Emotion, Mood, and Mind Wandering:

Laboratory and naturalistic studies with respect to mental health

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DECLARATION

This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the Preface and specified in the text. I further state that no substantial part of my thesis has already been submitted, or, is being concurrently submitted for any such degree, diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. It does not exceed the prescribed word limit for the relevant Degree Committee.

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ABSTRACT

Affective experiences colour much of human experience, shaping how we feel about, respond to, and regulate daily life. While emotion and mood are distinct though related affective phenomena, many studies use these terms interchangeably and draw conclusions on the latter based on findings that may be more pertinent to the former. Key theoretical differences delineate emotion versus mood, with importance placed in maladaptive experiences of long-term mood rather than short-term emotion in mood disorders such as depression. Unpacking differences in these affective dynamics is vital to approaching improvements in mental health and well-being. In addition, much of waking life is spent mentally wandering, and furthering our understanding of mentation and mind wandering in mental health is of importance in conjunction with affect. Where the mind may go to at rest free from distraction may possess important insights into the nature of the mental landscape and mental well-being. This thesis investigates differential aspects of emotion, mood, and mind wandering in diverse clinical populations with the goal of elucidating these experiences in relation to mental health. This includes investigations through a series of studies on: (i) the underlying structure of emotion and mood representations in adolescents, (ii) intraday emotions dynamics using clinical diagnostic and data-driven assessment of person-specific models of temporal emotion, (iii) interrelationships of emotion and mood over time and summary metrics of group-level complexity for both affect types, (iv) naturalistic mood regulation strategy use and outcomes, (v) a theoretical framework for comprehensive mind wandering study, and finally, (vi) naturalistic mind wandering, related affect, and a sensory deprived assessment of mind dimensions using novel methodologies. Altogether these findings provide evidence for the significance in studying emotion, mood, and mind wandering with the aim of providing a foundation for clarifying affective experience and multidimensional aspects of thought content in mental health.

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CHAPTER 1 – INTRODUCTION

1.1 OVERVIEW

When it comes to the human experience, our feelings about the world within and around us and the thoughts, memories, and images our minds entertain in large part drive our psychological reality. These feelings manifest as either emotions or moods – affective states with different theorised purposes – and the dynamic navigation of our mental content has been aptly named 'mind wandering'. The way we feel and the nature of our thought content plays a role in countless aspects of daily life, from how we view, interpret, respond to, and value features of our environment. and how this in turn effects our fleeting emotions, our lingering moods, and our ability to be mindfully aware of the given moment. The goal of this thesis was to untangle the intertwined threads of emotion, mood, and mind wandering as ongoing internal experiences, and describe their relationship to mental health; specifically, to the experience of having or being vulnerable to a mood disorder.

In the first chapter, I present a brief and necessarily selective overview of the past literature on these concepts, alongside some discussion on mood disorders their diagnostic characterisation as well as note on a transdiagnostic approach to these problems. To elaborate on a study of affective functioning in mental health, operational definitions of affect, emotion, and mood are outlined. Selected models and theories of emotion and mood in the field of affect will be discussed and delineated by distinctions between these two often-interchanged terms. Further, the importance of understanding dynamic processes of affect and differential dynamics between emotion and mood is reviewed. Mood regulation as a novel field of naturalistic study in mental health will be additionally highlighted alongside its relevance for clinical applications.

Following this overview of emotion and mood in the context of mood disorders, theoretical accounts of the study of mind wandering will be briefly summarised with identified areas for improving and elaborating on this aspect of phenomenology. The importance of such approaches with respect to mental health will be covered alongside a preview for an expanded theoretical framework outlined in detail in Chapter 6. I also discuss mental wandering in relation to affective trends and mental health, in addition to novel study paradigms to explore mental content phenomenology.

The work reported in this thesis thus focuses on key aspects of the personal mental experience of individuals with mood disorders, both the nature of their affective experience and the nature and content of their mental wandering. This personal level psychology lies at the heart of patients' clinical presentations and shifting the nature of these experiences over time is the goal of clinical interventions. However, personal level experiences arguably have received less attention outside of the direct clinical literature, with a strong emphasis on subpersonal cognitive mechanisms and on behavior. This thesis seeks to somewhat redress that balance and I return to this issue further below.

Following the literature overview here in Chapter 1, the thesis comprises seven additional chapters. Chapters 2-5 and 7 present six studies on the representation and experience of emotion, mood and mind wandering in individuals with and without a history of mood-related problems. Chapter 6, as noted, presents an integrated taxonomy of mind-wandering, and Chapter 8 offers a general overview and discussion of the work presented in the thesis.

More specifically, I will probe the underlying representations of emotion and mood constructs in adolescents with varying depression risk status in Chapter 2. Then, I will elucidate possible diagnostic, transdiagnostic, and adiagnostic subgroups of within-person emotion dynamics in a well-characterised sample of adults with and without a mood disorder history in Chapter 3. Following this, the next two chapters will further probe research questions on affect in this same well-characterised adult sample: Chapter 4 will consider emotion and mood summary features and interrelationships across time, and Chapter 5 will explore strategy use and perceived efficacy of the regulation of mood states.

From here, the remaining components of the thesis will focus on the nature and content of mental wandering for individuals with mood disorders. As noted, Chapter 6 will detail a synthesised and expanded theoretical framework on taxonomies of mental wandering, and Chapter 7 will feature two studies of mental wandering, one in relation to concurrent emotion and ongoing naturalistic daily life, and a second in relation to possible dimensions of mind during mental wandering absent of external distraction in a 'sensory deprived' state in individuals with and without depression.

1.2 MOOD DISORDERS

Major Depression

Major Depressive Disorder is a psychiatric diagnosis and an encumbering mental health syndrome that affects millions of individuals. It is heavily associated with serious consequences both personally – suicide or suicide risk, self-harm, reduced quality of life – and societally – disability, reduced productivity, and lost wages (Alonso et al., 2011; Greenberg et al., 2015, 2021; Kessler et al., 2014; McIntyre & O'Donovan, 2004). Across over 90 studies comprising a large representative sample population (n=1.1 million), meta-analyses have found diagnostic depression prevalence rates to be very high, at 12.9% aggregate levels, 7.2% one-year levels, and 10.8% lifetime levels (Lim et al., 2018). Over 350 million people are estimated to be experiencing depression worldwide at a given time (Lim et al., 2018; Summergrad, 2016). Despite increases in treatment options, affordability, and access, depression prevalence remains high without significant measured reductions over time (Ormel et al., 2019).

The high prevalence of depression globally alongside its high burden of disability, social or economic development, and stigma (e.g., Summergrad, 2016) all highlight the exigent need for improved understandings of (e.g., Insel, 2014; Insel & Charney, 2003) and treatment for (e.g., Fried, 2017; Newby et al., 2015; Stimpson et al., 2002), mood disorders. Indeed, depression affects individuals across the lifespan, from youth to old age (Solmi et al., 2021; Sorenson et al., 1991). In adolescents, the mean age of onset of depression is 14.9 years old, and adolescent depressive episodes appear to last an average of 26.4 weeks, though similarly wide ranges from two weeks to over one and a half years (Lewinsohn et al., 1994). Lengthier depressive episodes in adolescents were associated with earlier initial onset (Lewinsohn et al., 1994) highlighting an importance in early identification of depression (Gladstone & Beardslee, 2009). In general populations including adults, mean age of onset appears to be 20.5 years old (Solmi et al., 2021) with roughly 75% of individuals experiencing recurrent episodes over their lifetime (Kessler et al., 1997). Such episodes tend to last an average of 68.7 weeks (Kessler et al., 1997).

Depression is linked to a number of symptoms including feeling sad, empty, or depressed moods, losing interest or pleasure in activities or interests that normally bring joy, reduced or increased appetite or weight, insomnia or hypersomnia, psychomotor agitation or slowing down, feelings of guilt or worthlessness, trouble concentrating, and suicidal ideation (for a full account of diagnostic criteria for meeting Major Depressive Disorder, see

Appendix 1.1 based on the DSM-5, American Psychiatric Association & Association (APA), 2013). These widely-used and established diagnostic criteria cover a broad range of symptoms, and a person is said to have met criteria for major depression when at least five such symptoms are self-reported over at least two weeks. Some of these symptoms are, as noted, paradoxically opposite behavioural experiences (e.g., increased or reduced appetite/weight, increased or reduced sleep). Taken together, depression is a highly heterogenous disorder and consideration of the many patterns or profiles of individuals' varied symptom experiences (e.g., Fried, 2017; Goldberg, 2011) is an important aspect of better clarifying what mechanistic treatments may better improve quality of life and outcomes in depression.

Remission from Major Depression

Remission from depression tends to be defined as when symptoms are absent or minimal, and normal psychosocial and behavioural functioning returns (Frank et al., 1991). Remission remains a central goal for defining the successful treatment of depression (Ballenger, 1999; Ferrier, 1999). If depressive symptoms still present then clinical status is characterised as partial remission, and these residual symptoms are still unfortunately associated with impaired quality of life (Keller, 2003). Indeed, persons with residual symptoms appear to have a threefold higher risk for recurrence relative to individuals achieving asymptomatic remission (Judd et al., 1998; Lin et al., 1998; Paykel et al., 1995).

Firsthand patient perspectives on perceived recovery from depression highlight the importance of absent depressive symptoms and returned features of positive mental health (e.g., optimism, vigor) as important indicators of recovery and remission (Zimmerman et al., 2006). Despite stable and increased availability of treatment options however, the number of individuals experiencing depression appears to be increasing over time, with higher proportional economic burdens reported alongside these experiences, suggesting depression remains a mental health condition in need of improved treatment options (Greenberg et al., 2015, 2021; Ormel et al., 2019).

Further, remission is typically not sustained with relapse rates as high as 40% in longitudinal studies following participants over a 15-month period (Paykel, 1998) and as high as 85% over a 15-year period (Mueller et al., 1999). The great heterogeneity of depression (Dalgleish et al., 2020; Fried, 2017; Goldberg, 2011), the difficulties in treatment response across this heterogeneity (Newby et al., 2015; Ormel et al., 2019; Stimpson et al., 2002), the exigent need for clarifying underlying mechanisms of depression (Insel, 2014; Insel &

Charney, 2003), and stable high prevalence of depression despite continued decades of research and treatment options (Ormel et al., 2019; Summergrad, 2016) all signal pressing demand for clarification of functioning, symptom experience, and the nature of experience for individuals suffering from depression in aims of improving outcomes for this debilitating mental health condition.

Bipolar Disorder

While in diagnostic terms major depression is a 'unipolar' syndrome with mood shifting only towards one pole of a hypothetical continuum of low to elevated mood, bipolar disorder encompasses depressive episodes but also manic (Bipolar I) or hypomanic (Bipolar II) episodes of elevated mood (see Appendix 1.2 for full criteria; APA, 2013). Recent meta-analyses on lifetime prevalence have shown that Bipolar I Disorder has a prevalence of 1.06%, and Bipolar II, 1.57% (Clemente et al., 2015). Further, such lifetime prevalence for bipolar disorders has been shown to be increasing, which may be related to changes in diagnostic criteria as the DSM has been updated, or possibly reflects genuine rises in overall prevalence in the general population (Clemente et al., 2015).

Bipolar I disorder can occur with or without psychotic episodes, or disconnection from reality, while Bipolar II disorder typically tends to consist of shorter periods of mania that are associated with less severity (DSM-5; APA, 2013). The criteria for depressive episodes in bipolar disorder are the same as that detailed for Major Depressive Disorder. Criteria for meeting a manic episode include distinct periods of at least one week of abnormally and persistently elevated or irritable mood and sustained hyperactivity, increased functioning, grandiose self-esteem, euphoria, distractibility, goal-directed activity, and reduced need for sleep or inhibitions related to higher risk-taking behaviours, and similarly hypomanic episodes are met if aforementioned symptoms are experienced but last for less than a week (see Appendix 1.2; DSM-5, APA, 2013).

Individuals with bipolar disorder seek to utilise treatment services for depressive episodes at two to threefold the rate during manic states, prompting questions as to whether clinically depressed patients seeking support may be receiving accurate differential diagnoses in healthcare settings (McIntyre & Calabrese, 2019; McIntyre & O'Donovan, 2004). This is additionally pertinent when taken together with past findings that more than half of individuals meeting criteria for bipolar disorder originally have been misdiagnosed with unipolar depression, and through this misclassification, possibly having received less efficacious treatment (Hirschfeld et al., 2003; Hirschfeld & Vornik, 2003; Lish et al., 1994).

Some work has shown significant delays in individuals receiving a bipolar diagnosis with up to a third receiving their diagnosis after ten years from the initial point of seeking help (Lish et al., 1994), which suggests expansive periods of time spent navigating a differential diagnosis clarification to pursue improved treatment based upon targeted interventions aimed to improve symptoms of the bipolar spectrum of dysfunction in both depression and hypomania/mania.

Following treatment, 37% of individuals with bipolar disorder appear to still relapse to depression or mania within a one-year period, and up to 60% further relapse within two years (Gitlin et al., 1995). These recurrences and relapses tend to be more associated with the depressive polarity than with the (hypo)manic polarity (Perlis et al., 2006) relating to possible misclassifications of individuals seeking support during depressive episodes (Hirschfeld et al., 2003; Hirschfeld & Vornik, 2003; Lish et al., 1994). Furthermore, the majority of persons with bipolar disorder appear to experience residual depressive symptoms for about a third of weeks across their life (Judd et al., 2002), and as discussed in unipolar major depression, residual depressive symptoms are associated with continued distress and impaired quality of life (Keller, 2003; Paykel, 1998).

As with individuals living with major depressive disorder, bipolar disorder is also significantly associated with staggering personal and societal costs including suicide, disability and distress in daily life (Woods, 2000). Given that individuals with bipolar disorder who are more satisfied with their treatment also appear to have improved coping and outlook (Hirschfeld et al., 2003; Hirschfeld & Vornik, 2003), it is vital to continue incrementally improving our understanding and treatment options for bipolar disorder. There is significant need for development of treatments for bipolar disorder that consider both neurobiological and psychosocial mechanisms underlying the experience of bipolar disorder (e.g., Geddes & Miklowitz, 2013; Whitton et al., 2015). Indeed, individuals at highest risk for bipolar disorder appear to experience significantly higher mood instability and fluctuations across time (Bonsall et al., 2012; Hofmann & Meyer, 2006; Holmes et al., 2016) and these features are ripe for further study to better locate points for intervention, identification, and for improving the observed misclassification of unipolar depression for individuals experiencing Bipolar I or Bipolar II disorder (Woods, 2000; Lish et al., 1994).

Similarities Across Unipolar Major Depression and Bipolar Disorder

Major depression and bipolar disorder both are associated with debilitating disability, distress, impaired daily functioning, difficulties in chronic recurring mood states, suicide and self-harm, and shortened lifespan relative to the general population (Alonso et al., 2011; Greenberg et al., 2015, 2021; Hirschfeld et al., 2003; Hirschfeld & Vornik, 2003; Kessler et al., 2014; Lish et al., 1994; McIntyre & O'Donovan, 2004). Both mood disorder classifications are associated with staggering costs, and recognition that treatment options could be bettered for improved outcomes (Geddes & Miklowitz, 2013; Insel & Charney, 2003). Further, dysfunction of affective processes related to emotion and mood are shared features of both depression and bipolar disorder, alongside problems in affective instability, regulation, and chronicity of negative affect (Hofmann & Meyer, 2006; Holmes et al., 2016; Rottenberg, 2005; van de Leemput et al., 2014).

For individuals who experience major depression or bipolar disorder, residual depressive symptoms are experienced by many following treatments and tend to be associated with reduced quality of life (Gitlin et al., 1995; Perlis et al., 2006; Judd et al., 2002; Keller, 2003; Paykel et al., 1998). High rates of relapse in the approximately 40% to 80% range are observed in longitudinal studies assessing risk and relapse in depressed and bipolar individuals over multiyear periods (Paykel, 1998; Mueller et al., 1999; Gitlin et al., 1995). These findings further reflect the need for improved targeted interventions to sustain remission or successful treatment, an important defined feature of ideally absent symptoms and sustained positive functioning (Ballenger, 1999; Ferrier, 1999).

1.3 TRANSDIAGNOSTIC APPROACHES

Applying a psychiatric diagnostic taxonomy to guide assessment and treatment of clinical disorders as separated by boundaries based on differential diagnosis have been heavily used as the standard in clinical research and care (Marecek & Hare-Mustin, 2009). However, while useful as a means for summarising classifications of disorders, there remains additional need to account for the wide heterogeneity of mental health symptoms and their underlying processes (Dalgleish et al., 2020; Kotov et al., 2021) as well as the aforementioned overlaps between the two phenotypes. Here, case-control approaches are reviewed, as they are used as a means of comparing groups in several studies of this thesis, followed by transdiagnostic approaches, which were also used for Studies 2 and 3.

Case-Control Approaches

Case-control approaches are heavily used in establishing differences clinically between individuals with and without problems in mental health via boundaries of differential diagnoses, that is, for example, comparing between a case of current depression and a control of healthy never-depressed individuals. A benefit to a case-control approach involves the ability to gather information about processes relating to different individuals experiencing a mental health condition and comparing functioning aggregated across these persons to individuals without any such mental health issue.

Clinical groups of individuals with major depression or bipolar disorder have both been examined in terms of their affective dynamics (aan het Rot et al., 2012; Bonsall et al., 2012; Gruber, Kogan, Mennin, et al., 2013; Gruber, Kogan, Quoidbach, et al., 2013) with most prior work on affect considering participants meeting criteria for either disorder in comparison to healthy non-depressed controls (see e.g., aan het Rot et al., 2012). There have also been studies exploring questions such as affective functioning intraday in patients with bipolar disorder, but relatively few have examined this patient group in comparison to depressed persons (Gruber, Kogan, Mennin, et al., 2013) despite the shared experiences of symptoms or dysfunction underlying aspects of these disorders (Alonso et al., 2011; Woods, 2000; APA, 2013, Whitton et al., 2015).

Some studies have assessed patients with bipolar disorder or remitted depression alongside healthy controls (Knowles et al., 2007), bipolar disorder or current depression alongside healthy controls (Myin-Germeys et al., 2003), or current and remitted depression and healthy controls (Thompson et al., 2021). While some past work directly compares differences between bipolar and depressed participants, most consider bipolar participants in isolation or with respect to healthy controls (aan het Rot et al., 2012). This is of further import in updating study designs and consideration of recruiting participants spanning both major depressive and bipolar disorders and current/remitted depression episode status in comparing variants of mental health statuses against a control status. Using a case-control approach to compare multiple clinical diagnostic groups provides the basis for disaggregating effects of emotional and mental functioning with respect to distinctly defined group boundaries of importance clinically.

The overall benefit to using a case-control approach is the ability to describe differences pertaining to the heterogenous individuals that make up a subgroup sample of participants meeting clinical criteria for a disorder (APA, 2013). However, the presence of such heterogeneity highlights the fact that it may not always be appropriate to describe group differences solely from a case-control perspective (Dalgleish et al., 2020). Taking a transdiagnostic approach to similarities and differences in clinical participants may provide a more valid way of characterising sets of heterogenous and comorbid conditions where continuities between problematic and healthy functioning do not sit easily with the binary all-or-none projection of a diagnostic label (Craske, 2012; Dalgleish et al., 2020; Newby et al., 2015). It is therefore useful to briefly discuss transdiagnostic approaches for mood difficulties such as depression and these advances have been considered in work described in this thesis.

Transdiagnostic Approaches

Transdiagnostic approaches to mental health differ from case-control approaches in that traditional diagnostic categories are set aside. Transdiagnostic methods extend upon the binary taxonomy of mental health disorders and instead considers how underlying processes may relate to dysfunctional mental health across diagnostic boundaries (Dalgleish et al., 2020). In addition to more typical case-control approaches, a transdiagnostic approach can help illuminate subtle differences that may differ between clinically depressed, sub-clinically depressed, and healthy individuals, and whether aspects related to a transdiagnostic or adiagnostic framework may more adequately capture differences in functioning (Dalgleish et al., 2020; Insel et al., 2014). For example, it is possible that subtle differences in dynamic processes of affect are more adequately captured by shared symptoms that cut across depressed, bipolar, and never-depressed status (Dalgleish et al., 2020; Kotov et al., 2017), and these features may not be well summarised when using only case-control approaches. As such, considering a transdiagnostic study approach is worthwhile for its ability to consider shared features that possibly cut across clinical boundaries by clustering affective or behavioural outcomes and comparing resultant features cross-clinically (see Chapter 3) in addition to also considering how features of interest may differ related to diagnostic status (see Chapters 4, 5).

There exist gaps in the literature with respect to parsing apart differential trends between emotion in a diverse and well-characterised sample transdiagnostically, which could potentially help explain why there is a lack of convergence on how overall affect contributes to depressed mood (Gruber, Kogan, Quoidbach, et al., 2013; Houben et al., 2015). To begin with, assessing summary features of emotion and mood separately by pinning down differential trends of intensity, instability, granularity, inertia, and chronometry of affect in clinically defined groups would help provide a descriptive picture of affect and mental health respecting clinical diagnoses, but moving past clinical boundaries to use a data-driven approach of shared emotion dynamic interdependencies and processes across such samples is also considered in this thesis.

Examining multiple groups of individuals with clinical disorders related to affective dysfunction may help illuminate the relationship between affective dynamics and the experience of mental health symptoms with respect to more precision around individual within-person patterns instead of only comparing group-level averages of static average level of affect. For the high temporal resolution of the frequently and constantly fluctuating emotion processes (Lazarus, 1991) captured through extensive experience sampling, we conducted an investigation into considering person-specific models and similarities cutting across clinical boundaries in addition to assessing similarities within clinical boundaries (see Chapter 3). Given the unique ability to capture a large set of emotion intraday information, such data-driven intensive investigation was possible at this temporal level, but case-control approaches were still used for the datasets involving mood and mind wandering where high levels of self-report signals required to generate intensive person-specific models were unable to be collected at a similar timescale (e.g., mood-related sampling collected at the lower frequency of daily self-report given the theoretical changes in mood momentum unfolding slower and preventing confusion over emotion and mood sampling to be collected at different times, and mind wandering sampling being event-based as occurrence is not expected at every signal also resulting in fewer total timepoints).

Combining both idiographic-transdiagnostic and case-control diagnosis-based approaches to compare clinical and data-driven groups along various summary metrics and dimensions clarifies the intertwined relationships between emotion, mood, and mind wandering. This illumination between dynamic psychological phenomena and the experience of mental health provides more precision on individual patterns in addition to comparing group-level emotion dynamic summary metrics when possible (Chapter 3), while the well-established case-control approach allows for further clarification in the foundational study of novel phenomena including mood state changes, mood regulation, and mind wandering dimensions (Chapters 4, 5, 7).

Personal Level Research

Having described the debilitating consequences in quality of life for individuals experiencing mood disorders and case-control and transdiagnostic approaches for studying these disorders, I briefly return to the value of considering personal-level research into such clinical and functional processes. The studies into the nature of experience covered in this thesis relate to the personal level of what patients with depression describe in therapeutic contexts (e.g., Beck, 1979). A patient account of their psychotherapeutic experience is indeed related to problems and difficulties as described by negative experiences, hopeless feelings, or unwanted thoughts (e.g., Beck, 1979, 2005; Zimmerman et al., 2006). Much of cognitive therapy treatments for depression have focused on patients monitoring their thoughts (e.g., negative, automatic cognitions), the connections between such thoughts and their affect and behaviour and learning to indeed identify and work on distortions or dysfunctions in these interconnected inner experiences e.g., Beck, 1979; Beck, 2005).

The distinction between personal and subpersonal levels of explanation relates to how people experience their psychological mental states (Dennett, 1969). The personal level of individual sensations and perceptions of thoughts and feelings differs from the subpersonal level of a psychological study into cognitive processes (Dennett, 1969; Drayson, 2014). The work conducted in this thesis aims to focus primarily on the former level of personal experiences in depression related to emotions, moods, and mental wandering of unfolding thought content – aspects of phenomenological experience related more closely to the patient perspective in therapeutic contexts (Beck, 1979) rather than subpersonal components more distal to the personal level.

By designing a series of studies where these multidimensional components of the individual experience of affect and mind may be measured, the goal of this thesis is to generate a more detailed picture on this intertwined psychological reality and its implications for mental health. This thesis encapsulates an attempt to generate a cohesive picture that includes multiple dimensions of emotion, mood, and mind wandering examined across multiple studies and reviewed in the remaining Introduction.

1.4 AFFECT, EMOTION, AND MOOD

In the study of psychology, there is a great deal of interest from many researchers on quantifying types of affective processes, and as mentioned earlier, there are many reasons to consider the study of affect in mood disorder functioning. The importance and significance of doing so is valuable to both the psychological study of functional affect and the study of dysfunctional affective experience – a defining aspect of clinical mood disorders, for example major depression (Alonso et al., 2011; Friedrich, 2017). In many previous studies, the distinction between emotion and mood remains unclear when persons are probed on what general affect states they are feeling (aan het Rot et al., 2012; Killingsworth & Gilbert, 2010).

While most literature converges on the agreement that mood and emotion are distinct though related phenomena, no study to date has made a thorough attempt to measure these states differentially based squarely on phenomenology. For example, in March 2020, as countries announced lockdowns in succession and months of shelter-in-place came to be the new norm with job losses and uncertainty looming, it is likely an anxious mood was felt by many around the globe (see e.g., Shevlin et al., 2020). During an anxious mood, one can imagine that it is entirely possible to still feel acute joyful emotions from a passing event, such as enjoying a phone call with a loved one, or hearing a funny joke, before returning to the background state of mind of anxiety and worry – just as the reverse is possible, to be in a happy mood from many things going well in one's life, but feel stress as an emotion when shattering a plate by accident, yet also returning to the background state of mind of pleasantness after sweeping up the unfortunate mistake. These two types of affective states; emotion and mood, contain interesting differences that are worth unpacking.

Core Affect

Core affect is considered a neurophysiological state of varying nonreflective feelings, theorised to be comprised of a measure of hedonic feelings, from pleasure to displeasure, and arousal, from deactivated to activated (Russell, 2003)(see Figure 1.1). Core affect is thought to underlie both emotion and mood constructs and denotes a conscious state of 'feeling' (Russell, 1980, 2003; Thayer, 1989).

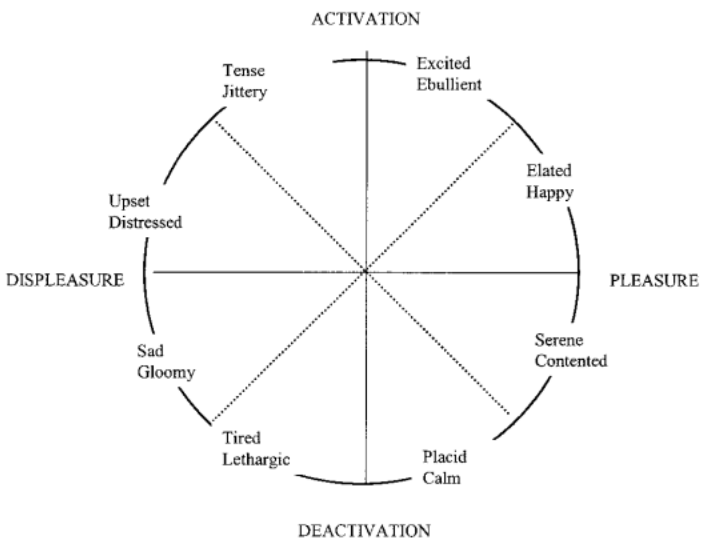


Figure 1.1. From Russell (2003), affective concepts arranged in a circular order as per a circumplex theory of affect along a hedonic dimension (displeasure to pleasure) and arousal dimension (deactivation to activation).

One of the most widely cited dimensional models of core affect structure is the circumplex model of affect (Russell, 1980) which proposes that the core underlying structure of affect can be represented as a circular formation such that various affect states are conceptually arranged in a circumference about the axes, and that the bipolar axes represent valence and arousal (Russell, 1980). Evidence suggests that multidimensional scaling of individual ratings of discrete affect terms (in all cases hitherto these are emotion terms) results consistently in a separation of discrete terms along these valence and arousal axes, strongly suggesting that these two dimensions adequately capture the granular variance of emotion states (Feldman, 1995; Posner et al., 2005; Russell, 1980). This underlying structure represents a core component of the phenomenological conceptualisation of emotion in individuals and provides the basis for the comprehensive selection of discrete emotion terms in widely used measures and studies (e.g., aan het Rot et al., 2012; Visted et al., 2018; Watson et al., 1988)

Distinctions between Emotion and Mood

While the study of affect is common, it is important to understand what researchers are reporting on when they study affect. Secondary concepts stemming from a core affect structure relate to feelings – that is, emotions, or affective events that are object-oriented and about something (e.g., feeling 'excited' about spotting a cardinal when birdwatching) and thus, intentional in the directed experience (Russell, 2003). Moods, on the other hand, are considered prolonged affective states that are not object-oriented in nature, and circumscribed by fuzzier boundaries with respect to duration, cause, stability, and direction (e.g., Russell, 2003).

Emotion is at the forefront of affective research – while the term 'affect' is used heavily, acute emotions appear to be the focus of this research construct also. Studies on affect focus on self-report, behavioural or neural measures of short-lasting emotion responses driven by some environmental stimuli (e.g., Cacioppo & Gardner, 1999; Mauss & Robinson, 2009). Drawing conclusions on experiences of affect and the relation to both emotion and mood via quantifications of stimuli-based and response-driven emotions is not necessarily all-encompassing of the range of affective modes for all individuals (Russell, 2003). When considering the importance that affective research plays in our understanding of the human psychological experience, from short-term joy to longer-term life quality, or from mental health issues to suicidality, it is imperative that our understanding of what we study when we define 'affect' is appropriate. I propose throughout this thesis the importance of attempting to quantify and additionally study moods within the affective research domain, above and beyond the study of emotions. To consider the two interchangeable, as is the current status quo of much related research, is limiting the nuance of our understanding of affect. Pinning down improved representations, dynamics, and regulation of mood states is vital in furthering the academic field of psychology, as well as central to improving translational application of clinically relevant insights gathered from broad affective research.

As noted, the literature on affect tends to discuss moods and emotions interchangeably. Sometimes emotion responses are taken as mood, other times work on emotions is extrapolated to draw conclusions about mood states (see e.g., aan het Rot et al., 2012; Ruby et al., 2013). However, qualitative research on moods suggests meaningful differences in how people understand mood states compared to emotion states (e.g., Beedie et al., 2005; Eldar et al., 2016), yet not as much research has explored what these specific differences, or similarities, can be characterised from a quantitative perspective. Across studies, affect has usually been conceptualised in a broad way – for example, by using terms that represent a mix of mood and emotion states or by a basic non-granular proxy for mood along a single dimension of general valence, rather than specific states (i.e., how 'good' or 'bad' mood is felt, aan het Rot et al., 2012). A granular and concrete separation of specific felt emotions versus granular mood states has not been operationalised by any study to date to our knowledge, as proxies for affect usually consisted of collapsing these various states together. There exists a gap in differentially understanding whether overall background moods or specific emotion states may differ in their manifestation between individuals experiencing depression relative to mentally healthy controls.

Given that maladaptive experiences of long-term mood, rather than short-term emotion, appear to be central to mood disorders such as depression, unpacking the quantifiable differences between these affective states is vital to approaching potential treatments and interventions. The clinical relevance of understanding differential attributes and representations of emotion versus mood provides a theoretical foundation for the improved study on affect in mental health. Collapsing these concepts and using specific states interchangeably limits the understanding of research going forward and may be contributing to differing conclusions in affective research in mental health. The implications for teasing apart the constructs of emotion and mood and their interrelationship is therefore central to improving treatments and interventions for mental health disorders as further discussed.
In laying out the groundwork for the distinctive study of emotion and mood, it is important to consider theoretical foundations for quantifying emotion and mood as differential affective states. With this, theoretical frameworks on emotion and mood are next both discussed and synthesised.

Theoretical Models of Emotion

Contemporary theories of emotion have suggested these short-lived reactions are responses to environmental cues or brief stimuli experiences (Cacioppo & Gardner, 1999; Dennett, 1987; Russell, 2003; Thayer, 1989) and tend to have directional intention comprising an object-oriented feeling elicited by and toward something (e.g., Russell, 2003). Emotions can encompass psychological, behavioural, and physiological responses to the external environment, and are theorised to arise from various neural activation pathways (Barrett & Wager, 2006). Emotions can be viewed as processes or states, and in appraisal-based theories (see e.g., Moors et al., 2013), can be theorised as a series of fluctuating changes in 'components'; appraisal components between the environment and individual, motivation components with possible action intentions, somatic components with physiological responses, and feeling components with subjective experience (Ellsworth, 1991; Scherer, 2009). These various components influence one another in an emotion episode (e.g., changes in appraisal may alter somatic components and vice versa), with a main theoretical basis consisting of the notion these appraisal processes interpret situational cues related to survival and well-being, an interaction between the event and the individual appraising it (Lazarus, 1991).

In addition to emotions being posited to provide an adaptive value in responding to external situations, they are considered as separate, discrete states (e.g., discrete physiological states of angry versus happy; Ekman, 1992) or dimensional states (e.g., a dimensional construction of angry based on valence (pleasantness) and arousal (activation state); Barrett & Wager, 2006; Russell & Barrett, 1999). The ongoing debate on the structure of emotion arises from the debate of whether emotions may be discrete and irreducible states or multidimensional representations. Neuroimaging studies that have tied specific emotion states to neural regions have been questioned through meta-analyses on consistency (Barrett & Wager, 2006), suggesting that for example, the amygdala may play a role in affective significance of a stimuli rather than discrete emotional state (Barrett & Wager, 2006). The importance of considering emotion states along a dimensional structure is highly important in accurately clarifying a picture of affect.

Theoretical Models of Mood

Moving beyond emotion, theories of mood have suggested that these states exist as a background state of mind with fuzzier boundaries around a lack of directional intention (Russell, 2003), or a homeostatic response to ongoing cumulative feedback from the environment (e.g., Eldar et al., 2016; Keren et al., 2021). Mood states are far more often thought to be diffuse, longer-lasting, less intense or focused than discrete emotion states, and related to more general feelings rather than directed feelings as in emotion (Beedie et al., 2005; Dennett, 1987; Parkinson, 1996; Russell, 2003). Given the relevance to mood disorder symptoms in prolonged negative moods (APA, 2013) and recurrent negative feelings and difficulty removing symptoms of such diffuse yet sustained depressed moods (Judd et al., 1998; Lin et al., 1998; Paykel et al., 1995; Zimmerman et al., 2006), it is vital to study personal-level analysis of mood experiences in clinical contexts.

There has recently been an increasing emphasis placed in theories that mood relates to a computational process related to reward processing and prediction errors (Clark et al., 2018; Eldar et al., 2016). In the external world, there is a variety of positive and negative outcomes based on situational factors at any given moment, and the feedback these rewards (or lack thereof) provide an individual versus their initial expectations can be described in terms of prediction errors. These prediction errors may represent parameters for the learning process of an individual attempting to receive rewards from their environment in learning how reality may differ from their expectations, both in a positive manner (higher rewards than expected, or a happy surprise) and a negative manner (lower rewards than expected, or a disappointing surprise; Eldar et al., 2016)(see Figure 1.2).

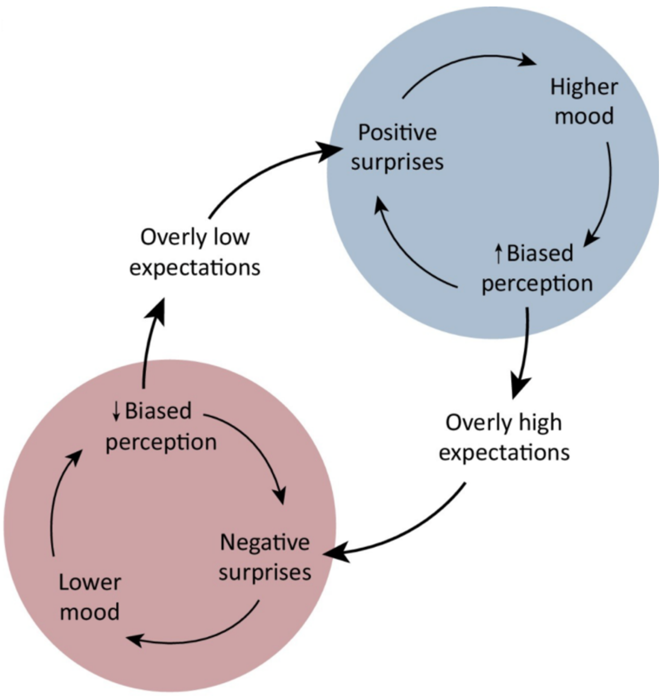


Figure 1.2. From Eldar et al. (2016), mood as a representation of momentum and expectations from the external environment cumulatively over time.

Mood therefore is theorised to shift in line with this cumulative momentum over time of surprises and let-downs in rewards processing and aid in providing a homeostatic signal of when to spend energy (surprises) or conserve energy (let-downs) in order to maximise rewards and subsequent evolutionary survival (Dayan & Daw, 2008; Eldar et al., 2016; Niv, 2009). Reward processing and prediction errors within a reinforcement learning paradigm are suggested to closely relate to the theoretical basis for mood, and mood's subsequent changes over time are thus thought to more closely align with an accumulation of information from the environment, such that one might interpret emotions as first-order derivatives and mood as second-order derivatives on these experiential feeling states.

Further emphasising the importance of reward processing on mood phenomenology and mental health, clinical neuroscience work has shown disruption in reward-related neural regions of depressed individuals (Admon & Pizzagalli, 2015; Russo & Nestler, 2013). A decreased responsiveness to rewards has also been uncovered in depressed individuals (Henriques & Davidson, 2000), tying together the theoretical basis for the suggested detrimental impact that normal mood functioning may have on an ability to update mood in the face of reward information (Eldar et al., 2016). The suggestions from findings that chronic depression is related to abnormalities in reward processing prompts the importance in understanding how mood may be experienced and represented by individuals with lower levels of mental health, and the significance in teasing apart mood from emotion in assessing how the accumulated momentum may lead to a difference in mood updating for clinical populations.

While the circumplex model of affect has been heavily tested for emotion states with valence and arousal strongly signifying a two-dimensional structure, it has not been tested with discrete mood states to our knowledge. Despite this, research on discrete mood states has also been conducted, with several instances of researchers compiling and validating specific mood terms for descriptive study also alongside comprehensive valence and arousal dimensions (Matthews et al., 1990; Mayer & Gaschke, 1988; McNair et al., 1971; Terry et al., 1999). The majority of these various standardised scales of specific mood self-report were formed following investigations suggesting moods, similar to emotion, were also bipolar in dimensionality (Lorr et al., 1982). However, the bipolar dimensionality of mood has not yet been tested through the same mathematical multidimensional scaling efforts as emotion to uncover its underlying structural representation as a more diffuse, less directed state (Beedie et al., 2005; Dennett, 1987; Parkinson, 1996; Russell, 2003).

Studying Emotion and Mood Constructs

The reactive short-lived manner of emotions to singular stimuli are theorised to provide evolutionary-advantaged information on how an individual might respond to events, and are described as more intense, directed, intentional, and object-oriented (Frijda, 2017; Lane & Terry, 2000; Russell, 2003). On the other hand, longer-term moods can be characterised in terms of the affective momentum of accumulated environmental expectations of predictions and theorised to provide evolutionary-advantaged information on conservation/expenditure of energy in the face of navigating one's environment cumulatively across time, and are diffuse, not directed or object-oriented, longer-lasting and cumulatively general about the environment (Beedie et al., 2005; Dennett, 1987; Parkinson, 1996; Russell, 2003).

Both affect states come from different theoretical bases but relate in terms of their evolutionary advantages in terms of survival and understanding how to respond to the external world. The aim in quantifying these different affect states in study would be to provide further means for testing aspects of the theoretical foundation of emotion versus mood, such as the chronological time-course of these unfolding states, how emotions and moods may influence each other across time, the response of underlying mood to external momentum versus the response of emotion to stimuli cues, or the differences in attempts made to regulate these states as they occur. Each of these questions includes the relationship of findings to mental health, in terms of the clinical importance of emotion and mood in the role of mood disorders.

Fluctuations in Affect Over Time

In addition to studying representations of emotion and mood, exploring individual experiences in ecologically valid studies will potentially provide a closer basis for uncovering the relationship of these affect states to mental health. Understanding the dynamics of momentary shifts in affect provide a greater understanding of the variability and instability of these core features of individuals with mental health difficulties. After all, emotions are not merely just stagnant states, but dynamic fluctuating occurrences constantly subject to change from the external environment or various internal appraisal components (Lazarus, 1991; Moors et al., 2013). In almost all studies on affective dynamics, the distinction between mood and emotion remains unclear during sampling procedures. While most literature converges on the agreement that mood and emotion are distinct though related phenomena, affective dynamics have not yet attempted to thoroughly measure these states differentially.

By using a clear definitional distinction between emotion and mood when considering affect (Beedie et al, 2005), we may be able to better understand nuanced intra-day affective trends across clinical and healthy samples. In past studies of dynamic changes, affect was usually either conceptualised via general positive or negative affect terms representing a mix of both emotion and mood states (Watson et al., 1988), by assessing depressed mood symptoms specifically (Deady et al., 2018; Pemberton & Tyszkiewicz, 2016), or by a basic non-granular proxy for mood without specificity (Heiy & Cheavens, 2014).

A granular and concrete separation of different mood states versus specific felt emotions has not been teased apart by any study to our knowledge, as proxies for affect usually consisted of collapsing these various states together. There exists a gap in differentially understanding whether specific emotion states or overall background moods may differ in their intra- and inter-day trends between individuals with and without mental health problems. By considering emotion and mood differentially and with specific states that map across bipolar dimensions of valence and arousal, we can assess what kinds of emotions predict specific mood states, and how specific moods may bidirectionally influence emotions.

Common Summary Features of Affective Fluctuation

There are several summary metrics of emotion complexity used in studying fluctuations in affect measured over time by experience sampling, including intensity, instability, granularity, inertia, and chronometry. The most common is assessment of intensity, or average valence levels of specific states across time (aan het Rot et al., 2012; Crowe et al., 2018). There is also instability, or variability in fluctuations of intensity across time, with higher levels of negative emotion instability typically seen in depression (Gruber, Kogan, Mennin, et al., 2013; Gruber, Kogan, Quoidbach, et al., 2013; Houben et al., 2015; Thompson et al., 2021). Granularity is another metric referring to what extent an individual can make nuanced differentiations between similar emotions, lower differentiation abilities having been associated with poorer emotion regulation capabilities (Smidt & Suvak, 2015). Inertia refers to the extent to which affective states are resistant to change across time and can be operationalised as the extent to which a past affect state may predict a future affect state, with higher levels typically associated with onset of depressive episode (Kuppens et al., 2012; van de Leemput et al., 2014). Finally, chronometry refers to the duration of an affect state (Davidson, 2015).

Intensity, instability, and granularity have been extensively assessed in the emotion dynamics literature (Gruber, Kogan, Quoidbach, et al., 2013; Houben et al., 2015; Thompson et al., 2021) with an increased interest in studying the relationship of emotional inertia to mental (Kuppens et al., 2012; Thompson et al., 2021; van de Leemput et al., 2014). Chronometry has not been typically measured within most experience sampling studies of affect and mental health, but theoretical distinctions of emotion and mood with respect to length, onset, and shifts in dynamic experience offer insight into predicting onset of clinically relevant states such as depressive episodes similar to inertia (van de Leemput et. al., 2014). We may also be able to answer questions regarding how individual differences in chronometry relate to the experience of maladaptive long-term mood states within clinical samples. While the majority of studies on affective dynamics investigate the relationships of these various markers of affective complexity in emotion, there has been no work to-date, as far as I am aware, on the nature of these dynamic metrics on mood complexity. Understanding how mood fluctuations may unfold and relate to mental health is of further importance in clarifying distinctions in affective dynamics.

Conducting further research to expand upon our knowledge of how these measures of affective complexity relate to mood disorders and day-to-day functioning can provide insights into understanding how clinical interventions may impact and improve well-being. No other studies to date, as far as I am aware, have assessed affect dynamics when defining emotion and mood states separately, and more specifically, pinning down differential intra-day trends of intensity, instability, granularity, inertia, and chronometry of affective types in depressed and healthy individuals. In a series of following studies, I used ecologically valid methods to assess affective dynamics of emotion (see Chapter 3), as well as metrics of emotion and mood complexity and interrelationships between ongoing emotion and mood over time (see Chapter 4).

Regulation of Emotion

When it comes to regulation of affect, a great deal of the literature has focused on regulation of emotion (Gross, 1998, 2015). Theories of regulation can be reviewed in context with emotion theories detailed earlier. As emotions are brought on by various situations and are accompanied by behavioural, physiological, psychological, or somatic responses, regulation of emotion serves to modulate these responses as an individual evaluates such situations (e.g., Gross, 1998, see Figure 1.3). These various external situations are proposed to provide cues for an individual to evaluate, followed by emotion response tendencies (e.g., behavioural, physiological), and then modulation of these response tendencies to temper the final emotional response (Gross, 1998). In line with emotion theories, regulation of emotion is related to modifying the emotional responses that occur and one's individual experience of positive or negative emotion states through several possible coping, cognitive, or behavioural strategies (Gross, 1998, 2015).

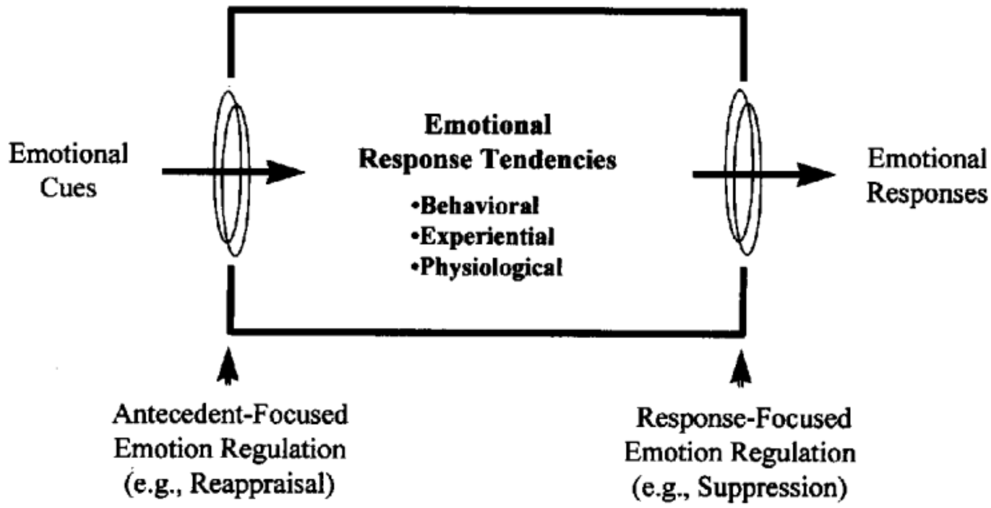


Figure 1.3. From Gross (1998), a process model for emotion regulation highlighting two broad classes of regulation of emotion.

Emotion regulation has high relevance for depression and mental health (Aldao et al., 2010; Joormann & Stanton, 2016). Depression has been strongly associated with poor emotion regulation capabilities, negative cognitive biases, and lower cognitive control (Aldao et al., 2010; Joormann & Stanton, 2016) with specific strategies used more often including avoidance, problem solving, and suppression, along with reappraisal and acceptance (Aldao et al., 2010). It is important to examine mood regulation strategies to draw conclusions on whether findings from emotion regulation research extrapolate, or not, to mood regulation outcomes, especially given the base theoretical differences existing between emotion and mood as affective states.

Regulation of Mood

Returning to the theoretical model of mood as described earlier, it is plausible that mood regulation differs in comparison to emotion regulation. Theoretical bases for mood regulation suggest emphasis more strongly based on the mood itself (Beedie et al., 2005; Larsen, 2000) rather than emphasis on interpretations of events or responses to them as in emotion regulation (Gross, 1998; Larsen, 2000). This key theoretical difference focuses on the notion an individual may regulate mood with the aim of maintaining a desired set point for general affect (e.g., reducing rising negative mood or maintaining present positive mood).

An individual regulating their emotion, on the other hand, may instead notice the event component and regulate their reaction until it shifts appropriately (Gross, 1998, 2015; Gross & Muñoz, 1995).

Related to the lack of intentionality regarding diffuse moods, it may be such that mood regulation could be described as a series of processes ranging from identifying an ideal set point state, detecting differences from the current state to this ideal optimal state, and then engaging in appropriate strategies to reduce the present differences and return to an optimal mood point (Larsen, 2000)(see Figure 1.4). These theories strongly suggest a focus on mood state experience and selection of strategies focused on that mood experience which may be cognitive or behavioural (Larsen, 2000; Parkinson, 1996; Thayer et al., 1994). Given discernible differences in emotion and mood, it is possible that different regulation strategies carry more weight for one type of affect over another, and the relevance for mood disorder experiences is vital given the predominant experience of mood dysfunction for these individuals (e.g., Friedrich, 2017) and noted in key emotion regulation literature (Gross, 1998).

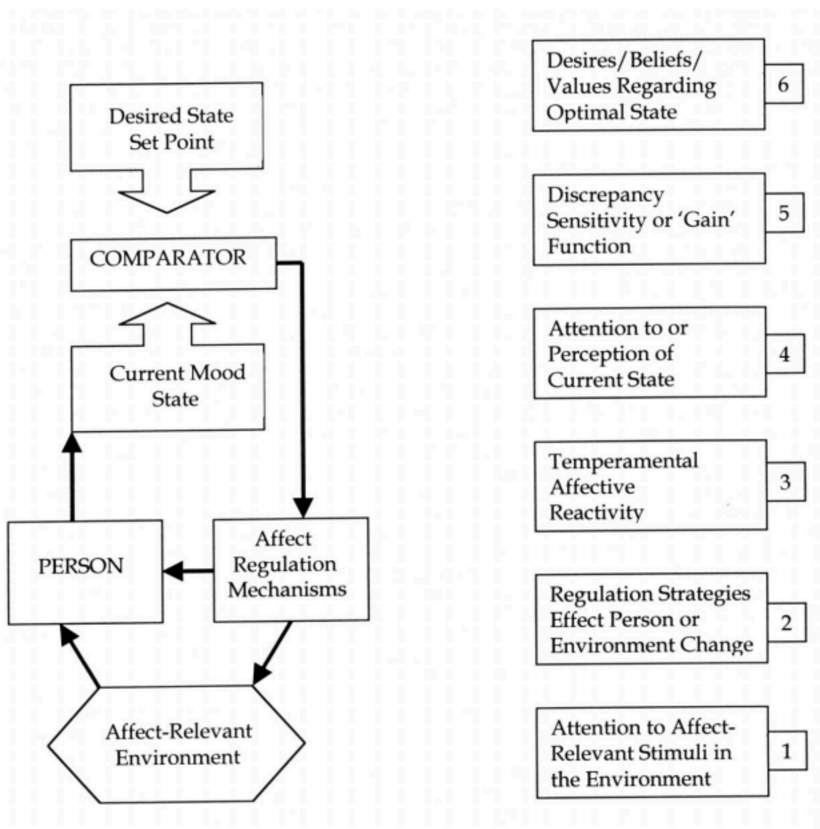


Figure 1.4. From Larsen (2000), a theoretical model of mood regulation regarding potential mechanisms related to individual differences on mood regulation processes.

Emotion regulation has been explored through ecologically valid study methods in typically healthy non-depressed samples (e.g., Brans et al., 2013; Heiy & Cheavens, 2014; Nezlek & Kuppens, 2008). As far as I am aware, mood regulation has not been assessed in any experience sampling study to-date, prompting inquiry into the need to investigate how individuals with mood disorders may differentially regulate their mood, rather than just emotion, in comparison to healthy individuals. This is vital for understanding how some individuals may be able to update their background state-of-mind while others experience greater difficulty in the form of mood disorders. Measuring mood and regulation attempts throughout the day allows for a richer ability to consider how regulation may change affect over time and how efficacy may be perceived in real-time and amid naturally occurring life stressors in vulnerable groups of individuals. It also allows for exploration into an understudied question regarding the regulation of mood in depressed and healthy individuals.

Thus, beyond differentiating between mood and emotion, little is known about how individuals regulate their overall mood state. Targeting real-time assessment of individual engagement in regulatory strategies based on theoretical underpinnings of mood regulation to adjust or improve their mood can offer insight into why some individuals remain 'stuck' within negative moods, such as in depression, while others recover from negative states more easily. While some studies have examined the effects of trait or real-time emotion regulation strategy use in relation to broad affect sampled throughout the day (Brans et al., 2013; Heiy & Cheavens, 2014; Nezlek & Kuppens, 2008), no study to date has attempted to sample real-time mood regulation strategy use in an ecologically valid method in a depressed or transdiagnostic sample.

1.5 OVERVIEW OF STUDIES REPORTED IN THIS THESIS ON AFFECT

Representation of Emotion and Mood

The first aim for assessing differences in emotion and mood is conducted in several experimental chapters. Affect representation is studied in Chapter 2, where adolescent individuals provided spatial configurations on emotion and mood based on perceived similarity between discrete terms. The goal was to apply multidimensional scaling in order to uncover possible underlying structure among bipolar dimensions in the context of circumplex models of affect and determine whether mood may be similarly structured to past research on representation of emotion. These structures were also examined by comparing the solutions generated by those with higher and lower depression risk to examine how discrete states may be represented in relation to mental health.

Fluctuating Emotion and Mood Experiences in Daily Life

Dynamic trends were unpacked across three studies that include idiographic emotion dynamics (see Chapter 3), emotion and mood features and relationships (see Chapter 4), and mood regulation (see Chapter 5). Chapter 3 covers a confirmatory and exploratory approach to assessing person-specific models of within-person emotion dynamics and statistically determining whether clinical diagnosis may accurately relate to individually shared temporal features of emotion over time, or whether some other aspect relates to similarity across persons when emotion dynamics are clustered through data-driven methods. Individuals provided up to seventy experience sampling responses as they went about their daily lives for two weeks, and these data were modelled through idiographic statistical methods to explore what may capture nuance in emotion dynamics information of a well characterised clinical sample comprising currently depressed, remitted from depression, bipolar, and healthy never-depressed individuals.

Chapter 4 covers an investigation into comparing several summary metrics of emotion and mood complexity based on experience sampling of intraday emotion and daily diary collection of mood that have been extensively studied for emotion, but less so for mood, including intensity, instability, granularity, inertia, and chronometry. Emotion and mood dynamics are also modelled in order to assess how current and remitted depression versus healthy never-depressed status may suggest differential trends between emotion and mood experience across time. And finally, in Chapter 5, the regulation of mood states in unpacked in this same sample to characterise the naturalistic use of several theorised mood regulation strategies and their effects on ongoing mood between clinical groups.

1.6 MENTAL WANDERING

The final two chapters and studies of the thesis shift focus to examine mind wandering. The literature on mind wandering is extensively discussed in Chapter 6, but is briefly overviewed here also.

In addition to the study of affect, there has been an increasing shift of interest in psychological research into where the mind wanders and how we may describe and assess this phenomenological experience. Human beings spend a significant amount of their time navigating internal ebb and flow of thought occurrences decoupled from their present moment and present environment (Killingsworth & Gilbert, 2010). For individuals who experience Major Depressive Disorder, marked by chronic, recurrent depressed mood states and negative emotion experiences (Rottenberg, 2005), the nature of this mental wandering may very well differ from the nature of mental wandering in 'healthy' non-depressed persons. Unpacking the nature of these mental experiences can provide further clarity to how multidimensional features of these thoughts may relate to one's overall well-being. Considering a cohesive explanation and definition for attempting to study the nature of mind and using a theoretically grounded framework for investigating the phenomenological experience of the nature of mind is of utmost importance in unpacking mental content and mind wandering experiences and their relationship to mental health.

The nature as well as the content of mental life is another aspect quite central to understanding mental health, and while prior studies have explored mind wandering to investigate what simple attributes may link to mental health experiences, much work is arguably needing to be done to better understand mental health and the internal navigation of mental experiences. For example, commonly studied dimensions of mind wandering such as valence and time-based dimensions are unlikely to be the sole attributes of importance in understanding the relationship between mind wandering and depression, and there is increasing value in investigating multiple domains of mental phenomenology to improve our understanding of mood disorders and maladaptive mental events.

As the study of mind wandering has progressed, so the definition of mind wandering has expanded beyond task-independent thoughts. Specifically, mind wandering has been conceptualised as the experience of mental content outside of not just task-based but any attention-focused constraints (Seli et al, 2016; Christoff et al., 2016) or when 'at rest'. Several researchers have proposed taxonomies of such unconstrained mental experiences either by utilising large-scale self-report responses and uncovering interpretable factors present through data-driven approaches, or through a priori theoretical frameworks for the study of thought with named dimensions of interest. Thus, data-based and theoretical approaches for models of mind wandering are discussed here briefly. These models are detailed in the non-empirical Chapter 6 which reviews and synthesises information pertaining to the benefits, overlapping dimensions, and areas for expansion that can be considered across these existing frameworks.

Data-based Approaches to Mental Wandering

Data-driven methods for modelling mind wandering seek to gather information on dimensions of the mind at rest and cluster these using bottom-up analytic approaches into interpretable components arising from large-scale self-report studies. I briefly mention and summarise some data-based approaches here, but further review and discuss these approaches in detail in Chapter 6. The strengths of data-driven approaches include the ability to quantify information with great transparency by utilising large-scale data responses from participants and uncovering interpretable factors present in the data. Many of the studies employing data-driven approaches have based the development and testing of these reports on resting state neuroimaging, in which a participant lies in a magnetic resonance imaging scanner without any task at hand, free to mind wander.

Theoretical Approaches to Mental Wandering

The strength of theoretical approaches towards modelling mind wandering include targeted means of addressing dimensions that add to our understanding based on prior findings and theoretical traditions such as mindfulness. For example, multiple operational definitions of mindfulness have been described from neurocognitive frameworks of mindfulness to aid in the diffuse spread of mindfulness types across literature, thus being compatible with definitions across practices and fields (Lutz et al., 2015, see Figure 1.5). When considering such dimensions, mental wandering could be described as a non-effortful, unstable occurrence of mind low in meta-awareness (Lutz et al., 2015).

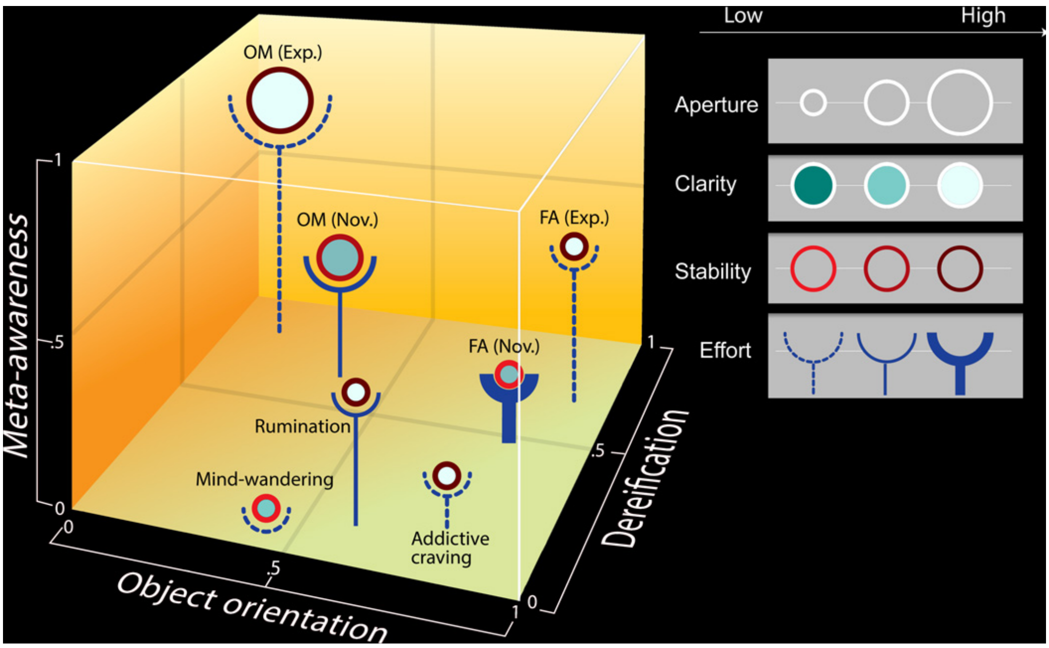


Figure 1.5. From Lutz et al., 2015, a phenomenological matrix of mindfulness-related practices in a multi-dimensional space. FA=Focused Attention meditation, OM=Open Monitoring meditation, Exp=expert practitioners, Nov=novice practitioners.

Other frameworks provide greater nuance around aspects like meta-awareness, such as the differences between deliberate versus spontaneous thoughts (Seli et al., 2016), which does add further information that may aid clinical distinctions of mental content that have not been considered in data-driven frameworks. Beyond this, considering the onset and occurrence of thought (Smallwood, 2013), constraints around mental wandering experience (Christoff et al., 2016) or memory processes related to mental wandering (Mildner & Tamir, 2019) all further highlight the shifting nature of mental content above and beyond its occurrence, unlike most data-driven approaches which focus on the tangible occurrence attributes.

In Chapter 6, overarching key components derived from these mind wandering frameworks are discussed and synthesised in a proposal for a theoretical taxonomy with relevance to mental health. This includes (i) type of representation, (ii) affect, (iii) temporal nature, and (iv) relation to the experience, and within these broad divisions, I propose a number of existing and novel dimensions to quantify and describe mental content in investigative study. Considering such a taxonomy will allow future researchers to consider multiple central components of mind wandering nature while accounting for a full phenomenological picture on the experience of mind wandering.

A Note on the Therapeutic Contexts for Studying the Resting Mind

The clinical importance of considering mental wandering, and opposingly, mindfulness is related to several widely used psychotherapies that relate to bringing one's mind to the present moment in non-reactive and non-judgmental manners. Many clinical psychotherapies aimed to help treat and aid in depression incorporate aspects of mindfulness including Dialectical Behaviour Therapy (DBT, Linehan, 1993), Mindfulness-Based Stress Reduction (MBSR, Kabat-Zinn, 1990), Mindfulness-Based Cognitive Therapy (MBCT, Kabat-Zinn, 2003), and Acceptance and Commitment Therapy (ACT, Hayes et al., 2009) so understanding how extraneous mental content, or a lack of mindfulness, is related to variability in affect and differences in mental health provides value.

Dispositional mindfulness has been compared to emotion instability and granularity in experience sampling work (Hill & Updegraff, 2012) but in non-clinically defined samples. Assessing whether the experience of mind wandering is associated with differences in intraday trends of affect could provide a unique understanding of the complex relationships between how multiple dimensions of mind wandering may interplay with concurrent shifting emotion in daily life, and how such relationships may differ between groups based on clinical status.

Mindfulness frameworks appear to bring up dimensions of importance in studying the phenomenology of resting mind that may also carry import in mental wandering, which includes one's relationship to the mental experience (Lutz et al., 2015; Seli et al., 2016; Smallwood, 2013). The nature of the relationship one has to the experience of mind wandering differs on dimensions more specifically tied to aspects such as perceived control (intentionality or constraints; Seli et al., 2016), immersion (or meta-awareness; Smallwood, 2013), or specificity (clarity, aperture; Lutz et al., 2015), and these are related concepts to attributes of mindfulness described through clinically targeted therapies suggest value in understanding these features of mentally wandering experiences as well in the face of varied mental health. This is especially important provided the personal-level analytical level of mental wandering research that carries great importance in clinical contexts (Beck, 1979; Kabat-Zinn, 1990).

1.7 OVERVIEW OF STUDIES REPORTED IN THIS THESIS ON MENTAL WANDERING

A Novel Study of Mental Wandering in Daily Life

Through prior experience sampling methods, studies have found that people spend almost half of their waking life thinking about something other than what they are doing (Killingsworth & Gilbert, 2010). This is a considerable amount of time spent mentally engaging in extraneous ways that may impact one's mental health. The content of one's mental thoughts have been associated with lower affect in certain cases, such as when one is thinking about the past (Killingsworth & Gilbert, 2010; Ruby et al., 2013). In related fashion, frequent use of rumination has been associated with depression and anxiety due to its maladaptive nature in revisiting past events repetitively (Aldao et al., 2010).

The first study on mind wandering in this thesis aims to assess a sub-selection of mind wandering dimensions proposed in the theoretically synthesised framework presented in Chapter 6 along with concurrent intraday emotions in currently depressed, remitted depressed, and healthy participants (see Chapter 7; Study 5). Following naturalistic methods to assess mind wandering attributes affective trends, experience sampling was used in an event-based manner such that if participants were mind wandering at the time of random prompts about their daily life, self-report on dimensions was collected and compared alongside concurrent emotion. This initial study on mind wandering combines naturalistic collection methods along with assessment of multiple theorised and novel dimensions.

A Novel Study of Mental Wandering in Sensory Deprived Conditions

In the second study, Study 6 of Chapter 7, I conduct an initial study to explore mind wandering in this context of synthesised theoretical frameworks for mind wandering. A novel sensory deprivation mind wandering task is used in conjunction with experience sampling probes to gather information on mental content throughout a window of time in which a participant has free reign to move mentally across thoughts, time, and space without anchoring to external stimuli or cues. These methods aim to combine task-independent definitions and resting-state neuroimaging paradigms for the targeted unpacking of differences in how mental representation relates to mental health in depressed and healthy never-depressed persons. Thus, in Chapter 7, Study 5 provides a naturalistic daily life investigation of real-time mind wandering experiences while Study 6 provides a controlled design limiting external environmental cues to probe into freeform unfolding mental representations. Together, mind wandering is unpacked as a phenomenological process through these various methods and clinically relevant dimensional attributes.

1.8 THESIS AIMS AND STRUCTURE

In all, the goals of this thesis are to (i) assess the underlying representational structure of both emotion and mood in the context of contemporary theories of affect, (ii) consider dynamic trends of affect by considering emotion and moods and the relationships between them, (iii) elaborate on a novel framework of dimensions for studying the nature of mental content in a wandering mind, (iv) consider how mental content from a wandering mind influences or is influenced by dynamic trends in ongoing affect, and (iv) explore mind wandering dimensions using a novel 'sensory deprivation' study paradigm. Each experimental chapter (Chapters 2, 3, 4, 5, 7) provides an introduction, methods, analytic procedures, and discussion of findings and their relation to mental health, while the more theoretical chapter (Chapter 6) provides a comprehensive review on past frameworks, proposal for synthesis, and discussion on the implications such a framework may have on mental health. Each chapter is designed to somewhat 'stand-alone' and so there is brief recapping of key aspects of the literature relevant to the chapter at hand in the chapter introductions.

CHAPTER 2 – STUDY 1: PROBING THE UNDERLYING REPRESENTATIONS OF EMOTION AND MOOD CONSTRUCTS IN ADOLESCENTS WITH VARYING DEPRESSION RISK STATUS

2.1 OVERVIEW

In the Introduction (Chapter 1), I reviewed theoretical work on emotion and mood, and highlighted the importance of studying these two affective types. The first study reported here to that end focuses on how individuals mentally represent emotion and mood terms. Beyond ratings of valence or arousal, one can further examine possible multidimensional representation of emotion and mood items. By using multidimensional spatial arrangement instead, we may instead ask individuals to physically arrange affect terms in two-dimensional space based on their similarity; that is, closer together if perceived as more similar, and further apart if perceived as more different, which can correspond to nuanced differences in dimensional representation beyond linear scales. This underlying structure has been heavily described in circumplex models of affect (Russell, 1980).

This first study was therefore conducted to study how representations of emotion and mood may be perceived by individuals, and elucidate possible similarities and differences between the uncovered dimensions of these respective representations. Participants were able to view subsets of emotion terms and rearrange them on a computer screen based on their perceived similarity until all pairwise emotions were compared, then multidimensional scaling methods were used to visualise the arrangement of group average emotions. This was repeated on a different day in the same participant sample for mood terms. This study operated as an initial proof-of-concept for assessing both emotion and mood terms to determine whether both types of affect states are represented within a similar circumplex frame and for assessing the relationship of this representational structure to mental health.

Participants in this first study were adolescents, as the study was conducted as part of a broader programme of research on adolescent mental health we were invited to contribute to – the MYRIAD project (https://myriadproject.org/). The study was initially planned with a large target sample (N=300), but data collection was halted due to the COVID-19 pandemic and so the final sample (n=69) only allows preliminary investigation of our research questions.

2.2 INTRODUCTION

Unlike the remaining studies in the thesis, this first study was carried out with an adolescent sample. Adolescence is a time of significant emotional development when emotional experiences increase in intensity, complexity, and negativity (Larson & Lampman-Petraitis, 1989; Larson et al., 2002; McLaughlin et al., 2015). Increasing understanding of subsequent associations between emotion processes and mental health symptoms occurring during adolescence could help improve identification of those at risk and avenues for intervention, especially given that adolescent-onset depression has been strongly associated with chronic, recurrent depression in adulthood (Friedrich, 2017; Lewinsohn et al., 1999; Lopez et al., 2006; Rao et al., 1999).

Further, it is important to understand how individuals may perceive and understand emotion and mood states distinctively, and how this may be linked to mental health risk. As noted in the Introduction, theoretical models of emotion and mood differ such that emotions are viewed as processes resulting from fluctuating appraisals of environmental stimuli with more discrete, intensely felt, and intentional object-oriented directionality (Cacioppo & Gardner, 1999; Ellsworth, 1991; Lazarus, 1991; Russell, 2003). Moods are viewed as diffuse, non-directed, non-object-oriented, less intense but generally related to cumulative feedback from the environment (Beedie et al., 2005; Eldar et al., 2016; Parkinson, 1996; Russell, 2003). As discussed, much of affective research has led to 'emotion' and 'mood' being used interchangeably despite their theoretical and phenomenological differences (Beedie et al., 2005; Watson & Clark, 1997) and there remain important distinctions in how these states may be felt, experienced, and regulated for individuals (Beedie et al., 2005; Eldar et al., 2016; Larsen, 2000; Rottenberg, 2005) and the impact this may have on adolescents (Silk et al., 2003). For example, dysregulation and chronic or recurrent negative experiences of mood can be linked to numerous affective disorders, lower quality of life, and shortened life span (Friedrich, 2017; Lopez et al., 2006).

Investigating how mood states may be perceived by individuals may help provide information on comparable differences between emotion and mood. One of the most well-cited representational models of affect is Russell's proposed circumplex model of affect (Russell, 1980) which was summarised in Chapter 1. This model postulates that the core configuration of affective experience can be represented along a circular arrangement such that similarity between specific affect terms arranged around this circle is a direct function of their distance from each other (Russell, 1980; Russell, 2003; see Figure 1.1 in Chapter 1). This proposal suggests relations between affect states can be embedded within two bipolar dimensions interpreted as valence and arousal.

Valence and Arousal Dimensions and Mental Health

In an early study, it was found that while mood also was represented in a circumplex structure, with a more restricted arousal dimension correlating with self-reported difficulties in differentiating depressed from anxious mood (Feldman, 1995). However, this study did not examine underlying representations in relation to participant depression or anxiety information. This further raises the question of how valence and arousal are associated with possible mental health risk in self-reported labeling of affect. Individuals considering arousal less than valence when labeling their mood states connected to the theoretical difficulties in participants being able to differentiate clinical mood states, like anxiety or depression (Feldman, 1995), emphasising a need to clarify the psychological representation of emotion versus mood representations.

Findings in the adolescent emotion complexity literature, such as emotion differentiation – the ability to precisely label discrete but similar emotion states – have been linked to higher levels of depression following stress alongside lower emotion differentiation (Starr et al., 2020) and reduced vulnerability to stress alongside higher emotion differentiation (Nook, 2021; Nook et al., 2021). These relationships have not yet been explored in adolescent conceptualisation of mood, and further work on differentiation between moods may provide elucidation on another aspect of adolescent affective experiences, especially given the suggestion from past initial work suggesting lower mood arousal differentiation correlated with less granularity on perceived depression and anxiety mood states (Feldman, 1995).

Indeed, affective differentiation is typically represented by the intra-class correlation between similar-valenced states which represents how closely correlated (lower differentiation) or lesser correlated (higher differentiation) similar valenced moods may be perceived (Nook et al., 2021; Pond Jr et al., 2012), leaving questions as to how additional possible dimensions of similarity (e.g., arousal) may be associated with restricted ranges related to functioning or mental health outcomes. Further study of representational structures of affect, and distinctively so between emotion versus mood states, may help contribute to affect and mental health research in elucidating the dimensions that capture both these affect states and comparing differences in vulnerable populations.

Multidimensional Scaling as a Methodology for Assessing Representational Structure

Multidimensional scaling (MDS) is an approach that refers to a class of techniques that use distance between items as a proxy for similarity between items in a high-dimensional space (Kruskal, 1977; Kruskal, 1978) and can arrange a spatial configuration of items – here, emotion or mood – in a two-dimensional space such that original pairwise distances between items are preserved across dimensions. The resulting spatial arrangement is configured such that more similar items are closer, and more distant items are further apart in Euclidian distance. While other dimension-reduction techniques are used to find and interpret dimensions (e.g., principal components analysis (PCA), factor analysis) the benefit of MDS is that it instead focuses on the relations among items. For example, PCA displays multidimensionality on orthogonal dimensions of maximised variability using correlation matrices, while MDS projects multidimensionality onto a two-dimensional space with item similarity interpretable by distance, the mathematical basis for constructing circumplex models of affect (Russell, 1980).

Using the MDS approach to explore differences in adolescent views of affective similarity would allow for assessment of perceived differences between emotion and mood in two-dimensions, while considering distinctions in the underlying structure of these two states and affective differentiation (Nook et al., 2021; Pond Jr et al., 2012; Starr et al., 2020) during an important affective development period. Given past evidence on suggested emotion context insensitivity (Rottenberg, 2005), that is, a restricted range of emotional reactions to relevant contexts in depression, there may be importance in understanding how moods are also represented or restricted (Feldman, 1995) in those at-risk for depression. Past studies suggesting the presence of restriction of emotional functioning in depression (Rottenberg, 2005) may be a feature of affect related to potential restriction of representation of moods as well.

To collect dissimilarity information on affect states, rather than directly asking for ratings for all pairwise combinations of terms, there exists a spatial arrangement method task

(SpAM; Hout et al., 2013). This computerised task asks individuals to drag and drop terms closer together or further apart on a screen depending how similar they perceive all pairwise states and is significantly faster than typical pairwise ratings while offering accurate and reliable dimensional solutions (Hout et al., 2013; Richie et al., 2020; Verheyen et al., 2020).

Multidimensional scaling seeks to find an optimal configuration that gives accurate distance as close as possible to the dissimilarity values when pairwise data is quantitative (Kruskal, 1978), while nonmetric MDS considers distance as a monotone function of dissimilarity where data are qualitative, such as in ordinal data (i.e., data with dissimilarities known only by rank order; Kruskal, 1978). These distance scaling methods undergo optimisation processes that minimize the stress function, a measure of the solution's goodness of fit (Borg & Groenen, 2005; Kruskal, 1964), solved by iterative algorithms (Jaworska & Chupetlovska-Anastasova, 2009). Previous studies on multidimensional scaling of similar concepts (e.g., emotion, emotion expressions) have used nonmetric scaling methods on item dissimilarity due to the ordinal data collection methods of Likert-scale pairwise ratings (Morgan & Heise, 1988; Russell, 1980). However, SpAM allows for direct collection of dissimilarity ratings via matrices of distances between terms (Hout et al., 2013; Kruskal, 1978). Given this, the distance between affect items through spatial arrangement may be construed as quantitative data and analysed through metric MDS.

The goal of this present investigation was to provide a proof-of-concept for using spatial arrangement methods to multidimensionally scale both emotion and mood differentially across two tasks to assess uncovered representational structure for each affect type. Based on prior work, we hypothesised that we would replicate past findings for the emotion circumplex structure and that this same structure would be mirrored for mood terms. Further, we sought to link this to possible depression risk given the centrality of mental health experiences to adolescence and possible mood representation (Feldman, 1995; McLaughlin et al., 2015; Rottenberg, 2005). This study aims to assess whether depression risk during this important developmental stage may associate with hypothesised stronger restrictions in spread of arousal dimensions in emotion and mood.

Thus, in the present study we used metric multidimensional scaling methods to consider differences in emotion and mood representation in adolescents. We assess representational differences in structure for low- and at-risk depression in this adolescent sample with the aim of taking a multidimensional approach to view, interpret, and compare possible structure differential representations of emotion and mood, and how this may be related to mental health in a developmental time period.

