0.07	-0.03*	-0.23	0.02	0.17	0.51*	-0.06	0.99	-0.05														-0.12*		
	Altruism		-0.09	-0.26*	-0.55*	-0.46*	-0.18	0.15	-0.39*	0.99	-0.30														-0.13*		
	Compliance		-0.02	-0.33*	-0.70*	-0.10	-0.52*	-0.22	-0.48*	0.97	-0.03														-0.04		
	Modesty		-0.13*	0.51*	-0.29	0.48*	0.24	0.59*	0.06	1.02	0.14														0.18*		
	Tendermindedness		-0.12*	0.23*	-0.07	0.42*	0.29*	0.34*	0.42*	1.01	-0.14														-0.04		
Openness	Fantasy	0.40**	0.09	0.31*	0.52*	0.40*	0.38*	-0.46*	0.62*	1.00	0.00			-0.07											0.08		-0.01
	Aesthetics	0.34**	0.03	0.15*	0.17	-0.06	0.20	-0.41*	0.37*	0.99	-0.14			0.00											-0.07		0.35*
	Feelings	0.37**	0.11	0.20*	0.03	-0.05	0.21	-0.09	0.29*	1.00	0.13			-0.10											0.03		0.14
	Actions	-0.18	-0.10	-0.17*	-0.58*	-0.74*	-0.37*	-0.48*	-0.55*	0.98	0.00			-0.20**											-0.26**		-0.15
	Ideas	0.12	-0.20**	0.02	0.12	-0.20	0.07	-0.48*	0.02	0.97	-0.19			-0.14*											-0.04		0.02
	Values	0.12	-0.08	0.32*	-0.02	-0.06	0.16	-0.23	0.22	0.99	-0.25			-0.20**											-0.12*		0.08

Note. * Significant at p<0.05; ** Significant at p<0.01
Blank if not reported/investigated
1 Data were collected at two times, measuring depression with both the Beck Depression Inventory and the Hamilton Depression Rating Scale. Correlations are reported for time 1, using the Beck Depression Inventory
2 This study investigated correlations between personality facets and Health Anxiety and Health Behaviour, as subscales of the Illness Anxiety Scale. Correlations are reported for the Health Anxiety subscale
3 This study only stated whether results were significant at p<0.05
4 This study used Hedges' g effect size differences, comparing personality facet scores of psychiatric outpatients with population norms described by Costa & McCrea (1992)
5 The vast majority of this subsample consisted of patients with major depressive disorder (n = 788); this subsample also included several patients with persistent depressive disorder (n = 12) and major depression not otherwise specified (n = 3)
6 This study used odds rations, of depressed vs non-depressed participants
7 This study only stated whether results were significant at the Bonferroni-corrected p<0.0016
8 This study measured semipartial correlations between affective disorders and facets of conscientiousness, controlling for trait neuroticism
9 This study measured social phobia with both the Social Interaction Anxiety and the Social Phobia Scale, with similar results. Correlations using the Social Phobia Scale are reported
10 This study measured depression with both the Inventory to Diagnose Depression and the Beck Depression Inventory. Correlations using the Beck Depression Inventory are reported

Chapter Five

Paper Three

Big Five Personality Facets explaining variance in Anxiety and Depressive Symptoms in a Community Sample

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Kieran Lyon conceived the original idea for the study, planned and performed all statistical analyses, wrote the manuscript, and completed all revisions following review by the co-authors.

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Abstract

Background

Personality traits are risk and protective factors in affective disorders. However, few studies have investigated the role of narrow personality facets, with existing research yielding contradictory results. Previous research has mostly focused on simple correlations. Several studies have performed separate multiple regressions within each trait, and have used non-standard measures of personality, making it difficult to determine how individual facets make unique contributions.

Method

This study performed secondary analysis of the "NewMood" data set (collected 2004-2009), comprising 264 participants from Greater Manchester. Participants provided self-reports of all NEO-PI-R personality facets, and semi-structured questionnaires of clinical depression and anxiety. All personality facets were entered into multiple regressions to explain variance in depression and anxiety.

Results

Variance in both anxiety and depression were explained by a small number of personality facets, namely facet depression (referring to sadness and demotivation), facets positive emotion and assertiveness in extroversion, and facet competence in conscientiousness.

Limitations

This study relies on cross-sectional data and cannot determine causation. This study uses a mostly female sample, and the results were not stratified by sex due to the small sample.

Conclusion

Previous studies suggest that broad trait neuroticism positively associates with affective disorders; this study adds that the effect of neuroticism is limited to facet depression (related to sadness and demotivation). Contrary to previous studies, no facet of agreeableness or openness explained variance in affective disorders, and facet assertiveness positively associated with affective disorder scores. These findings may help to improve treatment matching and explain the mechanisms through which affective disorders develop.

Highlights

- Neuroticism, extroversion and conscientiousness facets explained affective disorders
- Most personality facets did not significantly explain variance in affective disorders
- Depression was explained by 4 facets; anxiety by 5 facets

5.1 **Introduction**

There is a long history of research into the relationship between personality and affective disorders. As early as 1902, William James wrote about a morbid-minded temperament, which contributed to the risk of developing melancholy (James, 2003). By the 1990s, personality research converged on five dimensions of personality, which are described in various five-factor models (Goldberg, 1990). Of these, the dominant model of personality became the Big Five model (Church, 1994; DeYoung et al, 2015), which posits that personality varies across five traits: neuroticism, extroversion, conscientiousness, agreeableness, and openness (Costa & McCrea, 1995; 2008). While other models of personality are still used, the widespread use of the Big Five means that results can be easily compared and integrated across the personality literature.

Big Five personality traits are derived from factor analysis, meaning each trait is a statistical common factor of various narrower personality measures (Costa & McCrea, 1995; DeYoung et al, 2007). This means that personality can be investigated at various levels of what DeYoung calls the personality hierarchy, from broad higher-order traits, to narrow lower-order facets (DeYoung et al, 2007). In the Neuroticism Extroversion Openness – Personality Inventory – Revised (NEO-PI-R), each personality trait comprises six facets, measured with a separate subscale, all of which correlate with each other, yet represent distinct concepts (Costa & McCrea, 1995; 2008). For example, extroversion includes facets such as facet positive emotion, relating to positive affect in temperament, and facet assertiveness, relating to competitiveness and leadership (Costa & McCrea, 1995; 2008).

Big five personality traits are strongly related to affective disorders, with affective disorders relating to high neuroticism and low scores across the other four Big Five personality dimensions (Bienvenu et al, 2004; Eisenberg et al, 2009; Karsten et al, 2012; Kotov et al, 2010). For example, the amount of variance explained in depression by personality has been shown to be around 36% (Quilty et al, 2013). There is also evidence of a reciprocal relationship between personality traits and affective disorders, with personality traits being risk factors for affective disorders, known as the vulnerability model (Ormel et al, 2013; Watson et al, 2006), and affective disorders causing changes in personality, known as the scar model (Ormel et al, 2013; Watson et al, 2006).

Personality-informed interventions at the trait level have been used for treatment matching in affective disorders. For example, individuals higher in neuroticism tend to be more responsive to pharmacotherapy compared to psychotherapy (Bagby et al, 2008; 2016). Higher extroversion also relates to greater responsiveness to interpersonal therapy (Joyce et al, 2007). Using a sample of psychiatric outpatients, Quilty et al (2013) found that lower-order personality constructs consistently explained more variance in depression than higher-order traits. Treatment-matching for affective disorders may, therefore, be improved by investigating personality facets, which are conceptually different enough to relate to different treatment approaches to affective disorders (Zinbarg et al, 2008).

Existing literature has hypothesized that personality facets may affect responsiveness to treatment. For example, individuals with lower facet positive emotion may be more responsive to Positive Psychology Interventions compared to other psychotherapies (González-Robles et al, 2019); individuals with low facet assertiveness may benefit most from assertiveness training (Zinbarg et al, 2008); and

individuals low on facet competence may benefit most from Behavioural Activation (Martínez-Vispo et al, 2018; Kanter et al, 2010; Richards et al, 2016; Zinbarg et al, 2008). As facets have higher specificity than traits (DeYoung et al, 2007; Soto & John, 2017), investigating personality facets may, therefore, improve treatment-matching for affective disorders.

Many studies rely on simple correlations (Bienvenu et al, 2004; Hayward et al, 2013; Walton et al, 2018) or between-group comparisons (Rector et al, 2002) rather than using multiple regression to determine which combination of facets best predict affective disorders. This is important as some correlations between facets and affective disorders may be better explained by other facets, and not contribute any unique predictive value. For example, Cox et al (1999) used multiple regression, entering facets of neuroticism and anxiety sensitivity as predictors of OCD. While all six neuroticism facets significantly correlated with OCD, multiple regression reduced this to the two facets, facet anxiety and facet vulnerability (controlling for anxiety sensitivity), demonstrating the value of using this approach when considering facet-level predictors of all relevant traits.

Whilst some recent studies have performed multiple regressions of personality facets explaining variance in affective disorders, these analyses are often limited to individual personality domains. For example, Naragon-Gainey (2011) and Uliaszek et al (2009) only investigated facets of neuroticism, concluding that only facet depression (related to sadness and demotivation, rather than clinical depression) positively associated with depression. Similar multiple regressions have investigated facets of extroversion, finding that only facet positive emotion significantly negatively associated with both depression (Naragon-Gainey, 2011) and psychological wellbeing (Margolis et al, 2019). Furthermore, some of these studies

have derived their own personality facets from measures of both Big Five and non-Big Five personality measures in a single sample, with one study identifying four facets of extroversion (Naragon-Gainey, 2011); one identifying five facets of neuroticism (Naragon-Gainey et al, 2009); and another identifying three facets for each Big Five trait (Naragon-Gainey & Watson, 2014). While these studies help to explain the structure of personality traits, such studies do not use validated measures of personality, making it different to generalize their results.

We are only aware of one study which performed multiple regressions of facets across all Big Five traits (Quilty et al, 2013). However, this study performed separate multiple regressions for facets within each personality trait. Performing separate analyses for each trait separately assumes that traits vary independently, whereas, in fact, personality traits vary across a common pattern, with individuals higher in neuroticism tending to be lower in agreeableness and conscientiousness, while individuals high in extroversion also tend to be high in openness (DeYoung et al, 2017). As Big Five traits are not entirely independent, it is possible that the effects of a facet in one personality trait may be better explained by the effect of a facet across another trait. For example, neuroticism contains the facet angry hostility, and agreeableness contains the facet trust. When analysing personality domains separately, both facets appear to significantly explain variance in depression (Quilty et al, 2013). However, these facets have conceptual overlap, as individuals high in angry hostility may be less trustful. In fact, the factor-analysis derived personality facets used by Naragon-Gainey (2011) included mistrust as a facet of neuroticism. Future multiple regression studies should, therefore, include all personality facets as predictors in the same regression, to account for correlations and conceptual overlap between personality facets.

While previous studies use novel measures of personality facets or analyse facets from different traits separately, this study uses a single, validated measure of personality facets (all facets of the NEO-PI-R; Costa & McCrea, 2008) to collectively examine the role of all personality facets on in the same multiple regression. The NEO-PI-R was considered the most appropriate measure of personality as it measures six facets per trait, thus providing a more focused level of description than other measures of the Big Five which split each trait into two aspects (DeYoung et al, 2007) or three facets (Soto & John, 2017). While participants in the study reported symptoms relating to a range of mental illnesses, this study focuses on depression and anxiety. Based on previous research, we predict that variance in anxiety and depression will be explained by the neuroticism facet depression (Naragon-Gainey et al, 2011; Uliaszek et al, 2009), and the extroversion facet positive emotion (Naragon-Gainey et al, 2009; Quilty et al, 2013), and the conscientiousness facet self-discipline, the agreeableness facet trust, and the openness facet actions (Quilty et al, 2013). We also predict that the conscientiousness facet competence will explain variance in anxiety and depression, as competence conceptually overlaps with both internal locus of control and self-efficacy (Costa & McCrea, 1995; 2008).

5.2 **Methodology**

5.2.1 Participants

This study uses the New Molecules in Mood Disorder ("NewMood") dataset, which contains data from a range of self-report questionnaires and semi-structured interviews collected between 2004 and 2009 (Freeborough & Kimpton, 2011;

Deakin et al, 2011). This study used a general population sample. 264 participants were recruited within the Greater Manchester area of the UK through general practices and via the project website. Participants were between the ages of 18 and 60 years. Data were collected with the approval of institutional ethics committees and in accordance with the Declaration of Helsinki, and all participants gave signed informed consent (Juhasz et al, 2009).

5.2.2 Measures

The NEO-PI-R consists of 240 items and measures six facets for each of the Big Five traits (Costa & McCrea, 2008). Each personality facet is measured using a subscale of 8 items, and personality traits are measured by calculating total scores across these subscales. Although two of the facets of NEO-PI-R neuroticism share names with clinical disorders, namely facet depression and facet anxiety, it should be noted that these facets do not represent or conceptually relate to clinical disorders or symptoms (Costa & McCrea, 1995; 2008). That is, facet anxiety refers to trait-like threat apprehension, relating to whether individuals perceive their environment as threatening, and how easily they worry or panic (Costa & McCrea, 1995). Facet depression refers to both demotivation and sadness, as individuals high in facet depression are easily discouraged, and report frequently feeling guilty and low in energy (Costa & McCrea, 1995).

The Montgomery–Åsberg Depression Rating Scale (MADRS; Montgomery & Åsberg, 1979), which uses a semi-structured interview, was administered to assess current symptoms of depression such as sadness, anhedonia, pessimistic and suicidal thoughts, and physical symptoms involving sleep and appetite.

The Clinical Anxiety Scale (CAS; Snaith et al, 1982), which uses a semi-structured interview, was administered to assess current symptoms of anxiety disorders, including tension, ability to relax, startle response, worrying and anticipation of disaster. The interview question related to panic attacks was excluded as this pertained to panic disorder rather than anxiety disorders more broadly. Both the MADRS and CAS semi-structured interviews were carried out by trained researchers under the supervision of a psychiatrist.

5.2.3 Analysis

Data analysis was carried out in R version 3.5.1 (for analysis script, see supplementary materials). Data are available upon request for researchers. Both correlational analysis and multiple regressions were carried out using the tidyverse and dplyr packages. Correlations between personality facets were conducted to test for multicollinearity. This was confirmed by calculating variance inflation factors (VIFs) of personality facets using the car package with a threshold of VIF>10 (Dormann et al, 2013). All 30 NEO-PI-R personality facets were simultaneously entered into a multiple regression model to determine which combination of facets best explained variance in both depression and anxiety. A post-hoc power analysis in G*power (version 3.1) found that both multiple regressions achieved >99% statistical power.

Several facets correlated with each other above the multicollinearity threshold of r = 0.7 (Supplementary tables 3 and 4). High multicollinearity can lead to inflated variance in hierarchical regression (Dormann et al, 2013). Therefore, variance inflation factor (VIF) was calculated between all predictors. 30 VIF calculations were performed, one for each NEO-PI-R facet as an outcome variable.

Facet depression consistently had the highest VIF, between 4.43 (when facet anxiety was the outcome variable), and 5.57 (when facet assertiveness was the outcome variable; and when facet dutifulness was the outcome variable). As all VIFs were below 10, variance would not be inflated, meaning multiple regression could be carried out using ordinary least squares regression (Dormann et al, 2013).

This paper also investigates the possibility of suppressor effects, in which the predictive validity of variables is inflated (Conger, 1974). Suppressor effects result from high correlations between variables, including variables sharing statistical common factors (Beckstead, 2012; Conger, 1974), such as multiple personality facets mapping onto personality a trait. Zero-order correlations between predictors and outcome variables were therefore investigated to determine whether significant regression coefficients could be explained by suppressor effects (Beckstead, 2012).

5.3 **Results**

5.3.1 Participant characteristics

The sample comprised 264 participants, with 185 females and 79 males. The average age of participants was 33.56 years (SD = 11.00 years). The vast majority of participants were white, making up 95.45% of the sample. A quarter of the sample were married, and 20.46% of the sample reported one or more children under the age of 16 living with them. The vast majority of the sample (98.48%) had GCSE's or O-level secondary school qualifications, and 53.41% of the sample reporting have a degree. 45.07% of the sample reported working full-time; 13.26% reported working part-time; 29.54% were university students, and 9.85% of the sample reported being unemployed.

Table 5.1
Rates of psychiatric history by disorder and sex

Psychiatric history	Total sample (%)	Males (%)	Females (%)
Depression	58.33	45.57	63.78
Suicide attempt/self-harm	18.56	15.19	20
Manic episode/bipolar	1.52	2.53	1.08
Anxiety/panic/phobia	25.00	20.25	27.03
OCD	1.89	0.00	2.70
Eating disorder	8.71	1.27	11.89
Drug or alcohol problem	3.41	6.33	2.16
Other	1.14	1.27	1.08

All participants completed a background questionnaire, which included yes/no questions about whether they had a history of various mental illnesses. Analysis of the background questionnaire revealed that over half of the sample reported a history of depression, while a quarter of the sample reported a history of an anxiety disorder. A history of an eating disorder was reported by 8.71% of the sample, and a history of drug or alcohol problems was reported by 3.41% of the sample (Table 1). Means and standard deviations MADRS depression symptoms, CAS anxiety symptoms and NEO-PI-R personality facets are provided in Supplementary able 5.1.

5.3.2 Multiple regression of personality facets explaining variance in depression

When all 30 NEO-PI-R facets were entered into a single model, variance in MADRS scores were significantly explained by the facets depression ($b = 0.5$, $t = 4.45$, $p<0.05$), assertiveness ($b = 0.32$, $t = 2.85$, $p<0.05$), positive emotion ($b = -0.40$, $t = -3.22$, $p<0.05$), and competence ($b = -0.39$, $t = 0.15$, $p<0.05$; Table 5.2; Figure 5.1). Facets depression and assertiveness positively regressed onto MADRS scores, while facets positive emotion and competence negatively regressed onto MADRS scores. Analysis of variance found that the model including facets depression, assertiveness, positive emotion, and competence did not significantly

differ from a model including all 30 NEO-PI-R facets as predictors of MADRS scores (Pr(>F) = 0.11).

5.3.3 Multiple regression of personality facets explaining variance in anxiety

When all 30 NEO-PI-R facets were entered into a single model, variance in CAS scores were significantly explained by facets depression (b = 0.18, t = 3.33, p = 0.001), gregariousness (b = -0.11, t = -1.99, p<0.05), assertiveness (b = 0.17, t = 3.14, p = 0.002), positive emotion (b = -0.14, t = -2.38, p<0.05), and competence (b = -0.25, t = -3.50, p<0.001; Table 5.3; Figure 5.2). Facets depression and assertiveness positively regressed onto CAS scores, while facets gregariousness, positive emotion and competence negatively regressed onto CAS scores. Analysis of variance found that the model including facet depression, facet gregariousness, facet assertiveness, facet positive emotion and facet competence did not significantly differ from a model including all 30 NEO-PI-R facets as predictors of CAS scores (Pr(>F) = 0.17).

5.3.4 Investigation of suppressor effects

In his foundational paper on suppressor effects, Conger (1974) identified three types of suppressor situations: traditional suppression, in which a non-significant correlation between a predictor and an outcome variable results in a significant regression coefficient controlling for other variables; reciprocal suppression, when two predictor variables significantly negatively correlate with each other, but both significantly correlate with the outcome variable; and negative suppression, also called cross-over suppression, in which a weak positive correlation results in negative regression coefficient (Beckstead, 2012; Paulhus et al, 2004; Watson et al, 2013).

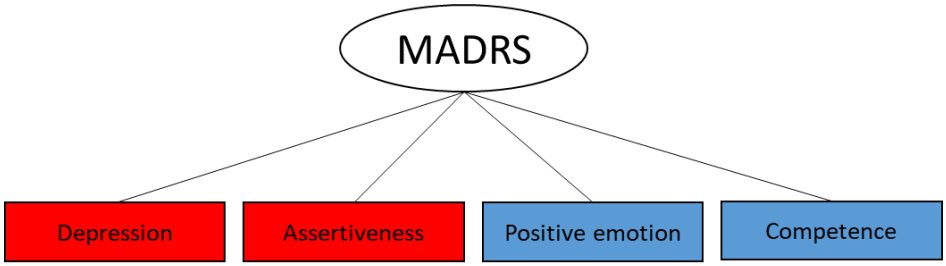

Figure 5.1. Personality facets explaining variance in depression

NEO-PI-R facets explaining variance in MADRS scores. Facets in red positively regressed onto MADRS scores. Facets in blue negatively regressed onto MADRS scores. MADRS: Montgomery–Åsberg Depression Rating Scale

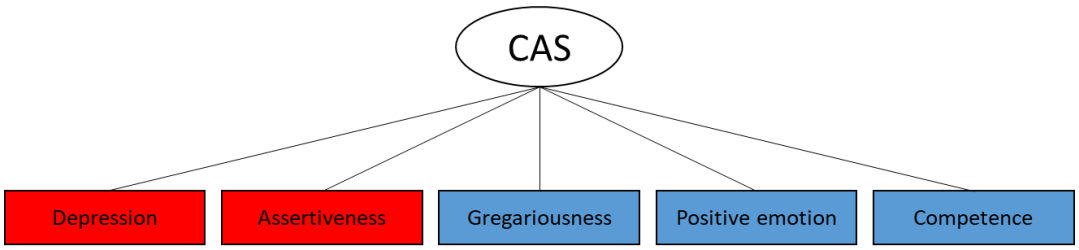

Figure 5.2. Personality facets explaining variance in anxiety

NEO-PI-R facets explaining variance in CAS scores. Facets in red positively regressed onto CAS scores. Facets in blue negatively regressed onto CAS scores. CAS: Clinical Anxiety Scale

Table 5.2
Personality facets explaining variance in depression

Trait	Facet	Estimate	Std. error	t value
Neuroticism	Anxiety	-0.17	0.11	-1.58
	Angry hostility	0.02	0.12	0.18
	Depression	0.50	0.11	4.45***
	Self-consciousness	-0.10	0.12	-0.89
	Impulsivity	-0.15	0.11	-1.39
	Vulnerability to stress	0.08	0.14	0.57
Extroversion	Warmth	-0.05	0.17	-0.32
	Gregariousness	-0.20	0.11	-1.76
	Assertiveness	0.32	0.11	2.85***
	Activity	-0.09	0.13	-0.67
	Excitement-seeking	-0.10	0.11	-0.91
	Positive emotion	-0.40	0.12	-3.22***
Conscientiousness	Competence	-0.39	0.15	-2.64***
	Order	-0.03	0.10	-0.34
	Dutifulness	-0.22	0.13	-1.65
	Achievement striving	0.08	0.12	0.67
	Self-discipline	0.10	0.12	0.87
	Deliberation	-0.11	0.11	-0.97
Agreeableness	Trust	-0.12	0.11	-1.02
	Straightforwardness	0.10	0.12	0.87
	Altruism	0.26	0.16	1.57
	Compliance	0.04	0.10	1.57
	Modesty	-0.12	0.11	-1.12
	Tendermindedness	0.06	0.13	0.45
Openness	Fantasy	0.04	0.10	0.45
	Aesthetics	0.15	0.09	1.57
	Feelings	0.10	0.14	0.76
	Actions	-0.22	0.12	-1.76
	Ideas	-0.01	0.10	-0.13
	Values	-0.07	0.15	-0.45

Note. * significant at $p<0.05$; ** significant at $p<0.01$; *** significant at $p<0.001$
All 30 NEO-PI-R facets explaining variance in MADRS scores. All figures are given to 2 decimal places.

Table 5.3
Personality facets explaining variance in anxiety

Trait	Facet	Estimate	Std. error	t value
Neuroticism	Anxiety	0.02	0.05	0.47
	Angry hostility	-0.00	0.06	-0.01
	Depression	0.18	0.05	3.33***
	Self-consciousness	-0.07	0.06	-1.22
	Impulsivity	-0.04	0.05	-0.74
	Vulnerability to stress	0.05	0.07	0.71
Extroversion	Warmth	-0.05	0.08	-0.59
	Gregariousness	-0.11	0.05	-1.99*
	Assertiveness	0.17	0.05	3.14***
	Activity	-0.00	0.06	-0.02
	Excitement-seeking	-0.08	0.05	-1.51
	Positive emotion	-0.14	0.06	-2.38*
Conscientiousness	Competence	-0.25	0.07	-3.50***
	Order	0.05	0.05	0.95
	Dutifulness	-0.04	0.06	-0.64
	Achievement striving	0.10	0.06	1.78
	Self-discipline	0.01	0.06	0.22
	Deliberation	-0.06	0.05	-1.15
Agreeableness	Trust	-0.07	0.05	-1.22
	Straightforwardness	0.02	0.06	0.41
	Compliance	0.03	0.07	0.82
	Altruism	0.13	0.08	1.65
	Modesty	-0.06	0.05	-1.12
	Tendermindedness	0.05	0.06	0.84
Openness	Fantasy	0.04	0.05	0.82
	Aesthetics	0.07	0.05	1.58
	Feelings	-0.01	0.07	-0.16
	Actions	-0.07	0.06	-1.19
	Ideas	-0.04	0.05	-0.89
	Values	-0.04	0.07	-0.62

Note. * significant at $p<0.05$; ** significant at $p<0.01$; *** significant at $p<0.001$
All 30 NEO-PI-R facets explaining variance in CAS scores. All figures are given to 2 decimal places.

Zero-order correlations between all personality facets, and between personality facets and affective disorder scores, were investigated to determine whether significant effects were explained by statistical suppression (Beckstead, 2012).

All variables significantly explaining variance in MADRS and CAS scores in the multiple regression had at least moderate Pearson correlations with outcome variables. These ranged from $r = -0.32$, $p<0.001$ (between facet assertiveness and CAS) to $r = 0.63$, $p<0.001$ (between facet depression and MADRS; Supplementary table 2) and suggest that results are unlikely to be explained by traditional suppression. Reciprocal suppression is also unlikely, as no significant predictors negatively correlated with each other, while both significantly positively correlating with affective disorder scores (Supplementary tables 2, 3 and 4). Facet assertiveness negatively correlated with both MADRS scores ($r = -0.35$, $p<0.001$) and CAS scores ($r = -0.32$, $p<0.001$), but positively regressed onto both MADRS and CAS in the multiple regression analyses. This reversal suggests a negative, or cross-over, suppression situation.