2.3 METHODS

Participants

A total of 75 participants participated in this study, aged 13-18 years. The data were collected as part of the wider MYRIAD study and the present tasks were included as part of a larger task set. Participants were recruited from 3 secondary schools and one college in the Cambridge, United Kingdom area. Researchers visited secondary schools in-person and invited college participants to in-person testing at the Cognition and Brain Sciences Unit to provide study information and collect data. As participants were adolescents, informed consent was provided by parents alongside assent from participants under 16 years of age, while those over 16 years old directly provided informed consent. Data were collected across two sessions per participant as described in the procedures below.

Six participants were excluded from analysis due to missing demographics and depression risk information given time constraints during the primary testing session. The final analysis sample comprised 69 participants who were divided into those deemed low-risk or at-risk for depression based on established measure cut-offs (see next). As mentioned, the intention had been to collect a sample of 300 participants, but data collection had to be suspended due to the COVID-19 pandemic.

Participant education on affect types

Given the study aim of piloting a differential test on emotion versus mood representation, it was important that participants understood the difference between emotion and mood. Hence, participants were educated on the theoretical differences of probing emotion one day, versus mood the next day (see Appendix 2.1). This involved providing written explanations for emotions versus moods on each based on affective research on emotion and mood models, describing emotions as appraisal processes in response to stimuli and mood as a homeostatic, diffuse, non-directed state related to more long-term affective updating (Beedie et al., 2005; Eldar et al., 2016; Ellsworth, 1991; Larsen, 2000; Lazarus, 1991; Watson & Clark, 1997) in plain and simple text to be clear and comprehensible for adolescents (see Appendix 2.1). This plain participant education text was presented on each testing day, along with a short instruction that either emotion or mood was the focus for the day's task.

Measures

Demographic information

Demographics of age, sex, socioeconomic status, and cognitive abilities were collected. English postcodes of participants' family homes were used to generate an index of socioeconomic status by using them to assign an English Index of Deprivation 2019 (Ministry of Housing, Communities & Local Government (HCLG), 2019). This is a rank comprising seven domains of deprivation including income, employment, education, health, crime, barriers to housing, and living environment (HCLG, 2019)(Ministry of Housing, Communities & Local Government, 2020). The deprivation rank ranges from 1 (most deprived area) to 32,844 (least deprived area).

Cognitive Ability (Nonverbal IQ). A measure for cognitive ability was gathered from the Cattell Culture Fair Intelligence Test. This test measures non-verbal fluid intelligence while controlling for sociocultural and environmental influences such as language abilities and general knowledge to remain fair to these participant attributes and has been shown to be reliable and valid (Cattell, 1963). In this test, participants completed a series of timed, visual puzzles that require identifying patterns and relationships between novel stimuli, with raw scores standardized to a normalised IQ score (see Appendix 2.2 for a copy of the Cattell Culture-Fair Intelligence test).

Center for Epidemiological Studies-Depression Scale (CES-D). The CES-D measures symptoms of depression and includes a cutoff score (Lewinsohn et al., 1997) to identify individuals potentially at risk for clinical depression ($\geq$16) and this was employed in the present study (see Appendix 2.3). The CES-D has been shown to have good sensitivity and specificity and high internal consistency across wide age ranges (Lewinsohn et al., 1997). Internal consistency was also high in our sample (α=.92).

The Spatial Arrangement Method (SpAM). The SpAM allows us to collect similarity data for perceived representations of different affect terms by asking participants to spatially arrange terms such that terms with the closest subjective meaning are positioned more proximally to each other (Hout et al., 2013). Here, the SpAM was programmed in E-prime and conducted on a laptop computer provided to participants in full-screen mode (see Figure 2.1). Participants completed experimental sessions on two different days, using the SpAM for emotion terms on one day and mood terms the next day. Order of affect-type (mood, emotion) presentation was counter-balanced across all participants.

For each affective task version, 31 affect terms were compared against each other in subsets of 6 terms at a time (see Figure 2.1), such that spatial configurations of all pairwise combinations of affect were collected. Participants were provided with a written explanation of the difference between emotions and mood to plainly describe the difference between tasks and perception of the written affect states (e.g., ‘happy’ emotion versus ‘happy’ mood, see Appendix 2.1).

Figure 2.1. The Spatial Arrangement Method (SpAM) task. Displayed full-screen of a laptop computer, six randomized emotion items would appear at a time, and participants were instructed to use their computer mouse to drag and drop word items closer together if they felt they were more similar or further apart if they felt they were more different. Participants were instructed to consider and use the entire screen. Once satisfied with their final spatial arrangement, participants moved on to the next set of emotion terms by pressing a computer key.

SpAM data were analysed using multidimensional scaling (MDS) techniques**.** Pairwise distances between all 31 terms per affect type per participant were transformed into 31×31 individual matrices. MDS algorithms were employed to find a configuration between terms that mapped onto lower dimensional space considering closeness and goodness-of-fit via a stress-1 index as the loss function (Kruskal, 1964). Stress-1 measures the extent to which the two-dimensional space deviates from the ideal representation of the data, and then further norms that value through denominator division. Normalised stress-1 is reported as it provides the proportion of variance of the dissimilarities not accounted for by the final distances and the fitted proportion, or a coefficient of determination (Borg & Groenen, 2005).

The SpAM task provides Euclidian distance measures between all pairwise terms but does not provide a visual arrangement or interpretable configuration of the data. To visualize and analyse the data appropriately, all distance values gathered from the SpAM must be dimensionally reduced with MDS in order to analyse the distance relationally. If MDS was not applied, the only resultant information would be a matrix of pairwise combinations of all 31 terms (34,875 total rows per subject and pairwise term combinations) and a Euclidian distance value relating each pairwise distance. MDS transforms these values to be relationally distances among two interpretable axes. All plots and values shared in the Results section are from MDS analysis of the distance data collected by the SpAM.

Individual participant matrices were averaged by group status of depression risk based on the CES-D established cut-off for low- versus at-risk depressed groups. Spatial configurations of mood terms were compared by assessing statistical qualities of the mean and spread of the two bipolar dimensions representing the similarity structure.

Affect Terms for the SpAM

Given the importance of studying differences between emotion and mood, special care was placed into ensuring selected terms for each type of affect were appropriately selected.

Emotion. A diverse set of emotion terms was selected for the study based on prior and established emotion scales. This initially involved collating emotion terms from several emotion differentiation tasks in the literature that had already been carefully selected to capture distinctive states based on their respective methodologies (Nook et al., 2018; Nummenmaa et al., 2014, 2018). We also reviewed reliable and validated affective self-report scales including the Positive and Negative Affect Schedule (PANAS; Watson, et al., 1988), Differential Emotions Scale-IV (DES-IV; Blumberg & Izard, 1986), modified DES (Fredrickson et al., 2003), and the circumplex model of affect (Russell, 1980).

Emotion terms that were consistently present across these different studies and measures were included (e.g., happy, surprised). Theoretical considerations of each emotion term were considered, such that terms comprised emotion processes that suitably represented models of emotions as appraisals to external information (e.g., Lazarus, 1991). This resulted in a final set of 31 emotion terms with corresponding affective norms for all terms assessed to confirm this final set captured wide ranges of valence and arousal along with their frequency in English language (Van Heuven et al., 2014; Warriner et al., 2013)(see Appendix 2.4).

Mood. Similar methods were used to capture a diverse set of granular mood terms including prior validated and established mood scales compiled, including the Brunel Mood Scale (BRUMS; Terry & Lane, 2003), the Profile of Mood States Scale (POMS; McNair et al., 1971), the UWIST Mood Adjective Checklist (UMACL; Matthews et al., 1990), and the Brief Mood Introspection Scale (BMIS; Mayer & Gaschke, 1988).

Mood terms present in at least two of the mood scales were selected. Terms were not included if they were deemed more closely related to object-directed emotions to ensure the focus was on object-free mood terms in line with theoretical formulations of mood states (i.e., differentiating whether the affective state was a response to a singular event such as how one feels ‘anger’ in emotional response to a negative event, versus a prolonged mood state as response to ongoing situational information such as ‘irritable’).

Other terms were set aside if they described physiological states without concrete associated valence (e.g., tired), were terms uncommon to British English (e.g., peppy), or were terms that reflected more cognitive states (e.g., confused). This resulted in 31 final mood terms for assessment (see Appendix 2.5). As with the emotion terms, affective norms and frequency of use in English language for the mood terms were collated (see Appendix 2.5).

Procedure

All methods and study procedures were approved by the Cambridge University Psychology Research Ethics committee (PRE.2019.036). For the school sites, researchers visited classrooms to carry out testing in small groups of 10-13 participants supervised by two researchers. For college sites, students visited the CBU and conducted testing in a similar manner. To assess enrolled adolescents on the two affect types, data were collected across two separate days such that emotion tasks and mood tasks were delivered separately with differing instruction. Participants provided basic demographics followed by completion of the SpAM task. Additional unrelated measures and tasks were administered as part of the wider MYRIAD study on adolescent and social psychological phenomena, not reported here. All participants were reimbursed for their time on each day, debriefed, and thanked on their last participation day.

2.4 RESULTS

Demographics and clinical characteristics of the sample

Participants were divided into two groups based on the cutoff score for being low-risk (CES-D<16, n=28) or at-risk for depression (CES-D$\geq$16, n=41).

There were no significant differences between the low- and at-risk groups with respect to age, sex, socioeconomic status, or cognitive abilities (see Table 2.1). We compared depression risk for the two groups using a Wilcoxon test, with the at-risk group (M=28.8, SD=8.98) and low-risk groups (M=8.89, SD=4.24) significantly differing (p<.001, r=.85 95%CI[.79,.86]).

	Whole Sample	At-Risk Depression	Low-Risk Depression	Statistic
N	69	41	28	
Demographics				
Age (*M, SD*)	15.55 (1.70)	15.59 (1.61)	15.50 (1.86)	*F*=.04, *p*=.84
Female	46 (66.67%)	28 (68.29%)	18 (64.29%)	$\chi 2$=.01 *p*=.93
Male	23 (33.33%)	13 (31.71%)	10 (35.71%)	
Socioeconomic Status				
Deprivation Rank	21743 (7954.15)	21477.83 (8300.19)	22132.61 (7550.82)	*F*=.11, *p*=.74
Cognitive Abilities				
IQ	118.85 (18.03)	118.28 (17.34)	119.68 (19.27)	*F*=.10, *p*=.76

Table 2.1. Demographic characteristics for the adolescents with low- and at-risk groups in Study 1.

Spatial Arrangement of Emotion

Circumplex Dimensions

The sets of individual participant matrices of pairwise dissimilarity were averaged by group to generate group-level distance matrices, read in as Euclidian distances and MDS algorithms applied. The spatial solutions of emotion similarity/dissimilarity between the two risk groups were then displayed in a two-dimensional space, with dimension one (x-axis) strongly suggesting representation of valence, and dimension two (y-axis) strongly suggesting representation of arousal in line with circumplex models of emotion (Russell, 1980) (see Figure 2.2a; for values see Appendix 2.6).

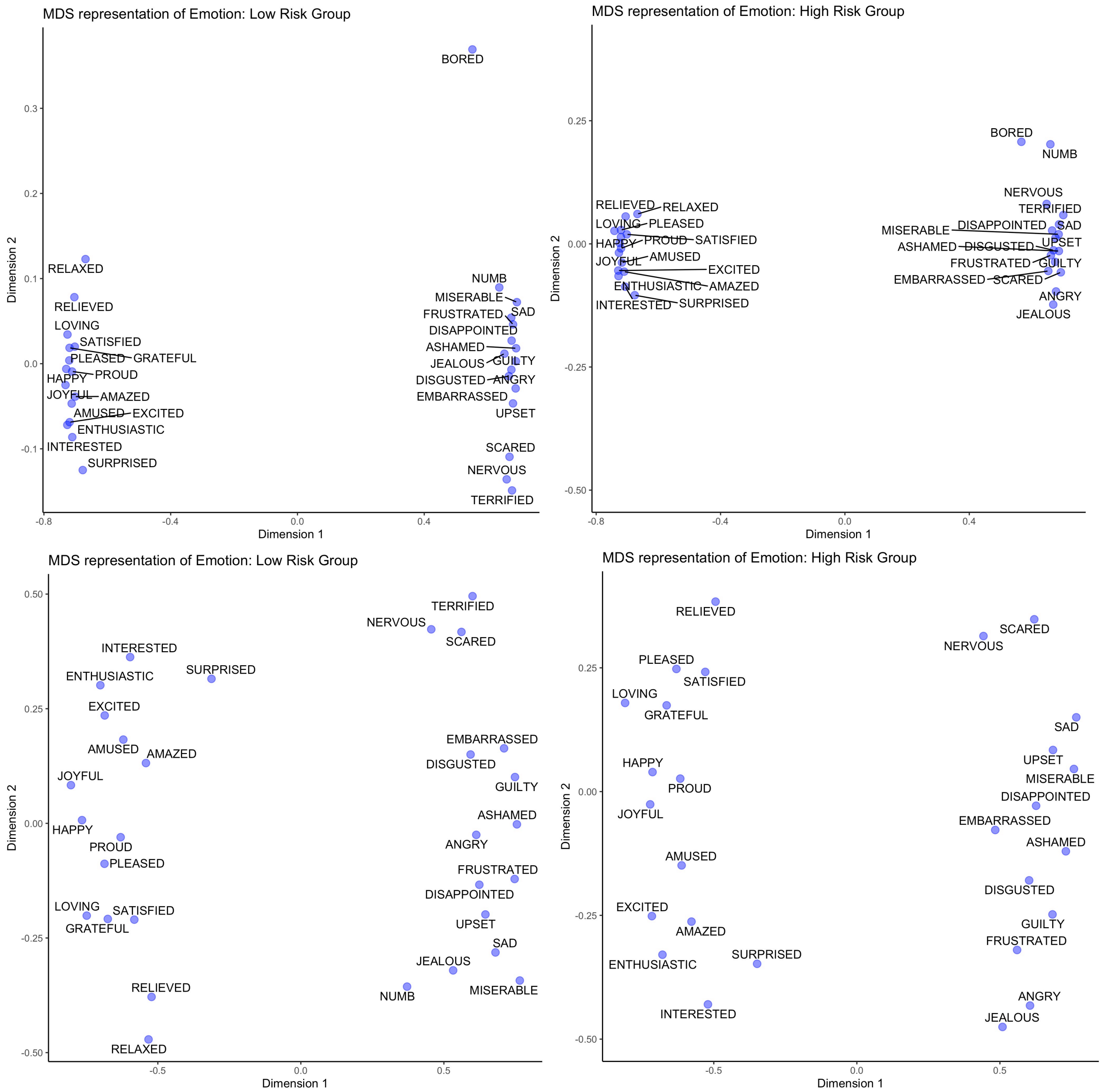
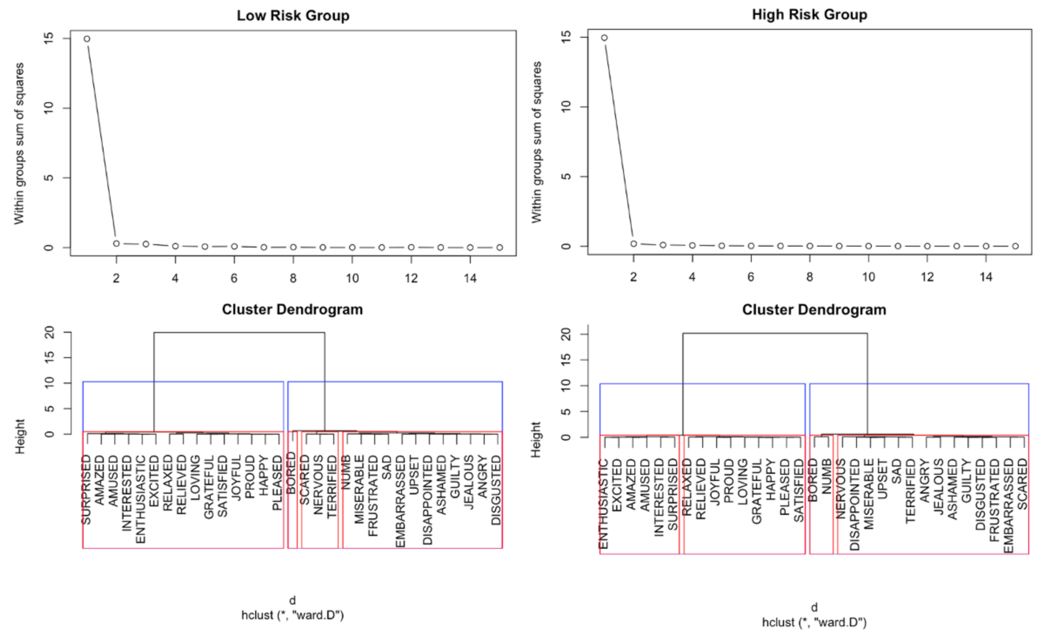


Figure 2.2. (a) Multidimensional scaling solution of low (upper left) and high (upper right) depression risk groups with all emotion terms present, and (b) with the outlier 'bored' emotion, removed (low-risk, lower left; high-risk, lower right).

Results indicated excellent goodness-of-fit scores for both the low-risk (stress-1=.04, normalised stress-1=.002) and at-risk groups (stress-1=.05, normalised stress-1=.003) (Kruskal, 1964). The within-groups sum-of-squares (Krzanowski & Lai, 1988) was assessed for each group solution. This suggested two clusters of emotion (see Figure 2.3a). Ward hierarchical clustering methods of possible dendrogram cuts (Murtagh & Contreras, 2012) also suggested two strong clusters related to the first 'valence' dimension, which further separation into four possible sets, were one to consider the second 'arousal' dimension (see Figure 2.3a).

(a)



(b)

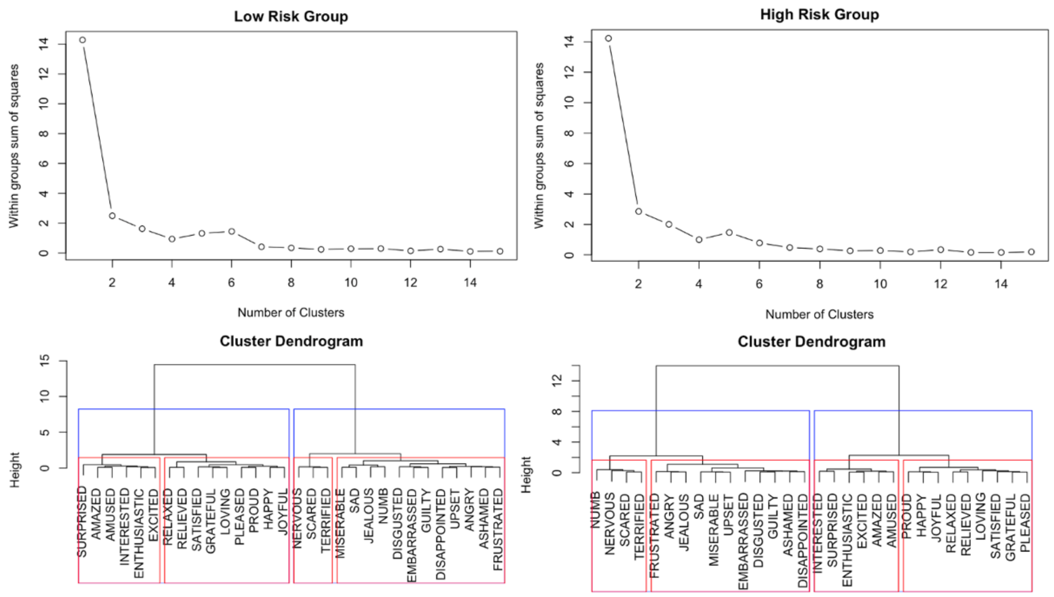


Figure 2.3. (a) Within group sum of squares (upper) and Ward hierarchical dendrogram cuts (lower) for the circumplex of all emotion terms, and (b) Within group sum of squares (upper) and Ward hierarchical dendrogram cuts (lower) for the circumplex of emotion terms without the outlier term ‘bored’.

The four clusters of emotions in the low-risk depression group consisted of (i) all positive emotions, (ii) bored, (iii) a group of high-arousal negative emotions (scared, nervous, terrified), and (iv) low-arousal negative emotions (numb, miserable, frustrated, sad, embarrassed, upset, disappointed, ashamed, guilty, jealous, angry, disgusted) (see Figure 2.2a). The at-risk depression group instead showed four distinct clusters of (i) low-arousal positive emotions (relaxed, relieved, joyful, proud, loving, grateful, happy, pleased, satisfied), (ii) high-arousal positive emotions (enthusiastic, excited, amazed, amused, interested, surprised), (iii) bored and numb, and (iv) all remaining negative emotions together. These differences appeared to be strongly influenced by the presence of the outlier emotion ‘bored’.

This was statistically confirmed in the low-risk group as the multidimensional scaling dissimilarity value for 'bored' was 3.88 standard deviations above the mean. In the at-risk group, 'bored' was within three standard deviations of the mean (*Z*=2.76)(for all values see Appendix 2.6).

Assessing Structure

Outliers in small samples can be harder to appropriately detect and may not be problematic or necessary to exclude when data are valid (Bakker & Wicherts, 2014b, 2014a), but can still have negative influence on power, resulting in possible mis-characterisations among groups and increased Type-I error rates (Bakker & Wicherts, 2014b; Wilcox et al., 2018). Nonparametric tests have been found to be a robust even when outliers are present (Bakker & Wicherts, 2014), resulting in reasonable Type-I error rates (near .05) and adequate power (insignificantly lower), even in the face of smaller samples (n<40; Bakker & Wicherts, 2014), however, the same does not apply to assessing sample variance with included outliers (Lix et al., 1996). Thus, in the case of multidimensional scaling and comparing dimension variance, it seemed pertinent to remove the outlier that may have undue influence in further restricting representations of other terms.

Emotion pairwise dissimilarity was thus reassessed without the outlier term of 'bored', resulting in a more explicit circumplex model of emotion visualisation after appropriate multidimensional scaling around a noticeable circumference (see Figure 2.2b; for values see Appendix 2.6). Results indicated adequate goodness-of-fit scores for both the low-risk (stress-1=.12, normalised stress-1=.01) and at-risk groups (stress-1=.14, normalised stress-1=.02). Data also appeared normal, providing reassurance to statistically assess variance using sensitive tests (see Figure 2.2b).

Within-groups sum-of-squares for each risk group suggested two to four clusters of emotion terms, in line with theoretical bases for positive and negative valence and high and low arousal (see Figure 2.3b). When assessing the dendrograms, this resulted in the low-risk group showing positive emotion clustered into low and high arousal, a small set of high-arousal negative emotion terms (nervous, scared, terrified) and all other negative emotion terms clustered together (see Figure 2.3b). A difference highlighted in the at-risk adolescents was one additional high-arousal negative emotion of 'numb' clustered along with nervous, scared, and terrified. There were no other differences in clustering for positive emotions.

With the outlier of 'bored' emotion removed, the dimensions showed similar properties between the low-risk (Valence: *M*=0, *SD*=.65, Arousal: *M*=0, *SD*=.27) and at-risk groups (Valence: *M*=0, *SD*=.64, Arousal: *M*=0, *SD*=.29). There were no significant differences between dimension spreads on valence ($F(29,29)=0.99$, $p=.92$) or arousal ($F(29,29)=1.61$, $p=.62$). Within-groups, there was significantly higher spread for valence than arousal for both the low-risk ($F(29,29)=5.82$, $p<.001$) and the at-risk groups ($F(29,29)=4.66$, $p<.001$). As a note, these analyses with the outlier 'bored' still included generated similar results (see Appendix 2.6).

Spatial Arrangement of Mood

Circumplex Dimensions

Pairwise dissimilarity of mood was processed with the same methods as described for emotion. Similarly, the representational structure of mood appeared to display valence as the dimension along the x-axis, and arousal as the second dimensions along the y-axis (see Figure 2.4a; for values see Appendix 2.7).

Results indicated excellent goodness-of-fit scores for both the low-risk group (stress-1=.07, normalised stress-1=.005) and at-risk group (stress-1 = .05, normalised stress-1=.002) (Kruskal, 1964).

The within-groups sum-of-squares for each group solution suggested two clusters of mood terms (see Figure 2.5a). Dendrogram cuts also suggested two to four strong clusters related to valence and arousal (see Figure 2.5a).

There were some differences among which terms were clustered together between the low- and at-risk sample. The mood 'guilty' was grouped among the low arousal mood terms for the low-risk group (bored, bitter, guilty, depressed, gloomy, miserable, fed up, pessimistic, sad), but was clustered among the high arousal mood terms in the at-risk group (manic, desperate, anxious, panicky, stressed, irritable, tense, guilty, uneasy). There were no group differences in clustering of positive moods based on arousal level.

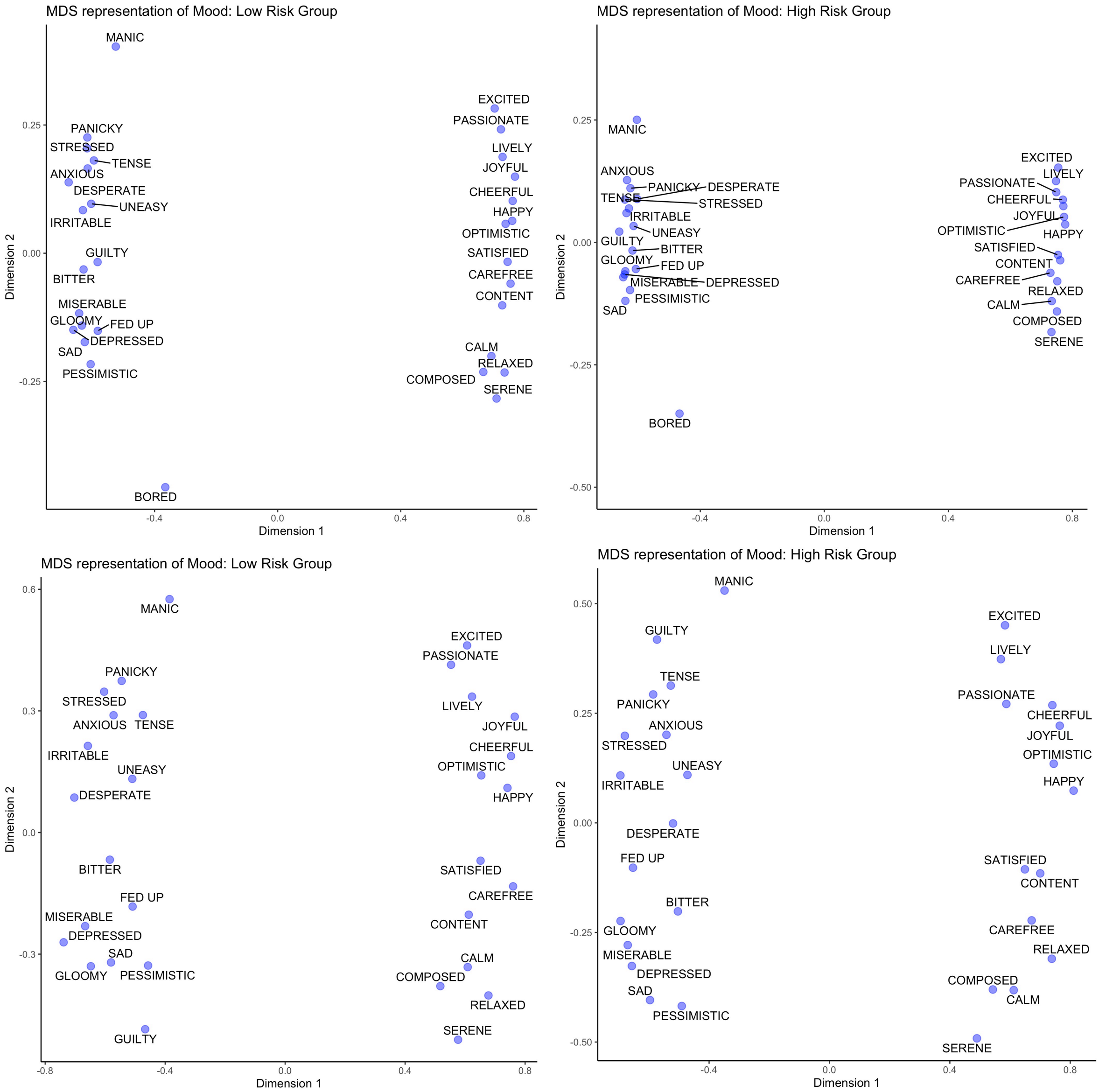


Figure 2.4. (a) Multidimensional scaling solution of low (upper left) and high (upper right) depression risk groups with all mood terms present, and (b) with the outlier 'bored' mood, removed (low-risk, lower left; high-risk, lower right).

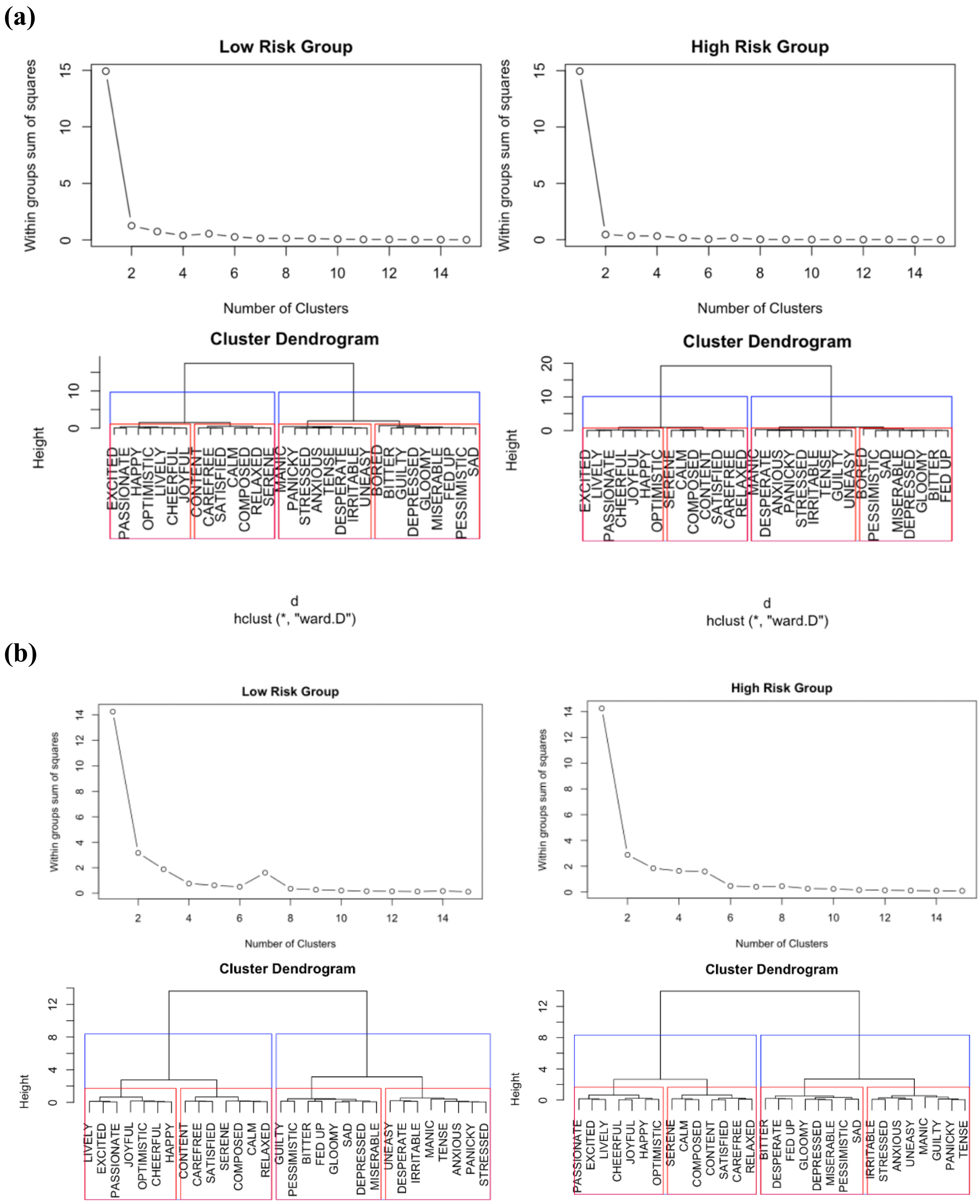


Figure 2.5. (a) Within group sum of squares (upper) and Ward hierarchical dendrogram cuts (lower) for the circumplex of all mood terms, and (b) Within group sum of squares (upper) and Ward hierarchical dendrogram cuts (lower) for the circumplex of mood terms without the outlier term ‘bored’.

Assessing Structure

We compared both dimensions for the low-risk (Valence: *M*=0, *SD*=0.68; Arousal: *M*=0, *SD*=0.19) and at-risk groups (Valence: *M*=0, *SD*=0.69; Arousal: *M*=0, *SD*=0.11). We tested whether the variance between the two groups significantly differed by using a *F*-test to compare two variances. There was no significant difference between the variance of the two groups on valence ($F(30,30)=0.95$, $p=.88$), but there was a significant differences between the two groups on the variance of arousal ($F(30,30)=2.75$, $p=.007$). Within-groups, we tested the spread of valence versus arousal for the low-risk ($F(30,30)=11.74$, $p<.001$) and the at-risk groups ($F(30,30)=34.17$, $p<.001$) which showed that for both groups, arousal displayed significantly lower spread than valence in graphical representation of mood.

The mood term 'bored' again appeared to be a possible outlier (see Figure 4a), although it did not cross the threshold of three standard deviations from either group mean (low-risk group: $Z=–2.31$; at-risk group: $Z=–2.94$; see Appendix 2.7).
Given that 'bored' mood approached three standard deviations from the mean, the small sample size, and the benefits of using equivalent dataset comparisons to the emotion dataset (removal of 'bored' emotion suggesting the removal of 'bored' mood in assessing representational structure), the mood analyses were recomputed following the removal of 'bored'. With this near-outlier removed, as with the emotion terms, a clearer circumplex model was uncovered with terms displayed along a circumference and relatively normal data structure (see Figure 2.4b; for values see Appendix 2.6). Results indicated adequate goodness-of-fit scores for both the low-risk (stress-1=.13, normalised stress-1=.02) and at-risk groups (stress-1=.13, normalised stress-1=.02). The within-groups sum-of-squares was reassessed, which suggested two to four clusters of mood terms (Krzanowski & Lai, 1988) and dendrograms using Ward hierarchical clustering methods of possible cuts (Murtagh & Contreras, 2012) again showed two strong clusters related to the valence dimension, and then the four valence/arousal dimension clusters (see Figure 2.5b).

This clustering of terms into valence and arousal still showed that low-risk adolescents appear to group 'guilty' in with low-arousal moods (guilty, pessimistic, bitter, fed up, gloomy, sad, depressed, miserable), while at-risk adolescents grouped 'guilty' with high-arousal moods (irritable, stressed, anxious, uneasy, manic, guilty, tense) (see Figure 2.5b). There remained no differences in the clustering of positive moods once the outlier was removed.

With the outlier removed, the spread of dimensions was reassessed for the low-risk (Valence: $M=0$, $SD=0.62$; Arousal: $M=0$, $SD=0.32$) and at-risk groups (Valence: $M=0$, $SD=0.63$, Arousal: $M=0$, $SD=0.30$). Dimension spread was not significantly different between groups for valence ($F(29,29)=0.95$, $p=.94$) or arousal ($F(29,29)=2.75$, $p=.77$). With the near-outlier now removed, the F-statistic was robust to examining variance and did not suggest discernable differences in spread of mood valence or arousal. Within-groups, the result of significantly higher spread in valence versus arousal for the low-risk ($F(29,29)=3.86$, $p<.001$) and the at-risk groups ($F(29,29)=4.42$, $p<.001$) still held.

Comparing Emotion and Mood Structures

Following comparisons of both adolescent risk groups for emotion and mood separately, we next sought to compare emotion and mood directly on spread within-groups. We assessed emotion versus mood for the low-risk group, and then for the high-risk group. Given the outlier status of 'bored' emotion or mood in structures, the term was not included in these secondary analyses.

Comparing the dimensions within-groups utilized a Pitman-Morgan test, which is a common approach to testing homogeneity of variance when variances may be correlated as in paired samples (Morgan, 1939; Pitman, 1939). Caution is recommended in interpretation given there is not a satisfactory control for both Type-I and Type-II errors when comparing variances of paired data, especially in smaller samples as in this proof-of-concept study (Wilcox, 2015), while other studies have suggested that that without heavy skew (as in these resulting data structures absent of possible outlier terms), the Pitman-Morgan test can retain conservative Type-I error even in small samples (n<50)(Grambsch, 1994).
There were no differences between emotion and mood dimension spread for the low-risk group on valence ($t(28)=0.20$, $p=.85$) or arousal ($t(28)=-0.90$, $p=.37$), or for the at-risk group on valence ($t(28)=0.02$, $p=.98$) or arousal ($t(28)=-0.12$, $p=.91$).

2.5 DISCUSSION

In this proof-of-concept study on representations of affect in adolescents, we were able to multidimensionally scale underlying structure for both (i) emotion and (ii) mood in (a) adolescents with low-risk depression and (b) adolescents deemed at-risk of depression. Spatial arrangements for emotion and mood terms strongly suggested that perceived similarity of terms was based upon valence and arousal in line with circumplex models of affect. For both emotion and mood solutions, within-group differences showed that both low-risk depressed adolescents and high-risk depressed adolescents consistently represented moods over less range in arousal than they did range in valence. Further findings for emotion and mood are discussed.

Representations of Emotion

At first, the lack of a strong closed form in the overall configuration did not strongly depict an obvious circumplex model when all affect terms were included, but the results were still circular in broad spread. Circumplex models tend to require that its comprising elements display in a circle form with a lack of variation around the line of such a circle (Morgan & Heise, 1988). However, any outlier in a multidimensional scaling space may have undue influence on the remaining terms, restricting their ultimate spread – and indeed 'bored' emotion was identified as an outlier. Thus, data were re-analysed resulting in a strong visual depiction of a circumplex model of emotion, and also highlighting the importance to analysing states absent of outliers (Bakker & Wicherts, 2014a; Wilcox et al., 2018) in multidimensional scaling. Clustering methods also suggested four groupings once the outlier was removed, as opposed to just two distinct groupings when all terms were included, thus further indicating more appropriate portioning to both bipolar dimensions of valence and arousal once statistical outliers were removed.

The remaining difference in clustering of emotion terms on valence and arousal was that at-risk adolescents appeared to represent 'numb' emotion alongside high-arousal negative terms, while the low-risk individuals appeared to perceive it more closely alongside low-arousal negative emotion. While very tentative given the small illustrative sample, this may be interpreted as an area for further exploration, as it is possible there are certain negative emotions that may be perceived as higher-arousal when adolescents are at high-risk for depression. Identification of such states may be ripe areas for considering specific interventions or regulation strategies geared towards relevant discrete emotions that may be perceived differently when mental health risk is increasing.

There was no difference between-groups for the low- and at-risk adolescents on the spread of their valence or arousal dimensions, and thus no evidence supporting overall restricted emotional arousal representations in a higher-risk mental health group. However, for both risk groups, within-group comparisons showed a significantly lower spread of arousal on emotion than valence. This may suggest that valence is more a more readily distinguishable dimension in the representation of emotion than arousal, though not necessarily related to depression risk status. This replicates and adds to past findings on assessing representational structure of affect (Feldman, 1995).

Representations of Mood

The initial weaker circumplex formation most strongly delineated by the valence dimension was most likely due to the inclusion of a possible outlier mood term. As with 'bored' emotion, 'bored' mood was removed and data re-analysed, resulting in a strong circumplex formation in the data. While 'bored' mood was not a statistical outlier ($Z<3.00$), it did approach this cut-off, and sample size was relatively small – thus we reconducted analyses transparently for a proof-of-concept to mirror emotion analytic methods. The dimensions of valence and arousal distinguished the moods similar to emotion, with four groupings of mood terms suggested through clustering evaluation methods once outliers were removed.

These results may tentatively suggest that mood states may be distinguished into positive or negative valence and further differentiated by arousal. Some of the differences tentatively may also suggest that for adolescents with higher depression risk, 'guilt' may be more associated with high-arousal negative moods, as this clustering held even with and without 'bored' mood included. The specific mood state of 'guilt' may be of interest in understanding further relationships between mood differentiation and perceptions during periods of development or the role of guilt in depression onset, especially given links between experiences of guilt in women (Zahn-Waxler et al., 1991) and the higher onset of depression in adolescent girls (Joormann et al., 2007; Petersen et al., 1991).

Low- and at-risk depression groups did not differ significantly on the spread of their moods across the valence dimension, suggesting valence may be a clearer universal distinguishing factor for both types of affect, regardless of depression risk. When representation of all moods was considered (including 'bored' mood), arousal appeared to be significantly restricted in the at-risk adolescents compared to the low-risk adolescents, but this result did not hold once the influence of the higher outlier value was removed in assessing sample variance (Wilcox, 2015). While it is possible restricted views of mood arousal may be experienced similarly to restricted emotion functioning in depression found previously (Feldman, 1995; Rottenberg, 2005), a larger sample size would need to be tested and data assessed for outlier presence before drawing firm conclusions. This was the original aim of this research study given the initial data collection goal (n=300), but it must be reiterated the COVID-19 pandemic caused data collection to halt and the current sample size collected up to that point (n=75) was used.

However, these findings are mentioned as they may tentatively point towards further inquiry in investigating whether arousal of moods may be more closely correlated to depression risk than arousal of emotions. Given that mood is theorised to assist humans with a homeostatic internal system for choosing actions in the environment (Eldar et al., 2016), spread of valence and arousal of general mood state may help persons use or conserve energy with nuance to fulfilling greater needs. Thus theoretically, it is possible that higher depression risk may be associated with an individual perceiving the arousal state of many kinds of moods as more similar than for those with lower depression risk and an inability to associate mood context more broadly across the arousal spectrum (Eldar et al., 2016; Russell, 2003). Future work with larger samples and increased power could attempt to further probe the difference on dimensional spread of arousal based on depression risk.

As with emotion, within-groups comparison of the spread of valence and arousal dimensions yielded significant results that suggested a smaller range of arousal in representing mood terms than valence range. This was true for both depression risk groups, and regardless of the higher value of ‘bored’ mood included. Given this finding appears present in both emotion and mood, it is worthwhile considering other ways in which representation of affective arousal may differ between individuals. It is tentatively suggested it may have possible relationship to depression risk even more so, but this must be explored in a larger sample. It is possible that it relates to ability to better regulate affect or chronometry (i.e., duration) of self-reported higher-arousal moods, but these are all research questions for future work.

Summary

Comparisons between emotion and mood within-groups yielded no significant differences in spread of either affect state across valence or arousal. Results are tentative given the small sample size, but this finding may suggest that both affect types are represented similarly within-groups. Both groups appeared to show less spread on arousal than valence when comparing at the two dimensions within affect type (e.g., how emotion terms spanned less range over arousal than valence), but not when comparing arousal or valence across affect type (e.g., arousal ranges for emotion and mood were not significantly different within either low- or at-risk groups). Direct comparison of representations for emotion and mood in paired samples are a beginning attempt at unpacking similarities and differences between these affect states. This specific comparison may have suggested individuals represent either affect type similarly over valence and arousal spreads, or that these dimensions are appropriate in sampling a wide and representative array of emotion or mood for experimental studies.

In summary, Study 1 provides a prototype for methods of assessing both emotion and mood differentiation through spatial arrangement mapping and provides suggestions of multidimensional aspects of emotion and mood similarity and dissimilarity with the goal of better conceptualizing distinctions in affect and mental health status. This proof-of-concept highlighted the ability to replicate circumplex models of affect in both emotion and mood, especially when care is taken to ensure selection of non-outlier items and instructional information distinguishing layperson definitions of emotion and mood to participants. In all, future work continuing to compare emotion and mood as distinctive states and underlying differences may continue to clarify the picture of affect and its underlying representations in individuals.

Limitations and Future Considerations

Limitations in this study include the small sample size. Because the study involved in-person visits to school campuses, data collection was disrupted and permanently halted due to the COVID-19 pandemic and prompt shutdowns in the United Kingdom, where this study took place. Further work could consider spatial arrangement of emotion and mood terms in a larger adolescent sample to validate these results and possible differences. Future work could gather ordinal ratings of valence and arousal of affect terms and compare such data to multidimensional scaling methods to consider how closely two-dimensional reductions of higher-dimensional differences in affect align with standard ratings like valence and arousal. It is also possible that piloting affect terms prior to collection may help ensure outlier terms may not be included and possibly inappropriately restrict the spread of other terms when using multidimensional scaling methods. Given the mapping of affect to circumplex defined space, an outlier that may representationally be external to such a circular formation could warp the underlying structure of affect, as suggested in our findings.

In addition, a limitation may lie in the selection methods of affect terms. Given that a wide range of terms were selected due to their spread across valence and arousal dimensions, another critique may be that this imposes an uncovered circumplex structure based upon these very dimensions. However, the benefit to multidimensional scaling is that relational aspects of terms are considered. The implications of the results lie in valence and arousal appearing to most strongly represent relationships between emotions and moods. Rather than an unexpected dimension more strongly capturing the nuanced relationship between varying states, results uncover these prior dimensions are strong axes. Limitations also exist such that if both affect types showed no difference in within-groups spread when comparing emotion and mood directly, there may not be a discernible difference in these states for study. However, we suggest that this result rather implies valence and arousal may be satisfactory dimensions alluding to relationships between states for both affect types (Feldman, 1995; Russell, 1980, 2003), and the similar representation structures over both highlight a shared quantitative feature gleaned from the subjective arrangement by individuals when assessing terms. Multidimensional scaling is not merely a data reduction technique, and thus these relational dimensions may highly relate to how individuals represent various discrete states.

Further, in this study of adolescents, we collected self-reported postal codes of their addresses, however other additional sociodemographic measures that may have informed upon socioeconomic status (SES) were not collected. For adult participants, SES can typically be inferred from occupational, educational, or income-related data, but for adolescents there are challenges in requesting reports of their parental SES features (Wardle et al., 2002). Provided the limitations in this study design only collecting postal codes, efforts were made to relate sociodemographic status with the index of multiple deprivation (IMD) for an overall deprivation score of that area based on national U.K. data. Limitations here include the implicit assumption that individuals from similarly deprived geographic areas are homogenous, which is not valid, nor a claim posited by this research (see e.g., Mueller & Parcel, 1981). In future research, we could aim to include a more holistic self-report measure of possible socioeconomic status that recognizes the heterogeneity of SES beyond postal code and geographic deprivation. This may be incorporating validated questionnaires on SES inferred through material items (e.g., asking adolescents to report rented or owned homes, number of vehicles owned by parents) and relating these features to socioeconomic outcomes (Wardle et al., 2002).

Another component to participant demographics that must be discussed is the above-average IQ of the adolescents in the study. Given adolescents were recruited from surrounding schools in the Cambridge area that are particularly competitive, this may have resulted in a skew towards above-average IQ for the adolescent sample. Students with higher IQ levels tend to achieve higher academic scores, experience higher motivation intrinsically and extrinsically, and have performance levels in school less related to their parental education (e.g., Guez et al., 2018). These are components that may affect the generalisability of results gleaned from the present sample of adolescents to adolescents without high-IQ, and future research could aim to enrol a broader sample of adolescents with varying IQ levels to consider whether further differences in affect representation may be similar across fluid intelligence levels.

Future work could consider sampling states representatively across other domains, such as frequency of use or word length to test uncovered dimensions. Frequency and length attributes were gathered in selection of terms in this study and found to span a wide range (see Appendix 2.4, 2.5), but this feature was not the basis for representational selection. Thus, selection of affect words differing on frequency, length, popularity in language, or other semantic features could also certainly be areas for further exploration in better understanding underlying structure of affect.

The experience of affect in the forms of emotion and mood is a complex phenomenon to pin down, and this initial study is one attempt to begin quantitative examination of these differences. If participant education on distinctions between emotion and mood is deemed highly successful and feasible to further clarify during testing, future work could consider attempting spatial arrangement methods with emotion and mood terms simultaneously and map the multidimensional structure of both emotion and mood altogether. This may fall in line with valence and arousal, but could also uncover relational aspect of representation of these distinct affect states, such as diffuseness or duration (e.g., Larsen, 2000; Parkinson, 1996; Russell, 2003; Thayer, 1989) or other possible dimensions representing differential experience.

From Representation to Dynamics

In all, we hope this tentative initial exploration into the distinctive representations of emotion versus mood constructs helps provide a proof-of-concept for future work in the field of affect. Given this initial exploration of emotion and mood representations in the lab, we next aimed to consider naturalistic unfolding experiences of affective content. Provided the differential theories of emotion versus mood, and thus the higher likelihood of emotion changes occurring more frequently over time, emotion dynamics was of interest to explore further with respect to mental health in Chapter 3.

CHAPTER 3 – STUDY 2: ELUCIDATING DIAGNOSTIC, TRANSDIAGNOSTIC, AND ADIAGNOSTIC SUBGROUPS OF WITHIN-PERSON EMOTION DYNAMICS ACROSS INDIVIDUALS WITH AND WITHOUT A HISTORY OF MOOD DISORDERS: AN EXPERIENCE SAMPLING STUDY

3.1 OVERVIEW

This second study focused on examining emotion dynamics over time, this time in adult individuals with and without formal diagnoses of mood disorders. The study uses experience sampling methods on a large sample (N=114) with either a history of or no history of mood disorders. The ambulatory assessments on this sample provided the data for the current study as well as for the work in Chapters 4, 5, and 7 and the sample details pertaining to all these studies are provided here (with the exception of bipolar participants not included in further work due to the low sample size for this group).

Emotion is a highly dynamic process by nature, states are not simply experienced as stable occurrences, but as constantly fleeting and shifting across time and as sensitive to environmental and internal changes. Much of emotion dynamics research has used naturalistic methods such as ambulatory assessment to measure emotion changes, but the tendency has been to report group summary metrics; for instance, how intense emotions were on average for depressed versus remitted individuals over time. There is now a burgeoning interest in using idiographic methods to examine within-person patterns of emotion dynamics over time. Putative clusters of individuals with similar within-person patterns can thus be examined or uncovered either using top down a priori groupings such as diagnoses, or through data-driven subgroupings that have the potential to identify adiagnostic or transdiagnostic clusters. This was the focus of the current study.

In the present study, individuals with current depression, remitted depression, bipolar disorder, and healthy never-depressed status enrolled into a 14-day experience sampling study to naturalistically measure ongoing intraday emotion. Group iterative multiple model estimation (GIMME) was used to build individual person-specific models of emotion dynamics and cluster these models to determine whether distinct profiles of emotion dynamics exist. We tested whether clinical diagnostic information adequately generated robust groupings of individuals, or if data-driven clustering in a transdiagnostic or adiagnostic framework better represented similarities in individual emotion dynamic processes. Groups were then summarised by common emotion summary metrics based on the robust groupings of dynamic real-time trends in emotions over time.

3.2 INTRODUCTION

As highlighted in the Introduction in Chapter 1, mood disorders, such as depression and bipolar disorder, are a leading cause of distress and disability worldwide (Alonso et al., 2011; Friedrich, 2017; Grande et al., 2016). They are characterised by core difficulties with negative affect and motivation (Rottenberg, 2005) alongside myriad behavioural, somatic, and cognitive symptoms, including manic or hypomanic episodes in bipolar presentations (APA, 2013). These characterizations have historically been developed based on comparisons of ‘disordered’ individuals against normative distributions of functioning. This approach has generated a vast corpus of nomothetic (between-person) clinical research whereby individuals diagnosed with a mood disorder are compared, along multiple dimensions, with relevant mentally-healthy control groups.

This nomothetic research tradition has generated many valuable insights into the nature of human mood difficulties. However, there is a long-standing awareness that individuals with mood disorders, in addition to showing marked between-group differences from healthy peers, are also characterised by complex dynamic, *within-person or idiographic* processes that manifest and change over time in response to and in interaction with the environment. Indeed, the differences in behaviour, affect and cognition that vary within-person across situations can be of comparable magnitude to any differences between individuals. Furthermore, relationships between variables that are valid at the between-person level are not necessarily applicable at the within-person level (Fleeson, 2001; Molenaar, 2004). It is likely that there are rich between-person differences in the within-person patterning of behaviour, affect, and cognition, such that they are best understood ideographically, that is in person-specific or personalized ways. Thus, although the prototypical between-person research studies that typify the clinical literature can clarify how individual differences are structured in the population, they provide little insight about how behaviour, affect, and cognition are organized ideographically within the individual (Fleeson & Noftle, 2012)[1].

This long-standing awareness of the importance of dynamic intra-individual interactions over time between symptoms, and with events in the environment, is at the heart of established and contemporary psychological theories of mood disorders (e.g., Beck & Haigh, 2014; Borsboom & Cramer, 2013; Smith et al., 2021). These theories characterise mood disorders as emerging through entrenched patterns of relationships within this dynamically unfolding matrix. These theoretical conceptualizations then provide a natural route to person-specific, idiographic formulations within the clinic whereby the particular dynamic profile of inter-relating factors for each patient is elucidated (e.g., Persons, 2012). These formulations then motivate bespoke intervention protocols that seek to disrupt dysfunctional within-person processes to enable change.

Two further features of these theories merit comment. First, their purview extends beyond the traditional sets of signs and symptoms enshrined within diagnostic manuals to include key biopsychosocial processes deemed to play a causal role in etiology, maintenance and recovery. For example, the central role of diverse types of maladaptive cognitions within Cognitive Therapy conceptualizations (Beck & Haigh, 2014). Secondly, these theories often do not respect traditional nosological boundaries between diagnoses. Rather, they are compatible with a transdiagnostic approach (Dalgleish et al., 2020) that seeks to formulate the profile of clinical difficulties for each patient, regardless of whether that profile is best characterised in terms of no clear diagnosis, a single diagnosis, or comorbid diagnoses.

Taken together, this suggests that both between-person differences and within-person fluctuations in behaviour, affect and cognition should have comparable influence on our efforts to better understand disorders of mood. However, although idiographic research

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[1] In fact, insights from between-person data can only help explain within-person patterns when two very strict criteria are satisfied. When the within-person process is (i) stationary; i.e., the statistical characteristics such as mean, variance and covariances do not vary over time, and (ii) homogeneous across subjects; i.e., an identical statistical model applies to each individual in the population (Gayles & Molenaar, 2013; Molenaar, 2004).

methods have a long tradition, because they have typically relied on single-case designs they have historically not yielded data that has readily led to generalizable principles about the nature of mental ill health (Spencer & Schöner, 2003). Further, because idiographic models need to be elucidated separately for each individual within a given study, this has traditionally limited their scalability.

Recent rapid technological advancements have now rendered the scalability problem entirely tractable. Detailed assessment of processes implicated in mental health within the naturalistic setting of day-to-day life is now feasible due to the development of ambulatory assessment methodologies. Participant behaviour, affect, and cognition (along with contextual environmental features) can now be recorded repeatedly during everyday life routines, after which the researcher can probe within-person fluctuations across constructs of interest. As such methods allow data collection from large samples of individuals at the same time, this then also opens the door to addressing historical generalizability concerns.

What is then required is an analytic method able to bridge the traditional idiographic-nomothetic divide. Such an approach would need to provide a personalized analysis of an individual's dynamic associations among relevant psychological and/or behavioural domains, while also nesting these person-specific analyses within a broader nomothetic structure. Any such approach must also accommodate the putatively high heterogeneity in the idiographic pathways across individuals, while also revealing important commonalities if/when present. This integrating methodology would thus not only capture the clinical reality of mood disorders and mental health, but also contribute to the bottom-up data-driven development of behavioural and psychopathological taxonomies grounded in shared patterns of processes among individuals that may also differ from those operationalized in established diagnostic taxa (e.g., Insel, 2014).

A compelling approach that meets these bridging criteria is Group Iterative Multiple Model Estimation (GIMME; Gates & Molenaar, 2012). GIMME uses principles of unified structural equation models and vector autoregression to capture within-person associations between study variables, while also taking advantage of between-person information across the sample by including group-level information in the final derived individual-level solutions (Beltz & Gates, 2017). This allows GIMME to generate clustered subgroups with similar within-person dynamic process profiles (Gates et al., 2017). An important added benefit is that these subgroupings within GIMME can either be derived in a data-driven manner, based on discovered shared commonalities across individual profiles, or they can be evaluated using a confirmatory approach, whereby potential commonalities across a priori subgroups can be assessed; for instance, based on pre-existing diagnoses (Gates et al., 2017). This allows the same analytic framework to be used to elucidate traditional diagnosis-based commonalities within a study sample, alongside putative data-driven adiagnostic or transdiagnostic subgroupings (Dalgleish et al., 2020; Insel et al., 2010)[2].

Group Iterative Multiple Model Estimation

The present study leveraged these technological and methodological advantages by using ambulatory assessment allied with GIMME to further our understanding within one dynamic processing domain central to theoretical, empirical and clinical approaches to human mood disorders – unfolding emotion experience. Human emotional life is a fluctuating and time-dependent phenomenon (aan het Rot et al., 2012; Bonsall et al., 2012; Crowe et al., 2019; Scherer, 2009) where emotions shift in type and intensity as a result of internal and external events (Frijda, 2017) and where, critically, given our chosen empirical and analytic approach, such within-person fluctuations are distinct from mean levels of emotions aggregated across individuals and/or over time (Eaton & Funder, 2001; Larsen & Diener, 1987; Sperry & Kwapil, 2019). A substantive nomothetic literature already indicates that disruptions in affective fluctuations characterise mood disorders such as major depressive or bipolar disorder with consistent findings revealing higher levels and greater 'inertia' of negative affect, alongside lower levels of positive affect intensity, and greater affective instability over time in, relative to both healthy persons and those in remission from depression (aan het Rot et al., 2012; Bonsall et al., 2012; Crowe et al., 2019; Dejonckheere et al., 2018; Ebner-Priemer & Trull, 2009; Gruber et al., 2013; Houben et al., 2015; Koval et al., 2013; Kuppens et al., 2012; Thompson et al., 2012, 2021).

Such disrupted patterns of emotion experience also seem to precede and predict the onset and course of mood disorders over-and-above mean levels of emotion (Kuppens et al., 2012; van de Leemput et al., 2014; Wichers et al., 2015). Unsurprisingly, given this growing body of data, emotion dynamics are important clinically, and normalizing maladaptive affective patterns is a key focus of psychological interventions (e.g., Lazarus & Fisher, 2021). An important aspect of emotion experience that has received less empirical attention is what we might characterise as the 'affective montage', where a given emotion experience self-perpetuates or morphs into a different emotion or where emotions become stuck within

[2] Because of these advantages, GIMME is gaining currency within mental health research. A detailed primer on GIMME is beyond our scope here, but the reader is directed to a number of excellent papers introducing and applying the method (Ellison et al. 2020; Hofmans et al., 2019; Lane et al., 2019; Woods et al., 2020; Wright et al., 2019).

maladaptive reciprocal positive or negative feedback cycles, either relatively contemporaneously or over longer time periods ('lagged' affective dynamics) (Izard, 1972). For example, specific negative emotions such as sadness can reactively prompt different emotions such as disgust or anger such that those emotions can be thought of as 'coupled' (Power & Dalgleish, 2015), and breaking dysfunctional affective cycles is a core focus within the clinic (Greenberg & Watson, 2006; Power, 2010).

The focus of the present study was therefore to enlist repeated intensive data collection within everyday life using ambulatory assessment, combined with GIMME, to elucidate such idiographic dynamic patterns across a core range of positive and negative emotions over a two-week period in a sample of patients with and without a history of mood disorders. GIMME estimates person-specific models that elaborate patterns of associations for both contemporaneous emotion relationships, and also cascading lagged emotions, (i.e., how emotions at time t may vary as a possible result of emotions at time t–1). This further enables us to use GIMME to identify potential subgroups within the sample with similar idiographic profiles. Thus, our key research question investigated whether these putative subgroups align with traditional diagnostic groupings, evaluated using confirmatory GIMME, that allows the user to specify the groupings of participants, and/or whether data-driven GIMME, that uses algorithms to search for similar patterns in person-specific models, can identify robust subgroups that cut-across these a priori nosological boundaries.

Experience Sampling Methods

Experience sampling has been very successful in exploring intra-day trends of various measurements by providing a level of ecological validity in following individuals about their daily life and subsequent psychological phenomena. There has been an increasing amount of emphasis in understanding micro-level fluctuations of experience rather than average-level reports of various symptoms or mood or recollective experiences with affect or mind wandering (see e.g., aan het Rot et al., 2012; Crowe et al, 2018). By repeatedly sampling an individual in their daily life via real-time reporting, we can investigate time-series patterns on various affect and mind wandering states as they naturally occur, thus providing a clearer picture on how these experiences unfold day-to-day, how they differ within-person and between-groups, and how they relate to clinical dysfunction (Bolger et al., 2003; Curran & Bauer, 2011).

In addition to the naturalistic advantages provided by experience sampling, a further benefit includes the ability to greatly reduce biases involved in retrospective reporting

(Ebner-Priemer & Trull, 2009), providing us more information to complement findings uncovered in our laboratory studies which can be retrospective and involving participants estimating their recollective thoughts. Study designs in this thesis that used experience sampling was applied to collect information on fluctuations of experience across multiple manifestations of mental health symptoms in transdiagnostic patient samples, but also in case-control samples with group comparisons. Both approaches are used to summarise appropriately depending on the research question between instances of clinical diagnoses, or shared processes crossing over clinical boundaries. Ultimately, experience sampling methods were used in several studies in this thesis beyond this present chapter due to its valuable ability to validly measure daily ongoing experience (see Chapter 4, 5, and 7).

Experience Sampling Idiographic Emotion Dynamics

Within the canon of experience sampling work to date, a central focus has been on whether patterns of affective experience reliably differ across groups of individuals classified according to established diagnostic criteria (aan het Rot et al., 2012; Crowe et al., 2019; Ebner-Priemer & Trull, 2009; Houben et al., 2015; Kuppens et al., 2012; Thompson et al., 2021; van de Leemput et al., 2014) and that is therefore the first question we address here with respect to putative subgroupings of idiographic emotion dynamics. However, as noted, there has been increasing emphasis on examining whether processes fundamental to psychopathology aggregate in ways that do not closely align with traditional diagnoses (Dalgleish et al., 2020). Initiatives such as the Research Domain Criteria (RDoC; (Insel et al., 2010) and the Hierarchical Taxonomy of Psychopathology (Kotov et al., 2021) propose interesting and important alternative conceptualizations of symptoms alongside underlying biopsychosocial processes. This raises the question of whether there are important variations in emotion dynamics that do not map directly onto diagnostic status that could be identified using data-driven analysis within GIMME. The patterns across such processes might better align with sets of disorders, with sets of symptoms that certain disorders have in common, or more radically, may completely diverge from diagnostic or symptom-based divisions altogether (Cicchetti & Rogosch, 1996; Dalgleish et al., 2020).

Having used GIMME to potentially identify robust subgroups that are either aligned with diagnoses and/or exhibit differential data-driven profiles, we can then examine how these putative subgroups differ from one another on key additional demographic (e.g., age, gender), clinical (e.g., symptom frequency, intensity), and emotion metrics. These latter emotion metrics include intensity – the average strength of felt emotion across time (aan het

Rot et al., 2012; Crowe et al., 2019), instability – the degree of fluctuation across time, granularity – the degree of differentiation between similar emotions (Smidt & Suvak, 2015), and inertia – the extent to which a person's current emotion state is predicted by their previous state (Kuppens et al., 2012; van de Leemput et al., 2014).

The Present Study

Specifically, then, the current study gathered naturalistic information about emotion dynamics across a 14-day period in a diverse sample who met diagnostic criteria for (i) major depression currently in episode, (ii) major depression in remission, (iii) bipolar disorder, or (iv) no history of mood disorder. We analysed multiple intraday ratings across a range of specific emotions to elucidate intra-individual and subgroup profiles of associations between emotions. We evaluated the following three tiers of confirmatory diagnostic subgroupings: 2-subgroups, one with a mental ill-health history and one with no mental ill-health history (with all three clinical groups collapsed together relative to healthy controls); 3-subgroups, one with a unipolar depression history (pooling currently depressed and remitted individuals), one with a bipolar history, and healthy controls; and, 4-subgroups comprising currently-depressed, remitted-depressed, bipolar disorder[3], and healthy participants. We then also used data-driven analysis within GIMME to cluster person-specific models into possible bottom-up subgroups respecting shared dynamic commonalities. Having derived and extracted information about dynamic associations between positive and negative emotions across diagnostically-defined and data-driven subgroups, where indicated we sought to further characterise how any putative subgroups might differ from one another on a range of demographic, clinical, and affective metrics.

3.3 METHODS

Description of the Sample

The sample recruited here was used for the present study as well as studies reported in Chapters 4, 5, and 7 (however, bipolar participants were not included in these following chapters as this subgroup sample was too small for the analysis methods used subsequently). All 114 participants, aged 18-70, underwent a diagnostic assessment based on the DSM-5 criteria for mood/anxiety disorders via the Structured Clinical Interview for DSM (First et al.,

[3] Participants with bipolar disorder history were not further separated by episode status due to the majority being in depressive episode and no currently manic/hypomanic participants available for participation (see Participants section).

2015). Recruitment was transdiagnostic in aim within the mood disorders and included individuals with: (i) Major Depressive Disorder (MDD) in episode (n=39); (ii) MDD in remission (n=28); (iii) bipolar disorder (n=14); and (iv) no history of any mood or anxiety disorder (n=33).

Clinical samples were recruited from a patient database at the Cognition and Brain Sciences Unit. Additional inclusion criteria included normal or corrected-to-normal vision, English fluency, and possession of a personal smartphone with SMS service and internet access for experience sampling. Exclusion criteria included current alcohol/substance use disorder, organic brain damage, current psychosis, brain injury, intellectual disabilities, or current requirements for ongoing management of self-injury/suicide risk.

A priori power analysis for time-series approaches have not yet been sufficiently developed, and thus as many participants possible were enrolled into the study within our time constraints in line with similar studies (Aalbers et al., 2019; Greene et al., 2020). For GIMME analysis, ability to detect effects is determined by the timepoint numbers, rather than sample size per se, with a minimum of 10 participants and 60 timepoints advisable to adequately detect signal from noise and recover accurate models (Gates et al., 2017; Lane et al., 2019). On this basis, it is reasonable to assume we had adequate power for our analysis approach. Five enrolled participants were excluded from analyses; three completed fewer than 50% of experience sample surveys (*M*=30.67%), and two withdrew participation in the first few days due to technical issues.

For this present study specifically, data from four further participants were set aside due to data quality. The analysis sample therefore comprised 105 individuals with a relatively high number of observations (n=6,543 fully-complete observations across 70 timepoints) compared to other experience-sampling-based studies (e.g., Crowe et al., 2019; Hill & Updegraff, 2012; Ludwig et al., 2020; van Winkel et al., 2015).

Measures

Clinical Information

The Structured Clinical Interview for the DSM-5 – Research Version (SCID-5-RV) (First et al., 2015). The SCID is a comprehensive structured interview including modules for mood, anxiety and stressor disorders, with good reliability, specificity, and clinical validity (Osório et al., 2019). Interviews were completed by a trained researcher, and all diagnoses were second-rated blind by a clinical psychologist with 100% agreement. This clinical measure was similarly used to ensure diagnostic information for the work represented in Chapters 4, 5, and 7.

The Patient Health Questionnaire-9 (PHQ-9) (Kroenke et al., 2001). The PHQ-9 is a severity measure for depression and was included to provide a brief, reliable and valid (Kroenke et al., 2001) measure of current depression symptom severity over the previous two weeks across all participants (see Appendix 3.1).

The Generalized Anxiety Disorder-7 (GAD-7) (Spitzer et al., 2006). The GAD-7 is a 7-item severity measure for generalized anxiety and was included to provide a brief reliable and valid (Löwe et al., 2008) measure of anxiety symptoms over the previous two weeks across all participants (see Appendix 3.2).

Internal consistencies for the PHQ-9 (α=.91) and GAD-7 (α=.92) were high in our sample. Both of these clinical measures were also used to summarise depression and anxiety severity in the work represented in Chapters 4, 5, and 7.

The Inventory of Depression and Anxiety Symptoms (IDAS) (Watson et al., 2007). The IDAS is a widely-used symptom self-report measure spanning 19 transdiagnostic mental health subscales: General Depression, Dysphoria, Lassitude, Insomnia, Suicidality, Appetite Loss, Appetite Gain, Well-Being, Ill Temper, Mania, Euphoria, Panic, Social Anxiety, Claustrophobia, Traumatic Intrusions, Traumatic Avoidance, Checking, Ordering, and Cleaning (see Appendix 3.3). For this present study, the IDAS allowed us to characterise our confirmatory and/or data-driven subgroups in terms of continuous transdiagnostic symptom dimensions. The IDAS is a reliable and valid measure (Watson et al., 2007). Internal consistency in our sample was high across all subscales (Cronbach's αs=.72-.94; see Appendix 3.4).

Experience Sampling

To collect naturalistic dynamics ratings, a novel web-based platform was developed and used for signal-contingent data collection (see Figure 3.1). This platform was used to collect various sets of ambulatory assessment data analysed here, as well as for research questions presented in subsequent chapters.

Experience sampling collection was employed via personalised survey links sent to participants' mobile phones by SMS at pre-programmed times. Participants were prompted for 14 days with five intraday signals on emotion and mental wandering occurrence beginning at 10:00am and continuing every 2 hours. An additional single daily diary signal was sent at the end of each day at 8:00pm for self-report of mood and mood regulation (not analysed here for the present research question, though reviewed in Chapters 4 and 5 for respective research questions).

To avoid formulaic responses to expected collection times, signals were delivered within a 30-minute window (e.g., the first signal was sent at a randomised time between 9:45am-10:15am).

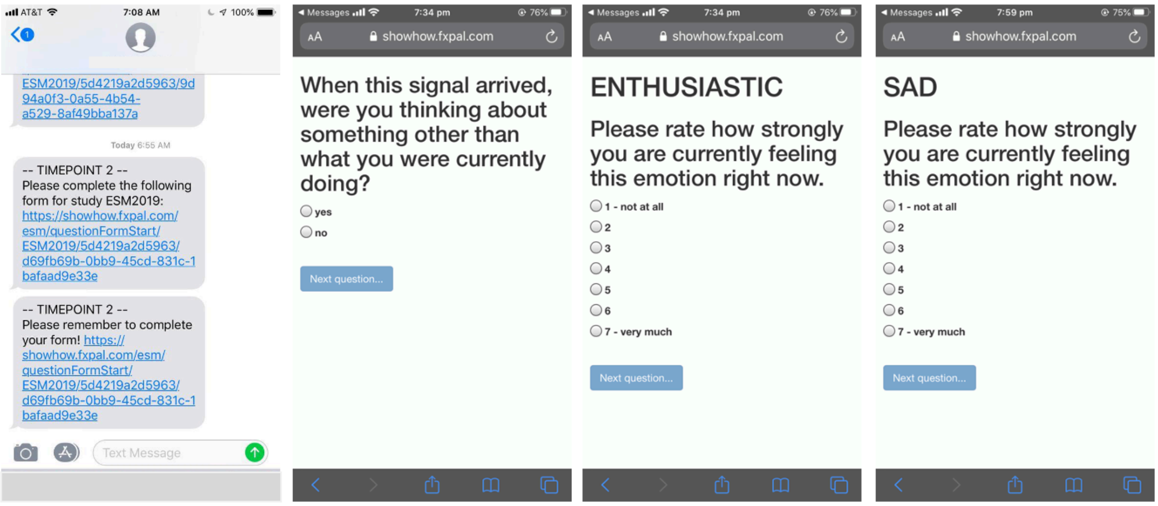

Figure 3.1. The experience sampling platform used to collect intraday and daily diary data. Upon clicking a link provided by SMS (with reminder messages if needed), participants were directed to an online survey link to answer several experience sampling self-report items, presented in random order.

Intraday Self-Report. Participants were asked to rate the present intensity of 9 emotions (enthusiastic, happy, pleased, relaxed, nervous, sad, angry, irritated, stressed) on 7-point Likert scales from 1 (not at all) to 7 (extremely). Emotions were selected to represent the complete bi-dimensional space of positive to negative valence and high to low and arousal (see Appendix 3.6 for emotion term selection methods and a list of all experience sampling items). Following each set of emotion ratings, participants rated the chronometry of their overall current emotion state by estimating how long it had lasted (in minutes). Participants also provided a yes/no response as to whether they were thinking about something other than what they were currently doing (Chaieb et al., 2021), with additional follow up questions on the nature of that extraneous thought content asked only if participants reported 'yes' to mental wandering occurrence (see Study 5 [Chapter 7] for this research question).

Given that limited information is added when investigating covariance across time when emotion terms very frequently co-occur, we examined post-hoc patterns of repeated measures inter-correlations (r_{rm}) between positive- and negative-valence emotions, and collapsed the highest inter-correlating positive emotions ('happy' and 'pleased' hereafter referred to as “Happy”; $r_{rm}(6,446)=.71$, $p<.001$) and negative emotions (‘angry’ and ‘irritated’ hereafter referred to as “Angry”, $r_{rm}(6,444)=.63$, $p<.001$) to single terms. The between-person spearman correlation confirmed they were the highest correlating valence pairs (Happy-Pleased $r(103)=.95$, $p<.001$ and Angry-Irritated $r(103)=.88$, $p<.001$). Seven final emotion terms (happy, angry, enthusiastic, relaxed, nervous, sad, and stressed) were therefore used in final analysis to maintain a granular set of emotion terms while mitigating the influence of highly correlating items (see Appendix 3.5).

Procedures

Methods and procedures were approved by the Cambridge University Psychology Research Ethics Committee (PRE.2019.040). Participants attended an initial session where they were briefed on study procedures and provided informed consent and then completed clinical measures (SCID-5, IDAS, PHQ-9 and GAD-7) and were introduced to the experience sampling platform which commenced the following day. At the end of the 14-day experience sampling period, participants were debriefed, paid, and thanked.

Analytic Plan.

Group iterative multiple model estimation. GIMME was estimated in the R statistical language with *gimme.* Solutions were assessed for robustness using *perturbR* (Gates et al., 2019; Lane & Gates, 2017). GIMME estimates unified-SEMs for each individual, which can be understood to be networks of regression paths, both contemporaneous and lagged (lag-1). GIMME provides an emergent group-level model/structure (i.e., the set of paths that will be freely estimated for all individuals) across participants, and person-specific (idiographic) models for each individual. Group-level structure was determined through modification indices that identified the contemporaneous and lagged paths that significantly ($p\leq.05$) improved model fit for the majority ($\geq75\%$) of the sample iteratively – a cut-off determined to be optimal for signal-to-noise detection in simulation studies (Gates et al., 2017). This process iterates until no further relations significantly improve the models of the sample majority (see Appendix 3.6 for further details). For GIMME, preprocessing included assessing missingness, constant variables, linear trends, and inclusion of hypothesised outside (exogenous) influences on the model like diurnal ‘time of day’ (see Appendix 3.6 for further details).

For the confirmatory analysis, as noted in the Introduction, subgroup assignments were based on our a priori diagnostic groupings, identifying whether any significant paths exist for the majority of participants (51%) within these predetermined subgroups. For our exploration of putative data-driven subgroups, subgroup assignments were determined for clusters of individuals with similar dynamic processes (i.e., patterns of contemporaneous and lagged emotion associations). To do this, similarity matrices were generated based on person-specific models, and a community detection algorithm (*Walktrap*) based on random walks between pairwise person-specific similarity matrices searched for possible clusters (Pons & Latapy, 2006). Subgroup-level analysis continued to iterate for paths that significantly ($p \leq .05$) improve model fit for the majority (≥51%) of the subgroup, a cut-off determined to be optimal for subgroups (Gates et al., 2017).

Finally, to return to the person-specific level models, structure was established for each participant using modification indices to determine the contemporaneous and lagged relations that significantly improve model fit for the participant, iterating until there are no more significant relations, with non-significant relations removed. Thus, each final person-specific model is a combination of the group structure (i.e., paths present in the majority of the sample), subgroup structure (i.e., paths identified as present in the majority of the sub-group), and person-specific structure (i.e., paths that are present only in the individual or in a minority of participants). All estimated paths have weights unique to each individual (Gates et al., 2017).

Evaluation of GIMME solution robustness. For both the confirmatory and putative data-driven subgroupings, a modularity value (Q) was generated for the overall solution. Q indicates the extent to which there is greater similarity between individuals within a subgroup, compared to between subgroups, than would be expected by chance (i.e., calculated as the summation of the number of edges falling within subgroups, minus the expected number in an equivalent network with edges placed at random) (Gates et al., 2017; Newman, 2006). A positive Q value therefore indicates the presence of community structure (Newman, 2004, 2006) while a negative Q value means there are fewer edges within a subgroup than expected by chance and may be interpreted as 'anti-modular'. A negative Q value indicated that solutions are not robust and in that eventuality, no further solution evaluations are applied (Hintze & Adami, 2010; Newman, 2006).

Modularity values (Q) are a measure of the robustness of the edges in a clustered network occurring significantly higher than by chance. The modularity value of the analytic solution was compared to the upper 5th percentile (effectively the modularity significance level of .05) of a distribution of randomly perturbed matrices with similar properties to the veridical dataset. This allowed for a statistical interpretation of how modular (i.e. appropriately clustered) the solution was compared to chance (Gates et al., 2019).

Further evaluation of the robustness of subgroups with acceptable *Q* values then include; perturbing the paths relating to individual similarity matrices within subgroups incrementally to test stability of the subgroup clusters; examining the variance of information (VI) as the distance between resulting subgroups in comparison to a random distribution; and calculating an Adjusted Rand Index (ARI) as a cluster validation measure of agreement on subgroup partitions (Gates et al., 2019).

3.4 RESULTS

Demographics and Clinical Characteristics

As noted, for the analytic method of the present study, data from four participants were set aside due to constant self-report of '1' across all timepoints for 'Nervous' or 'Angry', since the uSEM framework of GIMME cannot assess constant variables for which there is no variance as is the case with all association-based analyses (Lane & Gates, 2017). This provided a final analysis sample of n=105. Clinical groups were not significantly different for age, gender, ethnicity, income, and education (see Table 3.1). Clinical data on the sample is presented in Appendix 3.7.

The total missingness of all intraday experience sampling measures was low at 10.62% missing timepoints across the sample, and 0.35% partially missing timepoints. There was no significant difference in missingness across the diagnostic groups, ($X^2(3,109)=3.72$, $p=.29$). Given the relatively low level of data missingness in the sample, we moved forward with a full information maximum likelihood (FIML) approach utilized by GIMME that can handle missing values (Beltz & Gates, 2017).

	Whole Sample	Depressed	Remitted	Bipolar	Healthy	Statistic
N	105	37	28	11	29	
Demographics						
Age, *M* (*SD*)	40.32 (13.56)	40.41 (12.59)	43.36 (13.29)	35.27 (12.49)	39.21 (15.26)	F=1.04, p=.38
Female	76 (72.38%)	27 (72.97%)	24 (85.71%)	8 (72.72%)	17 (58.62%)	p=.16*
Male	29 (27.62%)	10 (27.03%)	4 (14.29%)	4 (30.77%)	13 (41.94%)	
Ethnicity						p=.74*
White (British)	94 (89.52%)	32 (86.49%)	26 (92.86%)	10 (90.91%)	26 (89.66%)	
White (other)	5 (4.76%)	3 (8.11%)	1 (3.57%)	-	1 (3.45%)	
Asian	4 (3.81%)	2 (5.40%)	1 (3.57%)	-	1 (3.45%)	
Black	1 (0.95%)	-	-	-	1 (3.45%)	
Mixed White/Asian	1 (0.95%)	-	-	1 (9.09%)	-	
Income (£)						p=.39*
<10,000	23 (21.90%)	8 (21.62%)	6 (21.43%)	4 (36.36%)	5 (17.24%)	
10,000-29,999	48 (45.71%)	20 (54.05%)	14 (50.00%)	4 (36.36%)	10 (34.48%)	
30,000-49,999	16 (15.24%)	5 (13.51%)	4 (14.29%)	1 (9.09%)	6 (20.69%)	
50,000-69,999	5 (4.76%)	1 (2.70%)	1 (3.57%)	2 (18.18%)	1 (3.45%)	
Preferred not to say	13 (12.38%)	3 (8.11%)	3 (10.71%)	-	7 (24.14%)	
Highest Education Level						p=.54*
GCSE	9 (8.57%)	5 (13.51%)	4 (14.29%)	-	-	
A-levels	15 (14.29%)	4 (10.81%)	3 (10.71%)	3 (27.27%)	5 (17.24%)	
HND/BTEC/NVQ levels	14 (13.33%)	5 (13.51%)	5 (17.86%)	2 (18.18%)	2 (6.90%)	
Bachelor's degree	38 (36.19%)	13 (35.14%)	8 (28.57%)	4 (36.36%)	13 (44.83%)	
Master's degree	21 (20.00%)	6 (16.22%)	5 (17.86%)	2 (18.18%)	8 (27.59%)	
Doctoral degree	8 (7.62%)	4 (10.81%)	3 (10.71%)	-	1 (3.45%)	

Table 3.1. Demographic sample characteristics for the diagnostic groups and healthy controls. *=Fisher's exact test was used with p-value noted.
Note. GCSE = General Certificate of Secondary Education; A-Level = Advanced level; HND = Higher National Diploma; BTEC = Business and Technology Education Council; NVQ = National Vocational Qualifications.

GIMME Outcomes

Confirmatory Analyses Examining a priori Diagnostic Sub-Groups.

As outlined in the Introduction, three levels of theoretically-based confirmatory subgroupings were modelled: (i) 2-subgroups with all clinical participants combined (n=76) compared to healthy controls (n=29), (ii) 3-subgroups with current/past major depression (n=65), bipolar disorder (n=11), and healthy controls (n=29), and (iii) 4-subgroups with currently depressed (n=37), remitted depressed (n=28), bipolar disorder (n=11), and healthy controls (n=29). All participant person-specific models loaded successfully, except for one participant whose individual solution estimation failed to converge with the subgroup solution.

For all three levels of confirmatory subgroupings based on diagnosis, the modularity of the subgroupings was negative (2-subgroups Q=–.0049; 3-subgroups Q=–.0042, 4-subgroups Q=–.0106). As noted, such negative modularity implies there are fewer edges between subgrouped participants than expected by chance (Hintze & Adami, 2010; Newman, 2006) indicating these subgroupings were not robust. There was therefore no support for any of the three levels of a priori diagnostic subgroupings in the data and neither further assessments of subgroup robustness, nor additional analyses characterizing the subgroups, were conducted.

Data-Driven Subgroups

Next, we proceeded with the data-driven approach of putatively clustering participants to subgroups based on dynamic emotion patterns rather than clinical diagnostic status. This uncovered two approximately equal-sized subgroups (Subgroup 1, n=53; Subgroup 2, n=51). In contrast to the confirmatory diagnostic subgroups, the modularity of this data-driven two subgroup solution was positive Q=.1008 and indicative of potentially robust community structure in the clustering solution. Further validity checks were therefore conducted.

The two data-driven subgroups were evaluated through comparisons between the solutions from the produced matrix against possible random solutions obtained by perturbing path weights incrementally (Gates et al., 2019). This involved three tests for solution robustness; evaluating whether the solution modularity (Q) was significantly higher than that of a null distribution (critical value for significance; Q_{95}=.0641), the variance of information (VI), and the Adjusted Rand Index (ARI), (see Appendix 3.8). All three tests indicated that the quality of the data-driven two-subgroup solution was significantly acceptable and robust (modularity: $Q_{solution}$=.1008>Q_{95}=.0641); VI=.433, α>.20; ARI=.627, α>.20).

The clustering of participants across these two subgroups is displayed in Figure 3.2a. Here, individuals (represented as nodes) with more similar person-specific dynamic emotion models are displayed closer together, based on their underlying similarity matrices[4]. These clusters were determined through random walks, based on the robust mathematical basis that random walks along a graph between nodes tend to stay within the same cluster (Harel & Koren, 2001). Paths between individual nodes were not interpreted. Figure 3.2b depicts group

[4] Similarity matrices consist of the counts of all significant possible and estimated paths shared and in the same direction for all pairwise individuals (Gates et al., 2017). A unique aspect of GIMME is that it does not force all participants into subgroups if the fit for a given participant is more heterogenous than uncovered subgroups. On this basis, one participant was not clustered to either subgroup, reflecting a relatively high degree of idiosyncrasy in his/her individual temporal model (see Figure 3.2a).

and subgroup pathways for the two subgroups. The overall group majority shared path (valid across both subgroups) isdisplayed in bolded black. This indicated that for more than 75% of the whole sample, experiencing the emotion 'Happy' influenced experiencing the emotion 'Enthusiastic' at the contemporaneous level. The Figure 3.2b plots also show bolded green subgroup-level paths shared by the majority (≥51%) of participants within a subgroup.

These subgroup-specific paths showed notable differences across the two subgroups. Within Subgroup 1, there was a robust contemporaneous pathway with feeling 'Angry' influencing the experience of 'Sad', but this was not a robust path in Subgroup 2. Other paths linked the same emotion pairs across the two subgroups, but indicated that the emotions influenced each other in opposing directions, as indicated by the directional arrowheads of pathways. For instance, in Subgroup 1, the experience of 'Stress' influences the experience of 'Angry', whereas the direction of influence is reversed for Subgroup 2. It is important to note that the subgroup paths plotted here are those that apply to the majority of participants within each subgroup. There will also be shared pathways across smaller proportions of individuals within each subgroup that are not plotted but that will contribute to the robustness of the overall two subgroup solution, given that the clustering solution draws upon all person-specific similarity matrices. The plots therefore also display individual-level paths in faded grey to illustrate the underlying heterogeneity among person-specific paths; the thicker grey lines indiciate greater numbers of individuals showing that within-person relationship (see Appendix 3.9 for a walk through of some sample person-specific paths to illustrate the richness of the data).

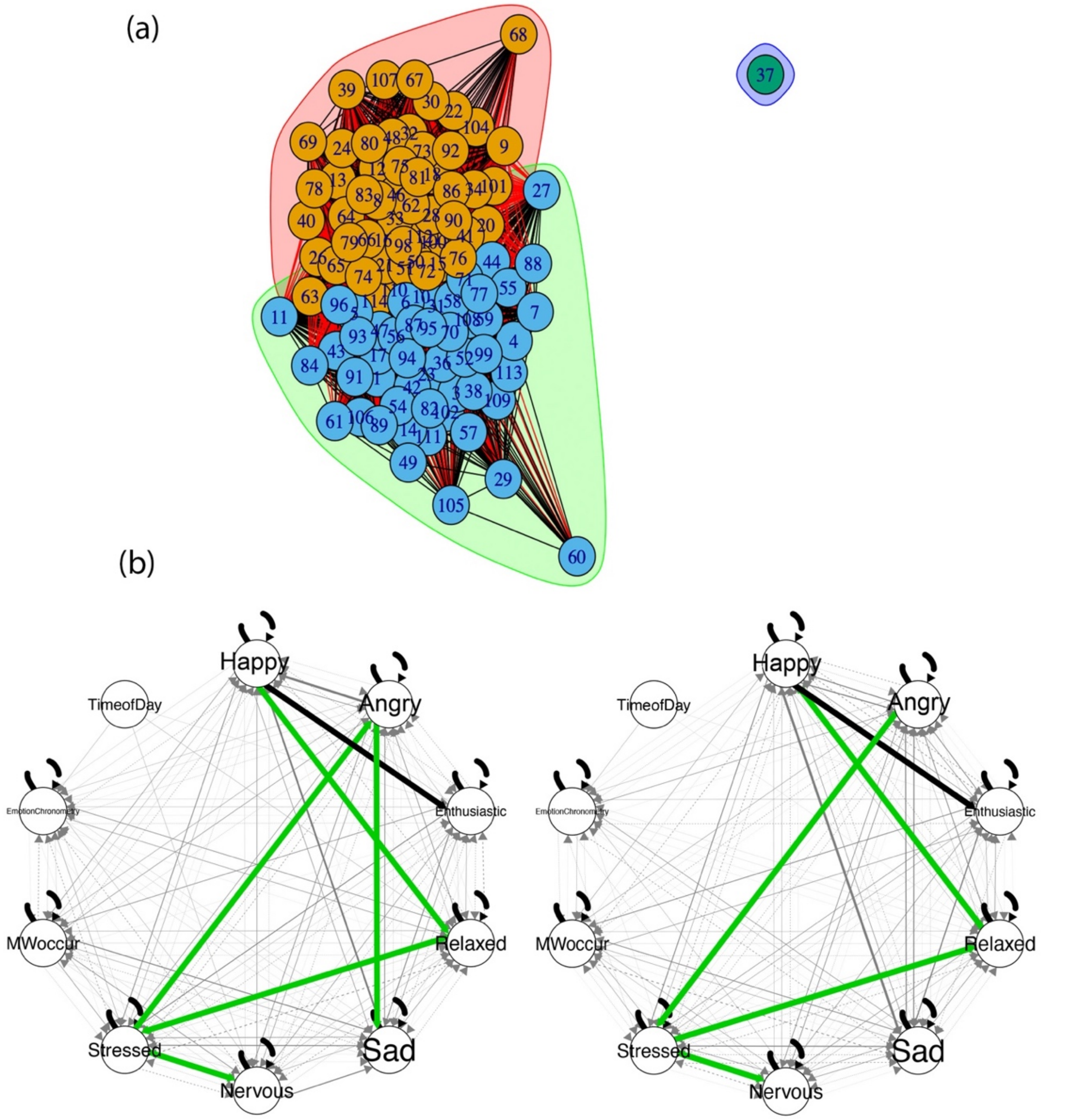

Figure 3.2. The (a) resulting two data-driven subgroups using group iterative multiple model estimation (GIMME); each node represents an individual, shaded by subgroup and provides the distribution of individual similarity matrices. More similar individuals are displayed closer together, paths and specific node distance were not manually interpreted. (b) the paths within the resulting subgroup emotion time-course changes; Subgroup 1 on the left and Subgroup 2 on the right. Each grey line represents a path present in an individual's data, thicker lines represent more total counts of individuals experiencing that path. Solid black lines indicate group-level paths, and green lines represent subgroup-level paths. Arrow directions indicate the direction of influence. Note. "MWoccur" = whether an individual was thinking about something other than their current setting, "EmotionChronometry" = reported duration of that emotion experience, "TimeofDay" = the exogenous variable of diurnal time.

Further characterising the two data-driven subgroups. Our next step was to test for any diagnostic, clinical, or emotion summary metric differences across these two data-driven subgroups.

We first examined whether the two subgroups differed in terms of demographic characteristics. There was no support for demographic differences on age ($F(1,102)=1.57$, $p=.21$), sex ($X^2=0.30$, df=1, $p=.59$), ethnicity ($p=.27$), income ($p=.99$), education level ($p=.91$) (see Appendix 3.10).

We next evaluated any differences on clinical metrics. Although, the a priori diagnostic groupings did not lead to robust subgroupings within GIMME, it remained possible or even likely that the subgroups differed on aspects of their clinical make up. However, the clinical diagnoses were distributed evenly across the two subgroups (Figure 3.3a) and the proportions of participants from each diagnostic category did not significantly differ from the overall sample proportions in either Subgroup 1 ($X^2=3.41$, df=3, $p=.33$) or Subgroup 2 ($X^2=3.54$, df=3, $p=.32$). Similar comparability across the subgroups was evident across our continuous symptom measures with no significant subgroup differences for depression and anxiety severity: IDAS–General Depression ($p=.71$); IDAS–Dysphoria ($p = .73$); PHQ-9 ($p=.84$); GAD-7 ($p=.59$) (Figure 3.3b), nor on any other IDAS subscales, (all *ps*>.05; see Appendix 3.7).

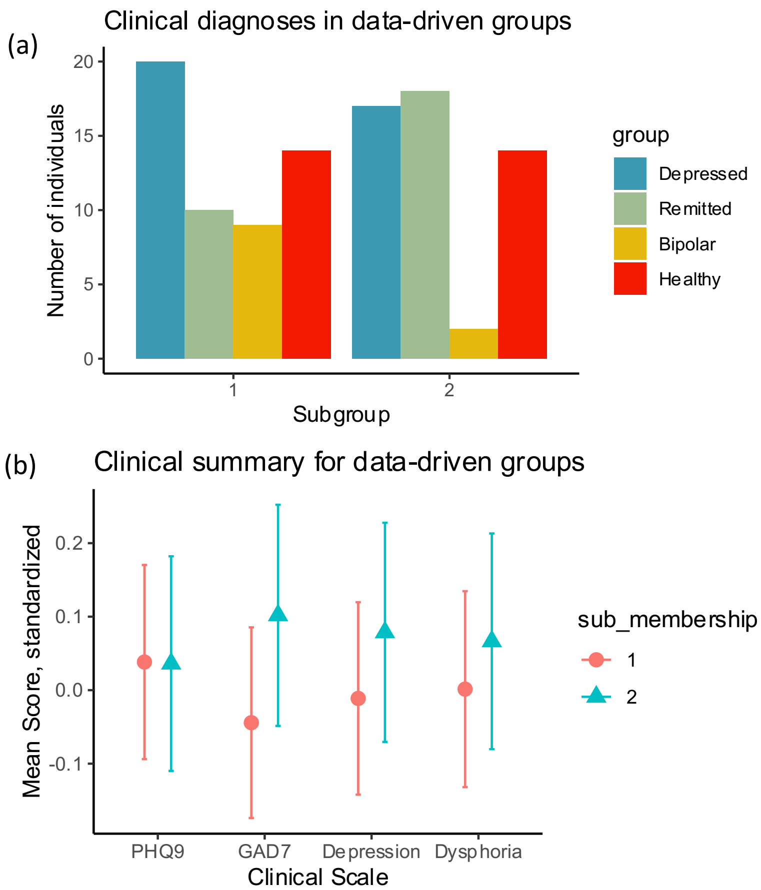

Figure 3.3. Clinical characteristics for the two data-driven subgroups. (a) The distribution of diagnoses of participants in each data-driven subgroup. (b) The group means and standard errors for the symptom measures for the data-driven subgroups. PHQ-9= Patient Health Questionnaire-9; GAD-7=General Anxiety Disorder-7; Depression=IDAS general depression subscale; Dysphoria=IDAS dysphoria subscale.

Affective dynamics. We next compared the two data-driven subgroups nomothetically on our pre-specified emotion indices: intensity, instability, granularity, and inertia, across aggregated sets of positive and negative emotions. For these analyses, positive (happy, enthusiastic, relaxed) and negative emotion ratings (angry, sad, nervous, stressed) were therefore averaged within-individuals. Cross-subgroup comparisons employed Wilcoxon tests due to non-parametric data distributions and a Bonferroni-corrected α to adjust for the six comparisons (critical p=.0083).

There were no significant group differences in overall intensity of positive (Z=2.02, p=.04) or negative emotion (Z=0.20, p=.85) (Figure 3.4b).

To measure emotion instability, we calculated the mean sum of squared differences (MSSD) between data timepoints (Houben et al., 2015). Subgroup 1 showed significantly higher positive (Z=3.72, p<.001) and negative emotion instability (Z=4.49, p<.001) than Subgroup 2 (Figure 3.4b), with moderate effect sizes (r=.37 95%CI[.19, .53], r=.44 95%CI[.27, .59], respectively).

Emotion granularity was measured by computing intraclass correlations (ICC). High ICC scores suggest that emotion terms of a similar valence were strongly correlated across time; coefficients were reverse coded to facilitate interpretation, such that higher scores represent greater granularity. Subgroup 2 showed significantly higher positive (Z=3.86, p<.001) and negative emotion granularity (Z=4.55, p<.001) than Subgroup 1 with moderate effect sizes (r=.38 95%CI[.2,.54], r=45 95%CI[.27,.61] respectively) (Figure 3.4b).

For emotion inertia, we used multilevel modeling due to the nested structure of the data in assessing how emotion at time t may be predicted from time t–1 for each individual and subgroup (Thompson et al., 2021). Predictor variables were person-mean centered at Level-1 (within-person emotion) with subgroup as a moderator at Level-2 (between-person subgroup assignment). Subgroup 2 significantly differed from Subgroup 1 on both positive (b=0.11, SE=0.03, t(104)=4.41, p<.001) and negative emotion inertia (b=0.19, SE=0.03, t(104)=.66, p<.001) (Figure 3.4b; see Appendix 3.11).

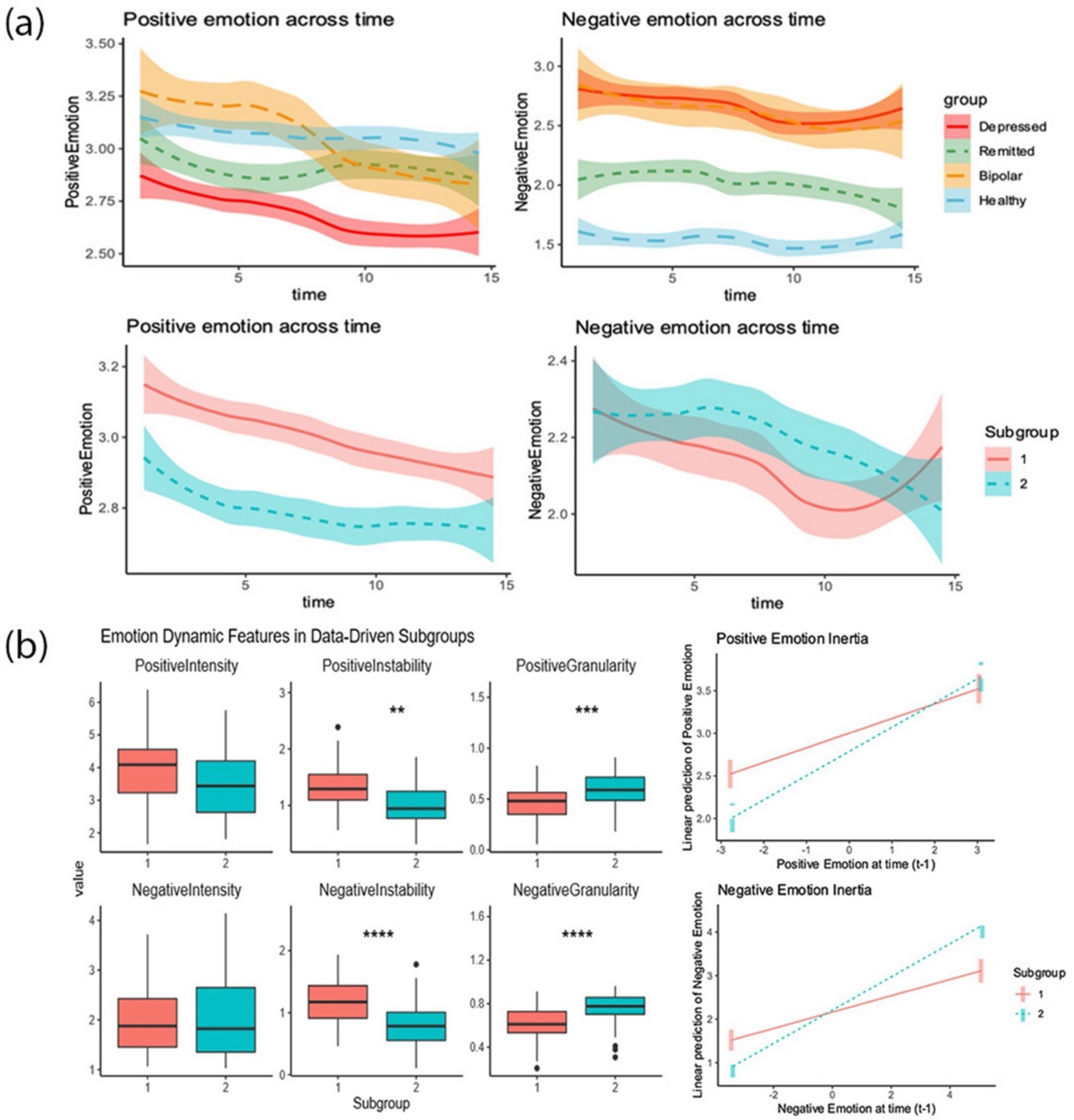

Figure 3.4. Data-driven subgroup differences on emotion metrics. (a) Aggregated positive and negative emotion intensity ratings across time in the diagnostic groups and the data-driven subgroups with mean and standard error smoothed curves plotted per group. (b) emotion metrics for the two data-driven subgroups in the form of boxplots for positive and negative emotion intensity, instability, and granularity (adjusted p-values as **: p < .01 ***: p < .001, ****: p < .0001, exact p values in text) and multilevel modeling of group interactions for positive and negative emotion inertia.

Overall, although showing no significant clinical or demographic differences, the two identified subgroups were delineated in terms of the summary emotion metrics of emotion instability, granularity, and inertia (Figure 3). This opposing interplay between instability and granularity in the two data-driven subgroups was further probed using Bonferroni-corrected (α=.025) correlations, which revealed an inverse relationship in these emotion metrics across the whole sample for both positive ($r=-0.56$, $p<.001$) and negative ($r=-0.54$, $p<.001$) emotions (see Figure 3.5).

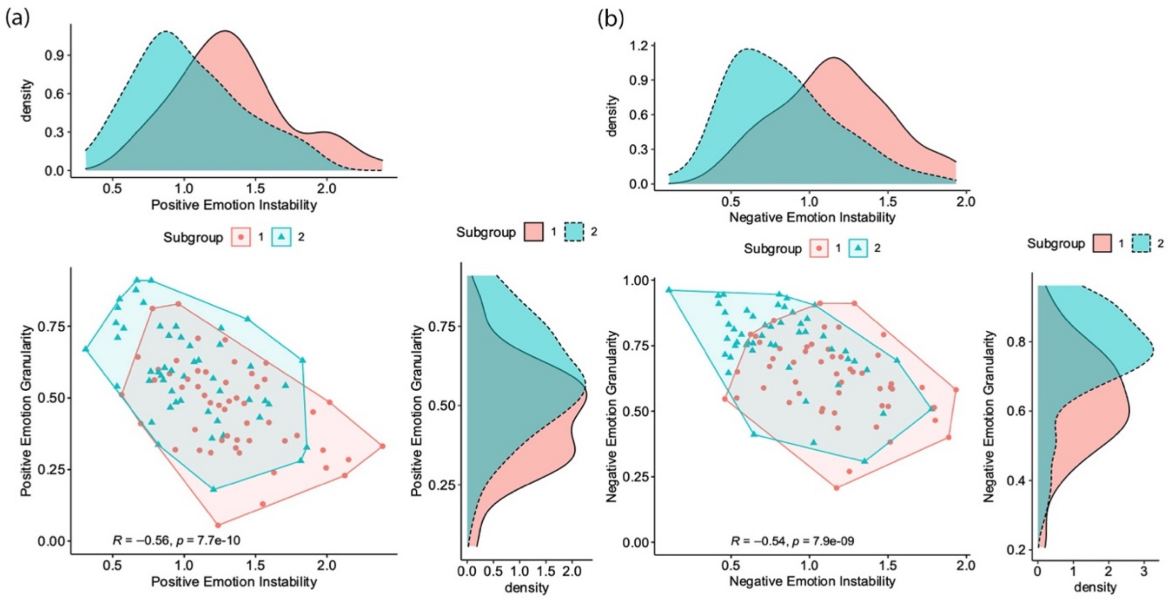

Figure 3.5. The inverse relationships between emotion instability and granularity across the two data-driven subgroups for both (a) positive and (b) negative emotions. On the scatter plots each individual score is plotted with granularity (y-axis) against instability (x-axis). Convex plots superimposed on the data scatter indicate the bounds of the data-driven partition for the two subgroups. Density plots of the subgroup scores are also shown above and to the right of the scatter plots, aligned with the axes, to illustrate group distributions for instability and granularity.

3.5 DISCUSSION

This study was the first on our ambulatory assessment dataset and used group iterative multiple model estimation (GIMME) to examine person-specific (idiographic) patterns of within-person daily emotion dynamics collected via experience sampling for a large group of participants with and without a history of mood disorders. Our research question probed whether putative subgroups of participants derived from this set of person-specific models in this important psychopathology processing domain would either align with traditional diagnostic groupings, evaluated using confirmatory GIMME, and/or whether data-driven GIMME would identify robust subgroups that potentially cut-across these a priori diagnostic boundaries.

For our three sets of a priori diagnostic groupings; 2-subgroup (all clinical versus healthy), 3-subgroup, (all with depression history, bipolar disorder history, and healthy), and 4-subgroup (currently depressed, remitted depressed, bipolar history, and healthy), GIMME yielded non-significant, non-robust model fits that represented a poorly differentiated forced partitioning of the dynamic emotion data. Contrary to our expectations, this indicates that any differences in the profiles of within-person emotion dynamics across time were not well captured by any arrangement of clinical diagnostic subgroups.

However, this did not mean that there were no robust subgroups within the data. Applying a data-driven approach identified a robust two-subgroup partition of the intraday emotion data patterns. These two comparably sized subgroups were characterised by pathways between different emotion pairs that were distinct from one another in both direction and composition. Interestingly, these data-driven subgroups did not appear to be delineated by differences in their clinical diagnostic composition, with proportions of diagnoses instead being distributed evenly across the two subgroups. There were also no significant differences between these subgroups on any symptom measures indicating that even sub-diagnostic clinical metrics were not definitive of subgroup status. Finally, demographics also did not delineate the two subgroups. This indicates that the within-person pattern of emotion dynamics that GIMME used to search for similarities across individuals provides information distinct from that provided by between-person clinical and demographic variables.

Importantly, despite their clinical and demographic similarity, the emotion data did reveal strong and clear subgroup differences on a pre-specified set of emotion metrics. Although there were no significant differences between the subgroups in mean levels of emotion intensity for either positive or negative emotions, the subgroups did differ in their emotion instability, granularity, and inertia. Instability for both positive and negative emotions was significantly higher in Subgroup 1, while granularity and inertia for both positive and negative emotions were significantly higher in Subgroup 2.

In sum, these findings indicate that individuals can be categorized into one of two distinct comparably sized subgroups in terms of their dynamic patterns of daily emotions. There is no support that these subgroups are characterised by differences in demographics, diagnostic status, clinical symptoms, or mean affective intensity. Instead, they can be summarised as (a) a subgroup relatively high in emotion instability, but low in granularity and inertia, alongside (b) a subgroup relatively high in emotion granularity and inertia, but low in instability.

These results suggest that assessments of real-time emotion dynamics hold valuable information about individual differences in the unfolding experience of emotion that cut across diagnostic boundaries and is thus adjunctive to traditional current diagnostic and symptom severity information (Wright & Zimmermann, 2019). Arguably, these data-driven insights emerge as a function of elucidating subgroups using the collective patterns of within-person pathways across our sample, in contrast to traditional nomothetic analytic approaches.

The absence of support for any robust subgroups within the sample that aligned to our a priori diagnostic groupings was counter to our expectations. As noted in the Introduction, clinical theory and data indicate that differential profiles of emotion experience over time are characteristic of the mood disorders; for example, emotion dysregulation, vicious cycles of negative emotions cascading over time, experiencing negative emotional reactions to positive affective experiences, and so on. Instead, our data seem to indicate distinct subgroups of individuals, with comparable compositions of individuals meeting diagnostic criteria, who not only evidence different idiographic patterns from one another, but also differ on the stability, granularity, and inertia of their emotion experience in aggregate analyses. The presence of data-driven subgroupings that cut across traditional diagnostic divisions in this manner is consistent with recent transdiagnostic approaches to understanding mental health and affect such as the Research Domain Criteria (Insel et al., 2010). It may of course be the case that other analyses would indicate the clinical relevance of these data-driven subgroupings in terms of vulnerability to later mental health problems or amenability to psychological interventions for those individuals who meet criteria for a diagnosis, and these questions remain for future research. For instance, we know that the metrics of greater instability and lower granularity characterizing Subgroup 1 are associated with poorer emotion regulation and this group therefore might plausibly be more vulnerable to stressors or to a poorer prognostic course with respect to downstream mental health difficulties (Kashdan et al., 2015; Tugade et al., 2004).

There are some potential limitations of the present study that merit discussion. The first is the 14-day sampling period. Future work could consider measuring longer timelines of emotion changes alongside longer-term prediction of changes in clinical or diagnostic status to examine whether these two data-driven profiles will show differential longitudinal predictive relationships with mental health indices over longer time periods. Given that emotions can fluctuate and shift at faster rates than the 2-hour gap between experience sampling probes, future work could also consider more frequent ratings of emotions to model their micro time-course.

It is also worth noting that although our assessments varied across time and, undoubtedly, situations, the models estimated here did not include potentially important intra- and inter-personal contextual factors, or life events that may also play a meaningful role in understanding the (dys)function of emotion dynamics. Emotions of course vary with context reflecting and facilitating interactions with our environment. Thus, by themselves emotion dynamics offer only part of the information relevant to their putative functions or dysfunctions (Wright & Hopwood, 2021). Future research could extend beyond the assessment of momentary emotion to include contextual features at the intra- (e.g., motivation, cognition) and inter-personal (e.g., interaction partner, social vs. non-social location) levels. Incorporating information that provides greater texture to the context of emotions would facilitate a move towards understanding individuals as complex dynamic systems, better approximating the full clinical picture with which practitioners are often presented. At the same time, due to issues of complexity and burden, acutely comprehensive assessments are unlikely to be viable, at least to the extent they rely on self-report (Wright & Woods, 2020; Wright & Zimmermann, 2019). An alternative is passive sensing of potentially relevant variables using Smartphone or wearable technology to allow automatic detection of some of these factors (e.g., whether a person is in a social environment, whether a person is indoors or outside) thus reducing reporting overheads, albeit at some cost in terms of privacy or anonymity (Doherty et al., 2014; Gruteser & Hoh, 2005).

In summary, the present ambulatory assessment study revealed that patterns of intra-individual emotion dynamics over a two-week period in participants with different diagnoses of mood disorders and healthy controls were best captured by two similarly-sized data-driven subgroups that were comparable in terms of their diagnostic, clinical and demographic status. This contrasted with unacceptable model fit for any divisions of the data based on psychiatric diagnoses. The data-driven subgroups reliably differed on key emotion metrics across both positive and negative emotions. These metrics indicated that individuals either belong to a subgroup with a relatively less stable and less granular emotion profile or to one with a relatively more stable, more granular profile, with higher inertia. The findings highlight the importance of both experience sampling and of data-driven approaches in understanding idiographic and nomothetic affective dynamics in daily life.

Further Consideration of Emotion and Mood

Given the findings of this study in emotion dynamics and rich temporal patterns across time, we next turned back to the question of differential features of emotion and mood. Provided mood unfolds on a hypothesised slower timeframe from ongoing momentum, mood was not sampled to the extent that emotion was and thus unable to be assessed with GIMME. Given mood has not yet been assessed alongside emotion before in a past study, we took a group-comparison approach and employed multilevel modeling to consider differential features of naturalistic emotion and mood across time, considering the role of both within- and between-person data, albeit not to the depth GIMME allowed with unique parameter weights and paths per person. However, multilevel modeling is still a strong method for assessing group differences and thus Chapter 4 approaches the question of how aspects of emotion and mood may differ clinically in the depressed, remitted depressed, and healthy participants from this same sample.

CHAPTER 4 – STUDY 3: RELATIONSHIPS BETWEEN EMOTION AND MOOD IN DEPRESSED, REMITTED, AND HEALTHY PERSONS: AN EXPERIENCE SAMPLING STUDY

4.1 OVERVIEW

The aim of Study 2 in Chapter 3 was to examine distinct profiles of emotion dynamics with the experience sampling data, and this next goal was to investigate the interrelationships of emotion and mood across time within the same sample. The study reported in this chapter combined experience sampling of emotion with daily diary assessment of mood to model these affective interrelationships. Due to theoretical understandings and hypotheses that mood shifts more slowly, in addition to minimising participant confusion over type of self-reported affect, mood was measured at a less frequent timescale and thus not assessed by the previous chapter's analytic methods that required a higher resolution timescale. Rather, multilevel modeling was used to estimate fluctuations in group trends as the first study-to-date on comparing mood and emotion over time, that we are aware of.

In this study, the same group of participants from Chapter 3 were used (except the bipolar participants for whom sample numbers were too low to assess through multilevel modeling) to compare diagnostic groups on emotion and mood summary metrics. To further consider a transdiagnostic approach as well, we also examined possible differences in mood summary metrics for the two transdiagnostic data-derived subgroups (this time including the bipolar individuals) shown to differ robustly on emotion dynamics in the results from Study 2 in Chapter 3. These transdiagnostic subgroups sharing emotion dynamic features may or may not differ on meaningful metrics for mood, and here we assess this possibility.

These results summarise an initial attempt to exploring emotion and mood over time through a clinical lens. This is the first study to-date, as far as we are aware, that has asked individuals to self-report both emotions and moods to differentially describe the relationship between these two affective states and how they may relate through repeated measures.

4.2 INTRODUCTION

As discussed in the Introduction, the literature on affect tends to discuss moods and emotions interchangeably. There is a meaningful difference in how people understand mood states compared to emotion states (Beedie et al., 2005), yet limited research has explored what these specific differences, or similarities, may be from a quantitative perspective. In many studies, distinctions between mood and emotion remains unclear when affective states are sampled (aan het Rot et al., 2012; Killingsworth & Gilbert, 2010; Ruby et al., 2013). While most literature converges in agreement that mood and emotion are distinct though related phenomena, no study to date, as far as we are aware, has made a thorough attempt to differentially quantify these affective types. Conclusions on affect tend to overlap across both states, despite a remaining meaningful difference between the phenomenology of an emotion versus a mood (Eldar et al., 2016; Russell, 2003; Thayer, 1989). Emotions tend to be experienced as short-lived reactions, or responses to brief environmental stimuli (Parkinson, 1996; Russell, 2003; Russell & Barrett, 1999), whereas moods exist within the background state of affect, is more diffuse, and pertains to broader contexts of self and world rather than specific intentional objects (Eldar et al., 2016; Keren et al., 2021; Russell, 2003; Thayer, 1989).

Mood disorders cause significant and debilitating consequences for individuals (Alonso et al., 2011; Friedrich, 2017) as they are often experienced as difficulties with negative affect during episodes of chronic, recurrent negative mood along with a multitude of other behavioural, somatic, and cognitive symptoms (Rottenberg, 2005; APA, 2013). When a depressed individual experiences remission, the various negative symptoms associated with an acute depressive episode dissipate, providing relief and a return to a more normal relationship with one's mood states and emotional experiences (First et al., 2015). Remission can be temporary or more enduring, and a major goal of clinical research, interventions, and treatments is to help depressed individuals reach and stay within remission (Ballenger, 1999; Keller, 2003; Paykel et al., 1995), especially given research suggests remission is an incredibly difficult state to maintain – a great majority of all remitted individuals relapse to experience depression again (Kessler et al., 2014; McIntyre & O'Donovan, 2004).

While there is a wealth of research on emotion states, their fluctuations, and regulation attempts (e.g., aan het Rot et al., 2012; Barrett et al., 2007; Russell & Barrett, 1999), we know far less about differentiated mood experiences and their relationship to emotion. There may be unique relationships in how positive versus negative emotion more strongly affect moods, especially in order to reduce current depression or prolong remission (Visted et al., 2018). Exploring how emotion and mood may relate, influence the other, and change across time may help provide evidence for what conclusions hold for their interrelatedness. Understanding the associations between emotion and mood and whether these relationships differ as a function of clinical status may help better clarify upon clinical experiences of affect.

When defining changes in affective states throughout the day, most studies conceptualise positive and negative affect by using specific lists of emotion terms (aan het Rot et al., 2012; Hill & Updegraff, 2012; Watson et al., 1988). As described and discussed in Chapter 2, by using a clear definitional distinction between mood and emotion when considering affect (Beedie et al., 2005; Parkinson, 1996; Russell, 2003), we may be able to better understand nuanced intra-day affective trends across clinical and healthy samples. To that end, we explored several aspects of emotion and mood complexity suggested to have clinical importance and that have been frequently used to summarise differences in affective functioning using repeated measures designs: average intensity levels, instability, granularity, and inertia, for both positive and negative affect.

In Chapter 3, these metrics were used in emotion to characterise within-person summary features on emotional dynamics across time and these definitional constructs are detailed thoroughly within that chapter introduction (see Chapter 3). In brief, average affect intensity is measured as average valenced affect levels, affect instability is the individual variability of affective fluctuations over time, affect granularity is the ability to differentiate between similarly valenced affect states, and finally, affective inertia is the extent to which a person's affect level may be predicted by their preceding affect state. These key features that have commonly been used to describe the complexity of emotion experiences, including as in Chapter 3, but such metrics have not been thoroughly explored with respect to mood states. In the present study, we further assess chronometry, or the duration of an affective state provided relationships to inertia and subjective reports of difficulties in long-lasting negative moods as in depression (e.g., Rottenberg, 2005, APA, 2013) for both emotion and mood durations.

Provided that the results of Chapter 3 suggested that robust subgroups sharing temporal emotion qualities were not delineated by clinical diagnosis, summary metrics of emotion were not further computed there by clinical diagnostic group status. However, provided it is still of importance to consider how clinical status may be associated with key differences in emotional and mood processing providing the debilitating experience of this disorder (Alonso et al., 2011; Greenberg et al., 2015, 2021), we still aimed to study how differences or similarities may emerge between these groups here. These data-driven subgroups that had cut across clinical boundaries (see Chapter 3) may indeed also further differ on mood functioning as well, and this is additionally probed in the present study.

Determining how emotion and mood differ or are similar across these features is of importance in better understanding affective states through a differentiated lens. Clinical utility for possible differences across these features is of importance, with work finding aspects like granularity and instability may together associate with treatment responses and reductions in symptoms (Lazarus & Fisher, 2021). The clinical relevance for an individual's mood instability, for example, could help add information on how mood states may change in and out of depression, and adds further context above and beyond emotion instability (Keren et al., 2021). In addition to exploring features of both emotion and mood, we explored associations between how emotion and mood change across time and may predict one another.

We hypothesised that depressed individuals will report lower positive moods and higher negative moods in line with work on general affective functioning in depression (aan het Rot et al., 2012; Rottenberg, 2005) and higher negative mood instability as in line with emotion instability literature (aan het Rot et al., 2012; Houben et al., 2015; Thompson et al., 2012). Based on past work suggesting lower differentiation of mood states, we hypothesized that depressed individuals may display lower levels of negative mood granularity, as well as higher negative mood inertia given the findings on emotion inertia (Kuppens et al., 2012; van de Leemput et al., 2014).

As a novel study feature of chronometry, we hypothesised that depressed individuals may display higher levels of negative mood chronometry and lower levels of positive mood chronometry given the central feature of depression is chronic, long-lasting moods (e.g., Rottenberg, 2005; APA, 2013). In assessing relationships between concurrent emotion and mood over time, we hypothesised that depressed individuals may show less of an impact of positive emotions on negative mood functioning, and greater impact of negative emotion on general mood functioning. Finally, although we assess averaged positive and negative mood levels for these research questions, we also further assessed specific clinical mood states of 'depressed' and 'anxious' mood provided how central these clinically relevant moods are to debilitating experiences of poor mental health (e.g., Beck, 1979; Feldman, 1995; Rottenberg, 2005; aan het Rot et al., 2012; APA, 2013).

With respect to transdiagnostic aims, we hypothesised that, as seen in the findings of Study 2 in Chapter 3, there may be significant group differences for mood instability, granularity, and inertia of the data-driven subgroups. Key delineating features of these subgroups were differences in these emotion features (see Chapter 3), it may be that moods are experienced in the same light transdiagnostically, with one subgroup showing higher rates of frequent mood changes and lower ability to differentiate between experienced moods, while another subgroup shows more stable mood experience and greater ability to differentiate between similarly valenced mood states, and we test this hypothesis here.

To date, and to the best of our knowledge, no studies have incorporated a naturalistic investigation of how individuals may experience emotion and mood separately, and their associations to clinical mental health or transdiagnostic shared features. By using ecologically valid sampling methods, we can probe realistic occurring experiences of both emotion and mood in a clinical sample of currently depressed, remitted, and healthy controls. In all, this study aims to add information on how individuals experience emotions and moods differentially, what clinical or transdiagnostic differences may exist between the emotion and mood differentially, and how these affect states may relate to one another across time.

4.3 METHODS

Participants

The participants for this study comprised the same depressed, remitted, and healthy participants from Chapter 3, based on the same inclusion and exclusion criteria (see Chapter 3). The bipolar disorder diagnostic group was set aside due to the small sample size in this group with respect to the needs of multi-level modelling. The final sample for statistical analysis in this study of clinical diagnostic group differences therefore comprised 96 individuals with current depression, remitted depression, and healthy controls.

For the transdiagnostic aim, data-driven subgroups compared alongside emotion chronometry and mood summary measures still retain the bipolar individuals belonging to each subgroup (and the demographics and clinical characteristics of Chapter 3 apply).

Measures

Clinical Information

The same clinical measures were used for this study as in Chapters 3, please see the previous chapter for further information regarding the SCID, PHQ-9, and GAD-7. Internal consistency was still high in this sample of the PHQ-9 ($\alpha = .91$) and GAD-7 ($\alpha = .92$).

Affect Terms

The same emotion ratings as those presented in Chapter 3 were used for the current study and followed the same previously described selection methods. To capture a diverse set of granular mood terms, prior validated and established mood scales were compiled and selected to cover a matching range of arousal and valence as emotion term selections, including the Brunel Mood Scale (Terry & Lane, 2003), the Profile of Mood States Scale (McNair et al., 1971), the UWIST Mood Adjective Checklist (Matthews et al., 1990), and the Brief Mood Introspection Scale (Mayer & Gaschke, 1988)(see Appendix 4.1 for mood term list and reliability measures for these constructs as well).

Mood terms present in at least two mood scales were selected, and specifically removed if more closely related to an object-directed emotions to ensure the selection of object-free mood terms in line with theoretical bases (i.e., whether the affective state was a response to a singular event such as how one feels 'anger' in emotional response to a negative event, rather than as a prolonged mood state such as 'irritable'). Other terms were further removed if they described physiological states without concrete associated valence (e.g., tired), terms uncommon to British English (e.g., peppy), and terms that reflected confusion (e.g., confused), or terms with high degree of similarity to one another to capture greater granularity of mood terms. This resulted in nine final mood terms (happy; lively; content; satisfied; depressed; bored; anxious; irritable; tense) rated on the same scale as emotion. All participants also rated how much time in the day they felt in each mood on a Likert scale from 1 (very little) to 7 (most of the day).

Experience Sampling

Experience sampling methods for emotions are the same for this study as detailed in Chapter 3 (for full list, see Appendix 3.6).

Emotion. Enthusiastic, happy, pleased, and relaxed were averaged to create a composite score of 'positive emotion' and nervous, sad, angry, irritated, and stressed were averaged within-individual to create a composite score of 'negative emotion' for statistical analyses.

Daily Diary

To collect naturalistic mood ratings, the same novel web-based platform used for experience sampling also collected daily diary data, following the same methods outlines in Chapter 3 (see Figure 4.1). Participants were prompted for 14 days total with 1 daily signal at 8:00pm (with a jittered delivery time within +/–15 minutes to lower expectancy) for mood self-report across the day (see Appendix 4.1 for mood term selection methods and a list of all daily diary items).

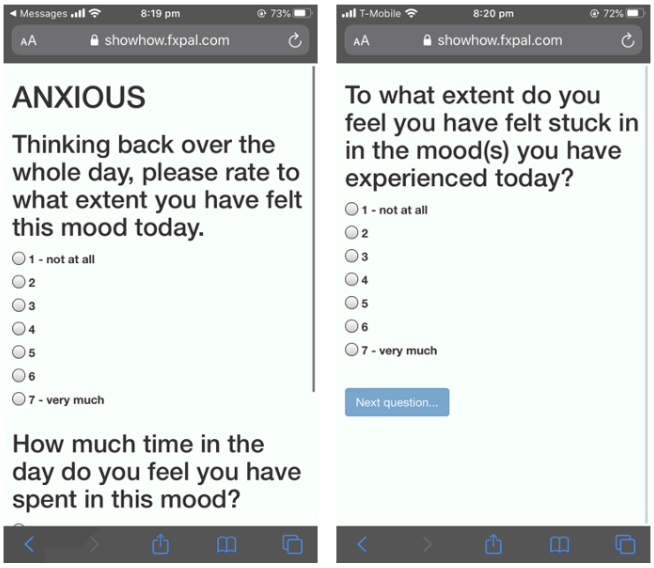

Figure 4.1. The same experience sampling platform as in Study 2 in Chapter 3 (see Figure 3.1) was used to collect daily diary information as well. The first image shows how a participant could make a rating for ‘anxious’ mood, scrolling further down to report on time spent in that mood on the same page (chronometry). The second image shows an example rating page for self-report of ‘mood stuckness’.

Mood. At the end of each day, participants rated which mood states they felt that day from 1 (not at all) to 7 (very much) and the extent to which they experienced each mood across the day for a measure of mood chronometry from 1 (very little) to 7 (most of the day). Happy, lively, content, and satisfied were averaged to create a composite score of ‘positive mood’ while depressed, bored, anxious, irritable, and tense were averaged for a composite score of ‘negative mood’. In addition to these average mood scores, the individual mood ratings for ‘depressed’ and ‘anxious’ were also used as outcome mood variables given the great clinical importance of those specific mood states in this population.

As noted in the above, mood states were only assessed once each day at the end of the day for theoretical considerations regarding the study design. Separating sampling times for emotion versus mood was conducted to (i) avoid possible participant confusion if self-reporting on both affect states simultaneously and (ii) acknowledge the theoretical basis for mood to shift slower alongside updating expectations (e.g., Eldar et al., 2016) than fleeting emotions.

Procedures

The overarching procedure was the same as for Study 2 (see Chapter 3).

Analytic Plan

Mixed effects multilevel models. By using multilevel modeling, we can account for both within-person variance at the first level of the model and between-person variance at the second level of the model, both of which are important when considering the hierarchical structure of repeated measurements nested within persons nested within clinical groups (e.g., Raudenbush & Bryk, 2002). Furthermore, mixed models allow us to account for missingness in the data, unequal observation counts per participants, modeling and estimating the random components, and nonindependence of the data (Raudenbush & Bryk, 2002).

To determine how positive and negative mood may have been associated with concurrent daily emotion levels and possibly differing by clinical group status, each mood state was predicted by two separate multilevel models. One model used a predictor variable of positive emotion, while the second used negative emotion as the predictor variable. To test how clinical group status moderates the relationship between emotion and mood, diagnostic group status was entered as a categorical moderator in each model such that the remitted and healthy groups were compared to the depressed group at the base level through *R* statistical programming and packages *lme4* and *lmerTest*. To also additionally directly compare remitted and healthy groups, pairwise assessment was calculated through estimated marginal means using *R* package *emmeans*. For transdiagnostic cases, subgroup membership was entered as the Level-2 categorical moderator when assessing affective chronometry.
All predictor variables were person-mean centered at Level-1 (within-person) and subgroup as the moderator was at Level-2 (between-person group assignment).

4.4 RESULTS

Demographics and Clinical Characteristics

The analysis sample for the present study was different to the final analysis sample in Study 2 (Chapter 3). Here, we did not exclude participants that had reported a stationary response to the single emotion items of ‘angry’ or ‘nervous’, as the analytic assumptions for group iterative multiple model estimation differ for this present study assessing aggregate ‘positive emotion’ and ‘negative emotion’ (as opposed to individual emotion responses across time as in Chapter 3). However, we did exclude bipolar participants due to their small sample size not powered for multilevel modeling. The depressed, remitted, and healthy participant groups were not significantly different with respect to age, gender, race, income, and education (see Table 4.1).

	Whole Sample	Depressed	Remitted	Healthy	Statistic
N	96	37	28	31	
Demographics					
Age (*M, SD*)	40.32 (13.56)	40.41 (12.59)	43.36 (13.29)	40.1 (15.26)	*F*=0.50, *p*=.61
Female	78 (71.56%)	27 (72.97%)	24 (85.71%)	18 (58.06%)	*p*=.39*
Male	31 (28.44%)	10 (27.03%)	4 (14.29%)	13 (41.94%)	
Ethnicity					*p*=.90*
White (British)	98 (89.91%)	32 (86.49%)	26 (92.86%)	28 (90.32%)	
White (other)	5 (4.59%)	3 (8.11%)	1 (3.57%)	1 (3.23%)	
Asian	4 (3.66%)	2 (5.40%)	1 (3.57%)	1 (3.23%)	
Black	1 (0.92%)	-	-	1 (3.23%)	
Mixed White/Asian	1 (0.92%)	-	-	-	
Income (GBP)					*p*=.71*
<10,000	25 (22.94%)	8 (21.62%)	6 (21.43%)	7 (22.58%)	
10,000-29,999	48 (44.04%)	20 (54.05%)	14 (50.00%)	10 (32.26%)	
30,000-49,999	17 (15.60%)	5 (13.51%)	4 (14.29%)	6 (19.35%)	
50,000-69,999	6 (5.50%)	1 (2.70%)	1 (3.57%)	1 (3.23%)	
70,000+	-	-	-	-	
Preferred not to say	13 (11.92%)	3 (8.11%)	3 (10.71%)	7 (22.58%)	
Highest Education Level					*p*=.21*
GCSE	10 (9.1	5 (13.51%)	5 (17.86%)	-	
A-levels	18 (16.51%)	4 (10.81%)	3 (10.71%)	7 (22.58%)	
HND/BTEC/NVA levels	10 (9.17%)	4 (10.81%)	3 (10.71%)	1 (3.23%)	
Bachelors	43 (39.45%)	14 (37.84%)	10 (35.71%)	15 (48.39%)	
Masters	20 (18.35%)	6 (16.22%)	4 (14.29%)	7 (22.58%)	
Doctorate	8 (7.34%)	4 (10.81%)	3 (10.71%)	1 (3.23%)	

Table 4.1. Demographic sample characteristics for the depressed, remitted, and healthy controls. *=Fisher's exact test was used with p-value noted.
Note. GCSE = General Certificate of Secondary Education; A-Level = Advanced level; HND = Higher National Diploma; BTEC = Business and Technology Education Council; NVQ = National Vocational Qualifications.

All 37 depressed participants were diagnosed with chronic (n=5, 13.51%) or recurrent depression (n=32, 86.49%). All 28 remitted participants were diagnosed with past recurrent depression, and all 31 healthy participants did not meet criteria for any disorders.
Clinical data for the PHQ-9 and GAD-7 scores were fully complete with no missingness. Group differences were assessed using Kruskal-Wallis tests (with Bonferroni corrected adjusted p-values) between the diagnostic groups. There were significant differences present for self-reported depression levels via the total PHQ-9 (p<.001, η_p^2=.56 95%CI[.43,.68]) and

self-reported anxiety levels via the GAD-7 (χ^2=43.75, p<.001, $\eta_p{}^2$=.45 95%CI[.29,.61]). As expected, depressed participants had the highest ratings of depression and anxiety scores, followed by relatively lower levels in the remitted participants, and very low levels in the healthy group (see Figure 4.2a).

For demographics and clinical characteristics of the transdiagnostic data-driven subgroups, see Chapter 3.

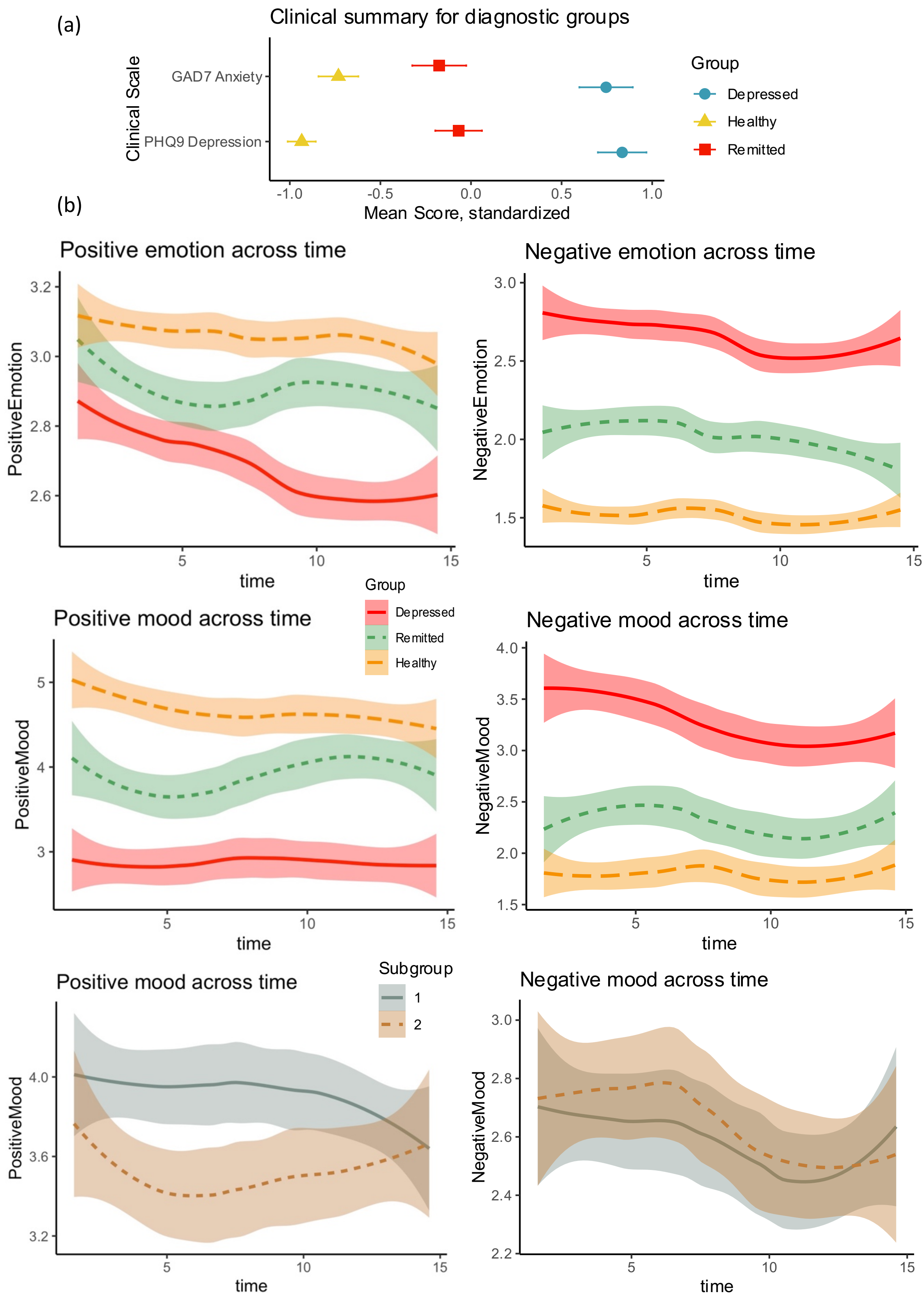

Figure 4.2. (a) Self-reported depression and anxiety levels of depressed, remitted, and healthy controls depicted by point (*M*) and line (*SE*) of the PHQ-9 and GAD-7 scales; all groups significantly differed from one another. (b) Diagnostic groups positive and negative emotion (upper row) and mood (middle row), and data-driven groups derived from Chapter 3 positive and negative mood (bottom row) are displayed over the two-week sampling period.

Comparing Qualities of Emotion and Mood

Affect Summary Features

We began by comparing the three diagnostic groups on features of intensity, instability, and granularity for both positive and negative emotion (see Figure 4.3) and mood (see Figure 4.4a). For transdiagnostic subgroups, these features were probed in mood (see Figure 4.4b; for emotion features, see Chapter 3). Comparisons used Kruskal-Wallis tests with a Bonferroni correction for the multiple comparisons of six tests per affective construct generating a critical value of alpha of .0083, followed by Bonferroni adjusted p-values to indicate pairwise Wilcoxon comparisons of specific diagnostic groups.

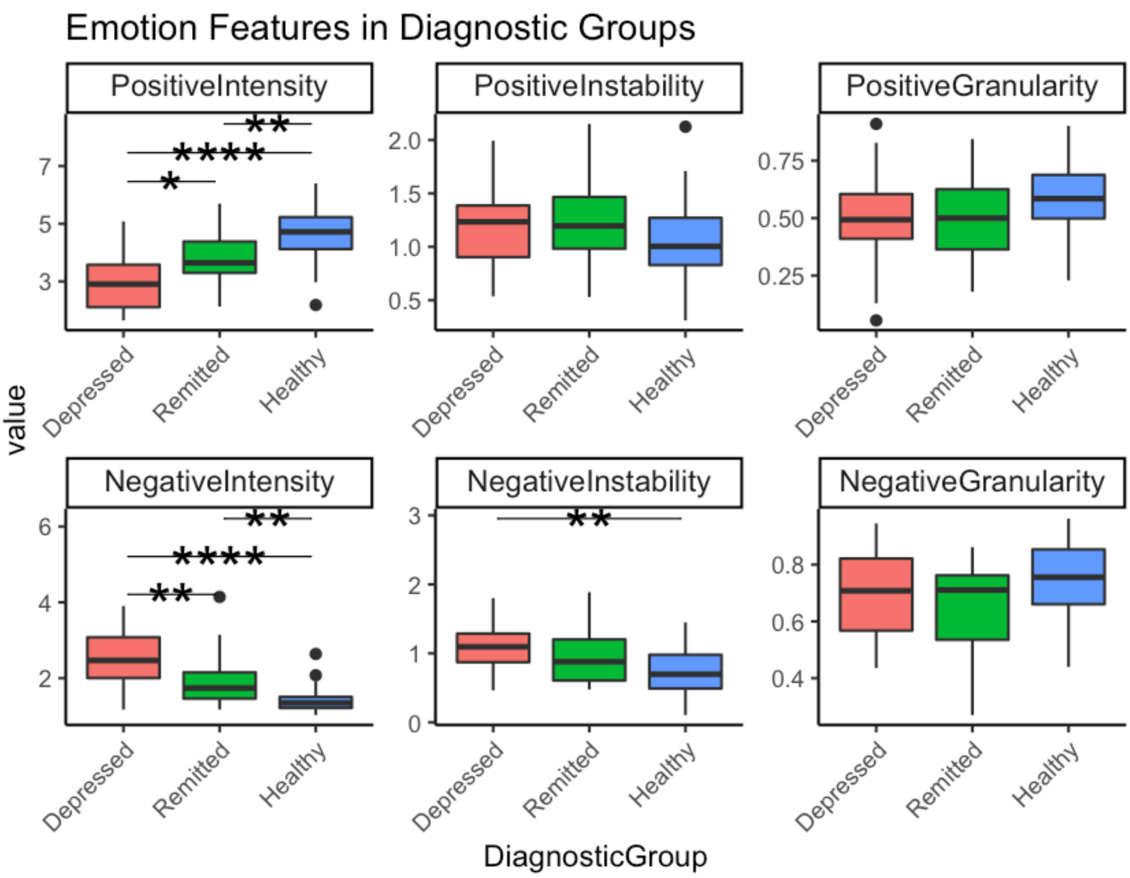

Figure 4.3. Emotion intensity (average levels), instability (mean sum of squared differences), and granularity (reverse intraclass correlation) for positive (row 1) and negative emotion (row 2). Reported *p*-values are Bonferroni adjusted, **p*<.05, ***p*<.01, *****p*<.001.

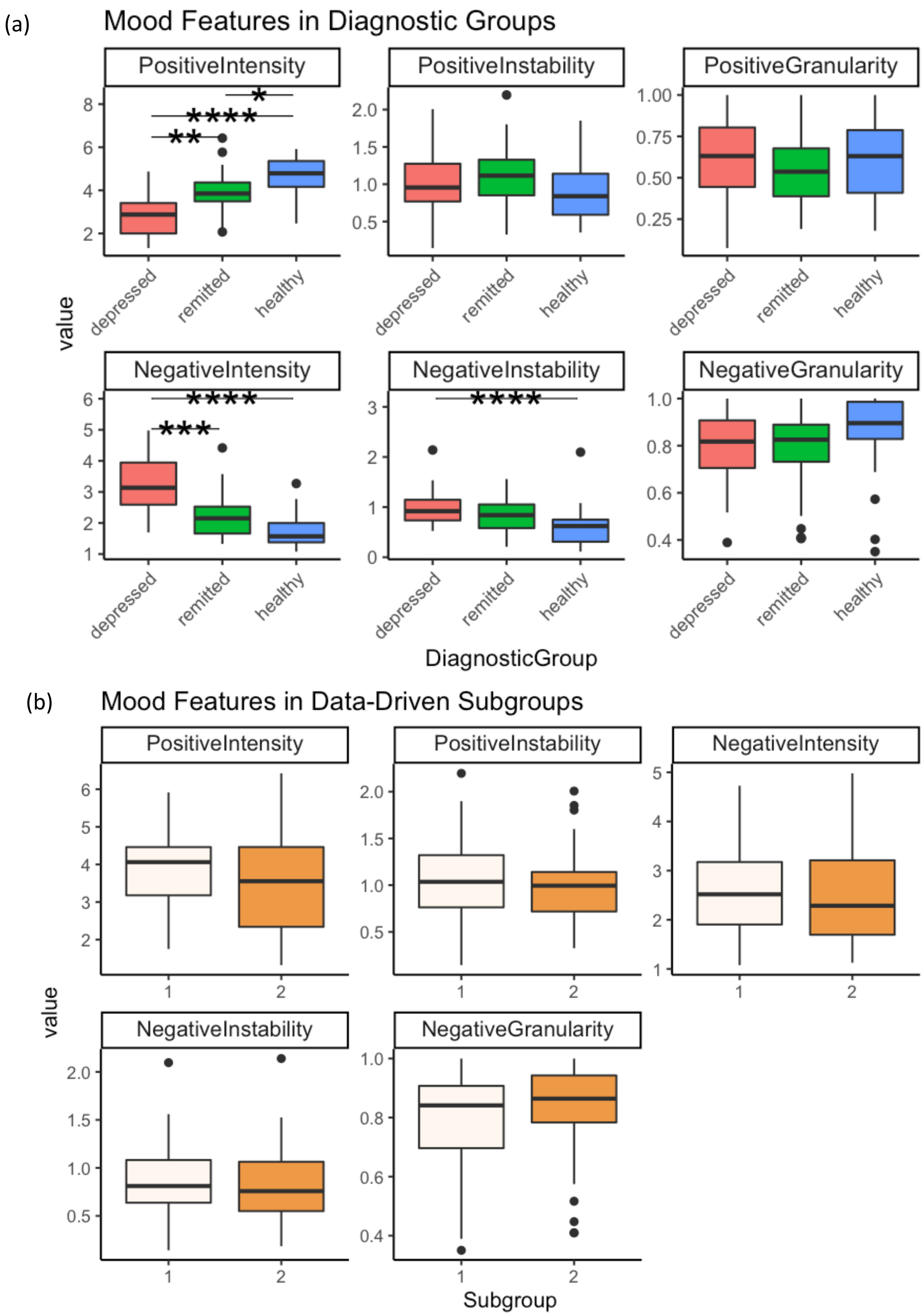

Figure 4.4. (a) Mood intensity (average levels), instability (mean sum of squared differences), and granularity (reverse intraclass correlation) for positive (row 1) and negative mood (row 2). (b) These same mood metrics for transdiagnostic data-driven subgroups that were previously identified (see Chapter 3). Reported *p*-values are Bonferroni adjusted, **p*<.05, ***p*<.01, *****p*<.001.

We then assessed clinical differences of intensity, instability, and granularity for our two specific mood states of greatest clinical relevance; ‘depressed’ and ‘anxious’ mood (see Figure 4.5). Tests involving these two specific clinical mood states results were also Bonferroni adjusted in reports below.

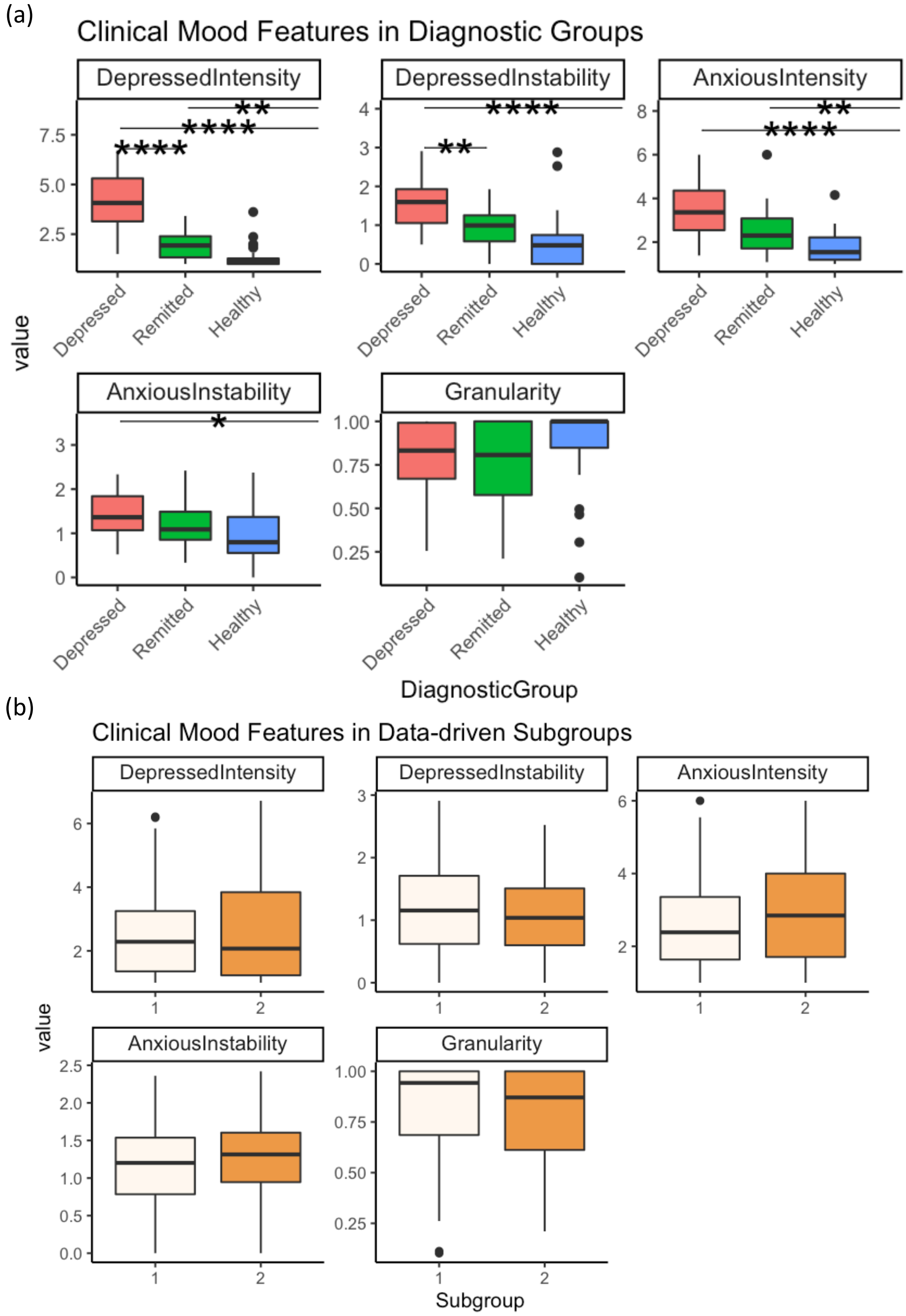

Figure 4.5. (a) Mood intensity (average levels), instability (mean sum of squared differences), and granularity (reverse intraclass correlation) for ‘depressed’ and ‘anxious’ mood. (b) These same mood metrics for transdiagnostic data-driven subgroups that were previously identified (see Chapter 3), no significant differences. Reported *p*-values are Bonferroni adjusted, *p<.05, **p<.01, ****p<.001.

Intensity. There were significant group differences in overall intensity of positive emotion (p<.001, η_p^2=.36 95%CI[.22,.54]). This was present in all three pairwise comparisons between groups; between depressed and healthy (p<.001, r=.67 95%CI[.52,.78]) and remitted groups (p=.02, r=.41 95%CI[.18, .60]), and remitted and healthy groups (p=.008, r=.45 95%CI[.22,.65]). Similarly, these differences were also present between all for positive mood intensity (p<.001, η_p^2=.41 95%CI[.25,.58]); with pairwise differences between depressed and healthy (p<.001, r=.71 95%CI[.59,.81]) and remitted groups (p=.002, r=.49 95%CI[.28,.66]), and remitted and healthy groups (p=.04, r=.41 95%CI[.17, .62]).

There were also significant group differences between all three groups in negative emotion intensity levels (p<.001, η_p^2=.43 95%CI[.27,.59]); with pairwise differences significant between depressed and healthy (p<.001, r=.72 95%CI[.58,.82]) and remitted groups (p=.006, r=.43 95%CI[.23,.62]), and remitted and healthy groups (p=.002, r=.49 95%CI[.26,.68]). There were also significant group differences in negative mood intensity levels (p<.001, η2=.47 95%CI[.32,.61]), with the depressed group significantly differing from the healthy (p<.001, r=.75 95%CI[.64,.82]) and remitted groups (p<.001, r=.55 95%CI[.36,.71]), though no significant differences between the remitted and healthy groups (p=.05, r=.39).

We next investigated the individual mood states of ‘depressed’ and ‘anxious’. All groups exhibited significant differences on intensity levels for depressed mood (p<.001, η_p^2=.60 95%CI[.46,.71]); with pairwise differences between all groups; depressed and healthy (p<.001, r=80 95%CI[.71,.85]) and remitted groups (p<.001, r=.66 95%CI[.49,.77]), and remitted and healthy (p<.001, r=.52 95%CI[.31,.70]). Significant group differences were present in anxious mood (p<.001, η_p^2=.35 95%CI[.19,.53]); with pairwise differences between depressed and healthy (p<.001, r=.66 95%CI[.51,.78]) and remitted groups (p=.04, r=.36 95%CI[.15,.56]), and remitted and healthy groups (p=.006, r=.46 95%CI[.23,.65]).

Instability. Instability of positive and negative affect was calculated as the mean sum of squared differences (MSSD) separately for positive emotion, negative emotion, positive mood, and negative mood (see Chapter 3; Houben et al., 2015). This method was also used to assess instability of the clinical moods of ‘depressed’ and ‘anxious’.

There were no significant differences between any groups for instability of positive emotion (p=.27, η_p^2=.007) nor positive mood (p=.09, η_p^2=.03), thus possible pairwise differences did not need to be further assessed.

There was a significant difference between groups on negative emotion instability (p<.001, $\eta_p{}^2$=.15 95%CI[.04,.31]). The depressed and healthy group differed in negative emotion instability (p=.001, r=.47 95%CI[.25,.65]), however there were no significant differences between the remitted and depressed group (p=.52, r=.27) or healthy group (p=.99, r=.22).

There were significant group differences in negative mood instability (p<.001, $\eta_p{}^2$=.20 95%CI[.08,.38]), with pairwise differences between the depressed and healthy group (p<.001, $\eta_p{}^2$=.54 95%CI[.37,.71]) only. There was no significant difference in negative mood instability between the remitted group and depressed group (p=.99, r=.18) or healthy group (p=.09, r=.37).

There were significant differences in groups for depressed mood instability (p<.001, $\eta_p{}^2$=.35 95%CI[.46,.71]); with significant pairwise comparisons between the depressed and healthy (p<.001, r=.64 95%CI[.44,.78]) and remitted group (p=.002, r=.47 95%CI[.26,.63]), There was no significant pairwise difference between the remitted and healthy group (p=.06). Groups showed significant differences in anxious mood instability (p=.002, $\eta_p{}^2$=.11 95%CI[.01,.28]) but in assessing pairwise differences, only the depressed group significantly differed from the healthy group (p=.01, r=.41 95%CI[.18,.61]). The remitted group did not significantly differ from either the depressed participants (p=.64, r=.02) or the healthy participants in anxious instability (p=.77, r=.24).

Granularity. Granularity was measured by computing average intraclass correlations (ICC) separately for positive and negative emotions, and positive and negative moods (Pond Jr et al., 2012). High ICC scores for within-individual ratings suggest that emotion terms of a similar valence were strongly correlated across time. ICC coefficients were reverse coded to allow more intuitive interpretations as indices of granularity, such that a higher score represents a greater degree of granularity.

There were no significant group differences in granularity of positive emotion (p=.16, $\eta_p{}^2$=.02), positive mood (p=.15, $\eta_p{}^2$=.02), negative emotion (p=.09, $\eta_p{}^2$=.03), or negative mood (p=.03, $\eta_p{}^2$=.05) between any clinical groups at our corrected significance levels, thus further pairwise differences were not further assessed.

For granularity between the specific mood states of ‘depressed’ and ‘anxious’, there were no significant differences between groups (p=.09, $\eta_p{}^2$=.03) with further pairwise differences thus not assessed.

Transdiagnostic Data-Driven Subgroups. Across all mood summary metrics, there were no significant differences between data-driven subgroups for positive and negative intensity (p=.66; p=.99), positive and negative instability (p=.99; p=.99), or positive and negative granularity (p=.99; p=.99). There were also no significant differences on 'depressed' or 'anxious' mood for intensity (p=.95; p=.25), instability (p=.43; p=.26), or granularity (p=.33).