5.4 **Discussion**

The aim of this study was to investigate which personality facets uniquely explain variance in affective disorders. Previous research has focused on simple correlations (Bagby et al, 1995; Hayward et al, 2013; Newby et al, 2017) or performed separate multiple regression analyses for each personality domain (Quilty et al, 2013), making it difficult to determine the unique contributions of individual personality facets. Several studies using multiple regression have derived personality facets from factor analysis of both Big Five and non-Big Five measures,

rather than validated personality measures, making it difficult to generalize results (Naragon-Gainey et al, 2009; Naragon-Gainey, 2011; Naragon-Gainey & Watson, 2014). This is the first study we are aware of to enter all NEO-PI-R facets into a single multiple regression to explain variance in both anxiety and depression. The findings of this study add to the existing literature by showing that the previously observed effects of neuroticism were limited to facet depression (referring to sadness and demotivation); that variance in anxiety and depression were also explained by facets positive emotion and assertiveness in extroversion, and facet competence in conscientiousness; and that the extroversion facet gregariousness uniquely explained variance in anxiety, but not depression. Another novel finding of this work is that no facet of agreeableness or openness uniquely explained variance in anxiety or depression.

A novel finding of this study is that, of all facets of neuroticism, only facet depression uniquely explained variance in affective disorders. This facet does not refer to clinical depression, but instead refers to both sadness and demotivation, as individuals high in facet depression report being easily discouraged and often feeling hopeless (Costa & McCrea, 1995). This conflicts with correlational studies suggesting that all six NEO-PI-R neuroticism facets correlate with anxiety disorders, and that broad trait neuroticism positively associates with affective disorders (Hayward et al, 2013; Newby et al, 2017; Quilty et al, 2013); these previously observed correlations between neuroticism facets and affective disorder scores may be best explained by the effect of facet depression. As facet depression involves motivation (Costa & McCrea, 1995), this suggests that neuroticism not only contributes to affective disorders through high sensitivity to negative affect, but also through lower persistence of positive affect. Individuals low in facet depression may

therefore benefit from psychological therapies focusing on developing persistent motivation, such as Motivational Interviewing (Rubak et al, 2005) or Behavioural Activation (Kanter et al, 2010).

Two of the personality facets contributing to affective disorders conceptually relate to motivation: facet depression (which includes demotivation); and facet positive emotion (sensitivity to positive affect). Positive affect has been conceptualized as approach motivation, maintained by progress toward goals (Carver & Scheier, 2013; Wilt et al, 2017). Furthermore, maladaptive goals contribute to affect disorders, with anxiety disorders being associated with unrealistic avoidance goals away from threats, and depressive disorder associated with unrealistic approach goals toward challenges (Bandura, 1997, pp. 153-156; Eccles et al, 2014; Johnson et al, 2010). Taken together, these findings suggest that individuals high in facet depression, and low in facet positive emotion, may benefit from treatments focusing on adaptive goal setting, such as Behavioural Activation (Kanter et al, 2010), and treatments focusing on motivation and positive affect, such as Motivational Interviewing (Rubak et al, 2005) and Positive Psychology Interventions (Chaves et al, 2017).

Another novel finding is that, when considered alongside other facets, there was a positive association between facet assertiveness and anxiety and depression symptoms. This contrasts with the results of simple, pairwise correlations (both in the current paper and in previous studies; Bagby et al, 1995; Quilty et al, 2013), showing negative correlations. This is an example of negative, or cross-over, suppression, in which the relationship between a predictor variable and the outcome variable reverse when controlling for additional predictors (Beckstead, 2012; Conger, 1974). While suppression effects are often dismissed as statistical artefacts,

several suppression effects in personality research have been replicated (Paulhus et al, 2004; Watson et al, 2013), suggesting that they can be theoretically meaningful, and highlight the differential impact of facets within a common factor (Watson et al, 2013). One possible explanation is that the effect of facet assertiveness may have been masked by that of facet positive emotion. As facet assertiveness conceptually relates to competitiveness (Costa & McCrea, 1995), it is possible that higher facet assertiveness reduces social support. The effect of facet assertiveness may be moderated by social support associated with facet positive emotion.

In line with previous research, personality facets explaining anxiety and depression greatly overlapped: all facets explaining variance in depression also explained variance in anxiety. These common predictors help to explain the high comorbidity of anxiety and depression (Hopwood et al, 2018; Kotov et al, 2017). Nevertheless, the extroversion facet gregariousness explained variance in anxiety but not depression. Individuals with clinical anxiety often perceive their environment in terms of threats with which they are unable to cope (Eccles et al 2014; Johnson et al, 2010). Individuals higher in facet gregariousness may have more social support to cope with these perceived threats, which may reduce anxiety severity.

Another primary finding is that variance in affective disorders symptoms was explained by the conscientiousness facet competence, but not by the conscientiousness facet self-discipline. Previous studies have consistently suggested that both facet competence and facet self-discipline negatively correlate with affective disorders (Cox et al, 2000; Jourdy & Petot, 2017). Facet competence, also called generalized self-efficacy (Costa & McCrea, 1995), refers to an individuals' belief in the ability to solve problems. Facet competence may protect from affective disorders via active coping (Mirnics et al, 2013) and protecting from maladaptive

beliefs such as hopelessness (Abramson et al, 1978; Anderson & McLean, 1997; Schurer et al, 2017). Previous researchers have also suggested that facet self-discipline is associated with improved emotion regulation, protecting from affective disorders (Eisenberg et al, 2014). However, this study suggests that self-discipline does not uniquely explain variance in affective disorder scores. This may imply that trait conscientiousness contributes to affective disorders, not through top-down control of negative emotions, but through the development of skills to respond to stressors, and beliefs concerning those skills.

One surprising result from this study is that facet anxiety did not uniquely explain variance in affective disorder. Facet anxiety does not refer to clinical anxiety, but to trait-like threat apprehension (Costa & McCrea, 1995). Entering all facets of neuroticism in a multiple regression, Quilty et al (2013) found that variance in depression was significantly explained by both facet depression and facet anxiety. However, this study found that the effect of facet anxiety became non-significant controlling for other facets of other traits. One possible explanation is that the effect of anxiety was masked by the effect of competence, whereby an individual's level of facet competence determines whether stressors are appraised as threats or challenges (Bandura, 1994; Folkman, 1984). Therefore, individuals low in facet competence may be more likely to perceive environments as threatening and have higher facet anxiety and may benefit more from treatments focusing on developing skills and coping strategies, such as Behavioural Activation (Kanter et al, 2010), compared to other psychotherapies.

Another novel result is that no facet of agreeableness or openness uniquely explained variance in affective disorders. Previous research has consistently found that facet trust in agreeableness, and facet actions in openness, significantly

negatively associates with affective disorders. However, such studies rely on simple correlations (Jourdy & Petot, 2017; Kaplan et al, 2015) or perform separate regression analyses for each personality trait (Quilty et al, 2013). The current study suggests that these effects are better explained by facets of neuroticism, conscientiousness, and extroversion, and implies that treatment-matching for affective disorders should primarily focus on traits neuroticism, extroversion, and conscientiousness.

As the multiple regressions included many predictors, some of which are highly correlated, results may be affected by multicollinearity (Dormann et al, 2013) or suppressor effects (Beckstead, 2012; Conger, 1974). No personality facets had a VIF of over 10, the common multicollinearity threshold (Dormann et al, 2013), meaning it is unlikely that regression coefficients were artificially inflated. Nevertheless, many facets had statistical common factors, increasing the likelihood of suppressor effects (Beckstead, 2012; Conger, 1974). Investigations of zero-order correlations between personality facets, and between personality facets and affective disorder scores, lead us to conclude that the effects of facet assertiveness on affective disorders were negative, or cross-over, suppression effects. As discussed above, this suppression effect is not necessarily a statistical artefact but instead may be a meaningful result (Paulhus et al, 2004; Watson et al, 2013), explaining the complex role of assertiveness in affective disorders.

This study is not without limitations. Firstly, using a cross-sectional design, this study is unable to test models of causation. Secondly, by measuring broad clinical anxiety with CAS, the current study is also unable to distinguish between anxiety disorders. Furthermore, participants reported histories of mental illnesses other than affective disorders, meaning the results may be affected by comorbidity.

However, comorbidity is common in psychopathology (Hopwood et al, 2018; Kotov et al, 2017) therefore a sample with comorbidity may be more representative than pure cases of affective disorders. Thirdly, the current study also does not investigate the relationships between personality facets and specific symptoms; while this is an interesting area of research, it is beyond the scope of this study and is a potential area for future research. Fourthly, the current study has a relatively small and mostly female sample (N = 264, 70.08% female), meaning this study is not able to determine whether results differ by sex. The effect of sex on personality facets explaining variance in affective disorders is another possible area for future research. Fifthly, the large number of predictor variables per analysis may have led to unstable results. Although both multiple regressions achieved >99% statistical power, replication of these findings in additional datasets is now needed.

5.5 **Conclusion**

When accounting for all facets, facets positive emotion and competence negatively associated with affective disorder scores; facets depression (relating to sadness and demotivation) and assertiveness positively associated with affective disorder scores. Facet gregariousness also negatively associated with anxiety but not depression scores. The results suggest that the effect of neuroticism is largely driven by facet depression (referring to sadness and demotivation). The significant effects of facets depression and positive emotion suggest that several personality constructs contribute to affective disorders via reward sensitivity, rather than negative affect, as previously suggested (Ormel et al, 2013; Watson et al, 2006). Contrary to previous research, this study also suggests that facet assertiveness positively associates with

affective disorders, when controlling for other personality facets; and that no facet of agreeableness or openness significantly contribute to affective disorders. Treatment-matching for affective disorders may be improved by focusing on these narrow facets.

5.6 **Acknowledgement and author contributions**

All authors were involved in study conceptualization and report writing. Rebecca Elliott and Gabriella Juhasz were involved in data collection. Kieran Lyon conducted all data analyses. We would like to thank Nóra Eszlári for providing feedback on all data analyses.

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5.6.2 Conflict of interest

The authors report no conflict of interest.

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Supplementary table 5.1
Means and standard deviations of MADRS depression symptoms, CAS anxiety symptoms, and NEO-PI-R personality facets

		Mean	Standard deviation	Cronbach's alpha
Affective disorder	Depression symptoms	5.98	8.59	0.91
	Anxiety symptoms	2.72	4.03	0.88
Neuroticism	Anxiety	17.30	6.45	0.88
	Angry hostility	14.38	5.13	0.77
	Depression	16.77	7.83	0.92
	Self-consciousness	16.90	5.79	0.80
	Impulsivity	17.11	4.72	0.69
	Vulnerability to stress	13.47	5.85	0.86
Extroversion	Warmth	21.74	4.64	0.79
	Gregariousness	17.28	5.81	0.82
	Assertiveness	14.83	5.58	0.83
	Activity	16.39	4.27	0.64
	Excitement-seeking	16.45	5.41	0.72
	Positive emotion	18.68	6.11	0.86
Conscientiousness	Competence	19.79	4.46	0.74
	Order	16.96	4.87	0.72
	Dutifulness	21.24	4.28	0.65
	Achievement striving	16.98	5.11	0.79
	Self-discipline	17.75	5.58	0.83
	Deliberation	17.31	4.85	0.77
Agreeableness	Trust	18.76	5.24	0.84
	Straightforwardness	20.36	4.71	0.73
	Altruism	23.17	3.58	0.67
	Compliance	18.20	4.46	0.67
	Modesty	19.45	5.37	0.80
	Tendermindedness	20.67	3.95	0.65
Openness	Fantasy	18.79	5.10	0.77
	Aesthetics	18.43	5.81	0.81
	Feelings	21.81	3.95	0.68
	Actions	17.43	3.99	0.64
	Ideas	19.96	5.33	0.80
	Values	22.43	3.36	0.58

Note. MADRS: Montgomery–Åsberg Depression Rating Scale. CAS: Clinical Anxiety Scale.

Supplementary table 5.2
Pearson's correlations between personality facets and affective disorder scores

Personality trait	Personality facet	MADRS	CAS
Neuroticism	Anxiety	0.47***	0.53***
	Angry hostility	0.34***	0.35***
	Depression	0.63***	0.60***
	Self-consciousness	0.46***	0.45***
	Impulsivity	0.07	0.09
	Vulnerability to stress	0.52***	0.51***
Extroversion	Warmth	-0.43***	-0.43***
	Gregariousness	-0.41***	-0.42***
	Assertiveness	-0.35***	-0.32***
	Activity	-0.34***	-0.26***
	Excitement-seeking	-0.27***	-0.29***
	Positive emotion	-0.54***	-0.51***
Conscientiousness	Competence	-0.41***	-0.41***
	Order	-0.13*	-0.03
	Dutifulness	-0.22***	-0.17**
	Achievement striving	-0.25***	-0.17**
	Self-discipline	-0.27***	-0.23***
	Deliberation	-0.06	-0.05
Agreeableness	Trust	-0.37***	-0.37***
	Straightforwardness	0.13*	0.13*
	Altruism	-0.14*	-0.13*
	Compliance	-0.05	-0.05
	Modesty	0.32***	0.31***
	Tendermindedness	0.13*	0.14
Openness	Fantasy	-0.05	-0.06
	Aesthetics	0.04	0.03
	Feelings	0.002	0.00
	Actions	-0.38***	-0.38***
	Ideas	-0.19	-0.22***
	Values	-0.24***	-0.27***

Note. All figures are given to 2 decimal places.
* significant at $p<0.05$; ** significant at $p<0.01$; *** significant at $p<0.001$
MADRS: Montgomery–Åsberg Depression Rating Scale. CAS: Clinical Anxiety Scale.

Supplementary table 5.3
Pearson's correlations between NEO-PI-R facets

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Anxiety															
2 Angry hostility	0.45***														
3 Depression	0.8***	0.48**													
4 Self-consciousness	0.64****	0.43***	0.74***												
5 Impulsivity	0.27***	0.3***	0.28***	0.25***											
6 Vulnerability to stress	0.76***	0.48***	0.79***	0.7***	0.31***										
7 Warmth	-0.31***	-0.36***	-0.41***	-0.41***	0.10	-0.38***									
8 Gregariousness	-0.26***	-0.24***	-0.37***	-0.38***	0.03	-0.23***	0.71***								
9 Assertiveness	-0.50***	-0.16*	-0.57***	-0.61***	-0.09	-0.57***	0.39***	0.41***							
10 Activity	-0.34***	-0.13*	-0.45***	-0.40***	-0.12	-0.47***	0.36***	0.32****	0.53***						
11 Excitement-seeking	-0.23***	0.06	-0.22***	-0.26***	0.29***	-0.16*	0.38***	0.53***	0.39***	0.29***					
12 Positive emotion	-0.47***	-0.29***	-0.56***	-0.58***	0.16*	-0.51***	0.69***	0.55***	0.52***	0.44***	0.47***				
13 Competence	-0.47***	-0.29***	-0.55***	-0.45***	-0.37***	-0.62***	0.23***	0.11	0.48***	0.38***	-0.03	0.26***			
14 Order	-0.09	-0.04	-0.19**	-0.06	-0.20**	-0.23***	-0.05	-0.08	0.15*	0.27***	-0.15*	-0.01	0.36***		
15 Dutifulness	-0.21***	-0.20**	-0.28***	-0.15*	-0.38***	-0.36***	0.12	-0.00	0.12*	0.36***	-0.13*	0.00	0.50***	0.45***	
16 Achievement striving	-0.28***	-0.11	-0.39***	-0.29***	-0.28***	-0.47***	0.19**	0.09	0.38***	0.56***	0.01	0.21***	0.57***	0.43***	0.53***
17 Self-discipline	-0.36***	-0.27***	-0.48***	-0.34***	-0.40***	-0.56***	0.14*	0.04	0.29***	0.46***	-0.08	0.12	0.6***	0.51***	0.61***
18 Deliberation	-0.12	-0.15*	-0.11	0.01	-0.47***	-0.19**	-0.16*	-0.16**	-0.00	-0.00	-0.36***	-0.22***	0.42***	0.42***	0.49***
19 Trust	-0.34***	-0.53***	-0.35***	-0.35***	-0.03	-0.33***	0.59***	0.41***	0.22***	0.13*	0.10	0.51***	0.23***	0.02	0.10
20 Straightforwardness	0.18**	-0.16**	0.17**	0.26***	-0.07	0.15*	0.01	-0.06	-0.31***	-0.08	-0.34***	-0.25***	-0.08	0.03	0.23***
21 Altruism	-0.05	-0.35***	-0.13*	-0.06	-0.03	-0.15*	0.53***	0.30***	0.02	0.17**	0.01	0.22***	0.24***	0.06	0.31***
22 Compliance	0.01	-0.52***	-0.01	0.08	-0.16**	-0.00	0.19**	0.08	-0.29***	-0.07	-0.27***	-0.07	-0.05	-0.02	0.14*
23 Modesty	0.41***	0.02	0.49***	0.47***	0.09	0.45***	-0.21***	-0.25***	-0.52***	-0.35***	-0.35***	-0.43***	-0.35***	-0.05	-0.02
24 Tendermindedness	0.20***	-0.12	0.25***	0.20**	0.17**	0.19**	0.17**	-0.00	-0.28***	-0.14	-0.17**	0.02	-0.11	-0.09	-0.00
25 Fantasy	0.06	0.08	-0.01	-0.08	0.27***	0.06	0.22***	0.17**	0.11	0.01	0.28***	0.31***	-0.05	-0.18**	-0.28***
26 Aesthetics	0.08	-0.00	0.12	-0.02	0.19**	0.08	0.24***	0.14*	0.03	0.11	0.19**	0.31***	0.00	-0.00	-0.06
27 Feelings	0.16*	0.13*	0.13*	0.02	0.36***	0.11	0.34***	0.21***	0.07	0.13*	0.20**	0.35***	-0.03	0.03	-0.05
28 Actions	-0.31***	-0.22***	-0.34***	-0.35***	0.06	-0.29***	0.35***	0.39***	0.37***	0.29***	0.34***	0.47***	0.23***	-0.10	-0.04
29 Ideas	-0.19**	-0.22***	-0.20**	-0.28***	-0.03	-0.22***	0.26***	0.15*	0.29***	0.27***	0.21***	0.36***	0.33***	-0.01	0.08
30 Values	-0.18**	-0.25***	-0.18**	-0.19**	0.11	-0.19**	0.29***	0.17**	0.08	0.13*	0.20**	0.29***	0.21***	-0.06	0.05

Note. All figures are given to 2 decimal places. * significant at p<0.05. ** significant at p<0.01. *** significant at p<0.001. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised.

Supplementary table 5.4
Pearson's correlations between NEO-PI-R facets continued

	16	17	18	19	20	21	22	23	24	25	26	27	28	29
17 Self-discipline	0.69***													
18 Deliberation	0.34***	0.41***												
19 Trust	0.11	0.06	0.01											
20 Straightforwardness	0.02	0.08	0.15*	0.20**										
21 Altruism	0.16*	0.22***	0.08	0.41***	0.42***									
22 Compliance	-0.10	0.01	0.21***	0.39***	0.42***	0.38								
23 Modesty	-0.22***	-0.15*	0.05	-0.08***	0.55***	0.20**	0.40***							
24 Tendermindedness	-0.06	-0.06	-0.04	0.24***	0.40***	0.44***	0.33***	0.38***						
25 Fantasy	-0.18**	-0.23***	-0.23***	0.06	-0.23***	0.01	-0.12*	-0.19***	0.05					
26 Aesthetics	0.07	-0.08	-0.12	0.19**	-0.11	0.13	-0.07	-0.06	0.29***	0.36***				
27 Feelings	0.03	-0.07	-0.17**	0.14*	-0.04	0.24***	-0.04	-0.01	0.33***	0.41***	0.53***			
28 Actions	0.13*	0.11	-0.19**	0.31***	-0.11	0.07	-0.10	-0.25***	-0.01	0.17**	0.19**	0.16*		
29 Ideas	0.23***	0.11	-0.02	0.17**	-0.17	0.07	-0.07	-0.27***	0.03	0.35***	0.48***	0.24***	0.38***	
30 Values	0.04	0.11	-0.06	0.24***	0.03	0.22***	0.13*	0.04	0.27***	0.23***	0.16*	0.25***	0.37***	0.37***

Note. All figures are given to 2 decimal places. * significant at p<0.05. ** significant at p<0.01. *** significant at p<0.001. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised.

Analysis script

```
#Installation

install.packages("viridis")

library (viridis)

install.packages("tidyverse")

library (tidyverse)

install.packages("dplyr")

library (dplyr)

#Install "car" to calculate variance inflation factor for multiple regression:

install.packages("car")

library(car)

#

#Descriptive statistics

attach(newmood)

table(newmood$GENDER)

table(newmood$AGE)

sd(newmood$AGE, na.rm = TRUE)

#Means and standard deviations of variables, shown here for depression

mean(MADRS_or, na.rm = TRUE)

sd(MADRS_or, na.rm = TRUE)

#

#Tests of multicollinearity

#Correlations were calculated between facets within the same trait, shown her for
facet anxiety and facet hostility within neuroticism:

cor.test(NEUR_ANX, NEUR_ANG)
```

```
#Variance inflation factor (VIF) was calculated for each NEO-PI-R facet

#VIF calculation for facet anxiety:

anx <- lm(NEUR_ANX ~ NEUR_ANG + NEUR_DEP + NEUR_SCONS + NEUR_IMP + NEUR_VULN +

EXTR_WARM + EXTR_GREG + EXTR_ASSE + EXTR_ACT + EXTR_EXC + EXTR_POS +

CONS_COM + CONS_ORD + CONS_DUTI + CONS_ACHI + CONS_DISC + CONS_DELI +

AGR_TRUST + AGR_STRA + AGR_ALTR + AGR_MOD + AGR_MIND + AGR_COMP +

OP_FANT + OP_AEST + OP_FEEL + OP_ACT + OP_IDEA + OP_VALU)

vif(anx)

#30 VIF calculations were performed, one for each NEO-PI-R facet

#

#Multiple regression of personality facets and depression

MADRS <- lm(MADRS_or ~ NEUR_ANX + NEUR_ANG + NEUR_DEP + NEUR_SCONS + NEUR_IMP +
NEUR_VULN +

EXTR_WARM + EXTR_GREG + EXTR_ASSE + EXTR_ACT + EXTR_EXC + EXTR_POS +

CONS_COM + CONS_ORD + CONS_DUTI + CONS_ACHI + CONS_DISC + CONS_DELI +

AGR_TRUST + AGR_STRA + AGR_ALTR + AGR_MOD + AGR_MIND + AGR_COMP +

OP_FANT + OP_AEST + OP_FEEL + OP_ACT + OP_IDEA + OP_VALU)

summary(MADRS)

#Remove facets which do not significantly explain variance in MADRS

MADRS2 <- lm(MADRS_or ~ NEUR_DEP + EXTR_ASSE + EXTR_POS + CONS_COM)

#These models were compared using ANOVA

anova(MADRS, MARDS2)

#Multiple regression of personality facets and anxiety

CAS <- lm(CAS1_6 ~ NEUR_ANX + NEUR_ANG + NEUR_DEP + NEUR_SCONS + NEUR_IMP + NEUR_VULN
+

EXTR_WARM + EXTR_GREG + EXTR_ASSE + EXTR_ACT + EXTR_EXC + EXTR_POS +

CONS_COM + CONS_ORD + CONS_DUTI + CONS_ACHI + CONS_DISC + CONS_DELI +
```

```
AGR_TRUST + AGR_STRA + AGR_ALTR + AGR_MOD + AGR_MIND + AGR_COMP +

OP_FANT + OP_AEST + OP_FEEL + OP_ACT + OP_IDEA + OP_VALU)

summary(CAS)

#Facets which did not significantly explain variance in CAS were removed, and

compared to the model with all facets using ANOVA

CAS2 <- lm(MADRS_or ~ NEUR_DEP + EXTR_GREG + EXTR_ASSE + EXTR_POS + CONS_COM)

#These models were compared using ANOVA

anova(CAS, CAS2)
```

Chapter Six

Paper Four

Emotion Regulation Strategies Mediate the Relationship between Personality and Mental Health during COVID-19

Lyon, K.A.[1]; Brown, L.J.E.[2]; Juhasz, G.[34]; Elliott, R.[1]

Kieran Lyon conceived the original idea for the study, decided on the study design, submitted an ethics application to the Division of Neuroscience and Experimental Psychology ethics committee (University of Manchester), collected all data, wrote the manuscript, and completed all revisions following review by the co-authors.

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Abstract

The effects of Big Five personality traits on affective disorders are explained by a small number of lower-order personality facets. However, the mediating mechanisms are unknown. This study investigated whether the effects of these personality facets on anxiety and depression associated with the COVID-19 pandemic were mediated by emotion regulation strategies in 210 university students. Structural equation modelling revealed that the strategy of acceptance partially mediated the relationship between facet depression (referring to sadness and demotivation, not clinical depression) and COVID-related anxiety, and fully mediated the relationship between facet assertiveness and COVID-related anxiety. The strategy planning also fully mediated the effects of facets gregariousness, assertiveness, positive emotion, and competence, on COVID-related depression. These results provide evidence that personality facets affect the risk of experiencing mental health symptoms in response to stressful life events and suggest the mediating effects of emotion regulation strategies.

6.1 **Introduction**

The COVID-19 pandemic, and measures taken to contain it, have presented various psychological stressors, including fear of infection, financial loss, and reduced social interaction and social support (Brooks et al, 2020; Modersitzki et al, 2020). This has resulted in increased prevalence of anxiety, depression, and post-traumatic stress disorder (PTSD) symptoms worldwide (Shevlin et al, 2020; Xiong et al, 2020). These findings are in-line with the effects of previous pandemics. For example, individuals quarantined in China and Toronto during the SARS pandemic reported increased PTSD, depression, and alcoholism symptoms three years later (Brooks et al, 2020).