Affect Time-varying Summary Features

We next assessed emotion and mood chronometry and inertia using multilevel models for the repeated measures. Given the four tests conducted per construct, we applied a Bonferroni corrected alpha of .0125 to correct for multiple comparisons. For exploring possible associations in clinically relevant mood states of depressed and anxious mood, we similarly applied a Bonferroni corrected alpha of .0125.

Inertia. To measure inertia, we used multilevel modeling to account for the nested structure of the data in assessing how affect at time t may be predicted at time t–1 for each individual and group (Thompson et al., 2021). Each valenced emotion and mood was assessed in a separate model to differentiate valenced inertia with predictor variables person-mean centered at Level-1 (within-person affective changes) and group status as a moderator at Level-2 (between-person group) across all models (see Appendix 4.2 for all model estimates).

The healthy group did not significantly differ from the depressed group on positive emotion inertia (b=0.07, SE=.03, t(95)=–2.23, p=.03), but did show significantly lower negative emotion inertia (b=–0.14, SE=.03, t(95)=–4.33, p<.001)(see Figure 4.6). There were no other significant group differences in emotion inertia (see Appendix 4.2 for model estimates). Across positive, negative, 'depressed', and 'anxious' mood, there were no significant differences between clinical groups and inertia (see Figure 4.6 for mood inertia interactions, see Appendix 4.2 for model estimates). A longer time lag of t–3 was applied to test if inertia in mood states may occur at longer timeframes, given past findings on lagged effects of mood peaking at intervals longer than lag-1 (Starr & Davila, 2012), but this also did not yield any significant group differences on mood inertia (see Appendix 4.2).

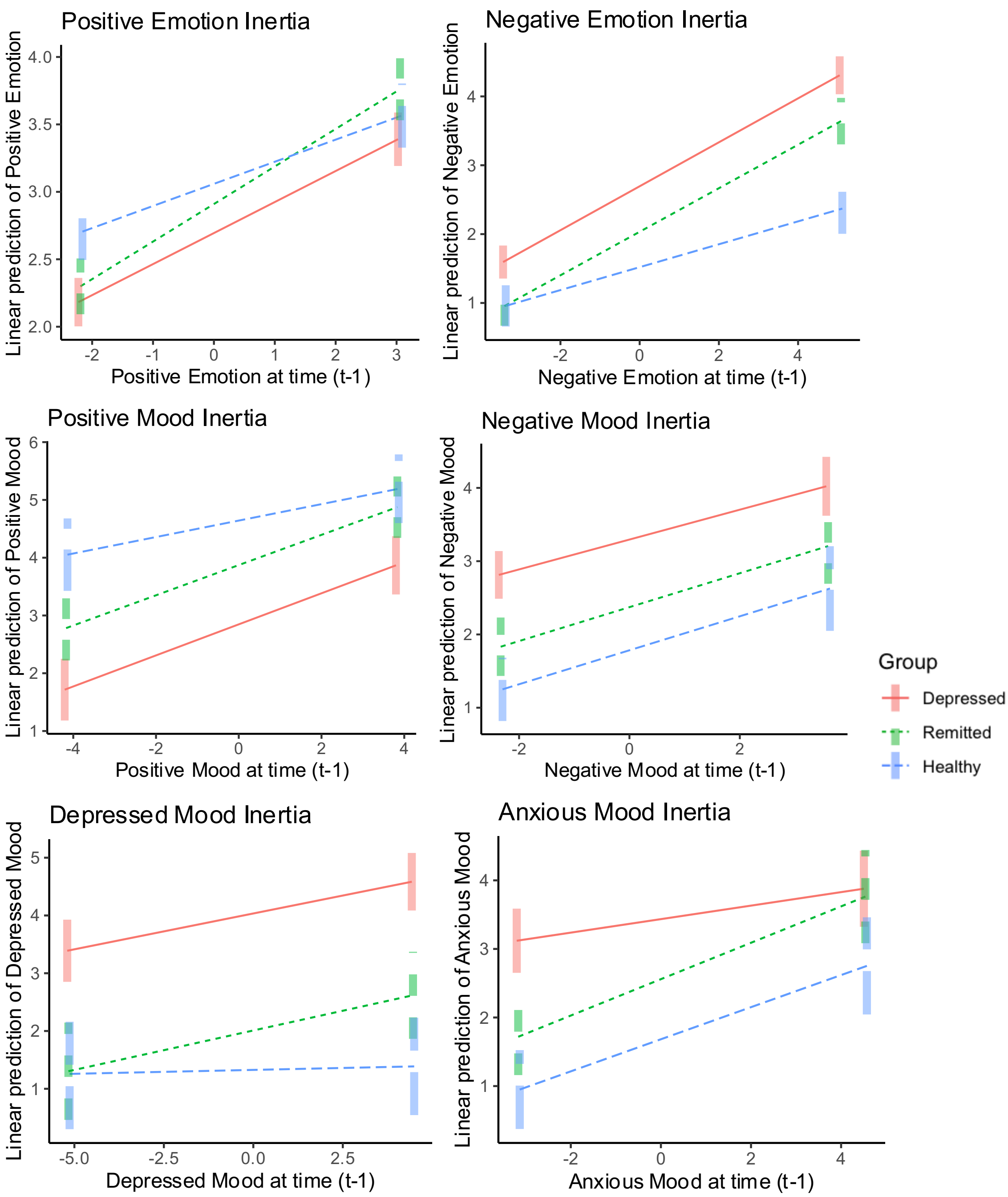

Figure 4.6. Inertia for positive and negative emotion (upper row), positive and negative mood (middle row), and depressed and anxious mood (bottom row). The only group difference present was between the depressed and healthy group on negative emotion inertia. Transdiagnostic data-driven mood inertia model estimates are included in Appendix 4.2, no differences were significant.

Chronometry. Average values of self-reported emotion and mood duration were assessed for measures of affective chronometry. For emotion, a single chronometry value was collected at each timepoint on self-reported duration of the current emotion state. Emotion chronometry therefore was measured concurrently for positive and negative emotions, and for analysis, negative emotion was therefore reverse coded to provide an analytic directional scale for interpretation (i.e., a single scale of negative emotion (–7) to positive emotion (7) corresponding to each chronometry value).

For mood chronometry, participant provided self-report of how much time they spent daily in each mood for both positive and negative valence. This was used to first generate two chronometry levels for positive and negative mood separately. However, in order to transform mood chronometry to also similarly expressed as emotion chronometry, negative mood was also reverse-coded and a single chronometry index created (i.e., a single scale of negative mood (–7) to positive mood (7) corresponding to chronometry values). The absolute value of the chronometry was used so the now negative values of chronometry (representing a higher amount of time spent in daily negative moods over positive moods) could be mapped to the mood index (whereby a value representing lower mood is now linked to the appropriate absolute value of chronometry reflecting higher amount of time spent in that mood). This allowed chronometry to be analysed similarly between the two affective states of emotion and mood. As with inertia, we applied multilevel modeling to assess the nested chronometry data with the affect state as a predictor variable person-mean centered at Level-1 and diagnostic group as a moderator at Level-2 (see Appendix 4.3 for all model estimates).

There were no significant main effects of emotion valence on chronometry, nor any group differences between how changes in valence may lead to changes in length of emotion experience (*p*s>.0125, see Figure 4.7). However, there were significant group differences in mood chronometry such that compared to the depressed group, both the healthy group (b=0.53, SE=.05, $t(95)$=10.02, p<.001) and remitted group (b=0.46, SE=.05, $t(95)$=9.75, p<.001) showed significantly less time spent in negative moods and more time spent in positive moods (see Figure 4.7, see Appendix 4.3 for model statistics).

Transdiagnostic Data-Driven Subgroups. As emotion inertia was already examined between data-driven subgroups in Chapter 3, only mood inertia was further examined here. There were no group differences for inertia of positive mood (b=0.08, SE=.06, $t(95)$=1.23, p=.21), negative mood (b=–0.02, SE=.06, $t(95)$=–0.34, p=.73), depressed mood (b=–0.03, SE=.06, $t(95)$=–0.47, p=.64), or anxious mood (b=–0.04, SE=.06, $t(95)$=–0.63, p=.53)(see Appendix 4.2 for model statistics).

There were no significant group differences for transdiagnostic data-driven subgroups on emotion chronometry between Subgroup 1 and 2 (b=–0.04, SE=.70, $t(95)$=–0.06, p=.95). However, on mood chronometry, Subgroup 2 showed significantly lower mood chronometry increases as mood valence increased than subgroup 1 (b=–0.14, SE=.04, $t(95)$=–3.29,

p=.001), in other words, more time spent in negative mood and less time spent in positive moods (see Figure 4.7, see Appendix 4.3 for model statistics).

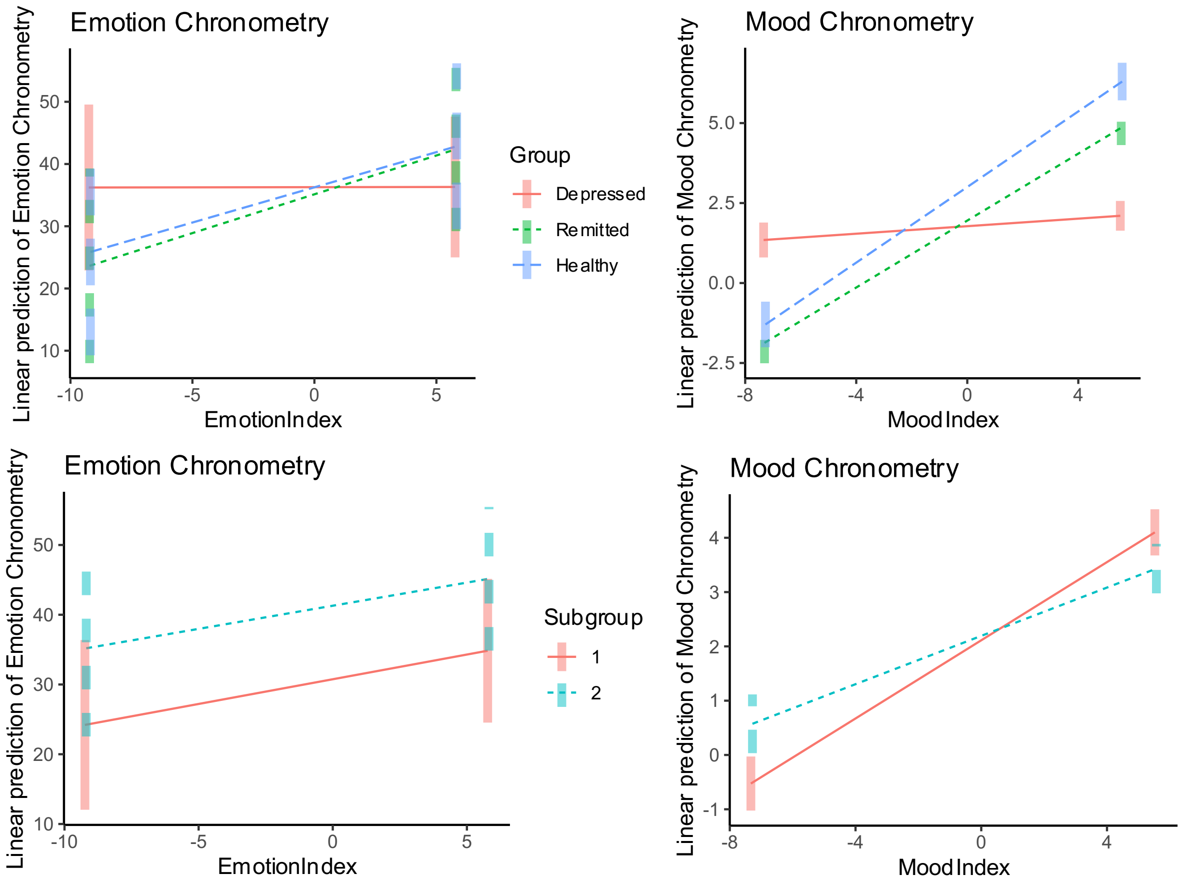

Figure 4.7. Diagnostic groups (upper row) showed no significant differences on emotion chronometry. On mood chronometry, there were significant differed for the depressed group compared to both the healthy and remitted groups. For data-driven groups (lower row), there were similarly no significant differences in emotion chronometry, but significant differences for mood chronometry. Both the emotion and mood index depicted on respective x-axes represent a single index spanning both valenced states from low or negative to high or positive affect.

Associations Between Emotion and Mood across Time

Having assessed key features of affective complexity for emotion and mood summarised and varying across the time-course of the study, we next assessed how emotion and mood may have covaried over time between clinical diagnostic groups. This was similarly conducted through multilevel models, with emotion entered as a Level-1 predictor variable and clinical group status as a Level-2 moderating variable. There were two models per mood, with positive emotion and negative emotion modelled separately, with an applied Bonferroni corrected alpha of .0125 to correct for multiple comparisons. Data-driven transdiagnostic groups were set aside for this next research question to focus on how diagnostic groups differed on ongoing emotion and mood fluctuating relationships.

Concurrent Emotion and Mood

There were no significant group differences for how concurrent positive emotion associated with concurrent positive mood (see Figure 4.8; see Appendix 4.4 for all model estimates). However, lower levels of negative emotion were associated with higher levels of positive mood for healthy participants compared to depressed participants (b=–0.37, SE=.12, $t(95)$=–3.07, p=.002). There were no other statistically significant group differences between clinical groups for the relationships between concurrent emotions and negative mood (see Appendix 4.4 for all model statistics).

For anxious and depressed moods, there were significant group differences such that the depressed group showed higher levels of depressed mood alongside lower concurrent positive emotion than both the remitted group (b=0.60, SE=.08, $t(95)$=7.28, p<.001) and healthy group (b=0.45, SE=.10, $t(95)$=4.60, p<.001). Alongside higher levels of negative emotion, depressed mood was also significantly higher for depressed participants than for remitted (b=–0.40, SE=.10, $t(95)$=–3.94, p<.001), though there was no significant difference at our corrected level compared to healthy persons (b=–0.28, SE=.13, $t(95)$=–2.10, p=.03).

For concurrent emotion on anxious mood, there were no significant group differences for how concurrent emotion and anxious mood covaried (see Appendix 4.4 for all model statistics).

Lagged Emotion and Next-Day Mood

The lagged effect of emotions on next-day mood were assessed using the average emotion levels on day (t–1) and examining how this was associated with group differences of mood on day (t).

There were no significant group differences between any clinical groups on how lagged positive or negative emotion affected next-day moods for either positive or negative moods (see Figure 4.9; see Appendix 4.5 for all model statistics. There were similarly no significant group differences for depressed and anxious moods (see Appendix 4.5 for all model statistics).

To assess the opposing directionality, lagged mood effects on emotion were also assessed in additional exploratory analyses, however there were no significant group differences (see Appendix 4.6).

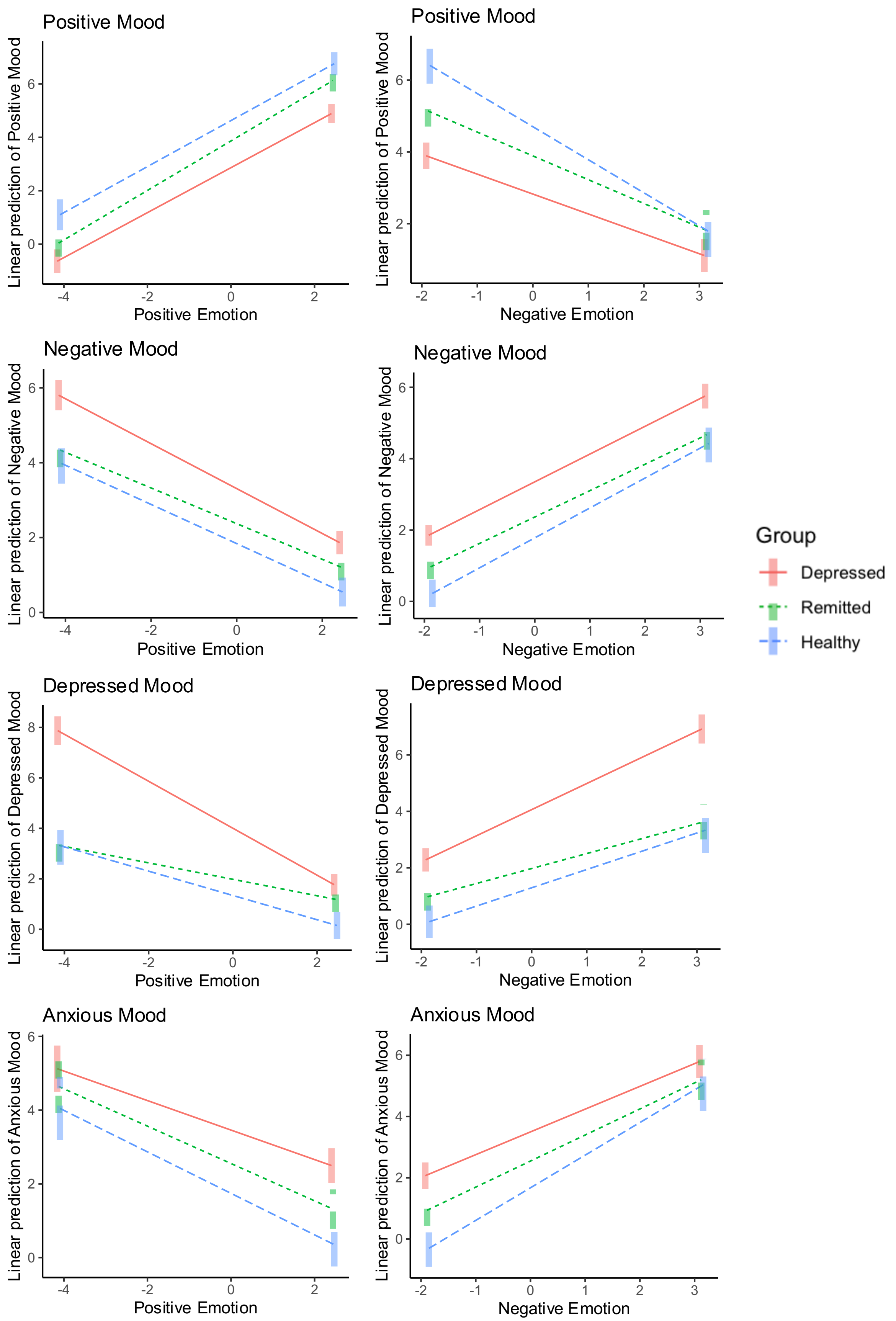

Figure 4.8. Concurrent emotion and mood over time, labeled by valence, plotted are clinical group interactions. Significant differences described in main text (between depressed and healthy in positive mood predicted by negative emotion, between depressed and both remitted and healthy in depressed mood predicted by positive emotion, and between depressed and remitted in depressed mood predicted by negative emotion).

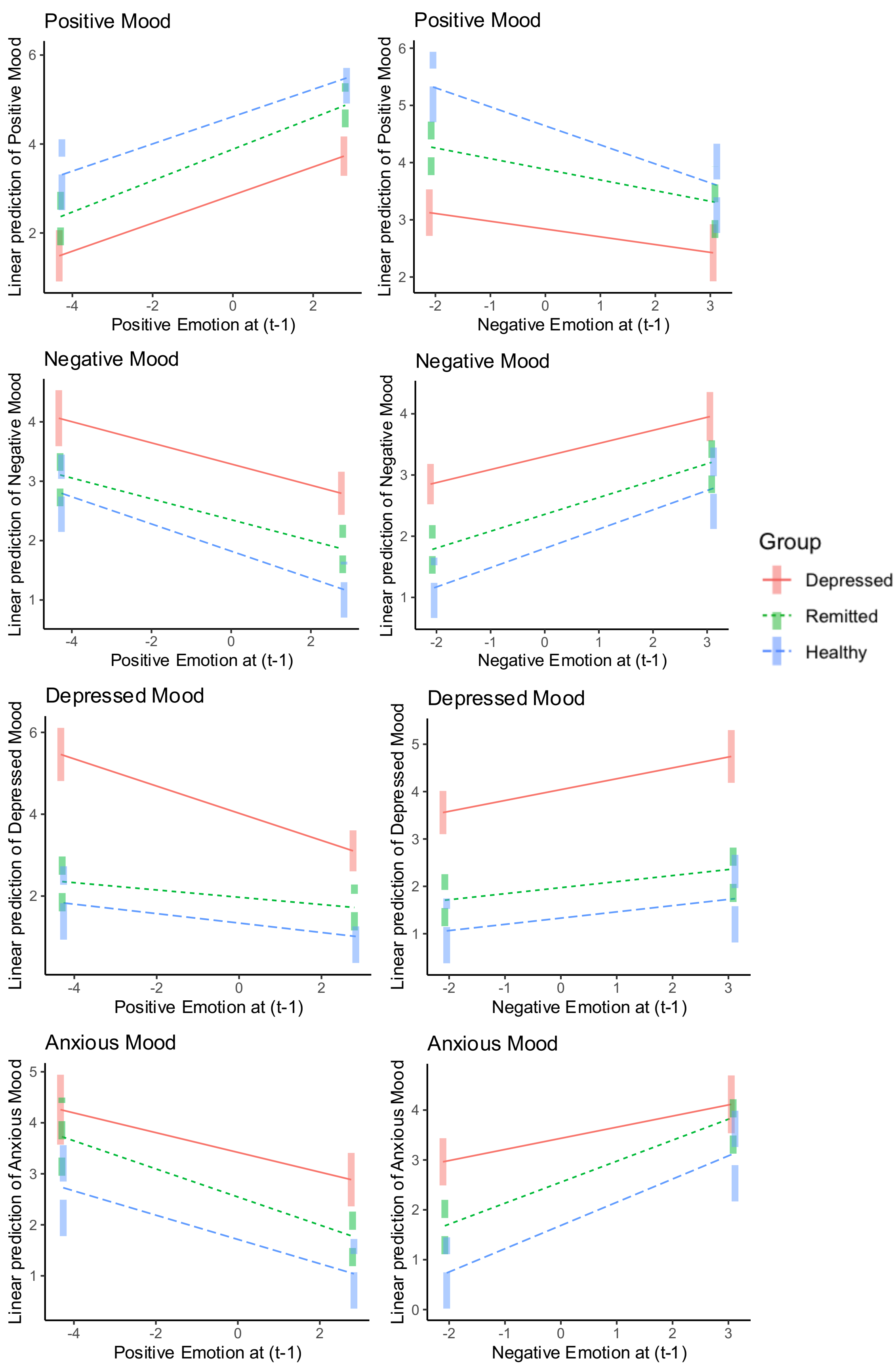

Figure 4.9. Lagged positive emotions (left column) and lagged negative emotions (right column) on next-day positive mood, negative mood, depressed mood, and anxious mood across clinical groups. There were no significant clinical group differences.

4.5 DISCUSSION

By exploring summary features that have been typically used to describe emotional complexity in both distinct types of affect states (aan het Rot et al., 2012; Kuppens et al., 2012; Pond Jr et al., 2012; Thompson et al., 2021), this study aimed to better clarify similarities and differences in emotion and mood (Barrett et al., 2007; Beedie et al., 2005; Dennett, 1987; Eldar et al., 2016; Frijda, 2017; Russell, 2003; Thayer, 1989). Group differences on clinical expression of these states can allow for improved awareness of the role emotion versus mood experiences may play for targeted hypotheses. Below we summarise the interpretations of these findings, followed by further explanation of possible varying interrelationships between concurrent emotion and mood in clinical samples.

Diagnostic Groups and Affective Summary Features

Average Intensity

Expected and plausible clinical differences in average intensity levels for emotion and mood were found. The depressed group experienced the lowest average intensity for positive emotion and mood followed by the remitted group, with healthy persons experiencing highest relative levels. The reverse was true of negative emotion and mood intensity, such that depressed persons showed the highest levels of intensity, followed by the remitted and healthy group. While these affect states comprised an aggregate of all specific terms sampled in this study, as is typical in past work (e.g., Thompson et al., 2021), we also aimed to summarise possible differences in specific clinically relevant mood states as well provided the repeat measures gathered for 'depressed' and 'anxious' mood (e.g., Rottenberg, 2005; APA, 2013). Similarly, the depressed group showed the highest levels of depressed and anxious mood intensity, followed by the remitted group, and the healthy group with the lowest levels of these clinically relevant moods. These data therefore provide a good validity check for our methodology.

Although the remitted group did experience higher negative emotion intensity than the healthy group, there were no significant differences between the two with respect to negative mood intensity. This may suggest that higher average intensity levels of negative emotions may occur more frequently in remitted persons than healthy never-depressed persons (e.g., Thompson et al., 2021), but that long-term negative mood states both are felt at equivalent levels in non-depressed persons, regardless of their past depression history (or lack thereof). This may provide some insight that is useful for considering one possible differentiating feature of felt intensity in affect. These findings are similar to past work on emotion functioning in remitted individuals compared to currently depressed participants (e.g., Thompson et al., 2021).

Instability

In terms of affect instability, there were no significant differences in either positive emotion or positive mood instability, thus providing no support for clinical mood disorder status being associated with differences in within-person fluctuations of positive affect levels. For negative emotion and mood instability, significant differences were present such that the depressed individuals experienced higher instability than healthy persons, but no such differences were present between remitted individuals to either depressed or healthy persons. Both these findings for emotion replicated past work in similar populations of depressed, remitted, and healthy controls (Schoevers et al., 2021; Servaas et al., 2017; Thompson et al., 2021), and appear to suggest findings for instability in mood mirrors that of emotion instability diagnostically, though not from data-driven transdiagnostic subgroupings (see next).

Instability of depressed mood was higher in the depressed group compared to the remitted and healthy persons, and in anxious mood the depressed group also displayed higher levels of instability than healthy persons. The remitted and healthy groups did not experience significantly different levels of instability in these clinically relevant moods, which may suggest that entering remission provides less frequent successive changes from normal to clinically abnormal moods, expanding from recent work on negative mood instability in remission (Schoevers et al., 2021; Servaas et al., 2017; Thompson et al., 2021).
This was especially relevant for depressed mood, such that there was no support for a history of depression related to remitted persons experiencing levels of depression instability higher than never-depressed persons, and during remission the group appeared to show significantly lower instability than depressed persons overall. Given this was not the case for anxious mood instability, in which case there were not significant differences between the remitted group to the depressed or healthy group, it may be worthwhile further considering the role of anxiety symptoms or prolonged moods during remission.

Granularity

Of all summary complexity features assessed, granularity, or the ability for one to differentiate between similarly valenced states, did not show many group differences. No such differences in emotion or mood granularity were present for any clinical groups, providing no support in the present study for differences in affective granularity through naturalistic sampling of near real-time fluctuation of these states, despite past studies illustrating these differences (Kashdan & Farmer, 2014; Smidt & Suvak, 2015; Starr et al., 2020).

This was true even for granularity of 'depressed' versus 'anxious' mood. Given research suggesting the difficulties in distinguishing between depressed and anxious moods (see e.g., Feldman, 1995; Starr & Davila, 2012) and strong overlap of comorbid depression and anxiety symptoms clinically (see e.g., Mineka et al., 1998; Byers et al., 2010), it was of interest to assess whether naturalistic affect data may showcase any meaningful clinical differences on clinical mood granularity. This did not appear to be the case, and all groups appeared to distinguish their depressed and anxious mood from one another to a similar degree. This was an interesting result provided the relevance for symptom overlap of clinical moods (Byers et al., 2010), but indeed did not appear to map towards diagnostic group statuses in a differential manner.

Transdiagnostic Data-Driven Groups and Mood Summary Features

With respect to transdiagnostic considerations (Dalgleish et al., 2020; Kotov et al., 2021), there was interestingly no support for any significant mood differences across summary metrics of average intensity, instability, granularity, or inertia for the data-driven subgroups derived (see Chapter 3) from emotion dynamics metrics in Study 2. Intriguingly, this finding may suggest that while these robust groups were delineated on features of importance in emotion experience like instability, granularity, and inertia (see Chapter 3), these same features did not map onto similarly delineated experiences of mood fluctuations over time. This may highlight a differential aspect of emotion versus mood fluctuations in thinking about shared dynamic patterns of affective experience, and what may be significant for emotion patterns (see Chapter 3) not does consistently apply to mood patterns, as in the present study indeed suggesting further importance in differential study of these features.

Diagnostic Groups and Affective Time-varying Summary Features

While intensity, instability, and granularity are important features to probe based upon a summary of affective measures across each individual's within-person fluctuations across time, there are also additional summary features we may consider that also capture time-varying features, namely inertia and chronometry. Both were explored through multilevel modeling of within-person experiences with intriguing differential results for emotion versus mood experience clinically.

Inertia

In assessing inertia, a common complexity feature of affect associated with depression risk and possible early warning signs of entering a depressive episode (Kuppens et al., 2012; van de Leemput et al., 2014), we aimed to question whether emotion and mood inertia patterns were differentially represented in our sample. The only significant finding was that the depressed group showed higher negative emotion inertia than healthy persons, with no other group differences. This implies that the emotional states of depressed persons more strongly predict their next emotion states when said emotion is negative, more so than for never-depressed individuals. This has implications in suggesting that there is higher risk of cascading effects of negative emotion associated with depression (Koval et al., 2013).

No differences were present, however, with respect to positive or negative mood inertia, regardless of the window of past timepoints, should mood have been unfolding in a delayed temporal pattern (Starr & Davila, 2012). There was therefore no support for any differences between clinical groups for how past mood states may influence later mood states. This initial assessment of mood state inertia offered interesting null results for group differences, while negative emotion inertia in these same groups did display findings consistent with past literature(Koval et al., 2013; Kuppens et al., 2012; Thompson et al., 2021).

This differential finding distinguishing inertia as a feature that differed by clinical groups in emotion, though not in mood, suggests the possibility of cascading negative emotional responses predicting further negative emotions at higher levels in depressed persons, but there is no support that this is true of mood in the present study. It appears that the past mood states of depressed, remitted, and healthy individuals appear to have similar effects on later mood experiences.

Chronometry

When next exploring chronometry, a feature less typically assessed in affect work regarding duration of affective states (Davidson, 2015), results intriguingly suggested that there was no support that individuals experienced duration of their positive or negative emotion states differently regardless of clinical status. In other words, the self-reported durations of positive and negative emotion experiences were not significantly different for individuals with depression in-episode, in remission, or for those never having been depressed. This may be interpreted in line with emotion processing theories that strongly highlight emotion as an object-oriented response directed at something (Ellsworth, 1991;

Russell, 2003; Scherer, 2009), and this interesting finding suggests that such responses do not differ by length during a mood disorder.

Given the nature of emotions to be experienced as fleeting affective states, this finding suggests that emotions occur and fade without bias towards valence, and without clinical difference. For mood chronometry however, results indicated that depressed individuals spend significantly more time in negative moods than remitted and healthy persons, indeed highlighting the difficulty in chronicity of mood experience in poor mental health (e.g., Rottenberg, 2005; APA, 2013).

This may suggest that the unique affective profile of a depressed individual differs in their negative emotions more likely predicting further negative emotional responses later, though no such difference for their mood inertia, and that it is not the length of emotional responses that differ, but the sustained length of negative mood. For example, it may be that a depressed individual does not show longer occurrence of sad emotion but is more likely to feel sad emotion again thereafter, while also showing longer occurrence of sad mood than non-depressed persons. Inertia and chronometry of affective states imply there remains a clinical difference in sustained mood length especially, rather than emotion length with respect to the phenomenology of depression. This may be of importance in considering the implications of regulation strategies to focus on mood regulation (Beedie et al., 2005; Larsen, 2000; Parkinson, 1996; Thayer, 1989), rather than specific emotion regulation, and ideally intervene at the level of ameliorating dysfunctional mood length.

Transdiagnostic Data-Driven Groups and Mood Time-varying Summary Features

The results for the transdiagnostic groups also appear to suggest that while these participants did experience transdiagnostic similarities in their affective montage of emotion, as uncovered in the previous chapter, this does not necessarily mean the same features of emotion carry over to differences in mood. In other words, there does not appear to be evidence that the emotion dynamic profile that fluctuating across time and distinguished participants into these two transdiagnostic clusters maps directly onto summary metrics of mood.

The information gleaned by group iterative multiple model estimation in parsing emotion patterns may be uniquely distinct from mood patterns. Future work could collect a greater number of datapoints on fluctuations in mood to apply an iterative modeling approach and directly compare possible data-driven groups based on mood versus emotion. Doing so may allow one to directly infer what features may delineate the same participants between these two affect metrics of emotion and mood along the same analytic method.

Mirroring the diagnostic groups, there was no transdiagnostic data-driven subgroup difference on emotion chronometry, but there was a significant difference between data-driven subgroups on mood chronometry. Subgroup 2 showed significantly higher levels spent in negative moods, and lower levels spent in positive moods. Alongside these robust data-driven subgroups differing from their emotion temporal experience and in emotion patterns of instability, granularity and inertia (see Chapter 3), the subgroup found to have lower instability, higher granularity, and higher inertia showed lower mood chronometry from the other data-driven subgroup (i.e., more time spent in negative moods, and less time spent in positive moods). This further points toward the significance of mood chronometry being a key feature of importance for further study in research questions of affect and worth greater consideration alongside these emotion features in both diagnostic and transdiagnostic contexts.

Associations Between Emotion and Mood across Time

Following considerations of possible similarities and differences of emotion and mood complexity features, we also sought to use the combined experience sampling and daily diary data to examine interrelationships of emotion and mood at both concurrent and lagged levels.

Concurrent Emotion and Mood

As expected, there were strong positive associations between emotions and moods of similar valence, and strong negative associations between emotions and moods of opposing valence across all groups (see Figure 4.8). However, intriguingly, there were limited significant group differences between emotion and mood over time when compared together.

Reduced negative emotion was associated with significantly higher levels of positive mood for healthy persons compared to depressed persons. This suggests the impact of reductions in negative emotion more strongly impact those with no history of depression than those currently already experiencing clinical depression. The reduced intensity of positive moods despite reductions in negative emotion experiences in currently depressed persons suggests that even when negative emotions are felt less strongly, those with depression do not experience benefits in terms of positive mood as much as those with no depression history.

No other significant differences between clinical status and interrelating affect were uncovered, despite hypotheses that depressed persons may have had stronger impacts of negative emotion on negative mood or less strong impacts of positive emotion on negative mood. Considering a theoretical model of mood as ongoing momentum from expectations (Eldar et al., 2016), an interpretation may be that healthy functioning adults experiencing higher levels of negative emotion may be updating their positive moods lower in response, possibly related to appropriate learning from negative outcomes (Eldar et al., 2016; Keren et al., 2021; Niv, 2009). Given work suggesting that negative information may be more evolutionarily advantaged in face of updating moods (Eldar et al., 2016; Rozin & Royzman, 2001), this appears to perhaps fall in line with that finding by suggesting healthy persons may update positive mood status in line with negative emotion with greater sensitivity than depressed persons, but these findings are only associative, and causation cannot be determined.

In the case of specific clinically relevant moods, depressed individuals appeared to experience a stronger negative relationship between depressed mood alongside higher positive emotions, relative to remitted and healthy individuals. While not causal, this may still strongly suggest the value in emotion regulation techniques for up regulating positive emotion (Tugade et al., 2004; Tugade & Fredrickson, 2007).

With respect to negative emotion, depressed persons experienced significantly higher levels of depressed mood alongside higher negative emotions than remitted persons, though, surprisingly, not significantly differently from healthy persons. This may suggest that in remission, individuals show a less strong associative relationship between negative emotion and depressed mood. While this study cannot speak to the mechanism underlying this finding, it is possible that this could signify a possible feature in remitted individuals preventing depressed mood from occurring alongside higher negative emotion. The lack of any significant group differences involving emotion and anxious mood may suggest the interplay of those states is similar regardless of clinical status.

Lagged Emotion on Next-Day Mood

There were no significant group differences on how lagged emotion affected next-day mood. However, while there was interest in employing a lagged model for emotion and mood, these two affect states were modelled on different timeframes, and more than inertia, there are many limitations around assuming an average of one's day's emotion may be linked directionally to the following day's moods. Based on this premise, there was no support for differences across clinical groups in terms of how a day's emotion may possibly shift mood.

Summary

Emotion and mood are distinct states that make up our rich inner affective life and studying the effect of these differential experiences is important to better understand mental health and clinical disorders (Barrett et al., 2007; Frijda, 2017; Rottenberg, 2005). Unpacking the different effects that measures of emotion or mood may have for risk status, outcomes, interventions, and treatment may provide more nuanced help for individuals currently experience or at risk of experiencing depression.

Given the significant difference in affective chronometry for depressed individuals occurring with respect to negative moods, but not negative emotion, this may be a key area to focus intervention or measurement of change within. Indeed, mood chronometry differed significantly in transdiagnostic data-driven manners as well, while emotion chronometry did not. Definitions of major depression relate to long-lasting negative mood rather than long-lasting negative emotions (APA, 2013), and it is possible that regulatory efforts and clinical treatment may want to move towards work on improving regulation of mood to mitigate the effects of long-lasting negative mood shown present in depressed persons (Beedie et al., 2005; Larsen, 2000; Parkinson, 1996; Thayer, 1989; Tugade et al., 2004; Tugade & Fredrickson, 2007). However, significant differences in affective inertia for depressed individuals lie in emotion, rather than mood – where there were no clinical differences, pointing towards emotion perhaps providing useful cues for possible depressive episode risk (Koval et al., 2013; van de Leemput et al., 2014), though not necessarily in mood where chronometry delineates an experience of mood.

Thus, it appears that compared to healthy controls and remitted persons, depressed persons experience longer-lasting negative moods (but no support for differing negative emotion lengths) and more carryover effects of past emotions (but no support for differing mood carryover effects of inertia). Further, across clinical boundaries, individuals experiencing lower emotion instability, higher emotion granularity, and lower emotion inertia also appeared to have significantly higher chronometry in negative moods and lower chronometry in positive moods than individuals with contrasting emotion dynamic features. These findings illustrate the importance of considering the diffuse, long-lasting features of moods as qualities worth quantitatively unpacking and comparing to emotion (Beedie et al., 2005; Larsen, 2000; Parkinson, 1996; Thayer, 1989; Tugade et al., 2004; Tugade & Fredrickson, 2007).

Limitations in this study include the measurement of emotion and mood on different timescales, though as mentioned, this choice was made to reduce participant confusion for self-reporting differing states and because a priori moods were presumed to shift at a slower timescale than emotions. However, this introduces room for error in considering the nature of unfolding intraday emotion and daily mood. Although we assessed concurrent and lagged differences between inter-day measurements of emotion and mood, there are limitations to how we can attest to the true directionality of these relationships as all was observed, not intervened with as an independent variable upon the other and thus results on interrelationships are all associative, not causal. Future work could focus on testing the effects of interventions on emotion and measuring subsequent changes in mood in one group, while applying interventions of mood and measuring subsequent change in emotion in a second group for possible illumination of directed effects.

Towards a Study on Regulation of Ongoing Moods

In all, this study demonstrates the feasibility of measuring both emotion and mood and assessing relationships between these differential affective constructs in clinical contexts and transdiagnostic data-driven contexts, with the importance of doing so to shed light upon what is experienced similarly between these states (e.g., average intensity, negative instability) and what differs between these states (e.g., chronometry versus inertia), alongside possible relationships in how emotion and mood may both unfold over time. Following this differential study of emotion and mood states over time, a further question asked how mood states occurring across this time period may have been regulated. Mood regulation strategies are not typically studied in current affective research, and it is possible there may exist clinical group differences as to which strategies work best, and when they may be efficacious. With this, Chapter 5 reports a study on mood regulation using these same participants across the same sampling period.

CHAPTER 5 – STUDY 4: A NATURALISTIC INVESTIGATION INTO MOOD REGULATION STRATEGIES AND PERCEIVED EFFICACY IN DEPRESSED, REMITTED AND NON-DEPRESSED INDIVIDUALS

5.1 OVERVIEW

Having now assessed underlying representations of emotion and mood (see Chapter 2), within-person emotion dynamics over time (see Chapter 3), and relationships between emotion and mood in daily life (see Chapter 4), our next question focused on the regulation of mood experiences. There is thorough and extensive research into how individuals regulate emotion. Through theories of the emotional experience and emotion regulation strategies employed, several past studies have expanded our understanding of successful emotion regulation, regulation under stress, naturalistic emotion regulation, and clinical implications in relation to mental health. Given the focus on distinctly studying emotion and mood throughout this thesis, the next goal was to investigate mood regulation through naturalistic methods.

In this study using the same participant sample as in Study 3 in Chapter 4, past theoretical frameworks of mood regulation were reviewed to collate a representative set of specific strategies spanning multiple proposed areas of mood regulation. Participants were probed daily over a 14-day period on what regulation strategies they engaged in to mitigate their moods, and relationships of efficacy, strategy usage, and effect upon moods were examined through mixed effects multilevel models. The great value of using daily diary methods to probe naturalistic mood regulation resulted in a first-of-its-kind study, as far as we are aware, into individuals with varied clinical status and their selective engagement with regulation and effects reported on their subsequent moods.

5.2 INTRODUCTION

As we have explored in Studies 1-3, emotions and moods are important distinct features of affect (Batson et al., 1992; Beedie et al., 2005; Russell, 2003). How we regulate and respond to our experiences of affect plays a large role in our responding to everyday events and interactions. Many studies have investigated the strategies and efficacy of emotion regulation in healthy and clinical samples (Aldao et al., 2010; Gross, 1998, 2015). However, we suggest the distinction between emotion and mood (Beedie et al., 2005; Russell, 2003) should be considered when considering affective regulation. Mood experiences are of great interest in researching the nature of mood disorders with implications for how individuals may attempt to change their mood (Larsen, 2000).

As described throughout this thesis, emotions can be viewed as situation-dependent, that is, behavioural reactions to stimuli arising from external situations in a number of contexts that are object-oriented, directed, discrete, more intensely felt acutely, and shorter-lasting (Barrett et al., 2007; James, 1894; Russell, 2003). Moods on the other hand, may be viewed more in the context of a background state of mind that updates, possibly with respect to the momentum of external environment status (Eldar et al., 2016), without direct intentional object-oriented responses, and more diffuse, less intense, and longer durations (Beedie et al., 2005; Russell, 2003). The nuance of these two distinctive types of affect carries importance clinically and socially. Mood disorders such as major depression are described and defined by their maladaptive occurrence of chronic, recurrent, prolonged depressed mood (e.g., Rottenberg, 2005; APA, 2013). Therapeutic treatment of clinical depression may involve targeted approaches towards management of maladaptive moods and management of maladaptive emotion occurrences in different ways. Given theoretical bases of emotion versus mood, treatment or interventions on these two affective states may strongly differ due to their pathology – managing causes of emotions due to their connections to external stimuli, or managing resultant feelings associated with moods (Thayer, 1989) due to their connections with larger momentum, accumulation of prediction errors, and biased perceptual shifts, diffuse non-directed state (Eldar et al., 2016; Russell, 2003) and suggested differences in chronometry (see Chapter 4).

There is increasing focus in affective research to model and predict mood states in line with computational theories where mood has been theorised to shift in line with cumulative momentum of both positive and negative outcomes experienced or with significant shifts of internal or external context (Clark et al., 2018; Eldar et al., 2016). One influential way that this has been modelled and conceptualised has been reward processing, such that mood states provide evolutionarily advantaged information for an individual to adjust learning and acquire rewards from their environment (Eldar et al., 2016). For example, an animal attuned to rewards arising from certain trees providing more fruits than other trees, adjusting resources to visit these trees more often accordingly, and if all trees begin to provide fewer fruits than expected over time, this animal could further adjust to lower its energy expenditure as it receives fewer rewards and learns more from its environment.

The theoretical basis of mood and reward processing, and subsequent deleterious impact of depression on normal mood functioning points strongly towards the importance of studying targeted regulation of mood states in mental health. Experimental studies have shown that positive mood induction leads to higher reward-related neural activity on subsequent reward-based decision-making tasks (Young & Nusslock, 2016) further emphasizing the role mood changes may have upon one's interactions with their environment and motivational processing. Given this, there is value in better understanding mood, in addition to emotion, in relation to depression.

The maladaptive experience of chronic, recurrent depressed mood in major depression is of course not only characterized by reduced reward processing information, but also higher experiences of affective inertia, or higher likelihood of past affect predicting future affect with respect to emotion (Koval et al., 2013; Kuppens et al., 2010, 2012). As we saw in Study 3 (Chapter 4), greater negative emotional inertia is indeed present in depression, though not in mood inertia. Mood chronometry appeared to delineate the subjective experience of depression from non-depression, with significantly higher amounts of self-reported time spent in negative moods, though not in negative emotion (see Chapter 4). Reiterating the importance of the study of mood features in addition to emotion, understanding how subjectively 'stuck' within moods individuals may feel also can elucidate upon the ebb and flow of differing moods in depression. We hypothesise this self-reported aspect of mood as defined by mood stuckness, may lie at higher levels for depressed individuals when considering theories of mood and maladaptive reward processing (Clark et al., 2018; Eldar et al., 2016; Henriques & Davidson, 2000; Russo & Nestler, 2013) as depressed persons may be slower to update their mood when provided with contrasting environmental information due to their reduced sensitivity to rewards (Admon & Pizzagalli, 2015; Eldar et al., 2016).

The Importance of Emotion Regulation

Many emotion theories view emotional states as directed reactions and thus regulation of reaction differs from regulation of the impact of a state itself, i.e., in emotion, how a stimulus makes one feel, versus in mood, how a mood state makes one feel. There is a plethora of experimental work expounding emotion regulation's relevance for mental health (Aldao et al., 2010; Gross & Muñoz, 1995; Joormann & Stanton, 2016). Indeed, depression is highly associated with poor emotion regulation capabilities, negative cognitive biases, and lower cognitive control, and strategies that tend to be used more by depressed persons in managing their emotions include avoidance, problem solving, and suppression strategies, in addition to reappraisal and acceptance (Aldao et al., 2010; Joormann & Stanton, 2016). It is important to also specifically examine mood regulation strategies to draw conclusions on whether findings from emotion regulation research extrapolate, or not, to mood regulation outcomes.

Possible Mood Regulation Focuses

Given these findings on mood and mental health, regulating the experience of negative moods and maintaining positive moods are important therapeutically. Theoretical bases of mood suggest that, for regulation, emphasis is more strongly placed on the mood itself (Beedie et al., 2005; Larsen, 2000) in contrast to emotion regulation where the optimal emphasis is on interpretations related to identification of objective external events followed by cognitive modulation of responses towards them (Gross, 1998; Larsen, 2000). Regulating a mood state would in theory help an individual maintain their desired 'set point' for mood (e.g., maintaining a mildly positive mood, reducing the onset of a negative mood as it arises), whereas emotion may be focused on an individual noticing and regulating a reaction to allow it to dissipate or shift (Gross, 1998; Gross & Muñoz, 1995; Larsen, 2000).

Mood regulation can thus be characterised as a series of processes involving (i) beliefs about an optimal set point for a given mood, (ii) a comparator detecting discrepancies from this ideal state, (iii) engagement in regulatory activities to reduce discrepancies and return to the ideal set point (Larsen, 2000). This theory points towards two larger branches of mood regulation – a focus on the current situation or a focus on the mood itself, and engagement with either behavioural or cognitive strategies (Larsen, 2000).We compiled overlapping strategies spanning these cognitive and behavioural branches used in prior mood regulation research (Larsen, 2000; Parkinson, 1996; Thayer, 1989) and reduced items to ten strategies for naturalistic assessment in a clinical population. Our selected strategies included:

cognitive avoidance, behavioural avoidance, cognitive relaxation, behavioural relaxation, cognitive distraction, exercise, cognitive reappraisal, support seeking, problem solving, and acceptance.

As discussed in the previous chapters, studying regulation in daily life through experience sampling methods has many benefits, and in the context of regulating affect, these methods also reduce the possible limitations of studying regulation in controlled settings where inductions of affect do not yet adequately mimic real-life settings that require regulation (e.g., stimuli from the International affective picture system (IAPS); Lang et al., 1997). Even in emotion regulation studies, there is an increasing shift to using experience sampling methods to improve real-time reports of regulation attempts (Burr & Samanez-Larkin, 2020; Gruber et al., 2013).

The Present Study

In the current study, we used the large sample of clinically depressed, remitted depressed, and healthy controls from Study 3 in Chapter 4 to study mood regulation. Given the importance in unpacking mood regulation clinically, understanding group differences for current and past depression impacting regulation use compared to non-depressed participants was summarised in this initial study into mood regulation. We examined the main research questions of what strategies are employed to regulate moods across our ten strategies chosen specifically to cover a broad range of hypothesised types of regulation mentioned in the literature (Larsen, 2000; Parkinson, 1996; Thayer et al., 1994). We further assessed mood stuckness and how efficacious each strategy was perceived to be, as well as how use and efficacy impacted later moods felt by individuals. We hypothesised that in line with theoretical bases of mood, depressed individuals would feel stuck within their mood states at higher rates than remitted or healthy individuals and that individuals with depression may engage in higher rates of avoidance strategies and less engagement with reappraisal strategies, as in line with past work in emotion regulation (e.g., (Aldao et al., 2010; Burr & Samanez-Larkin, 2020; Gross, 1998, 2015; Gross & Muñoz, 1995).

To date, as far as we are aware, no studies have conducted a naturalistic investigation of how individuals may attempt to regulate their moods and associations with mental health. In all, this study aims to investigate how individuals may choose to regulate their moods in their day-to-day lives and unpack what differences are driven by the experience of mood disorders. Provided this initial novel investigation into mood regulation strategy usage and clinical depression, remission, and healthy control status, the focal research question was to describe relationships of regulation strategy to overall positive and negative mood states. Therefore here, regulation strategies used for specific moods of 'depressed' and 'anxious' were not further assessed (though for summary metrics of these specific clinically-relevant moods, see Chapter 4), nor were data-driven groups differing on emotion dynamics (see Chapter 3) assessed for differences in mood regulation.

5.3 METHODS

Participants

The same participants as described in Chapter 4 were used for this study.

Measures

Clinical Information

The same clinical measures were used for this study as in Chapters 3 and 4, please see prior chapters for further information regarding the SCID, PHQ-9, and GAD-7. For internal consistency in this study sample, see Chapter 4.

Daily Diary

The same daily diary data collection methods were used to gather mood regulation information as in Chapter 4.

Mood states. As with Chapter 4, the final mood terms selected for self-report were happy, lively, content, satisfied for 'positive mood', and depressed, bored, anxious, irritable, and tense for 'negative mood'. These states were averaged by valence to study the relationship of regulation strategies to overall positive or negative mood (see Chapter 4 and Appendix 4.1 for more information on the selection and list of mood terms).

Mood 'stuckness'. Participants were also asked to rate to what extent they felt stuck in the moods they experienced that day, and if they actively tried to change (regulate) their overall mood state, both on Likert 7-point scales from 1 (not at all) to 7 (very much).

Mood regulation strategies. To probe into affective regulation strategies for mood, we adapted a list of strategies to cover theorised and previously studied strategies regulation literature specifically for mood (Larsen, 2000; Thayer et al., 1994), as noted above. This included covering strategies related to disengagement (e.g., avoidance), distraction (e.g., seeking pleasure or relaxation, or by reallocating resources to other tasks) and engagement (e.g., reappraising, problem-solving, venting, or seeking support), and acceptance (e.g., allowing oneself to feel bad, accepting the situation)(Larsen, 2000; Parkinson, 1996; Thayer et al., 1994) covering both broader cognitive and behavioural components.

This resulted in the ten mood regulation strategies used in the daily sampling (for a full list of mood regulation strategy items used in daily diary data collection, see Appendix 5.1). To measure strategy use, participants were also asked to rate how much they engaged in each strategy to try and regulate their mood that day and to measure perceived efficacy, they were also asked how much each strategy helped change their mood, both on Likert 7-point scales from 1 (not at all) to 7 (very much).

Procedures

As with Chapter 4, the overarching procedure was the same here as for Study 2 (see Chapter 3).

Analytic Plan

Mixed effects multilevel models. The approach to using multilevel modeling to assess group differences on mood regulation followed the same approach as described in Chapter 4. All predictor variables were person-mean centered at Level 1 (within-person) and diagnostic clinical group status was placed as the moderator at Level 2 (between-person group assignment).

5.4 RESULTS

Demographics and Clinical Characteristics

For participant demographics and clinical characteristics, see Chapter 4.

Differences in Mood, Stuckness, and Strategy Use

Basic group differences were assessed via multilevel models to descriptively summarise baseline differential experience of the nested data across time for mood features and strategy usage (see Figure 5.1). Depressed participants on average reported the lowest levels of positive mood (M=2.87, SD=1.30), with higher levels in the remitted group (M=3.91, SD=1.37), and highest levels in the healthy group (M=4.65, SD=1.13)(see Chapter 4 for group differences on average mood intensity). Depressed participants also reported high levels of negative mood (M=3.29, SD=1.20) and mood stuckness (M=4.60, SD=1.66), with lower levels in the remitted group for negative mood (M=2.31, SD=1.00) and mood stuckness (M=3.50, SD=1.72), and lowest levels in the healthy group for negative mood (M=1.81, SD=0.79) and mood stuckness (M=2.67, SD=1.65)(see Chapter 4 for group differences on average mood intensity).

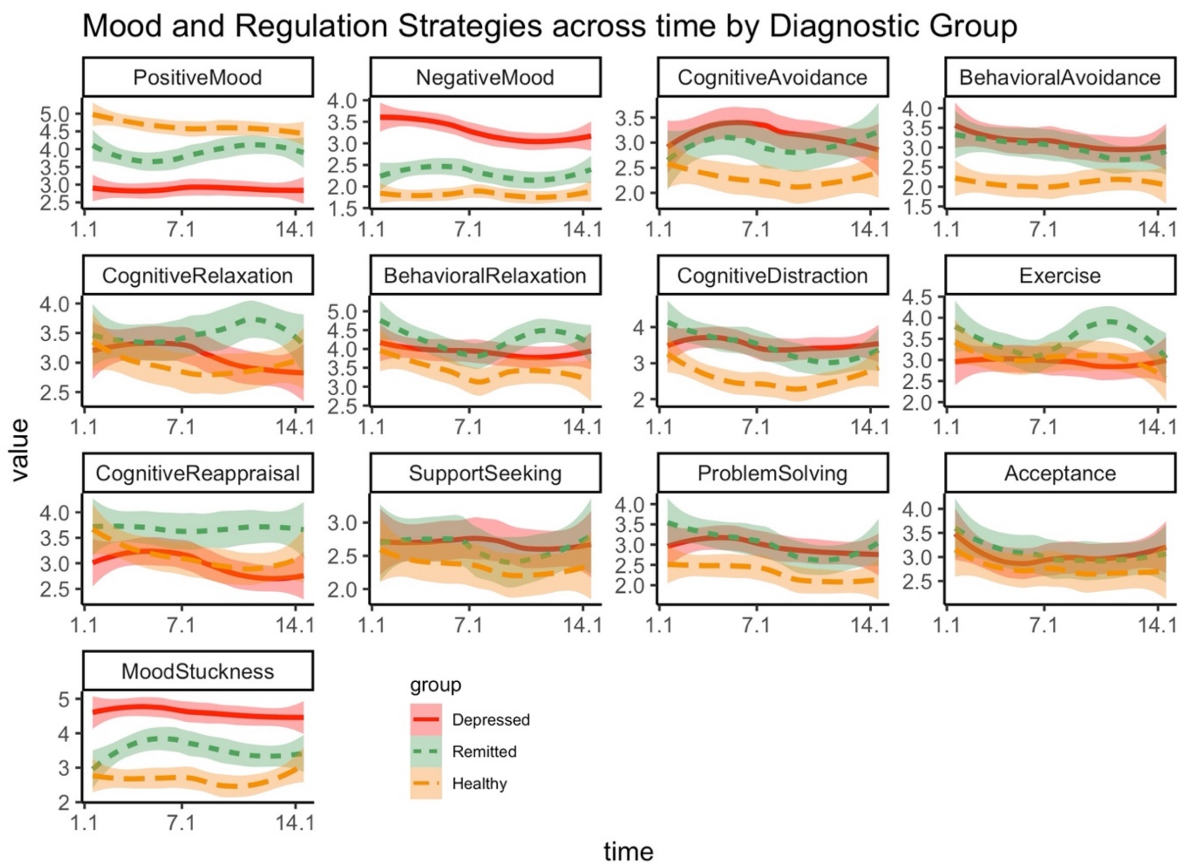

Figure 5.1. Positive and negative mood, the reported use of ten mood regulation strategies, and mood stuckness across time by clinical group status. Each clinical group trend is depicted by line-type and colour in the legend included beneath the figure.

Provided the ten tests for assessing group differences on each of the ten regulation strategies, we applied a Bonferroni corrected alpha of .005 to correct for multiple comparisons. With respect to basic group differences for mood stuckness and strategy usage (see Appendix 5.2 for all model statistics), the results were as follows:

Depressed participants reported feeling higher levels of mood stuckness (b=4.59, SE=.18, t(95)=25.89, p<.001) than remitted (b=–1.07, SE=.27, t(95)=–3.98, p<.001) and healthy participants (b=–1.88, SE=.26, t(95)=–7.17, p<.001). Depressed participants reported using higher levels of cognitive avoidance (b=3.15, SE=.19, t(95)=16.59, p<.001) than the healthy participants (b=–0.82, SE=.28, t(95)=–2.93, p=.004), but not the remitted participants (p=.56). Similarly, depressed participants reported using higher levels of behavioural avoidance (b=3.10, SE=.20, t(95)=15.35, p<.001) than the healthy participants (b=–0.98, SE=.30, t(95)=–3.26, p=.001), but not the remitted participants (p=.77). Depressed participants also reported using higher levels of cognitive distraction than the healthy participants (b=–0.86, SE=.28, t(95)=–3.03, p=.003), but not the remitted participants (p=.91).

Finally, there were no significant group differences in how participants used cognitive relaxation, behavioural relaxation, cognitive reappraisal, exercise, support seeking, problem solving, or acceptance (all *p*s>.005, see Appendix 5.2 for all model statistics).

Mood Regulation and Relationships to Mood

The effects of mood stuckness and strategies were assessed in separate models with group interactions for group differences. Self-reported mood stuckness was entered as a Level-1 predictor (within-person stuckness in moods) and clinical group as a Level-2 moderator to predict each strategy usage in its own model (see Figure 5.2). Similarly, to test how within-person mood stuckness predicted differences in perceived efficacy of each strategy, the same predictor variables were used to predict each strategy self-reported efficacy (see Figure 5.3). Provided the ten tests for assessing group differences of mood stuckness to each of the ten regulation strategies, and to each of their perceived efficacies, we applied a Bonferroni corrected alpha of .005 for each research question to correct for multiple comparisons.

Strategy Use Predicted by Mood Stuckness

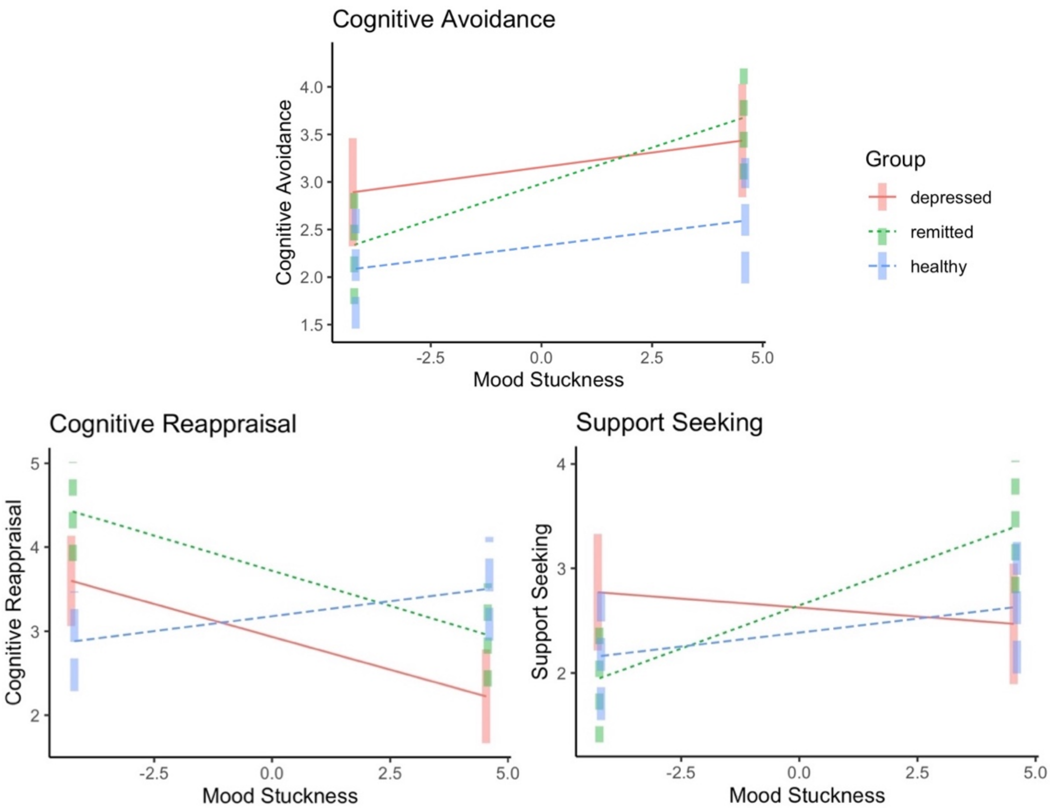

Figure 5.2. Clinical group interactions on level-1 within person mood stuckness (x-axis) on subset of mood regulation strategy usages (y-axis). Cognitive avoidance has a significant main effect across groups, but no group differences. Strategies in lower row showed significant group differences between the healthy to depressed and remitted group (cognitive reappraisal) and remitted to depressed group (support seeking). No other findings were significant as reported in main text.

Efficacy predicted by Mood Stuckness

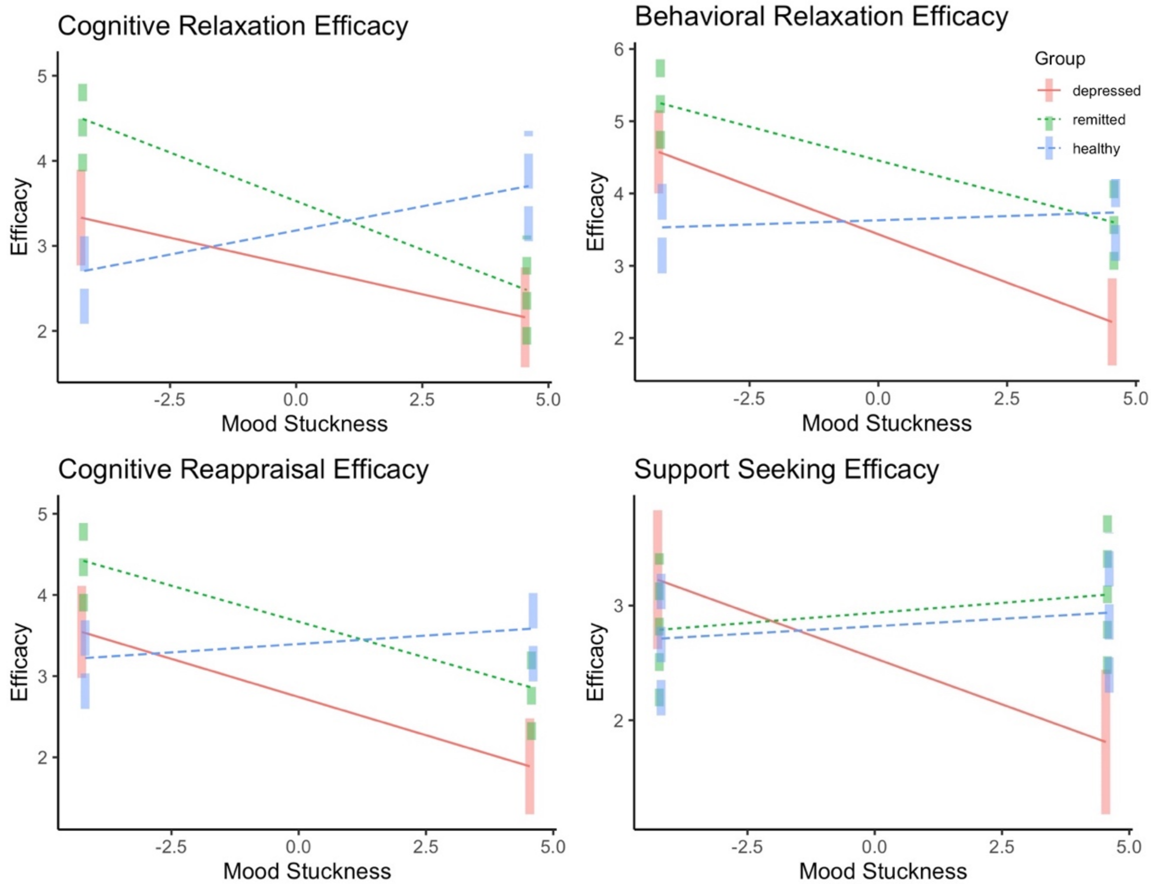

Figure 5.3. Clinical group interactions on level-1 within person mood stuckness (x-axis) and perceived efficacy (y-axis) on subset of mood regulation strategies. The depressed group significantly differed from the healthy group on all these strategies displayed, except support seeking, which showed a significant main effect across groups only. No other findings were significant as reported in main text.

Mood Stuckness on Use and Efficacy

Increasing feelings of mood stuckness were also associated with both depressed and remitted groups not using cognitive reappraisal as much as healthy participants (*b*=0.23, *SE*=.06, *t*(95)=3.35, *p*<.001; *b*=0.24, *SE*=.07, *t*(95)=3.44, *p*=.002 respectively). Higher feelings of mood stuckness also suggested that depressed participants use of support seeking was used less than remitted participants use (*b*=0.20, *SE*=.06, *t*(95)=3.09, *p*=.002)(see Appendix 5.3 for all model statistics). No other group differences emerged.

On efficacy, depressed participants reported the perceived effectiveness of a number of strategies lower than the healthy group when mood stuckness levels were higher, including cognitive relaxation (*b*=0.25, *SE*=.07, *t*(95)=3.34, *p*<.001), behavioural relaxation (*b*=0.29, *SE*=.08, *t*(95)=3.68, *p*<.001), and cognitive reappraisal (*b*=0.23, *SE*=.07, *t*(95)=3.18, *p*=.002). For remitted participants, only cognitive relaxation was associated with lower perceived efficacy during high mood stuckness than healthy participants (b=0.34, SE=.08, $t(95)$=4.53, p<.001)(see Appendix 5.4 for all model statistics).

Specific Strategies and Mood

Several group differences were assessed between each regulation strategy, mood, and efficacy. This includes (i) how concurrent positive mood (see Figure 5.4) or negative mood (see Figure 5.5) predicts strategy use (see Appendix 5.5 for all model estimates), (ii) how strategy use predicts perceived efficacy (see Figure 5.6 see Appendix 5.6 for all model estimates), and, finally, (iii) how lagged strategy use predicts next-day mood (see Figure 5.7; see Appendix 5.7 for all model estimates).

Group differences were assessed through multilevel models with mood or strategy use entered as a Level-1 variable and diagnostic group status as a Level-2 variable to predict strategy, efficacy, and next-day mood accordingly. Once again, a Bonferroni corrected alpha of .005 was applied to determine significance across the given ten regulation strategies per research question.

Strategy Use Predicted by Positive Mood

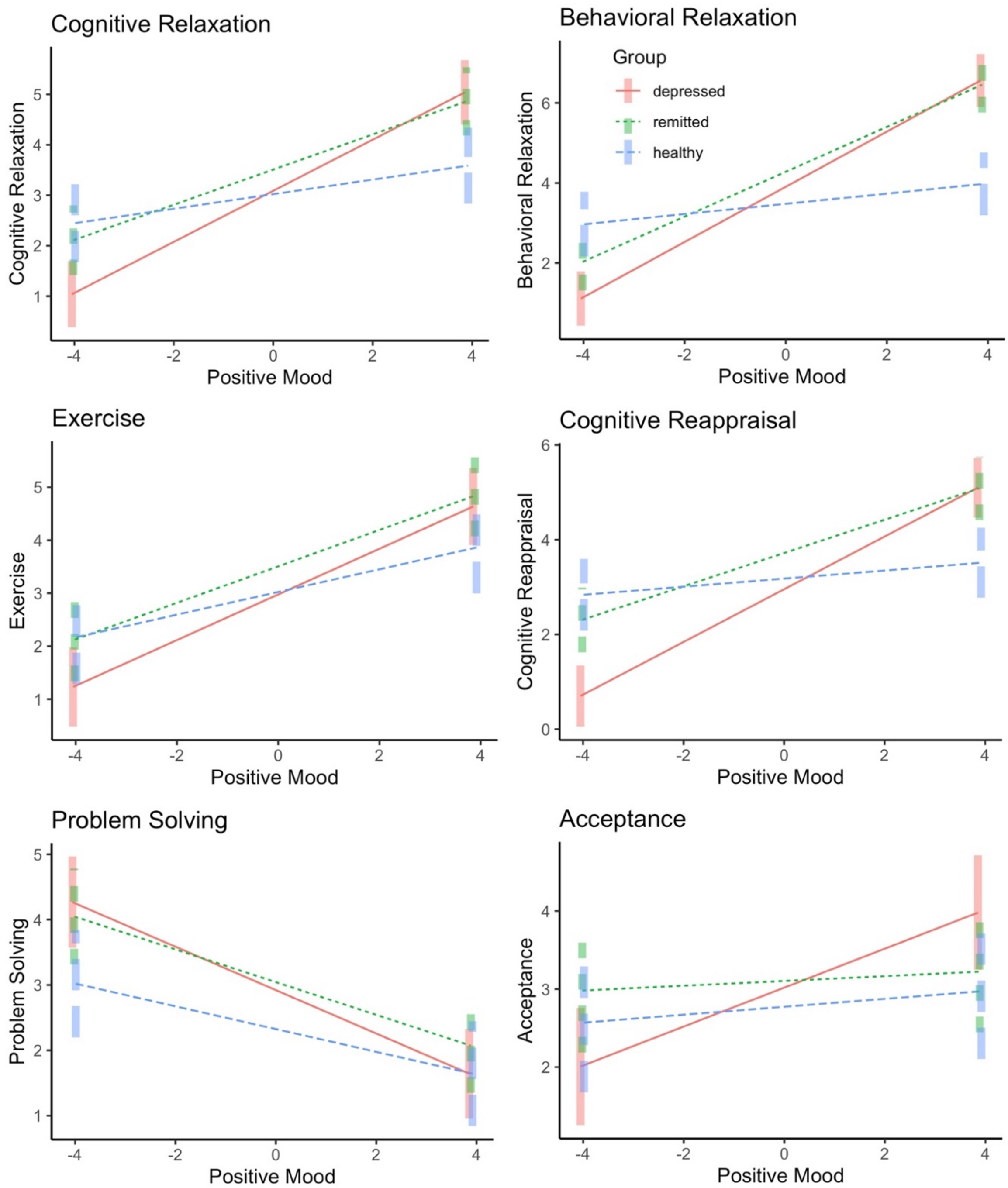

Figure 5.4. Clinical group interactions on level-1 within person mood (x-axis denotes positive mood as predictor variable) and mood regulation strategy use (y-axis). All strategies displayed here showed a significant main effect across groups, and cognitive relaxation, behavioural relaxation, and cognitive reappraisal showed significant group differences between the depressed and healthy groups. Remitted participants also significantly differed from healthy participants for behavioural relaxation. No other findings were significant as reported in main text.

Strategy Use Predicted by Negative Mood

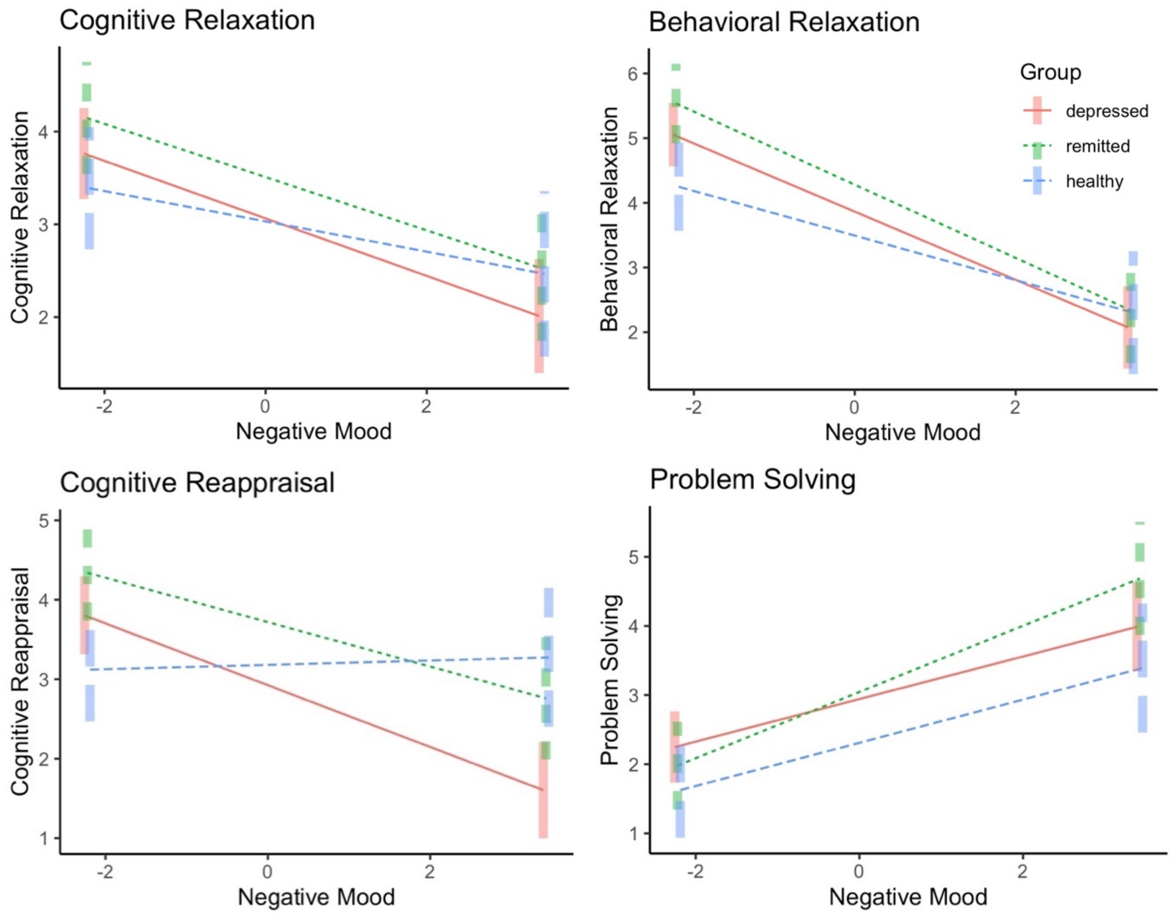

Figure 5.5. Clinical group interactions on level-1 within person mood (x-axis denotes negative mood as predictor variable) and mood regulation strategy use (y-axis). All strategies displayed here showed a significant main effect across groups, and only cognitive reappraisal showed significant group differences between the depressed and healthy groups. No other findings were significant as reported in main text.

Efficacy predicted by Strategy Use

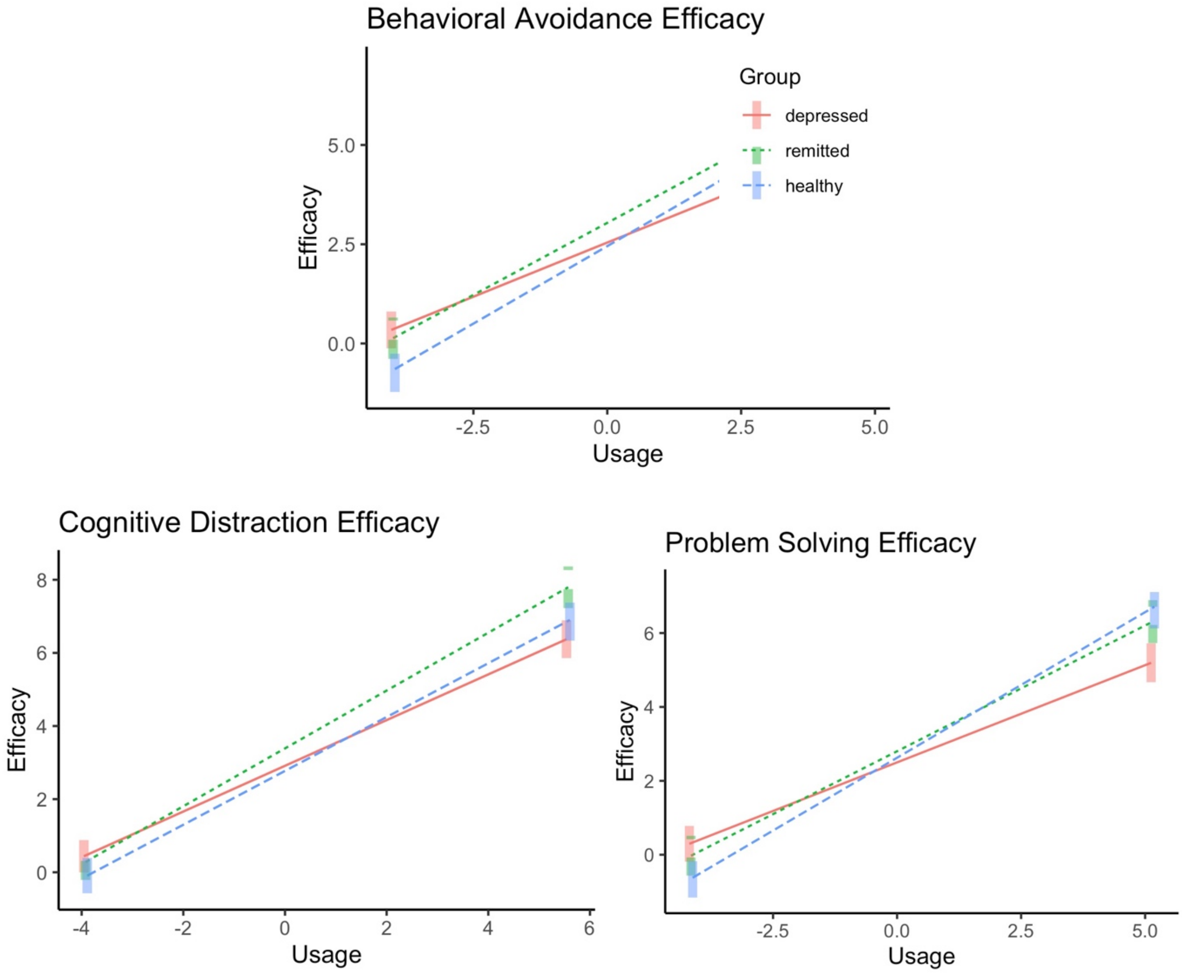

Figure 5.6. Clinical group interactions on level-1 within person mood strategy use (x-axis) and perceived efficacy (y-axis). The depressed group significantly differed from the healthy and remitted groups in behavioural avoidance and problem-solving efficacy, and the remitted group differed from the depressed group in cognitive distraction efficacy. All strategies showed a significant main effect of efficacy along use, but there were no other group differences than those displayed here.

Positive and Negative Mood predicted by Strategy Use at time (*t*–1)

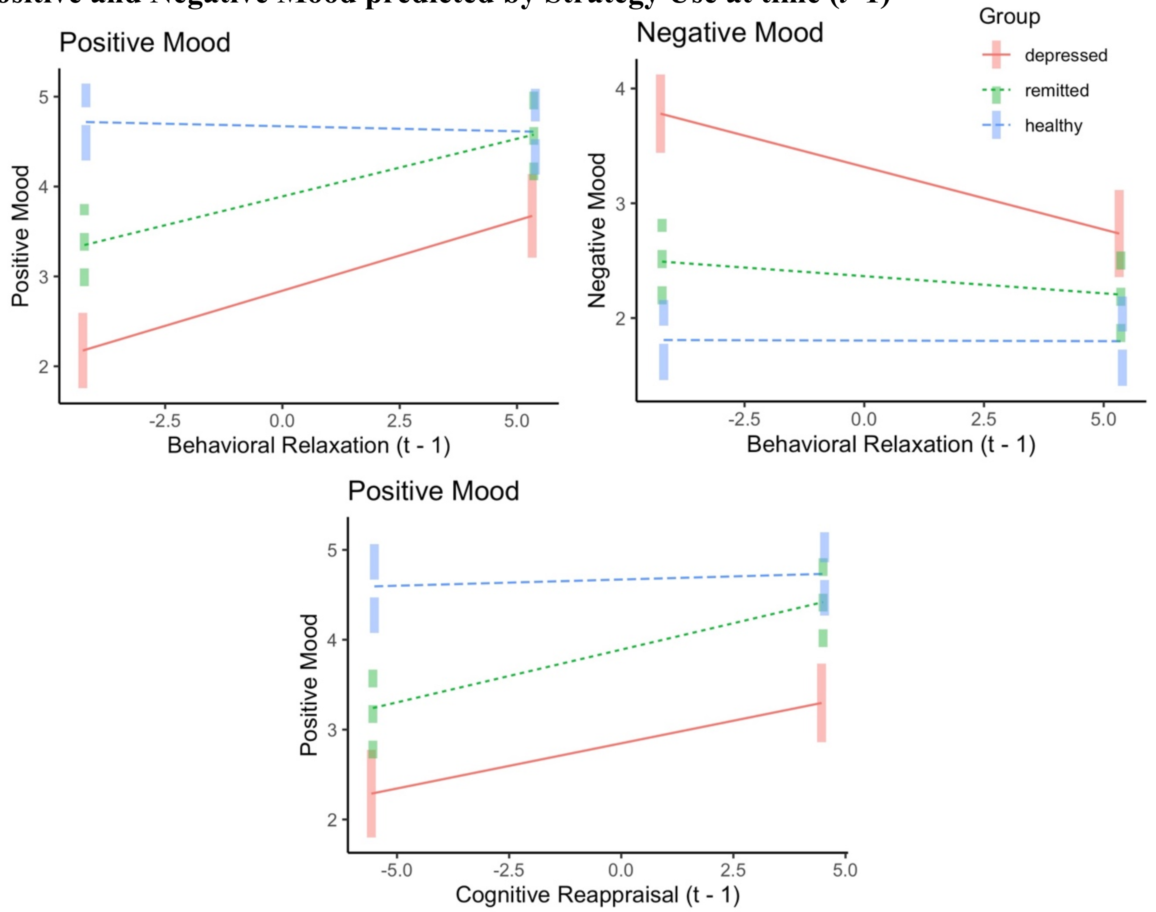

Figure 5.7. Clinical group interactions on level-1 within person use of lagged mood regulation strategy from previous day (*t*–1) (x-axis) and next-day mood (y-axis denotes positive or negative mood). There was a significant main effect across groups for lagged use of behavioural relaxation and cognitive reappraisal and positive mood, and only in lagged behavioural relaxation for negative mood. The depressed and healthy group significantly differed on lagged behavioural relaxation for both positive and negative mood. There were no significant differences than those displayed here.

Cognitive Avoidance. There was no main effect associated with changes in positive or negative mood. There were no group differences between the relationship of positive or negative mood on use, or in how rated efficacy of this strategy changed as use increases.

When previous day strategy use increased, there were no subsequent main effects of changes in positive or negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

Behavioural Avoidance. There was no main effect associated with changes in positive or negative mood. There were no group differences between the relationship of positive or negative mood on use. Depressed participants rated this strategy as less efficacious when usage increased compared to healthy and remitted participants (b=0.24, SE=.06, $t(95)$=3.92, p<.001; b=0.18, SE=.05, $t(95)$=3.81, p<.001 respectively).

When previous day strategy use increased, there were no subsequent main effects of changes in positive or negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

Cognitive Relaxation. There was a significant main effect of increased use associated with higher positive mood (b=0.51, SE=.07, t(95)=7.44, p<.001) and decreased use associated with increased negative mood (b=–0.31, SE=.07, t(95)=–4.29, p<.001). Group differences suggest depressed participants' use of this strategy increased more strongly than the healthy participants' use when positive mood increased (b=–0.36, SE=.11, t(95)=–3.38, p<.001). There were no significant group differences in the relationship of negative mood on use. Depressed and remitted participants rated this strategy as more efficacious when usage increased compared to healthy participants (b=–0.12, SE=.05, t(95)=–2.40, p=.02; b=–0.18, SE=.05, t(95)=–3.31, p=.003 respectively).

When previous day strategy use increased, there were no subsequent main effects of changes in positive or negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

Behavioural Relaxation. There was a significant main effect of increased use associated with higher positive mood (b=0.69, SE=.07, t(95)=9.36, p<.001) and decreased use associated with increased negative mood (b=–0.53, SE=.08, t(95)=–6.67, p<.001). Group differences suggest depressed and remitted participants' use of this strategy increased more strongly than healthy participants' use, as positive mood increased (b=–0.56, SE=.12, t(95)=–4.82, p<.001; b=–0.43, SE=.12, t(95)=–3.69, p<.001 respectively). There were no group differences between the relationship of negative mood on use. There were no group differences in how rated efficacy of this strategy changed as use increases.

When previous day strategy use increased, main effects showed increases in positive mood (b=0.16, SE=.03, t(95)=4.68, p<.001) and decreases in negative mood (b=–0.11, SE=.03, t(95)=–3.99, p<.001). Group differences suggest that as lagged strategy use increases, depressed participants experience more of an increase in positive mood than healthy participants (b=–0.17, SE=.05, t(95)=–3.63, p<.001). There were no group differences in how lagged strategy use affected later negative moods.

Cognitive Distraction. There was no main effect associated with changes in positive or negative mood. There were no group differences between the relationship of positive or negative mood on use. Depressed participants appeared to rate this strategy as less efficacious when usage increased compared to remitted participants (b=0.17, SE=.05, t(95)=3.27, p=.001).

When previous day strategy use increased, there were no subsequent main effects of changes in positive or negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

Exercise. There was a significant main effect of increased use associated with higher positive mood (b=0.43, SE=.08, t(95)=5.37, p<.001). There was no main effect of negative mood on use. There were no group differences in the relationship of positive or negative mood on use. There were no group differences in how rated efficacy of this strategy changed as use increases.

When previous day strategy use increased, there were no subsequent main effects of changes in positive or negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

Cognitive Reappraisal. There was a significant main effect of increased use associated with higher positive mood (b=0.56, SE=.07, t(95)=8.49, p<.001) and decreased use associated with increased negative mood (b=–0.39, SE=.07, t(95)=–5.58, p<.001). Group differences suggest depressed participants' use of this strategy increases more strongly than healthy participants' use (b=–0.21, SE=.09, t(95)=–4.56, p<.001) when positive mood increases. Group differences further suggest than depressed participants' use of this strategy increases less than healthy participants' use as negative mood increases (b=0.42, SE=.13, t(95)=3.12, p=.002).

When previous day strategy use increased, main effects suggests an increase in following positive mood (b=0.10, SE=.03, t(95)=2.89, p=.004) but no subsequent main effects of changes in negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

Support Seeking. There was no main effect associated with changes in positive mood or negative mood. There were no group differences between the relationship of positive or negative mood on use, or in how rated efficacy of this strategy changed as use increases.

When previous day strategy use increased, there were no subsequent main effects of changes in positive or negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

Problem Solving. There was a significant main effect of decreased use associated with increased positive mood (b=–0.33, SE=.07, t(95)=–4.55, p<.001) and increased use associated with increased negative mood (b=0.31, SE=.08, t(95)=4.07, p<.001). There were no group differences between the relationship of positive or negative mood on use. Depressed participants appeared to rate this strategy as less efficacious when usage increased compared to healthy and remitted participants (*b*=0.26, *SE*=.05, *t*(95)=4.89, *p*<.001; *b*=.15, *SE*=.05, *t*(95)=3.02, *p*=.003 respectively).

When previous day strategy use increased, there were no subsequent main effects of changes in positive or negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

Acceptance. There was a significant main effect of increased use associated with higher positive mood (*b*=0.25, *SE*=.08, *t*(95)=3.14, *p*=.002). There was no main effect associated with changes in negative mood. There were no group differences between the relationship of positive or negative mood on use, or in how rated efficacy of this strategy changed as use increases.

There were no main effects of changes in positive or negative mood. There were no group differences in how lagged strategy use affected later positive or negative moods.

5.5 DISCUSSION

This study sought to assess how mood regulation strategies may be used and perceived by a clinical sample with and without a depressive disorder history. As hypothesised, people with depression appeared to self-report the highest levels of feeling stuck within their mood states. While mood inertia as a feature of positive or negative mood (see Chapter 4) did not appear to differ clinically, self-reported feelings of being trapped in moods did indeed appear to distinguish clinical experience. It may be that mood inertia, the likelihood of past affect predicting future affect, (Koval et al., 2013; Kuppens et al., 2010, 2012) is felt similarly across individuals, but that a subjective sense of being trapped in inert mood states is a problematic aspect of poor mental health, as in depression. This may relate to theoretical models of mood as momentum (see e.g., Eldar et al., 2016) and dysfunctional processing of depression to be trapped in feedback cycles of negative biases during low mood that further exacerbate the negative mood experience.

With respect to specific strategy use, multilevel modeling of within-person strategy use between clinical groups suggested that depressed participants tended to engage in cognitive avoidance, behavioural avoidance, and cognitive distraction more than healthy participants, though no such difference was present compared to remitted participants. Interestingly, it did not appear that depressed persons used cognitive reappraisal any less than healthy persons despite this being a feature of emotion regulation group differences (Aldao et al., 2010; Dryman & Heimberg, 2018; Gross, 1998). Given how central cognitive reappraisal is to emotion regulation contexts (Aldao et al., 2010; Gross, 1998), the present findings further suggest probing of this strategy in mood contexts to better understand if and how reappraisal may be related to remission onset or maintenance, or healthy functioning. Provided moods are more diffuse and less object-oriented or directed towards something (e.g., Russell, 2003) it could be interpreted that it is less likely or difficult for one to cognitively reappraise something causing their mood if this very affect state is not theoretically believed to be 'caused' by a particular object (Larsen, 2000; Parkinson, 1996; Russell, 2003).

Lack of significant group differences in usage of cognitive relaxation, behavioural relaxation, exercise, support seeking, and acceptance strategies may suggest that, regardless of the current status of one's mental health, these strategies are engaged with relatively equivalently to manage mood. Parallels may be drawn to meta-analytic reviews of corresponding emotion regulations strategies, where acceptance was not found to have a significant association to psychopathology (Aldao et al., 2010).

To further understand how mood regulation strategies may be associated with changes in real-life mood across all clinical groups, further modeling tested interactions between usage, efficacy, and mood.

Mood Stuckness and Perceived Efficacy of Strategies

The use of strategies related to within-person feelings of mood stuckness was next explored. These interactions help provide information on whether individuals with differing mental health diagnoses experience disparities in their ability to attempt mood regulation, or feel effective results following regulation, when they feel stuck within moods. Alongside higher levels of mood stuckness, findings suggested that depressed and remitted individuals did not use cognitive reappraisal as much as healthy individuals. Further, remitted persons did use support seeking more than depressed persons during these higher 'stuck' feelings. Given these were the only strategies impacted differentially by clinical status with respect to mood stuckness, it is likely that mental health plays a role in the ability to use cognitive reappraisal and support-seeking successfully when feeling trapped within stagnant negative mood states.

An interpretation for these findings may be that regulating mood during periods of "stuckness" may require significant efforts, and for those with a history of mental health, these efforts are more difficult to allocate resources to when difficult mood states are recurring and chronic. It may also be interpreted as a possible sensitivity to lower abilities to regulate within stuck moods relating to mental health history. Causality was not possible to determine here, but the findings help provide information about future research directions and possible explorations further targeting regulation in the context of stuckness.

More specific interpretations include possibilities that during remission, seeking out support from social connections to try and reduce feelings of mood stuckness occur more or be felt as more helpful than for those currently depressed. This may be related to past findings in a general adolescent population where support seeking was found to predict fewer depression and anxiety symptoms when individuals had low rumination, though engagement with support seeking actually appeared to predict more symptoms when rumination was high where it may be harder to actively gain support in episode (Vélez et al., 2016). Given our clinical groups consisted of adults with chronic, recurrent major depressive disorder in episode or in remission, it may be possible this context applies here as well, providing further evidence that support seeking as a regulation strategy for mood is helpful when rumination is lower (e.g., remission) but not when it is higher (e.g., depression).

Alongside feelings of being stuck within mood states, the perceived efficacy of how helpful participants found their engagement with mood regulation to be was also assessed. Particularly when we consider these findings on the perceived efficacy of these strategies during mood stuckness, it may be reasonable to interpret this as resultant from the additional resources and effort possibly required for clinical groups to engage during stuckness. Depressed participants found many strategies to be less helpful than healthy individuals including cognitive relaxation, behavioural relaxation, and cognitive reappraisal. Comparing remitted persons to healthy persons also resulted in cognitive reappraisal being felt as less efficacious during higher mood stuckness. This may point towards this self-reported nature of feeling stuck within moods as a problematic bias that impacts the successful engagement of regulation, even when it being attempted (e.g., Dryman & Heimberg, 2018; Joormann & Quinn, 2014).

Remitted participants' lower perceived efficacy of reappraisal than healthy persons may imply that during remission, it may still be difficult or feel less helpful to engage in relaxation strategies or reappraise mood content more positively than for those with no depression history. It may also be that lower ability to engage with these strategies in associated with depression and remission, such that focusing intervention and treatment efforts on specifically improving abilities to mentally relax, encouragement of engagement with relaxing activities, and continued work on improving reappraisal efforts. It may be that ultimately, self-directed use of these strategies is higher in individuals with lower risk of depression.

Strategies and Concurrent Mood, Efficacy, and Next-Day Mood

Use and Concurrent Mood

Across all groups, strategies that appeared to be associated with higher positive mood included higher use of cognitive relaxation, behavioural relaxation, exercise, cognitive reappraisal, and acceptance, and lower use of problem solving. Strategies that appeared to be associated with lower negative mood across all groups included higher use of problem solving, and lower use of cognitive relaxation, behavioural relaxation, and cognitive reappraisal. Strategies for which there was no support for an association with positive or negative mood included cognitive avoidance, behavioural avoidance, cognitive distraction, and support seeking.

Individuals may be engaging more in relaxation and reappraisal and less in problem-solving strategies when in better moods, or to help boost positive and lower negative mood states. Exercise and meditating on or accepting one's mood state lack of association with reduced or increased negative moods, and presence of association with increased positive moods may suggest that acceptance regulation strategies are more relevant for maintaining positive moods only.

In assessing how clinical status may have affected levels of use and concurrent mood state, several group differences were uncovered. Depressed participants, compared to healthy participants, appeared to use cognitive relaxation, behavioural relaxation, cognitive reappraisal at higher levels when positive moods were higher. However, depressed persons only used cognitive reappraisal at lower levels when negative moods were higher compared to healthy persons.

Strategies with no significant group differences as positive or negative mood shifted included cognitive avoidance, behavioural avoidance, cognitive distraction, and support seeking, suggesting mental health status may not lead to differences in use dependent on the mood states in question. Further, cognitive and behavioural relaxation strategies did not differ between groups with respect to negative mood changes suggesting all groups engaged in similar levels of relaxation regulation attempts when negative mood levels changed, although it did appear that healthy persons could engage in cognitive reappraisal more than depressed persons when negative mood was higher, relating to emotion regulation findings in this nuanced relationship (e.g., Aldao et al., 2010; Dryman & Heimberg, 2018; Gross, 1998).

Perceived Efficacy and Use

There were no mood regulation strategies that depressed persons reported as more efficacious alongside use than non-depressed persons.

There were several strategies that depressed participants found to be less helpful than remitted participants when use increased including behavioural avoidance, cognitive distraction, and problem solving. In addition, depressed participants appeared to find behavioural avoidance and problem solving as less efficacious than healthy participants when use increased.

This may suggest different possibilities. It may be that remitted persons tend to find several mood regulation strategies as more helpful than currently depressed persons, and this association is a feature of remission, that is, the tendency to find several mood regulation strategies more helpful even though such differences for remitted persons may have been more minimal in emotion regulation work (e.g., Visted et al., 2018). We reiterate the importance in addressing limitations on directional interpretation of this observational study and recommend future work to probe possible directional relationships through targeted applied interventions.

In addition to remitted participants finding more strategies efficacious than depressed persons with higher use, the remitted group also appeared to find cognitive relaxation and cognitive reappraisal as more efficacious alongside higher use than healthy participants when further pairwise tests were conducted, suggesting possible further utility of these strategies in being useful for remitted persons.

There were no group differences in how clinical groups perceived efficacy as use increased for cognitive avoidance, cognitive relaxation, behavioural relaxation, exercise, cognitive reappraisal, support seeking, and acceptance. Depressed, remitted, and healthy persons appear to all feel similarly on how helpful it feels to self-regulate by engaging in relaxing activities, exercise, receiving social support, and accepting their mood states.

Strategy Use and Next-Day Mood

The final modelled relationships explored how strategy usage may have had an effect on next-day moods[5]. There were very minimal main effects or differences between groups when exploring this lagged relationship. Here, we must be careful in interpreting the causality of these relationships. Given these lagged relations are still only observed data, it is not clear

[5] It is important to note here that the lagged effects of strategy use on subsequent mood do not adjust for the effects of same-day strategy use.

whether the use on one day may have predicted a change in later mood, or if the gradual improvement in mood is correlatively preceded by increases in strategy use, which may be easier and less effortful to engage in when moods are improving.

Across all groups, increased use of behavioural relaxation was related to higher next-day positive mood and lower next-day negative mood, and increased use of cognitive reappraisal was related to higher next-day positive mood (though no change in next-day negative mood). This may suggest that engaging in relaxing activities behaviourally to regulate mood aid people in general, regardless of clinical status, to boost positive moods and reduce negative moods for a relatively longer perceived timeframe than other regulation strategies that are used concurrently. However, this may also suggest a possibility that increases in positive mood over time may show easier use cases of mood regulation strategies while such improvements are underway. Cognitive reappraisal further showed boosted positive mood, but not reduced negative mood interestingly, which may mean while reappraisal may help during positive moods, it may not universally help in tolerating negative states collapsed across all groups.

In fact, group differences further granulated how clinical groups negative moods differed following these strategy uses, such that for depressed participants compared to healthy participants, increased use of behavioural relaxation was related to more increases in next-day positive mood and more reductions in negative mood than for healthy persons. Results continue to emphasize the possibility of clinical difficulty in ameliorating negative moods when in clinical depression following mood regulation strategies, even when behavioural relaxation boosted positive moods, they did not unfortunately reduce negative moods for depressed persons to the extent compared to non-depressed persons.

Strategies for which there was no support in associated next-day positive or negative mood included cognitive avoidance, behavioural avoidance, cognitive relaxation, cognitive distraction, exercise, support seeking, problem-solving, and acceptance. There were similarly no other group differences, suggesting behavioural relaxation may help aid in lagged manners towards mood regulation, or be a strategy easier to engage with when moods are improving.

Summary

In all, the aim of this study was to assess ten different mood regulation strategies in the context of depression, remission, and healthy persons and summarise concurrent and lagged relationships alongside measures of self-perceived feelings of being trapped or stuck within mood states, perceived efficacy or helpfulness of having engaged in each strategy, and subsequent relationships to ongoing naturalistically felt mood. We assessed the extent to which clinical groups differed among their experiences to provide a comprehensive summary of mood regulation behavior and mental health.

Limitations to this study include transparent expression we cannot conclude on causation between mood regulation strategies and impact on or towards depression or remission. All models and relationships discussed on feelings of stuckness, strategy use, perceived efficacy, and concurrent/lagged mood are associative and not causational. To better determine how we can understand causation and context, future work may consider enrolling individuals in chronic depressed mood and healthy non-depressed mood to engage specifically with certain strategies, monitor possible changes in their mood over time, and report on possible directional findings (i.e., is a depressed person instructed to engage in behavioural relaxation strategies for mood regulation as they go about their daily life indeed experiencing a an increase in positive mood and reduction in negative mood?). Given the importance discussed in understanding regulation of mood states differentially (e.g., Beedie et al., 2005; Eldar et al., 2016; Larsen, 2000; Parkinson, 1996; Thayer et al., 1994), we hope our initial study into naturalistic real-life use of mood regulation strategies prompts further continued research of these many important remaining questions, and continues to grow as compared to the plethora of well-reviewed and expansive work on emotion regulation (Aldao et al., 2010; Burr & Samanez-Larkin, 2020; Gross, 1998, 2015; Gross & Muñoz, 1995; Joormann & Quinn, 2014; Joormann & Stanton, 2016).

Research on Affect Summary

In summary, this study hopefully provides a foundational description of several regulation strategies used specifically for maintaining positive mood or reducing negative mood and nuanced complexities in their use, perceived efficacy, and directional relationships to mood changes across clinical groups. At this time, several questions on affect with respect to mental health have been unpacked. This has included how developing adolescents with varying depression risk status may represent emotion and mood states (Chapter 2), how emotion dynamics may unfold over time within-person in an adult transdiagnostic sample (Chapter 3), how differential emotion and mood may be along multiple summary metric features and in relation to one other across time in a depressed, remitted, and healthy sample (Chapter 4), and finally here in Chapter 5, how these aforementioned individuals may regulate their mood experiences in their daily life. These highlighted findings thus far provide an initial foundation for investigation into several aspects of emotion and mood.

From Affect to Mental Wandering

Given the findings of Chapter 4 in highlighting the chronometry of negative mood and findings of the present Chapter 5 for perceived feelings of being stuck within such mood that depressed persons report feeling, the next part of this thesis examines how unfolding spontaneous thought may be impacted and measured in persons experiencing these difficulties in mood. The next chapter aims to orient the reader to a proposed synthesis and expansion of the study of mental wandering along a number of dimensions of hypothesised importance (see Chapter 6), and the final following experimental chapter explores dimensionality of mental wandering in the same sample assessed here (Chapter 4 and 5) as well as a separate sample of chronically depressed and healthy controls.

CHAPTER 6 – THE DECOUPLED, UNCONSTRAINED MIND: TAXONOMIES OF MENTAL WANDERING

6.1 OVERVIEW

The prior chapters have covered several research questions aimed at elucidating distinctions of emotion and mood in relation to mental health. Given the findings that individuals with depression are spending greater amounts of time in chronic negative mood states (see Chapter 4) and that they feel stuck within these negative moods (see Chapter 5), a question is raised as to how these affective difficulties may relate to unfolding thought content in the mind at rest. Much of internal mental life is spent mind wandering, and the relevance of the nature of this great span of time on one's mental health carries weight and importance in clinical research.

Mind wandering in real-time situations involves many possible scenarios, environments, distractions, and external stimuli that it is hard to control or accounted for in understanding hypothesised dimensions of mind, but that still provide a naturalistic picture of the experience. The phenomenology of what it means to measure the wandering mind is also valuable to consider through methods that control for variability in external distraction. There exists a need for determining a comprehensive set of dimensions that express clinical value and allow for a vivid picture of the mental phenomenological experience.

Considering this, here we draw together the previous literature to outline a novel theoretical taxonomy for considering multiple dimensions of mind wandering. For this framework proposal dimensions were included based on their theorized importance to mental health experiences.

6.2 INTRODUCTION

A majority of life is spent in mental wandering, with findings suggesting people psychologically drift away from their present moment to focus on the inner content of their experience for nearly half their waking hours (Killingsworth & Gilbert, 2010). Research on such ‘mind wandering’ – the intentional or spontaneous movement of mind to various abstractions that differ from one’s present state (e.g., Killingworth & Gilbert, 2010) – has burgeoned in the last 20 years, generating a series of influential self-report, behavioural, and neuroimaging methods that in turn have influenced a number of phenomenological accounts of mind wandering (Christoff et al., 2016; Gruberger et al., 2011; Smallwood & Schooler, 2015). In this chapter, the intention is to review these various accounts and propose a unified framework for the phenomenology of mental wandering.

Historically, a great deal of research has framed the study of psychological phenomena in terms of subpersonal cognitive functions, focusing on assessing specific task-based processes engaged during controlled tasks (Amodio & Frith, 2006; Burgess, 2008; Mitchell et al., 2005). The standard methodology within the fields of psychology, cognitive science, and behavioural neuroscience attempts to study these task-based responses to make conclusions about underlying mental processes and/or their neural correlates (Corbetta & Shulman, 2002; Martin & Chao, 2001; Posner & Petersen, 1990). While this is certainly important, as noted in the thesis Introduction in Chapter 1, an equally important area for understanding human mental life concerns the nature of personal level mental content, particularly when that content is decoupled form the experiences of engaging in discrete external tasks (Christoff et al., 2016; Fox et al., 2015; Seli et al., 2016).

With respect to psychological phenomena, while all conscious beings in the animal kingdom possess the ability to experience mental content, these experiences are assumed to be constrained by their present environment, so called primary or sensory consciousness (e.g., Edelman, 1989). Animals may evolutionarily be able to mentally navigate in the context of their immediate environment in ways that directly help their biological drives succeed (e.g., Dukas, 2004), while mental content in human beings, in contrast, can be decoupled from immediate related environmental information, and comprise a primary phenomenology of, for example, thoughts and memories spanning past and future times (Edelman, 1989; Feinberg & Mallatt, 2016; James, 1904). In addition, human mentation is characterized by higher-order awareness allowing second-order reflection on these primary contents of conscious experience whether they be sensory experiences of the immediate present or memories and decouple cognitions (Edelman, 1989; Feinberg & Mallatt, 2016).

These higher-order experiences, while unlocking massive human cognitive capacities spanning evolutionary civilization (e.g., Edelman, 1989), also operate in counterproductive maladaptive ways (Christoff et al., 2016; Killingsworth & Gilbert, 2010; Ruby et al., 2013) that lead to debilitating mental health disorders affecting quality of life (Friedrich, 2017).

Many of us may have instances our minds drift towards the past, to our own detriment. In other cases, ruminative negative thoughts can then drive feelings of depression and low mood (Aldao et al., 2010). While such occurrences can be purposeful and elicited by the person intentionally, many times such thoughts may also spontaneously arise (Mildner & Tamir, 2019; Seli et al., 2016) as in instances of mind wandering. Navigating mental content in ways that are completely unrelated and, at times, disadvantageous to current surroundings can be theorised to be a uniquely human psychological experience and worthy of further investigation.

Mind Wandering and Mental Health

Relatedly, given the profound global burden of chronic clinical disorders such as major depression with respect to disability, reduced workload, and reduced quality of life (Alonso et al., 2011; Friedrich, 2017), and the corresponding amount of time a person is engaging in an internal navigation of mental abstractions (Killingsworth & Gilbert, 2010), there remains a strong question as to what distinct differences underlie the phenomenological experience of mental well-being in relation to nature of mind. Past studies have assessed the relationships of qualities of mind wandering or mindfulness to depressive symptoms and well-being (Deng et al., 2014; Poerio et al., 2013; Ruby et al., 2013; Seli et al., 2019), but more work can be done in elucidating frameworks with respect to the phenomenology of mind and relations to mental health. A goal of this chapter is therefore not only to review and synthesise prior frameworks, but to provide an account for why key components and dimensions of the nature of mind may hold value in improving understanding of both poles of well-being and clinical dysfunction.

Considering Mind Wandering Concepts

While mental abstractions, otherwise described as thoughts or mental content, simultaneously arise from the mind and also constitute the nature of mind, this internal flow has been referred to in different ways. Most commonly, research has considered this ebb and flow of mental content as ‘mind wandering’ (Killingsworth & Gilbert, 2010; Mildner & Tamir, 2019; Mrazek et al., 2012; Smallwood & Schooler, 2015). There has been a gradual rise in such research of these internally driven representations. Despite this increase in interest of what processes occur in the mind outside of external influences and explicitly defined tasks, many pertinent differences exist in how researchers define and therefore investigate these processes.

Definitional constructs influence the methods to which research may frame questions on mind wandering, therefore impacting the ability to investigate the occurrence and nature of these subjective internal experiences. Mental abstractions may consist of mental content that may arise spontaneously (Christoff et al., 2016; Mildner & Tamir, 2019), be either intentional or unintentional in its occurrence (e.g., Seli et al., 2016), and happen far more often and freely in resting state conditions where external environmental cues or stimuli are greatly reduced (e.g., Gruberger et al., 2011).

The Present Review

Studying the nature of mind has evolved over time to harmonize this definition, as evidenced in the literature discussed throughout this proposal. We begin by touching upon current foundations and express our motivation in integrated expansion of these approaches to fine-tune our ability to assess mental content. This is especially with respect to the importance of understanding not just the ways in which we may capture dimensions of mental content for the general population, but also the ways in which such dimensional processes become maladaptive and negatively impact individuals with depression.

In this narrative review, we therefore overview existing frameworks and propose additional components of study with the ambition of elaborating upon these shared goals of better studying the ways in which the mind wanders. We review past work and offer a cohesive explanation and definition for attempting the study the nature of mind, a historical account on the shifts in psychological research on mental processes, and a proposal for an integrated theoretically grounded framework for investigating the phenomenological experience of the nature of mind.

This review therefore (i) summarises the evolution of mind wandering definitions as a construct of study, (ii) considers the ways these definitions influence study designs, and (iii) explores multiple past proposals and undercurrents to derived frameworks. Moving past this review, I offer (iv) a proposed synthesis of dimensions of interest that may help phenomenologically describe the experience of mental events arisen by a wandering mind along with suggestions for further study.

Historical Aspects of the Study of Mind Wandering

Task Independent Thought

Mind wandering was prototypically conceptualized as task-unrelated or stimulus-independent thought, and interchangeably defined with these terms (Giambra, 1995; Mason et al., 2007). In attempting to study the unfolding experience of this kind of self-generated thought, a combined construct pairing spontaneous occurrence of these independent experiences (Smallwood, 2013; Smallwood & Schooler, 2015), it is important to understand the boundaries that define the existence of the phenomena. Thus, this early definition was an appropriate foundational point for conceptualising a common-sense approach for defining mind wandering – the unrelated mental thoughts when one's mind drifted from a task at hand or stimuli meant to focus attention. Many prototypical studies on mind wandering have used this definition (Christoff et al., 2009; Killingsworth & Gilbert, 2010; Mason et al., 2007; Ruby et al., 2013; Schooler et al., 2011).

However, these prototypical definitions miss the distinction between when a mind drifts from a task or stimulus at hand and the unfolding spontaneous mental experiences that occur when the mind is 'at rest' or otherwise free to wander unconstrained (e.g., Gruberger et al., 2011). As thoughts shift around to various abstractions free from external cues, such as that measured passively in resting-state neuroimaging (Christoff et al., 2009; Diaz et al., 2013; Gruberger et al., 2011) it is possible to consider unfolding consciousness as it relates to self-generated various internal representations, thoughts, or memories, and philosophically consider what is nature of mind (Northoff, 2012). As a consequence, more recently this distinction between mind wandering away from an intended focus versus unconstrained mental wandering has been promoted (Smallwood & Andrews-Hanna, 2013; Smallwood & Schooler, 2015).

Resting-State Spontaneous Thought

Neuroimaging has proved central to advanced investigation of passive and consistently self-generating ebb and flow of mind (Christoff et al., 2009; Diaz et al., 2013; Gorgolewski et al., 2014; Gruberger et al., 2011; Smallwood & Schooler, 2015). Resting-state functional magnetic resonance imaging (fMRI) explores functional brain activity absent of any psychological, cognitive, or motor tasks while participants simply lie down in neuroimaging scanners with black screens as visual stimuli, or eyes closed (Gruberger et al., 2011). Numerous resting state fMRI studies have explored network connectivity between regions active at rest, termed 'the default mode network' (Gusnard & Raichle, 2001; Raichle, 2015). While there are attentional or task-based neural systems in the brain, the default mode network is largely active absent of any attentional or motive-driven tasks (Raichle, 2015).

Neural activity in regions associated with the default-mode network (e.g., medial prefrontal cortex, posterior cingulate, precuneus; Gusnard & Raichle, 2001; Raichle, 2015) have allowed researchers to determine aspects of how resting-state neural architecture relates to mental health in in novel manners above controlled tasks (Mulders et al., 2015; Sheline et al., 2009). Resting-state findings have further been used differentiate mental health problems such as depression or schizophrenia, (Greicius et al., 2007; Liang et al., 2006) and general health issues like dementia and Alzheimer's (Hafkemeijer et al., 2015; Sheline & Raichle, 2013). These avenues of research suggest that the underlying brain activity of the mind at rest varies across mental health and cognitive conditions when compared to control participants (Lee et al., 2013; Smith et al., 2013). At rest in such conditions, of course, an individual will be navigating their own mental environment in a self-generated manner absent of external distraction (Hurlburt et al., 2015), and these neural connectivity differences will likely reflect systematic differences in these profiles of mental wandering, which are next considered.

Approaching a Synthesised Study of Mind Wandering

With these definitional concepts of mental wandering taken into consideration, the further goal of this review is to parse apart the different types of content that may be represented in mental abstractions (e.g., thoughts, images, memories, affective valence) as well as our relationships to these thoughts (e.g., immersion, detached observation, intentionality).

Current Approaches and Frameworks to Identify Mind Wandering Components

Several researchers have developed frameworks for decomposing the nature of the contents of the wandering mind. Some have done so by utilising large-scale data responses from participants and uncovering data-derived interpretable factors from reduction techniques, while others have elaborated theoretically driven frameworks for the study of thought from clinical, meditative, or neurological perspectives, with proposed dimensions of interest.

Identifying a framework of study into the wandering mind is important in furthering the study of mind in a comprehensive way across researchers in psychology and neuroscience. Agreeing upon assessed dimensions or aspects of the experience a participant ought to self-report helps collectively move forward on such shared research objectives. By reviewing existing taxonomies that have leveraged either data-based approaches or theoretical approaches to mental phenomenology, our goal is to synthesise overlapping existing dimensions across frameworks and identifying additional dimensions of potential significance for mental health and well-being.

Data-Based Approaches

One approach in gathering information on dimensions of the mind at rest involves data-driven methods which seek to cluster and analyse bottom-up manifestations of interpretable components arising from large-scale self-report studies, often using standardized questionnaires in the context of resting state fMRI (see Table 6.1).

Reference	Data-derived Scale	Key Components	Proposed Dimensions
Delamillieure et al., 2010	*Resting-State Questionnaire (ReSQ)*	Type of Representation	–Visual Mental Imagery –Inner Language/Inner Speech/Auditory Mental Imagery –Inner Musical Experience –Mental Processing of Numbers
		Somatosensory Awareness	–Somatosensory Awareness
Diaz et al., 2013	*Amsterdam Resting-State Questionnaire (ARSQ)*	Relation to Experience	–Discontinuity of Mind –Theory of Mind –Self
		Type of Representation	–Planning
		Somatosensory Awareness	–Sleepiness –Comfort
Gorgolewski et al., 2014	*New York Cognition Questionnaire (NYC-Q)*	Temporal Nature	–Past –Future
		Affect	–Positive thoughts –Negative thoughts
		Relation to Experience	–Social Cognition
		Types of Representation	–Words –Images –Specificity

Table 6.1. Summary of related key components across data-driven frameworks for understanding components of mind wandering. Each of the proposed dimensions represent a construct probed upon by self-report question items that map onto a broader key component of mind wandering (e.g., mental abstractions in mental wandering can be reported to have some dimension of visual mental imagery from low to high levels, and this related to the component of a type of representation, whereas a dimension of discontinuity of mind relating to subjective sense of control may instead map onto a component of one's relationship to the mental experience rather than the type of representation).

Resting-State Questionnaire. In one early study by DeLamielleure et al. (2010), researchers developed a semi-structured Resting-State Questionnaire (ReSQ) based on domains of mental activities based on translations of prior qualitative interviews. This structure parsed apart five types of mental activities, two of which were derived from their qualitative interviews of 180 participants: Visual Mental Imagery, Inner Language/Inner Speech/Auditory Mental Imagery, Somatosensory Awareness, Inner Musical Experience, and Mental Processing of Numbers.

This semi-structured interview covered these components through a series of binary (yes/no), categorical (subject or content types), continuous (proportion of time spent from 0-100%), and open-ended responses (free response, semi-structured clarifications). Descriptive statistics of the frequency of these dimensions during the overall experience were assessed following resting-state fMRI and indicated that participants largely thought about memories and visual imagery, and to a far lesser extent, bodily awareness or numbers (Delamillieure et al., 2010).

Amsterdam Resting-State Questionnaire. More recently, in a large-scale study including self-report from 813 participants, Diaz et al. (2013) developed a data-driven framework to uncover cognitive phenotypes to explain differences in what participants experience while in resting-state fMRI, resulting in a novel self-report questionnaire – the Amsterdam Resting-State Questionnaire (ARSQ; see Appendix 6.1). Over 100 Likert-scale statements were generated from mind wandering, mindfulness, and personality inventories relating to thought content and affect, and the total set was narrowed to half after piloting and removing items that were overly ambiguous or without variance (Diaz et al., 2013).

The questionnaire was delivered after both "behavioural resting-state" (i.e., eyes closed for five minutes in front of a computer task delivered at home) and neural resting-state with simultaneous electroencephalogram (EEG) recordings in the lab. Exploratory factor analyses and confirmatory factor analyses were used to uncover seven factors: Discontinuity of Mind, Theory of Mind, Self, Planning, Sleepiness, Comfort, and Somatic Awareness. These domains have since been used to interpret thought content under a variety of conditions from sleep disorders to psychopharmacological influences on the nature of mind (Palagini et al., 2016; Stoffers et al., 2015; Wießner et al., 2021).

New York Cognition Questionnaire. Other studies have also leveraged large-scale data collection methods to generate other taxonomies of latent factors, including the New York Cognition Questionnaire (NYC-Q; see Appendix 6.2), another self-report measure designed for implementation in resting-state fMRI (Gorgolewski et al., 2014). Exploratory factor analysis was used to discover eight components using data from 166 participants: Past, Future, Positive thoughts, Negative thoughts, Social Cognition, Words, Images, and Specificity, which were then related to whole-brain analyses (Gorgolewski et al., 2014).

Comparing Data-Based Approaches. By generating large scale self-report questions across a variety of possible features and implementing these in large samples, these aforementioned investigations have worked to uncover various factors that help quantify the mind during resting-state. Translating such uncovered factors into self-report questionnaire through data-driven methods of reduction and interpretability, other researchers have further benefitted from using such scales to assess subjective differences in participants after resting-state neural data collection (Palagini et al., 2016; Pipinis et al., 2017; Stoffers et al., 2015; Wießner et al., 2021) and to draw further associations with other traits (Delamillieure et al., 2010; Diaz et al., 2013; Gorgolewski et al., 2014; Palagini et al., 2016; Pipinis et al., 2017; Stoffers et al., 2015; Wießner et al., 2021).

Some components of these derived dimensions relate more closely to resting-state context, understandably, as this is the purpose of their production, and some of these dimensions may not provide theoretically relevant information that is generalisable across contexts. For example, some data-derived dimensions are closely relevant to rating a quality of participant alertness in scanners or testing situations (sleepiness or comfort, ARSQ), but less relevant to the phenomenology of mind (Diaz et al., 2013). Other components may be theoretically tied together with the respect to what information provided may relate to, such as valence (positive or negative, NYC-Q; Gorgolewski et al., 2014), and point towards the inclusion of additional nuance of an arousal-based component of affective mental content in addition to valence, rather than the arousal of bodily state (see Table 6.1).

There exist overlapping key components that map across multiple data-derived studies. Type of representation and relation to experience appear frequently as broad components, followed by identification of temporal nature, affect, and somatosensory awareness. Altogether, these data-driven dimensions across prior studies highlight the opportunity to converge and consolidate dimensions of importance in mind wandering. The benefit to drawing on data-driven methods to uncover possible latent factors to mind wandering include the rigour and high-volume of data quality generated from large-scale self-reported information on thought content. Reducing a large number of items on quality of thought content into factors or profiles that further map onto neurological data can aid in interpreting such dimensions, but the data-based focus of these factors removes an aspect of theoretical importance relevant to phenomenological thought content.

Theoretically Driven Approaches

With the aim of better understanding the phenomenological of mental content, it is important to supplement data-driven approaches with theoretically driven proposals (see Table 2). The strength of such approaches and resulting frameworks is the focus on dimensions that potentially add to our understanding based on prior findings and theorised importance to the nature of mind, particularly with respect to mental health. For example, there are strong influences of mindfulness-based practices in improving well-being, and these features of non-judgement mal acceptance of the content of mind are present across various clinical psychotherapies (e.g., Dialectical Behaviour Therapy (DBT), Linehan, 1993; Mindfulness-Based Stress Reduction (MBSR), Kabat-Zinn, 1990; Mindfulness-Based Cognitive Therapy (MBCT), Kabat-Zinn, 2003; Acceptance and Commitment Therapy (ACT), Hayes et al., 2009).

Reference	Framework	Key Components	Proposed Dimensions
Lutz et al., 2015	*Neurocognitive Framework for Mindfulness*	Relation to Experience	–Object Orientation –De-reification –Meta-Awareness –Aperture –Clarity –Stability –Effort
Seli et al., 2016	*Axis of Intention for Mind Wandering*	Relation to Experience	–Intentionality
Smallwood, 2013	*Process-Occurrence Framework of Mind Wandering*	Relation to Experience	–Current Concerns –Decoupling –Executive Failure –Meta-Awareness
Christoff et al., 2016	*Dynamics of Mental Wandering (Spontaneous Thought)*	Relation to Experience (Dynamics)	–Constraint Exertion
Mildner & Tamir, 2019	*Dynamics of Mental Wandering (Unconstrained Memory)*	Temporal Nature (Dynamics)	–Memory Processes

Table 6.2. Summary of related key components across theoretical frameworks of qualities of mind wandering. Most dimensions of these frameworks relate to theoretical relationships one may have with the unfolding experience of mental wandering.

Neurocognitive Framework for Mindfulness. Stemming from such meditative traditions, Lutz et al. (2015) has therefore proposed a neurocognitive framework for mindfulness that has relevance to the present considerations. Multiple operational definitions of mindfulness were incorporated to aid in the diffuse spread of types of mindfulness across the literature, thus being compatible with mindfulness definitions across practices and fields (Kabat-Zinn, 1990; Suzuki, 1970). Mindfulness practices are mapped into two streams: Focused Attention meditation and Open Monitoring meditation, and three mental states relevant for psychopathology: Object Orientation, Dereification, and Meta-Awareness. Further secondary dimensions include: Aperture, Clarity, Stability, and Effort (see Figure 1.5 in Introduction). Through these multiple dimensions, the authors suggest that a state relevant to nature of mind, such as mind wandering is captured as low in Effort, Meta-Awareness, Aperture, Stability, and Dereification while mid-level in Clarity, and Object Orientation (Lutz et al., 2015). A state such as rumination is suggested to be mid-level in Meta-Awareness but still low in Dereification (Lutz et al., 2015). These multiple dimensions cover not only nature of the representation of mental content, but also a relation to these representations, an important distinction in attempting to phenomenologically study mind given the nature of mental wandering to decouple attentional focus from perception (Smallwood & Schooler, 2015).

This meditative framework overall acts as a heuristic for creating and relaying hypotheses in the neurocognitive understanding of mindfulness-related practices, and the utility in using these attributes to study mental health is considered. In addition to the proposed attributes, shared contextual features are considered across all mindfulness-related practices: Physical Posture, Non-aversive Affect, Axiological Framework, and Task-set Maintenance/Retention (Lutz et al., 2015). The multiple dimensions provided generate a sophisticated and highly granular framework for mindfulness-related practices with clear incorporation of traditional Eastern ideology (e.g., importance of posture in Zen Buddhism, Suzuki, 1970), in addition to clinical experimental research (e.g., importance in affective tone of thought and acceptance, Shapiro et al., 2006).

Axis of Intention for Mind Wandering. Another framework emphasising the conceptual difference of two cognitive experiences of deliberate versus spontaneous thought has been described by Seli et al. (2016), focused on the intentional basis for a mind wandering occurrence as providing meaningful information that can parse apart types of mind wandering with other traits or states (Seli et al., 2016). This framework strongly suggests intention as a further dimension of study not widely captured by prior researchers and the clinical relevance is shown in unintentional mind wandering occurrence being associated with attention-deficit/hyperactivity disorder and obsessive-compulsive disorder (Seli et al., 2016).

Process-Occurrence Framework of Mind Wandering. Such frameworks have focused on phenomenological experience when captured in a static moment (i.e., features that describe a mental abstraction that occurs at a single point of time). However, the movement and dynamic processes related to fluctuating streams of mental content is also a critical feature. The process-occurrence framework of mind focuses on the spontaneous onset of thoughts and how external and self-produced experiences may impact the onset and occurrence of thought (Smallwood, 2013). The importance of considering the occurrence of these thoughts in stimulus-independent contexts is discussed, along with the acknowledgement that it is difficult to pinpoint what process may have been led to the mind decoupling toward an extraneous thought (Smallwood, 2013). Specifically, four cognitive hypotheses are highlighted as candidate instigators mind wandering: Current Concerns, Decoupling, Executive Failure, and Meta-Awareness.

Dynamics of Mental Wandering. Furthering integrated dimensions to aid the quantification of mental content past occurrence level as well may further aim phenomenological pictures of mind, as in the work by Christoff et al. (2016), which proposes spontaneous thoughts can be considered with respect to constraints, such that mind wandering is more deliberately constrained than dreaming, but less than creative thinking or goal-directed thought. Neural models for the interactions of these automatic or semi-constrained thought content are further proposed with respect to the default-mode network as sources of variability and salience and attentional networks as sources of constraint exertion (Christoff et al., 2016; Mildner & Tamir, 2019). Mildner & Tamir (2019) similarly suggest a framework for spontaneous thought as an unconstrained memory process such that modes of memory form thought content and the context of one's current state exert constraints on the directional path of the memory content. These dynamic frameworks especially highlight the shifting nature of mental content

Towards an Integrated Framework

Each of these frameworks uses specific guided theory to outline and generate their theoretical proposals. The nuance and level of detail of proposed dimensions aims to provide structure within which to shape and communicate hypotheses. Our ambition is to integrate the key components from these theoretically guided frameworks within our integrated taxonomy (see Table 6.3). Our next aim was to seek to integrate these different approaches into a unified theoretically grounded taxonomy with reference to mental health. This is conducted by considering the key components that broadly capture qualities across studies and specific dimensions that holistically describe the phenomenology of mind wandering.

Some past limitations existed in the nature of what dimensions of mind wandering have been reported. The frameworks reviewed above have tended to investigate how associations between some features of mind wandering (such as occurrence, frequency, valence, and temporal nature) relate to overall affect or life satisfaction (e.g., Killingsworth & Gilbert, 2010), and more work can be done to explore conceptual insights into the nature of mind wandering and the impact on mental health. Some studies have shown that phenotypes exist for kinds of thoughts occurring during task-free resting state (Diaz et al., 2013; Gorgolewski et al., 2014), but none to date has unpacked mind wandering occurrences separate from the resting-state neuroimaging context.

We argue that looking into the subjective experience of mind wandering may be best understood through studies into its subjective phenomenological experience, therefore relating task-independent mind wandering with at-rest/"eyes-closed" designs of resting-state neuroimaging. By delving into the perceptions, perspectives, considerations, and feelings of an individual's understanding of their thoughts, research into the nature of mind can progress with greater acuity. In the next section, we therefore outline a proposal for a phenomenological framework of the subjective experience of mind wandering by detailing features of interest aimed to capture phenomenological dimensions of the mind and further integrating dimensions uncovered by prior frameworks.

6.3 A PROPOSED INTEGRATED FRAMEWORK

This proposed framework aims to provide a comprehensive overview of the multiple theorised dimensions that make up the phenomenological experience of the mind, as well as provide grounds for considering why certain aspects may become disruptive and maladaptive in the context of mental health and affective well-being. We integrate existing dimensions of interest and detail newly proposed inclusions. For each novel dimension introduced, we include the rationale behind why its study provides more clarity into unpacking the meaning and importance of mind wandering occurrences. We hypothesise this taxonomy will be able to capture unique differential elements involved in how we may measure phenomenological experience.

Proposed Dimensions

We considered three overarching key components extant across prior data-driven and theoretically based frameworks with respect to the dimensions we provide: (i) type of representation, (ii) affect, (iii) temporal nature, and (iv) relation to the experience (see Table 6.3). More specifically within these broad divisions, we propose a number of dimensions, existing and novel, to quantify and describe mental content. Each dimension is briefly described in relation to the experience of mental health and noted relevance for understanding well-being components to nature of mind.

Type of Representation.

Word-based/Self-Talk. This feature is strongly represented in data-derived studies (Delamillieure et al., 2010; Gorgolewski et al., 2014), though does not tend to be a feature of a priori theoretical frameworks. As not all thoughts are necessarily imagery-based in nature, probing on the propositional nature of thoughts can provide further insight on the nature of statement-like thoughts individuals may experience. Whether it be internal planning, or talking to oneself, understanding this experience may help in elucidating mental phenomenology of the thought experience. Depressed individuals may engage in greater forms of negative self-talk when experiencing such propositional thoughts, leading to the negative thoughts and ruminations known to characterise depression (Pietromonaco & Markus, 1985). Parsing apart the experience of negative valence in thought content may help clarify whether negative connections in mind wandering and mental health may relate to statements in self-talk or other dimensions. Internal statements may be geared toward concrete problem-solving (as in mood regulation strategies such as Chapter 5) or 'self-talk' over something extraneous beyond the present moment.

Visual Imagery. Research on mental imagery has considered components of visual imagery and how these aspects may be experienced by individuals (Kosslyn et al., 1999), although mind wandering research does not yet universally gather information on these processes from individuals (Delamillieure et al., 2010). Early studies on imagery dating back as far as 140 years began the process of questioning individuals on illumination, definition, and colouring, among other qualities, to assess what one might have imagined in their 'mind's eye' (Galton, 1880).

We argue that a similar probing (though with less granularity) can help assess differences in how individuals may be experiencing scenes and thoughts as their minds naturally wander. Investigating whether individuals viewed visual images or heard auditory sounds in their mind may help illuminate differences in experience related to the nature of one's mental environment. Research has shown that mental imagery tends to require an activation of information stored in memory, absent of a stimulus (Kosslyn et al., 1999) relating to the notion of theoretical proposals in considering mental wandering as decoupled perceptual attention (Schooler et al., 2011; Smallwood, 2013; Smallwood & Schooler, 2015). Within visual imagery, we theorise that mental content can be further unpacked to consist of recalled images or imagined images, providing information on whether individuals navigate towards prior memories to recreate and relive scenes memories, or opposingly, visualising imagined future events or immersion into daydreams. These domains are clarified by the additional dimensions described below.

Perspective. In visual imagery, scenes and content may be depicted in multiple ways. Individuals may be representing images in their head and viewing them from distinct points of views, namely a first-person point of view as if through their own eyes, a third-person point of view as if through an objective distanced observer, or through an imagined specific other person's point-of-view (Nigro & Neisser, 1983). In viewing a scene through the first-person, a person may be wandering mentally to images viewed as occurring in real life and observed in similar fashion, versus more distanced views as in third-person. Including perspective in mental scenes within a theoretical framework on the nature of mind wandering allows for investigation into how perspectives involved in mental representations may be further linked to the relationship between mind wandering occurrences and other markers of well-being.

While some research has asked on whether content of thoughts has been self-focused or other-focused (Diaz et al., 2013; Ruby et al., 2013), an inclusion of perspective would allow one to test whether viewing thoughts from the self's point of view may probe differential processes at play in navigating the mind. In the other cases of perspective, there is a possibility that distance or theory of mind (Frith & Frith, 2005) may play unique roles in the experience of the wandering mind. Many aspects of theory of mind and perspective relate to mental health, and this component of a wandering mind seems worthy of further exploration (e.g., Inoue et al., 2006; Washburn et al., 2016). An objective point of view where an individual may imagine a scene through a distanced objective eye, perhaps viewing themselves or scenery, may be a discernably different experience that when wandering mentally to create scenes of imagining how others might have viewed something, which involves processes like perspective-taking (Batson et al., 1997). By probing individuals on the nature of possible imagery, we can capture nuanced information on relationships of imagery to immersion or content with granularity.

Non-visual Sensory Imagery. With respect to auditory imagery, we can also further unpack differences in whether individuals may be hearing imagined sounds or music, or their 'mind's voice' commenting on internal representations (Delamillieure et al., 2010; Zatorre et al., 1996). Neural representations of auditory imagery have been studied to assess the phenomenological experience of 'mental sounds/music' and the brain (Kosslyn et al., 1999; Zatorre et al., 1996). Auditory imagery provides an account beyond visual images and phenomenological differences in mental health. Furthering a comprehensive sensory imagery outlook, one may also probe individuals on possible olfactory or somatic imagery for completeness on the picture of mental imagery in spontaneous thought (Stevenson & Case, 2005).

Affect

Valence. One of the most commonly reported probes used to assess the experience of mind wandering is subjectively reported valence of mental content (Felsman et al., 2017;

Killingsworth & Gilbert, 2010; Ruby et al., 2013). This allows understanding of whether a person may drift towards mental representations of a certain affective type, alongside clinical relevance with relation to rumination and worry (Nolen-Hoeksema et al., 2008; Roelofs et al., 2008; Starcevic, 1995).

Arousal. We also propose additionally studying psychological arousal associated with mental content. Investigating arousal of mental content in addition to valence allows for greater insight into how content may fit into the affective circumplex that was the focus of the work in Chapter 2 (Feldman, 1995; Russell, 1980, 2009). Arousal within affective dimensionality and relation to depression may relate to restricted range of arousal in depression (Rottenberg, 2005) or possible restricted representation of emotion on arousal (Feldman, 1995). Despite the ubiquitous inclusion of valence in current mind wandering frameworks, existing approaches have not yet assessed the associated arousal of mental abstractions.

***Temporal Nature*.**

Past/Future Focus. There is evidence that most people spend the majority of their time thinking about the past or future rather than the present (Shapiro et al., 2006). Research on where people mentally wander temporally provides insights into how time is considered by individuals and what effect this may have on well-being. Reports have been mixed; some studies have shown that people reported themselves as more unhappy when thinking about the past or future compared to the present (Killingsworth & Gilbert, 2010) while other studies have found no between-group differences in the effect of temporal focus of mental content and self-reported affective well-being (Felsman et al., 2017). With a great deal of mindfulness research, practices, and therapies being based on the notion that increased mindful attention to the present moment helps reduce stress or negative affect (Grossman et al., 2004), further extrapolation of the temporal nature of mental events will continue to provide insightful advances to the field.

Memory Constraints. Whether the mind represents actual events – such as memories – or imagined events that have never occurred, is another dimension that provides further context. Memory recall and rumination of experiences are both highly studied areas in healthy and clinical populations (Watkins & Teasdale, 2001). We propose that mental contents may be a relived memory or a dynamically altered memory 'recalled' in new ways unlike exactly how it happened. Expanding these domains to assess the nature of how mind may represent reality and nonreality through past and anticipated events can provide a further context for how memory plays a role in mental experiences.

For example, in depression there may be greater reliving of past experiences rather than imagining future ones or nonreality, similar to how rumination has been shown to be prevalent in depressed individuals (Nolen-Hoeksema et al., 2008). Within the context of memory recall, there is a possibility that memories may appear in a realistic or counterfactual way (Kuyken & Dalgleish, 1995). At opposite ends of this spectrum, a person may fixate on a past event by ruminating on it as it occurred or imagining alternate ways it could have gone. Similarly, individuals may imagine future events in a realistic or unrealistic manner. Perhaps in some cases, a person may be mentally imagining how their next day may go or preparing to meet someone later that day. They may be representing these events in a realistic way. However, in other cases it is possible that a person represents future events with a low degree of realistic nature (Gross et al., 2021), perhaps imagining becoming famous or daydreaming about winning the lottery – events unlikely to occur. Unpacking the occurrence of these differences in realistic and nonrealistic mental events can further provide background to the nature of one's internal environment respective to well-being and mental health.

Relation to Experience

Self/Social focus. Many previous investigations into mind wandering have probed whether a person experienced more self-focused or others-focused thoughts (e.g., Ruby et al., 2013), also a proposed dimension in our taxonomy. Further consideration of the personal significance of mental experiences are further considered. This is consistent with theoretical considerations of selective attention models, where the importance of various stimuli or information is weighted (Deutsch & Deutsch, 1963). Meaningful distinctions may arise when one wanders mentally toward trivial or extraneous, loosely connected thoughts compared to significant or highly personal, important thoughts for oneself. There may be greater perceived importance on bias towards thoughts regarding the self than others during depression (e.g., Gotlib, 1983; Watkins & Teasdale, 2001).

Perceived Control. With respect to occurrences of mind wandering, there exist varying degrees of perceived control one feels over mental wandering (Mason et al., 2007). By assessing an individual's perceived control of mind wandering instances, we can gain insight into how attempts to control or manipulate mind wandering may be related to the type of content, valence, or other dimensions. Feeling a reduced sense of control in mind wandering instances may be linked with poorer mental health, greater distraction, and negative affect as suggested from prior research on uncontrolled negative thoughts in depressed individuals (e.g., Pietromonaco & Markus, 1985; Wenzlaff et al., 1988). The intentionality versus spontaneity behind mental content has also been proposed as a point of further study (Christoff et al., 2016; Seli et al., 2016), and we therefore suggest considering perceived control of mind and intentionality as important domains to include in an integrated analysis (Seli et al., 2016; Zetsche et al., 2012).

Meta-awareness. Assessing the state of an individual's meta-awareness, or opposingly, their immersion, with respect to their mental experiences is a further key dimension with implications for mental well-being. This dimension places immersion and metacognitive awareness on opposite ends of a continuum, marking the difference between a complete immersion into one's thoughts versus a meta-aware experience of observing thoughts as fleeting and temporary mental events through metacognitive awareness as is recommended in practicing meditation (Hanh, 1975).

Research has shown that in the experience of both visual and auditory imagery, activation in primary sensory brain regions V1 and A1 tends to be suppressed (Daselaar et al., 2010). This suggests that suppression of primary sensory systems may be facilitating greater immersion into mentally-produced imagery. Some therapeutic models such as mindfulness-based cognitive therapy (MBCT; Kabat-Zinn, 2003) engage depressed individuals to monitor their thoughts with awareness of their nature, a similar concept to metacognitive awareness and a means to prevent a deep attachment to thoughts in favour of recognizing and accepting their transient nature. In this light, high immersion and low meta-awareness could be linked to a feeling of being stuck within thoughts, a common feature of depression (Nolen-Hoeksema et al., 2008).

Specificity. The final dimension proposed in this integrated framework covers the range of specificity of mental representations. This has been touched upon before in both data-derived frameworks (Gorgolewski et al., 2014) and theoretical frameworks on mind (e.g., aperture or clarity, Lutz et al., 2015). We refer to specificity as how specific, detailed, or vivid thoughts may be, with the alternate end of this spectrum considering more general or categorical thoughts. In some cases, individuals may be more likely to phenomenologically experience specific describable mental representations with clarity and the ability to detail and describe their 'mind's eye' experience, whether that be vivid images or precise thoughts that are straightforward to recount in concrete details.

At other times, there may be greater generalization in mind wandering instances, emphasising broad thoughts that conflate across specific events or refer to extended periods of time. Such lack of specificity has been noted for example as characteristic of depressed individuals' recounts of episodic autobiographical memory (e.g., Kuyken & Dalgleish, 1995). Assessing the degree of specificity of an individual's subjective experience can therefore open the possibility of drawing conclusions on how the precise nature of thoughts may be linked to other dimensions such as valence or importance.

Summary

Provided these various dimensions synthesised and integrated from past work and considered altogether across data-based and theoretically grounded frameworks, we suggest these key components and resulting dimensions be further studied in the context of mental wandering and understanding phenomenology of mind wandering in depression (see Table 6.3).

Key Components	Proposed Dimensions	Proposed Items
Type of Representation	–Word-based/Self-Talk	–Mental words or sentences –Planning –Problem-solving
	–Visual Imagery	–Visual mental images
	–Perspective	–First-person point of view –Second-person point of view –Third-person point of view
	–Non-visual Sensory Imagery	– Imagined sounds or music –Imagined voices –Imagined scents –Imagined sensations (temperature, touch)
Affect	–Valence	–Positive content –Negative content –Higher-order valence
	–Arousal	–Physiological arousal
Temporal Nature	–Past/Future Focus	–Past or future temporal relation
	–Memory Constraints	–Remembering or reliving –Imagining or daydreaming –Ruminating repetitive content
Relation to Experience	–Self/Social Focus	–Self-focused motivations, beliefs, preferences
		–Self-generated views on others
		–Perceived importance
		–Thoughts on motivations, beliefs, preferences of others
		–Perspective taking of others
	–Perceived Control	–Intentionality –Spontaneity –Intrusiveness
	–Meta-awareness	–Immersion –Meta-awareness –Dissociation
	–Specificity	–Level of detail or vivid clarity –Foggy, broad, general thoughts

Table 6.3. Proposed key components integrated across data-based and theoretically derived frameworks (see Tables 6.1, 6.2) and subsequent dimensions of phenomenological nature of mind. Items proposed to be relating to these dimensions nested within these key components are further included for clarity.

6.4 DISCUSSION

Explicitly considering the various contributions of features theorized to underlie the nature of internal representations in mind wandering is central to being able to better unpack how multiple dimensions may be experienced and understood in context. How these components integrate is vital to improve how we connect findings from existing literature on resting-state neuroimaging, experience sampling, mindfulness, and mind wandering to continue to develop increasingly targeted future studies into the nature of mind in a guided manner. This proposal provides a background for generating specific hypotheses with respect to investigating mental representation in a more systemized and clear manner with expansion on key concepts of type of representation, affect, temporal nature, and relation to experience by naming strategic new dimensions for further inquiry into mental health including words/self-talk, visual imagery, perspective, non-visual sensory imagery, valence, arousal, personal importance, past/future focus, memory constraints, self vs. social focus, perceived control, immersion vs. metacognitive-awareness, and specificity. The goal of such a framework is leveraging organized investigation of targeted hypotheses related to proposed dimensions of mind to better clarify a phenomenological picture of mind.

The ambition behind this more granular framework is to facilitate transition from describing associations between initial trends such as general valence of mind wandering being linked to reports of life satisfaction (Felsman et al., 2017), toward greater generalizations on the nature of mind and conceptualizations of the dimensions that make up the mental landscape of the mind that we measure in instances such resting-state neuroimaging (Diaz et al., 2013). By utilizing this theoretical account, we may be able to better understand the relationship between ways in which individuals represent thoughts internally and how these may relate to their greater mental health. By designing future studies where these multidimensional components of the individual experience of mind may be measured, we can generate more detailed conclusions on what features make the most impact on life satisfaction and well-being.

Studies that explore naturalistic probes of the occurrence of mind wandering in context-free and task-based settings can continue to parse apart dimensions that play a greater functional role in the experience of mind wandering based on the setting at hand. This will be useful in delineating contextual influences on mind, like what an individual is doing at rest without external stimulation when they are free to think openly and move within a completely mentally driven environment. Better understanding the ways in which individuals move in their mental environment will allow for further investigations into how these dimensions may become maladaptive when individuals experience mood disorders like depression. Based on this, the following final experimental chapter of this thesis covers two studies into mind wandering. Study 5 in Chapter 7 explores a subset of key hypothesised dimensions of mental wandering in daily life through naturalistic experience sampling using the sample from Studies 2-4, while Study 6 explores the viability of the integrated framework presented in the current chapter for individuals experiencing a sensory deprived state, absent of external cues or distractors, where there are minimal constraints on where their mind wanders.

CHAPTER 7 – STUDIES 5 & 6: INVESTIGATING MENTAL WANDERING AND DEPRESSION USING EXPERIENCE SAMPLING AND SENSORY DEPRIVATION METHODS

7.1 OVERVIEW

In this final experimental chapter, building upon the proposed taxonomy of Chapter 6, mind wandering was assessed (i) naturalistically using experience sampling methods to compare mental health differences in wandering thoughts in daily life, and through (ii) novel experimental methods to control external influences on the nature of mental content. Experience sampling methods allowed the study of how often individuals were wandering mentally in their day-to-day along several key mind wandering dimensions and the relationship that had to their concurrent emotional states. Rather than using in-lab tasks of rote tasks and attentional probes into drifting thought, naturalistic sampling allows for more realistic pictures of extraneous thoughts occurring at random in daily life.

With the dimensions of theoretical importance to depression and phenomenology of mind considered (see Chapter 6), the second study in this chapter was conducted to probe across theorised dimensions of interest in mental study in a controlled environment deprived of sensory distractions. This study design attempted to account for environmental distractions and respect probing mind wandering within itself, not only fleeting or perching thoughts related to possible external stimuli. Removing external stimuli to probe the mental mindscape was accomplished by creating a task involving randomized auditory beeps among white noise generated for the individual through pre-recordings, and participants listened to this task with eyes instructed to be closed.

Thus, in this final chapter, Study 5 assessed the same participant groups as Chapter 4 and 5 to sample event-based mind wandering dimensions as individuals went about their day over a 14-day period. This mind wandering occurrence and subsequent dimensions of theoretical interest were probed alongside concurrent emotion to assess how mind wandering related to trends in affect. Observations were modelled with mixed effects multilevel models to examine the relationship between mind wandering dimensions of interest and emotion and clarify a descriptive picture of mind wandering in mental health by assessing diagnostic group differences through interaction effects. Study 6 took an online approach by assessing dimensions of mind wandering in currently depressed and healthy-never depressed individuals absent of external distraction through sensory-deprivation-inspired instruction. Participants self-reported on several mind wandering probes on mind wandering dimensions as outlined in our proposed framework. The goal of this final study was to assess the differences within resting mind wandering and mental health on these purported dimensions with descriptive statistics of dimensions and group differences.

7.2 INTRODUCTION

Mind wandering is associated with greater levels of broad unhappiness (Killingsworth & Gilbert, 2010), greater measures of biological aging and stress (Epel et al., 2013), less compassion and caring behaviours towards others and oneself (Jazaieri et al., 2016), and lower performance on attention-requiring tasks (Mrazek et al., 2012). Given so many associations between mind wandering and negative functioning, there is import in unpacking its relation to mental health. Given the high rate at which most individuals find themselves mentally wandering regardless of mental health status (Killingsworth & Gilbert, 2010), understanding the phenomenology of such frequently occurring mental experience is valuable as it may play a sizable role in the occurrence, remission, and prevention of conditions such as chronic depression or regulating general low mood.

As reviewed in Chapter 6, study designs for mind wandering have used task-independent thought in laboratory designs to assess off-task mind wandering (e.g., Ruby et al., 2013; Seli et al., 2013), naturalistic study designs as in experience sampling of daily life and possible mind wandering (e.g., Felsman et al., 2017; Killingsworth & Gilbert, 2010; Ottaviani et al., 2015), or have evaluated the mind at rest, for example, as in resting-state neuroimaging studies (Delamillieure et al., 2010; Diaz et al., 2013; Gorgolewski et al., 2014). Describing the multifaceted picture of a wandering mind necessitates an approach that considers mind wandering in both a naturalistic sense (i.e., how are fluctuating thoughts arising and dissipating in a naturalistic manner rather than in-laboratory) as well as a phenomenological approach (i.e., what does it mean to mentally wander experientially).

The present chapter covers two studies using different methodologies to examine facets of mind-wandering and mental health using the taxonomy detailed in Chapter 6. The first study uses a subset of dimensions in the same experience sampling dataset reported in Chapters 3-5, and the second study uses the full dimensions compiled to examine the nature of mind-wandering in a case-control study where participants are deprived of sensory input and then probed concerning the ebb and flow of mental content. For a detailed consideration for inclusion of dimensions of hypothesised importance to mind wandering phenomenology and mental health, see Chapter 6.

7.3 STUDY 5: MIND WANDERING IN DAILY LIFE AND CONCURRENT EMOTION

Experience sampling methods tend to provide naturalistic information on associated qualities of mental thought and have proven to be strongly used methodologies (e.g., Felsman et al., 2017; Killingsworth & Gilbert, 2010; Poerio et al., 2013). The overarching goal of the first study outlined in this chapter is to investigate naturalistic mind wandering occurrences and related multiple dimensions of wandering mental content in currently depressed, remitted depressed, and healthy non-depressed individuals. The impact of concurrent emotion on mind wandering phenomenology is further clarified, provided how chronic negative mood (depression) and non-negative mood (healthy controls or previously depressed persons in remission) may play a role in mental wandering experience. Better understanding of how these interrelationships may help elucidate past findings, given some works shows mind wandering to be broadly associated with general negativity (Killingsworth & Gilbert, 2010) while other studies find emotions not being affected by mind wandering unless the mental content is negative (Poerio et al., 2013).

Work to date has also suggested that induced negative moods (Smallwood & O’Connor, 2011) and concurrent sadness (Poerio et al., 2013) lead to biases towards past-focused thoughts. Further, dimensions like future-related thoughts have been found to be associated with increases in positive mood, even when the mental content was negative, while past-focused thoughts were associated with lower mood even when mental content was positive (Ruby et al., 2013). We hypothesise that the present study may replicate these findings in temporal bias of mental wandering to the past alongside negative concurrent emotions, with greater levels seen in the depressed group provided their chronic depressed mood possibly intensifying such relationships (Chaieb et al., 2021; Deng et al., 2014; Ottaviani et al., 2015). We further hypothesise depressed persons will display mental wandering experiences that are more negative, self-focused, uncontrolled, with less meta-awareness and less specificity providing past work on the relevance of these features in depression (e.g., Chaieb et al., 2021; Lemogne et al., 2006; Ruby et al., 2013; Schooler et al., 2011; Watkins & Teasdale, 2001).

To test these research questions across clinical diagnostic groups, multiple intraday reports of mind wandering occurrences were gathered over two weeks as individuals went about daily life. There remains a balance in minimising participant burden of repetitive intraday timepoints, and thus Study 5 probed a smaller core subset of dimensions (valence, temporal (past/future) nature, self/social focus, perceived control, meta-awareness, and specificity) than that contained in our complete taxonomy outlined in Chapter 6.

Study 5: Methods

Participants

These participants comprise the same sample used in Chapters 4 and 5. The final sample for statistical analysis in this mind wandering investigation therefore comprised 96 individuals with a relatively high number of total experience sampling observations (n=5,957 complete observations across 70 timepoints).

Measures

Clinical Information

The same clinical measures were used for this study as in Chapters 3-5, please see prior chapters for further information regarding the SCID, PHQ-9, and GAD-7. For internal consistency in this study sample, see Chapter 4.

Trait Measures

Five Facet Mindfulness Questionnaire (FFMQ). To assess aspects related to trait mindfulness, we employed the FFMQ (see Appendix 7.1), which has been shown to be a valid measure to assess constructs of mindfulness facets (Baer et al., 2008). This includes subscales of Observing (Cronbach's α=.83 in our sample), Describing (α=.79), Acting with Awareness (α=.91), Non-judging (α=.94), and Non-reactivity (α=.84).

Momentary Mind Wandering

Occurrence. To assess mind wandering, participants were asked to provide a free response to what they were currently doing when the probe arrived. They were then asked whether they were thinking about something other than what they were currently doing, to probe for the occurrence of mind wandering. If the participant answered 'yes', they were then asked to further self-report on six dimensions of mind wandering, described below (all on 7-point Likert scales). If participants responded 'no' to state they were not thinking of something other than what they were doing, they moved on to answer the emotion questions without needing to respond to follow up mental content questions (see Appendix 3.5 for full list of experience sampling items).

Valence. Participants were asked to rate how positive or negative the experience was from 1 (very negative) to 7 (very positive).

Temporal Nature. Participants reported whether mental content was related to the past or future to gather temporal information from 1 (distant past) to 7 (distant future).

Subject. Participants were asked whether content was more related to themselves or others from 1 (yourself) to 7 (others).

Perceived Control. Participants reported how much control they felt they had over what they were thinking, from 1 (not at all) to 7 (very much).

Meta-awareness. Participants reported how aware they felt of mentally wandering from 1 (completely immersed) to 7 (completely meta-aware) of their mental content.

Specificity. Participants reported whether their thoughts were very specific (such as a specific scene or image) or general in nature (such as a broad feeling or general thought) from 1 (very specific) to 7 (very broad).

Momentary Emotion

As outlined in Chapter 3, to assess current emotions, participants were asked to rate the present intensity of 9 emotion terms on a 7-point Likert scale ranging from 1 (not at all) to 7 (extremely). All positively-valenced emotions (enthusiastic, happy, pleased, relaxed) were averaged to form the 'positive emotion' term for analyses as well as all negatively-valenced emotions (nervous, sad, angry, irritated, stressed) to analyse 'negative emotion' (for full list of items, see Appendix 3.5).

Procedures

The overarching procedure was the same as for Study 2 (see Chapter 3).

Analytic Plan

Mixed effects multilevel models. To test how relationships may differ for clinical groups between mind wandering dimensions and emotion, group status was entered as a categorical moderator in multilevel models such that the remitted and healthy groups were compared to the depressed group at the base level. All predictor variables were person-mean centered at Level-1 (within-person) and diagnostic group as the moderator was at Level-2 (between-person group assignment) with random intercepts per individual as is typical in prior work involving similar methods (Poerio et al., 2013).

Study 5: Results

Demographics and Clinical Characteristics

For demographics and clinical characteristics of this sample, see Chapter 4.