The effects of psychological stressors on mental health are believed to be moderated by individual risk and resilience factors (Sheerin et al, 2018). Personality variables constitute one class of such factors. A meta-analysis of 175 correlational studies of personality traits and common mental illnesses found that the personality trait neuroticism correlated positively with affective disorders, while the traits of extroversion and conscientiousness correlated negatively (Kotov et al, 2010). Longitudinal studies add that the combination of low neuroticism, high extroversion and high conscientiousness protect against affective disorders in response to stressful life events (Spinhoven et al, 2016; Struijs et al, 2018). A population study by Han et al (2021) also showed that high negative affect, high openness, low extroversion, and low agreeableness were associated with anxiety, depression, and suicide risk during the COVID-19 pandemic; low conscientiousness was also associated with lower depression.

Personality traits refer to stable patterns of thoughts and behaviour (Costa & McCrea, 2008; Soldz & Vaillant, 1999). In most models of personality, broader personality traits can be broken down into narrower constructs, such as facets, which significantly correlate with each-other yet are conceptually distinct (Schwaba et al, 2020). In the Neuroticism Extroversion Openness – Personality Inventory – Revised (NEO-PI-R), each Big Five personality trait comprises six personality facets; for example, trait extroversion consists of the facets: warmth, gregariousness, assertiveness, activity, excitement-seeking and positive emotion (Costa & McCrea, 2008).

While most studies of personality and mental illness use trait measures, the effects of personality on affective disorders may be better explained by personality facets (Lyon et al, 2020; Quilty et al, 2013). A systematic review found strong evidence that a small number of personality facets, such as positive emotion (in trait extroversion) and competence (in trait conscientiousness, referring to perceived ability to solve problems; similar to self-efficacy; Bandura, 1994; Costa & McCrea, 2008) strongly associate with affective disorders (Lyon et al, 2021). Furthermore, Lyon et al (2020) showed that variance in clinical anxiety and clinical depression were uniquely explained by high facet depression (a facet of neuroticism, referring to the sadness and demotivation, not clinical depression), high facet assertiveness (a facet of extroversion, referring to the competitiveness and leadership), low facet positive emotion, and low facet competence. In addition, clinical anxiety, but not clinical depression, was associated with low facet gregariousness (a facet of extraversion, referring to sociability).

The mediating mechanisms underlying personality-related risk and resilience factors are not yet well understood. Emotion regulation strategies constitute one

possible class of mediators, significantly correlating with affective disorders and associated personality traits (Connor-Smith & Flachsbart, 2007). Strategies such as acceptance, positive reframing, seeking social support, active coping, and planning are negatively correlated with affective disorders, while denial and substance use are positively correlated (Bjørkløf et al, 2013). However, it is unclear which facets of each trait are correlated with these strategies.

The COVID-19 pandemic provides an opportunity to examine these potential mediating mechanisms, in the context of exposure to psychological stressors. The pandemic and resulting measures have increased psychological distress (Brooks et al, 2020), rates of mental illnesses (Shevlin et al, 2020; Xiong et al, 2020) and have also impacted the availability of existing emotion regulation strategies. For example, social distancing measures have reduced opportunities to receive social support (Brooks et al, 2020), and lockdown measures have made it more difficult to maintain ordinary routines (World Health Organisation, 2020). The COVID-19 pandemic can therefore be viewed as a natural experiment to investigate the mediating effects of emotion regulation strategies on relationships between personality facets and mental health. The aim of the current study is to investigate which personality facets are related to anxiety and depression associated with the COVID-19 pandemic, and how emotion regulation strategies mediate these effects.

6.2 **Methodology**

6.2.1 Procedure

Bulk advertisements for the study were sent to all students within the Faculty of Biology, Medicine and Health at the University of Manchester. Individuals were

only eligible to participate if there were at least 18 years of age and did not have a self-reported clinical diagnosis of a mental illness. Data were collected online using the Select Survey platform, between June 30th, 2020, and August 28th, 2020, while the UK government was easing restrictions following the first national lockdown. During this time, households could form "support bubbles" where two households were able to meet indoors, and up to five people from two households were able to meet outdoors, while staying two metres apart. Pubs and restaurants were able to re-open, while indoor gyms and swimming pools remained closed (Public Health England, 2020). Ethical approval for this study was provided by the Division of Neuroscience and Experimental Psychology ethics committee at the University of Manchester. All participants indicated their consent to take part by completing an online checklist before beginning the study and were incentivized with entry to a prize draw to receive shopping vouchers.

6.2.2 Measures

Age, sex, education level and number of children were reported, as these variables have predicted psychological distress in previous quarantines (Academy of Medical Sciences, 2020; Umucu & Lee, 2020).

Participants were asked whether they had experienced any of 12 stressors associated with the COVID-19 pandemic (Academy of Medical Sciences, 2020; Qiu et al, 2020): experiencing COVID-19 symptoms, a family member experiencing COVID-19 symptoms, family arguments or family breakdown, financial loss, disruption of university work, loss of access to mental health services, quarantine, an increase in children responsibilities, loss of access to physical activity, reduced quality of work environment, loss or reduced quality of interaction with friends, loss

of access to outdoor space, and loss of personal space. Participants were asked to report whether they had experienced each stressor and, if so, how severely they had been affected, on a scale from 1, “much less severe than most people who experience this” to 5, “much more severe than most people who experience this.”

Personality facets were assessed using the Neuroticism Extroversion Openness – Personality Inventory – Revised (NEO-PI-R; Costa & McCrea, 2008), which measures six personality facets within each of the Big Five traits, with eight items per facet. Each item was scored from 0, “strongly disagree” to 4, “strongly agree.” The current study only measured five Big Five personality facets: depression (referring to sadness and demotivation, not clinical depression), assertiveness, gregariousness, positive emotion, and competence. These facets were chosen as they are commonly associated with, and uniquely explain variance in, affective disorders (Lyon et al, 2020; 2021; Quilty et al, 2013).

The use of emotion regulation strategies in response to the COVID-19 pandemic was measured using an adapted version of the Coping Orientations to Problems Experienced Inventory (COPE Inventory; Carver et al, 2013). This study only measured the strategies of substance use, active coping, planning, positive reinterpretation and growth, acceptance, and emotional support seeking, as these strategies are most consistently associated with affective disorder severity during pandemics (Academy of Medical Sciences, 2020; Umucu & Lee, 2020). Each strategy was assessed using four items, asking participants how often they engaged in this strategy, on a scale of 1, “I don’t usually do this at all”, to 4, “I usually do this a lot”. As we were specifically interested in coping during the pandemic, the original instruction was reworded to “Indicate what you do when you experience

stress *related to the COVID-19 pandemic*." The preface "Due to the impact of COVID-19" was also added to each item in the scale.

COVID-related anxiety and depression were measured using adapted versions of the Generalized Anxiety Disorder – 7 (GAD-7; Spitzer et al, 2006) and the Patient Health Questionnaire – depression module – 9 (PHQ-9; Spitzer et al, 1999), respectively. In both the GAD-7 and PHQ-9, participants respond to questions about how often they have experienced symptoms of each disorder over the past two weeks. To capture symptoms related to the impact of the COVID-19 pandemic, both scales were revised by adding the preface "Due to the impact of COVID-19" to each item.

6.2.3 Analysis

Data were analysed using R version 3.5.1 (for analysis script, see supplementary materials). Data are available for researchers upon request. There were 149 cases of missing datapoints, spread across the dataset (the maximum missing datapoints for a single item was six). Missing datapoints were replaced with the variable mean. Participants were only excluded from the analysis if they did not provide any data regarding their age, sex, or any one of the subscales of the NEO-PI-R, COPE Inventory or COVID-related mental health scales. Cronbach's alphas were calculated using the psych package.

Variable normality was tested using the Shapiro-Wilk test, indicating that most variables were not normally distributed. Nevertheless, inspections of histograms revealed only mild deviations from normality. All NEO-PI-R facets, COVID-related anxiety, COVID-related depression, and most COPE Inventory subscales approached normality. However, substance abuse had an extreme positive

skew, with 63.33% of participants scoring 0 out of a possible score of 32; this subscale was therefore excluded from all analyses. Pearson correlations were calculated using the pre-set cor.test function, being used to inform the subsequent structural equation modelling.

Structural equation modelling was performed using the lavaan package (Rosseel, 2012) to investigate which emotion regulation strategies mediated the relationship between personality facets and COVID-related anxiety and depression. Statistical power was estimated with RMSEA-based power analysis, using the power4SEM app (Jak et al, 2020), which estimates a model's power to detect the difference between a close fit and a non-close fit (MacCallum et al, 1996). The original model had 59.70% power, and the final model had 59.40% power.

All significant correlations (at $p<0.05$) between personality facets and emotion regulation strategies, between personality facets and COVID-related mental health scores, and between emotion regulation strategies and mental health outcomes, were included as regression paths. The model controlled for covariance between personality traits, and between emotion regulation strategies (Supplementary figure 6.1). Modification indices were investigated using the modindices function. As poor fit is often due to the exclusion of relevant paths, regression paths were added if they were theoretically viable and exceeded the critical value of $\chi^2 = 3.84$, meaning the additional path could significantly improve the model fit (Whittaker, 2012).

6.3 **Results**

6.3.1 Sample characteristics

The initial sample consisted of 241 participants, however 31 participants did not complete the COPE Inventory, so were excluded from analysis. The remaining sample (N = 210) consisted of 43 males and 167 females (79.52% female), mean age 24.86 (SD: 7.40; Table 6.1) years, the majority (92.86%) having no children. All participants reported experiencing at least two COVID-related stressors (mean: 6.46; SD: 1.80). Most participants reported that the COVID-19 pandemic had negatively impacted their university work and interactions with friends (both 93.8%). Over half (56.7%) reported an increase in family arguments or a family breakdown (see Supplementary table 6.1).

Table 6.1
COVID-related stressors, personality facets and emotion regulation strategies

		Mean (Standard deviation)	Cronbach's alpha	Shapiro-Wilk test
Age (years)		24.86 (7.40)	-	0.73*
Number of COVID-related stressors (out of 13)		6.46 (1.80)	-	0.96*
Total severity of COVID-related stressors (out of 65)		20.31 (8.01)	-	0.97*
COVID-related anxiety		8.47 (5.15)	0.88	0.96*
COVID-related depression		9.90 (5.87)	0.86	0.97*
NEO-PI-R	Facet depression	21.94 (5.42)	0.85	0.99
	Facet gregariousness	24.48 (5.49)	0.79	0.98*
	Facet assertiveness	22.63 (5.33)	0.81	0.99
	Facet positive emotion	27.91 (5.06)	0.78	0.99
	Facet competence	27.20 (4.00)	0.62	0.99*
COPE Inventory	Positive reinterpretation and growth	6.34 (3.01)	0.84	0.97*
	Active coping	5.22 (3.02)	0.79	0.97*
	Emotional support seeking	5.11 (3.53)	0.89	0.95*
	Substance use	1.49 (2.77)	0.95	0.61*
	Acceptance	7.94 (2.93)	0.84	0.95*
	Planning	5.67 (3.20)	0.86	0.97*

Note. * significant at $p<0.05$
Cronbach's alphas are reported where applicable. All figures are given to 2 decimal places. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised. COPE Inventory: Coping with Problems Experienced Inventory.
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6.3.2 Correlations between personality facets, emotion regulation strategies and COVID-related mental health

The facets of depression, positive emotion and competence correlated with both COVID-related anxiety and depression, and several emotion regulation strategies (Table 6.2). Facets gregariousness and assertiveness did not significantly correlate with either COVID-related anxiety or depression. However, both correlated with emotion regulation strategies (Table 6.2), meaning these facets may indirectly predict mental health outcomes via emotion regulation strategies (Fairchild & McDaniel, 2017). Therefore, all personality facets were included in the structural equation model. COVID-related anxiety negatively correlated with acceptance, positive reinterpretation and growth, and active coping. COVID-related depression negatively correlated with acceptance, positive reinterpretation and growth, active coping, and planning. Acceptance, positive reinterpretation and growth, active coping and planning significantly correlated with both a personality facet and a mental health outcome and were therefore included as mediators in the structural equation model. Emotional support seeking was included in the model as it significantly correlated with facets gregariousness and assertiveness but was not included as a mediator as it did not significantly correlate with COVID-related anxiety or depression.

6.3.3 Structural equation modelling

The structural equation model included the personality facets depression, gregariousness, assertiveness, positive emotion, and competence as predictors; acceptance, positive reinterpretation and growth, active coping, and planning as mediators; and COVID-related anxiety and depression as outcome variables.

Table 6.2
Pearson correlations between variables

	1	2	3	4	5	6	7	8	9	10	11
1 COVID-related anxiety											
2 COVID-related depression	0.75***										
3 NEO-PI-R – Depression	0.56***	0.55***									
4 NEO-PI-R – Gregariousness	-0.06	-0.02	0.04								
5 NEO-PI-R – Assertiveness	-0.09	-0.07	-0.23***	0.32***							
6 NEO-PI-R - Positive emotion	-0.25***	-0.17*	-0.26***	0.50***	0.32***						
7 NEO-PI-R – Competence	-0.19**	-0.25***	-0.41***	-0.04	0.28***	0.09					
8 COPE - Positive reinterpretation and growth	-0.22**	-0.29***	-0.30***	-0.11	0.21**	0.20**	0.17*				
9 COPE - Active coping	-0.16*	-0.27***	-0.32***	-0.07	0.25***	0.11	0.28***	0.69***			
10 COPE - Emotional social support	0.08	-0.08	-0.02	0.18**	0.19**	0.11	0.09	0.20**	0.28***		
11 COPE- Acceptance	-0.23***	-0.18**	-0.20**	-0.13	0.19**	0.11	0.10	0.58***	0.49***	0.03	
12 COPE – Planning	-0.08	-0.23***	-0.22**	-0.14*	0.28***	0.14*	0.30***	0.71***	0.79***	0.25***	0.51***

Note. All figures are given to 2 decimal places. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised. Inventory: Coping with Problems Experienced Inventory.
* significant at p<0.05. ** significant at p<0.01. *** significant at p<0.001

Acceptance partially mediated the relationship between facet depression and COVID-related anxiety; and fully mediated the relationship between assertiveness and COVID-related anxiety. The effects of gregariousness, assertiveness, positive emotion, and competence on COVID-related depression were fully mediated by planning. This model yielded a good statistical fit (CFI: 0.987; RMSEA: 0.066; SRMR: 0.039; Supplementary figure 6.2). In consideration of modification indices, a second model was tested, adding a regression path from facet gregariousness to positive reinterpretation and growth; the mediating paths did not differ between the two models. The second model had a slightly improved fit (CFI: 0.992; RMSEA: 0.055; SRMR: 0.034; Figure 6.1), and so was selected and focused on for the discussion.

Due to the strong correlation between mental health outcomes ($r = 0.75$), a supplementary analysis was performed in which both COVID-related anxiety and depression were combined into a common COVID-related mental health variable. When including this common variable, the relationship between assertiveness and emotional social support became non-significant. The mediating pathways did not differ from the previous models; however, the addition of the common variable worsened the statistical fit (CFI: 0.982; RMSEA: 0.073; SRMR: 0.041; Supplementary figure 3). Therefore, this model was rejected, in favour of the second structural equation model.

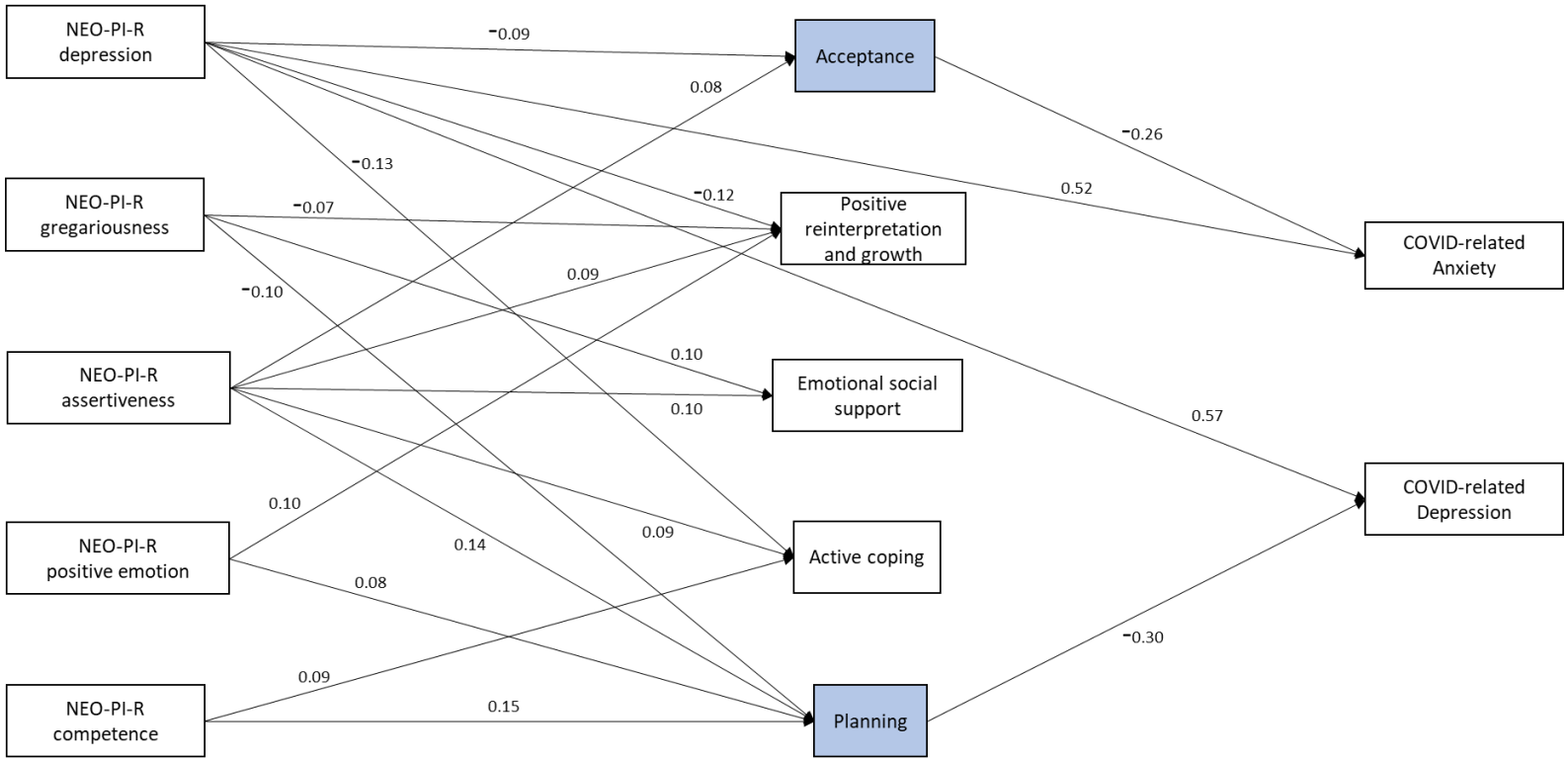

Figure 6.1. Structural equation model, after alteration in consideration of modification indices

Covariations between personality traits, and between emotion regulation strategies, and are not shown but were included in the analyses. Only significant ($p<0.05$) paths are displayed. Significant mediators are shaded. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised.

6.4 **Discussion**

This study aimed to investigate associations between Big Five personality facets and COVID-related anxiety and depression, and the mediating role of emotion regulation strategies. Analysis of pairwise correlations revealed that facet depression (referring to sadness and demotivation, not clinical depression) was positively correlated with both COVID-related anxiety and depression, whereas facets positive emotion and competence were negatively correlated. Structural equation modelling added that acceptance mediated the effects of facets depression and assertiveness on COVID-related anxiety; and that planning mediated the effects of gregariousness, assertiveness, positive emotion, and competence on COVID-related depression.

Pairwise correlation analyses showed that facets depression, positive emotion and competence significantly correlated with COVID-related mental health, whereas facets assertiveness and gregariousness did not. These results confirm previous research suggesting that facet depression positively associates with both clinical anxiety and depression, whereas facets positive emotion and competence negatively associate (Lyon et al, 2020; 2021). These results further concur with research at the trait level, suggesting that negative affect (similar to neuroticism) is associated with higher COVID-related anxiety and depression, while extroversion is associated with lower COVID-related anxiety and depression, and conscientiousness is associated with lower COVID-related depression (Han et al, 2021). The non-significant effects of gregariousness and assertiveness are surprising, as previous research suggests that these facets negatively correlate with affective disorders (Lyon et al, 2021). The null effect of gregariousness on COVID-related mental health is especially surprising, as isolation is a

risk factor associated with COVID-related mental illness (Brooks et al, 2020). However, these findings are consistent with a recent population study, suggesting that sociability and assertiveness did not significantly correlate with COVID-related psychological wellbeing (Modersitzki et al, 2020). Taken together, these results suggest that the lack of significant direct effects of gregariousness and assertiveness on affective disorders may be specific to some of the circumstances of the COVID-19 pandemic. For instance, individuals higher in gregariousness tend to have larger and closer social networks (Costa & McCrea, 2008), which normally provide more opportunities for social support. Lockdown and social distancing measures may have prevented people higher in gregariousness from benefitting from this support, thus eliminating the normal protective effect of this facet. However, these explanations are speculative; further research is needed to clarify the impact of gregariousness and assertiveness on affective disorders.

Structural equation modelling showed that acceptance mediated the effects of facets depression and assertiveness on COVID-related anxiety. This builds upon previous studies suggesting that facets depression and assertiveness are associated with, and significantly explain variance in, clinical anxiety (Lyon et al, 2020; 2021). These mediating effects also extend our knowledge of the effects of neuroticism and extraversion on acceptance (Connor-Smith & Flachsbart, 2007), by showing that facets depression and assertiveness, as components of neuroticism and extroversion respectively, contribute to anxiety via acceptance, at least in the context of COVID-19.

The effects of facets gregariousness, assertiveness, positive emotion, and competence on COVID-related depression were mediated by planning. These results

build on existing findings at the trait level, showing that extroversion and conscientiousness positively associate with planning (Connor-Smith & Flachsbart, 2007), and that planning is negatively associated with clinical depression (Christensen & Kessing, 2005; Visted et al, 2018). Our facet-level findings provide a more detailed insight into the specific components of trait extroversion and conscientiousness which have been linked with COVID-related depression (Han et al, 2021).

Given that extroversion is positively associated with planning (Connor-Smith & Flachsbart, 2007), one surprising result of the structural equation model is that facet gregariousness negatively regressed onto planning. One possible explanation is that individuals high in gregariousness may typically organise their plans around opportunities for social interaction, which are restricted during the COVID-19 pandemic. However, this explanation is speculative; further research is needed to understand the associations between personality facets and mental health in circumstances where emotion regulation strategies are altered or limited.

One limitation of this study is that it uses a cross-sectional design and is therefore unable to determine causation. The mediating effects discussed here therefore refer to statistical rather than causal mediation. However, given that personality is generally considered to be relatively stable over time (Soldz & Vaillant, 1999), it is unlikely that participants' personality facets were causally affected by either COVID-related mental health issues or emotion regulation strategies used in response to these issues. This clear temporality suggests that personality is more likely to cause changes in emotion regulation strategies or COVID-related mental health than to be affected by them. Nevertheless, this study is still unable to determine the extent to which emotion

regulation strategies affected COVID-related mental health, versus COVID-related mental health affecting the use of emotion regulation strategies.

A second limitation is that it is unclear whether COVID-related mental health is attributable to the COVID-19 pandemic. COVID-related anxiety and depression may refer to symptoms caused by the pandemic; alternatively, they may represent anxiety and depression during, but not caused by, the COVID-19 pandemic. Additionally, these constructs may refer to a combination of both mental health affected by the COVID-19 pandemic, and mental health affected by other factors at the same time.

A third limitation of this study is that only a small number of emotion regulation strategies were measured. Potential mediating effects of other emotion regulation strategies were not assessed. For example, substance use is strongly associated with COVID-related mental illness (Academy of Medical Sciences, 2020; Umucu & Lee, 2020) but was not investigated here, due to the high levels of skew in the data. Future research is needed to investigate possible mediating effects of additional emotion regulation strategies.

A final limitation is that this study investigated strategy selection, not strategy effectiveness. For example, this study suggests that assertiveness predicted the frequent use of acceptance; this study cannot determine whether assertiveness impacted the effectiveness of acceptance in regulating emotions. In line with previous articles, we suggest that future research should investigate strategy effectiveness along with strategy selection (Hughes et al, 2020; Kobylińska & Kusev, 2019).

6.5 Conclusion

This is the first study to investigate the mediating role of emotion regulation strategies in the relationship between personality facets and COVID-related mental health. Structural equation modelling revealed that the relationship between facet depression and COVID-related anxiety was partially mediated by acceptance; the relationship between facet assertiveness and COVID-related anxiety was fully mediated by acceptance. The effects of gregariousness, assertiveness, positive emotion, and competence on COVID-related depression were fully mediated by planning. This study helps to clarify one mechanism through which personality facets contribute to affective disorders. Further research is needed to investigate additional mediators, the impact of personality on the effectiveness of emotion regulation strategies, and the extent to which these findings generalise beyond the specific context of COVID-19. Future research may also benefit from using longitudinal designs to investigate the causal effect of personality facets and emotion regulation strategies on mental health.

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All authors were involved in study conceptualization and report writing. KL performed all data collection and data analyses. GJ was supported by the Hungarian Brain Research Program, Semmelweis University (Grants: 2017-1.2.1-NKP-2017-00002), and the Thematic Excellence Programme (2020-4.1.1.-TKP2020) of the Ministry for Innovation and Technology, Hungary.

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6.6.2 Conflict of interest

The authors report no conflict of interest.

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COVID-related stressors questionnaire

Have you experienced the following stressors, **due to the COVID-19 pandemic, associated restrictions, and impact on everyday life?**

If yes, please state the severity of the stressor, compared to those which other people are experiencing, one a scale of 1 to 5:

1: Much less severe than most people who experience this

2: A little less severe than most people who experience this

3: About the same severity as most people who experience this

4: A little more severe than most people who experience this

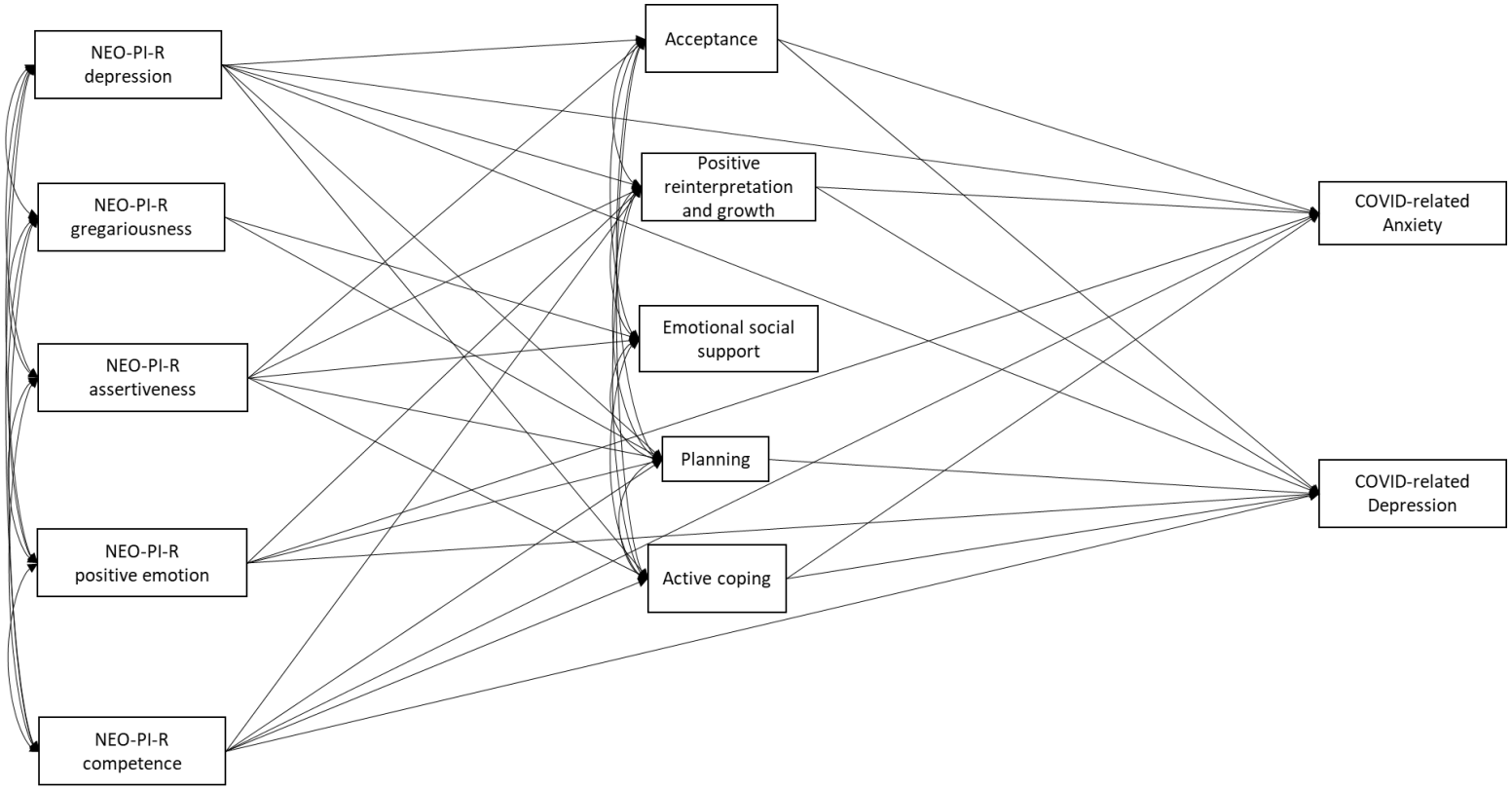
5: Much more severe than most people who experience this

	Yes	No	If Yes: How severe was this stressor compared to other people who have experienced it? (1-5)
Have you experienced symptoms of COVID-19?			
Has a member of your family experienced symptoms of COVID-19?			
Have you experienced family arguments or a family breakdown?			
Have you experienced a financial loss?			
Have you experienced disruption to your university work?			
Have you had a loss of access to mental health services?			
Have you experienced quarantine?			
Have you experienced an increase in childcare responsibilities?			
Have you experienced loss of access to physical activity?			
Have you experiences reduced quality of working environment?			
Have you experienced loss of, or reduced quality of, interaction with friends?			
Have you experienced loss of access to outdoor space?			
Have you experienced loss of personal space?			
Any other stressor (please state)?			

Supplementary table 6.1
Prevalence of COVID-related stressors.

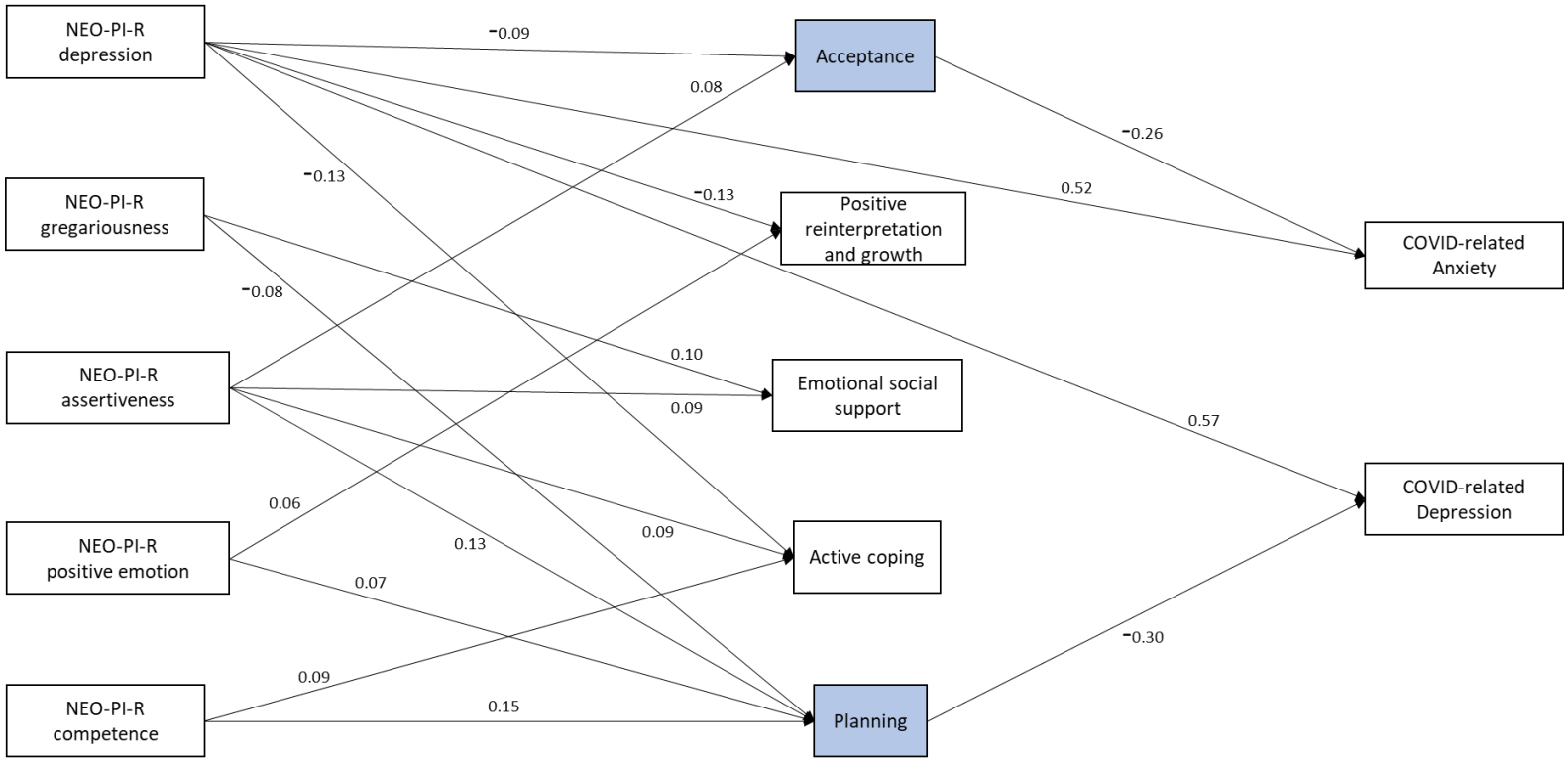
Stressor	Number of participants	% of sample
Disruption of university work	197	93.8
Loss, or reduced quality, of interaction with friends	197	93.8
Reduced quality of working environment	157	74.8
Loss of access to physical activity	133	63.3
Quarantine	130	61.9
Family arguments or a family breakdown	119	56.7
Loss of personal space	111	52.9
Loss of access to outdoor spaces	94	44.8
Financial loss	86	41.0
Family member with COVID symptoms	47	22.4
COVID symptoms	38	18.1
Loss of access to mental health services	31	14.8

Note. All figures are given to 1 decimal place.



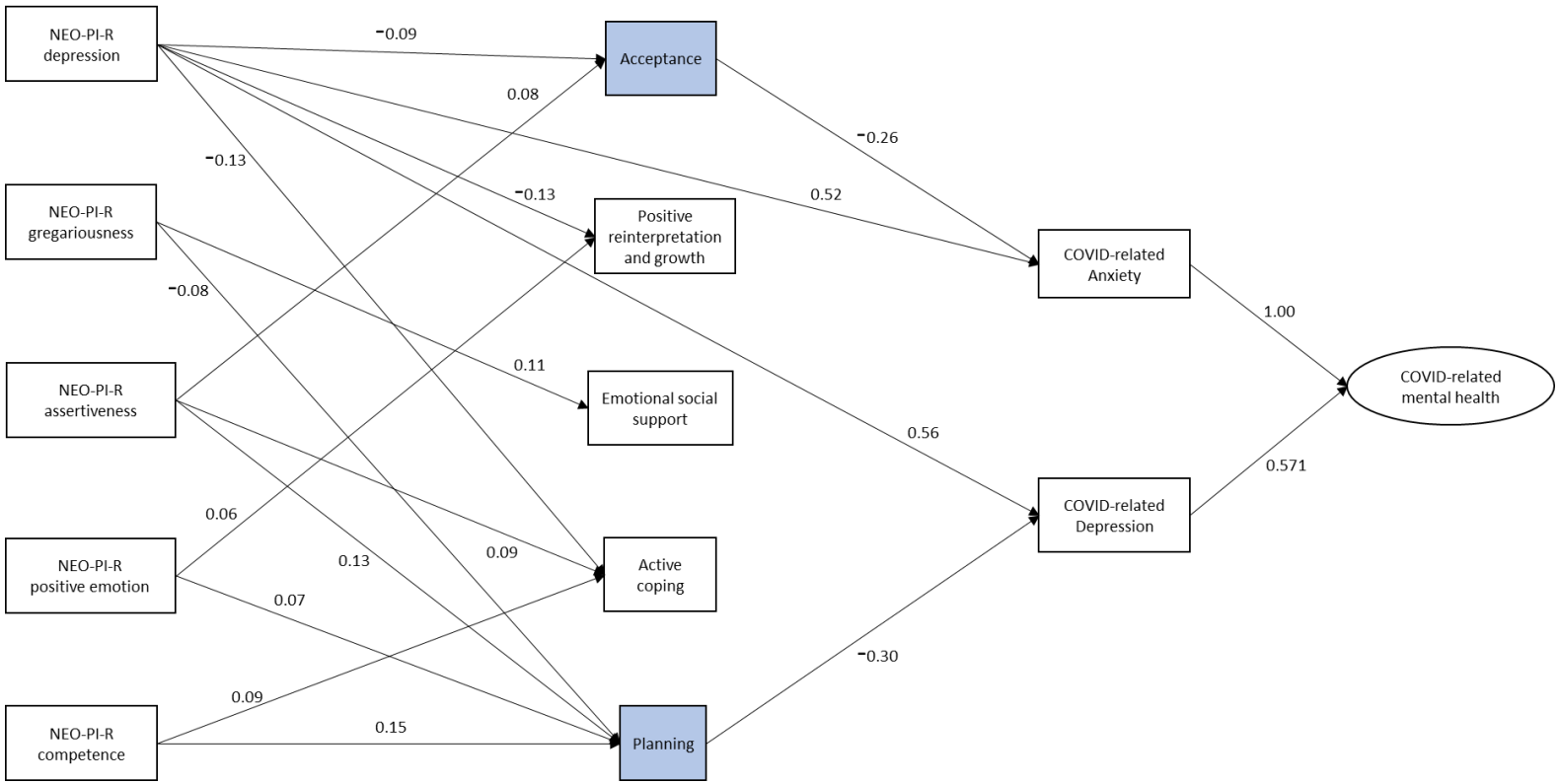
Supplementary figure 6.1. Tested model of regression (path) coefficients between personality facets, emotion regulation strategies, and COVID-related anxiety and depression

Double-ended arrows represent covariance. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised.



Supplementary figure 6.2. Structural equation model, before alteration in consideration of modification indices

Covariations between personality traits, and between emotion regulation strategies, and are not shown but were included in the analyses. Only significant ($p<0.05$) paths are displayed. Significant mediators are shaded. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised.



Supplementary figure 6.3. Structural equation model, including a combined COVID-related mental health variable

Covariations between personality traits, and between emotion regulation strategies, and are not shown but were included in the analyses. Only significant ($p<0.05$) paths are displayed. Significant mediators are shaded. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised.

Analysis script

```
attach(COVIDdata)

#To calculate the means and standard deviations all of variables, shown here for age:

mean(age)

sd(age)

#To calculate the Cronbach's alpha of a scale, each of the items of that scale were entered into a separate data frame, which was then analysed using the "alpha" function. Shown here for COVID-related anxiety:

library(psych)

alpha(GAD_items)

#To calculate variable normality, shown here for age:

shapiro.test(age)

#To calculate Pearson correlations, shown here for the correlated between age and the number of COVID-related stressors

cor.test(age, stressor_no)

#

#Structural equation modelling

library(lavaan)

path <-  'acceptance ~ facet_dep + facet_asse

            positive_reinterpretation_and_growth ~ facet_dep + facet_pos + facet_com + facet_asse

            planning ~ facet_dep + facet_pos + facet_com + facet_asse + facet_greg

            active_coping ~ facet_dep + facet_com + facet_asse

            emotional_social_support ~ facet_asse + facet_greg
```

```
            anx_total ~ facet_dep + facet_pos + facet_com +
positive_reinterpretation_and_growth + acceptance + active_coping

            dep_total ~ facet_dep + facet_pos + facet_com +
positive_reinterpretation_and_growth + acceptance + active_coping + planning

            facet_dep ~~ facet_pos + facet_com + facet_asse + facet_greg

            facet_pos ~~ facet_com + facet_asse + facet_greg

            facet_com ~~ facet_asse + facet_greg

            facet_asse ~~ facet_greg

            positive_reinterpretation_and_growth ~~ active_coping + acceptance +
planning + emotional_social_support

            active_coping ~~ acceptance + planning + emotional_social_support

            acceptance ~~ planning + emotional_social_support

            planning ~~ emotional_social_support'

fit <- sem (path, data = COVIDdata)

summary(fit, fit.measures = T)

fitMeasures(fit, c("cfi", "rmsea", "srmr"))

modindices(fit)

#This model had an acceptable statistical fit. It was then adjusted based on
modification indices, and the adjusted model was tested:

path <-  'acceptance ~ facet_dep + facet_asse

            positive_reinterpretation_and_growth ~ facet_dep + facet_pos + facet_com +
facet_asse + facet_greg

            planning ~ facet_dep + facet_pos + facet_com + facet_asse + facet_greg

            active_coping ~ facet_dep + facet_com + facet_asse

            emotional_social_support ~ facet_asse + facet_greg

            anx_total ~ facet_dep + facet_pos + facet_com +
positive_reinterpretation_and_growth + acceptance + active_coping
```

```
            dep_total ~ facet_dep + facet_pos + facet_com +
positive_reinterpretation_and_growth + acceptance + active_coping + planning

            dep_total ~~ anx_total

            facet_dep ~~ facet_pos + facet_com + facet_asse + facet_greg

            facet_pos ~~ facet_com + facet_asse + facet_greg

            facet_com ~~ facet_asse + facet_greg

            facet_asse ~~ facet_greg

            positive_reinterpretation_and_growth ~~ active_coping + acceptance +
planning + emotional_social_support

            active_coping ~~ acceptance + planning + emotional_social_support

            acceptance ~~ planning + emotional_social_support

            planning ~~ emotional_social_support'

fit <- sem (path, data = COVIDdata)

summary(fit, fit.measures = T)

fitMeasures(fit, c("cfi", "rmsea", "srmr"))

modindices(fit)

#

#Supplementary analysis, including a latent mental health variable:

#This model resulted in a negative variance for dep_total, meaning that p-values and
standard errors could not be calculated.  In response, the line "dep_total ~~
0.01*dep_total" was added

path <-  'MH =~ dep_total + anx_total

            dep_total ~~ 0.01*dep_total

            acceptance ~ facet_dep + facet_asse

            positive_reinterpretation_and_growth ~ facet_dep + facet_pos + facet_com +
facet_asse
```

```
            planning ~ facet_dep + facet_pos + facet_com + facet_asse + facet_greg

            active_coping ~ facet_dep + facet_com + facet_asse

            emotional_social_support ~ facet_asse + facet_greg

            anx_total ~ facet_dep + facet_pos + facet_com +
positive_reinterpretation_and_growth + acceptance + active_coping

            dep_total ~ facet_dep + facet_pos + facet_com +
positive_reinterpretation_and_growth + acceptance + active_coping + planning

            facet_dep ~~ facet_pos + facet_com + facet_asse + facet_greg

            facet_pos ~~ facet_com + facet_asse + facet_greg

            facet_com ~~ facet_asse + facet_greg

            facet_asse ~~ facet_greg

            positive_reinterpretation_and_growth ~~ active_coping + acceptance +
planning + emotional_social_support

            active_coping ~~ acceptance + planning + emotional_social_support

            acceptance ~~ planning + emotional_social_support

            planning ~~ emotional_social_support'

fit <- sem (path, data = COVIDdata)

summary(fit, fit.measures = T)

fitMeasures(fit, c("cfi", "rmsea", "srmr"))
```

Chapter Seven

Paper Five

Links between Personality, Affective Cognition, Emotion Regulation and Affective Disorders

Lyon, KA[1]; Juhasz, G[23]; Brown, LJE[4]; Elliott, R[1]

Kieran Lyon conceived the original idea for the study, decided on the study design, submitted an ethics application to the Division of Neuroscience and Experimental Psychology ethics committee (University of Manchester), collected all data (self-report questionnaires and computerised cognitive tasks), wrote the manuscript, and completed all revisions following review by the co-authors.

This is the final draft of a manuscript to be submitted to the *Journal of Affective Disorders*.

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Abstract

Background

Big Five personality constructs explain variance in affective disorders. However, it is unclear which mechanisms mediate the relationships between personality and affective disorders. Affective cognition and emotion regulation constitute two possible mediating mechanisms.

Methods

This study included data from 276 participants (81.52% female; mean age: 27.25 years), who completed questionnaire measures of the Big Five personality (traits and facets), emotion regulation strategies, symptoms of affective disorders (anxiety and depression), and questionnaire and cognitive measures of affective cognition (attentional biases and interpretation of emotional information). Structural equation modelling investigated the mediating effects of affective cognition and emotion regulation on the relationships between personality and affective disorders.

Results

Several of the relationships between personality facets and both anxiety and depression were mediated by affective cognition and emotion regulation. Affective cognitive and emotion regulation mediating the effects of Big Five traits on depression, but not anxiety.

Limitations

Most of the participants were female (81.52%). Therefore, the results may not generalise to males. The limited power of the models mean that non-significant effects may be type II errors, or that significant effects may be exaggerated. The cross-sectional design makes it impossible to determine causation.

Conclusions

The relationships between personality constructs and affective disorders are mediated by affective cognition and emotion regulation. Personality-informed interventions may benefit from focusing on these mediators.

7.1 Introduction

Affective disorders such as anxiety and depression are the most prevalent mental illnesses, with 12-month prevalence rates of 14% and 6.9%, respectively (Wittchen et al, 2011). Affective disorders are associated with an increased risk of suicide, with 42.1% of suicides involving a mood disorder (McLean et al, 2014). Affective disorders also have large economic costs, with mental health problems being the third most common cause of sick leave in the UK and costing around £70 billion per year (McManus et al, 2016).

One class of variables thought to impact affective disorders are personality constructs (Hankin et al, 2016). In particular, the Big Five traits of neuroticism, extroversion, and conscientiousness have been shown to predict affective disorders (Klein et al, 2011; Watson et al, 2006), with neuroticism positively associating with affective disorders, while extroversion and conscientiousness negatively associate with affective disorders (Kotov et al, 2010; Lyon et al, 2020a; Naragon-Gainey & Simms, 2017a). Recent research has focused on narrower measures of personality, such as personality facets (Jourdy & Petot, 2017; Naragon-Gainey & Simms, 2017b), referring to more specific individual differences in thoughts and behaviours (Costa & McCrea, 2008; DeYoung et al, 2007). Investigating traits and facets have comparative advantages, with broad traits having greater "bandwidth," being associated with a wider range of outcomes, whereas narrower facets have greater "fidelity," explaining greater variance in a narrower range of outcomes (Soto & John, 2017). Broad traits predict a wider range of affective disorder outcomes (Kotov et al, 2010), with trait neuroticism predicting mental illness in general (Ormel et al, 2013), while personality facets explain

greater variance in affective disorders than broad traits (Quilty et al, 2013; Quirk et al, 2003). Additionally, Lyon et al (2020b) found that variance in affective disorders was explained by a small number of personality facets: facet depression (referred to sadness and demotivation, not clinical depression) in neuroticism; gregariousness, assertiveness, and positive emotion in extroversion; and competence in conscientiousness. Therefore, it is important to investigate how both broad and narrow personality constructs associate with affective disorders.

Whilst previous studies have focused on correlations between personality and affective disorders, it is not yet clear which processes mediate these relationships (Durbin & Hicks, 2014). One possible class of mediators are affective cognitive biases, defined as biases in the processing of emotionally relevant information (Beck & Haigh, 2014; Harmer et al, 2004; Roiser et al, 2012). For instance, the Generic Cognitive Model of Mental Illness posits that affective disorders are maintained via cognitive biases such as biases in attention (in which individuals devote more attention to negatively-valanced information), memory (in which negatively-valanced information is more likely to be remembered) and interpretation (in which ambiguous stimuli are perceived as negative; Beck & Haigh, 2014). Affective disorders positively correlate with biases in attention, interpretation, and memory (Cisler & Koster, 2010; Elliott et al, 2011; Everaert et al, 2014; Platt et al, 2017). Personality traits also significantly correlate with these affective cognitive biases, with neuroticism positively correlating with biases toward negative information, while extroversion positively correlates with biases toward positive information (Amin et al, 2004; Canli et al, 2004; Chan et al,

2007; Chitsazi et al, 2016; Rusting et al, 1999). Affective cognition may therefore mediate the relationship between personality facets and affective disorder risk.

Another possible class of mediators is the use of emotion regulation strategies, defined as cognitive and behavioural strategies to affect the intensity and duration of an emotion (McRea & Gross, 2020). Emotion regulation strategies significantly correlate with personality traits, with extroversion and conscientiousness positively correlating with adaptive strategies such as positive reframing, support seeking and problem-solving (Connor-Smith & Flachsbart, 2007), while neuroticism positively correlates with maladaptive strategies such as denial and avoidance (Connor-Smith & Flachsbart, 2007). Emotion regulation strategies also relate to affective disorders, with affective disorders negatively correlating with adaptive strategies, and positively correlating maladaptive strategies (Schäfer et al, 2017; Visted et al, 2018). Therefore, personality may impact affective disorders via emotion regulation strategies. The mediating effect of emotion regulation is supported by a recent study, suggesting that the emotion regulation strategies of acceptance and planning mediated the relationships between personality facets and COVID-related anxiety and depression (Lyon et al, 2021a).

Emotion regulation may also mediate the relationship between affective cognition and affective disorders. The Extended Process Model of Emotion Regulation posits than an individual's emotions are generated and regulated by comparing their cognition model of the environment to their goals, including goals about their desired emotional state (Gross, 2015; Ochsner & Gross, 2014). As emotion generation and regulation are both informed by an individual's cognitive model, affective cognitive biases may therefore impact emotion regulation. For example, negative interpretations

of the environment may encourage the use of maladaptive emotion regulation strategies such as avoidance. Therefore, affective cognition may contribute to affective disorders via emotion regulation.

Taken together, affective cognition and emotion regulation may mediate the relationships between personality constructs and affective disorders. Additionally, the effects of affective cognition biases on affective disorders may be mediated by emotion regulation. The current study therefore aims to investigate these mediating paths, by testing a model whereby personality constructs predict affective cognitive biases, in turn predicting emotion regulation, in turn predicting affective disorder scores.

7.2 **Methodology**

7.2.1 Sample characteristics

Participants for this study were recruited using email announcements sent to all students and staff within the Faculty of Biology, Medicine and Health at the University of Manchester. The advert stated that to be eligible to participate, individuals had to be at least 18 years old, and able to read information on a standard computer screen, using regular glasses or contact lenses if needed. Data were collected from 289 participants, consisting of 237 females (82.01%) and 52 males. Participant ages ranged between 18 and 69, with a mean age of 27.01 (SD: 10.28).

7.2.2 Procedure

Recruitment adverts included a link to the study on Gorilla Experiment Builder (Anwyl-Irvine et al, 2020), where data collection was hosted. Each participant provided data unsupervised, using their own device. Participants gave consent to take part by filling in an online checklist before beginning the study. Each participant was compensated with a £10 shopping voucher. Ethical approval for the study was given by the Neuroscience and Experimental Psychology divisional ethics committee at the University of Manchester.