Trait Mindfulness

Dispositional mindfulness of observing, describing, acting with awareness, non-judging, and non-reactivity, and total FFMQ self-report were descriptively summarised by group (Table 7.1). Group differences on trait mindfulness were assessed by Wilcoxon tests (Bonferroni adjusted p-values reported) with significant differences on acting with awareness between the healthy and both the depressed ($p<.001$, $r=.63$, 95%CI[.46,.76]) and remitted group ($p=.005$, $r=.47$, 95%CI[.23,.66]), for non-judgement of thoughts between the healthy and both the depressed (p<.001, r=.74, 95%CI[.61,.83]) and remitted group (p<.001, r=.55, 95%CI[.33,.71]), and on non-reactivity between healthy and both the depressed (p=.003, r=.46, 95%CI[.23,.64]) and remitted group (p=.005, r=.47, 95%CI[.25,.68]). There were no other significant pairwise differences on dispositional mindfulness (all ps>.05).

Dimension	***M (SD)***	***M (SD) by group***		
Five Facet Mindfulness	All	Depressed	Remitted	Healthy
Observing	24.27 (6.35)	–0.05 (1.15)	0.27 (.94)	–0.21 (.82)
Describing	26.48 (6.95)	–0.19 (.99)	–0.11 (1.08)	0.35 (.91)
Acting with Awareness	25.09 (6.71)	–0.52 (.91)	–0.13 (.95)	0.78 (.67)
Non-judging	24.53 (8.22)	–0.59 (.76)	–0.19 (.95)	0.90 (.65)
Non-reactivity	19.91 (5.20)	–0.34 (.99)	–0.18 (.88)	0.58 (.92)
FFMQ Total	120.28 (5.20)	–0.54 (.93)	–0.11 (.95)	0.77 (.63)
Momentary Mind Wandering				
Valence	3.92 (1.56)	–0.37 (.91)	0.23 (.95)	0.48 (.94)
Temporal (past-future)	4.36 (1.11)	–0.09 (1.02)	0.14 (1.05)	0.02 (.88)
Subject (self-others)	3.69 (1.95)	–0.24 (.95)	0.29 (.99)	0.14 (.99)
Perceived control	4.30 (1.91)	–0.35 (.94)	0.21 (.95)	0.45 (.92)
Meta-awareness	3.78 (1.85)	–0.08 (.99)	0.07 (1.02)	0.08 (.99)
Specificity	3.69 (1.94)	–0.003 (.94)	0.03 (1.06)	–0.03 (1.04)

Table 7.1. Summary descriptive statistics of whole sample and groups across all trait mindfulness subscales and mind wandering dimensions. Trait Mindfulness descriptive summary was assessed with Five Facet Mindfulness Questionnaire (FFMQ) subscales and momentary mind wandering dimensions through experience sampling reports. Whole sample *M, SD* calculated on raw data units alongside group *M, SD* on standardized units.

Mind Wandering Dimensions

Dimensions were assessed in a descriptive summary (*M, SD*; see Table 7.1) with group differences compared and assessed through multilevel models as detailed next. Concurrent affect was modelled alongside mind wandering dimensions here. See Figure 7.1 for all mind wandering dimensions plotted over time by diagnostic groups.

Study 5: Mind Wandering Dimensions Over Time

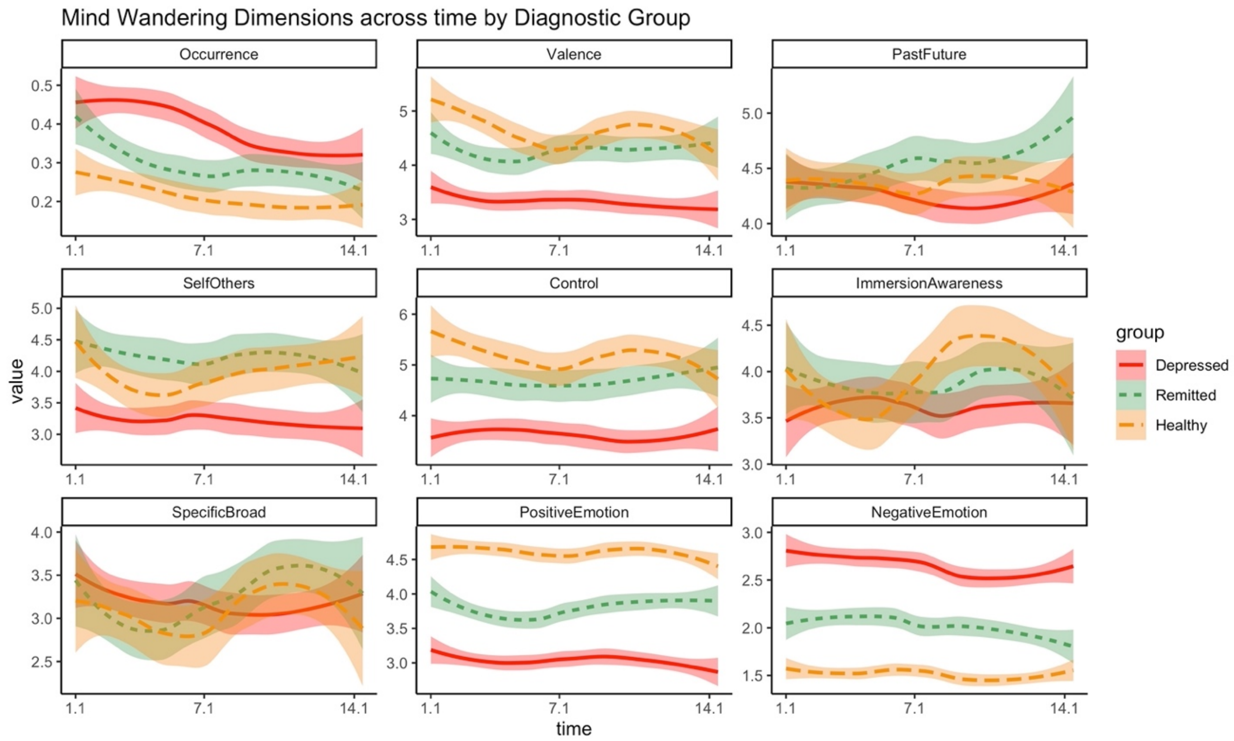

Figure 7.1. For Study 5, mind wandering occurrence and dimensions across study sampling period by clinical group status along with concurrent positive and negative emotion across time.

Group Differences and Concurrent Emotion

Differences between groups were assessed by multilevel models for all dimensions, except occurrence, which was predicted in a binary logistic regression given the outcome was either mind wandering did occur (1) or did not occur (0), where the odds ratio (*OR*) is also reported below. Results were compared to a Bonferroni-corrected alpha of .007 for the tests across seven dimensions (see Appendix 7.2 for all model statistics), and .004 for the 14 tests of concurrent positive or negative emotion over the seven dimensions (see Appendix 7.3. for all additional model statistics). See Figure 7.2 for a subset of group interactions on dimensions detailed below.

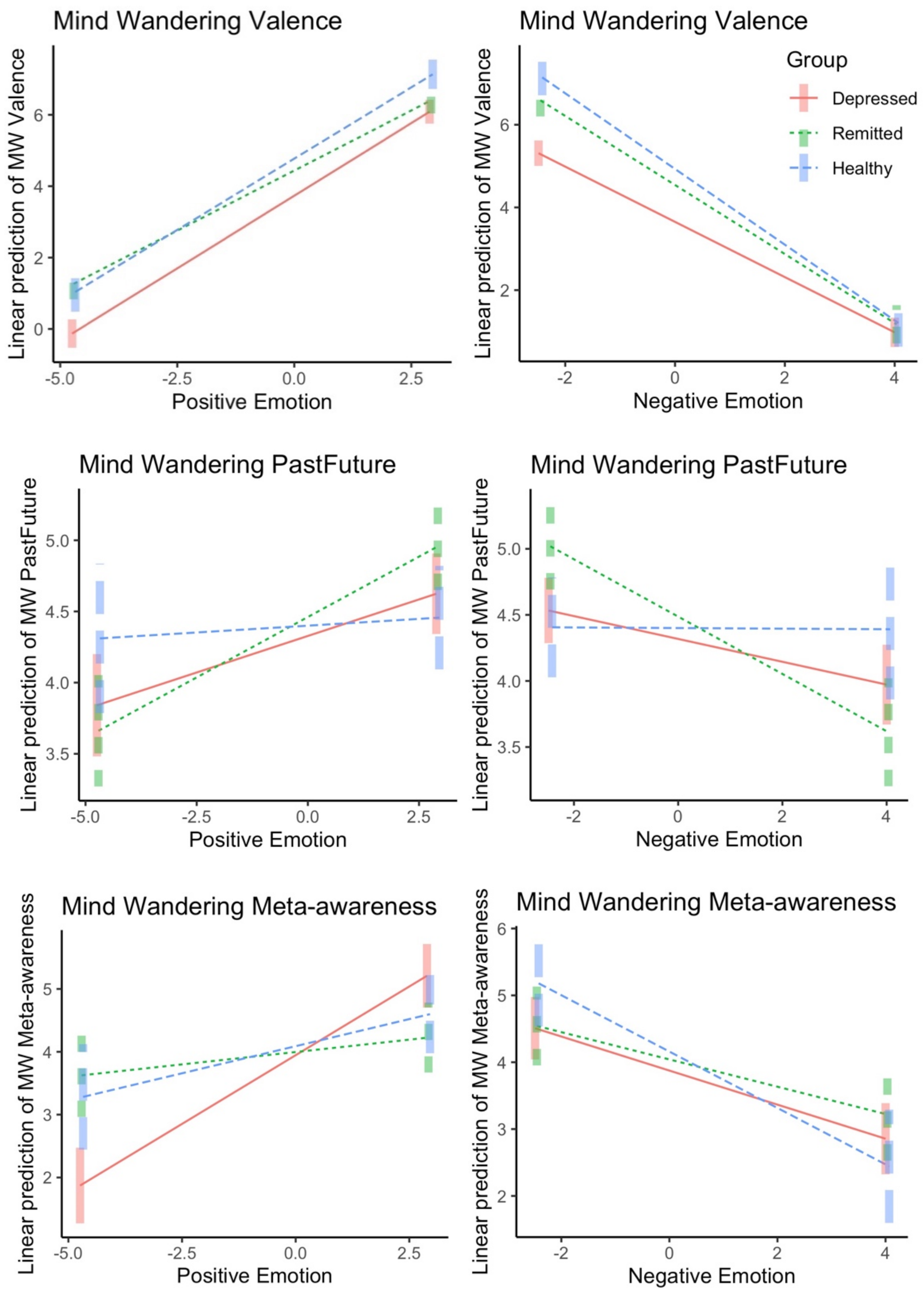

Figure 7.2. A subset of group interactions on mind wandering dimensions from multilevel modeling of within-person fluctuations of positive and negative emotion in Study 5. The x-axes are labelled by emotion state (left column is positive emotion, right column is negative emotion) and y-axes and plot titles are labelled by mind wandering dimension.

Occurrence. Mind wandering occurred at significantly different levels across groups such that compared to the depressed group, both the healthy (b=–0.84, SE=0.07, t(95)=–

12.16, $p<.001$, $OR=.43$ 95%CI[.38,.49]) and remitted group were significantly less likely to mind wander ($b=–0.44$, $SE=0.07$, $t(95)=–6.44$, $p<.001$, $OR=0.64$ 95%CI[.56,.74]).

There were significant main effect relationships between higher levels of positive emotion and less occurrences of mind wandering ($b=–0.43$, $SE=0.04$, $t(95)=–10.54$, $p<.001$ $OR=.65$ 95%CI[.60,.71]), as well as higher levels of negative emotion associated with higher occurrences of mind wandering ($b=0.48$, $SE=0.05$, $t(95)=10.38$, $p<.001$, $OR=1.62$ 95%CI[1.48,1.77]).

Group interactions were significant such that the depressed group appeared to experience more mind wandering occurrences alongside lower positive emotion compared to the healthy group ($b=0.33$, $SE=0.07$, $t(95)=4.63$, $p<.001$, $OR=1.40$ 95%CI[1.21,1.62]). There was no significant difference between the remitted and depressed groups ($p=.02$). Conversely, there did not appear to be group differences in mind wandering occurrence alongside negative emotion between the depressed and healthy ($p=.03$) or remitted groups ($p=.01$).

Valence. Mind wandering valence significantly differed for the depressed group compared to both the remitted ($b=0.82$, $SE=0.20$, $t(95)=4.09$, $p<.001$) and healthy groups ($b=1.31$, $SE=0.20$, $t(95)=6.51$, $p<.001$) in experiencing significantly less positive thought content, with no significant difference between the remitted and healthy group ($p=.06$).

There were significant main effects between current emotion and valence of mind wandering content for higher levels of positive mental wandering content alongside higher levels of positive emotion ($b=0.81$, $SE=0.04$, $t(95)=22.48$, $p<.001$) and higher levels of negative mental wandering content alongside negative emotion ($b=–0.67$, $SE=0.04$, $t(95)=–18.74$, $p<.001$).

The depressed group experienced a relatively less strong negative relationship between valenced thought content and negative emotion than compared to the healthy group ($b=–0.25$, $SE=0.07$, $t(95)=–3.32$, $p<.001$). However, the depressed group did not appear to experience a significantly different relationship between positive or negative emotion and valence of mental content compared to the remitted group ($p=.007$; $p=.007$, respectively for positive and negative emotion).

Temporal nature. There were no significant differences between the depressed and remitted (p=.31) or healthy groups (p=.40), or remitted and healthy groups (p=.99), with respect to the past/future focus of mind wandering.

There were also no significant main effects in terms of the temporal nature of thought content related to concurrent positive (p=.006) or negative emotion (p=.01), nor were there any significant group interactions between concurrent emotion and past/future focus of thought (p>.05).

Subject. Self/social focus of thought content significantly differed such that, compared to the depressed group, both the remitted (b=1.03, SE=0.23, t(95)=4.55, p<.001) and healthy groups (b=0.69, SE=0.23, t(95)=2.99, p=.004) displayed more others-focused thought content, with no significant differences between the remitted and healthy groups (p=.35).

There was no significant main effect of subject of thought content associating with positive (p=.01) or negative emotion (p=.96), nor any significant group interactions (ps>.05).

Perceived control. Mind wandering perceived control significantly differed such that compared to the depressed group, the healthy group (b=1.50, SE=0.32, t(95)=4.68, p<.001) had more perceived control over their thought content, with no significant differences between the remitted group compared to the depressed (p=.008) or healthy groups (p=.17).

In assessing how concurrent emotion associated with perceived control, there were main effects across all groups for higher perceived control associated with higher positive emotion (b=0.47, SE=0.04, t(95)=10.69, p<.001) and lower negative emotion (b=–0.35, SE=0.04, t(95)=–8.39, p<.001), with no significant group interactions (p>.05).

Meta-awareness. There were no significant differences between the depressed and remitted (p=.57) or healthy groups (p=.32), or remitted and healthy groups (p=.92) with respect to the meta-awareness of mind wandering.

There were main effects across all groups such that higher meta-awareness was associated with higher positive emotion (b=0.44, SE=0.05, t(95)=7.97, p<.001) and lower negative emotion (b=–0.25, SE=0.05, t(95)=–4.92, p<.001). Group interactions were also significant such that the depressed group appeared to experience a greater positive relationship between positive emotion and higher meta-awareness compared to the remitted group (b=–0.36, SE=0.08, t(95)=–4.52, p<.001), though no significant difference compared to the healthy group (p=.006) following our Bonferroni correction. There were no group differences for negative emotion on meta-awareness (p>.05).

Specificity. There were no significant differences between the depressed and remitted (p=.73) and healthy groups (p=.70), or remitted and healthy groups (p=.99) with respect to the specificity of mind wandering content.

There was no main effect of the specificity of mental content with respect to positive (p=.63) or negative emotion (p=.06), nor any group interactions (ps>.05).

Discussion

In this study, we modelled individual differences in mind wandering dimensions across time with respect to trait mindfulness, clinical group status, and concurrent emotion on a subset of mind wandering dimensions with theorised importance to mental health. Results indicated that depressed individuals experienced higher rates of mind wandering occurrences that are perceived to be of greater negative content, more self-focused, and less controlled, compared to both remitted individuals with past history of chronic depression and to healthy individuals with no history of mood disorders. This suggests that mind wandering experiences in depression are more strongly associated with negative, self-focused, and uncontrolled attributes and in line with past work (Chaieb et al., 2021; Deng et al., 2014; Ottaviani et al., 2015; Seli et al., 2019).

The absence of significant differences between remitted and healthy individuals across all dimensions may suggest that upon recovery from depression, the phenomenological makeup of mind wandering content transition to a similar pattern as an individual without mood dysfunction. Intriguingly, although past research on the temporal nature of mind wandering has suggested more future-focused thought for individuals (Baird et al., 2011) or induction of negative mood biases towards past-focused thought (Smallwood & O'Connor, 2011), these results were not replicated in this sample, suggesting that in naturalistic settings, there may not be a general bias towards past or future thoughts, even during chronic negative mood as in depression. Similarly, the lack of group differences on meta-awareness or specificity of thought content suggests that generally, mental health status does not lead to an average difference in how aware one is of thought content and whether that thought content is broad or specific in nature.

Next, the relationship between concurrent emotion and mind wandering dimensions was assessed. We uncovered main effects and group interactions in several dimensions. Across all groups, higher positive emotion was associated with more positive, more future-focused, more controlled, and more meta-aware thought content, while higher negative emotion was associated with more negative, less controlled, and less meta-aware thought content.

Here, interestingly, concurrent emotion did not appear to impact the temporal nature of thoughts, indeed differing from past findings (Baird et al., 2011; Smallwood & O'Connor, 2011). There were group differences in the relationship between (i) negative emotion and valence of thoughts, such that depressed persons experienced less of a decrease in valence of mind wandering content than healthy persons when concurrent negative emotion increased and (ii) positive emotion and meta-awareness, such that depressed persons also showed had a stronger association between higher levels of positive emotion and greater meta-awareness of thought content compared to the remitted and healthy group.

Taken together, this suggests that feeling negative emotion was associated with healthy never-depressed persons mentally wandering in a more negative manner and that feeling positive emotion was associated with relatively lower levels of meta-awareness of mental wandering occurrences, when compared to depressed persons. These findings highlight the importance in considering multiple aspects of a mind wandering experience above and beyond occurrence – especially alongside current emotional experiences. Despite there being no baseline group differences on meta-awareness, when considered alongside concurrent emotion, this group difference emerged. This may possibly highlight how emotion may influence mind wandering content unfolding in day-to-day patterns that may not always be captured in lab settings where concurrent emotional states are not assessed.

All clinical groups experienced similar relationships along positive emotion and valence of thought content, and for both positive and negative emotion, perceived control was felt similarly. This was also true for negative emotion and meta-awareness. Given that there were no relationships between emotion and temporal nature, self/social focus, and specificity of thought, there was no support these dimensions may have fluctuated alongside affective experiences.

In the next study we sought to replicate the findings involving depressed and healthy participants in a different context, as well as introducing greater granularity in the taxonomy of mental wandering. While experience sampling methods provided an avenue for naturalistic exploration of a multidimensional account of mind wandering, a great deal of uncontrolled variability may be present in individual's daily lives. This can provide for more naturalistic occurrences of mental wandering than in laboratory contexts, but as stated, introduces a wide range of variation in the settings to which individuals may have mentally wandered. The next and final study of this thesis followed up on this initial approach by instead taking a controlled approach to studying mental wandering to clarify a phenomenological picture of mental wandering absent of varying external cues.

7.4 STUDY 6: MIND WANDERING IN A SENSORY-DEPRIVED CONTROLLED SETTING

By removing outside influences related to external stimuli, as found in daily life, and considering a means of study of mind absent of distraction, similar to resting-state neuroimaging contexts (Diaz et al., 2013; Pipinis et al., 2017; Stoffers et al., 2015), a study of mind wandering can further elucidate on phenomenological experience. Study 6 incorporated aspects of resting-state methods to better understand the mental phenomenology of a wandering mind absent of external daily life distraction in a sample of individuals with current major depression and healthy controls. Further, we assess the ability to collect self-report information on multiple dimensions of the nature of mental phenomena without the constraints of intraday brief reporting thus allowing us to consider the relevance of mind wandering components on mental health and mindfulness proposed in Chapter 6.

Here, we hypothesised that depressed persons would experience more negatively-valenced thought content, more distress in their mental wandering experience, higher levels of arousal, more past-focused thoughts, higher rumination, more self-focused thoughts, lower perceived control, lower meta-awareness and broader non-specific thoughts in this sensory deprived investigation.

Study 6: Methods

Participants

All 120 participants recruited were aged 18-65 with either: (i) a diagnosis of chronic recurrent Major Depressive Disorder (MDD) with a current major depressive episode (n=52) or (ii) no current or prior history of any mood or anxiety disorder (n=68), referred to as 'healthy never-depressed' controls. Five healthy participants were excluded from the study due to failing to follow instructions (see Procedure). This study was pre-registered (https://osf.io/xtqnw/; see Appendix 7.4).

Recruitment procedures and inclusion criteria were the same as Studies 2-5, except for the criterion of a personal smartphone with SMS capabilities. Instead, additional inclusion criteria included participant access to a computer or laptop with audio capabilities and headphones.

Measures

Clinical and mindfulness measures used in Study 6 were the same as in Study 5, with internal consistency in this study sample briefly outlined below.

Clinical Information

As with the experience sampling dataset, the SCID-5-RV was used to determine whether diagnostic criteria were met for recruited groups with all diagnoses second-rated and confirmed by a Clinical Psychologist. The PHQ-9 was also employed for self-reported depression severity, with high internal consistency in this sample (α=.95) alongside the GAD-7 for anxiety severity, also with high internal consistency (α=.95). See Chapter 3 for further details on clinical measures.

Trait Measures

Mindfulness. As with Study 5, the FFMQ assessed self-reported mindfulness dimensions. High internal consistency was found in this sample as well across the subscales of Observing (Cronbach's α=.85), Describing (α=.79), Acting with Awareness (α=.93), Non-judging (α=.96), and Non-reactivity (α=.85).

Resting State. ***Amsterdam Resting State Questionnaire (ARSQ).*** The ARSQ is an established 27-item self-report questionnaire on thoughts and feelings that may be experienced during a resting state (Diaz et al., 2013; see Appendix 6.1) that is administered following the period of resting-state and thus assesses retrospective judgements. It includes items on dimensions associated with individual resting state including Discontinuity of Mind (Cronbach's α=.32), Theory of Mind (α=.64), Self (α=.62), Planning (α=.71), Sleepiness (α=.83), Comfort (α=.88), and Somatic Awareness (α=.70). Internal consistency was moderate in our sample (Cronbach's αs = .32 to .88 across all subscales).

Affect. ***Positive and Negative Affect Schedule (PANAS).*** The PANAS is a measure of current affect states and was used to provide a brief and valid assessment of current affect for participants before beginning the study (Watson et al., 1988)(see Appendix 7.5). It has been shown to be a valid and reliable measure (Crawford & Henry, 2004) with high internal consistency in our sample for both positive and negative affect (α=.94 for both subscales). Rather than assess momentary emotion as with Studies 2-5, this study instead gathered baseline emotion levels before focusing in on greater detail in the study of multiple mind wandering dimension probes.

Mind Wandering Dimensions

To assess dimensions of mind, we used the integrated taxonomy developed in Chapter 6 and asked participants to rate each their mental experiences to each probe on our hypothesised key components of affect (valence, arousal), temporal nature (past/future focus, memory constraints), relation to experience (self/social focus, perceived control, meta-awareness, specificity), as well as the type of representation (word-based/self-talk, visual imagery, perspective, non-visual sensory imagery) and somatosensory awareness (for a full list of all sensory deprived mental wandering items, see Appendix 7.6). Participants rated each statement corresponding to these dimensions on a Likert scale from 1 (not at all) to 7 (very much) for all sensory deprived thoughts (for all self-report statements on mental content, see Appendix 7.6.

Affect. ***Valence.*** Participants reported how positive or negative their thoughts were.

Arousal. Participants reported how physiologically alert they felt in relation to the mental content, that is, whether it was a calm relaxed state or a highly arousing stimulating state. This included additional items on whether participants found the mental content enjoyable or distressing to experience.

Temporal Nature. ***Past/future focus.*** Participants reported whether their thoughts were related to the past, or to the future in addition to questions about nuanced features of the past or memories (see next).

Changing the past. Given the nature of mental experiences about memories to not only be re-living per se, participants were also probed upon imagining past memories in different ways, or experiencing the past as if it had gone differently (counterfactual memories).

Rumination. Participants reported the extent to which mental content may have been about repeat memories, thoughts, or ruminations (i.e., thought about many times before). Participants also reported to what extent they were re-living or re-imagining memories.

Relation to Experience. ***Self/Social Focus.*** Participants reported whether their thoughts were related to their sense of self, motives or preferences or how much they thought about others, or others' motives or preferences.

Perceived Control. Participants reported to what extent they felt control over their thought content, that is the perceived intentionality of deliberately choosing a thought versus spontaneously experiencing it, as well as intrusiveness of thought content.

Meta-awareness. Participants reported the extent to which they were immersed or aware of their thoughts. They rated whether they were watching their thoughts with the awareness of these fleeting episodes arising in the mind, or completely immersed in the occurrence without awareness until probing.

Specificity. Participants reported on whether thoughts were very discrete (such as a specific event or scene) or more general in nature (such as a broad feeling or general thoughts related to large concepts).

Type of Representation. ***Word-based/Self-Talk.*** Participants were probed on the extent they felt their thoughts were propositional, that is consisting of statement-like content, including self-talk, planning, problem-solving, word-based thought content.

Visual Imagery. Participants were probed on the visual nature of thoughts and vividness of such experience, and further asked whether they viewed things through their own eyes in the thought, through another person's eyes, or through an objective third person 'birds-eye view' perspective.

Non-visual Sensory Imagery. As with visual imagery, participants were asked whether they experienced auditory imagery. This included possible sounds such as musical content or voices. They were also asked about scent-based imagery such as imagined scents or smells, and somatic imagery such as imagined touch or temperature sensations.

Somatic Awareness. While somatic awareness is more related to physical state than the nature of mind, it was still probed to capture a full picture of possible experience during mental navigation. This included the extent to which participants felt aware of their actual physical bodily sensations, discomfort, fidgetiness, as well as mindfulness features such as awareness of breath, body posture, heartbeat, and calmness.

Procedures

All methods and study procedures were approved by the Cambridge University Psychology Research Ethics committee (PRE.2019.085). Recruited participants completed the SCID-5 administered by a trained researcher to confirm diagnostic criteria and group status (see Chapter 3 for further information on diagnostic determination).

Piloting was conducted through an initial semi-structured interview (n=10) to clarify wording of question items and ensure that concepts were clear and unambiguous. Pilot participants entered a prepared soundproofed testing room with minimal environmental stimuli present to minimise external distraction. To begin the session, participants completed a computerised testing battery of all clinical, affective, and mindfulness self-report measures. The mind wandering study portion was then explained to participants, and an educational overview of examples and clarification of each domain of theorised mental phenomenology was provided (for full written text explanation and spoken explanation script, see Appendix 7.7).

Participants were given the opportunity to ask questions and clarify any concepts before beginning the mind wandering portion of the study. During the mind wandering session, participants used headphones playing neutral white noise and lights were turned off for further minimisation of distraction. This was done for a short amount of time to provide participants a chance to adjust to the setting comfortably. For one practice minute, participants were asked to mind wander under these condition with a single randomised probe to familiarise themselves with procedures.

Following this practice, the mind wandering portion of the study was conducted for 15 minutes. Ten probes were randomly delivered across the 15 minutes, to each of which participants verbally provided keywords for the thought occurring at that probe. Following the 15-minute period, the mind wandering questions were asked one-by one for each of the ten probes. Participants were provided with their keywords to reorient to the mental content and gather ratings for each of the dimensions. Question phrasing was iteratively improved through piloting to settle on a set of questions for dimensions that the final pilot participants found clear to understand and provide self-report.

For the present study proper, 120 participants were invited to complete the study remotely (as by then, face-to-face testing was precluded due to the COVID-19 pandemic). The self-report questionnaires were completed via computerised assessment on Qualtrics. A pre-recorded video explanation of the study (see Appendix 7.7) was embedded into the online study delivery. Participants watched the video explanation alongside written instructions and examples of how to navigate the task by clicking on embedded videos and typing their keywords at probes upon hearing each randomized audio-beep. To begin the mind wandering portion of the study, participants used headphones to listen to a 15-minute white noise segment with 10 audio-beep probes, interspersed throughout the segment. They were asked to close their eyes and mentally wander freely during that time. At each audio probe, they would type in their keywords for the thought content at probe-time on a textbox displayed on screen. To ensure participants were accurately following instructions, embedded HTML code recorded the time at which participants entered their keywords. Participants who were found to have not entered their thought keywords at the time of the pre-recorded audio beeps were excluded from analysis for not following instructions (n=5) leaving a final analysis sample of 115 individuals.

Following the mind wandering portion, participants were provided their keywords for each mental content experience, one at time onscreen, and asked to respond to the full list of questions comprising all comprehensive dimensions of phenomenological study of mind (see Appendix 7.6). After providing all ratings, participants concluded the study by completing the ARSQ and being debriefed and reimbursed for their time.

Analytic Plan. Descriptive statistics were assessed as a means of summarising the experience of dimensions in individuals with respect to mental health. We also assess group differences in hypothesised dimensions by using repeated measures analyses of variance

(ANOVA), as pre-registered. Given the value of using multilevel models to better assess the hierarchical data (probed timepoints nested within persons nested within groups), we also employed multilevel modeling to assess group differences and relationships between dimensions across groups.

Study 6: Results

Demographics and Clinical Characteristics

The final analysis sample comprised 115 individuals with a diagnosis of major depressive disorder currently in episode, and healthy never-depressed controls. The depressed and healthy groups were not significantly different with respect to age, gender, race, income, and education (see Table 7.2).

All 52 currently depressed participants were diagnosed with chronic (n=8, 15.38%) or recurrent major depressive disorder (n=44, 84.62%) and a current major depressive episode according to the DSM-5. All 63 healthy participants did not meet criteria for any current or past mood or anxiety disorders.

	Whole Sample	Depressed	Healthy	Statistic
N	115	52	63	
Demographics				
Age (mean, range)	41.23 (19-65)	41.06 (24-63)	41.44 (19-65)	*F* = 0.02, *p*=.88
Female	70 (60.87%)	35 (67.31%)	35 (55.56%)	$\chi2$ = 3.25, *p*=.20
Male	45 (39.13%)	17 (32.69%)	28 (44.44%)	
Ethnicity				*p*=.39*
White (British)	96 (83.48%)	41 (78.85%)	55 (87.30%)	
White (other)	9 (7.83%)	6 (11.54%)	3 (4.76%)	
Asian	6 (5.22%)	2 (3.85%)	4 (6.35%)	
Mixed White/Asian	1 (0.87%)	1 (1.92%)	-	
Mixed Other	3 (2.61%)	2 (3.85%)	1 (1.59%)	
Income (GBP)				*p*=.66*
<10,000	23 (20%)	14 (26.92%)	9 (14.29%)	
10,000-29,999	46 (40%)	20 (38.46%)	26 (41.27%)	
30,000-49,999	21 (18.26%)	9 (17.31%)	12 (19.05%)	
50,000-69,999	8 (6.96%)	3 (5.77%)	5 (7.94%)	
70,000+	4 (3.48%)	1 (1.92%)	3 (4.76%)	
Preferred not to say	13 (11.30%)	5 (9.62%)	8 (12.70%)	
Highest Education Level				*p*=.548
GCSE	4 (3.48%)	3 (5.77%)	1 (1.59%)	
A levels	19 (16.52%)	8 (15.38%)	11 (17.46%)	
HND/BTEC/NVA levels	10 (8.70%)	6 (11.54%)	4 (6.35%)	
Bachelor's degree	53 (46.09%)	20 (38.46%)	33 (52.38%)	
Master's degree	25 (21.74%)	13 (25%)	12 (19.05%)	
Doctoral degree	4 (3.48%)	2 (3.85%)	2 (3.17%)	

Table 7.2. Demographics of Study 6 sample participants. For ethnicity, income, and education level, *=Fisher's exact test for small cell sizes was used and thus no additional test statistic reported.
Note. GCSE = General Certificate of Secondary Education; A-Level = Advanced level; HND = Higher National Diploma; BTEC = Business and Technology Education Council; NVQ = National Vocational Qualifications.

Group differences on clinical self-report data were assessed using Wilcoxon tests (Bonferroni corrected adjusted p-values reported)(see Figure 7.3). As expected, depressed participants had higher ratings of depression (PHQ-9: *p*<.001, *r*=.83 95%CI[.78,.86]) and anxiety (GAD-7: *p*<.001, *r*=.84 95%CI[.80,.87]) than the healthy group. There were multiple significant group differences across IDAS subscales, highlighting the transdiagnostic qualities of the depressed participants (see Appendix 7.8).

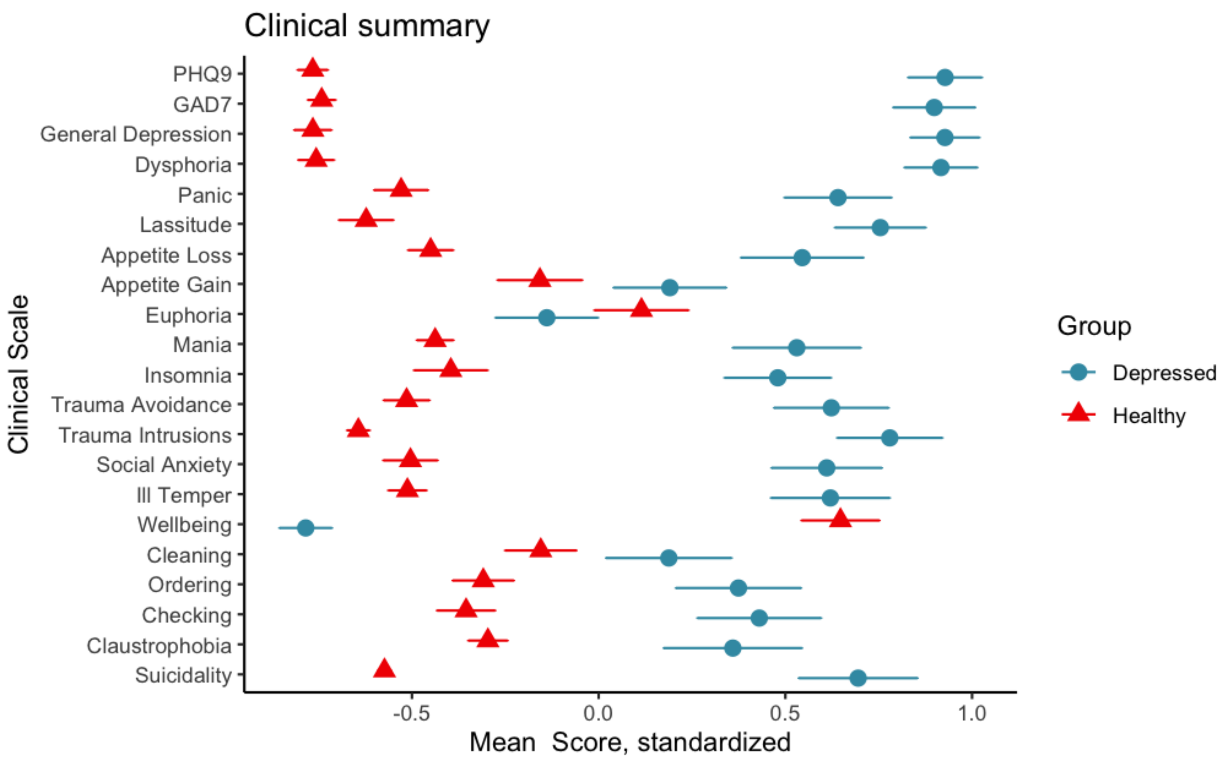

Figure 7.3. Clinical characteristics of groups in Study 6 across the Patient Health Questionnaire-9 (PHQ-9), Generalised Anxiety Disorder-7 (GAD-7), and Inventory of Depression and Anxiety Symptoms (IDAS) transdiagnostic subscales shown by *M* (point) and *SE* (line) by group. Mean is depicted by point and standard error is depicted by line.

Trait Measures

Group differences on positive and negative affect and mindfulness facets going into the study were assessed by Wilcoxon tests (Bonferroni adjusted p-values reported). Significant group differences upon entering the study were present such that, compared to the healthy group, the depressed group was lower on positive affect (p<.001, r=.74 95%CI[.65,.81]), higher on negative affect (p<.001, r=.75 95%CI[.65,.82]), and lower on mindfulness facets of acting with awareness (p<.001, r=.63 95%CI[.51,.73]), nonjudging (p<.001, r=.72 95%CI[.62,.79]), and non-reactivity (p<.001, r=.47 95%CI[.31,.61]), replicating the group differences of Study 5. There were no significant group differences in mindfulness facets of observing (p=.99) and describing (p=.36).

Following the sensory deprivation period, ARSQ resting-state dimensions were assessed and compared between groups, also by Wilcoxon tests (Bonferroni adjusted p-values reported). Groups differed significantly on comfort (p<.001, r =.64 95%CI[.53,.74]) and somatic awareness (p=.008, r=.30 95%CI[.13,.46]) during the mind wandering period.

Interestingly, there were no significant group differences in discontinuity of mind (p=.18), theory of mind (p=.99), self (p=.24), planning (p=.99), or sleepiness (p=.14).

Mind Wandering Dimensions

Next, the dimensions were assessed and summarised (*M, SE*) per group (see Table 7.3, see Figure 7.4). For group responses across dimensions over time, see Figure 7.5 and for density curves by groups, see Figure 7.6.

Dimension	*M (SD)*	*M (SD) by group*	
	All	Depressed	Healthy
Negative	2.65 (2.06)	0.37 (.65)	–0.30 (.51)
Positive	3.90 (2.13)	–0.32 (.64)	0.27 (.56)
Arousal	2.68 (1.90)	–0.02 (.77)	0.01 (.68)
Enjoyed	3.82 (2.13)	–0.29 (.62)	0.24 (.59)
Distressed	2.25 (1.91)	0.40 (.70)	–0.33 (.44)
Past	4.22 (2.57)	0.03 (.66)	–0.02 (.64)
Future	2.66 (2.28)	–0.10 (.59)	0.08 (.64)
Rumination	3.79 (1.93)	0.06 (.70)	–0.05 (.67)
Changing past	2.11 (1.89)	0.30 (.78)	–0.24 (.52)
Self	3.44 (1.70)	0.19 (.75)	–0.16 (.69)
Others	2.52 (1.92)	0.09 (.63)	–0.08 (.64)
Control	3.43 (1.60)	–0.20 (.68)	0.16 (.76)
Aware-Immersed	4.21 (1.28)	0.12 (.75)	–0.10 (.67)
Specificity	5.13 (1.51)	–0.08 (.70)	0.06 (.57)
Words	2.70 (2.26)	0.13 (.77)	–0.10 (.71)
Self-talk	2.86 (2.33)	0.21 (.83)	–0.18 (.67)
Planning	2.37 (2.07)	–0.02 (.58)	0.02 (.61)
Problem solving	2.04 (1.81)	0.06 (.65)	–0.05 (.55)
Visual imagery	4.97 (2.23)	–0.06 (.68)	0.05 (.66)
1st person POV	4.60 (2.48)	–0.11 (.69)	0.08 (.61)
2nd person POV	1.56 (1.39)	–0.05 (.44)	0.04 (.83)
3rd person POV	2.42 (2.13)	–0.12 (.57)	0.10 (.70)
Sounds	2.35 (2.14)	0.07 (.61)	–0.06 (.69)
Voices	2.28 (1.99)	0.01 (.64)	–0.01 (.66)
Scents	1.77 (1.67)	–0.04 (.66)	0.03 (.78)
Sensations	2.34 (2.07)	–0.02 (.66)	0.02 (.75)
Somatic Awareness	2.34 (1.72)	0.26 (.90)	–0.22 (.63)
Fidgety-Calm	4.52 (1.56)	–0.37 (.68)	0.30 (.59)

Table 7.3. Summary descriptive statistics of whole sample and groups across all sensory deprived mental wandering dimensions for Study 6. Whole sample *M, SD* on raw data units of Likert scale (1-7), with group *M, SD* on standardized units.

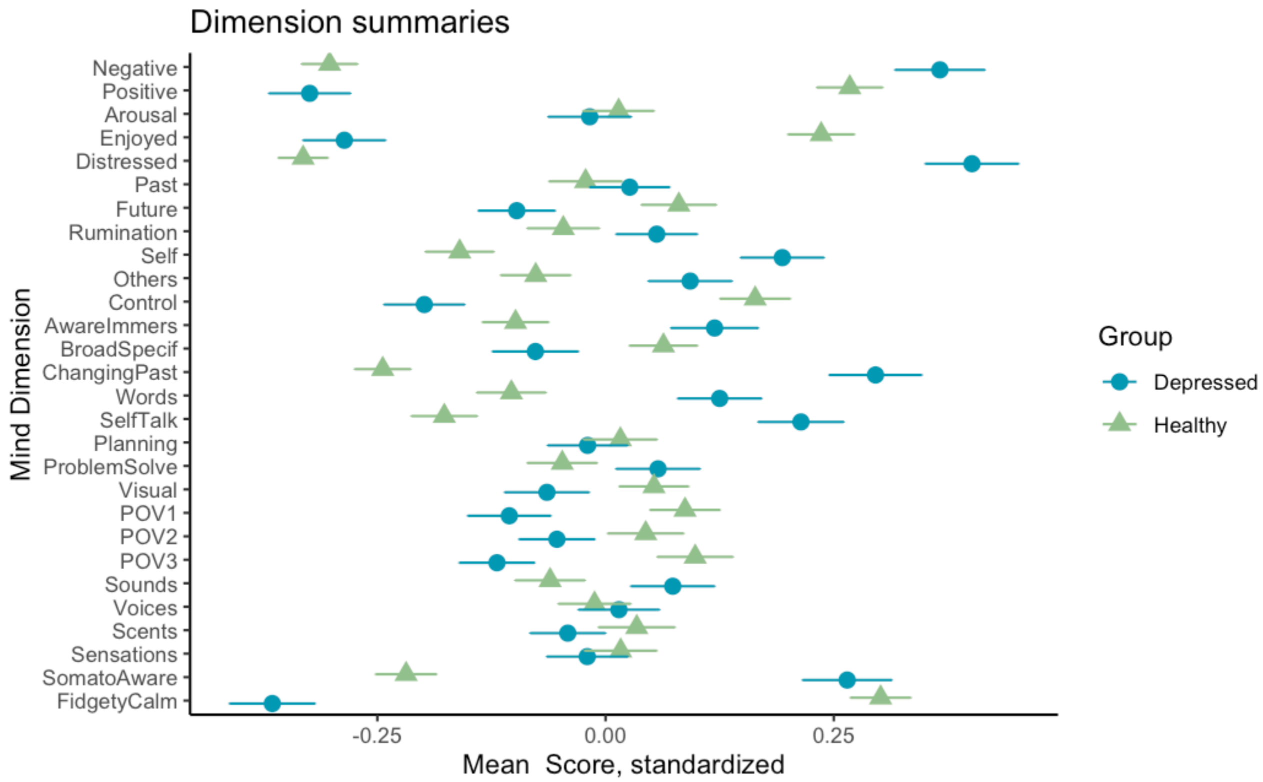

Figure 7.4. Summary of mental wandering dimensions *M (*point)*, SE* (line) by group in Study 6. The depressed and healthy groups are denoted by the legend on the right. Here, AwareImmers=higher meta-awareness to higher immersion along a dimension, BroadSpecifc=higher broadness to higher specificity along a dimension, POV1=perspective of visual imagery from first-person point of view, POV2=from second-person point of view, POV3=from third-person point of view, FidgetyCalm=high fidgetiness to high calmness dimension.

Group Differences

Our pre-registration stated use of repeated measures analyses of variance (ANOVAs) to summarise total sample effects for group differences (see Appendix 7.9 for these results). However, due to the greater strength of multilevel models in modeling the hierarchical data (Raudenbush & Bryk, 2002), we ultimately used the latter to assess group differences. Varying-intercepts were included for the repeated measures per individuals with significant differences per diagnostic group slope reported (see Appendix 7.10 for all model statistics)

To test hypotheses, models for valence (negative, positive), arousal, distress, temporal nature (past-,future-focus), rumination, changing the past, self-focus, perceived control, meta-awareness, and specificity were assessed with conservative correction (Bonferroni-corrected alpha comparison of .004) of the multiple comparisons across these 12 tests (see Appendix 7.10 for all model statistics).

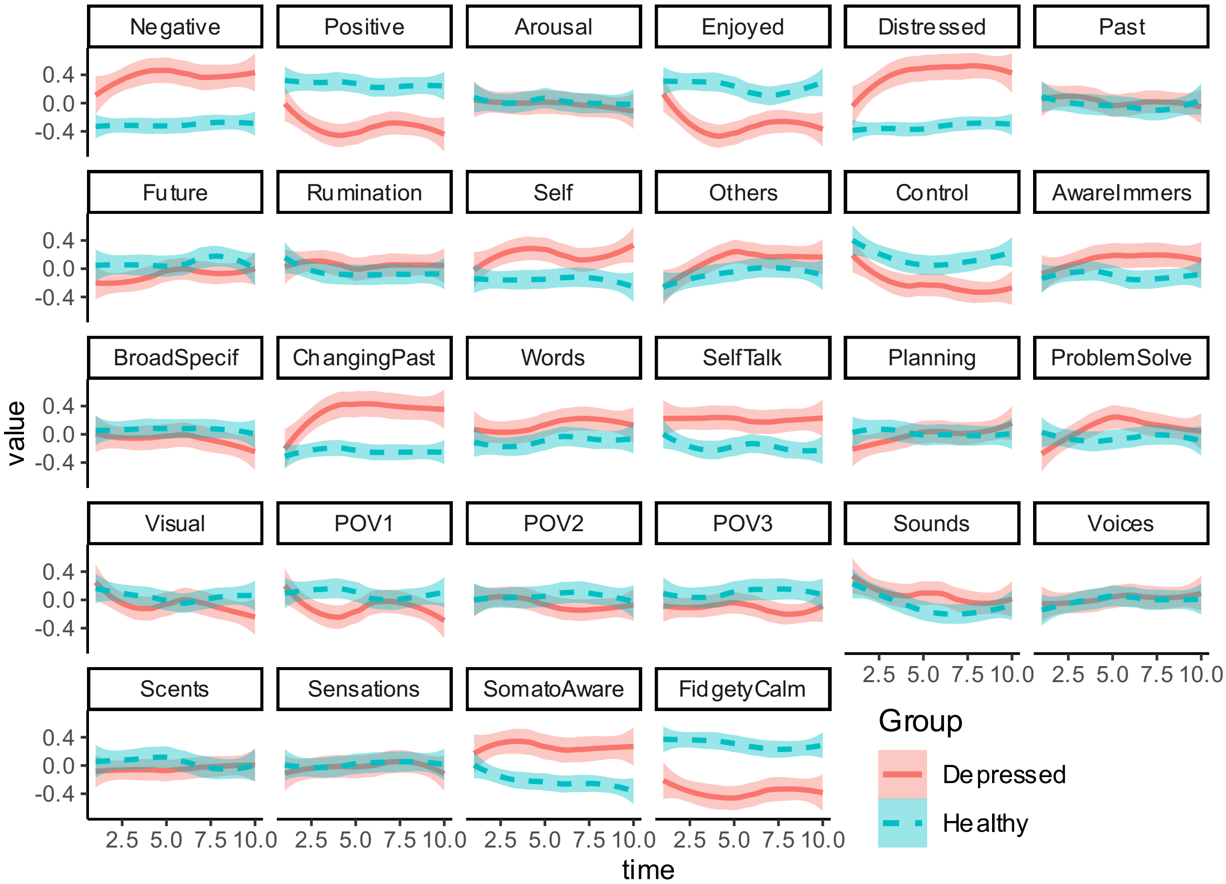

Figure 7.5. All assessed mental wandering phenomenology dimensions across time during the sensory deprivation period by group in Study 6 plotted by moving averages across time.

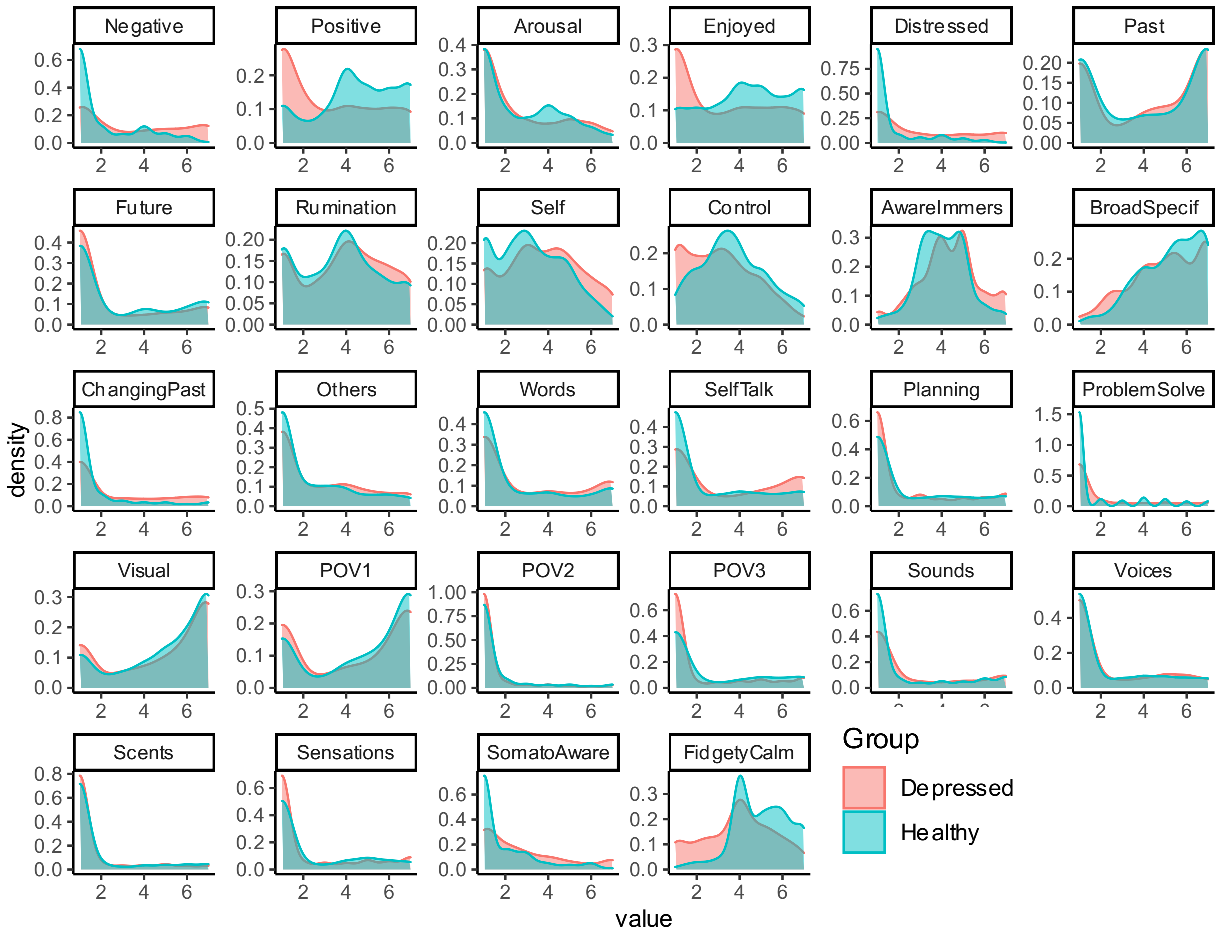

Figure 7.6. All assessed mental wandering phenomenology dimensions during the sensory deprivation period by group in Study 6, plotted by density of group-averages responses.

Valence. There were significant group differences on valence of mental wandering content, such that depressed participants showed higher levels of negative content (b=–1.37, SE=0.22, $t(95)$=–6.17, p<.001) and lower levels of positive content than healthy participants (b=1.26, SE=0.24, $t(95)$=5.26, p<.001).

Arousal. There were no significant differences on arousal of thought content between depressed and heathy persons (b=0.06, SE=0.26, $t(95)$=10.69, p=.82).

Distress. There were significant group differences on distress of mental wandering thought content, such that depressed participants showed higher levels of distress reported alongside thoughts than healthy participants (b=–1.40, SE=0.20, $t(95)$=–6.84, p<.001).

Temporal Nature. There were no significant differences for depressed persons on past-focus of thought content (b=–0.12, SE=0.31, $t(95)$=–0.40, p=.69), or future-focus of thought content compared to heathy persons (b=0.41, SE=0.25, $t(95)$=1.61, p=.11).

Rumination. There were no significant differences on ruminative nature of thought content between depressed and heathy persons (*b*=–0.20, *SE*=0.25, *t*(95)=–0.80, *p*=.42).

Changing the Past. There were significant group differences on mental wandering content regarding re-imagining the past in a changed way, such that depressed participants showed higher levels of re-imagining the past in different ways when mentally wandering than healthy participants (*b*=–1.02, *SE*=0.23, *t*(95)=–4.42, *p*<.001).

Self-focus. There were no significant group differences on self-focus of mental wandering thought content between the depressed and healthy participants (*b*=–0.60, *SE*=0.23, *t*(95)=–2.63, *p*=.01).

Perceived Control. There were no significant group differences on perceived control of mental wandering between the depressed and healthy groups (*b*=0.58, *SE*=0.22, *t*(95)=2.67, *p*=.009).

Meta-awareness. There were no significant group differences on meta-awareness of mental wandering between depressed and heathy persons (*b*=–0.28, *SE*=0.17, *t*(95)=–1.65, *p*=.10).

Specificity. There were no significant differences on specificity of thought content between depressed and heathy persons (*b*=0.21, *SE*=0.18, *t*(95)=1.18, *p*=.24).

Discussion

In assessing dispositional mindfulness measures prior to individuals engaging in the sensory deprived mind wandering session, depressed persons showed significantly lower capabilities than never-depressed persons with respect to acting with awareness for moment-to-moment experiences as well as having a non-judgmental and nonreactive attitude to passing thoughts, replicating Study 5 findings and in line with past work (Cash & Whittingham, 2010).

Interestingly, considering whether ARSQ factors differed during the sensory deprived mental wandering period did not lead to many significant group differences. Depressed individuals appeared to experience significantly lower comfort and significantly higher somatosensory awareness during the mind wandering period compared to never-depressed persons, but no other significant differences emerged. This highlights the emphasis for synthesising dimensions of hypothesised importance to describe aspects of mental wandering, as from this broad generalised probe, limited information was provided to help clarify what delineated mental wandering associated with depressed mind.

From here, the goal of the study focused on providing an initial account for how differences of mental wandering in resting-state conditions associated with sensory deprived contexts may differ on multiple dimensions integrated from past data-driven and theoretical frameworks as developed in Chapter 6. This allowed us to generate a descriptive summary across all dimensions that may guide further hypotheses around considering multidimensional features of mental wandering in resting-state contexts. For example, with respect to the type of representation in the mental content, depressed individuals experienced trends suggesting higher mean experience of word-based content, inner speech, and imagined sounds, while there were slightly higher levels of visual imagery in mental wandering occurrences of healthy individuals. Other descriptive differences lay in the higher mean levels of thoughts occurring in negative, distressing, self-focused, uncontrolled, immersed, broad, and with respect to thinking about the past in an altered way, in the depressed group. Following descriptive summary, we tested group differences across hypothesised dimensions as pre-registered.

Through group differences on key hypothesised mental wandering dimensions, it was suggested that compared to a healthy non-depressed mind, a depressed mind was a more negative, less positive, and more distressed mind with greater thought content relating to changing the past. There were no significant differences on arousal of thought content, temporal nature, rumination over repetitive thoughts, self-focus of thought content, perceived control, meta-awareness, or specificity to thought content. These results replicated some of the group differences of overlapping dimensions of Study 5 regarding valence of thought content, though not for self-focused thought, perceived control, or meta-awareness. It may be that with external distractors removed, depressed persons no longer show comparable differences during unfolding spontaneous thoughts cascading over time on these dimensions. Further study could consider probing multidimensional profiles or clusters of thought making up multiple dimensions at various levels.

7.5 SUMMARISED DISCUSSION

Overall, these studies on mental wandering aimed to assess how we can better clarify a phenomenological picture of the wandering mind and associations to depression. When chronic negative mood, as in the case of Major Depressive Disorder, colours an individual's daily life (Lane & Terry, 2000; Rottenberg, 2005), it is likely that the nature of their unfolding spontaneous thought may very well differ in marked ways from individuals without such chronic mood dysfunction. Through a naturalistic study of mental wandering in daily life, and an online study in a sensory deprived setting relating to resting-state conditions, we assessed multiple dimensions of mind wandering occurrence.

While for some of these dimensions there was no support for differences in individuals with or without depression, such as specificity or broadness of thought content, other dimensions indeed appeared to consistently delineate the experience of mind wandering, such as valence of thought content. Other dimensions displayed mixed results between naturalistic study showing significant differences between perceived control and self-focus, while controlled sensory deprived study no longer suggesting these differences are significant.

When concurrent ongoing affect during naturalistic study was also considered with respect to mind wandering dimensionality (Study 5), this suggested a stronger associative relationship between positive emotion and meta-awareness in depression than in remitted individuals. These kinds of multidimensional findings may help clarify a relationship between emotional functioning and mental wandering in ways that differ clinically. Further, when considering controlling for the variability as in ongoing daily life (Study 6), group differences on mental wandering further provided differences on how mind itself may navigate various dimensions outside of external variability. Taking a sensory deprived approach into a descriptive summary of mind outside of external distraction, group differences on hypothesised dimensions appeared to not replicate all findings, pointing further to the importance in the meta-awareness of mind or other dimensions worth further probing (Chaieb et al., 2021) given its stark differential connections to naturalistic occurrence, concurrent emotion, and sensory deprived state. Taking a granular approach to mental wandering as proposed in Chapter 6 may indeed help further clarify these associations if these concepts are probed across mind wandering investigations.

It is important to consider potential limitations. In the case of measuring unfolding mind wandering in daily life, while modelled relationships may be described and interpreted as associative at the contemporaneous level, these ongoing states do unfold at a faster rate than is possible to easily track. Thus, causal relationships of whether increasing positive emotion may lead to increased meta-awareness during mental wandering for depressed persons, for example, cannot readily be tested using these methodologies. Future work could consider interventional work on inducing emotion or mood and measuring unfolding changes in mental wandering.

While the descriptive aim of summarising differences across dimensions was provided through the sensory deprivation account, limitations also exist related to collection methods. We aimed to try and uncover possible lapses in following instructions, given the remote nature of the study, by covertly assessing timed entry of responses to mind wandering probes. However, beyond asking individuals to self-report on whether they did close their eyes or did follow instructions to listen the white noise audio provided, there were limited additional means of ensuring instructions were followed. It is possible some participants did not comply with the instructions and still viewed or listened to extraneous cues in their contextual environment. Further study into mind at rest that could rely on in-person data collection may benefit from higher levels of control in managing a research environment to study mind absent of external distraction. Here, this was precluded due to the onset of the COVID-19 pandemic. It may also be possible to consider neuroimaging studies that may allow individuals to wander freely during resting-state, occasionally responding with keywords for thought content, and then attempt a study into possible underlying neural states associated with multidimensional features of the thought content.

CHAPTER 8 – GENERAL DISCUSSION

8.1 SUMMARY

In all, the investigations covered in this thesis examined clinical differences among (i) static representations of emotion and mood states in developing adolescents, (ii) data-driven uncovered separations of shared temporal patterns of emotion dynamics transcending diagnostic information in a transdiagnostic sample of adults with and without a history of mood disorders, (iii) interrelationships of emotion and mood across time, and (iv) naturalistic description of mood regulation strategy use and efficacy in that same sample, (v) a theoretical proposal for a cohesive taxonomy of phenomenology of mind wandering, and finally, (vi) two initial assessments into mind wandering dimensions through experience sampling and sensory deprived experimental methods.

Each study described in this thesis included a self-contained detailed discussion of findings, interpretations, limitations, and future directions. This general discussion serves to summarise more broadly the implications and limitations of each study, and offer a narrative for future directions to continue expanding upon this initial exploration.

8.2 STUDY 1: EMOTION AND MOOD REPRESENTATIONS IN ADOLESCENCE

This initial study constituted a preliminary investigation of affect representations for emotions and moods in an adolescent population. The underlying affect structure that comprises a circumplex model was assessed for both emotion and mood, and further compared with respect to depression risk status. Using cut-off scores of the CES-D (Lewinsohn et al., 1997), just over half the adolescents appeared to have low-risk for depression (n=69) while the remainder may have been at-risk for depression (n=41). By using spatial arrangement methods to collect the data and multidimensional scaling to visualise and analyse underlying structure, we determined that both emotion and mood appeared to follow a circumplex structure. Furthermore, results indicated that both emotions and moods were consistently represented over less range along the arousal dimension than along valence, replicating past results (Feldman, 1995). Results did not support any differences in affect term spreads when directly comparing the paired subgroup results of emotion and mood for low- and at-risk depression.

There were slight differences in the overall clustering of affect terms for emotion and for mood based on depression risk, such that specific states like 'numb' were more closely aligned to high-arousal negative emotion for at-risk adolescents, though low-arousal negative emotion for low-risk adolescents. Likewise in mood, 'guilt' was tied to high-arousal negative mood in at-risk adolescents. These results are tentative given the small sample which was constrained from planned N=300 by the onset of the COVID-19 pandemic. They nevertheless provide a foundation for further investigation into emotion and mood structures. It may be pertinent to continue study into differing representational attributes of affect with respect to valence and arousal – the former of which underlies a great majority of affective complexity measures. Arousal was indicated as a possible important feature, and one that does not tend to be associated in the nature of affective complexity measures.

Provided the goal of this thesis is to clarify experiences of emotion and mood, it is important to discuss how to interpret findings that did not explicitly distinguish a difference between emotion and mood. In the context of study 1, the findings that valence and arousal both appear to structure the circumplex of both emotion and mood should not be interpreted as a lack of difference between the two affect states. Rather, running this line of inquiries and investigations should help provide evidence to what similarities between emotion and mood are valid, alongside the study of what differences may be present. In the case of underlying dimensions of representation for emotion and mood, the findings from this first study in adolescents suggest that valence and arousal are indeed appropriate ways to consider the structure of both emotion and mood. As we move further into other comparisons of possible distinguishing features of emotion and mood, as in study 3, differences are further highlighted.

This first study provided the grounds for a prototype into further investigation into the distinctive qualities of emotion and mood and abilities to mathematically consider conceptions of both terms and comparisons of average representations across subgroups.

8.3 STUDY 2: DISTINCT PATTERNS OF WITHIN-PERSON EMOTION DYNAMICS

This next study moved on to assessing dynamic information related to emotion in daily life. There exists extensive literature on emotion changes over time and summary metrics of the complexity of emotion experience; intensity, instability, granularity, inertia (aan het Rot et al., 2012; Kuppens et al., 2012; Thompson et al., 2021), but less so on the assessment of individual emotion dynamic similarities. This investigation aimed to assess how person-specific models of emotion changes over time may relate to clinical information, like diagnoses or symptoms, and to emotion complexity measures, as stated above. This study provides a first-of-its-kind look into data-driven assessment of individual emotion dynamic patterns over time in a sample of currently depressed (n=37), remitted from depression (n=28), bipolar (n=11), and control "healthy" non-depressed individuals (n=29) over a high number of timepoints (n=6,543).

Results showed that diagnostic or clinical information did not separate individuals into robust subgroups based on their emotion dynamics, but data-driven assessment through group iterative multiple model estimation (GIMME; Gates et al., 2017) did determine two statistically robust clusters. When these data-driven subgroups were described statistically across complexity measures, it was determined that one subgroup displayed higher emotion instability, lower emotion granularity, and lower emotion inertia while the second subgroup displayed the converse set of patterns. The importance of these findings highlight how nuanced affective dynamics may be better described through features of data not fully differentiated clinically. Indeed, the diverse sample of clinical depression, remitted depression, bipolar disorder, and 'healthy' never-depressed status were separated relatively equivalently between the two data-driven subgroups, further suggesting that patterns of emotion dynamics map in accordance with transdiagnostic similarities. The significance of this study was its ability to generate person-specific models of emotion dynamics and then cluster these models to appropriate subgroups to determine robustness of shared characteristics at a higher level that respected the individual heterogeneity (Gates et al., 2017; Lane et al., 2019).

Study 2 allowed for a complex assessment of person-specific emotion complexity and provided evidence suggesting that dynamic qualities of affect ought to considered beyond traditional diagnostic boundaries, as is the case in much of prior work. These robust differences in instability, granularity, and inertia highlight possible features of importance when considering personalised approaches to improving well-being or regulation strategies while respecting individual heterogeneity over and above the class of a diagnostic disorder.

8.4 STUDY 3: DIFFERNTIAL FEATURES AND INTERRELATIONSHIPS OF EMOTION AND MOOD

This next investigation aimed to synthesise information about both emotion and mood over time using the experience sample dataset from Study 2. While Study 2 focused in on nuanced relationships of person-specific models of emotion dynamics, this study sought to build upon the interrelationships between group-level emotion and mood. The nature of the data collection comprised both experience sampling of emotion and daily diary sampling of mood.

Results comprised comparisons of emotion and mood general complexity measures of intensity, instability, granularity, inertia, and chronometry in a diverse sample of depressed (n=37), remitted (n=28), and control "healthy" non-depressed persons (n=31); i.e., the Study 2 sample with the small number of bipolar participants set aside. Findings for affect were as expected, with highest levels of negative emotion and mood intensity, and negative mood instability in depressed persons. Depressed persons also showed higher negative emotion inertia than healthy persons, but there were no group differences on mood inertia, further highlighting differences between instability and inertia in considering clinical information. When the same transdiagnostic data-driven subgroups derived from Study 2 were assessed for possible differences in mood, only mood chronometry appeared to significantly differ – no other mood metrics nor emotional chronometry.

This may suggest that emotions, more so than moods, may have predictive capabilities of later affect in ways that differ clinically as seen in inertia. Further, there was no support that emotion chronometry differed across diagnostic or data-driven subgroups regardless of valence, suggesting that fleeting occurrences of positive or negative emotion occur and dissipate in similar fashion regardless of clinical status. However, in assessing mood chronometry, it unsurprisingly appeared that depressed persons spend significantly more time in negative moods than remitted or healthy persons. Intriguingly, the transdiagnostic data-driven subgroup with lower emotion instability, higher emotion granularity, and higher emotion inertia also appeared to spend significantly higher time in negative moods, and less time spent in positive moods. This investigation provided novel information useful for interpreting differences in these summary metrics of affective complexity. Inertia and chronometry carried important value for affect depending on the type of affective state, such that emotions were experienced with clinical differences for the former, and moods were experienced with clinical differences for the latter.

Modeling the relationship between emotion and mood intensity across time was next explored along with clinical group differences, and results allowed exploration into concurrent and lagged relationships. In brief, the depressed participants showed less decline in positive mood as negative emotions increased compared to healthy participants, greater decline in negative mood as positive emotions increased compared to remitted, greater decline in depressed mood as positive emotion increased and greater increase in depressed mood as negative emotion increased compared to both the remitted and healthy groups. Depressed persons also displayed less increase in anxious mood than the healthy group when negative emotions increased. While these relationships cannot be interpreted as causal due to the limitations in modelling in relation to causality, the correlation between the shifts in mood and emotion over time provide a starting point for understanding how the interrelationships of emotion and mood differ clinically across time.

Through this third investigation, near real-time experiences of ongoing emotion and mood were directly compared. This expanded upon the findings from study 1, as while emotion and mood were instead reported upon within controlled settings in-lab in that investigation, study 3 assessed naturalistic measures of these affect states. The uncovered differences included how emotions may relate to changes in mood between individuals with varying mental health. This nuanced relationship indeed points towards differences in how short-term emotion changes may be related to greater mood changes, as in the case of differences of negative emotion inertia, though not mood inertia between depressed and healthy persons, as well as no differences in emotion chronometry, but strong differences in mood chronometry for depressed individuals again.

Considering these findings holistically help place together an informative picture on emotion and mood. For example, with study 1 we are able to assess that emotion and mood both may be represented structurally on axes of valence and arousal while with study 3, we can further see that the inertia of emotion and chronometry of mood experiences differ in important ways the other features of these affect states may not. Altogether this carries clinical significance for how we may conceptualize emotion versus mood and their similarities (e.g., valence, arousal, intensity) and differences (e.g., inertia, chronometry) and helps clarify and elucidate the nuanced and complex picture of both emotion and mood.

8.5 STUDY 4: MOOD REGULATION

After now conducting a study on static affect representations (Study 1), daily person-specific models of emotion dynamics (Study 2), and group differences between daily emotion and mood (Study 3), this next study focused on mood regulation in everyday life in the same patient sample of depressed, remitted, and healthy persons as Study 3 with the goal of expanding upon a descriptive summary of strategies.

Reviewing literature on the theoretical foundations of mood (Beedie et al., 2005; Larsen, 2000; Russell, 2003) strongly suggested key differences in mood regulation versus the more heavily studied affective regulation field of emotion regulation (Aldao et al., 2010; Gross, 1998, 2015). No study to date had specifically assessed mood regulation strategies in everyday life. This study used a theoretical base to pull strategies from past work matching hypothesised domains of mood regulation (Larsen, 2000; Parkinson, 1996; Thayer et al., 1994) spanning ten cognitive and behavioural strategies. Findings covered many nuanced relationships between strategy use and efficacy, including self-reports of feeling stuck within one's mood affecting clinical groups differently. There was no support for either depressed or remitted persons engaging in cognitive reappraisal differently as feelings of 'stuckness' were higher when compared to healthy persons, but cognitive reappraisal was reported as less efficacious for depressed persons during times of high mood stuckness compared to healthy participants, suggesting that the experience of mood and relevant strategies differed across clinical groups. Many of these characteristics and findings are reported throughout Chapter 5, with main findings suggesting that mood regulation strategies more strongly associated with higher positive moods included higher use of relaxation, exercise, cognitive reappraisal, acceptance, and lower use of problem solving.

There were no differences between clinical groups in how they viewed the efficacy of relaxation, exercise, reappraisal, support seeking, or acceptance, suggesting these may be relatively similar in perceived usefulness even when experiencing chronic depression and engaging in use. Lagged relationships between strategy use and next-day mood were also assessed, with the caveat findings may still not be causal given the wide variety of events that may otherwise have influenced mood between sampling timepoints. Across all groups, higher use of behavioural relaxation was associated with higher next-day positive mood and lower next-day negative mood, and increased use of cognitive reappraisal was also associated with higher next-day positive mood though no association with next-day negative mood. Ultimately, this investigation aimed to contribute a high level of detail in real-use cases of several mood regulation strategies in a diverse clinical sample. Given that emotion regulation is more focused on changing appraisals of events that cause emotion (Gross, 1998), whereas mood is more focused on shifting mood itself to a more ideal set point (Larsen, 2000), it is important to consider actual use, efficacy, and clinical differences in engagement and effects on mood.

8.6 TOWARDS A THEORETICAL TAXONOMY OF MENTAL WANDERING

While research on affect was a main component of this thesis, the remaining focus shifted to the examination of mind wandering. Chapter 6 took the approach of synthesising past work on frameworks of mind wandering and expanding upon these dimensions of study with special attention to relevance for mental health.

Here, a brief history on the study of mind and early definitions of mental abstractions were encapsulated, followed by discussions on contemporary frameworks of study, largely derived from two pathways. First, a data-based approach built upon large-scale studies leveraging qualitative interviews translated to self-report surveys (Delamillieure et al., 2010; Diaz et al., 2013; Gorgolewski et al., 2014) were discussed with overlapping dimensions reflecting key components of (i) type of representation, (ii) somatosensory awareness, (iii) relation to experience, (iv) affect, and (v) temporal nature. Next, frameworks were reviewed stemming from theories of meditative traditions (Lutz et al., 2015), of nature of thought occurrence (Seli et al., 2016), and of dynamic components of fleeting thought conception and dissipation (Christoff et al., 2016; Mildner & Tamir, 2019; Smallwood, 2013). Likewise, these were also synthesised with theorised dimensions spanning (i) relation to experience and (ii) temporal dynamics. Across both types of frameworks, the specific dimensions relating to these key components are referred to by many names, but the overarching components carried similarities that the proposed integrative framework Chapter 6 aimed to synthesise and expand upon.

With the goal of considering past frameworks allied to considering the importance of mental health in the study of mind, this proposed framework covered (i) type of representation based on content (e.g., words, images, perspective, sensory imagery), (ii) affect (e.g., valence, arousal), (iii) temporal nature (e.g., past, future, memory constraints), and (iv) relation to experience (e.g., self/social focus, perceived control, meta-awareness, specificity). This framework was then used in the remaining studies to examine mind wandering in relation to depression.

8.7 STUDIES 5 AND 6: NATURALISTIC AND CONTROLLED INVESTIGATIONS INTO MIND WANDERING DIMENSIONS

This final experimental chapter covered the investigation into multiple dimensions of mind wandering through two studies; Study 5, a naturalistic mind wandering study through daily experience sampling probes in the same sample used in Studies 3 and 4, and Study 6, a sensory deprived mental wandering study without distraction in depressed (n=52) and healthy (n=63) individuals.

Results from Study 5 suggested that a depressed mind was a more negative, self-focused, and less controlled mind compared to the minds of remitted and healthy individuals, and that concurrent emotion appeared to be associated with clinical distinctions in differences of meta-awareness, such that positive emotion strongly associated with higher levels of meta-awareness in depressed persons more than healthy or remitted persons. When probing dimensions of sensory deprived mental wandering, the results of Study 6 replicated some components of Study 5. A depressed mind free of distraction appeared to also wander toward more negative thought content, in addition to also thinking more about changing the past and distress, but did not perceive a greater self-focus or lack of control in their experience, suggesting importance in considering further study into the phenomenology of mind in different contexts to clarify experience. The lack of group differences on temporal content with respect to past versus future focus, but on the nuance of thoughts related to changing the past, tentatively highlights the value in considering phenomenology of mind in assessing dimensionality.

Given how much time is spent mentally wandering (Killingsworth & Gilbert, 2010), understanding features of that mental wandering experience and how they relate to mental health is important. Taking a naturalistic approach to maximize generalisability of mental wandering while also taking a sensory deprived approach to better understand mental wandering in a context with minimal environmental variability both carry weight in helping to unpack a phenomenological picture of what it means for a mind to wander as we consider how various phenomenological features do or do not differ as a result of mental health status, and when this may carry significance, as in the context of meta-awareness clinical differences occurring with respect to positive emotion.

8.8 GENERAL CONCLUSIONS

With respect to the personal felt experience of depression, this thesis aimed to investigate and holistically consider findings on emotion, mood and mind wandering. Provided the staggering costs associated with depression (Alonso et al., 2011; Greenberg et al., 2021; Hirschfeld & Vornik, 2003; Kessler et al., 2014; McIntyre & O'Donovan, 2004; Ormel et al., 2019), it is vital that we move to clarify and continue to improve our understanding of these psychological processes of affect and resting-mind that underlie individual sensations and perceptions in daily life (Beck, 1979).

Confirming that emotion and mood states can be distinctly collated and probed in tasks and that both appear to be represented as valence by arousal circumflex (see Study 1; Chapter 2) led on to the assessment of these distinct states across time (Studies 2-5) with initial identification of robust transdiagnostic data-driven subgroups distinctly differing on their resultant emotion patterns, as well as emotion instability, granularity, and inertia (see Study 2; Chapter 3). While this indicated that depression as a diagnosis did not robustly map to shared individual emotion patterns, further work suggested depression was characterised by greater negative intensity and instability across both emotion and mood, and greater negative emotion inertia and mood chronometry, while these transdiagnostic subgroups only appeared to further differ on mood in chronometry only (see Study 3; Chapter 4). Clarifying these distinct experiences of emotion and mood, and clinical experience of regulation of said moods that were indeed reported as feeling much more ‘stuck’ within depression (see Study 4; Chapter 5) altogether provides further information on a distinct affective picture of mental health both diagnostically and transdiagnostically. With these higher negative emotion experiences observed in depressed individuals, the study of concurrent mind wandering dimensionality provided clarification that a depressed wandering mind shows increased meta-awareness of mental wandering alongside higher positive emotions to a greater extent than non-depressed persons, while meta-awareness may not otherwise differ at baseline, alongside other clinical differences in mental wandering phenomenology (see Studies 5 and 6; Chapter 7).