7.2.3 Measures

7.2.3.1 *Personality*

Big Five personality traits were measured using the Big Five Aspect Scale (DeYoung et al, 2007), consisting of 100 items, on a scale of 1 ("strongly disagree") to 5 ("strongly agree"); 48 items were reverse-coded, such that higher scores always indicated high levels of the relevant personality construct. In this questionnaire, each trait is split into two aspects, such as extroversion being split into assertiveness and enthusiasm. Scores for each personality trait were calculated by first summing the item scores for each of the two component aspects, and then taking the mean of the two aspect scores.

Personality facets were measured using the Neuroticism Extroversion Openness – Personality Inventory – Revised (NEO-PI-R; Costa & McCrea, 2008). Each personality facet is measured using eight items, on a scale from 1 ("strongly disagree") to 5 ("strongly agree"), in which each trait is calculated as the sum of these items. Five

personality facets were investigated: facets depression (referring to sadness and demotivation, not clinical depression), gregariousness, assertiveness, positive emotion, and competence. These facets were chosen as they most commonly associate with, or explain variance in, affective disorders (Lyon et al, 2020b; 2021b). Of the 40 items administered, 17 items were reverse-coded, such that higher scores always indicated high levels of the relevant personality facet.

7.2.3.2 *Emotion regulation*

Emotion regulation strategies were measured using the Coping Orientation to Problems Experienced Inventory (COPE Inventory; Carver, 2013), consisting of 60 items. This questionnaire measures how often participants use each of fifteen emotion regulation strategies, such as acceptance, emotional social support, active coping, denial, and religious coping. Each strategy is measured using four items, which are rated on a scale of 1 ("I don't usually do this at all") to 4 ("I usually do this a lot"). The scores for the fours item corresponding to each strategy are then summed, so that higher scores indicate greater use of that strategy. Using factor analysis, COPE scales were reduced to three factors, labelled "adaptive emotion regulation" (which comprised the strategies of positive reinterpretation and growth, active coping, acceptance, suppression of competing activities, and planning), "social and emotion-focused emotion regulation," (which comprised the strategies of focus on and venting of emotions, use of instrumental social support, and use of emotional social support) and "maladaptive emotion regulation" (which comprised the strategies of mental disengagement, denial, humour, and behavioural disengagement; see Supplementary table 7.1).

7.2.3.3 *Affective cognition*

Attentional biases to emotional information were measured using the dot-probe paradigm, which measures differences in response time between positively-valanced images and neutrally-valanced images, and differences in response time between negatively-valanced and neutrally-valanced images. This paradigm has been carried out using remote data collection (Cannito et al, 2020; Miloff et al, 2015). The task followed the procedures of Mather and Carstensen (2003) and used images from the Karolinska Directed Emotional Faces stimulus set (Lundqvist et al, 1998). The task consisted of sixty images and eighty trials. Each image showed one of twenty individuals (10 males, 10 females), with three images per individual: positively-valanced (happy), neutral, and negatively-valanced. For half of the individuals (5 males and 5 females), the negatively-valanced image depicted an afraid expression; for the other half, the negatively-valanced image depicted a sad expression. To counterbalance by image valence, every individual was shown in four trials: one where the positively-valanced image was the target; one where the negatively-valanced image was the target, and two where the neutrally-valanced image was the target.

On each trial, a fixation point was first shown in the centre of the screen for 500 milliseconds, with a blank screen presented 100 milliseconds before and after. A pair of images of the same individual then appeared on screen for 500 milliseconds, one on the left and one on the right. Each pair of images contained one neutrally-valanced image, paired with either a positively-valanced image or a negatively-valanced image. Once the pair of images disappeared, a dot appeared in one of two locations, corresponding to the previous positions of the images (Supplementary figure 7.1). Participants were

instructed to respond to the dot by pressing one of two buttons, reflecting each of the two locations, as quickly as possible. Reaction time responding to the dot was recorded for correct responses. Faster reaction times to the dot after viewing happy images, compared to neutral images, suggests an attentional bias to happy images. Faster reaction times to the dot after viewing sad images, compared to neutral images, suggests an attentional bias to sad images. Faster reaction time responding to the dot after viewing afraid images, compared to neutral images, suggests an attentional bias to afraid images.

Interpretation of ambiguous emotional scenarios was measured using the Ambiguous Scenarios Test for Depression (AST-D; Berna et al, 2011). This questionnaire consists of 24 statements about emotionally ambiguous situations, such as "You go to a place you visited as a child. Walking around makes you feel emotional." For each statement, participants are asked to imagine themselves in this scenario and rate how it would make them feel on a scale of 1 ("extremely unpleasant") to 9 ("extremely pleasant"). Higher scores denote more positive interpretations, and negative scores denote more negative interpretations. Interpretation of ambiguous situations is calculated as the sum of the individual item scores.

Interpretation of emotional images was investigated using a computerised cognitive task, adapted from Lythe (2006; examples images in Supplementary figure 7.2). Participants were shown 64 images, showing both social inclusion and exclusion. Images included an individual highlighted in a red circle; participants were asked to imagine how they would feel in a similar situation. Images were designed to evoke social emotions, being positively-valanced (happy expression), negatively-valanced (sad

expression) or neutrally-valanced (neutral expression). Images were presented at a rate of 1 per 11.25 seconds, with the image on screen for 8 seconds followed by a fixation cross for 3.25 seconds. After viewing the image, participants were asked to rate how positive or negative they would feel in a similar situation to the circled individual, on a scale of 1 ("extremely happy") to 9 ("extremely sad"). Participant ratings were averaged for each condition, therefore there were six scores for interpretation of emotional images: individual negative, individual neutral, individual positive, group negative, group neutral, and group positive. Using factor analysis, interpretation of emotional images scores were reduced to two factors, labelled "interpretation of negative emotional images" and "interpretation of neutral and positive emotional images" (Supplementary table 7.2). Higher scores denoted more negative interpretations, and lower scores denoted more positive interpretations.

7.2.3.4 *Affective disorders*

Depression was measured using the Beck Depression Inventory – 2 (BDI-II; Beck et al, 1996), consisting of 21 items which assesses depressive symptomatology in the past two weeks, such as loss of pleasure, feelings of guilt, and sense of worthlessness. For each item, participants are presented with a list of four statements, corresponding to different levels of the depressive symptom, and are asked to select the statement which most applies to them. BDI-2 scores were calculated as the sum of the item scores, such that higher scores indicated greater depressive symptomatology.

Anxiety was measured using the state anxiety subscale of the State Trait Anxiety Inventory (STAI-S; Spielberger, 1983), which measures how anxious participants feel at the time of data entry. The STAI-S includes 20 items, such as "I feel tense," "I feel at

ease," and "I feel nervous," and participants respond on a scale of 1 ("not at all") to 4 ("very much so"). STAI-S scores were calculated as the sum of the item scores, such that higher scores indicated higher state anxiety. State anxiety was chosen as the outcome measure of clinical anxiety, due to the conceptual overlap between trait anxiety and similar personality traits, such as NEO-PI-R facet anxiety (Costa & McCrea, 2008) and BFAS aspect withdrawal (DeYoung et al, 2007).

7.2.4 Analysis

Data were analysed using R version 4.1.0 (see supplementary materials for analysis script). Pearson correlations were calculated using the psych package in R (Revelle, 2021) to determine which regression paths to include in the structural equation models. To mediate the relationship between two variables, a mediator must significantly correlate with both variables (Fairchild & McDaniel, 2017). Therefore, an affective cognition score was only included in a model if it significantly correlated with an included personality construct, and an emotion regulation factor was only included in a model if it significantly correlated with the included affective disorder score.

Structural equation modelling was performed using the lavaan package in R (Rosseel, 2012), to investigate the mediating effects of affective cognition and emotion regulation on the relationships between personality constructs and affective disorders. The models tested pathways from personality variables to affective cognition, emotion regulation, and affective disorders; from affective cognition to emotion regulation and affective disorders; and from emotion regulation to affective disorders. Four structural equation models were tested: two investigating the effects of personality traits and facets

on depression scores; and two investigating the effects of personality traits and facets on anxiety scores.

Model fit was evaluated using the criteria of CFI ≥ 0.995, RMSEA ≤ 0.060 and SRMR ≤ 0.080 (Hooper et al, 2008). If a model did not meet these criteria, the model was adapted based on modification indices, using the modindicies function. Additional regression paths were only added if they had a theoretical explanation and met the threshold of $\chi^2 = 3.84$ and could therefore improve the model fit (Whittaker, 2012). If the adapted model remained a poor fit, it was adapted based on modification indices.

Due to the complexity of the models, it is not possible to calculate statistical power in structural equation modelling (Kline, 2015, p. 14-15). Using the "rule of thumb" of 200 participants for a structural equation model (MacCallum & Austin, 2000), all models had sufficient power for meaningful results. However, using the criteria of 10 participants per parameter, all models were statistically underpowered (Bentler & Chou, 1987; Schreiber et al, 2006). Rather than solely relying on rules of thumb, statistical power was estimated with RMSEA-based power analysis, using the power4SEM app (Jak et al, 2020), by estimating the power of each model to detect a significant difference between a close fit and a non-close fit (MacCallum et al, 1996). As statistical power is calculated for the overall model, power analysis is unable to determine the statistical power of individual regression paths (Jak et al, 2020). The power of each model ranged from 67.50% (for the model investigating personality facets and anxiety scores) to 70.30% power (for the models investigating BFAS traits; Supplementary table 7.6).

7.3 **Results**

7.3.1 Characteristics of the final sample

Of the 289 participants who took part, data from 8 participants (7 females) were excluded as insufficient data were provided to calculate a total score for one of the questionnaires or cognitive tasks. The resulting dataset included 145 missing data points, each of which were replaced with the variable mean (the most missing data points per variable was 6). Attentional bias scores were initially extremely skewed because of a small number of outliers, therefore attentional biases were recalculated, removing trials with outlying reaction times for each participant separately, based on the Tukey method (Tukey, 1977; Seo et al, 2006). The data for an additional five female participants were then excluded due to the high number of outlier trials making it impossible to calculate an attentional bias score.

The final sample consisted of 276 participants, 225 (81.52%) of whom were female, with a mean age of 27.26 (SD: 10.42) years. Most participants competed the study on a computer (271; 98.19%); three participants completed the study on a tablet, and two completed the study on a phone. For descriptive statistics of the variables, please see Table 7.1.

Table 7.1
Mental health, personality, emotion regulation, and affective cognition scores

		Mean (Standard deviation)	Cronbach's alpha
Age (years)		27.26 (10.42)	-
BDI-2 (out of 63)		18.10 (12.89)	0.94
STAI-S (out of 80)		46.23 (14.57)	0.96
BFAS	Neuroticism	3.15 (0.78)	0.93
	Extroversion	3.18 (0.66)	0.91
	Conscientiousness	3.30 (0.54)	0.85
	Agreeableness	3.88 (0.60)	0.90
	Openness	3.57 (0.53)	0.84
NEO-PI-R facets	Depression (facet)	24.46 (6.94)	0.87
	Gregariousness (facet)	23.53 (6.63)	0.84
	Assertiveness (facet)	22.32 (6.46)	0.86
	Positive emotion (facet)	23.79 (5.48)	0.83
	Competence (facet)	28.15 (4.92)	0.71
COPE	Positive reinterpretation and growth	10.86 (2.88)	0.80
	Mental disengagement	10.12 (2.67)	0.52
	Focus on and venting of emotions	10.52 (3.13)	0.84
	Use of instrumental social support	10.20 (3.08)	0.80
	Active coping	10.99 (2.59)	0.78
	Denial	6.03 (2.36)	0.77
	Religious coping	5.75 (3.33)	0.96
	Humor	8.96 (3.50)	0.92
	Behavioral disengagement	7.06 (2.71)	0.82
	Restraint	9.32 (2.32)	0.66
	Use of emotional social support	10.47 (3.51)	0.92
	Substance use	6.22 (3.16)	0.96
	Acceptance	11.28 (2.60)	0.77
	Suppression of competing activities	9.29 (2.17)	0.42
	Planning	11.69 (2.89)	0.86
Statistically derived COPE factors	Adaptive emotion regulation	-1.45e-11 (0.92)	-
	Social and emotion-focused emotion regulation	3.62e-11 (0.99)	-
	Maladaptive emotion regulation	-3.62e-12 (0.86)	-
AST-D (out of 216)		123.49 (24.02)	0.87
Attentional biases (in milliseconds, versus neutral faces)	Afraid faces	1.41 (43.51)	-
	Sad faces	1.44 (41.81)	-
	Happy faces	2.84 (34.73)	-
Interpretation of emotional images scores	Individual negative	5.86 (0.61)	-
	Individual neutral	3.51 (0.69)	-
	Individual positive	1.79 (0.71)	-
	Group negative	5.61 (0.74)	-
	Group neutral	3.97 (0.52)	-
	Group positive	2.33 (0.73)	-
Statistically derived interpretation of emotional images factors	Negative interpretation of negative social information	6.55e-17 (0.84)	-
	Negative interpretation of neutral and positive social information	-6.82e-17 (0.84)	-

Note. Cronbach's alphas are reported where applicable. All figures are given to 2 decimal places
BDI-2: Beck Depression Inventory - 2. STAI-S: State Trait Anxiety Inventory - State. BFAS: Big Five Aspect Scale. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised. COPE Inventory: Coping with Problems Experienced Inventory. AST-D: Ambiguous Scenarios Test for Depression

7.3.2 Variable selection for structural equation modelling

The emotion regulation strategies of substance use and religious coping showed strong skew, with more than half of participants giving the lowest possible score (55.80% for substance use; 69.75% for religious coping). Therefore, these variables were excluded from further analyses.

All Big Five traits and facets either significantly correlated with both affective disorder scores, or significantly correlated with an affective cognition or emotion regulation variable (Supplementary tables 7.3-7.5). Therefore, all Big Five traits and facets were included in the respective structural equation models.

Interpretation of ambiguous emotional scenarios, and interpretation of emotional images, but not attentional biases scores, significantly correlated with included personality constructs, affective disorders scores and at least one emotion regulation factor. Therefore, both interpretation measures, but not attentional bias scores, were included in all structural equation models. Adaptive and maladaptive emotion, but not social and emotion-focused emotion regulation, significantly correlated with anxiety and depression scores. Therefore, adaptive emotion regulation and maladaptive emotion regulation, but not social and emotion-focused emotion regulation, were included in all structural equation models.

7.3.3 Structural equation modelling

All four models initially had poor statistical fit (RMSEA < 0.060). However, each model had a good statistical fit after adaptation in consideration of modification indices (Supplementary table 7.6). The effects of neuroticism, extroversion, and

agreeableness on depression scores were mediated by interpretation of ambiguous emotional scenarios. The relationships between neuroticism, conscientiousness, and agreeableness on depression scores were mediated by maladaptive emotion regulation. The effects of extroversion, conscientiousness, and agreeableness on depression scores were mediated by interpretation of neutral and positive emotional images. Furthermore, the effects of neuroticism, agreeableness, and openness on maladaptive emotion regulation were mediated by interpretation of negative emotional images; and the effects of extroversion, conscientiousness, and agreeableness on maladaptive emotion regulation were mediated by interpretation of neutral and positive emotional images (Figure 7.1).

The effects of facets gregariousness, assertiveness, and competence on depression scores were mediated by adaptive emotion regulation. The effects of facets depression and competence on depression scores were mediated by maladaptive emotion regulation. The effects of facets positive emotion and competence on depression scores were mediated by interpretation of neutral and positive emotional images. Furthermore, the effects of all included personality facets on adaptive emotion regulation were mediated by interpretation of ambiguous emotional scenarios (Figure 7.2).

No affective cognition score or emotion regulation factor mediated the relationships between personality traits and anxiety scores (Figure 7.3). The effects of facets gregariousness, assertiveness, and competence on anxiety scores were mediated by adaptive emotion regulation. The effects of all included personality facets on adaptive emotion regulation were mediated by interpretation of ambiguous emotional scenarios (Figure 7.4)

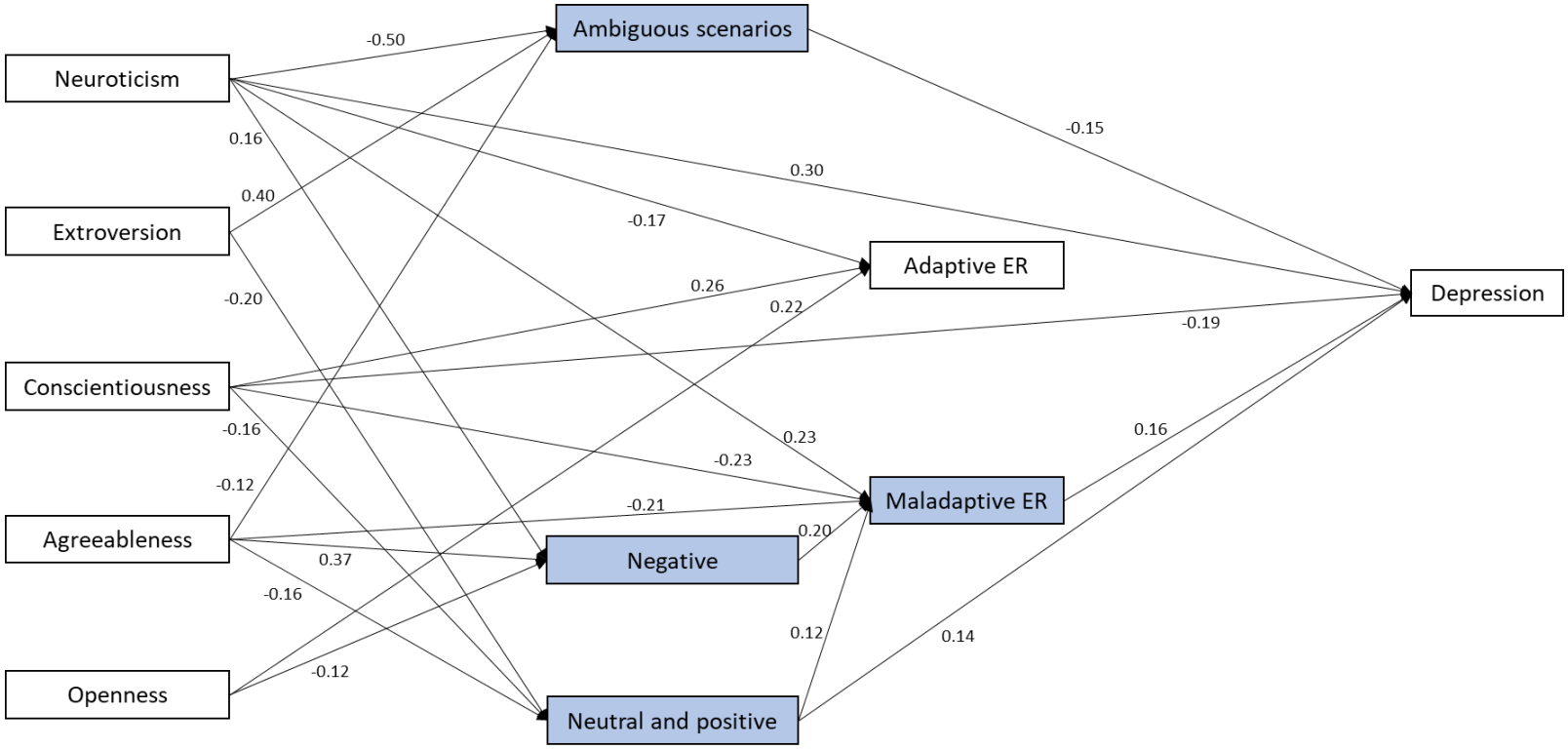

Figure 7.1. Structural equation model of Big Five personality traits, affective cognition, and emotion regulation factors explaining depression scores, after alteration in consideration of modification indices

Only significant ($p<0.05$) paths are displayed. Significant mediators in the relationships between personality traits and depression scores are shaded. Ambiguous scenarios: interpretation of ambiguous emotional scenarios. Negative: interpretation of negative emotional images. Neutral and positive: interpretation of neutral and positive emotional images. ER: emotion regulation.

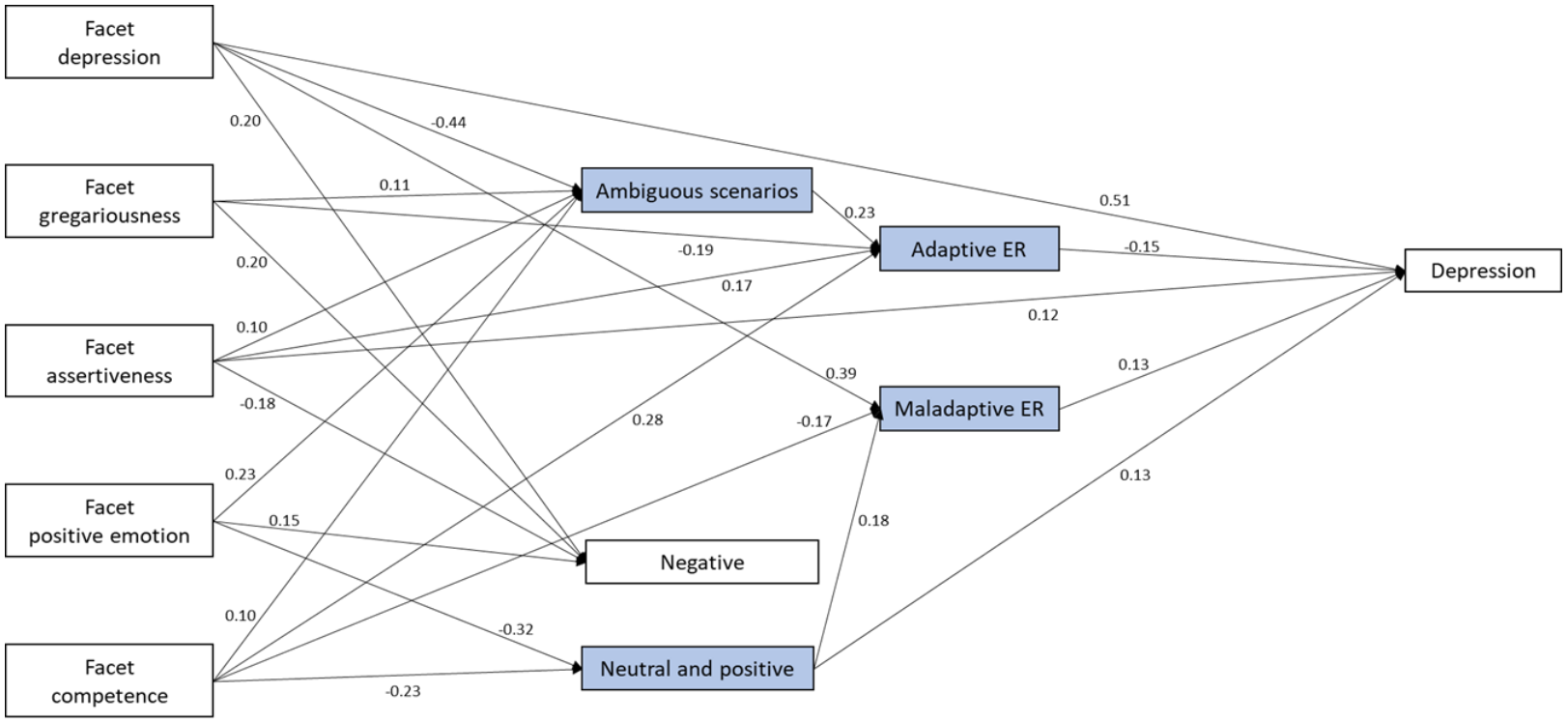

Figure 7.2. Structural equation model of Big Five personality facets, affective cognition, and emotion regulation factors explaining depression scores, after alteration in consideration of modification indices

Only significant ($p<0.05$) paths are displayed. Significant mediators in the relationships between personality traits and depression scores are shaded. Ambiguous scenarios: Interpretation of ambiguous emotional scenarios. Negative: interpretation of negative emotional images. Neutral and positive: interpretation of neutral and positive emotional images. ER: emotion regulation.

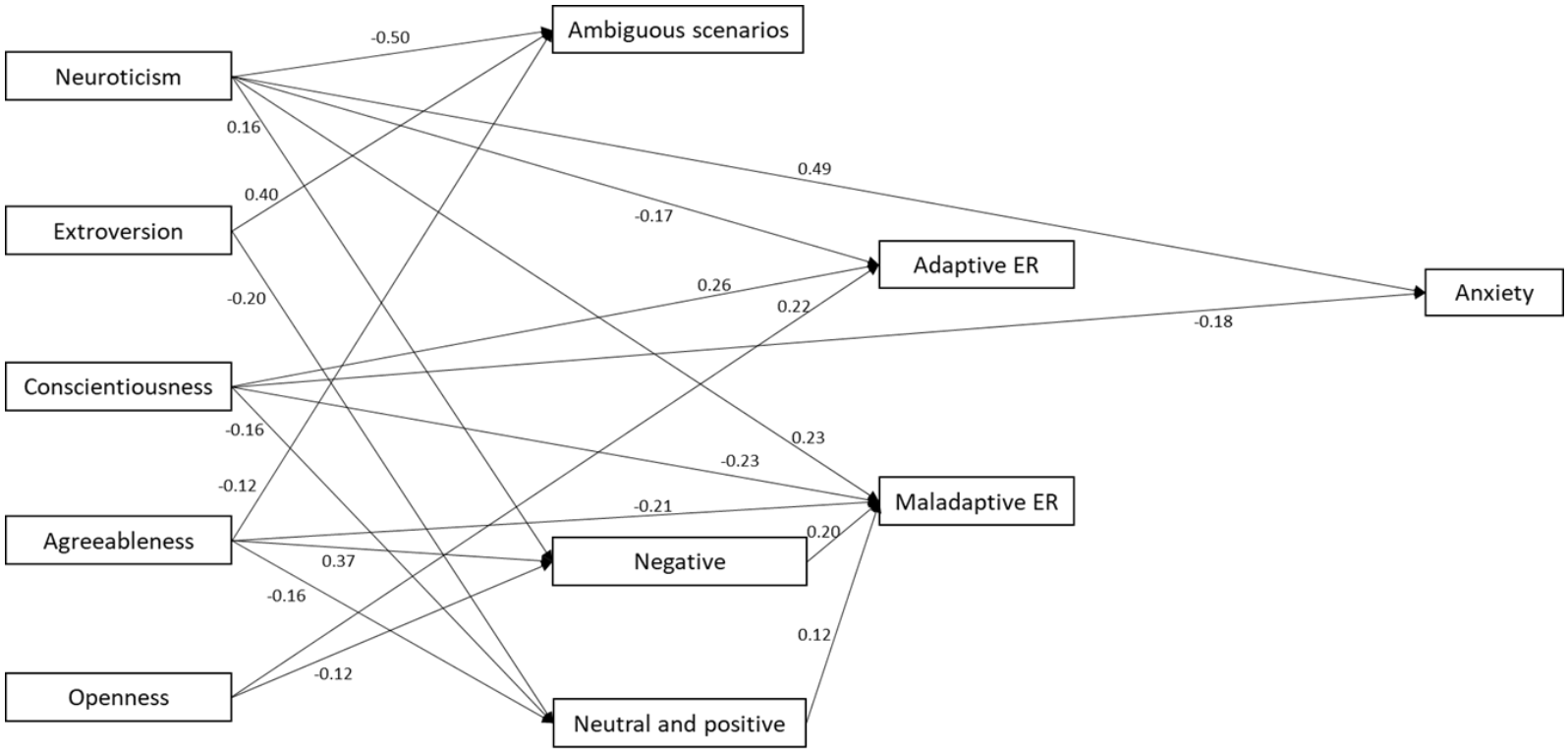

Figure 7.3. Structural equation model of Big Five personality traits, affective cognition, and COPE factors explaining anxiety scores, after alteration in consideration of modification indices

Only significant ($p<0.05$) paths are displayed. No variable significantly mediated the relationships between personality traits and anxiety scores. Ambiguous scenarios: interpretation of ambiguous emotional scenarios. Negative: interpretation of negative emotional images. Neutral and positive: interpretation of neutral and positive emotional images. ER: emotion regulation.

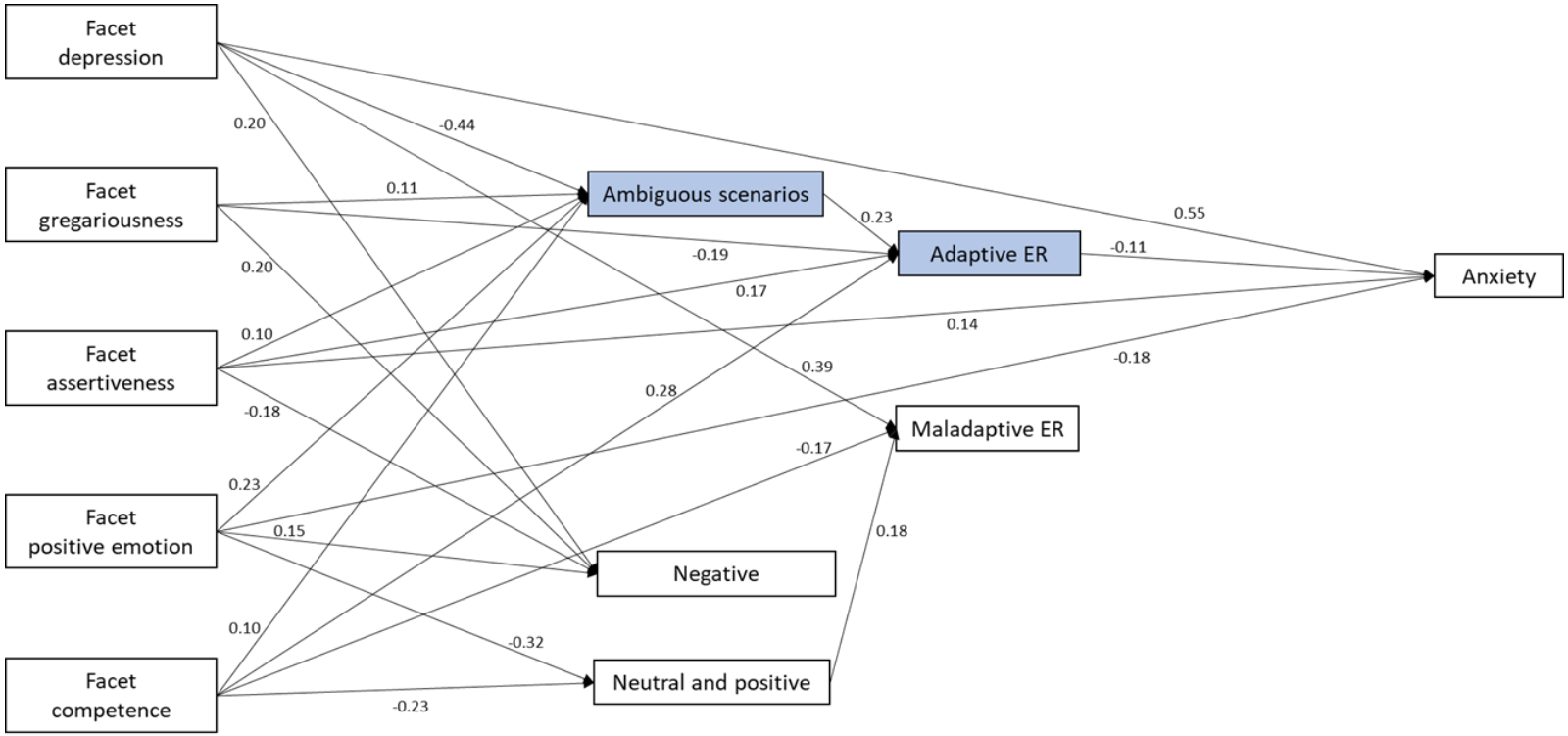

Figure 7.4. Structural equation model of Big Five personality facets, affective cognition, and COPE factors explaining anxiety scores, after alteration in consideration of modification indices

Only significant ($p<0.05$) paths are displayed. Significant mediators in the relationships between personality traits and anxiety scores are shaded. Ambiguous scenarios: interpretation of ambiguous emotional scenarios. Negative: interpretation of negative emotional images. Neutral and positive: interpretation of neutral and positive emotional images. ER: emotion regulation.

7.4 **Discussion**

This study aimed to investigate whether affective cognition and emotion regulation mediated the relationships between personality constructs and affective disorder scores. Interpretation of ambiguous emotional scenarios, interpretation of emotional images, and maladaptive emotion regulation mediated relationships between Big Five traits and depression scores. However, neither affective cognition or emotion regulation mediated the relationships between Big Five traits and anxiety scores. The effects of personality facets on depression scores were mediated by interpretation of ambiguous emotional scenarios, interpretation of emotional images, adaptive emotion regulation, and maladaptive emotion regulation. The effects of personality facets on anxiety scores were mediated by interpretation of ambiguous emotional scenarios and adaptive emotion regulation.

A primary finding is that both affective cognition and emotion regulation mediated the relationships between personality constructs and affective disorders. Personality traits predicted affective cognition, which in turn predicted emotion regulation, in turn predicting affective disorders. These mediating effects support the Extended Process Model of Emotion Regulation (Gross, 2015), which proposes that affective cognitive biases may affect emotion regulation. These findings suggest that individuals high in neuroticism, and low in extroversion and conscientiousness, with depression may therefore benefit from interpretation bias modification (Cristea et al, 2015; Hirsch et al, 2016), and interventions focusing on emotion regulation strategies, such as dialectical behaviour therapy (Neacsui et al, 2014) and affect regulation training (Mennin & Fresco, 2014).

Another primary finding is that all selected personality facets predicted affective disorders in a pathway from personality facets to interpretation of ambiguous emotional situations, to adaptive emotion regulation, to anxiety and depression scores. Additionally, facets positive emotion and competence predicted interpretations of neutral and positive emotional images, in turn predicting maladaptive emotion regulation, in turn predicting depression scores. As all facets explaining variance in affective disorders (Lyon et al, 2020b) do so via interpretation of emotional information, individuals with personality-related vulnerability factors to affective disorders may benefit from interpretation bias modification (Cristea et al, 2015; Hirsch et al, 2016).

One surprising result is that attentional biases did not significantly correlate with any personality constructs of interest, or either affective disorder. Therefore, attentional biases could not statistically mediate the relationships between personality constructs and affective disorders (Fairchild & McDaniel, 2017). This conflicts with previous research suggesting that attentional biases significantly correlate with both personality traits and affective disorders scores (Amin et al, 2004; Canli et al, 2004; Elliott et al, 2011; Lichtenstein-Vidne et al, 2017; Platt et al, 2017; Rusting et al, 1999). By measuring attentional biases using a dot-probe paradigm, the attentional biases scores are more likely to reflect automatic rather than strategic information processing (Cisler & Koster, 2010; Moors & De Houwer, 2006). However, both the interpretation measures were conscious and deliberative and are therefore more likely to reflect strategic information processing (Moors & De Houwer, 2006). Therefore, the effects of personality constructs on affective disorders may be mediated by biases in strategic, but not automatic, information processing.

Neither affective cognition nor emotion regulation mediated the relationship between personality traits and anxiety scores. Clinical anxiety is associated with affective cognitive biases toward threatening stimuli (Beck & Haigh, 2014; Cisler & Koster, 2010; Clark & Beck, 2010). However, the measures of interpretation did not focus on threatening stimuli, instead assessing participants' responses to sadness-inducing images (Lythe, 2006), or asking participant about the general unpleasantness of ambiguous statements (Berna et al, 2011), which may be off less relevance to clinical anxiety. Future research is therefore needed to determine whether affective cognitive biases toward threatening stimuli mediate the relationships between personality traits and anxiety disorder.

This study has some limitations. Firstly, most of the sample was female (81.52%), meaning the results may not apply to males, as affective disorders are more prevalent in females than males (Wittchen et al, 2011). Secondly, whilst the sample size was sufficient to meet the rule of thumb of 200 participants for a structural equation model (MacCallum & Austin, 2000), all structural equation models were statistically underpowered according to RMSEA-based power analysis (Jak et al, 2020; MacCallum et al, 1996), meaning true effects may not have been observed, or significant effects may be exaggerated (Button et al, 2013). Thirdly, emotion regulation scales were reduced to their principal components, to conserve statistical power. Therefore, the current study is unable to determine which narrow emotion regulation strategies mediate the relationships between personality constructs and affective disorder scores. Fourthly, by using a cross-sectional design, this study is unable to determine causation. That is, emotion regulation may have causally predicted affective cognition, rather than the other

way around. For example, individuals may use distraction when presented with negative images, thus reducing negative attentional biases (Cisler & Koster, 2010). Future research should utilize longitudinal designs to investigate causation. Finally, online data collection allowed for a larger sample size, but reduced experimental control over the attentional bias task, as participants may have been distracted or may not have understood the instructions, thus potentially introducing additional noise into the data.

7.5 **Conclusion**

Affective cognition and emotion regulation mediated the relationships between personality constructs and affective disorders, in the following pathway: personality to affective cognition, to emotion regulation, to affective disorders. The relationships between Big Five traits and depression scores were mediated by interpretation of ambiguous emotional scenarios, interpretation of emotional images, and maladaptive emotion regulation. The relationships between Big Five facets and depression scores were mediated by interpretation of ambiguous emotional scenarios, interpretation of emotional images, and adaptive and maladaptive emotion regulation. Additionally, the relationships between Big Five facets and anxiety scores were mediated by interpretation of ambiguous emotional scenarios and adaptive emotion regulation. These findings suggest that personality-informed interventions may benefit from focusing on affective cognition and emotion regulation. Future research should aim to identify the mediating effects of narrow emotion regulation strategies and incorporate longitudinal designs to investigate causation.

7.6 **Acknowledgements and author contributions**

All authors were involved in the conceptualization and writing of this study. Kieran Lyon performed all data collection and analysis.

7.6.1 Conflict of interest

The authors report no conflict of interest.

7.6.2 Role of the Funding Source

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Supplementary table 7.1
Factor analysis of COPE strategies

COPE scales	Factor loadings		
	Adaptive emotion regulation	Social and emotion-focused emotion regulation	Maladaptive emotion regulation
Positive reinterpretation and growth	0.675	0.160	
Mental disengagement	-0.127		0.516
Focus on and venting of emotions	-0.100	0.535	0.231
Use of instrumental social support	0.337	0.693	-0.101
Active coping	0.814	0.105	-0.260
Denial	-0.118		0.589
Humor	0.183		0.413
Behavioural disengagement	-0.305		0.738
Restraint	0.218		0.253
Use of emotional social support	0.144	0.983	
Acceptance	0.549		
Suppression of competing activities	0.560		0.210
Planning	0.795	0.183	-0.267

Note. COPE: Coping with Problems Experienced Questionnaire. Factor loadings below 0.1 are suppressed. All figures are to 3 decimal places

Supplementary table 7.2
Factor analysis of interpretation of emotional images variables

Social cognition variable	Factor loadings	
	Negative interpretation of negative emotional images	Negative interpretation of neutral and positive emotional images
Individual negative	0.694	
Individual neutral		0.471
Individual positive	-0.412	0.635
Group negative	0.718	
Group neutral	0.220	0.438
Group positive	-0.335	0.696

Note. Factor loadings below 0.1 are suppressed. All figures are to 3 decimal places

Supplementary tables 7.3. Pearson correlations between variables. All figures are given to 2 decimal places

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1 - Age																							
2 - BDI-2		-0.23***																					
3 - STAI-S		-0.18**	0.77***																				
BFAS	4 - Neuroticism	-0.21***	0.59***	0.67***																			
	5 - Extroversion	0.05	-0.38***	-0.37***	-0.29***																		
	6 - Conscientiousness	0.18**	-0.49***	-0.45***	-0.36***	0.31***																	
	7 - Agreeableness	0.18**	-0.07	-0.05	-0.1	0.17**	0.18**																
	8 - Openness	0.06	-0.17**	-0.21***	-0.18**	0.42***	0.2***	0.29***															
NEO-PI-R facets	9 - Depression	-0.23***	0.7***	0.71***	0.78***	-0.43***	-0.46***	0.02	-0.17**														
	10 - Gregariousness	-0.19**	-0.12	-0.14*	-0.12	0.56***	0.05	0.09	0.11	-0.14*													
	11 - Assertiveness	0.09	-0.23***	-0.23***	-0.24***	0.71***	0.25***	-0.17**	0.28***	-0.38***	0.43***												
	12 - Positive emotion	-0.05	-0.41***	-0.47***	-0.38***	0.63***	0.3***	0.26***	0.39***	-0.42***	0.43***	0.29***											
	13 - Competence	0.24***	-0.42***	-0.43***	-0.48***	0.41***	0.57***	0.22***	0.34***	-0.49***	0.15*	0.41***	0.36***										
COPE	14 - Positive reinterpretation and growth	0.04	-0.43***	-0.36***	-0.43***	0.41***	0.36***	0.13*	0.32***	-0.38***	0.15*	0.31***	0.43***	0.38***									
	15 - Mental disengagement	-0.3***	0.3***	0.36***	0.32***	-0.1	-0.35***	-0.02	0.04	0.37***	0.1	-0.1	-0.07	-0.24***	-0.09								
	16 - Focus on and venting of emotions	-0.16**	0.2***	0.27***	0.48***	0.07	-0.19**	0.11	0.02	0.35***	0.09	-0.13*	0.1	-0.2***	-0.04	0.22***							
	17 - Use of instrumental social support	-0.01	-0.18**	-0.11	-0.09	0.28***	0.1	0.2**	0.18**	-0.15*	0.21***	0.15*	0.34***	0.2**	0.39***	-0.14*	0.31***						
	18 - Active coping	0.15*	-0.41***	-0.39***	-0.39***	0.37***	0.44***	0.11	0.31***	-0.37***	0.07	0.36***	0.29***	0.44***	0.55***	-0.24***	-0.06	0.37***					
	19 - Denial	-0.25***	0.29***	0.27***	0.26***	-0.12*	-0.28***	-0.21***	-0.12	0.29***	0.11	-0.07	-0.14*	-0.33***	-0.11	0.33***	0.08	-0.11	-0.24***				
	20 - Religious coping	-0.1	-0.02	-0.03	-0.11	0.03	-0.01	-0.05	0.03	-0.11	0.02	0.01	0.08	-0.02	0.18**	0.07	0.01	0.12	0.04	0.22***			
	21 - Humor	-0.25***	0.15*	0.04	0.02	0.06	-0.14*	-0.1	0.07	0.12	0.1	0.11	0.08	-0.01	0.15**	0.25***	0.02	0.05	0.02	0.22***	0.11		
	22 - Behavioral disengagement	-0.19**	0.47***	0.4***	0.44***	-0.35***	-0.43***	-0.27***	-0.29***	0.47***	-0.08	-0.28***	-0.29***	-0.44***	-0.33***	0.38***	0.28***	-0.13*	-0.42***	0.49***	0.11	0.24***	
	23 - Restraint	0.02	-0.01	-0.04	-0.13*	-0.14*	0.07	0.05	0.07	-0.03	-0.02	-0.1	-0.01	0.05	0.17**	0.13*	-0.1	0.07	0.05	0.13*	0.12*	0.09	0.11

Note. BDI-2: Beck Depression Inventory: 2. STAI: State Trait Anxiety Inventory. BFAS: Big Five Aspect Scales. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised. COPE Inventory: Coping with Problems Experienced Inventory. * significant at p<0.05. ** significant at p<0.01. *** significant at p<0.001

Supplementary tables 7.4. Pearson correlations between variables continued. All figures are given to 2 decimal places

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
COPE	24 - Use of emotional social support	-0.06	-0.14*	-0.08	0.07	0.31***	-0.03	0.23***	0.17**	-0.04	0.2***	0.1	0.34***	0.02	0.26***	0.05	0.5***	0.73***	0.23***	-0.07	0.04	0.05	-0.04
	25 - Substance use	-0.12*	0.31***	0.3***	0.29***	-0.03	-0.19**	-0.22***	-0.05	0.3***	0.15*	0.1	-0.16**	-0.21***	-0.14*	0.21***	0.24***	0	-0.13*	0.31***	-0.05	0.15*	0.33***
	26 - Acceptance	0.07	-0.31***	-0.32***	-0.36***	0.15*	0.17**	0.09	0.28***	-0.26***	-0.04	0.14*	0.19**	0.3***	0.53***	-0.02	-0.09	0.18**	0.43***	-0.19**	0.09	0.26***	-0.19**
	27 - Suppression of competing activities	-0.03	-0.06	-0.08	-0.06	0.07	0.18**	-0.11	0.15*	0.01	-0.04	0.12*	0.07	0.17**	0.29***	-0.01	0.01	0.12*	0.43***	0.05	0.14*	0.13*	0.02
	28 - Planning	0.15*	-0.39***	-0.3***	-0.32***	0.32***	0.44***	0.22***	0.33***	-0.32***	0.05	0.27***	0.25***	0.46***	0.58***	-0.22***	-0.02	0.41***	0.76***	-0.25***	0.09	0.01	-0.43***
Statistically derived COPE factors	29 - Adaptive emotion regulation	0.09	-0.38***	-0.35***	-0.41***	0.32***	0.43***	0.1	0.35***	-0.33***	0.06	0.33***	0.28***	0.46***	0.73***	-0.14*	-0.11	0.36***	0.88***	-0.13*	0.15*	0.2***	-0.33***
	30 - Social and emotion-focused emotion regulation	-0.08	-0.08	-0.02	0.14*	0.27***	-0.1	0.22***	0.12	0.02	0.2***	0.05	0.31***	-0.05	0.16**	0.08	0.54***	0.7***	0.11	-0.04	0.03	0.04	0.03
	31 - Maladaptive emotion regulation	-0.3***	0.44***	0.37***	0.39***	-0.25***	-0.4***	-0.25***	-0.14*	0.46***	0.01	-0.18**	-0.19**	-0.37***	-0.11	0.6***	0.27***	-0.12	-0.3***	0.69***	0.2***	0.48***	0.86***
32 - AST-D		0.15*	-0.56***	-0.55***	-0.62***	0.54***	0.34***	0.01	0.24***	-0.64***	0.33***	0.43***	0.53***	0.46***	0.46***	-0.25***	-0.16**	0.26***	0.43***	-0.19**	0.14*	0	-0.36***
Attentional biases	33 - Afraid faces	-0.06	-0.09	-0.05	0.02	0.11	0.02	0.02	0.03	-0.08	0.1	0.09	0.08	0.09	0.01	-0.08	0.02	0.1	0.01	-0.16**	-0.05	-0.1	-0.1
	34 - Sad faces	0.08	-0.02	0.05	-0.05	-0.01	-0.04	-0.03	-0.07	-0.08	-0.04	0.11	0.02	0	0.02	0.07	-0.13*	-0.13*	-0.03	-0.01	0	0.02	0.02
	35 - Happy faces	0.07	-0.05	-0.03	-0.06	0.04	0	0.07	0.03	-0.1	0.03	0.04	0.06	0.02	0.07	0.04	0.06	0	0.05	-0.04	0.01	0.01	-0.06
Interpretation of emotional images scores	36 - Individual negative	-0.1	0.2***	0.17**	0.19**	-0.13*	-0.14*	0.29***	-0.11	0.27***	0.04	-0.2**	-0.01	-0.16**	-0.15*	0.2***	0.17**	0.06	-0.11	0.07	0.04	0.06	0.18**
	37 - Individual neutral	-0.11	0.18**	0.09	0.01	-0.1	-0.13*	-0.12*	-0.11	0.07	0.05	-0.03	-0.13*	-0.19**	-0.11	0.03	0.01	-0.11	-0.13*	0.26***	0.13*	0.02	0.22***
	38 - Individual positive	-0.09	0.28***	0.23***	0.16**	-0.19**	-0.28***	-0.22***	-0.12	0.19**	-0.1	-0.11	-0.29***	-0.28***	-0.2***	0	-0.06	-0.19**	-0.26***	0.11	0.02	0.03	0.16**
	39 - Group negative	-0.16**	0.11	0.13*	0.17**	0.03	-0.04	0.23***	0.01	0.14*	0.23***	-0.06	0.09	-0.07	-0.08	0.21***	0.21***	0.14*	-0.01	0.06	0.07	0.06	0.11
	40 - Group neutral	0.01	0.27***	0.23***	0.14*	-0.3***	-0.14*	-0.05	-0.23***	0.19**	-0.26***	-0.2***	-0.27***	-0.2***	-0.18**	0.09	-0.02	-0.12*	-0.09	0.09	0.03	0.02	0.2**
	41 - Group positive	-0.08	0.22***	0.16**	0.18**	-0.26***	-0.18**	-0.36***	-0.16**	0.14*	-0.32***	-0.06	-0.44***	-0.22***	-0.22***	-0.04	-0.08	-0.23***	-0.22***	0.18**	-0.01	-0.02	0.23***
Statistically derived interpretation of emotional images factors	42 - Negative interpretation of negative social information	-0.11	0.13*	0.12*	0.15*	-0.03	-0.05	0.32***	-0.05	0.18**	0.16**	-0.13*	0.1	-0.08	-0.09	0.22***	0.21***	0.13*	0	0.06	0.07	0.06	0.13*
	43 - Negative interpretation of neutral and positive social information	-0.14*	0.38***	0.3***	0.24***	-0.32***	-0.3***	-0.25***	-0.23***	0.27***	-0.22***	-0.17**	-0.43***	-0.35***	-0.3***	0.06	-0.02	-0.23***	-0.29***	0.24***	0.05	0.03	0.32***

Note. COPE Inventory: Coping with Problems Experienced Inventory. AST-D: Ambiguous Scenarios Task for Depression. * significant at p<0.05. ** significant at p<0.01. *** significant at p<0.001

Supplementary tables 7.5. Pearson correlations between variables continued. All figures are given to 2 decimal places