Altogether, these research studies holistically assessed relationships across emotion, mood, mental wandering and the heterogenous experience of depression, bipolar disorder, remission, and those without significant mental ill health history.

8.9 LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

There are potential limitations to take into consideration when interpreting the aforementioned results. In addition, provided the findings of this series of research studies, there is ample room for future work to further elucidate upon these findings.

Study 1 on mood representation was limited in interpretation of findings due to the small sample size. Unfortunately, due to the unfolding of the COVID-19 pandemic during initial data collection, the initial aims of larger total sample size (N=300) could not be met. Government restrictions on closing schools prevented continued data collection of adolescents. The smaller sample size also limited the power to parse out potential clinical risk of the adolescents, using depression self-report cut-off. Further work into targeted recruitment of non-depressed versus depressed adolescents may help better clarify findings in relation to depression. Future work on emotion and mood representation could consider inclusion of a greater variety of emotions representational of multiple dimensions in addition to valence and arousal, in case other representational structures may be better represented by some other underlying dimension. Spatial arrangement methods are flexible to stimuli type, and it may be possible mapping could be conducted with more naturalistic indicators of affect – for example, visual images depicting an emotion event or mood state. High dimensionality of the affective experience can be conveyed in visual stimuli when contextual clues are controlled for and investigating the multidimensional structure of perceived similarity of affect in other forms may well provide more information.

In Study 2 of emotion dynamics, there was sufficiently large sample size and recruitment of a wide array of individuals across clinical boundaries and diagnosis. However, limitations included the sampling period. Seventy intraday responses of emotion were collected across a 14-day experience sampling timeline, which is a relatively high amount in line with past work, yet these intraday emotion ratings were collected every two hours. Given that the dynamic unfolding of emotion can occur very rapidly, it is likely that emotion dynamics may differ on a shorter timescale than 2-hours. Future work could consider a shorter total timeline with higher consecutive ratings. For example, collecting frequency and consecutive real-time emotion ratings over the course of 15-minutes while individuals watch a video clip eliciting emotion. This may have drawbacks as well given it is less naturalistic, but these limitations must all be considered when attempting to assess the fleeting nature of emotion dynamics.

In Study 3, a potential limitation was the timescales for emotion and mood measurements. Because of theoretical understandings of the mood time-course in relationship to ongoing momentum from environment cues, self-report sampling was collected at a lower resolution timescale (once daily) than for the more rapid changes in emotion (five times intraday). With this, to adequately compare the two types of affect states, emotion was reduced down to the same timescale of mood, and thus average daily emotion was compared to correlations in average daily mood. The limitations involved in this may be that features involved in daily shifts of emotion that relate to mood may therefore be washed away. Further, given the structure of the study, causation is not possible to assess, and interrelationships were correlational in nature rather than predictive. The exploration of lagged emotion on mood was conducted to attempt a description of possible predictive effects of emotion on next-day mood, but given the time gap and many possible interpersonal or situational contexts that may also have occurred in that timeframe, there are limitations on drawing conclusions for this temporal relationship. Future work could strongly consider also sampling for situational information to better relate affective self-report to daily life context and attempt to isolate predictive effects. Further work could also consider probing emotion and mood for a longer time period, for example, across a month, to allow for the possibility of building person-specific models of the unfolding time course of emotion and mood, and assess how this related to clinical and transdiagnostic groupings as in Study 2.

Study 4 examined mood regulation strategies used in daily life for depressed, remitted, and healthy persons using the same sample as that in Study 3. Similar to mood self-report, regulation strategies were measured once at the end of each day, and limitations may have involved memory biases over what strategy was actually used earlier, given there was a slight delay in reporting. It is also possible that because daily diary methods were used to probe participants on strategy usage and efficacy, it may hard to model the 'true' changes in mood following these strategies. Unfortunately, measuring mood before and after the engagement of regulation attempts was not possible in this study design, and thus there exist some limitations in how to interpret the reporting of an individual's overall daily mood states, and overall daily regulation attempts. The timescale provided allowed for investigation into lagged use of regulation strategies on one day and the effects of next-day moods, but not necessarily within the same day. As with the aforementioned naturalistic studies, causation can still not be determined given the nature of data collection.

The final two experimental Studies 6 and 7 on mind wandering sought to provide descriptive trends between mind wandering in daily life and concurrent emotion, and testing the proposed dimensions of the theoretical taxonomy proposed in Chapter 6 in a clinically depressed and healthy never-depressed sample without external distraction. As with the other experience sampling studies in this thesis, limitations included an inability to draw conclusions on causality. It is possible concurrent affect led to mind wandering, or the reverse – results are associative rather than predictive. It is also possible that several additional factors related to daily life may have influenced mind wandering and/or affect but were not measured in this study. Limitations on length of sampling time and minimising participant burden led to study design decisions emphasising brief and quick survey collections. Further, since data collection was event-based in nature (i.e., participants could respond 'no' to mind wandering occurrence, and thus no data are present for dimensions at that time), the volume of total collected data and statistical analytic choices were limited. Future work could gather a higher number of mental wandering datapoints ($\geq$60) to further generate person-specific models of covariance of mental wandering dimensions, such as in Study 2 for emotion. The ways in which person-specific models of emotion dynamics were assessed, clustered, and compared while respecting heterogeneity would be an elucidating future analytic process to compare possible profiles of mental wandering, an important study beyond average dimensionality and an area of emphasis in furthering the study of mind (Mildner & Tamir, 2019).

With respect to Study 6, due to the COVID pandemic, our initial planned in-person study of sensory deprivation and mind wandering was not possible, and an online-delivered paradigm was instead designed. This is ultimately subject to limitations in terms of the control over the participant's environment and whether instructions were appropriately followed. To combat this main limitation, several design elements of the study were included. Video materials were created to explain the nature of the paradigm along with ways of verifying the alignment of self-report responses to the randomized mind wandering probes. These were programmed such that only participants that responded promptly had their data included, thus aiming to remove possible participants that simply clicked through or filled at random without paying attention. Questions were also asked during the end-of-study self-report to inquire whether instructions were understood (e.g., my eyes were closed during the mind wandering period). Further work could be conducted to test these study paradigms of sensory deprivation tasks and mind wandering probes in-laboratory settings, controlling for many of the limitations involved in a remote online-form study. Such work could help replicate findings of the online task.

Self-report data collection methods were used throughout the studies in this thesis. While a large benefit to using self-report does include the ability for a person to directly respond on their own interpretation of mental events, which is of importance when considering the labelling of discrete emotion or mood states or features of mental wandering, there are limitations to consider when employing this method. Care must be taken to ensure self-report measures are reliable and valid; within-person reliability of the self-report items used in the experience sampling study designs was indeed reported transparently and was relatively high (see Appendix 3.5). However, limitations still occur in self-report as people may hold biases in their responses (e.g., holding a bias to not want to self-label a mental wandering thought as outside of one's control) or be influenced by contextual cues of self-report questions (e.g., asking whether a person engaged in a regulation strategy leading them to respond in a socially desirable rather than accurate manner).

It is important to consider ways to address such limitations to self-report in future work. For example, using indirect methods to measure underlying neural activity, such as resting-state fMRI, and relate patterns of neural activity to self-reported features of mental wandering states could allow researchers to consider how self-reported control or meta-awareness may be distinguishable by underlying neural responses. A combination of directly reported and indirectly measured psychological functioning can help further elucidate these complex mechanisms.

8.10. CONCLUDING REMARKS

Altogether, these research findings provide nuanced and in-depth investigations into two key aspects of the affective montage and mental wandering phenomenology of everyday life, with important implications for mental health problems such as depression. The underlying structure of emotion and mood was compared in at-risk and low-risk depression groups of adolescents showing differences in valence and arousal representations of these affective states and the effects of depression risk status on structure of affect. Similarities across person-specific models of emotion dynamics were compared both clinically and transdiagnostically resulting in findings that emotion complexity features appeared agnostic to diagnostic status in a diverse sample. Daily emotion and mood were modelled over time and compared in clinical samples to see how current or remitted depression versus non-depressed status differed in complexity metrics of these affect states and the correlative nature of their interrelationships over time. Naturalistic engagement with mood regulation strategies in daily life were explored and compared clinically to provide a descriptive picture of how mental health status may have impacted the usage, efficacy, and subsequent effects on later mood states.

The study of mind wandering was theoretically examined in the context of prior theoretical frameworks and data-driven proposals and synthesised to propose a new theoretical taxonomy with emphasis on clinically relevant dimensions spanning key components of types of representation, affect, temporal nature, and relation to experience of mental content. Everyday occurrences of mind wandering were then explored and compared to concurrent emotion clinically, finding that a depressed mind was ultimately a more negative, self-oriented, and uncontrolled wandering mind, along with results suggesting that non-depressed wandering thoughts leaned more positive, others-focused, and intentional with higher perceived control. Finally, considering this proposed theoretical taxonomy of mind wandering dimensions, an explorative study into proposed dimensions of thought in a sensory deprived mind wandering paradigm between depressed and healthy persons was conducted, mirroring aspects of and expanding upon findings of the daily-life investigation into mind wandering and affect.

This thesis has examined all these findings, summarised in this final discussion, with the ultimate aim of contributing to furthering knowledge and understanding of the complex ways that affect colours the lives of individuals and strongly contributes to, and is a symptom of, mental health, alongside the study of the complex phenomenological experience of mental content in wandering minds.

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APPENDICES

Appendix 1 (Chapter 1)

Appendix 1.1. DSM-5 Criteria for Major Depressive Disorder

Major Depressive Disorder

Five (or more) of the following nine symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (i) depressed mood, or (ii) loss of interest of pleasure. Symptoms must occur in the same 2-week period; each of these symptoms represents a change from previous functioning. Symptoms can be indicated by subjective account or observation.

(i) Depressed mood (subjective or observed)
   a. In children and adolescents, mood can be irritable.
(ii) Loss of interest or pleasure
(iii) Change in weight or appetite
(iv) Insomnia or hypersomnia
(v) Psychomotor retardation or agitation (observed)
(vi) Loss of energy or fatigue
(vii) Worthlessness or guilt
(viii) Impaired concentration or indecisiveness
(ix) Thoughts of death or suicidal ideation or suicide attempt

Symptoms must cause clinically significant distress or impairment in social, occupational, or other important areas of functioning and are not attributable to the physiological effects of a substance or other medical condition. There has never been a manic or hypomanic episode.

Persistent Depressive Disorder

Depressed mood for most of the day, more days than not (subjective or observed) for at least two years (in children and adolescents, mood can be irritable and duration at least one year). Presence of two or more of the following symptoms during the same time-period, for more days than not, for 2 years or longer, and not without symptoms for more than two months.

(i) Depressed mood
(ii) Poor appetite or overeating
(iii) Insomnia or hypersomnia
(iv) Low energy or fatigue
(v) Low self-esteem
(vi) Poor concentration or indecisiveness
(vii) Feelings of hopelessness

Appendix 1.2. DSM-5 Criteria for Bipolar Disorder

In addition to meeting criteria for a depressive episode as in Appendix 1.1 for Major Depressive Disorder, to meet criteria for Bipolar Disorder I, individuals must meet criteria for a manic episode, or for Bipolar II, a hypomanic episode.

Manic Episode

A distinct period lasting at least several days of (i) abnormally and persistently elevated, expansive, or (ii) irritable mood and abnormally and persistently increased activity or energy lasting at least one week and present most of the day, nearly every day (or any duration if hospitalization is necessary). During the period of mood disturbance and increased energy or activity, at least three of the following symptoms have persisted (or four if mood was only irritable) and have been present to a significant degree and represent a noticeable change from usual behavior:

(i) Inflated self-esteem or grandiosity
(ii) Decreased need for sleep
(iii) More talkative than usual or pressure to keep talking
(iv) Flight of ideas or subjective experience that thoughts are racing
(v) Distractibility
(vi) Increase in goal-directed activity (socially, at work or school, or sexually) or psychomotor agitation
(vii) Excessive involvement in risk-taking activities

The mood disturbance is sufficiently severe to cause marked impairment in social or occupational functioning or necessitate hospitalization to prevent harm to self and is not attributable to the physiological effects of a substance or other medical condition.

Hypomanic Episode

All the above description for manic episode apply to a hypomanic episode, except the length of period of mood disturbance lasts four consecutive days, not a week or longer. The episode is also not severe enough to cause marked impairment in social or occupational functioning or to necessitate hospitalization and there are no psychotic features and is not attributable to the physiological effects of a substance or other medical condition.

Appendix 2 (Chapter 2)

Appendix 2.1. Emotion versus Mood Explanation for Participants

Lay Differences in Emotion and Mood

Participants were provided the following explanatory text about the differences in emotion states versus mood states by the experimental researcher in non-technical lay terms. This was provided in order to clarify any methodological misunderstanding around what was meant by experience sampling instructions to self-report on emotion intra-day versus mood end-of-day when receiving prompts.

Explanatory text. Our moods are a bit different to our emotions. Emotions tend to feel like intense responses to individual events, while moods develop ‘in the background’, tend to be longer lasting and tend not to be about one single event. So, while we feel emotions about one thing in particular, our moods are usually felt as a background state of mind. Some of the words we use to describe moods are the same as the ones we use to describe emotions, but we mean different things when we use them. For example, we might feel in an anxious mood about no one thing in particular OR we might feel anxiety as an emotion about a specific event; for example, a presentation we are just about to deliver.

Appendix 2.2. Cattell Culture Fair Intelligence Test

TEST 1

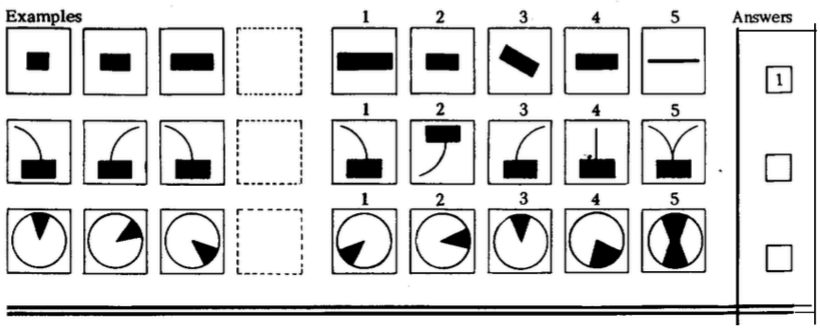
Instructions. In this task, you need to work out which picture comes next in the sequence.

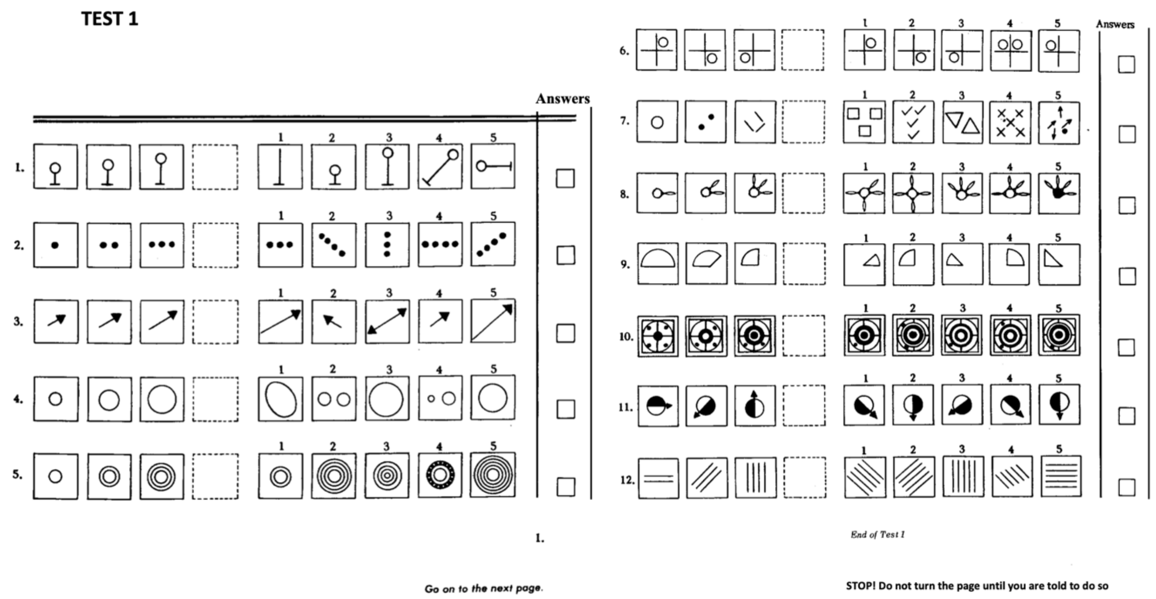
Below are three examples. For each example, you need to work out which picture goes best into the empty box on the left. You have to pick your answer from one of the five pictures on the right. Please select your answer in the small box on the right.

In the first example, you can see that the first three boxes on the left have black lines that keep getting longer, then an empty box. You need to pick which picture makes most sense to go in the empty box. Only one answer is correct.

Have a try with all three examples and ask for help if you don't understand. Only start the real task when the experimenter says. You have three minutes. It's fine if you don't finish all of them in that time.

Examples





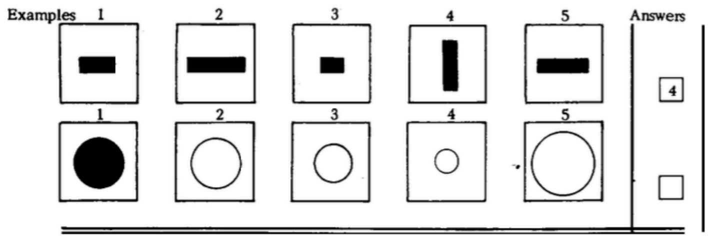
TEST 2

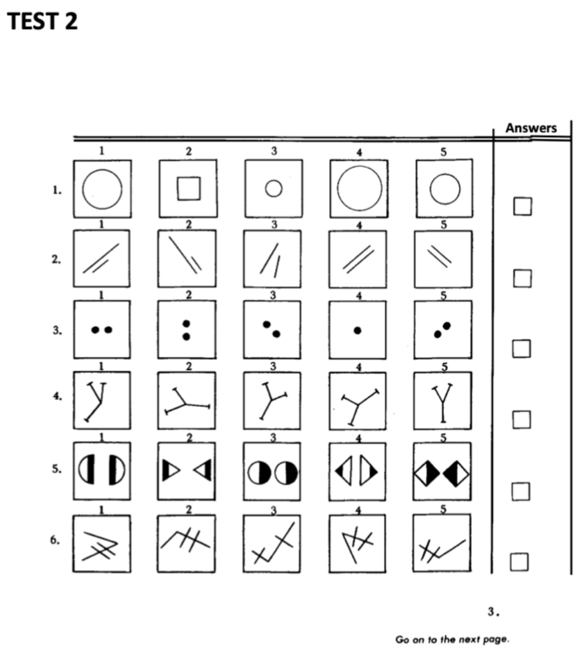
Instructions. In this next set, you need to decide which picture is the odd one out.

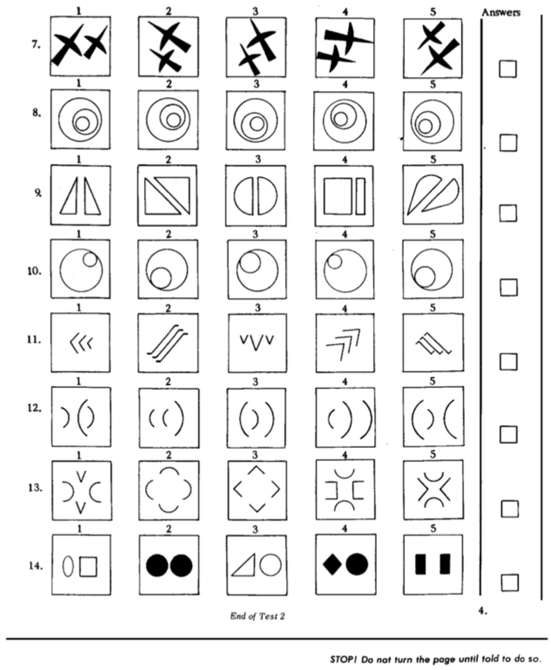
Below are three examples. For each example, four pictures are the same in some way, and one is different. In the first example, you can see that all the lines are horizontal except one. You need to pick which picture is the odd one out. Select your answer with the in the small box on the far right. Only one answer is correct.

Have a try with two examples and ask for help if you don't understand. Only start the real task when the experimenter says. You have four minutes. It's fine if you don't finish all of them in that time.

Examples





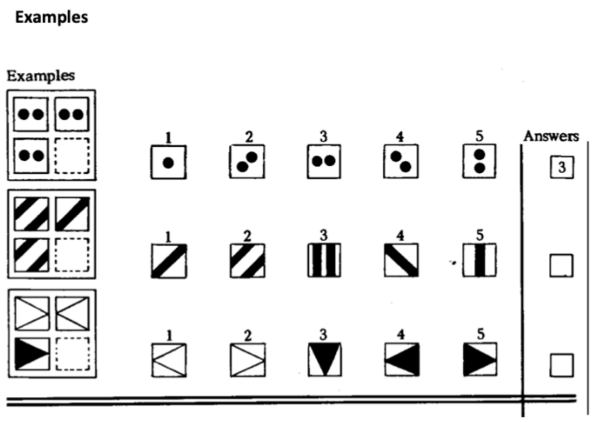


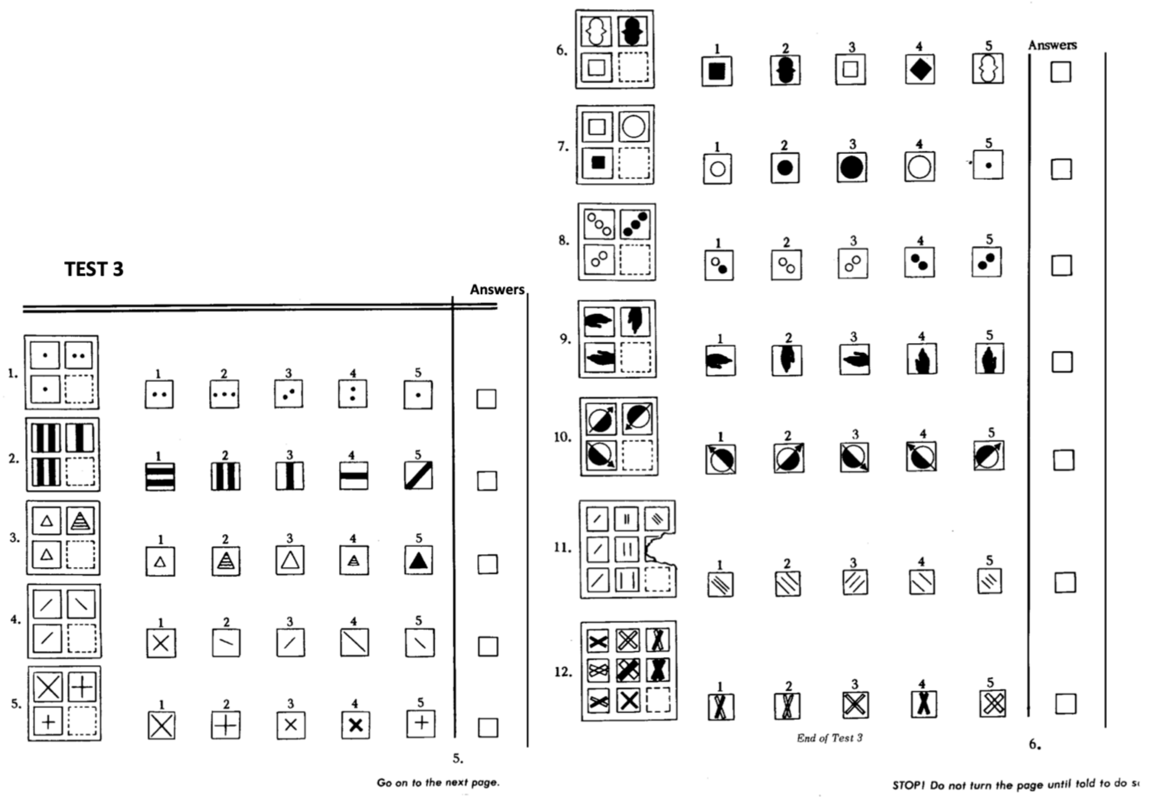
TEST 3

Instructions. In this task, you need to decide which picture fits best into the empty box on the left.

Below are three examples. For each example, there is a box on the left with an empty square. On the right, there are five pictures. You need to decide which picture on the right would fit best into the empty square on the left. Please select your answer in the small box on the far right. Only one answer is correct.

Have a try with three examples. and ask for help if you don't understand. Only start the real task when the experimenter says. You have three minutes. It's fine if you don't finish all of them in that time.





TEST 4

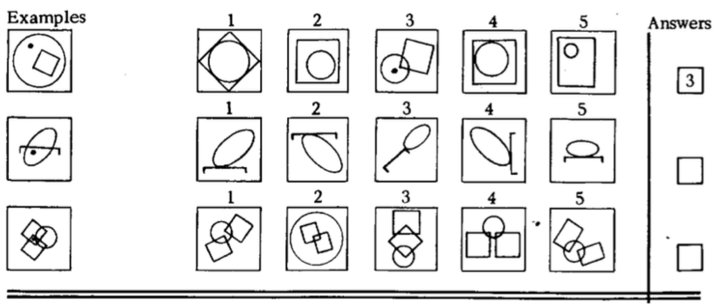
Instructions. In this task, you need to decide the rule that explains where the dot can go.

Below are three examples. For each example, there is a dot in the box on the left. In the first example, in the box on the left, you can see that the dot is inside the circle but outside the square. That is the rule for where the dot can go: it must be *inside* a circle but *outside* a square. You now need to pick which picture on the right follows that same rule.

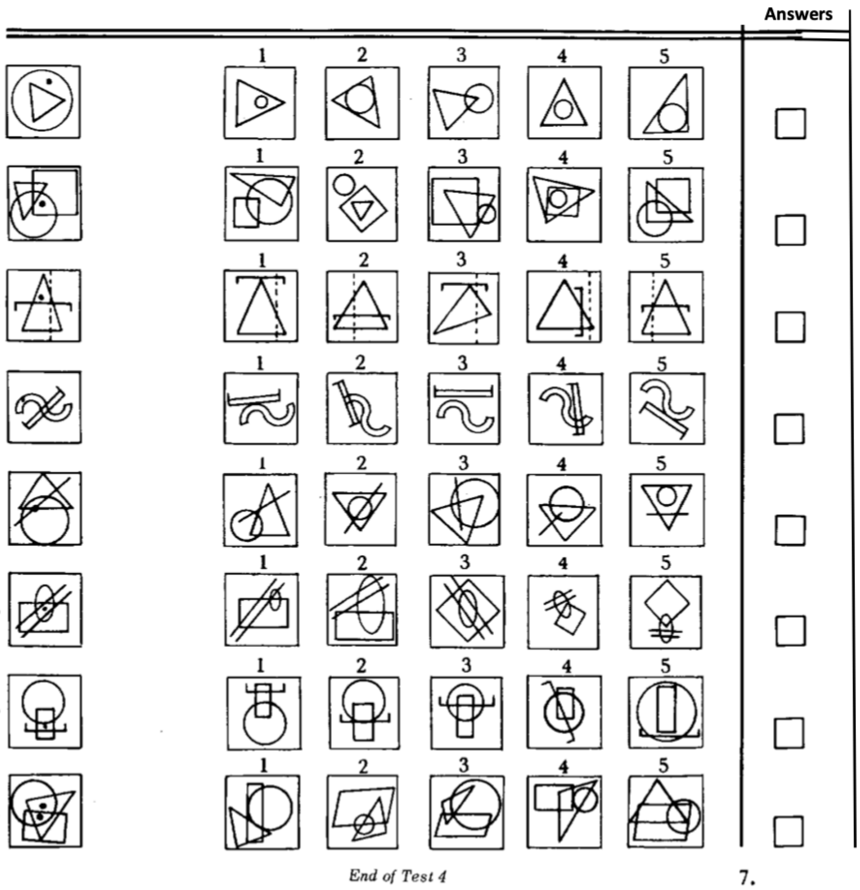
For each question, you need to a) decide what the rule is and b) work out which picture on the right follows the same rule. Please select the corresponding number for the response below the image. Only one answer is correct.

Have a try with three examples. and ask for help if you don’t understand. Only start the real task when the experimenter says. You have two and a half minutes for this set. It’s fine if you don’t finish all of them in that time.

Examples



TEST 4



Appendix 2.3. The Center for Epidemiological Studies Depression Scale (CES-D)

Instructions: Below is a list of the ways you might have felt or behaved. Please rate how often you have felt this way during the past week.

1-Rarely or none of the time (Less than 1 day)

2-Some of a little of the time (1-2 days)

3-Occasionally or a moderate amount of time (3-4 days)

4-Most or all of the time (5-7 days)

<u>During the past week:</u>

1. I was bothered by things that usually don't bother me.
2. I did not feel like eating, my appetite was poor.
3. I felt that I could not shake off the blues even with help from my family or friends.
4. I felt that I was just as good as other people.
5. I had trouble keeping my mind on what I was doing.
6. I felt depressed.
7. I felt that everything I did was an effort.
8. I felt hopeful about the future.
9. I thought my life had been a failure.
10. I felt fearful.
11. My sleep was restless.
12. I was happy.
13. I talked less than usual.
14. I felt lonely.
15. People were unfriendly.
16. I enjoyed life.
17. I had crying spells.
18. I felt sad.
19. I felt that people dislike me.
20. I could not get 'going'.

Scoring

Sum all items, reverse-code items 8, 12, 16.

Appendix 2.4. Emotion Affective Norms

Emotion	Frequency	Valence (*M, SD*)	Arousal (*M, SD*)
Angry	3008	2.53 (1.74)	6.20 (2.57)
Disgusted	90	2.68 (1.66)	4.89 (2.38)
Scared	6803	2.80 (1.83)	6.10 (2.39)
Upset	3800	2.45 (1.05)	4.49 (2.67)
Nervous	3425	3.56 (1.79)	5.51 (2.65)
Terrified	488	2.51 (1.55)	6.10 (2.55)
Jealous	1952	2.38 (1.43)	5.90 (2.07)
Frustrated	255	2.55 (1.00)	5.40 (2.29)
Sad	3232	2.01 (0.91)	3.49 (2.21)
Disappointed	1124	2.65 (1.62)	4.47 (2.37)
Bored	1029	2.95 (1.58)	3.65 (2.54)
Ashamed	1396	2.52 (2.23)	5.65 (2.39)
Embarrassed	1093	3.51 (1.72)	5.38 (2.44)
Guilty	3177	3.09 (1.76)	4.65 (2.43)
Miserable	1096	2.60 (1.90)	5.06 (3.04)
Numb	249	3.79 (1.84)	2.50 (1.44)
Happy	16993	8.47 (1.28)	6.05 (2.13)
Excited	2479	8.11 (0.90)	6.43 (2.54)
Joyful	76	8.21 (0.98)	5.53 (2.88)
Loving[1]	1275	8.00 (1.39)	5.36 (3.23)
Amused	128	7.05 (1.28)	4.27 (2.76)
Enthusiastic	142	7.55 (1.61)	5.90 (2.53)
Surprised	2808	6.57 (2.20)	5.95 (2.64)
Amazed	261	7.55 (0.89)	5.95 (2.68)
Pleased	1455	7.82 (1.18)	4.25 (3.01)
Relaxed	356	7.25 (1.92)	2.49 (2.51)
Proud	4265	7.00 (2.03)	5.55 (2.34)
Satisfied	791	7.16 (1.26)	3.95 (2.67)
Interested	4374	6.83 (2.12)	4.45 (2.78)
Relieved[2]	524	6.63 (1.54)	4.42 (2.87)
Grateful	1355	7.5 (1.34)	4.29 (2.51)

Table A2.4. Affective norms for all emotion terms including frequency of use in English, valence, and arousal. Note[1]: Norms for ‘love’ reported rather than ‘loving’ due to data availability. Note[2] Norms for ‘relief reported rather than ‘relieved’ due to data availability. These two terms were names as such to match grammatical tense of all other emotions. Frequency counts are from the SUBTLEX-UK word database (Van Heuven et al., 2014) and affective norms from the Affective Norms for English Words (ANEW) database (Warriner et al., 2013).

Appendix 2.5. Mood Affective Norms

Mood	Frequency	Valence (*M, SD*)	Arousal (*M, SD*)
Tense	522	2.75 (1.33)	5.32 (2.62)
Irritable	74	2.85 (0.93)	6.37 (2.27)
Anxious	719	3.80 (1.42)	6.20 (2.36)
Guilty	3177	3.09 (1.76)	4.65 (2.43)
Panicky	56	3.84 (1.92)	7.00 (1.97)
Desperate	1310	3.19 (1.47)	5.00 (2.52)
Stressed	283	2.62 (1.36)	5.65 (2.87)
Miserable	1096	2.60 (1.90)	5.06 (3.04)
Sad	3232	2.10 (0.91)	3.49 (2.21)
Bored	1029	2.95 (1.58)	3.65 (2.54)
Gloomy	123	3.15 (1.63)	3.32 (2.12)
Uneasy	106	2.86 (1.04)	4.48 (2.77)
Depressed	830	2.27 (1.48)	4.25 (3.24)
Fed up[1]	-	-	-
Bitter	568	3.63 (2.17)	4.64 (3.30)
Pessimistic	30	3.90 (2.28)	4.48 (2.18)
Passionate	306	7.17 (1.54)	6.33 (1.96)
Manic	70	4.19 (1.54)	4.55 (2.70)
Excited	2479	8.11 (0.90)	6.43 (2.54)
Cheerful	190	8.00 (1.41)	5.76 (2.41)
Happy	16993	8.47 (1.28)	6.05 (2.13)
Lively	207	7.12 (1.36)	6.10 (2.69)
Joyful	76	8.21 (0.98)	5.53 (2.88)
Carefree	69	7.32 (1.49)	4.15 (2.81)
Content	389	6.70 (2.05)	3.17 (2.64)
Relaxed	356	7.25 (1.92)	2.49 (2.51)
Calm	4541	6.89 (2.00)	1.67 (1.91)
Satisfied	791	7.16 (1.26)	3.95 (2.67)
Serene	63	6.90 (1.48)	4.67 (2.72)
Composed[1]	97	-	-
Optimistic	173	7.45 (1.71)	4.19 (2.40)

Table A2.5. Affective norms for all mood terms including frequency of use in English, valence, and arousal, with same reference databases used as for emotion in Table S1. Note[1]: Norms for ‘fed up’ and ‘composed’ words could not be found.

Appendix 2.6. Multidimensional Scaling Solutions for Emotions

Solution	**All Terms**						**After removal of 'bored'**					
Depression risk	**Low-Risk**			**High-Risk**			**Low-Risk**			**High-Risk**		
Emotion terms	**Dim.1**	**Dim.2**	**D2.*Z***	**Dim.1**	**Dim.2**	**D2.*Z***	**Dim.1**	**Dim.2**	***D2.Z***	**Dim.1**	**Dim.2**	**D2.*Z***
Amazed	-0.70	-0.04	-0.41	-0.71	-0.06	-0.75	-0.54	0.13	0.49	-0.58	-0.26	-0.89
Amused	-0.71	-0.05	-0.49	-0.72	-0.04	-0.51	-0.62	0.18	0.68	-0.61	-0.15	-0.51
Angry	0.67	-0.01	-0.07	0.68	-0.10	-1.29	0.61	-0.03	-0.09	0.61	-0.43	-1.47
Ashamed	0.69	0.02	0.19	0.69	-0.01	-0.19	0.76	0.00	-0.01	0.73	-0.12	-0.41
Bored	0.55	0.37	3.88	0.57	0.21	2.76	-	-	-	-	-	-
Disappointed	0.68	0.03	0.28	0.67	0.03	0.36	0.62	-0.13	-0.50	0.63	-0.03	-0.10
Disgusted	0.67	-0.01	-0.15	0.67	-0.01	-0.17	0.59	0.15	0.56	0.60	-0.18	-0.61
Embarrassed	0.69	-0.03	-0.31	0.65	-0.06	-0.73	0.71	0.16	0.61	0.48	-0.08	-0.26
Enthusiastic	-0.73	-0.07	-0.75	-0.73	-0.07	-0.87	-0.70	0.30	1.12	-0.68	-0.33	-1.12
Excited	-0.72	-0.07	-0.72	-0.73	-0.05	-0.72	-0.69	0.24	0.88	-0.72	-0.25	-0.85
Frustrated	0.68	0.05	0.48	0.66	-0.02	-0.31	0.75	-0.12	-0.45	0.56	-0.32	-1.09
Grateful	-0.72	0.02	0.20	-0.72	0.01	0.19	-0.67	-0.21	-0.78	-0.66	0.17	0.59
Guilty	0.69	0.00	0.03	0.68	-0.04	-0.49	0.75	0.10	0.38	0.68	-0.25	-0.84
Happy	-0.73	-0.01	-0.06	-0.72	0.00	0.02	-0.76	0.01	0.03	-0.71	0.04	0.13
Interested	-0.71	-0.09	-0.91	-0.71	-0.09	-1.16	-0.60	0.36	1.35	-0.52	-0.43	-1.46
Jealous	0.65	0.01	0.12	0.67	-0.12	-1.64	0.53	-0.32	-1.19	0.51	-0.48	-1.61
Joyful	-0.73	-0.03	-0.26	-0.73	-0.02	-0.24	-0.80	0.08	0.31	-0.72	-0.03	-0.09
Loving	-0.73	0.03	0.36	-0.74	0.03	0.35	-0.75	-0.20	-0.75	-0.81	0.18	0.61
Miserable	0.69	0.07	0.76	0.69	0.02	0.26	0.77	-0.34	-1.28	0.76	0.05	0.16
Nervous	0.66	-0.14	-1.43	0.65	0.08	1.08	0.46	0.42	1.57	0.44	0.31	1.07
Numb	0.64	0.09	0.94	0.66	0.20	2.69	0.37	-0.36	-1.33	0.46	0.64	2.17
Pleased	-0.72	0.00	0.04	-0.72	0.03	0.37	-0.69	-0.09	-0.33	-0.63	0.25	0.84
Proud	-0.71	-0.01	-0.10	-0.72	-0.01	-0.12	-0.63	-0.03	-0.11	-0.62	0.03	0.09
Relaxed	-0.67	0.12	1.29	-0.67	0.06	0.81	-0.53	-0.47	-1.75	-0.60	0.40	1.36
Relieved	-0.70	0.08	0.82	-0.71	0.06	0.74	-0.52	-0.38	-1.41	-0.49	0.38	1.30
Sad	0.67	0.05	0.57	0.69	0.04	0.53	0.68	-0.28	-1.05	0.77	0.15	0.51
Satisfied	-0.70	0.02	0.21	-0.70	0.02	0.26	-0.58	-0.21	-0.78	-0.53	0.24	0.82
Scared	0.67	-0.11	-1.15	0.69	-0.06	-0.77	0.56	0.42	1.55	0.62	0.35	1.18
Surprised	-0.68	-0.12	-1.31	-0.68	-0.10	-1.39	-0.31	0.32	1.17	-0.35	-0.35	-1.18
Terrified	0.68	-0.15	-1.56	0.70	0.06	0.78	0.60	0.50	1.84	0.70	0.40	1.37
Upset	0.68	-0.05	-0.49	0.68	0.01	0.16	0.65	-0.20	-0.74	0.69	0.08	0.29

Table A2.6. Group similarity ratings from the multidimensional scaling solution for emotion (with/without 'bored' present). Dim.1=dimension one of valence, Dim.2=dimension two of arousal, D2.Z=Z-score of dimension two of arousal.

Assessing structure with inclusion of outlier value. Although results already appeared influenced by an outlier emotion term, dimensions were compared between risk-status groups and indicated similar results to that without outlier influence. The low-risk group dimensions (Valence: M=0, SD=.70, Arousal: M=0, SD=.10) and high-risk group dimensions (Valence: M=0, SD=.70, Arousal: M=0, SD=.08) were very similar, with no significant differences (Valence: $F(30,30)=0.99$, p=.99, Arousal: $F(30,30)=1.61$, p=.20). Within-group, there was a significant difference between the spread of valence and arousal in both the low-risk group ($F(30,30)=53.99$, $p<.001$) and the high-risk group ($F(30,30)=87.38$, $p<.001$), such that arousal showed lower overall spread than valence, however these statistical tests of comparison of variance are heavily sensitive to outlier presence.

Appendix 2.7. Multidimensional Scaling Solutions for Moods

Solution	**All Terms**						**After removal of 'bored'**					
Depression risk	**Low-Risk**			**High-Risk**			**Low-Risk**			**High-Risk**		
Mood terms	**Dim.1**	**Dim.2**	**D2.*Z***	**Dim.1**	**Dim.2**	**D2.*Z***	**Dim.1**	**Dim.2**	***D2.Z***	**Dim.1**	**Dim.2**	**D2.*Z***
Anxious	-0.62	0.17	0.84	-0.64	0.13	1.07	-0.57	0.29	0.91	-0.54	0.20	0.67
Bitter	-0.63	-0.03	-0.16	-0.62	-0.02	-0.14	-0.58	-0.07	-0.21	-0.50	-0.20	-0.67
Bored	-0.37	-0.46	-2.31	-0.47	-0.35	-2.94	-	-	-	-	-	-
Calm	0.69	-0.20	-1.02	0.73	-0.12	-1.01	0.61	-0.33	-1.04	0.61	-0.38	-1.27
Carefree	0.76	-0.06	-0.30	0.73	-0.06	-0.52	0.76	-0.13	-0.42	0.67	-0.22	-0.74
Cheerful	0.76	0.10	0.52	0.77	0.09	0.73	0.75	0.19	0.59	0.74	0.27	0.89
Composed	0.67	-0.23	-1.17	0.75	-0.14	-1.18	0.52	-0.38	-1.19	0.54	-0.38	-1.26
Content	0.73	-0.10	-0.51	0.76	-0.04	-0.31	0.61	-0.20	-0.64	0.70	-0.12	-0.38
Depressed	-0.66	-0.15	-0.76	-0.64	-0.07	-0.55	-0.74	-0.27	-0.85	-0.66	-0.33	-1.08
Desperate	-0.68	0.14	0.70	-0.60	0.09	0.74	-0.70	0.09	0.27	-0.52	0.00	0.00
Excited	0.71	0.28	1.43	0.75	0.15	1.28	0.61	0.46	1.45	0.58	0.45	1.50
Fed up	-0.58	-0.15	-0.77	-0.61	-0.05	-0.46	-0.51	-0.18	-0.57	-0.65	-0.10	-0.34
Gloomy	-0.64	-0.14	-0.71	-0.64	-0.06	-0.49	-0.65	-0.33	-1.04	-0.69	-0.22	-0.74
Guilty	-0.59	-0.02	-0.09	-0.66	0.02	0.18	-0.47	-0.49	-1.53	-0.57	0.42	1.39
Happy	0.76	0.06	0.32	0.78	0.04	0.31	0.74	0.11	0.35	0.81	0.07	0.24
Irritable	-0.63	0.08	0.42	-0.64	0.06	0.50	-0.66	0.21	0.67	-0.69	0.11	0.36
Joyful	0.77	0.15	0.76	0.77	0.07	0.62	0.77	0.29	0.90	0.77	0.22	0.74
Lively	0.73	0.19	0.95	0.75	0.13	1.05	0.62	0.34	1.05	0.57	0.37	1.24
Manic	-0.53	0.40	2.04	-0.60	0.25	2.10	-0.39	0.58	1.81	-0.35	0.53	1.76
Miserable	-0.65	-0.12	-0.59	-0.65	-0.07	-0.60	-0.67	-0.23	-0.73	-0.67	-0.28	-0.93
Optimistic	0.74	0.06	0.29	0.77	0.05	0.44	0.65	0.14	0.44	0.75	0.13	0.45
Panicky	-0.62	0.23	1.14	-0.63	0.11	0.93	-0.55	0.37	1.18	-0.59	0.29	0.97
Passionate	0.73	0.24	1.22	0.75	0.10	0.86	0.55	0.41	1.30	0.59	0.27	0.90
Pessimistic	-0.61	-0.22	-1.10	-0.63	-0.10	-0.82	-0.46	-0.33	-1.03	-0.49	-0.42	-1.39
Relaxed	0.74	-0.23	-1.18	0.75	-0.08	-0.67	0.68	-0.40	-1.26	0.74	-0.31	-1.03
Sad	-0.63	-0.17	-0.88	-0.64	-0.12	-1.00	-0.58	-0.32	-1.01	-0.60	-0.40	-1.34
Satisfied	0.75	-0.02	-0.09	0.75	-0.03	-0.21	0.65	-0.07	-0.22	0.65	-0.11	-0.35
Serene	0.71	-0.28	-1.43	0.73	-0.18	-1.54	0.58	-0.51	-1.61	0.49	-0.49	-1.63
Stressed	-0.62	0.20	1.03	-0.64	0.09	0.73	-0.60	0.35	1.09	-0.68	0.20	0.66
Tense	-0.60	0.18	0.92	-0.63	0.07	0.58	-0.47	0.29	0.91	-0.53	0.31	1.04
Uneasy	-0.61	0.10	0.49	-0.62	0.03	0.28	-0.51	0.13	0.42	-0.47	0.11	0.36

Table A2.7. Group similarity ratings from the multidimensional scaling solution for mood (with/without 'bored' present). Dim.1=dimension one of valence, Dim.2=dimension two of arousal, D2.Z=Z-score of dimension two of arousal.

Appendix 3 (Chapter 3)

Appendix 3.1. The Patient Health Questionnaire (PHQ-9)

Instructions: Over the last 2 weeks, how often have you been bothered by any of the following problems?

0-Not at all

1-Several days

2-More than half the days

3-Nearly every day

PHQ-9 Items

1. Little interest or pleasure in doing things
2. Feeling down, depressed, or hopeless
3. Trouble falling asleep or staying asleep, or sleeping too much
4. Feeling tired or having little energy
5. Poor appetite or overeating
6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down
7. Trouble concentrating on things, such as reading the newspaper or watching television
8. Moving or speaking so slowly that other people could have noticed, or the opposite, being so fidgety or restless that you could have been moving around a lot more than usual
9. Thoughts that you would be better off dead or hurting yourself in some way

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

(1) Not at all difficult, (2) Somewhat difficult, (3) Very difficult, (4) Extremely difficult

Appendix 3.2. The Generalized Anxiety Disorder Scale (GAD-7)

Instructions: Over the last 2 weeks, how often have you been bothered by the following problems?

0-Not at all

1-Several days

2-More than half the days

3-Nearly every day

GAD-7 Items

1. Feeling nervous, anxious, or on edge
2. Not being able to stop or control worrying
3. Worrying too much about different things
4. Trouble relaxing
5. Being so restless that it is hard to sit still
6. Becoming easily annoyed or irritable
7. Feeling afraid as if something awful might happen

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

(1) Not at all difficult, (2) Somewhat difficult, (3) Very difficult, (4) Extremely difficult

Appendix 3.3. Inventory of Depression and Anxiety Symptoms (IDAS)

Instructions: Below is a list of feelings, sensations, problems, and experiences that people sometimes have. Read each item to determine how well it describes your recent feelings and experience. Then, rate the choice that best describes how much you have felt or experiences things this way during the past two weeks, including today.

1-Not at all

2-A little bit

3-Moderately

4-Quite a bit

5-Extremely

IDAS items

1. I did not have much of an appetite (Appetite Loss)
2. I had little interest in my usual hobbies and activities (Dysphoria)
3. I felt optimistic (Well-Being)
4. I slept less than usual (Insomnia)
5. I felt fidgety, restless (Dysphoria)
6. I felt exhausted (Lassitude)
7. I felt a pain in my chest (Panic)
8. I felt depressed (Dysphoria)
9. I had trouble making up my mind (Dysphoria)
10. I was proud of myself (Well-Being)
11. I had trouble falling asleep (Insomnia)
12. I was furious (Ill Temper)
13. I had thoughts of suicide (Suicidality)
14. I had disturbing thoughts of something bad that happened to me (Traumatic Intrusions)
15. I felt self-conscious knowing that others were watching me (Social Anxiety)
16. I felt dizzy or lightheaded (Panic)
17. I woke up early and could not get back to sleep (Insomnia)
18. I was worried about embarrassing myself socially (Social Anxiety)
19. I thought a lot about food (Appetite Gain)
20. I became anxious in a crowded public setting (Social Anxiety)
21. I blamed myself for things (Dysphoria)
22. I cut or burned myself on purpose (Suicidality)
23. I felt that I had accomplished a lot (Well-Being)
24. I ate when I wasn't hungry (Appetite Gain)
25. I woke up much earlier than usual (Insomnia)
26. I felt like eating less than usual (Appetite Loss)
27. I looked forward to things with enjoyment (Well-Being)

28. I had nightmares that reminded me of something bad that happened (Traumatic Intrusions)
29. I slept more than usual (Lassitude)
30. It took a lot of effort for me to get going (Lassitude)
31. I felt inadequate (Dysphoria)
32. I was trembling or shaking (Panic)
33. I thought that the world would be better off without me (Suicidality)
34. I had memories of something scary that happened (Traumatic Intrusions)
35. I felt like breaking things (Ill Temper)
36. I woke up frequently during the night (Insomnia)
37. I felt enraged (Ill Temper)
38. I hurt myself purposely (Suicidality)
39. I felt faint (Panic)
40. I felt discouraged about things (Dysphoria)
41. I found it difficult to make eye contact with people (Social Anxiety)
42. I got upset thinking about something bad that happened (Traumatic Intrusions)
43. I had trouble waking up in the morning (Lassitude)
44. I lost my temper and yelled at people (Ill Temper)
45. My heart was racing or pounding (Panic)
46. I thought about my own death (Suicidality)
47. I found it difficult to talk with people I did not know well (Social Anxiety)
48. I found myself worrying all the time (Dysphoria)
49. I had a very dry mouth (Panic)
50. I felt hopeful about the future (Well-Being)
51. I slept very poorly (Insomnia)
52. I thought about hurting myself (Suicidality)
53. I felt that I had a lot to look forward to (Well-Being)
54. I felt much worse in the morning than later in the day (Lassitude)
55. I felt drowsy, sleepy (Lassitude)
56. I was short of breath (Panic)
57. I talked more slowly than usual (Dysphoria)
58. I felt like I was choking (Panic)
59. I felt like I had a lot of interesting things to do (Well-Being)
60. I did not feel much like eating (Appetite Loss)
61. I had trouble concentrating (Dysphoria)
62. Little things made me mad (Ill Temper)
63. I ate more than usual (Appetite Gain)
64. I felt like I had a lot of energy (Well-Being)
65. I rearranged things so that they were in a certain order (Ordering)
66. I washed my hands excessively (Cleaning)
67. I kept racing from one activity to the next (Mania)
68. I checked things over and over again (Checking)
69. I felt the urge to rearrange things so that they were "just right" (Ordering)
70. I worried a lot about germs (Cleaning)
71. I spoke so rapidly that others could not understand me (Mania)
72. I felt elated for no special reason (Euphoria)
73. I tried not to think about bad things from my past (Traumatic Avoidance)
74. I avoided small spaces (Claustrophobia)
75. I found myself checking things, even though I knew it wasn't necessary (Checking)
76. I avoided handling dirty things (Cleaning)

77. It felt like my mind was moving “a mile a minute” (Mania)
78. I felt like I was “on top of the world” (Euphoria)
79. I avoided situations that bring up bad memories (Traumatic Avoidance)
80. I was afraid of getting trapped in a crowd (Claustrophobia)
81. I felt the urge to check to make sure I had done something (Checking)
82. I followed the same, fixed order in performing everyday tasks (Ordering)
83. My thoughts jumped rapidly from one idea to another (Mania)
84. I felt anxious in small spaces (Claustrophobia)
85. I felt compelled to follow certain rituals (Ordering)
86. I had difficulty touching something that was dirty (Cleaning)
87. My thoughts were moving so quickly it was hard to keep up (Mania)
88. I had so much energy it was hard for me to sit still (Euphoria)
89. I tried to ignore upsetting memories (Traumatic Avoidance)
90. I was afraid of tunnels (Claustrophobia)
91. I had to clean myself because I felt contaminated (Cleaning)
92. I felt that I could do things that other people couldn’t (Euphoria)
93. I avoided talking about bad experiences from my past (Traumatic Avoidance)
94. I avoided tight, enclosed spaces (Claustrophobia)
95. I had little rituals or habits that took up a lot of my time (Ordering)
96. I avoided using public restrooms (Cleaning)
97. I had much more energy than usual (Euphoria)
98. I used an object (such as a towel) so I could avoid touching something directly (Cleaning)
99. I was anxious about talking in public (Social Anxiety)

IDAS Subscale Scoring. Items are totaled, with any marked by an asterisk (*) to be reverse-scored.

General Depression (20 items): #1, #2, #5, #6, #8, #9, #11, #13, #21, #26, #27*, #30, #31, #40, #48, #51, #52, #57, #61, #64*
*reverse-keyed item

Dysphoria (10 items): #2, #5, #8, #9, #21, #31, #40, #48, #57, #61

Lassitude (6 items): #6, #29, #30, #43, #54, #55

Insomnia (6 items): #4, #11, #17, #25, #36, #51

Suicidality (6 items): #13, #22, #33, #38, #46, #52

Appetite Loss (3 items): #1, #26, #60

Appetite Gain (3 items): #19, #24, #63

Well-Being (8 items): #3, #10, #23, #27, #50, #53, #59, #64

Ill Temper (5 items): #12, #35, #37, #44, #62

Mania (5 items): #67, #71, #77, #83, #87

Euphoria (5 items): #72, #78, #88, #92, #97

Panic (8 items): #7, #16, #32, #39, #45, #49, #56, #58

Social Anxiety (6 items): #15, #18, #20, #41, #47, #99

Claustrophobia (5 items): #74, #80, #84, #90, #94

Traumatic Intrusions (4 items): #14, #28, #34, #42

Traumatic Avoidance (4 items): #73, #79, #89, #93

Checking (3 items): #68, #75, #81

Ordering (5 items): #65, #69, #82, #85, #95

Cleaning (7 items): #66, #70, #76, #86, #91, #96, #98

Appendix 3.4. IDAS Internal Consistency

IDAS subscale	
M (SD)	Cronbach's α
PHQ-9	.91
GAD-7	.92
IDAS subscales	
General Depression	.94
Dysphoria	.93
Panic	.91
Lassitude	.86
Appetite Loss	.90
Appetite Gain	.86
Euphoria	.85
Mania	.83
Insomnia	.89
Traumatic Avoidance	.85
Traumatic Intrusions	.87
Social Anxiety	.86
Ill-temper	.90
Well-being	.89
Cleaning	.87
Ordering	.91
Checking	.90
Claustrophobia	.85
Suicidality	.72

Table A3.4. Internal consistency of Inventory of Depression and Anxiety Symptoms (IDAS) across experience sampling participant sample.

Appendix 3.5. Emotion Term Selection and Experience Sampling Item List

Emotion Term Selection. A diverse set of emotion items was selected for the study based on prior and established emotion differentiation tasks (Nook et al., 2018; Nummenmaa et al., 2014, 2018), reliable and validated affective self-report scales including the Positive and Negative Affect Schedule (PANAS)(Watson et al., 1988), Differential Emotions Scale-IV (DES-IV)(Blumberg & Izard, 1986), and the circumplex model of affect (Russell, 1980). Emotion terms that were consistently present across these different studies and measures were included (e.g., happy). This resulted in a synthesized set of emotion items spanning each quadrant of positive and negative valence and high and low arousal, which were further reduced down to the final nine emotion terms used in this study for feasibility, two from each affective quadrant along with one extra high-arousal negative emotion term of 'stress'. The most highly co-occurring emotion terms were reduced ('happy' and 'pleased' to form 'happy', and 'angry' and 'irritated' to form 'angry'; see Main Text) resulting in 7 emotion items. Chronometry of the overall emotion state was also assessed to capture information about the duration of the emotion. We also probed whether the participant was thinking about something other than what they were currently doing (see Table S1 for affective norms of items and psychometric properties).

Experience Sampling Item Properties

Item	Valence (*M, SD*)	Arousal (*M, SD*)	Within-person reliability[a] (*M, SD*)
Happy	8.47 (1.28)	6.05 (2.13)	.70 (.03)
Enthusiastic	7.55 (1.61)	5.90 (2.53)	.76 (.03)
Relaxed	7.25 (1.92)	2.49 (2.51)	.83 (.02)
Sad	2.01 (0.91)	3.49 (2.21)	.86 (.02)
Nervous	3.56 (1.79)	5.51 (2.65)	.78 (.03)
Angry	2.53 (1.74)	6.20 (2.57)	.82 (.02)
Stressed	2.09 (1.41)	7.45 (2.38)	.88 (.02)

Table A3.5. Affective norms for emotion terms including reported valence and arousal from the Affective Norms for English Words (ANEW) database (Warriner et al., 2013) and psychometric properties for all experience sampling items. [a]Within-person coupling reliability (WPCR) *M* and *SD* was estimated following validated methods for calculating within-person variance in nested data for items contributing to positive emotion and items contributing to negative emotion (Neubauer et al., 2019). Chronometry and occurrence of mind wandering were single-items and not related to an affect construct. Here, Happy=Happy and Pleased collapsed, Angry=Angry and Irritated collapsed as noted in main text for variable reduction of highest co-occurring emotion items.

Experience Sampling Items

Each of the following questions was presented one at a time on phone screens during the daily experience sampling collection prompt, with response options also listed below.

1. When this signal arrived, what were you currently doing?
    a. Open-ended response, text characters
2. When this signal arrived, were you thinking about something other than what you were currently doing?
    a. Binary response, yes or no
    b. If yes, follow up questions:
        i. How positive or negative were these thoughts?
            1. Likert response, (1) very negative to (7) very positive
        ii. Are these thoughts related to yourself or others?
            1. Likert response, (1) yourself to (7) others
        iii. Were these thoughts related to things taking place in the…?
            1. Likert response, (1) distant past to (7) distant future
        iv. Were you completely immersed in these thoughts, or 'watching them' with an awareness they are fleeting and temporary mental events?
            1. Likert response, (1) completely immersed to (7) completely aware
        v. How much control do you feel you had over what you were thinking?
            1. Likert response, (1) none at all to (7) very much
        vi. Were these thoughts very specific (such as a specific scene or image) or general in nature (such as a broad feeling or general thought)?
            1. Likert response, (1) very specific to (7) very broad

For the following nine emotion terms (Question 3 to Question 11), ratings were all Likert responses, (1) not at all to (7) very much.

3. Please rate how strongly you are currently feeling this emotion right now: ENTHUSIASTIC
4. Please rate how strongly you are currently feeling this emotion right now: HAPPY
5. Please rate how strongly you are currently feeling this emotion right now: PLEASED
6. Please rate how strongly you are currently feeling this emotion right now: RELAXED
7. Please rate how strongly you are currently feeling this emotion right now: NERVOUS
8. Please rate how strongly you are currently feeling this emotion right now: SAD
9. Please rate how strongly you are currently feeling this emotion right now: ANGRY
10. Please rate how strongly you are currently feeling this emotion right now: IRRITATED
11. Please rate how strongly you are currently feeling this emotion right now: STRESSED
12. How long has your current emotional state been lasting?
    a. Numerical response, number of minutes

Appendix 3.6. Additional Information on Group Iterative Multiple Model Estimation (GIMME)

Advantages of Group Iterative Multiple Model Estimation (GIMME). GIMME has five key features that arguably provide advantages over comparable methods. First, GIMME has been extensively evaluated via simulation studies against benchmark person-specific data (Gates & Molenaar, 2012). GIMME is consistently and reliably better able to detect true patterns of effects even in heterogeneous samples relative to the majority of other connectivity methods (Gates & Molenaar, 2012; Smith et al., 2011). Secondly, GIMME's capacity to compile individual-level paths provides a significant benefit over, for example, multi-level modelling, which requires that all individuals have the same pattern of relations. Thirdly, GIMME's approach to identifying the pattern of relations for individuals has a robust stopping criterion that minimizes the risk of overfitting (Mumford & Ramsey, 2014) in addition to its ability to parse signal-to-noise adequately from an initial group-level model, and then iteratively add or prune paths between individual and group models to uncover final structure (Gates & Molenaar, 2012). Fourthly, each effect is estimated separately for each study participant with no assumptions placed on the distribution of estimates. Finally, the capacity to cluster individuals in a data driven manner based on their patterns and estimates of effects (Gates et al., 2017) greatly facilitates our understanding of the varied patterns of results that may occur across individuals, as noted in the main manuscript.

Mind wandering follow up items not used in GIMME. In addition to the key set of ratings included in the GIMME analysis, participants were asked to elaborate if they answered 'yes' at any given probe to the question of whether they were thinking about something other than what they were doing (labelled MWoccur). These additional contingent questions formed part of a separate study on the content of mind-wandering and were not included within the GIMME analysis for these theoretical and for a number of methodological reasons outlined below.

These follow up questions included asking participants if their extraneous thought was: positive or negative, referred to themselves or to others, about the past or future, a thought in which they were fully immersed or more distanced from, one they had control of, and specific or general. All of these follow up questions were rated on 7-point Likert scales.

As noted, there are multiple methodological reasons why these follow-up questions which were only answered to a subset of probes are not suitable for GIMME. These relate to the nature of the sampling frequency of these items, the number of variables deemed reasonable for inclusion in model estimations, and the interpretable 'missingness' of the event-based design on assessing patterns over time. With respect to sampling frequency, individuals will unsurprisingly differ in the number of datapoints collected for the follow-up questions as they are contingent on a 'yes' answer to the original probe. The follow-up responses therefore do not correspond to the frequency of the emotion ratings used in GIMME. GIMME also emphasizes the need for a reasonable number of variables for modeling in order to uncover accurate final estimations, with prior robust simulations suggesting between five to ten variables is ideal, but with higher numbers of timepoints strongly recommended when including higher variable counts (Beltz & Gates, 2017; Lane et al., 2019; Lane & Gates, 2017). The main emotion variables central to our research questions, and collected at every timepoint, along with our exogenous time variable approached the recommended upper limit of 10 variables. Including mind-wandering follow-up variables would have significantly exceeded this limit and required a far greater number of timepoints, even if there was complete data at each timepoint. Finally, including event-based items in GIMME (i.e., contingent on an initial affirmative answer to the first probe) would lead to incorrect assumptions about missingness patterns, and the overall unequal spacing of these collected event-based follow up items would violate statistical assumptions (Lane et al., 2019).

Analytic plan. ***Additional information on Group Iterative Multiple Model Estimation (GIMME).*** As outlined in the main text, GIMME is an approach to person-specific (i.e., ideographic) data analysis that is efficient and scalable, because it uses automatic searches to arrive at individual participant associative network models in time-series data. GIMME is iterative, searching for model features present in the majority of the sample at the group-level, then iteratively adjusting individual and group models by iteratively adding significant paths shared in all models, and pruning non-significant paths. It estimates these models through unified structural equation models (uSEM), combining the features of traditional SEM and structural vector autoregressive (VAR) techniques, to map how variables covary across time in terms of both time-lagged and contemporaneous relationships (Kim et al., 2007).

Though GIMME estimates person-specific models, it also identifies group/subgroup-level features that are significant for a majority of the participant sample while identifying individual-level features that vary uniquely (or less-frequently) across individuals. It thus conceptually combines nomothetic and ideographic approaches (Gates & Molenaar, 2012). Unlike multilevel modeling-based approaches, GIMME respects the individuality of participants, and does not constrain them to the same model such that variables can differ in directionality, sign, and strength across all individuals. GIMME only identifies common features (i.e., group/subgroup-level paths) that are significant for the majority of individuals and does not assume a particular distributional form for parameter estimates, as in multilevel modeling. All generated solutions are generated using alternative fit indices: a root mean square error of approximation (RMSEA)<.05, the standardized root mean residual (SRMR)<.05, a comparative fit index (CFI)>.95, and a non-normed fit index (NNFI)>.95. At least two of these four indices are required meet criteria to indicate excellent fit (Brown, 2015).

GIMME Preprocessing. To guard against within-person associations emerging that merely reflect shared trajectories of change and to eliminate stationarity from the data to fulfil uSEM assumptions, linear trends in the data were removed (Beltz & Gates, 2017). Raw data were imputed with local means and then regressed against time so that resulting standardized residuals could be used in analysis as recommended for time-series analysis (Beltz & Gates, 2017).

With respect to scaling time for the intraday measures, spacing of observations nested in each day for each participant were approximately equidistant in measurement (i.e., every two hours with a randomized jitter of 15 minutes), with the exception of the overnight time between subsequent days. To account for this, a single value of missingness was included as an overnight value to account for approximate equidistant intervals in the final time-series data estimations as typical in experience sampling analysis with GIMME (Beltz & Gates, 2017; Ellison et al., 2020).

An exogenous variable of time-of-day was included in the final analyses. Exogenous variables in time-series models influence variables in the model but are not influenced by them (e.g., passage of time (exogenous) may influence a person’s memory, but a memory cannot influence the passage of time). Time of day, or diurnal time, has been shown to influence subsequent emotion experiences in mental health research (van de Maat et al., 2020). Thus, we included diurnal time in the model to capture how variables may covary across diurnal time. The square root of intraday time was calculated as a proxy for the pattern of diurnal emotion rising around midday and stabilizing until evening (van de Maat et al., 2020).

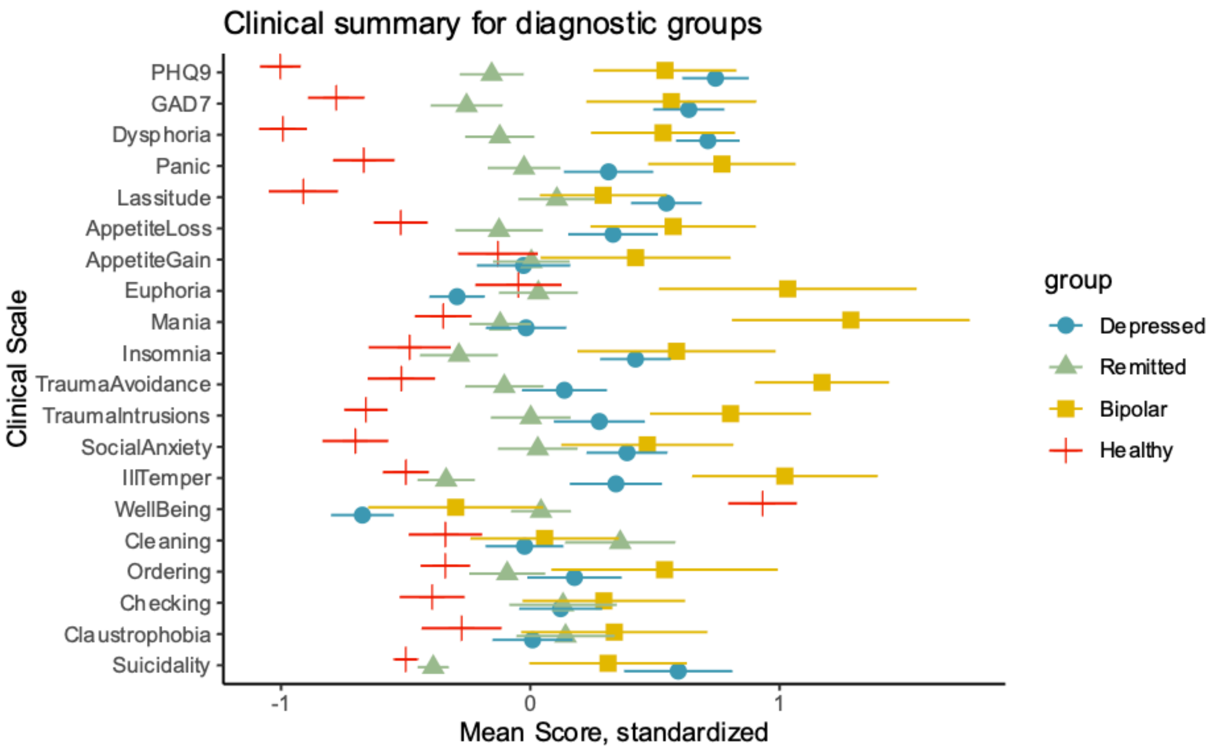
Appendix 3.7. Clinical Information about the Sample

Additional Clinical Characteristics. Additional details for the subscales and summary statistics (*M, SD/SE*) for the clinical scales across the different a priori diagnostic subgroupings and the uncovered data-driven subgroupings are presented in Figure A3.7 and Table A3.7. Currently depressed participants (n=37) were diagnosed with chronic (n=5, 13.51%) or recurrent (n=32, 86.49%) major depressive disorder and a current major depressive episode according to the DSM-5. Remitted depressed participants (n=28) were diagnosed with recurrent major depressive disorder, currently in remission. The 11 bipolar participants were diagnosed with either bipolar I (n=6, 54.54%) or bipolar II (n=5, 38.46%) disorder, with the majority (n=9, 81.81%) currently meeting criteria for a depressive episode, and no individuals currently in manic episode. None of the 29 healthy participants met criteria for any current or past mood or anxiety disorders.

Diagnostic group differences on clinical self-report subscales were assessed using Kruskal-Wallis tests with a Bonferroni-corrected α for the multiple comparisons (critical p=.0023)., with subsequent pairwise Wilcoxon tests (Bonferroni-corrected adjusted p-values reported) (see Figure 2). As expected, depressed and bipolar participants had the highest ratings of depression and anxiety, followed by lower levels in remitted participants, and very low levels in healthy participants (PHQ-9 (p<.001, η_p^2=.51 95%CI[.40,.65]), GAD-7 (p<.001, η_p^2=.41 95%CI [.26,.55]).

Significant differences between the depressed and remitted groups included: PHQ-9: p<.001, r=.50 95%CI [.30,.65]; GAD-7: p<.001, r=.48 95%CI[.27,.63],. Between the depressed and healthy groups: PHQ-9: p<.001, r=.80 95%CI[.73,.85]; GAD-7: p<.001, r=.75 95%CI[.62,.85]. Between the remitted and healthy groups: PHQ-9: p<.001, r=.59 95%CI[.39,.75]; GAD-7: p=.01, r=.40 95%CI [.17,.65] And between the bipolar disorder and healthy groups: PHQ-9: p<.001, r=.61 95%CI[.37,.78]; GAD-7: p<.001, r=.60 95%CI[.32,.75].

Group differences were assessed using Kruskal-Wallis tests across all measures and subscales and were Bonferroni-corrected for multiple comparisons for the 19 tests by applying an alpha of 0.0026 to indicate significance. Follow-up pairwise comparisons between clinical groups conducted on significant findings have also been Bonferroni corrected with the adjusted p-values reported. Group data across the IDAS subscales are also listed for the data-driven subgroups, with no significant difference on any subscale even at an uncorrected alpha of p<.05 (see Table A3.7.2).



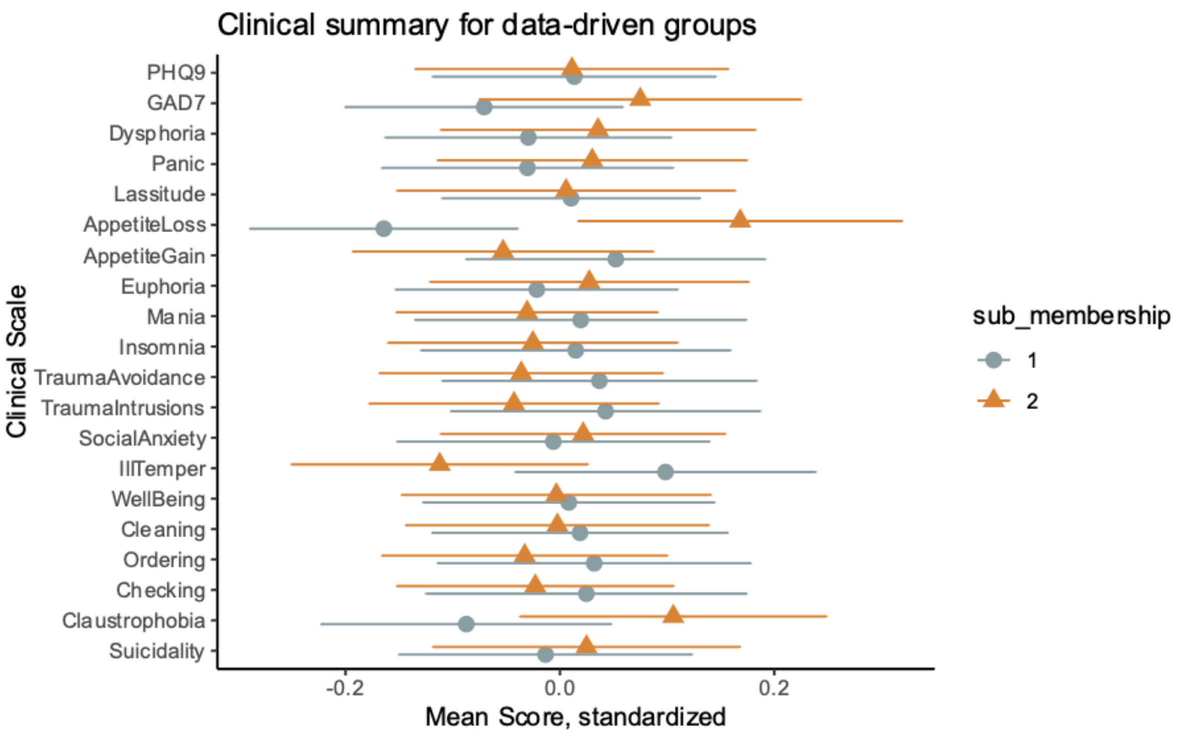


Figure A3.7. Standardized clinical measure means plotted across all measures and subscales for a priori diagnostic groups (top) and discovered data-driven Subgroups 1 and 2 (bottom). Means are depicted by points with accompanying standard error of the mean depicted by lines. PHQ9=Patient Health Questionnaire-9 depression summary score, GAD7=Generalized Anxiety Disorder-7 anxiety summary score, with all other subscale names of the Inventory of Depression and Anxiety Symptoms (IDAS).

IDAS subscale		***Data-driven subgroups***		***Clinical diagnostic groups***			
M (SD)	Cronbach's α	Subgroup 1	Subgroup 2	Depressed	Remitted	Bipolar	Healthy
PHQ-9	.91	10.11 (6.76)	10.10 (7.33)	15.24 (5.70)	8.93 (4.77)	13.82 (6.68)	2.97 (3.10)
GAD-7	.92	6.04 (5.46)	6.88 (6.21)	10.14 (5.03)	4.96 (4.43)	9.73 (6.56)	1.93 (3.54)
IDAS subscales							
General Depression	.94	36.27 (15.75)	37.75 (17.59)	49.50 (12.38)	34.42 (10.21)	45.91 (15.74)	19.97 (9.23)
Dysphoria	.93	25.22 (9.81)	25.88 (10.60)	32.73 (7.87)	24.28 (7.45)	30.91 (9.70)	15.48 (5.25)
Panic	.91	16.26 (7.67)	16.73 (7.99)	18.93 (8.46)	16.30 (5.98)	22.45 (7.61)	18.82 (5.16)
Lassitude	.86	15.26 (5.40)	15.24 (6.95)	18.57 (5.33)	15.86 (5.04)	17.00 (5.20)	9.57 (4.62)
Appetite Loss	.90	5.09 (2.80)	6.12 (3.32)	6.62 (3.37)	5.21 (2.86)	7.36 (3.38)	4.00 (1.79)
Appetite Gain	.86	7.38 (3.45)	7.02 (3.40)	7.11 (3.88)	7.21 (2.77)	8.64 (4.30)	6.76 (2.94)
Euphoria	.85	6.70 (2.83)	6.84 (3.14)	5.89 (2.00)	6.86 (2.48)	9.82 (5.08)	6.62 (2.76)
Mania	.83	8.65 (4.43)	8.45 (3.43)	8.50 (3.87)	8.09 (2.58)	13.64 (6.23)	7.19 (2.41)
Insomnia	.89	14.77 (6.92)	14.51 (6.36)	17.46 (5.68)	12.79 (5.45)	18.55 (8.70)	11.48 (5.85)
Traumatic Avoidance	.85	9.68 (4.84)	9.35 (4.28)	10.14 (4.70)	9.04 (3.76)	14.82 (4.05)	7.17 (3.30)
Traumatic Intrusions	.87	8.49 (4.34)	8.14 (3.99)	9.46 (4.60)	8.32 (3.50)	11.64 (4.43)	5.59 (1.94)
Social Anxiety	.86	15.46 (7.49)	15.66 (6.69)	18.24 (6.97)	15.71 (5.97)	18.82 (8.09)	10.55 (5.02)
Ill-temper	.90	9.19 (4.61)	8.24 (4.46)	10.30 (5.09)	7.21 (2.75)	13.36 (5.59)	6.48 (2.24)
Well-being	.89	21.70 (5.99)	21.63 (6.23)	17.57 (4.63)	21.91 (3.86)	19.84 (7.05)	27.29 (4.49)
Cleaning	.87	10.79 (5.39)	10.68 (5.42)	10.57 (5.10)	12.63 (6.29)	11.00 (5.31)	8.86 (4.27)
Ordering	.91	8.23 (4.68)	7.94 (4.18)	8.86 (5.07)	7.68 (3.55)	10.45 (6.62)	6.59 (2.35)
Checking	.90	5.43 (3.01)	5.30 (2.55)	5.70 (2.80)	5.72 (3.16)	6.18 (2.99)	4.28 (1.94)
Claustrophobia	.85	9.53 (5.11)	8.53 (5.29)	9.03 (5.07)	9.71 (5.41)	10.73 (6.42)	7.55 (4.48)
Suicidality	.72	7.33 (2.43)	7.42 (2.50)	8.81 (3.24)	6.41 (0.81)	8.12 (2.57)	6.14 (0.58)

Table A3.7. Reliability (Cronbach's α) across the whole sample, mean and standard deviation of symptom measures across data-driven subgroups and diagnostic groups. PHQ-9=Patient Health Questionnaire-9 depression summary score, GAD-7=Generalized Anxiety Disorder-7 anxiety summary score, with all other subscale names of the Inventory of Depression and Anxiety Symptoms (IDAS).