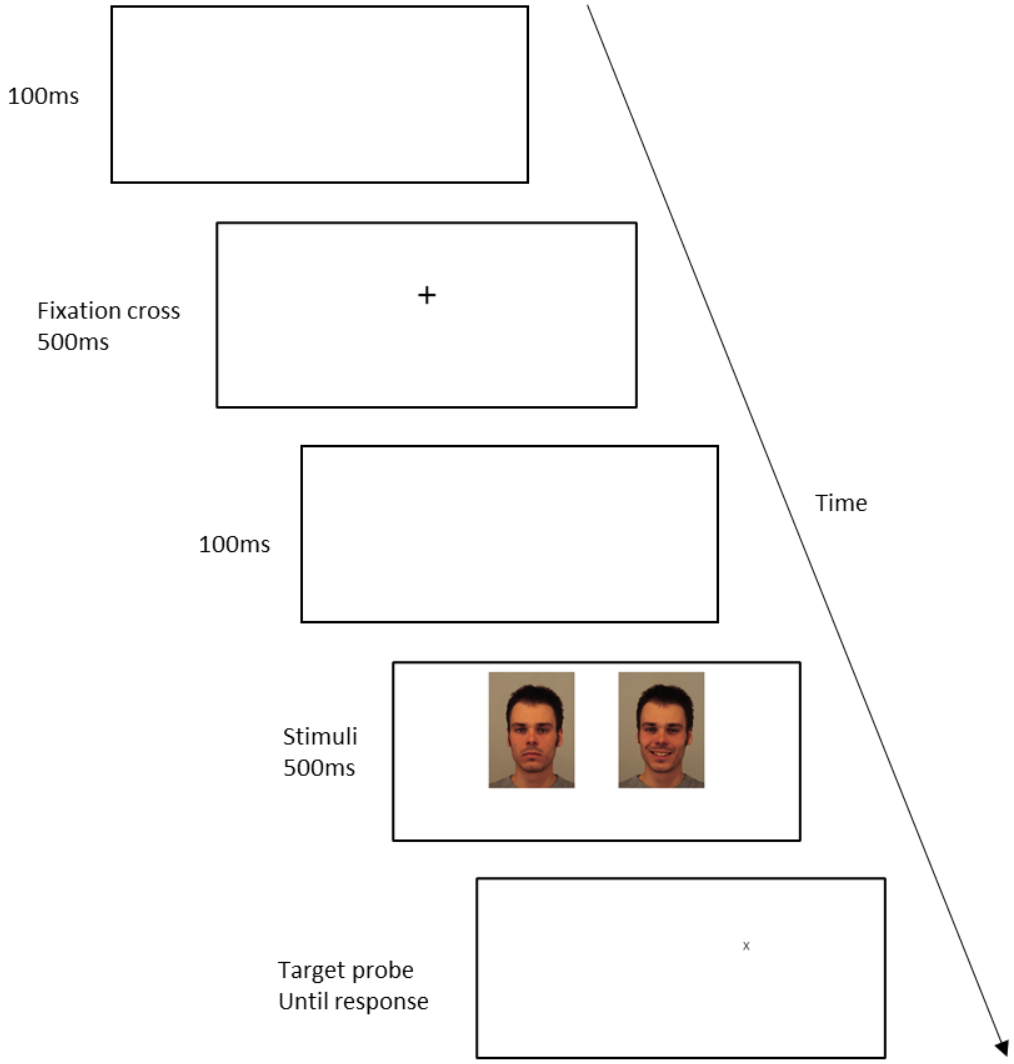
		23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
COPE	24 - Use of emotional social support	0.02																			
	25 - Substance use	0.03	0.07																		
	26 - Acceptance	0.19**	0.12	-0.11																	
	27 - Suppression of competing activities	0.24***	0.02	0.12*	0.23***																
	28 - Planning	0.09	0.3***	-0.13*	0.39***	0.39***															
Statistically derived COPE factors	29 - Adaptive emotion regulation	0.24***	0.16**	-0.09	0.59***	0.61***	0.86***														
	30 - Social and emotion-focused emotion regulation	0	0.99***	0.09	0.04	-0.06	0.18**	0.02													
	31 - Maladaptive emotion regulation	0.3***	-0.03	0.37***	0	0.25***	-0.31***	-0.09	0												
32 - AST-D		0.02	0.14*	-0.2***	0.26***	0.1	0.36***	0.41***	0.08	-0.3***											
Attentional biases	33 - Afraid faces	-0.14*	0.12*	-0.09	-0.14*	-0.14*	0.05	-0.06	0.12*	-0.19**	0.13*										
	34 - Sad faces	-0.07	-0.09	-0.01	0.01	-0.05	-0.02	-0.01	-0.09	0.01	0.07	0.01									
	35 - Happy faces	-0.01	0.01	-0.13*	-0.03	-0.09	-0.04	0	0.01	-0.04	0.02	0.08	0.01								
Interpretation of emotional images scores	36 - Individual negative	0.04	0.14*	0.06	-0.1	0	-0.07	-0.11	0.16**	0.18**	-0.28***	-0.06	-0.02	-0.05							
	37 - Individual neutral	0.05	-0.11	0.14*	-0.1	0.06	-0.2***	-0.11	-0.09	0.23***	-0.06	-0.13*	0.11	-0.04	0.04						
	38 - Individual positive	-0.06	-0.17**	0.05	-0.14*	-0.07	-0.3***	-0.26***	-0.13*	0.12	-0.23***	-0.05	0	-0.05	-0.28***	0.27***					
	39 - Group negative	0.1	0.17**	0.08	-0.05	0.08	0.03	0	0.17**	0.16**	-0.13*	0.01	0	-0.01	0.51***	0.06	-0.29***				
	40 - Group neutral	0.16**	-0.05	0.07	-0.08	0.03	-0.11	-0.09	-0.04	0.18**	-0.24***	-0.09	0.14*	-0.03	0.16**	0.29***	0.15**	0.13*			
	41 - Group positive	-0.03	-0.22***	0.06	-0.09	0.02	-0.22***	-0.19**	-0.2**	0.17**	-0.3***	-0.05	-0.05	-0.05	-0.18**	0.27***	0.59***	-0.28***	0.23***		
Statistically derived interpretation of emotional images factors	42 - Negative interpretation of negative social information	0.11	0.19**	0.08	-0.06	0.06	0.03	0	0.2**	0.17**	-0.16**	-0.04	0.03	-0.02	0.82***	0.1	-0.49***	0.85***	0.26***	-0.4***	
	43 - Negative interpretation of neutral and positive social information	0.03	-0.18**	0.11	-0.17**	0.01	-0.32***	-0.27***	-0.14*	0.27***	-0.38***	-0.11	0.03	-0.07	0.03	0.56***	0.76***	-0.03	0.52***	0.83***	-0.11

Note. COPE Inventory: Coping with Problems Experienced Inventory. AST-D: Ambiguous Scenarios Task for Depression. * significant at p<0.05. ** significant at p<0.01. *** significant at p<0.001

Supplementary table 7.6
Fit indices for structural equation models

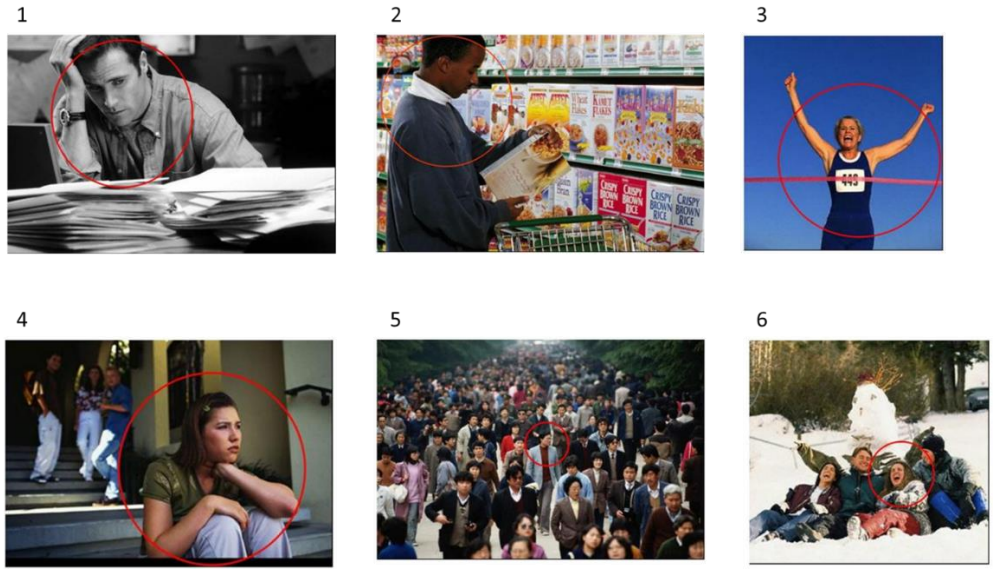
Structural equation model	Model fit indices			Statisical
	CFI	RMSEA	SRMR	power (%)*
Model 1	0.946	0.119	0.036	
Model 1 adapted based on modification indices**	0.995	0.045	0.015	70.30
Model 2	0.957	0.105	0.034	
Model 2 adapted based on modification indices**	0.996	0.044	0.018	69.00
Model 3	0.947	0.119	0.036	
Model 3 adapted based on modification indices**	0.995	0.045	0.015	70.30
Model 4	0.956	0.113	0.033	
Model 4 adapted based on modification indices**	0.995	0.058	0.018	67.50

Note. Model 1: Structural equation model of BFAS personality traits, affective cognitive biases and COPE factors explaining depression scores
Model 2: Structural equation model of NEO-PI-R personality facets, affective cognitive biases and COPE factors explaining depression scores
Model 3: Structural equation model of BFAS personality traits, affective cognitive biases and COPE factors explaining anxiety scores
Model 4: Structural equation model of NEO-PI-R personality facets, affective cognitive biases and COPE factors explaining anxiety scores
* Statistical power is only shown for the final models. Statistical power was estimated with the power4SEM app (Jak et al, 2020), using the power calculation described in MacCallum et al (1996)
** The final model, meeting all three model fit cutoffs, based on Hooper et al (2008)
BFAS: Big Five Aspect Scales. NEO-PI-R: Neuroticism Extroversion Openness – Personality Inventory – Revised. COPE: Coping Orgientation to Problems Experiences Inventory



Supplementary figure 7.1. Example trial of the dot-probe paradigm, measuring attentional biases

ms: milliseconds



Supplementary figure 7.2. Examples images from the interpretation of emotional images task

1: individual negative; 2: individual neutral; 3: individual positive; 4: group negative; 5: group neutral; 6: group positive

Analysis script

```
attach(Coping_and_cognition_data)

#To calculate means and standard deviations of variables, shown here for age:

mean(age)

sd(age)

To calculate variable normality, shown here for age:

shapiro.test(age)

hist(age)

#To calculate the Cronbach's alpha of a scale, each of the items of that scale were
entered into a separate data frame, which was then analysed using the "alpha"
function.  Shown here for facet positive emotion:

library(psych)

alpha(NEO_pos)

#

#Attention biases were calculated, and outliers removed, using a separate dataset,
extracted from Gorilla Experiment Builder.  Biases calculated separately for each
individual, show here for participant number 3869149:

attach(Attention)

#removing outliers

Ind <- subset(Attention, Participant_Private_ID == 3869149)

Q1 <- quantile(Reaction_Time, 0.25)

Q3 <- quantile(Reaction_Time, 0.75)

low_bench <- Q1 - 1.5*IQR(Reaction_Time)

high_bench <- Q3 + 1.5*IQR(Reaction_Time)

Ind <- subset(Ind, Reaction_Time < high_bench

              & Reaction_Time > low_bench)
```

```
#creating subsets for conditions

Sad <- subset(Ind, Target == "Sad")

Happy <- subset(Ind, Target == "Happy")

Afraid <- subset(Ind, Target == "Afraid")

Neutral_sad <- subset(Ind, randomise_blocks == "Female, sad vs neutral"

                      | randomise_blocks == "Male, sad vs neutral")

Neutral_sad <- subset(Neutral_sad, Target == "Neutral")

Neutral_happy <- subset(Ind, randomise_blocks == "Female, happy vs neutral"

                        | randomise_blocks == "Male, happy vs neutral")

Neutral_happy <- subset(Neutral_happy, Target == "Neutral")

Neutral_afraid <- subset(Ind, randomise_blocks == "Female, afraid vs neutral"

                         | randomise_blocks == "Male, afraid vs neutral")

Neutral_afraid <- subset(Neutral_afraid, Target == "Neutral")

#calculating means of RTs over trials

sad_RT <- mean(Sad$Reaction_Time)

happy_RT <- mean(Happy$Reaction_Time)

afraid_RT <- mean(Afraid$Reaction_Time)

Neutral_sad_RT <- mean(Neutral_sad$Reaction_Time)

Neutral_happy_RT <- mean(Neutral_happy$Reaction_Time)

Neutral_afraid_RT <- mean(Neutral_afraid$Reaction_Time)

#bias scores:

#sad bias:

Neutral_sad_RT - sad_RT

#happy bias

Neutral_happy_RT - happy_RT

#afraid bias

Neutral_afraid_RT - afraid_RT
```

```
#

#Factor analysis, shown here for COPE scales

attach(Data_276)

#scaling data

scale.data <- as.data.frame(scale(Data_276), centre = TRUE, scale = TRUE)

#To create a subset, only including emotion regulation variables

ER <- scale.data[c(6:11, 13:16, 18:20)]

#Principal components analysis

ER.pca <- princomp(ER, cor = TRUE, score = TRUE)

summary(ER.pca)

loadings(ER.pca)

#To view the scree plot

plot(ER.pca)

#in princomp, the eigenvalues are denoted as "standard deviation"

#Factor analysis, using 3 factors (based on the results of the principal components
analysis above)

ER.fa <- factanal(ER, factors = 3, rotation = "varimax", scores = "regression")

ER.fa

head(ER.fa$scores)

#Factor scores are computer for each individual, and are written to a csv file

write.csv(ER.fa$scores, "ER_fa_scores.csv")

#

#To calculate the correlation matrix:

corr.test(Coping_and_cognition_data, method = "pearson")

cormatrix <- corr.test(Coping_and_cognition_data, method = "pearson")

print(cormatrix, short=FALSE)

write.csv(cormatrix$r, "r_matrix.csv")
```

```
write.csv(cormatrix$p, "p_matrix.csv")

#

#Multipe regression, shown here for BFAS traits explaining variance in BDI-2:

reg <- lm(BDI ~ BFAS_N + BFAS_E + BFAS_C + BFAS_A + BFAS_O)

summary(reg)

#

#Structural equation modelling, shown here for BFAS traits, AST_D, COPE, and
interpretation of emotional images factors explaining variance in BDI-2:

scale.data <- as.data.frame(scale(Data_276_fa))

attach(scale.data)

#SEM:

scale.data <- as.data.frame(scale(Data_276))

attach(scale.data)

library(lavaan)

path <-  'AST_D ~ BFAS_N + BFAS_E + BFAS_C + BFAS_O

          Negative ~ BFAS_N + BFAS_A

          Neutral_and_positive ~ BFAS_N + BFAS_E + BFAS_C + BFAS_A + BFAS_O

          Adaptive_ER ~ BFAS_N + BFAS_E + BFAS_C + BFAS_O + AST_D +
Neutral_and_positive

          Maladaptive_ER ~ BFAS_N + BFAS_E + BFAS_C + BFAS_A + BFAS_O + AST_D +
Negative_social + Neutral_and_positive

          BDI ~ BFAS_N + BFAS_E + BFAS_C + BFAS_A + BFAS_O + Adaptive_ER +
Maladaptive_ER + AST_D + Negative + Neutral_and_positive'

fit <- sem(path, data = scale.data)

summary(fit, fit.measures = T)

fitMeasures(fit, c("cfi", "rmsea", "srmr"))

modindices(fit, minimum.value = 3.84)
```

```
#Statically and theoretically plausible regressions paths are added, based on the
modification indices, and the model is tested again, to improve statistical fit
```

Chapter Eight

General Discussion

8.1 **Summary of Main Findings**

This PhD focused on investigating the relationships between personality constructs and affective disorders. Specifically, this PhD had two aims: firstly, to identify lower-order personality constructs associated with, and explaining variance in, symptoms of anxiety and depression; and secondly, to identify mediating mechanisms in the relationships between personality constructs and symptoms of anxiety and depression. These aims were carried out across five studies, with Papers Two and Three focusing on the first aim, while Papers One, Four and Five focused on the second aim.

Paper One confirmed previous findings (Naragon-Gainey & Simms, 2017) that the Big Five traits of neuroticism, extroversion and conscientiousness uniquely explained variance in depressive symptoms. Structural equation modelling added that brooding mediated the effects of neuroticism, extroversion, conscientiousness, and openness on depressive symptoms; and reflection mediated the effects of neuroticism, extroversion, and openness on depressive symptoms.

Paper Two consisted of a systematic review of studies investigating associations between lower-order Big Five personality constructs and affective disorders. Best evidence synthesis found that all facets of neuroticism, and fantasy in openness, positively associated with various affective disorder scores. Best evidence synthesis also revelated that affective disorders negatively associated with positive emotion in extroversion, competence and self-discipline in conscientiousness, and trust in agreeableness. However, self-discipline also had non-significant associations and mixed associations with various affective disorder

scores, and the effect of trust on affective disorders scores was mainly limited to social anxiety.

Paper Three investigated which NEO-PI-R personality facets uniquely explained variance in affective disorder symptoms. Variance in symptoms of both anxiety and depression were explained by a small number of personality facets: facet depression (referring to sadness and demotivation, not clinical depression) in neuroticism; assertiveness and positive emotion in extroversion; and competence in conscientiousness. Facets depression and assertiveness positively regressed onto affective disorder scores, whereas facets positive emotion and competence negatively regressed onto affective disorder scores. Furthermore, facet gregariousness explained variance in anxiety symptoms, but not depressive symptoms, with a negative regression path.

Paper Four investigated the mediating effects of emotion regulation strategies on the relationships between personality facets (from Paper Three) and COVID-related anxiety and depression scores. Acceptance mediated the effects of facets depression and assertiveness on COVID-related anxiety scores. Planning mediating the effects of facets gregariousness, assertiveness, positive emotion, and competence on COVID-related depression scores.

Paper Five investigated the mediating effects of affective cognition and emotion regulation on the relationships between personality constructs and affective disorder symptoms. The effects of personality traits and facets on depression scores were mediated by interpretation of emotional information and emotion regulation, whereby interpretation of emotional information predicted emotion regulation. Additionally, the effects of personality facets on anxiety scores were mediated by

interpretation of emotional information and emotion regulation, whereby interpretation of emotional information predicted emotion regulation.

This PhD has contributed to the existing literature in two main ways. Firstly, this PhD has identified which personality facets are most strongly associated with affective disorders. In particular, this PhD found that variance in symptoms of anxiety and depression were explained by a small number of personality constructs associated with motivation and competence: facet depression (referring to sadness and demotivation, not clinical depression; Costa & McCrea, 1992, 2008) in neuroticism; facets assertiveness and positive emotion in extroversion; and facet competence (similar to self-efficacy; Costa & McCrea, 1992, 2008) in conscientiousness. Secondly, this PhD has identified both affective cognition and emotion regulation as mediators in the relationships between personality constructs and symptoms of affective disorders. The strategies of acceptance and planning mediated the relationships between personality constructs explaining variance in affective disorders (from Paper Three) and affective disorders scores. Furthermore, interpretation of emotional information, and the broad emotion regulation factors of adaptive emotion regulation and maladaptive emotion regulation, mediated the relationships between personality constructs and affective disorder scores. These findings have been used to develop the Motivation Competence Model of Personality and Affective Disorders, discussed in sections 8.2.1.1 and 8.2.2.2.

8.2 **Contributions of the thesis**

8.2.1 Contribution 1: Identifying lower-order personality constructs associated with affective disorders

Previous research suggests that the personality traits of neuroticism, extroversion, and conscientiousness both correlate with, and uniquely explain variance in, affective disorder symptoms (Klein et al, 2011; Kotov et al, 2010; Naragon-Gainey & Simms, 2017). However, it has been less clear which lower-order personality constructs are associated with affective disorder symptoms, due to three limitations of the existing literature:

Firstly, previous studies often used heterogenous measures of both lower-order personality constructs and affective disorder symptoms (Allen et al, 2018; Hayward et al, 2013; Jourdy & Petot, 2017), meaning it was not possible to determine whether the effects generalised across studies, or were limited to individual measures. Additionally, several studies investigated associations between lower-order personality constructs and affective disorder symptoms using statistically derived personality facets, based on factor analysis of both Big Five and non-Big Five questionnaires (Naragon-Gainey et al, 2009; Naragon-Gainey, 2011; Naragon-Gainey & Watson, 2014), whose results are difficult to map onto research using validated measures such as the NEO-PI-R (Costa & McCrea, 2008) and BFAS (DeYoung et al, 2007). Furthermore, as these studies derived personality facets from a small number of samples, it is unclear if these factor structures were generalisable.

Secondly, many existing studies have poor quality, rely on small samples which are likely to be underpowered. For example, Osma et al (2016) and Jourdy and Petot (2017) investigated simple associations between various NEO-PI-R facets

and affective disorder scores in samples of 52 and 58 participants, respectively. The use of underpowered samples increases the likelihood of type II errors, causing undue discrepancies in the results of the existing literature.

Thirdly, the existing literature has relied on simple associations; only one study included in the systematic review investigated the effects of personality facets using multiple regression (Quilty et al, 2013). As personality traits are statistical common factors across lower-order measures of personality, facets within the same trait are moderately-to-strongly correlated with each other (DeYoung et al, 2007; Soto & John, 2017). Between-facet correlations therefore increase the difficulty in determining which personality facets uniquely explain variance in affective disorder symptoms, as one facet may correlate with affective disorder symptoms due to its correlation with a second facet, which explains variance in affective disorder symptoms.

This PhD sought to address these limitations in two ways: Firstly, the systematic review in Paper Two investigated which personality aspects and facets associated with affective disorder scores across the existing literature. Using best evidence synthesis, this review was able to synthesise the existing knowledge across measures of affective disorders, while controlling for the effect of poor-quality studies. Secondly, Paper Three entered all NEO-PI-R facets into simultaneous multiple regressions to identify which facets uniquely explained variance in symptoms and anxiety and depression.

Paper Two found that that all facets of neuroticism positively associated with affective disorders, confirming previous research that neuroticism is a transdiagnostic risk factors in affective disorders (Hankin et al, 2016; Ormel et al,

2013). Additionally, this review revealed that several facets of extroversion, conscientiousness and agreeableness negatively correlated with affective disorder scores; facets positive emotion and competence most consistently negatively associated with affective disorders scores. Paper Three revealed that variance in symptoms of anxiety and depression were explained by facets depression (referring to sadness and demotivation, not clinical depression; Costa & McCrea, 2008), assertiveness, positive emotion, and competence (similar to self-efficacy; Costa & McCrea, 1985, 1995); facet gregariousness also explained variance in anxiety symptoms.

8.2.1.1 *The Motivation Competence Model of Personality and Affective Disorders*

The result of Papers Two and Three suggest that various personality facets associated with, or uniquely explaining variance in, affective disorder scores conceptually relate to motivation (i.e., facets depression, assertiveness, and positive emotion) or competence (i.e., facet competence). These findings informed the development of the Motivation Competence Model of Personality Affective Disorders, which posits that personality constructs predicting variance in affective disorder symptoms conceptually refer to either motivation or competence (Figure 8.1).

Several lower-order personality constructs explaining variance in affective disorder symptoms conceptually refer to motivation. This is unsurprising, as affective disorders are disorders of emotion (International Society for Affective Disorders, 2021), with emotions being a subclass of motivation (Ellis & Toronchuk, 2011).

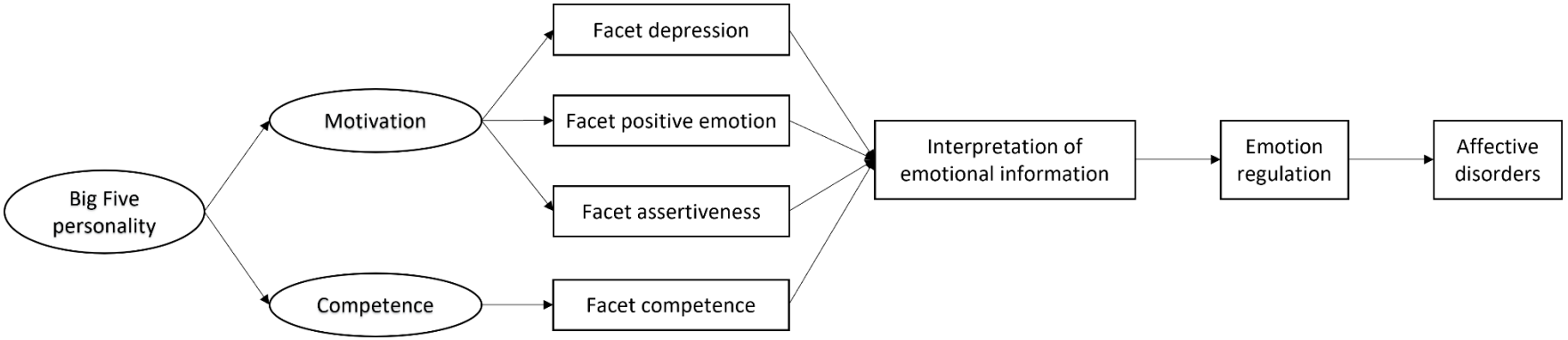


Figure 8.1. The Motivation Competence Model of Personality and Affective Disorders

This figure is original to this thesis.

The following paragraphs discuss how the personality facets of positive emotion, assertiveness, and depression relate to motivation, and how these processes may relate to affective disorder symptoms.

Two personality constructs explaining variance in affective disorders symptoms are the extroversion facets of positive emotion and assertiveness. Extroversion refers to individual differences in sensitivity to reward (DeYoung, 2015), with reward consisting of two distinct processes: hedonic or consummatory reward, or "liking," associated with a brief period of positive emotion and opioid activity upon goal attainment; and incentive reward, or "wanting," associated with sustained positive emotion and dopaminergic activity during goal progress (Berridge, 2018). Previous research indicates that the extroversion aspects of assertiveness and enthusiasm refer to individual differences in sensitivity to hedonic and incentive reward, respectively (DeYoung, 2015), as aspect enthusiasm is associated with opioid activity, whereas aspect assertiveness is associated with dopaminergic activity (Corr et al, 2013; DeYoung et al, 2013). Furthermore, there are both strong correlations and conceptual overlap between NEO-PI-R facet assertiveness and BFAS aspect assertiveness ($r = 0.84$, $p<0.001$, using the dataset from Paper Five), and between NEO-PI-R facet positive emotion and BFAS aspect enthusiasm ($r = 0.75$, $p<0.001$, using the dataset from Paper Five). Taken together, individuals low in facet positive emotion may receive little reward upon the attainment of a goal, and individuals low in facet assertiveness may receive little reward in approaching goals. This may lead to lack of goal progress seen in affective disorders, as anxiety is associated with lack of progress away from threats, while depression is associated with lack of progress toward goals (Carver & Scheier, 2001, pp. 138; Eccles, 2014).

Facet depression also uniquely explains variance in affective disorder symptoms. This facet refers to sadness and demotivation, with individuals high in this facet being more likely to feel guilt and discouragement (Costa & McCrea, 2008). Facet depression may therefore refer to the underlying sensitivity to reduced activation of the reward circuity. This is supported by affective neuroscience research suggesting that facet depression is both correlated with, and conceptually maps onto, the neurobiological SADNESS system (otherwise called the GRIEF or PANIC system), associated with the experience of loss and sadness, along with reduced opioid activity in the anterior cingulate cortex and ventral tegmental area (Ellis & Toronchuk, 2011; Panksepp & Watt, 2011). Individuals high in facet depression may therefore have an underlying biological sensitivity to signals of lack of goal progress, thus contributing to anhedonia in depression (Treadway & Zald, 2011) and lack of motivation for adaptive emotion regulation, which may contribute to the development of affective disorder symptoms.

Variance in affective disorder symptoms are also explained by competence, which conceptually overlaps with self-efficacy (Scholz et al, 2002), defined as an individual's belief in their ability to organise and execute plans to solve problems (Bandura, 1997, pp. 3). Individuals higher in self-efficacy therefore evaluate difficult circumstances as challenges to approach goals and values, rather than obstacles to avoid (Bandura, 1994). Self-efficacy therefore facilities incentive reward, reduces negative emotions in response to stressors, and facilitates the use of adaptive emotion regulation strategies (Bandura, 1994). The negative association between facet competence and affective disorders confirms the existing literature, that low self-efficacy is associated with affective disorders (Bandura, 1994; Muris, 2002). Individuals low in self-efficacy are more likely developed anxiety disorders,

due to the belief that stressors are unavoidable, and are more likely to develop depressive disorders, due to the belief that goals and values are unattainable (Bandura, 1997, pp. 153).

Along with personality constructs related to motivation and competence, variance in anxiety disorders may also be explained by personality constructs related to sociability. For example, Paper Two found weak evidence that facets warmth and gregariousness negatively associated with various anxiety disorders, Paper Three found that facet gregariousness explained variance in anxiety scores, and Paper Five added that facet gregariousness negatively correlated with anxiety scores. Future research is needed to investigate the possible role of personality constructs associated with sociability, controlling for personality constructs associated with motivation and competence. Nevertheless, this PhD has contributed to the current knowledge by finding that variance in both anxiety and depressive symptoms are uniquely explained by lower-order personality constructed related to motivation (such as facets depression, positive emotion, and assertiveness) and competence (i.e., facet competence).

8.2.2 Contribution 2: The identification of mediating mechanisms

Previous studies examining the relationships between personality constructs and affective disorders have focused on simple associations and have therefore been unable to identify mediating mechanisms (Durbin & Hicks, 2014; Ormel et al, 2013; Watson et al, 2006). This PhD contributed to the literature by identifying two mediating mechanisms: emotion regulation and affective cognition (in particular, interpretation of emotional information).

8.2.2.1 *Emotion regulation*

This PhD found evidence that emotion regulation mediates the relationships between personality constructs and affective disorders. Paper Four found initial evidence that the emotion regulation strategies of acceptance and planning mediated the relationships between personality facets and COVID-related anxiety and depression scores. However, this study only investigated a small number of emotion regulation strategies, which were most associated with response to pandemics (Academy of Medical Sciences, 2020; Umucu & Lee, 2020) and investigated COVID-related affective disorder scores, rather than affective disorders in general. Paper Five built on this study by investigating all emotion regulation strategies in the COPE Inventory (Carver, 2013), and using measures of affective disorder scores which were not limited to the context of COVID-19. Paper Five confirmed the mediating effect of emotion regulation, as emotion regulation factors mediated the effects of personality traits and facets on depressive scores, and the effects of personality facets on anxiety scores. Emotion regulation did not mediate the relationships between personality traits and anxiety scores. However, MacCallum et al (1996)'s RMSEA-based estimate of statistical power revealed that all structural equation models were statistically underpowered, with between 67.50% and 70.30% statistic power, therefore this non-significant effect may be a type II error. Additionally, emotion regulation strategies were statistically reduced to their principal components to conserve statistical power in the structural equation models. Therefore, it is unclear which narrow emotion regulation strategies mediate the relationships between personality constructs and affective disorder scores.

These results build on existing correlational research that emotion regulation strategies significantly correlate with both personality constructs and affective

disorders, with neuroticism and affective disorders positively associating with maladaptive strategies and negatively associating with adaptive strategies, while extroversion and conscientious show the opposite pattern (Carver & Connor-Smith, 2010; Connor-Smith & Flachsbart, 2007; Kotov et al, 2010; Naragon-Gainey et al, 2017; Schäfer et al, 2017; Visted et al, 2018). This PhD adds that both narrow emotion regulation strategies, such as acceptance and planning, along with broad emotion regulation factors, such as adaptive emotion regulation and maladaptive emotion regulation, mediate the effects of personality constructs on affective disorders.

8.2.2.2 *Affective cognition*

Both personality constructs and affective cognitive biases predict affective disorder symptoms (Klein et al, 2011; Watson et al, 2006; Beck & Haigh, 2014), and personality constructs such as neuroticism and extroversion significantly correlate with affective cognitive biases (Amin et al, 2004; Rusting et al, 1999). Therefore, affective cognitive biases may mediate the relationships between personality constructs and affective disorders (Fairchild & McDaniel, 2017). However, previous research had not investigated the mediating role of affective cognition in the relationship between personality constructs and affective disorder symptoms.

This PhD contributes to the existing literature by supporting the mediating role of affective cognition. The results of Paper Five suggest that interpretation of emotional information mediates the effects of broad personality traits and narrow personality facets on depressive symptoms, and the effects of narrow personality facets on anxiety symptoms. These mediating pathways support the Generic Cognitive Model of Mental Illness, whereby affective cognition is thought to

mediate the relationships between vulnerability factors and affective disorders (Beck & Haigh, 2014). However, interpretation of emotional information did not significantly mediate the relationships between broad personality traits and anxiety symptoms. This non-significant mediating effect may be an artifact of the measures used, as the measures of interpretation of emotional information assessed biases toward negative information, which are associated with depressive disorders (Beck & Haigh, 2014), rather than biases toward threatening information, which are associated with anxiety disorders (Beck & Haigh, 2014; Cisler & Koster, 2010; Ferreri et al, 2011).

Paper Five also suggested that affective cognition mediated the relationships between personality constructs and emotion regulation. These results support the Extended Process Model of Emotion Regulation, which posits that cognitive biases may impact emotion regulation (Gross, 2015). Furthermore, cybernetic models of personality propose that Big Five constructs refer to individual differences in sensitivity to signals of goal progress and threats (Corr et al, 2013; DeYoung, 2015), thus directing affective cognition and emotion generation. Taken together, these finding suggest a mediation pathway, in which a small number of personality constructs predict interpretation of emotional information, in turn predicting emotion regulation, in turn predicting affective disorders. This mediating pathway is included in the Motivation Competence Model of Personality and Affective Disorders (Figure 8.1).

8.3 **Strengths**

8.3.1 Statistical analysis

One strength of this PhD is the use of more advanced statistical techniques, such as multiple regression in Paper Three, to determine which personality facets explain variance in affective disorder symptoms; and structural equation modelling in Papers One, Four and Five, to investigate mediating mechanisms in the relationships between personality constructs and affective disorders. Previous studies have investigated associations between personality facets and affective disorders by performing a separate correlational test for each personality facet (Bagby et al, 1995; Cox et al, 2000; Newby et al, 2017). Using multiple regression and structural equation modelling, rather than testing individual associations, reduces the number of statistical tests, potentially reducing the likelihood of type I errors. Correcting for multiple tests, such as Bonferroni correction, increases the likelihood of type II errors (Perneger, 1998), therefore conducting a smaller number of tests potentially reduces the likelihood of type II errors.

This PhD found consistent results across studies. For example, Paper One, Paper Four and Paper Five concurred that emotion regulation mediating the effects of personality constructs on affective disorders. Furthermore, Paper Two and Paper Three suggested that the personality facets of depression, assertiveness, positive emotion, and competence associated with affective disorders. The consistency of the results allows for greater confidence that these findings are not type I errors.

8.3.2 Range of populations studied

Another strength of this PhD is the range of samples used, as several populations were studied to investigate both aims of this PhD. Firstly, associations

between personality constructs and affective disorders were investigated in a range of samples, including both samples in the systematic review of the existing literature in Paper Two, and the "NewMood" dataset used in Paper Three (Freeborough & Kimpton, 2011). The systematic review in Paper Two including both clinical samples (Allen et al, 2018; Friesen, 2008) and non-clinical samples (Kaplan et al, 2015; Newby et al, 2017), improving the generalisability of the results.

Secondly, multiple populations were studied to identify mediating mechanisms in the relationships between personality constructs and affective disorders, including both the "NewMood" dataset (N = 3,043; Freeborough & Kimpton, 2011) in Paper One, and samples of university staff and students in Papers Four and Five. Analyses of both populations confirmed that emotion regulation mediated the relationships between personality constructs and affective disorder symptoms. Furthermore, the mediating effect of emotion regulation was observed for emotion regulation and affective disorder scores in reference to the COVID-19 pandemic, in Paper Four; and in general, in Paper Five. These concurrent results improve confidence in the mediating effect of emotion regulation, supporting the generalisability of these effects. Therefore, the use of different samples increases confidence in addressing both aims of this PhD.

8.4 **Limitations**

8.4.1 Reliance on Big Five personality constructs

One limitation of this PhD is the reliance on the Big Five model of personality. Factor analysis consistently suggests that individual differences in personality are explained by five factors (Davis & Panksepp, 2018, p. 169-184;

DeYoung, 2015; Digman, 1996). However, multiple five factor models have been proposed. For example, the alternative five factor model consists of the traits of sensation seeking, neuroticism-anxiety, aggression-hostility, sociability, and activity (Zuckerman, 1992). Additionally, personality constructs may also exist outside of the Big Five taxonomy. For example, the HEXACO model of personality includes all Big Five traits, but adds an honesty-humility factor, referring to the tendency to behave fairly during interpersonal interactions (Lee & Ashton, 2004). Like the Big Five, this model has been replicated cross-culturally (Saucier & Srivastava, 2015). Additionally, the Dark Triad, referring to the antisocial personality traits of narcissism, Machiavellianism, and psychopathy (Muris et al, 2017), exists beyond the Big Five, and are better accounted for in the HEXACO model (Schreiber & Marcus, 2020). Together, all Big Five traits only explain a modest amount of variance in these traits (between $R^2 = 0.18$ for narcissism and $R^2 = 0.39$ for psychopathy; Vernon et al, 2008). The Big Five was chosen for this PhD as it has strong cross-cultural validity (Schmitt et al, 2007), and it is the dominant model of personality (DeYoung, 2015; Xie & Cobb, 2020), meaning the results of this PhD can conceptually map onto the personality literature. Nevertheless, additional variance in affective disorders may be explained by personality constructs beyond the Big Five.

This PhD relies on the NEO-PI-R (Costa & McCrea, 2008) in measuring personality facets. However, there is no scientific consensus regarding the number of personality facets (Schwaba et al, 2020; DeYoung et al, 2013), with the numbers of facets per trait only limited by discriminant validity between facets (DeYoung, 2015). For example, the NEO-PI-R splits each trait into six facets; the BFI-2 splits each trait into three facets (Soto & John, 2017); and factor analyses of various

measures of lower-order personality constructs have identified between three and four facets per trait (Naragon-Gainey & Watson, 2014). Costa and McCrea's (1995) decision to include six facets per trait was somewhat arbitrary. Six facets were chosen as it is difficult to replicate a factor solution with more than six factors, and Costa & McCrea (1995) wanted to limit the number of scales, so that the model did not become overwhelming. As with Big Five traits, the NEO-PI-R was chosen as it is the dominant model of personality (Xie & Cobb, 2020), meaning that the results regarding these facets are comparable with the existing literature. Furthermore, the NEO-PI-R was chosen as it measures more facets than any other Big Five questionnaire, meaning the investigation into associations between personality facets and affective disorders would be more thorough and have greater precision. Nevertheless, it is possible that variance in affective disorders may be explained by lower-order personality facets not represented in the NEO-PI-R.

8.4.2 Cross-sectional design

Another limitation of this PhD is that all five studies rely on cross-sectional designs, meaning they are unable to determine causal relationships between variables. This PhD was unable to use longitudinal designs for two reasons: Firstly, it was not possible to collect primary longitudinal data, due to the three-year limit on data collection. Secondly, no existing longitudinal dataset had investigated both lower-order personality constructs and affective disorders. For example, the Avon Longitudinal study of Parents and Children (ALSPAC) and Netherlands Study of Depression and Anxiety (NESDA) collected data from adolescents, examining the longitudinal effects of personality traits on internalising and externalising symptoms, but did not measure lower-order personality constructs (Fraser et al, 2012; Sayal et al, 2007; Spinhoven et al, 2013; 2016). Therefore, the inability to determine

causation regarding lower-order personality constructs is a limitation of both this PhD and the wider literature.

By relying on cross-sectional studies, this PhD cannot distinguish between models of causation, such as the vulnerability and scar models (Ormel et al, 2013; Klein et al, 2011; Watson et al, 2006). Additionally, it is not possible to determine causation regarding mediating mechanisms, with all references to mediation referring to statistical rather than causal mediation. Therefore, the proposed causal pathways in the Motivation Competence Model of Personality and Affective Disorders have yet to be investigated. More emphasis should be placed on longitudinal studies to understand the causal role of personality constructs in affective disorders (Durbin & Hicks, 2014), to determine whether lower-order personality constructs are risk and resilience factors in affective disorder symptoms.

Although no study was able to investigate causation, Paper Four investigated temporality between personality constructs and affective disorder scores. Participants provided data regarding their personality, use of emotion regulation strategies in response to COVID-19, and COVID-related anxiety and depression symptoms. As personality traits have moderate stability, between $r = 0.4$ and $r = 0.6$ over a 10-year period (Bleidorn et al, 2021), it is likely that the pandemic affected participants' personality scores less than it affected their use of emotion regulation strategies and affective disorder symptoms. Therefore, this study provides indirect evidence that personality constructs temporally impact COVID-related emotion regulation strategies and affective disorder symptoms.

8.4.3 Sample limitations

While the range of populations studied is a strength of this PhD (as discussed in section 8.3.2), there are nevertheless limitations to each of the samples used. The samples of Papers Four and Five are predominantly female (79.52% and 81.52%, respectively), meaning it is unclear whether the results will generalise to males. Furthermore, there are robust sex differences in personality traits, emotion regulation, and affective disorder prevalence (Kelly et al, 2008; Weisberg et al, 2011; Wittchen et al, 2011), therefore the effects of personality constructs and emotion regulation on affective disorders may be moderated by sex. When investigating the mediating effects of rumination facets on the effect of personality traits on depressive symptoms, Paper One only found small differences in results between sexes. However, it is unclear whether there are sex differences in the effects of personality facets, or in the mediators through which personality constructs predict affective disorders.

This PhD is limited by the reliance on university students and staff for primary data collection. The samples of Papers Four and Five do not represent the general population, having mean ages of 24.86 and 27.26 years, with all participants engaged in, or having completed, university education. Additionally, a sizeable proportion will have been studying on a Psychology-related degree, meaning these samples had increased interest in and knowledge of the studies' content, compared to the general population. Further research is needed to investigate mediators in the relationship between personality constructs and affective disorders in the wider population, such as samples with a broader age range, and participants without a degree. Taken together, the result of Papers Four and Five are most likely to

generalise to young women in higher education, particularly those with an interest in psychology.

The results of Papers One and Three are more likely to generalise to the wider population, using data from a population sample (Freeborough & Kimpton, 2011). However, individuals with a history of depression were overrepresented in both studies, with 41.40% and 58.33% of the samples reporting a history of depression in Papers One and Three, respectively. As Paper Three is based on a population sample, the results regarding personality facets explaining variance in affective disorder scores are likely to generalise to the wider population, strengthening the theoretical basis for investigating these facets in Papers Four and Five. Nevertheless, these effects may be exaggerated by the overrepresentation of individuals with a history of depression. Alternatively, the effects of these facets may be explained by scar effects, in which history of depression may have causally affected personality (Watson et al, 2006; Klein et al, 2011; Ormel et al, 2013).

8.4.4 Statistical power

A final limitation of this thesis is the use of underpowered samples. The structural equation models in Paper Four and Paper Five were statistically underpowered to detect a difference between a close fit and a non-close fit (Jak et al, 2020), with Paper Four having an estimated 0.597 and 0.584 power for the original model and the final model, respectively; and the models in Paper Five having estimated power between 0.675 and 0.703 (Jak et al, 2020). Therefore, several of the results of these papers may be type II errors, or significant effects may be exaggerated (Button et al, 2013). However, it is unclear which regression paths may be underpowered, as power is calculated for the overall model (MacCallum et al,

1996). While Papers One and Two may be underpowered, Paper One is likely to have sufficient statistical power, using a sample of 3,043 participants. Additionally, the best evidence synthesis in Paper Two controlled for statistically underpowered studies (Jourdy & Petot, 2017; Osma et al, 2016; Rees et al, 2005). Therefore, the results of Papers One and Two are unlikely to be type II errors.

8.5 **Clinical implications**

8.5.1 Screening and prevention

This PhD has applications regarding the screening and prevention of affective disorders. As personality constructs are considered vulnerability factors in affective disorders (Klein et al, 2010; Struijs et al, 2018; Spinhoven et al, 2016), personality questionnaires may be used to identify individuals at increased risk of developing affective disorders, and preventative measures may be developed for, and offered to, these individuals. This program has previously been carried out to reduce the risk of alcoholism in schoolchildren. For example, Newton et al (2016) screened 438 schoolchildren for personality risk factors of substance abuse, using the Substance Use Risk Profile Scale. Students scoring one standard deviation above the mean received sessions on coping, goal setting, and the cognitive behavioural model of mental illness; these children had a reduced rate of binge drinking 36 months later, compared to a personality-matched control group (Newton et al, 2016). Similarly, organisations such as schools, universities and high-stress professions may screen individuals based on personality-related vulnerability factors for affective disorders, where individuals with a vulnerable personality may receive preventative sessions focusing on interpretation of emotional information and emotion regulation

strategies. This program may prevent individuals from developing affective disorders. Screening and prevention methods are more likely to be effective if focused on personality facets explaining variance in affective disorder symptoms, as these constructs are stronger predictors of clinical outcomes than broad personality traits (Quilty et al, 2013; Quirk et al, 2003).

8.5.2 Informing treatment planning

Cognitive behavioural therapy (CBT) is currently the most widely used psychological therapy for mental illnesses, with a response rate of 46% for GAD, and between 51% and 87% for depression (Hofmann et al, 2012). Treatment efficacy may be improved by incorporating personality research for treatment planning (Bagby et al, 2016; Harkness & Lilienfeld, 1997). Firstly, assessing a patient's personality may allow clinicians to may plan for potential difficulties in therapy, such as individuals low in agreeableness having difficulties in maintaining the therapeutic alliance (Bagby et al, 2008) or individuals high in neuroticism engaging in self-defeating behaviour (Miller, 1991). Secondly, informing patients of their personality configurations may improve self-knowledge, helping patients to understand themselves and how to remain motivated (Bagby et al, 2016; Harkness & Lilienfeld, 1997). Thirdly, assessing personality constructs associated with affective disorders may inform treatment-matching, whereby individuals are directed to the treatment most likely to be effective for their personality configuration. For example, individuals high in neuroticism, and low in agreeableness, are less responsive to CBT, suggesting that pharmacological treatments may be more effective for this personality configuration (Bagby et al, 2008). Similar, individuals high in extroversion are more likely to respond to interpersonal therapy than CBT

(Joyce et al, 2007). By identifying the personality facets explaining variance in affective disorders, this PhD may inform treatment-matching. However, this field is still in its infancy, with many of the recommendations regarding treatment matching remaining speculative (Bagby et al, 2016).

8.3.3 Personality-targeted interventions

This PhD may also inform personality-target interventions, whereby mental illnesses are treated by psychological therapies explicitly targeting personality constructs. For example, the Unified Protocol for emotional disorders is a type of CBT which targets trait neuroticism, by reducing the associated avoidance and negative affective cognitive biases (Barlow et al, 2017). Firstly, targeting transdiagnostic personality-related vulnerability factors reduces clinician training time, as only one protocol is needed for transdiagnostic factors, rather than one treatment protocol per categorical disorder (Steele et al, 2018). Secondly, this approach targets common risk factors explaining comorbidity between affective disorders, therefore personality-targeted interventions may improve treatment outcomes for individuals with comorbid diagnoses (Steele et al, 2018). Personality-targeted interventions may be improved by focusing on narrow personality facets explaining variance in affective disorder symptoms, and by targeting the mediating mechanisms through which they contribute to affective disorders.

8.6 **Future directions**

This PhD has contributed to the existing literature by identifying lower-order personality constructs associated with affective disorder symptoms. Future studies may build on this by identifying lower-order personality constructs associated with

affective disorder treatment outcomes, as existing research into associations between personality constructs and treatment outcomes has focused on the broad trait level (Bagby et al, 2008; Bagby et al, 2016; Joyce et al, 2007). Treatment-matching may be improved by investigating the effects of lower-order personality constructs on treatment effectiveness (Zinbarg et al, 2008). For example, individuals low in facet positive emotion may be more likely to benefit from Behavioural Activation, which focuses on increasing pleasure and mastery, in treating depression (Kanter et al, 2010); individuals low in facet assertiveness may be more responsive to assertiveness training (Zinbarg et al, 2008).

This PhD contributed to the existing literature by identifying emotion regulation as a mediator in the relationship between personality constructs and affective cognition. However, Paper Four only investigated a small number of emotion regulation strategies associated with pandemics, within the context of COVID-19 (Academy of Medical Sciences, 2020; Umucu & Lee, 2020), and Paper Five investigated broad statistically derived emotion regulation factors. Identifying the mediating effects of narrow emotion regulation strategies may inform prevention programs discussed in section 8.5.1, whereby individuals with personality-related vulnerability factors may receive sessions based on these emotion regulation strategies.

Future research may build on this PhD by investigating moderating factors in the mediating role of emotion regulating, along with role of strategy effectiveness. The recent emotion regulation literature emphasises the importance of the emotion regulation effectiveness, and the moderating effects of the situation, the emotion being regulated, and the intensity of the emotion (Campbell-Sills et al, 2014; Doré et al, 2016; Sheppes, 2014). For example, avoidance is generally associated with

higher anxiety and depression scores (Schäfer et al, 2017; Visted et al, 2018), however situation selection, including the avoidance of craving-inducing stimuli, is a healthy strategy for coping with addiction (Hofmann & Kotabe, 2014; Hofmann & Vohs, 2016). Furthermore, it is unclear how personality constructs causally impact, or moderate, emotion regulation effectiveness (Hughes et al, 2020). Taken together, future research is needed to investigate how various factors, including personality constructs, impact the effectiveness of implementing emotion regulation strategies (Doré et al, 2016). Building on the theoretical framework on this PhD, future research may also investigate the possible mediating effects of affective cognitive biases in the relationships between personality constructs and emotion regulation effectiveness.

This PhD also identified affective cognition as a class of mediator in the relationship between personality constructs and affective disorders. However, only one study (Paper Five) investigated the mediating role of affective cognition. Therefore, future research is needed to investigate whether these effects replicate, and to address the methodological limitations of this study. Firstly, future research is required to investigate the mediating role of attentional biases under laboratory settings, to improve experimental control. Secondly, future research is needed to determine whether attentional biases to threatening information mediate the relationships between personality constructs and anxiety disorder symptoms, given that trait neuroticism and anxiety disorders are both associated with negative interpretations and threat-relevant maladaptive schemas (Beck & Haigh, 2010; Cisler & Koster, 2010; Thimm, 2010). Thirdly, future research is needed to investigate the mediating effect of memory biases in the relationships between personality constructs and affective disorders, as extroversion is associated with positive

memory biases (Rusting et al, 1999), while neuroticism and affective disorders are associated with negative memory biases (Elliott et al, 2011; Lichtenstein-Vidne et al, 2017; Platt et al, 2007; Rusting et al, 1999; Smith et al, 2018). By investigating affective cognitive biases in attention, memory and interpretation, future research may investigate the pathway proposed by the Generic Cognitive Model, in which risk factors such as personality constructs predict attentional biases, in turn predicting memory biases, in turn predicting interpretation biases, in turn predicting affective disorder symptoms (Beck & Haigh, 2014).

8.7 General Conclusions

Affective disorders are common mental illnesses associated with reduced quality of life and high social and economic costs (McLean et al, 2008; McManus et al, 2016). The Big Five personality traits of neuroticism, extroversion, and conscientiousness are transdiagnostic risk and resilience factors in affective disorders (Naragon-Gainey & Simms, 2017). However, it was previously unclear which lower-order components of these traits associated with affective disorders, and which processes mediated these relationships (Durbin & Hicks, 2014)

This PhD adds to the existing literature by identifying the lower-order personality constructs explaining variance in affective disorder symptoms, and by identifying affective cognition and emotion regulation as two mediators. Firstly, both a systematic review of the existing literature, and a multiple regression study, found that variance in affective disorder symptoms were explained by a small number of personality facets which conceptually relate to motivation, including facets depression (referring to sadness and demotivation, not clinical depression),

assertiveness, and positive emotion; and competence (facet competence, similar to self-efficacy; Costa & McCrea, 2008). Secondly, a population study and two online studies found that emotion regulation mediated the relationship between personality constructs and affective disorders; the second online study added that affective cognition also mediated the relationship between personality constructs and affective disorders. Personality constructs predicted interpretation of emotional information, in turn predicting emotion regulation, in turn predicting affective disorder scores. These findings are presented in the Motivation Competence Model of Personality and Affective Disorders (Figure 8.1). The mediating effects of affective cognition on the relationships between personality constructs and affective disorder scores support the Generic Cognitive Model of Mental Illness, which proposes that affective cognitive biases mediate the effects of genetic and environmental risk factors on mental illnesses (Beck & Haigh, 2014). Additionally, the effect of affective cognitive biases on emotion regulation supports the Extended Process Model of Emotion Regulation, which posits that an individual's emotions are generated and regulation not in reference to the objective world, but instead in reference to the individual's cognitive model of the world (Gross, 2015).

These insights may inform interventions to prevent the development of affective disorders, such as screening for individuals with a vulnerable personality configuration and providing preventative sessions focusing on affective cognition and emotion regulation strategies. Furthermore, this PhD may inform existing treatments and practices, such as treatment-matching by personality (Bagby et al, 2016), and the development of treatments targeting personality-related risk factors (Barlow et al, 2017). Future research is needed to clarify the roles of affective

cognitive biases in attention and memory, and to investigate the effects of personality constructs on the effectiveness of emotion regulation strategies.

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