Clinical Measures	*Group differences*			*Pairwise clinical group differences, Bonferroni adjusted p-value reported*					
Statistic	*Wilcoxon rank sum (p)*	*Kruskal-Wallis (p)*	*Effect size (η_p2) 95% CI [LL, UL]*	*Kruskal-Wallis*					
Groups	Subgroup 1 -Subgroup 2	Diagnostic groups		Depressed -Remitted	Depressed -Bipolar	Depressed -Healthy	Remitted -Bipolar	Remitted -Healthy	Bipolar -Healthy
PHQ-9	.84	<.001***	.51 [.40, .65]	<.001***	1.00	<.001***	.08	<.001***	<.001***
GAD-7	.59	<.001***	.41 [.26, .55]	<.001***	1.00	<.001***	.02*	.01*	<.001***
IDAS subscales									
General Depression	.71	<.001***	.54 [.4, .67]	<.001***	1.00	<.001***	.02*	<.001***	<.001***
Dysphoria	.73	<.001***	.50 [.39, .64]	<.001***	1.00	<.001***	.05	<.001***	<.001***
Panic	.85	<.001***	.22 [.10, .40]	1.00	1.00	<.001***	.16	0.004**	<.001***
Lassitude	.73	<.001***	.34 [.20, .54]	.03*	1.00	<.001***	1.00	<.001***	0.003**
Appetite Loss	.05	0.002*	.11 [.04, .28]	.53	1.00	0.006**	.43	.91	0.02*
Appetite Gain	.62	0.59							
Euphoria	.59	0.003							
Mania	.57	0.007							
Insomnia	.92	<.001***	.18 [.06, .33]	0.006**	1.00	<.001***	0.51	1.00	.15
Traumatic Avoidance	.79	<.001***	.18 [.09, .36]	1.00	.05	.04*	.003**	.35	<.001***
Traumatic Intrusions	.88	<.001***	.21 [.10, .37]	1.00	.89	<.001***	.27	0.01*	<.001***
Social Anxiety	.65	<.001***	.25 [.13, .44]	1.00	1.00	<.001***	1.00	<.001***	0.006**
Ill-temper	.12	<.001***	.24 [.08, .37]	.02*	.62	<.001***	0.005**	1.00	<.001***
Well-being	.99	<.001***	.44 [.28, .58]	<.001***	1.00	<.001***	1.00	<.001***	0.01*
Cleaning	.69	0.07							
Ordering	.88	0.15							
Checking	.99	0.03							
Claustrophobia	.18	0.10							
Suicidality	.66	<.001***	.26 [.11, .44]	<.001***	1.00	<.001***	.08	1.00	.03*

Table A3.7.2. Differences between data-driven (Subgroup1 compared to Subgroup2) and a priori diagnostic groups on symptom measures. P-value and effect size of each subscale test are reported and compared to a critical *p*=.0023, alongside subsequent pairwise comparisons of clinical groups. Pairwise clinical group p-values are already Bonferroni corrected and thus pairwise significance corresponds to: *: $p < .05$, **: $p < .01$, ***: $p < .001$. PHQ9=Patient Health Questionnaire-9 depression summary score, GAD7=Generalized Anxiety Disorder-7 anxiety summary score, and all other scale names reference subscales of the Inventory of Depression and Anxiety Symptoms (IDAS).

Appendix 3.8. GIMME Subgroup Robustness Tests

Additional Detail on the Assessment of Data-Driven Subgroup Robustness. Within GIMME there are several ways one can further evaluate a subgroup solution including (i) assessing the robustness of the solution to minor perturbations of edges (paths) when nodes (individuals) are randomly switched; and (ii) assessing the distribution of modularity values (Q) to determine whether the solution modularity is higher than expected by chance.

The modularity values from our derived two-subgroup solution (Q=.1008) was first compared to a modularity significance level (i.e., the value for the upper 5th percentile in a distribution of random perturbed matrices) that had similar properties to the dataset (Q_{95}=.0641). Our data-driven solution modularity was indeed above this calculated cut-off value (Q=.1008> Q_{95}=.0641). Figure A3.8a shows the histogram of comparison modularity values from the randomly perturbed matrices, with our derived solution modularity clearly delineated from that distribution.

In our derived solution, the variance of information (VI) measured the distance between the two subgroup clusters. In other words, 43.31% of the obtained two-subgroup solution paths would need to be changed in order to be as different as when 20% of participant subgroup assignments are switched. In contrast, a randomized solution at chance would only need as few as 2% of paths perturbed if groupings were altered (Figure A3.8b). Cluster solutions are considered robust if the resulting matrix requires 20% or more of its paths to be perturbed (α > 0.20) before crossing the line representing 20% of the nodes being in different clusters (Karrer et al., 2008). Figure 3.8b shows indeed that 43.31% of solution paths (in black) appear to require perturbation to cross this threshold, compared to the near immediate crossover at 2% of a comparison solution (in red).

The Adjusted Rand Index (ARI) – a cluster validation measure of agreement on subgroup partitions – was also computed for our two-subgroup solution. The distribution of the ARI value at α=.20 was significantly higher than the ARI value obtained when 20% of the subgroup assignments for participants were randomly changed indicating that our solution was robust. Figure A3.8c shows our solution (in black) again requiring further perturbation than the near immediate drop in a comparison solution at chance (in red).

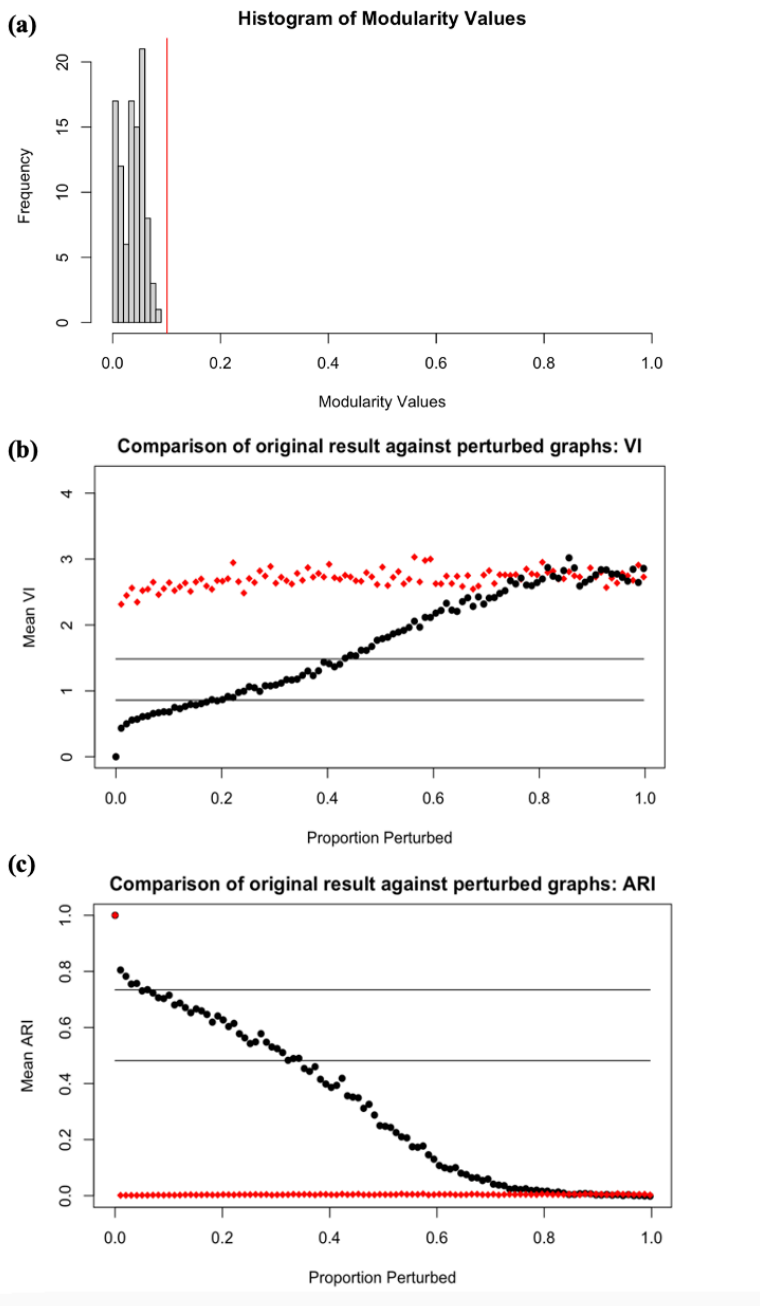


Figure A3.8. Three tests to evaluate whether the two data-driven subgroups were robust, including: (a) the modularity obtained from GIMME depicted by the red vertical line versus the plotted distribution of randomly perturbed modularity values; (b) the comparison of the variance of information (VI) between cluster assignments from our derived original matrix in black compared to the same comparisons made on an appropriate null matrix in red. The black horizontal lines indicate the values of similarity found between the original matrix and a matrix where 10 to 20% of participants were randomly assigned to different subgroups; and (c) the Adjusted Rand Index (ARI) of our derived original solution in black compared to the null matrix when proportion perturbed increased in red.

Appendix 3.9. Examples of Individual Person-Specific Models of Emotion

Additional Detail on the Assessment of Data-Driven Subgroup Paths. As noted in the main text and illustrated in Figure 3.2b in the main chapter, the data-driven iterative estimation discovered one group-level path linking a pair of emotions that was present for the majority of the sample (in addition to the autoregressive paths from each emotion to itself, which are estimated by default), and a total of nine subgroup-level paths that were present across the two data driven sub-groupings. Eight of these paths were between pairs of emotions that were the same for the two subgroups, albeit with different directionality per subgroup as indicated by the arrows in Figure 3.2b, suggesting that for one subgroup, directionality of the relationship occurred in one direction, while for the other, the opposing direction. One path was unique to Subgroup 1. All group and subgroup paths that satisfied these majority-level thresholds were contemporaneous, (i.e., were between measures taken at the same experience sampling probe), although there are frequent lagged relationships between emotions evident in the underlying individual level paths (see below for some examples).

The group-level majority path of co-occurring contemporaneous 'Happy' emotion' predicting "Enthusiastic' indicates that across most individuals in the sample, high arousal positive states tend to be coupled. The unique path in Subgroup 1 of 'Angry' predicting 'Sad' emotion suggests that for the majority of Subgroup 1 individuals these negative emotions frequently co-occur, potentially reflecting the lower overall levels of emotion granularity in that subgroup (see main results).

Within-Person Model Examples from the Data-Driven Subgroups. To illustrate GIMME's ability to elucidate within-person dynamics for each participant, in addition to patterns shared across the whole sample or across subgroups, it is helpful to look at data from sample individual participants. Four sample within-person level plots are presented in Figure A3.9. Taken together, the first thing to note about these visualizations is the heterogeneity both across the within-person models but also in their participant-specific divergences from the subgroup-level majority pathways illustrated in Figure 3.2b in the main chapter text. For example, in the first example from Subgroup 1 (Figure A3.9a) there are fewer lagged relationship with feeling 'Stressed' predicting reductions in later feelings of 'Relaxed', or 'Sad' predicting a possible increase in feeling 'Relaxed' later (possibly after engaging in regulation efforts), but there are multiple lagged pathways in the model for the second sample participant (Figure A3.9b). This second example participant also shows multiple relationships between emotions and the self-reported durations of emotion experience (EmotionChronometry) node, whereas these are absent in the first example. Similarly, for the Subgroup 2 examples, there is a marked difference in the numbers of pathways identified with the participant in Figure A3.9d showing quite a sparse set of relationships. Interestingly, both of the exemplars from Subgroup 1 show the unique Subgroup 1 majority pathway with ‘Angry’ (labeled as HighCorrNeg in individual models) predicting ‘Sad’ while neither of the exemplars from Subgroup 2 showing this relationship.

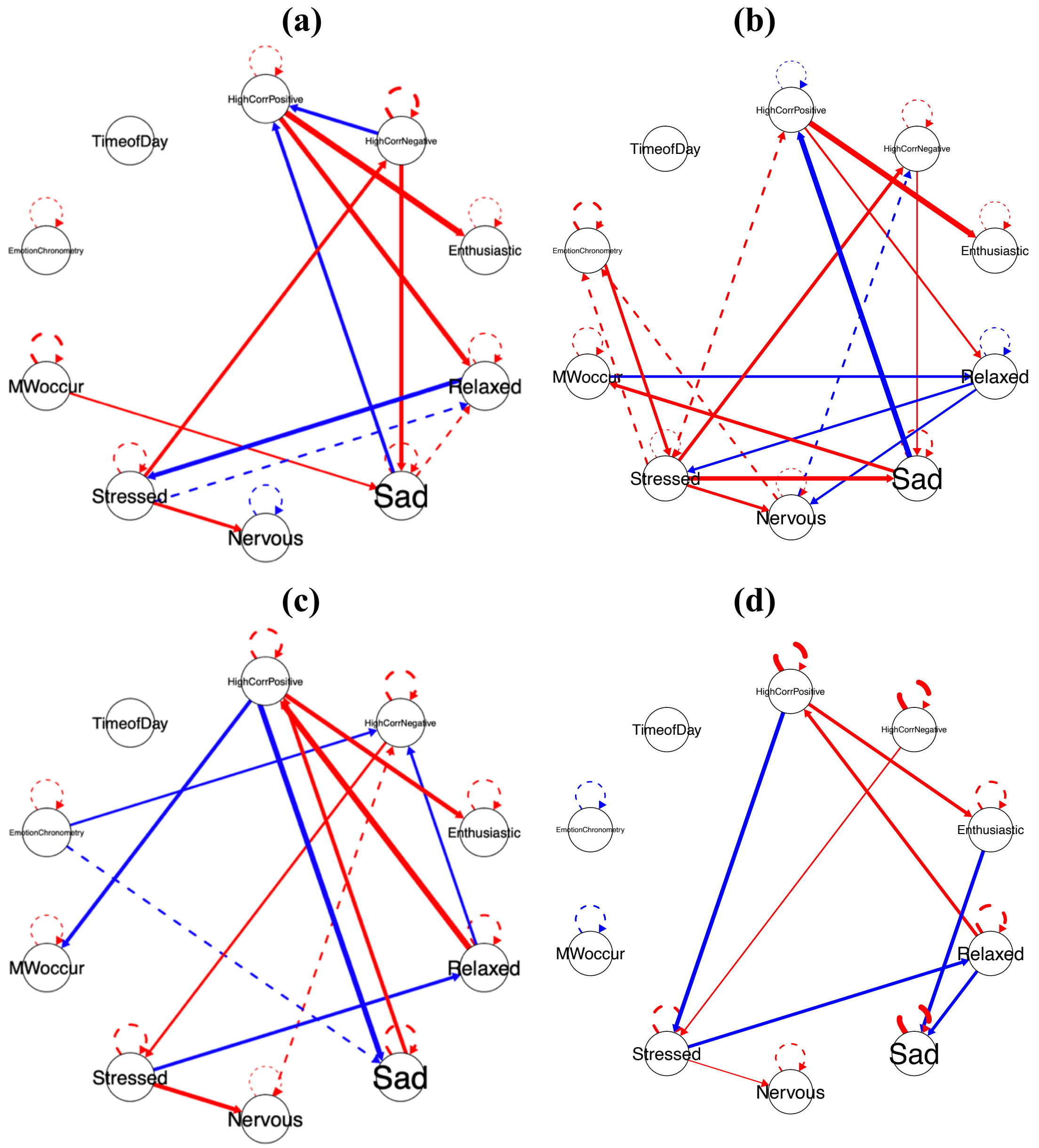


Figure A3.9. Individual person-specific models generated by GIMME for (a, b) example participants from Subgroup 1 and (c, d) from Subgroup 2. Red paths are positive weights, blue paths are negative weights, dashed lines are lagged relationships of lag-1 (autoregressive effects depicted above each variable node), and solid lines are contemporaneous from the same timepoint. Line thickness corresponds to strength of weight. HighCorrPositive=Happy, HighCorrNegative=Angry.

Appendix 3.10. Demographics of the Data-Driven Subgroups

Table A3.10 shows the summary statistics for the two data-driven Subgroups on demographic measures, alongside evaluation of the group differences, all of which were statistically non-significant.

	Subgroup 1	Subgroup 2	Statistic
N	53	51	
Demographics			
Age, years: *M* (*SD*)	41.96 (11.78)	38.62 (15.24)	*F*=1.57, *p*=.21
Female	37 (69.81%)	39 (76.47 %)	*p*=.51*
Male	16 (30.19%)	12 (23.53 %)	
Ethnicity			*p*=.27*
White (British)	45 (84.91%)	48 (94.12%)	
White (other)	4 (7.55%)	1 (1.96%)	
Asian	3 (5.66%)	1 (1.96%)	
Black	-	1 (1.96%)	
Mixed White/Asian	1 (1.89%)	-	
Income (£)			*p*=.99*
<10,000	11 (20.75%)	12 (23.53%)	
10,000-29,999	24 (45.28%)	24 (47.06%)	
30,000-49,999	9 (16.98%)	7 (13.73%)	
50,000-69,999	3 (5.66%)	2 (3.92%)	
Preferred not to say	6 (11.32%)	6 (11.76%)	
Highest Education Level			*p*=.91*
GCSE	4 (87.55%)	5 (9.80%)	
A-levels	6 (11.32%)	9 (17.65%)	
HND/BTEC/NVQ levels	7 (13.02%)	7 (13.73%)	
Bachelor’s degree	21 (39.62%)	17 (33.33%)	
Master’s degree	10 (18.87%)	10 (19.61%)	
Doctorate degree	5 (9.43%)	3 (5.88%)	

Table A3.10. Demographic sample characteristics for the two data-driven subgroups. *Fisher’s exact test was used with p-value noted, no other test statistic generated.
Note. GCSE = General Certificate of Secondary Education; A-Level = Advanced level; HND = Higher National Diploma; BTEC = Business and Technology Education Council; NVQ = National Vocational Qualifications.

Appendix 3.11. Emotion Inertia Multilevel Model Estimates for the Data-Driven Subgroups

Fixed Effect	*b* (*SE*)	*t*(104)	*p*
Positive Emotion			
Intercept (mean level)			
Subgroup 1	3.00 (.07)	43.47	<.001***
Subgroup 2	–0.20 (.10)	–2.06	.04*
Slope (inertia)			
Subgroup 1	0.17 (.02)	9.58	<.001***
Subgroup 2	0.11 (.03)	4.41	<.001***
Negative Emotion			
Intercept (mean level)			
Subgroup 1	2.16 (.11)	19.38	<.001***
Subgroup 2	0.06 (.16)	0.37	.71
Slope (inertia)			
Subgroup 1	0.19 (.02)	11.59	<.001***
Subgroup 2	0.19 (.03)	7.67	<.001***

Table A3.11. Group differences in inertia for data-driven subgroups. Effects were modelled separately for positive and negative emotion. In the models, Subgroup 1 was the referent group.

Appendix 4 (Chapter 4)

Appendix 4.1. Mood Term Selection and Daily Diary Item List

Mood Term Selection. A diverse set of mood items was selected for the study based on prior and established mood questionnaires (including the Brunel Mood Scale (BRUMS; Terry & Lane, 2003), the Profile of Mood States Scale (POMS; McNair, Lorr, & Droppleman, 1971), the UWIST Mood Adjective Checklist (UMACL; Matthews, Jones, & Chamberlain, 1990), and the Brief Mood Introspection Scale (BMIS; Mayer & Gaschke, 1988)) as described in the main text of Chapter 2 (and full list provided in Appendix 2.5).

This resulted in a synthesized set of mood items spanning each quadrant of positive and negative valence and high and low arousal, which were further reduced down to the final nine mood terms used in this study for feasibility, two from each affective quadrant along with one extra high-arousal negative mood term of 'tense'. Chronometry of each mood state was also assessed to capture information about the duration of the mood over the day. Mood regulation strategies were also probed about during this daily diary sampling for the following study in Chapter 5.

Daily Diary Item Properties

Item	Valence (*M, SD*)	Arousal (*M, SD*)	WPCR[a] (*M, SD*) for Average Mood	WPCR (*M, SD*) for Average Chronometry
Happy	8.47 (1.28)	6.05 (2.13)	.50 (.04)	.55 (.05)
Lively	7.12 (1.36)	6.10 (2.69)	.47 (.04)	.57 (.04)
Content	6.70 (2.05)	3.17 (2.64)	.56 (.04)	.57 (.04)
Satisfied	7.16 (1.26)	3.95 (2.67)	.60 (.04)	.61 (.04)
Depressed	2.27 (1.48)	4.25 (3.24)	.48 (.04)	.45 (.04)
Bored	2.95 (1.58)	3.65 (2.54)	.39 (.04)	.58 (.04)
Anxious	3.80 (1.42)	6.20 (2.36)	.51 (.04)	.44 (.04)
Irritable	2.85 (0.93)	6.37 (2.27)	.60 (.04)	.47 (.04)
Tense	2.75 (1.33)	5.32 (2.62)	.57 (.04)	.49 (.04)

Table A4.1. Affective norms for mood terms including reported valence and arousal from the Affective Norms for English Words (ANEW) database (Warriner et al., 2013) and psychometric properties for all daily diary items. [a]Within-person coupling reliability (WPCR) *M* and *SD* was estimated following validated methods for calculating within-person variance in nested data for items contributing to positive mood and items contributing to negative mood (Neubauer et al., 2019). The same methods were used to calculate chronometry WPCR based on each positive and negative mood chronometry value.

Daily Diary Items

Each of the following questions was presented one at a time on phone screens during the daily diary data collection prompt, with response options also listed below.

For the following nine mood terms (Question 1 to Question 9), ratings were all Likert responses, (1) not at all to (7) very much.

1. Thinking back over the whole day, please rate to what extent you have felt this mood today: HAPPY
2. Thinking back over the whole day, please rate to what extent you have felt this mood today: LIVELY
3. Thinking back over the whole day, please rate to what extent you have felt this mood today: CONTENT
4. Thinking back over the whole day, please rate to what extent you have felt this mood today: SATISFIED
5. Thinking back over the whole day, please rate to what extent you have felt this mood today: DEPRESSED
6. Thinking back over the whole day, please rate to what extent you have felt this mood today: BORED
7. Thinking back over the whole day, please rate to what extent you have felt this mood today: ANXIOUS
8. Thinking back over the whole day, please rate to what extent you have felt this mood today: IRRITABLE
9. Thinking back over the whole day, please rate to what extent you have felt this mood today: TENSE

For each mood, chronometry was self-reported (Question 10 to Question 18), ratings were all Likert responses, (1) very little to (7) most of the day.

10. How much time in the day do you feel you have spent in this mood?: HAPPY
11. How much time in the day do you feel you have spent in this mood?: LIVELY
12. How much time in the day do you feel you have spent in this mood?: CONTENT
13. How much time in the day do you feel you have spent in this mood?: SATISFIED
14. How much time in the day do you feel you have spent in this mood?: DEPRESSED
15. How much time in the day do you feel you have spent in this mood?: BORED
16. How much time in the day do you feel you have spent in this mood?: ANXIOUS
17. How much time in the day do you feel you have spent in this mood?: IRRITABLE
18. How much time in the day do you feel you have spent in this mood?: TENSE

The remaining questions (Question 19 – 22) all asked for Likert responses from (1) not at all to (7) very much.

19. To what extent do you feel you have felt stuck in in the mood(s) you have experienced today?
20. Have you tried to actively change (regulate) your overall mood state?

Each mood regulation strategy listed below was displayed with two questions asked per each mood: The corresponding regulation strategy name printed in brackets was not displayed to participants but is included here for ease of mapping mood regulation question item to named strategy in this manuscript.

21. How much did you engage in the above activity to try and regulate your mood(s)?
22. How much has this helped you change your mood(s)?
    a. Avoided thinking about my mood. [Cognitive Avoidance]
    b. Avoided situations I thought would worsen my mood. [Behavioral Avoidance]
    c. Thought about relaxing or pleasant things. [Cognitive Relaxation]
    d. Did relaxing or pleasant activities. [Behavioral Relaxation]
    e. Distracted myself by thinking about non-mood related things. [Cognitive Distraction]
    f. Exercised or engaged in a physical activity. [Exercise]
    g. Thought about things in a more positive way. [Cognitive Reappraisal]
    h. Sought out social support. [Support Seeking]
    i. Tried to problem-solve the things contributing to my mood. [Problem Solving]
    j. Meditated on or just accepted my mood. [Cognitive Acceptance]

Additional questions not used in analysis. The following questions were included in daily diary report and asked to all participants to determine in sleep problems contributed to mood disturbances (Riemann et al., 2001; Walker & van Der Helm, 2009), however due to a server error involving data collection of the self-reported timestamp, this data was missing in >90% of participants and therefore excluded from any additional analyses.

a. Approximately what time did you go to sleep last night?
    a. Timestamp response, XX:XX AM/PM.
b. Approximately what time did you wake up in the morning today?
    a. Timestamp response, XX:XX AM/PM.
c. Last night, approximately how many hours of actual sleep did you get? (Please answer in number of hours). This answer may be different than the number of hours you spent in bed.
    a. X hours.
d. How would you rate your overall sleep quality last night?
    a. Likert response, (1) very bad to (7) very good.

Appendix 4.2. Affective Inertia Multilevel Model Estimates

Emotion Inertia, Diagnostic Groups

		b (*SE*)	*t*(95)	*p*
Positive Emotion				
Intercept				
	Depressed	2.69 (.08)	33.91	<.001***
	Remitted	0.22 (.12)	1.85	.07
	Healthy	0.38 (.12)	3.23	.002**
Slope (**Positive Emotion, day *t*–1)**				
	Depressed	0.23 (.02)	11.37	<.001***
	Remitted	0.05 (.03)	1.55	.12
	Healthy	–0.07 (.03)	–2.23	.03
Negative Emotion				
Intercept				
	Depressed	2.68 (.10)	25.87	<.001***
	Remitted	–0.65 (.16)	–4.11	<.001***
	Healthy	–1.18 (.15)	–7.67	<.001***
Slope (**Negative Emotion, day *t*–1)**				
	Depressed	0.32 (.02)	17.41	<.001***
	Remitted	–0.005 (.03)	–0.16	.88
	Healthy	–0.14 (.03)	–4.33	<.001***

Table A4.2. Model estimates for positive and negative emotion inertia, *t*–1. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons. For transdiagnostic data-driven groups multilevel model estimates, see Appendix 3.12.

Positive and Negative Mood Inertia, Diagnostic Groups

Mood inertia with t – 1				Mood inertia with t – 3			
	b **(*SE*)**	***t*(95)**	***p***		***b*** **(*SE*)**	***t*(95)**	***p***
Positive Mood							
Intercept (**Positive Mood, day *t*–1)**				Intercept (**Positive Mood, day *t*–3)**			
Depressed	2.84 (.16)	17.88	< .001***	Depressed	2.84 (.16)	17.63	<.001***
Remitted	1.03 (.24)	4.29	<.001***	Remitted	1.05 (.25)	4.27	<.001***
Healthy	1.81 (.23)	7.72	<.001***	Healthy	1.76 (.24)	7.37	<.001***
Slope (**Positive Mood, day *t*–1)**				Slope (**Positive Mood, day *t*–3)**			
Depressed	0.27 (.05)	5.10	<.001***	Depressed	–0.07 (.06)	–1.15	.25
Remitted	–0.007 (.07)	–0.10	.92	Remitted	0.16 (.09)	1.82	.07
Healthy	–0.13 (.08)	–1.51	.13	Healthy	–0.03 (.10)	–0.30	.76
Negative Mood							
Intercept (**Negative Mood, day *t*–1)**				Intercept (**Negative Mood, day *t*–3)**			
Depressed	3.29 (.13)	25.55	<.001***	Depressed	3.25 (.13)	24.76	<.001***
Remitted	–0.92 (.20)	–4.68	<.001***	Remitted	–0.90 (.20)	–4.48	<.001***
Healthy	–1.50 (.19)	–7.87	<.001***	Healthy	–1.43 (.19)	–7.37	<.001***
Slope (**Negative Mood, day *t*–1)**				Slope (**Negative Mood, day *t*–3)**			
Depressed	0.20 (.04)	4.61	<.001***	Depressed	–0.01 (.05)	–0.27	.79
Remitted	0.03 (.07)	0.37	.71	Remitted	–0.05 (.08)	–0.56	.58
Healthy	0.03 (.08)	0.33	.74	Healthy	–0.07 (.10)	–0.71	.48

Table A4.2.2. Model estimates for inertia of positive and negative mood, *t*–1 and *t*–3. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Depressed and Anxious Mood Inertia, Diagnostic Groups

Mood inertia with t – 1				**Mood inertia with t – 3**			
	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Depressed Mood							
Intercept (**Depressed Mood, day *t*–1**)				Intercept (**Depressed Mood, day *t–3***)			
Depressed	4.03 (.18)	22.70	< .001***	Depressed	4.03 (.18)	22.86	<.001***
Remitted	–2.02 (.27)	–7.48	<.001***	Remitted	–2.09 (.27)	–7.77	<.001***
Healthy	–2.70 (.26)	–10.31	<.001***	Healthy	–2.70 (.26)	–10.34	<.001***
Slope (**Depressed Mood, day *t*–1**)				Slope (**Depressed Mood, day *t*–3**)			
Depressed	0.12 (.04)	3.07	.002**	Depressed	–0.08 (.05)	–1.85	.06
Remitted	0.01 (.08)	0.15	.88	Remitted	–0.21 (.09)	–2.26	.02
Healthy	–0.11 (.10)	–1.16	.25	Healthy	–0.01 (.11)	–0.10	.92
Anxious Mood							
Intercept (**Anxious Mood, day *t*–1**)				Intercept (**Anxious Mood, day *t*–3**)			
Depressed	3.43 (.18)	18.41	<.001***	Depressed	3.33 (.19)	17.92	<.001***
Remitted	–0.87 (.28)	–3.08	.002**	Remitted	–0.73 (.28)	–2.58	.01
Healthy	–1.74 (.27)	–6.32	<.001***	Healthy	–1.62 (.28)	–5.89	<.001***
Slope (**Anxious Mood, day *t*–1**)				Slope (**Anxious Mood, day *t*–3**)			
Depressed	–0.10 (.05)	2.11	.04	Depressed	–0.04 (.05)	–0.86	.39
Remitted	0.17 (.08)	2.21	.03	Remitted	–0.01 (.08)	–0.16	.87
Healthy	0.14 (.08)	1.68	.09	Healthy	0.008 (.09)	0.09	.93

Table A4.2.3. Model estimates for inertia of depressed and anxious mood, *t*–1 and *t*–3. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Mood Inertia, Data-Driven Groups

Positive and Negative Mood, t – 1				**Clinically Relevant Mood inertia, t – 1**			
	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Positive Mood				**Depressed Mood**			
Intercept (**Positive Mood, day *t*–1)**				Intercept (**Depressed Mood, day *t*–1)**			
Subgroup 1	3.89 (.16)	24.02	< .001***	Subgroup 1	2.60 (.22)	11.82	<.001***
Subgroup 2	–0.38 (.23)	–1.63	.11	Subgroup 2	0.17 (.31)	0.54	.59
Slope (**Positive Mood, day *t*–1)**				Slope (**Positive Mood, day *t*–1)**			
Subgroup 1	0.20 (.04)	4.52	<.001***	Subgroup 1	0.14 (.04)	3.27	.001**
Subgroup 2	0.08 (.06)	1.23	.22	Subgroup 2	–0.03 (.06)	–0.47	.64
Negative Mood				**Anxious Mood**			
Intercept (**Negative Mood, day *t*–1)**				Intercept (**Anxious Mood, day *t*–1)**			
Subgroup 1	2.60 (.14)	18.75	<.001***	Subgroup 1	2.55 (.19)	13.74	<.001***
Subgroup 2	0.08 (.20)	0.40	.69	Subgroup 2	0.40 (.26)	1.51	.14
Slope (**Negative Mood, day *t*–1)**				Slope (**Anxious Mood, day *t*–1)**			
Subgroup 1	0.24 (.04)	5.79	<.001***	Subgroup 1	0.21 (.05)	4.56	<.001***
Subgroup 2	–0.02 (.06)	–0.34	.73	Subgroup 2	–0.04 (.06)	–0.63	.53

Table A4.2.4. Model estimates for inertia of positive, negative mood, depressed mood, and anxious mood for *t*–1. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Appendix 4.3. Affective Chronometry Multilevel Model Estimates

	Diagnostic Groups				*Data-Driven Subgroups*		
	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Emotion Chronometry							
Intercept							
Depressed	36.28 (4.99)	7.28	<.001***	Subgroup 1	30.73 (4.53)	6.79	<.001***
Remitted	–1.14 (7.60)	–0.15	.88	Subgroup 2	10.58 (6.24)	1.70	.09
Healthy	0.01 (7.38)	0.002	.99				
Slope (**Emotion Index)**							
Depressed	0.005 (.50)	0.01	.99	Subgroup 1	0.71 (.46)	1.54	.12
Remitted	1.24 (.78)	1.58	.11	Subgroup 2	–0.04 (.70)	–0.06	.95
Healthy	1.13 (.87)	1.30	.19				
Mood Chronometry							
Intercept							
Depressed	1.78 (.16)	10.85	<.001***	Subgroup 1	2.10 (.15)	13.90	<.001***
Remitted	0.18 (.25)	0.71	.48	Subgroup 2	0.10 (.22)	0.44	.66
Healthy	1.25 (.24)	5.14	<.001***				
Slope (**Mood Index)**							
Depressed	.06 (.03)	1.91	.05	Subgroup 1	0.36 (.03)	12.93	<.001***
Remitted	0.46 (.05)	9.75	<.001***	Subgroup 2	–0.14 (.04)	–3.29	.001**
Healthy	0.53 (.05)	10.02	<.001***				

Table A4.3. Model estimates emotion and mood chronometry. Each model was predicted separately for emotion versus mood, and for clinical diagnostic groups versus for data-driven transdiagnostic groups derived from Chapter 3. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Appendix 4.4. Concurrent Emotion and Mood Multilevel Model Estimates for Diagnostic Groups

Concurrent Emotion on Positive and Negative Mood

	b (*SE*)	*t*(95)	*p*		*b* (*SE*)	*t*(95)	*p*
Positive Mood							
Intercept (**Positive Emotion**)				Intercept (**Negative Emotion**)			
Depressed	2.84 (.15)	18.61	< .001***		2.84 (.15)	18.56	<.001***
Remitted	1.03 (.23)	4.44	<.001***		1.04 (.23)	4.47	<.001***
Healthy	1.82 (.23)	8.07	<.001***		1.83 (.23)	8.06	<.001***
Slope (**Positive Emotion**)				Slope (**Negative Emotion**)			
Depressed	0.84 (.04)	21.08	<.001***		–0.55 (.06)	–9.85	<.001***
Remitted	0.09 (.06)	1.41	.16		–0.11 (.09)	–1.20	.23
Healthy	0.02 (.07)	0.28	.78		–0.37 (.12)	–3.07	.002**
Negative Mood							
Intercept							
Depressed	3.33 (.13)	26.43	<.001***		3.33 (.13)	26.49	<.001***
Remitted	–0.96 (.20)	–4.98	<.001***		–0.96 (.19)	–5.02	<.001***
Healthy	–1.51 (.18)	–8.08	<.001***		–1.52 (.19)	–8.16	<.001***
Slope (**Positive Emotion**)				Slope (**Negative Emotion**)			
Depressed	–0.60 (.04)	–15.40	<.001***		0.78 (.04)	19.53	<.001***
Remitted	0.12 (.07)	2.09	.04		–0.04 (.06)	–0.61	.54
Healthy	0.08 (.08)	1.11	.27		0.06 (.08)	0.71	.48

Table A4.4. Model estimates for concurrent emotion on positive and negative mood. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Concurrent Emotion on Depressed and Anxious Mood

	b (SE)	t(95)	p		b (SE)	t(95)	p
Depressed Mood							
Intercept (**Positive Emotion)**				Intercept (**Negative Emotion**)			
Depressed	4.04 (.17)	23.16	< .001***		4.03 (.17)	23.17	<.001***
Remitted	–2.06 (.27)	–7.74	<.001***		–2.05 (.26)	–7.75	<.001***
Healthy	–2.71 (.26)	–10.51	<.001***		–2.72 (.26)	–10.55	<.001***
Slope (**Positive Emotion)**				Slope (**Negative Emotion**)			
Depressed	–0.93 (.05)	–16.97	<.001***		0.93 (.06)	14.84	<.001***
Remitted	0.60 (.08)	7.28	<.001***		–0.40 (.10)	–3.94	<.001***
Healthy	0.45 (.10)	4.60	<.001***		–0.28 (.13)	–2.10	.03
Anxious Mood							
Intercept (**Positive Emotion)**				Intercept (**Negative Emotion**)			
Depressed	3.47 (.18)	19.29	<.001***		3.47 (.18)	19.34	<.001***
Remitted	–0.92 (.27)	–3.36	.001**		–0.93 (.27)	–3.39	.001**
Healthy	–1.75 (.27)	–6.57	<.001***		–1.76 (.27)	–6.64	<.001***
Slope (**Positive Emotion)**				Slope (**Negative Emotion**)			
Depressed	–0.40 (.06)	–6.27	<.001***		0.74 (.07)	11.16	<.001***
Remitted	–0.11 (.10)	–1.10	.27		0.11 (.11)	1.00	.32
Healthy	–0.16 (11)	–1.43	.15		0.15 (.14)	2.28	.02

Table A4.4.2. Model estimates for concurrent emotion on specific clinical moods. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Appendix 4.5. Lagged Emotion and Next-Day Mood Multilevel Model Estimates for Diagnostic Groups

Lagged Emotion and Next-Day Positive and Negative Mood.

	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Positive Mood							
Intercept (**Positive Emotion, day *t*–1**)				Intercept (**Negative Emotion, day *t*–1**)			
Depressed	2.84 (.16)	18.28	< .001***		2.84 (.16)	18.26	<.001***
Remitted	1.04 (.24)	4.39	<.001***		1.04 (.24)	4.39	<.001***
Healthy	1.78 (.23)	7.75	<.001***		1.79 (.23)	7.76	<.001***
Slope (**Positive Emotion, day *t*–1**)				Slope (**Negative Emotion, day *t*–1**)			
Depressed	0.32 (.06)	5.45	<.001***		–0.14 (.07)	–2.09	.04*
Remitted	0.04 (.09)	–0.08	.67		–0.05 (.11)	–0.47	.63
Healthy	–0.009 (.10)	–0.09	.93		–0.20 (.14)	–1.38	.17
Negative Mood							
Intercept (**Positive Emotion, day *t*–1**)				Intercept (**Negative Emotion, day *t*–1**)			
Depressed	3.30 (.13)	25.60	<.001***		3.30 (.13)	25.58	<.001***
Remitted	–0.94 (.20)	_4.82	<.001***		–0.94 (.20)	–4.79	<.001***
Healthy	–1.48 (.19)	–7.77	<.001***		–1.48 (.19)	–7.79	<.001***
Slope (**Positive Emotion, day *t*–1**)				Slope (**Negative Emotion, day *t*–1**)			
Depressed	–0.18 (.05)	–3.77	<.001***		0.21 (.05)	4.15	<.001***
Remitted	0.002 (.09)	0.04	.97		0.06 (.08)	0.73	.46
Healthy	–0.05 (.08)	–0.60	.55		0.10 (.11)	0.90	.37

Table A4.5. Model estimates for lagged emotion on positive and negative mood. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Lagged Emotion and Next-Day Depressed and Anxious Mood

	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Depressed Mood							
Intercept (**Positive Emotion, day *t*–1)**				Intercept (**Negative Emotion, day *t*–1)**			
Depressed	4.03 (.18)	22.74	< .001***		4.03 (.18)	22.78	<.001***
Remitted	–2.06 (.27)	–7.64	<.001***		–2.06 (.27)	–7.65	<.001***
Healthy	2.70 (.26)	–10.38	<.001***		–2.70 (.26)	–10.30	<.001***
Slope (**Positive Emotion, day *t*–1)**				Slope (**Negative Emotion, day *t*–1)**			
Depressed	–0.33 (.07)	–5.10	<.001***		0.23 (.07)	3.20	.001**
Remitted	0.24 (.10)	2.51	.01		–0.10 (.12)	–0.87	.39
Healthy	0.22 (.12)	1.87	.06		–0.10 (.16)	–0.62	.53
Anxious Mood							
Intercept (**Positive Emotion, day *t*–1)**				Intercept (**Negative Emotion, day *t*–1)**			
Depressed	3.43 (.18)	18.81	<.001***		3.43 (.18)	18.82	<.001***
Remitted	–0.88 (.28)	–3.18	.002**		–0.87 (.28)	–3.15	<.001***
Healthy	–1.72 (.27)	–6.39	<.001***		–1.72 (.27)	–6.40	<.001***
Slope (**Positive Emotion, day *t*–1)**				Slope (**Negative Emotion, day *t*–1)**			
Depressed	–0.19 (.07)	–2.79	.005**		0.22 (.07)	2.96	.003**
Remitted	–0.08 (.10)	–0.79	.43		0.20 (.12)	1.60	.11
Healthy	–0.04 (.12)	–0.36	.72		0.24 (.16)	1.47	.14

Table A4.5.2. Model estimates for lagged emotion on specific clinical moods. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Appendix 4.6. Lagged Mood and Next-Day Emotion Multilevel Model Estimates for Diagnostic Groups

Lagged Positive and Negative Mood and Next-Day Emotion

	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Positive Emotion							
Intercept (**Positive Mood, day *t*–1**)				Intercept (**Negative Mood, day *t*–1**)			
Depressed	2.96 (.15)	19.37	<.001***		2.96 (.15)	19.37	<.001***
Remitted	0.78 (.23)	3.33	.001**		0.77 (.23)	3.32	.001**
Healthy	1.66 (.23)	7.34	<.001***		1.66 (.23)	7.34	<.001***
Slope (**Positive Mood, day *t*–1**)				Slope (**Negative Mood, day t–1**)			
Depressed	0.21 (.04)	5.23	<.001***		–0.09 (.04)	–2.02	.04
Remitted	–0.02 (.06)	–0.31	.76		–0.03 (.07)	–0.40	.69
Healthy	–0.15 (.06)	–2.30	.02		–0.03 (.08)	–0.32	.75
Negative Emotion							
Intercept (**Positive Mood, day *t*–1**)				Intercept (**Negative Mood, day *t*–1**)			
Depressed	2.66(.11)	24.16	<.001***		2.66 (.11)	24.16	<.001***
Remitted	–0.60 (.17)	–3.56	<.001***		–0.60 (.17)	–3.56	<.001***
Healthy	–1.16 (.16)	–7.12	<.001***		–1.16 (.16)	–7.12	<.001***
Slope (**Positive Mood, day *t*–1**)				Slope (**Negative Mood, day *t*–1**)			
Depressed	–0.09 (.03)	–2.74	.006**		0.14 (.03)	4.09	<.001***
Remitted	0.02 (.05)	0.39	.70		–0.04 (.06)	–0.67	.50
Healthy	0.06 (.05)	1.07	.29		–0.03 (.07)	–0.51	.61

Table A4.6. Model estimates for lagged positive and negative mood on emotion. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Lagged Depressed and Anxious Mood and Next-Day Emotion

	b (SE)	t(95)	p		b (SE)	t(95)	p
Positive Emotion							
Intercept (**Depressed Mood, day *t*–1**)				Intercept (**Anxious Mood, day *t*–1**)			
Depressed	2.96 (.15)	19.36	< .001***		2.96 (.15)	19.37	<.001***
Remitted	0.78 (.23)	3.33	.001**		0.78 (.23)	3.33	<001**
Healthy	1.66 (.23)	7.34	<.001***		1.66 (.23)	7.34	<.001***
Slope (**Depressed Mood, day *t*–1**)				Slope (**Anxious Mood, day *t*–1**)			
Depressed	–0.07 (.03)	–2.43	.02		–0.01 (.03)	–0.47	.64
Remitted	0.004 (.06)	0.08	.94		–0.04 (.05)	–0.91	.36
Healthy	0.06 (.07)	0.97	.33		–0.08 (.05)	–1.47	.14
Negative Emotion							
Intercept (**Depressed Mood, day *t*–1**)				Intercept (**Anxious Mood, day *t*–1**)			
Depressed	2.66 (.11)	24.16	<.001***		2.66 (.11)	24.16	<.001***
Remitted	–0.60 (.17)	–3.56	<.001***		–0.60 (.17)	–3.56	<.001***
Healthy	—1.16 (.16)	—7.13	<.001***		–1.16 (.16)	–7.12	<.001***
Slope (**Depressed Mood, day *t*–1**)				Slope (**Anxious Mood, day *t*–1**)			
Depressed	–0.19 (.07)	3.30	.001**		0.04 (.02)	1.69	.09
Remitted	–0.01 (.05)	–0.31	.75		0.01 (.04)	0.30	.76
Healthy	–0.03 (.05)	–0.60	.55		0.05 (.04)	1.21	.22

Table A4.6.2. Model estimates for lagged specific clinical moods on emotion. A Bonferroni corrected alpha of .0125 was applied to consider significance and correct for multiple comparisons.

Appendix 5 (Chapter 5)

Appendix 5.1. Mood Regulation Strategy Items

Below is a list of the question items for each mood regulation strategy. For a full list of mood states and all questions asked in daily diary data, see Appendix 4.1.

1. Avoided thinking about my mood. [Cognitive Avoidance]
2. Avoided situations I thought would worsen my mood. [Behavioral Avoidance]
3. Thought about relaxing or pleasant things. [Cognitive Relaxation]
4. Did relaxing or pleasant activities. [Behavioral Relaxation]
5. Distracted myself by thinking about non-mood related things. [Cognitive Distraction]
6. Exercised or engaged in a physical activity. [Exercise]
7. Thought about things in a more positive way. [Cognitive Reappraisal]
8. Sought out social support. [Support Seeking]
9. Tried to problem-solve the things contributing to my mood. [Problem Solving]
10. Meditated on or just accepted my mood. [Cognitive Acceptance]

Appendix 5.2. Group Differences on Mood Stuckness and Strategy Use Multilevel Model Estimates

	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Mood Stuckness							
Depressed	4.59 (.18)	25.89	<.001***				
Remitted	–1.07 (.27)	–3.98	<.001***				
Healthy	–1.88 (.26)	–7.17	<.001***				
Cognitive Avoidance				**Behavioral Avoidance**			
Depressed	3.15 (.19)	16.59	<.001***		3.10 (.20)	15.35	<.001***
Remitted	–0.17 (.29)	–0.59	.56		–0.09 (.31)	–0.29	.77
Healthy	–0.82 (.28)	–2.93	.004**		–0.98 (.30)	–3.26	.002**
Cognitive Relaxation				**Behavioral Relaxation**			
Depressed	3.07 (.19)	16.15	<.001***		3.88 (.18)	21.82	<.001***
Remitted	0.43 (.29)	1.50	.14		0.40 (.27)	1.47	.15
Healthy	–0.05 (.28)	–0.17	.86		–0.41 (.26)	–1.52	.13
Cognitive Distraction				**Exercise**			
Depressed	3.50 (.19)	18.24	<.001***		2.96 (.20)	14.70	<.001***
Remitted	–0.03 (.29)	–0.11	.91		0.54 (.31)	1.77	.08
Healthy	–0.86 (.28)	–3.03	.003**		0.07 (.30)	0.23	.82
Cognitive Reappraisal				**Support Seeking**			
Depressed	2.94 (.20)	15.06	<.001***		2.63 (.21)	12.43	<.001***
Remitted	0.78 (.30)	2.62	.01		0.02 (.32)	0.06	.95
Healthy	0.24 (.29)	0.84	.40		–0.24 (.31)	–0.76	.45
Problem Solving				**Acceptance**			
Depressed	2.93 (.20)	14.59	<.001***		3.01 (.21)	14.36	<.001***
Remitted	0.11 (.31)	0.37	.71		0.09 (.32)	0.29	.77
Healthy	–0.61 (.30)	–2.06	.04		–0.24 (.31)	–0.76	.45

Table A5.2. Model estimates for group differences on mood 'stuckness' and each of the ten mood regulation strategies, displayed over two columns for ease of viewing. Model estimates reported are for intercepts of each clinical group along these various strategies and stuckness. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons.

Appendix 5.3. Mood Regulation Strategy Use Predicted by Mood Stuckness Multilevel Model Estimates

	b (*SE*)	*t*(95)	*p*		*b* (*SE*)	*t*(95)	*p*
Cognitive Avoidance				**Behavioral Avoidance**			
Depressed	0.06 (.05)	16.60	<.001***		0.06 (.05)	1.16	.25
Remitted	0.09 (.07)	1.21	.23		0.03 (.08)	0.44	.66
Healthy	–.004 (.08)	–0.06	.96		–0.05 (.08)	–0.68	.49
Cognitive Relaxation				**Behavioral Relaxation**			
Depressed	–0.04 (.05)	–0.81	.42		–0.11 (.05)	–2.05	.04
Remitted	–0.10 (.07)	–1.48	.14		–0.03 (.08)	–0.45	.65
Healthy	0.15 (.07)	2.17	.03		0.13 (.08)	1.64	.10
Cognitive Distraction				**Exercise**			
Depressed	0.03 (.05)	0.62	.54		–0.08 (.05)	–1.51	.13
Remitted	0.07 (.08)	0.86	.39		0.03 (.08)	0.33	.74
Healthy	0.14 (.08)	1.79	.07		0.08 (.08)	1.00	.32
Cognitive Reappraisal				**Support Seeking**			
Depressed	–0.16 (.05)	–3.45	<.001***		–0.03 (.04)	–0.77	.44
Remitted	–0.01 (.07)	–0.17	.87		0.20 (.06)	3.09	.002**
Healthy	0.23 (.07)	3.35	<.001***		0.09 (.07)	1.32	.19
Problem Solving				**Acceptance**			
Depressed	0.11 (.05)	2.15	.03		0.07 (.05)	1.26	.21
Remitted	0.03 (.07)	0.39	.69		–0.07 (.08)	–0.96	.34
Healthy	0.01 (.07)	0.09	.93		–0.01 (.08)	–0.12	.91

Table A5.3. Model estimates for group differences on each mood regulation strategy predicted by mood ‘stuckness’, displayed over two columns for ease of viewing. Model estimates reported are for group interaction effects only, as intercepts for strategy use are provided in Table S1. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons.

Appendix 5.4. Mood Regulation Strategy Efficacy Predicted by Mood Stuckness Multilevel Model Estimates

	b **(*SE*)**	***t*(95)**	***p***		***b*** **(*SE*)**	***t*(95)**	***p***
Cognitive Avoidance				**Behavioral Avoidance**			
Depressed	–0.07 (.05)	–1.43	.15		–0.06 (.05)	–1.10	.27
Remitted	0.11 (.07)	1.61	.11		0.07 (.07)	1.00	.32
Healthy	0.07 (.07)	0.90	.37		0.05 (.08)	0.63	.53
Cognitive Relaxation				**Behavioral Relaxation**			
Depressed	–0.13 (.05)	–2.70	.007		–0.27 (.05)	–5.10	<.001***
Remitted	–0.10 (.07)	–1.34	.18		0.08 (.08)	1.05	.29
Healthy	0.25 (.07)	3.34	<.001***		0.29 (.08)	3.68	<.001***
Cognitive Distraction				**Exercise**			
Depressed	–0.13 (.05)	–2.51	.01		–0.14 (.06)	–2.55	.01
Remitted	0.16 (.08)	2.11	.03		–0.03 (.08)	–0.38	.70
Healthy	0.21 (.08)	2.60	.009		0.06 (.08)	0.76	.45
Cognitive Reappraisal				**Support Seeking**			
Depressed	–0.19 (.05)	–3.90	<.001***		–0.16 (.05)	–3.11	.002**
Remitted	0.01 (.07)	0.16	.88		0.20 (.08)	2.61	.009
Healthy	0.23 (.07)	3.18	.002**		0.19 (.08)	2.40	.02
Problem Solving				**Acceptance**			
Depressed	–0.08 (.05)	–1.65	.10		–0.08 (.05)	–1.73	.08
Remitted	0.12 (.07)	1.68	.09		0.08 (.07)	1.07	.29
Healthy	0.20 (.07)	2.83	.005		0.04 (.07)	0.53	.59

Table A5.4. Model estimates for group differences on each mood regulation strategy efficacy predicted by mood ‘stuckness’, displayed over two columns for ease of viewing. Model estimates reported are for group interaction effects only, not intercepts. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons.

Appendix 5.5. Mood Regulation Strategy Use Predicted by Mood Multilevel Model Estimates

Use predicted by Positive Mood

	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Cognitive Avoidance				**Behavioral Avoidance**			
Depressed	–0.06 (.08)	–0.76	.45		–0.20 (.08)	–2.52	.01
Remitted	–0.18 (.11)	–1.61	.11		0.21 (.11)	1.84	.07
Healthy	–0.11 (.12)	–0.93	.35		0.09 (.12)	0.69	.49
Cognitive Relaxation				**Behavioral Relaxation**			
Depressed	0.51 (.07)	7.44	<.001***		0.69 (.07)	9.36	<.001***
Remitted	–0.16 (.10)	–1.64	.10		–0.13 (.10)	–1.23	.22
Healthy	–0.36 (.11)	–3.38	<.001***		–0.56 (.12)	–4.81	<.001***
Cognitive Distraction				**Exercise**			
Depressed	–0.03 (.08)	–0.42	.68		0.43 (.08)	5.37	<.001***
Remitted	–0.15 (.11)	–1.33	.19		–0.09 (.11)	–0.76	.45
Healthy	–0.12 (.13)	–0.99	.32		–0.22 (.13)	–1.71	.09
Cognitive Reappraisal				**Support Seeking**			
Depressed	0.56 (.07)	8.49	<.001***		–0.04 (.07)	–0.60	.55
Remitted	–0.21 (.09)	–2.21	.03		0.13 (.09)	1.35	.18
Healthy	–0.47 (.10)	–4.56	<.001***		0.16 (.11)	1.56	.12
Problem Solving				**Acceptance**			
Depressed	–0.33 (.07)	–4.55	<.001***		0.25 (.08)	3.14	.002**
Remitted	0.08 (.10)	0.79	.43		–0.22 (.11)	–1.93	.05
Healthy	0.16 (.11)	1.37	.17		–0.20 (.13)	–1.58	.11

Table A5.5. Model estimates for group differences on each mood regulation strategy usage predicted by positive mood, displayed over two columns for ease of viewing. Model estimates reported are for group interaction effects only, as intercepts for strategy use are provided in Table S1. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons.

Use predicted by Negative Mood

	b (*SE*)	*t*(95)	*p*		*b* (*SE*)	*t*(95)	*p*
Cognitive Avoidance				**Behavioral Avoidance**			
Depressed	0.10 (.08)	1.25	.21		–0.20 (.08)	–2.52	.01
Remitted	0.16 (.13)	1.22	.22		0.21 (.11)	1.84	.07
Healthy	0.07 (.15)	0.48	.63		0.09 (.12)	0.69	.49
Cognitive Relaxation				**Behavioral Relaxation**			
Depressed	–0.31 (.07)	–4.29	<.001***		–0.53 (.08)	–6.67	<.001***
Remitted	0.02 (.19)	0.19	.85		–0.04 (.13)	–0.29	.77
Healthy	0.15 (.14)	1.06	.29		0.18 (.15)	1.21	.23
Cognitive Distraction				**Exercise**			
Depressed	0.13 (.08)	1.60	.11		–0.19 (.09)	–2.18	.03
Remitted	0.23 (.14)	1.64	.10		–0.13 (.14)	–0.91	.36
Healthy	0.15 (.16)	0.97	.33		–0.01 (.16)	–0.03	.97
Cognitive Reappraisal				**Support Seeking**			
Depressed	–0.39 (.07)	–5.58	<.001***		0.04 (.07)	0.60	.55
Remitted	0.11 (.12)	0.94	.35		0.11 (.12)	.98	.33
Healthy	0.42 (.13)	3.12	.002**		–0.18 (.13)	–1.32	.19
Problem Solving				**Acceptance**			
Depressed	0.31 (.08)	4.07	<.001***		–0.14 (.08)	–1.72	.09
Remitted	0.17 (.13)	1.35	.18		0.26 (.14)	1.86	.06
Healthy	0.004 (.15)	0.03	.97		0.14 (.16)	0.88	.38

Table A5.5.2. Model estimates for group differences on each mood regulation strategy usage predicted by negative mood, displayed over two columns for ease of viewing. Model estimates reported are for group interaction effects only, as intercepts for strategy use are provided in Table S1. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons.

Appendix 5.6. Mood Regulation Strategy Efficacy Predicted by Strategy Use Multilevel Model Estimates

Efficacy predicted by Use

	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Cognitive Avoidance				**Behavioral Avoidance**			
Depressed	0.47 (.04)	12.59	<.001***		0.55 (.03)	16.77	<.001***
Remitted	0.13 (.05)	2.46	.01		0.18 (.05)	3.81	<.001***
Healthy	0.10 (.06)	1.67	.09		0.24 (.06)	3.92	<.001***
Cognitive Relaxation				**Behavioral Relaxation**			
Depressed	0.81 (.03)	23.20	<.001***		0.72 (.04)	19.38	<.001***
Remitted	0.06 (.05)	1.11	.27		–0.01 (.05)	–0.25	.80
Healthy	–0.12 (.05)	–2.40	.02		–0.06 (.05)	–1.16	.25
Cognitive Distraction				**Exercise**			
Depressed	0.63 (.03)	17.99	<.001***		0.76 (.03)	21.81	<.001***
Remitted	0.17 (.05)	3.27	.002**		0.06 (.05)	1.21	.23
Healthy	0.11 (.05)	2.16	.03		–0.0004 (.05)	–0.01	.99
Cognitive Reappraisal				**Support Seeking**			
Depressed	0.79 (.04)	22.45	<.001***		0.81 (.04)	19.74	<.001***
Remitted	0.08 (.06)	1.52	.13		0.02 (.06)	0.39	.69
Healthy	–0.03 (.05)	–0.63	.52		0.08 (.06)	1.33	.19
Problem Solving				**Acceptance**			
Depressed	0.53 (.04)	14.94	<.001***		0.57 (.04)	15.30	<.001***
Remitted	0.15 (.05)	3.02	.003**		0.04 (.05)	0.81	.42
Healthy	0.26 (.05)	4.89	<.001***		–0.05 (.05)	–1.00	.32

Table A5.6. Model estimates for group differences on how perceived efficacy for each mood regulation strategy usage was predicted by use, displayed over two columns for ease of viewing. Model estimates reported are for group interaction effects only. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons.

Appendix 5.7. Mood Predicted by Strategy Use from Previous Day Multilevel Model Estimates

Positive Mood predicted by Use at time (*t*–1)

		b (*SE*)	*t*(95)	*p*	*b* (*SE*)	*t*(95)	*p*
Cognitive Avoidance (*t*–1)					**Behavioral Avoidance (*t*–1)**		
	Depressed	0.007 (.03)	0.21	.83	–0.03 (.03)	–1.10	.27
	Remitted	–0.03 (.05)	–0.56	.58	0.03 (.04)	0.74	.46
	Healthy	.0001 (.05)	0.002	.99	0.02 (.05)	0.40	.69
Cognitive Relaxation (*t*–1)					**Behavioral Relaxation (*t*–1)**		
	Depressed	0.06 (.03)	1.87	.06	0.16 (.03)	4.68	<.001***
	Remitted	0.07 (.05)	1.39	.17	–0.03 (.05)	–0.59	.56
	Healthy	–0.08 (.05)	–1.63	.10	–0.17 (.05)	–3.63	<.001***
Cognitive Distraction (*t*–1)					**Exercise (*t*–1)**		
	Depressed	–0.01 (.03)	–0.41	.68	0.08 (.03)	2.46	.01
	Remitted	0.03 (.04)	0.74	.46	–0.05 (.04)	–1.25	.21
	Healthy	0.01 (.05)	0.19	.85	–0.13 (.05)	–2.70	.007
Cognitive Reappraisal (*t*–1)					**Support Seeking (*t*–1)**		
	Depressed	0.10 (.03)	2.89	.004**	–0.01 (.04)	–0.38	.70
	Remitted	0.02 (.05)	0.32	.75	0.05 (.05)	1.01	.32
	Healthy	–0.09 (.05)	–1.73	.08	0.03 (.05)	0.63	.53
Problem Solving (*t*–1)					**Acceptance (*t*–1)**		
	Depressed	–0.03 (.03)	–0.94	.35	0.08 (.03)	2.55	.01
	Remitted	–0.05 (.05)	–1.06	.29	0.02 (.05)	0.34	.74
	Healthy	0.04 (.05)	0.89	.38	–0.06 (.05)	–1.32	.19

Table A5.7. Model estimates for group differences on how positive mood was predicted by lagged strategy use from the previous day, displayed over two columns for ease of viewing. Model estimates reported are for group interaction effects only. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons.

Negative Mood predicted by Use at time (*t*–1)

	***b* (*SE*)**	***t*(95)**	***p***		***b* (*SE*)**	***t*(95)**	***p***
Cognitive Avoidance (*t*–1)				**Behavioral Avoidance (*t*–1)**			
Depressed	–0.05 (.03)	–1.83	.07		0.01 (.02)	0.49	.63
Remitted	0.07 (.04)	1.87	.06		–0.02 (.03)	–0.59	.56
Healthy	0.07 (.04)	1.71	.09		0.02 (.04)	0.55	.58
Cognitive Relaxation (*t*–1)				**Behavioral Relaxation (*t*–1)**			
Depressed	–0.05 (.03)	–1.89	.06		–0.11 (.03)	–3.99	<.001***
Remitted	0.004 (.04)	–0.10	.92		0.08 (.04)	2.02	.04
Healthy	0.09 (.04)	2.12	.03		0.11 (.04)	2.86	.004**
Cognitive Distraction (*t*–1)				**Exercise (*t*–1)**			
Depressed	–0.02 (.03)	–0.61	.54		–0.06 (.03)	–2.52	.01
Remitted	0.01 (.04)	0.25	.81		0.08 (.04)	2.28	.02
Healthy	0.02 (.04)	0.48	.64		0.09 (.04)	2.44	.01
Cognitive Reappraisal (*t*–1)				**Support Seeking (*t*–1)**			
Depressed	–0.05 (.03)	–1.92	.06		0.003 (.03)	0.09	.93
Remitted	0.05 (.04)	1.20	.23		0.03 (.04)	0.77	.44
Healthy	0.04 (.04)	1.07	.28		–0.03 (.04)	–0.71	.48
Problem Solving (*t*–1)				**Acceptance (*t*–1)**			
Depressed	0.003 (.03)	0.12	.91		–0.04 (.03)	–1.61	.11
Remitted	0.05 (.04)	1.24	.22		0.03 (.04)	0.79	.43
Healthy	–0.03 (.04)	–0.69	.49		0.05 (.04)	1.25	.21

Table A5.7.2. Model estimates for group differences on how negative mood was predicted by lagged strategy use from the previous day, displayed over two columns for ease of viewing. Model estimates reported are for group interaction effects only. A Bonferroni corrected alpha of .005 was applied to consider significance and correct for multiple comparisons.

Appendix 6 (Chapter 6)

Appendix 6.1. The Amsterdam Resting-State Questionnaire (ARSQ)

"Now follows a number of statements about possible feelings, physical sensations and thoughts during the eyes-closed rest period. Please, indicate the extent to which you agree with each statement."

1 (Completely disagree) - 5 (Completely agree)

1. I thought about my feelings.
2. I felt restless.
3. I felt tired.
4. I felt sleepy.
5. I felt comfortable.
6. I felt relaxed.
7. I felt happy.
8. I enjoyed the session.
9. I felt bored.
10. I felt nothing.
11. I felt the same throughout the session.
12. I thought about my health.
13. I thought about my work/study.
14. I thought about my behavior.
15. I had thoughts that I would not readily share with others.
16. I had busy thoughts.
17. I had similar thoughts throughout the session.
18. I thought about others.
19. I thought about myself.
20. I thought about pleasant things.
21. I thought about solving problems.
22. I thought about the aim of the experiment.
23. I had difficulty staying awake.
24. I had rapidly switching thoughts.
25. I had superficial thoughts.
26. I thought about the past.
27. I thought about the present.
28. I thought about the future.
29. I had deep thoughts.
30. I thought about nothing.
31. I had difficulty holding onto my thoughts.
32. I thought about people I like.
33. I thought in images.
34. I thought in words.
35. I thought about things I need to do.
36. I was conscious of my body.
37. I thought about the sounds around me.
38. I thought about the odors around me.
39. I thought about my heartbeat.

40. I thought about my breathing.
41. I placed myself in other people's shoes.
42. I had negative feelings.
43. I had my thoughts under control.
44. I felt ill.
45. I felt pain.
46. I pictured events.
47. I pictured places.
48. I had silent conversations.
49. I imagined talking to myself.
50. I felt motivated to participate.
51. I have difficulty remembering my thoughts.
52. I have difficulty remembering my feelings.
53. I had my eyes closed.
54. I was able to rate the statements.

Scoring

Discontinuity of Mind: Items 1, 2, 3
Theory of Mind: Items 4, 5, 6
Self: Items 7, 8, 9
Planning: 10, 11, 12
Sleepiness: 13, 14, 15
Comfort: 16, 17, 18
Somatic Awareness: 19, 20, 21

Appendix 6.2. The New York Cognition Questionnaire (NYC-Q)

Section 1: Content

"We are interested in the thoughts and feelings that you experienced during the MRI. Please indicate which statement describes the thoughts that you experienced while completing the MRI. Indicate the extent to which your thinking corresponded to each item by selecting the relevant option associated with each sentence."

1 (Completely did not describe my thoughts) - 9 (Completely did describe my thoughts)

1. I thought about things I am currently worried about
2. I thought about people I have just recently met
3. I thought of people I have known for a long time (friends)
4. I thought about members of my family
5. I thought about an event that took place earlier today
6. I thought about an interaction I may possibly have in the future
7. I thought about an interaction with somebody that took place in the past
8. I thought about something that happened at a place very close to me
9. I thought about something that made me feel guilty
10. I thought about an event that may take place later today
11. I thought about something that happened in the recent past (last couple of days but not today)
12. I thought about something that happened a long time ago in the past
13. I thought about something that made me angry
14. I thought about something that made me happy
15. I thought about something that made me cheerful
16. I thought about something that made me calm
17. I thought about something that made me sad
18. I thought about something that is important to me
19. I thought about something that could still happen today
20. I thought about something that may take place in the distant future
21. I thought about something that could take place in the near future (days or weeks but not today)
22. I thought about personal worries

Section 2: Form

"We are interested in the thoughts you had during the MRI. Please indicate the extent to which each of these statements correctly characterizes your thinking. Please indicate, using numbers, how much the statement characterizes your thoughts during the MRI."

1 (Completely does not characterize my experience) - 9 (Completely does characterize my experience)

During the MRI my thoughts were:

23. I thought about something that happened in a place far away from where I am now
24. In the form of images:
25. In the form of words:
26. Like an inner monologue or audiobook:
27. Like a television program or film:

28. Had a strong and consistent personal narrative:
29. Had a clear sense of purpose:
30. Vague and non-specific:
31. Fragmented and disjointed:

Appendix 7 (Chapter 7)

Appendix 7.1. Five Facet Mindfulness Questionnaire (FFMQ)

This instrument is based on a factor analytic study of five independently developed mindfulness questionnaires. The analysis yielded five factors that appear to represent elements of mindfulness as it is currently conceptualized. The five facets are observing, describing, acting with awareness, non- judging of inner experience, and non-reactivity to inner experience. More information is available in Baer et al. (2006).

Please rate each of the following statements using the scale provided. Write the number in the blank that best describes your own opinion of what is generally true for you.

1 (never or very rarely true), 2 (rarely true), 3 (sometimes true), 4 (often true), 5 (very often or always true)

_____ 1. When I'm walking, I deliberately notice the sensations of my body moving.

_____ 2. I'm good at finding words to describe my feelings.
_____ 3. I criticize myself for having irrational or inappropriate emotions.
_____ 4. I perceive my feelings and emotions without having to react to them.

_____ 5. When I do things, my mind wanders off and I'm easily distracted.
_____ 6. When I take a shower or bath, I stay alert to the sensations of water on my body.
_____ 7. I can easily put my beliefs, opinions, and expectations into words.
_____ 8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
_____ 9. I watch my feelings without getting lost in them.
_____ 10. I tell myself I shouldn't be feeling the way I'm feeling.
_____ 11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
_____ 12. It's hard for me to find the words to describe what I'm thinking.
_____ 13. I am easily distracted.
_____ 14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
_____ 15. I pay attention to sensations, such as the wind in my hair or sun on my face.
_____ 16. I have trouble thinking of the right words to express how I feel about things.
_____ 17. I make judgements about whether my thoughts are good or bad.
_____ 18. I find it difficult to stay focused on what's happening in the present.
_____ 19. When I have distressing thoughts or images, I 'step back' and am aware of the thought or image without getting taken over by it.
_____ 20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
_____ 21. In difficult situations, I can pause without immediately reacting.

_____ 22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.
_____ 23. It seems I am "running on automatic" without much awareness of what I'm doing.
_____ 24. When I have distressing thoughts or images, I feel calm soon after.

_____ 25. I tell myself that I shouldn't be thinking the way I'm thinking.

_____ 26. I notice the smells and aromas of things.

_____ 27. Even when I'm feeling terribly upset, I can find a way to put it into words.
_____ 28. I rush through activities without being really attentive to them.
_____ 29. When I have distressing thoughts or images I am able just to notice them without reacting. _____ 30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.
_____ 31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.
_____ 32. My natural tendency is to put my experiences into words.
_____ 33. When I have distressing thoughts or images, I just notice them and let them go.
_____ 34. I do jobs or tasks automatically without being aware of what I'm doing.
_____ 35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.
_____ 36. I pay attention to how my emotions affect my thoughts and behavior.
_____ 37. I can usually describe how I feel at the moment in considerable detail.
_____ 38. I find myself doing things without paying attention.
_____ 39. I disapprove of myself when I have irrational ideas.

Scoring

Observe items:
1, 6, 11, 15, 20, 26, 31, 36

Describe items:
2, 7, 12R, 16R, 22R, 27, 32, 37

Act with Awareness items:
5R, 8R, 13R, 18R, 23R, 28R, 34R, 38R

Nonjudge items:
3R, 10R, 14R, 17R, 25R, 30R, 35R, 39R

Nonreact items:
4, 9, 19, 21, 24, 29, 33

Appendix 7.2. Study 5: Group Differences in Mind Wandering Dimensions Multilevel Model Estimates

	b (*SE*)	*t*(95)	*p*
Valence			
Depressed	3.46 (.13)	26.53	<.001***
Remitted	0.82 (.20)	4.09	<.001***
Healthy	1.31 (.20)	6.51	<.001***
Temporal (Past or Future)			
Depressed	4.30 (.08)	53.08	<.001***
Remitted	0.13 (.13)	1.01	.31
Healthy	0.11 (.13)	0.84	.40
Subject (Self or Others)			
Depressed	3.22 (.15)	22.03	<.001***
Remitted	1.03 (.23)	4.55	<.001***
Healthy	0.69 (.23)	2.99	.004**
Perceived Control			
Depressed	3.86 (.21)	18.23	<.001***
Remitted	0.88 (.32)	2.71	.008
Healthy	1.50 (.32)	4.68	<.001***
Meta-awareness			
Depressed	3.81 (.19)	20.08	<.001***
Remitted	0.17 (.29)	0.58	.57
Healthy	0.29 (.29)	0.99	.32
Specificity			
Depressed	3.13 (.17)	18.80	<.001***
Remitted	0.09 (.26)	0.35	.73
Healthy	0.10 (.26)	0.39	.70

Table A7.2. Model estimates for diagnostic group differences on mind wandering dimensions from Study 5. Model estimates reported are for intercepts of each clinical group along these various dimensions representing group differences. A Bonferroni-corrected alpha of .007 was applied to test significance.

Appendix 7.3. Study 5: Mind Wandering Dimensions predicted by Concurrent Emotion Multilevel Model Estimates

Dimensions	*Positive Emotion*			*Negative Emotion*		
	b **(*SE*)**	***t*****(95)**	***p***	***b*** **(*SE*)**	***t*****(95)**	***p***
Valence						
Depressed	0.81 (.04)	22.48	<.001***	–0.67 (.04)	–18.74	<.001***
Remitted	–0.14 (.05)	–2.69	.007	–0.17 (.06)	–2.70	.007
Healthy	–0.02 (.06)	–0.25	.80	–0.25 (.07)	–3.32	<.001***
Temporal Nature (Past or Future)						
Depressed	0.10 (.04)	2.76	.006	–0.09 (.04)	–2.46	.01
Remitted	0.07 (.05)	1.24	.21	–0.13 (.06)	–2.15	.03
Healthy	–0.09 (.06)	–1.29	.20	0.08 (.07)	1.15	.25
Subject (Self or Others)						
Depressed	0.17 (.06)	2.58	.01	0.003 (.06)	0.05	.96
Remitted	–0.11 (.09)	–1.16	.25	0.10 (.10)	0.99	.32
Healthy	0.02 (.11)	0.15	.88	–0.02 (.13)	–0.19	.85
Perceived Control						
Depressed	0.47 (.04)	10.68	<.001***	–0.35 (.04)	–8.39	<.001***
Remitted	–0.01 (.06)	–0.15	.88	–0.05 (.07)	–0.73	.47
Healthy	–0.13 (.08)	–1.65	.10	–0.06 (.09)	–0.73	.47
Meta-awareness						
Depressed	0.44 (.05)	7.97	<.001***	–0.25 (.05)	–4.92	<.001***
Remitted	–0.36 (.08)	–4.52	<.001***	0.05 (.09)	0.56	.57
Healthy	–0.26 (.10)	–2.77	.006	–0.17 (.11)	–1.54	.12
Specificity						
Depressed	0.03 (.06)	0.49	.63	–0.11 (.06)	–1.87	.06
Remitted	0.02 (.09)	0.24	.81	–0.18 (.10)	–1.71	.09
Healthy	0.04 (.11)	0.34	.73	–0.16 (.13)	–1.26	.21

Table A7.3. Model estimates for group differences on each mind wandering dimension predicted by concurrent emotion, displayed over two columns for ease of viewing. Model estimates reported are for group interaction effects only. A Bonferroni-corrected alpha of .004 was applied to test significance.

Appendix 7.4. Study 6: Open Science Framework (OSF) Preregistration

Study Information

1. Title
   1.1. Investigating the psychological and behavioural mechanisms underlying individual experience and navigation of internal mental environments.

2. Authors
   2.1. Monica Kullar, Tim Dalgleish

3. Description
   3.1. The aim of this project is to investigate the multi-dimensional underpinnings involved in the subjective experience of mind wandering by using self-report and behavioural measures to assess where the mind goes and what it is doing at rest.
   3.2. The greater majority of research into cognitive function has focused on processes engaged during controlled tasks. Most studies within the fields of psychology, cognitive science, and behavioural neuroscience attempt to study these task-based responses in order to make conclusions about mental processes. While this is certainly of great importance, a relatively understudied area of human mental processes is regarding their nature outside of purely task-based constraints. Despite the great range of cognitive, social, and affective external influences that lead to such processes investigated in research, human beings spend a considerable amount of time 'in their head' engaging in mental processes in the absence of an explicit relationship to external stimuli. We aim to explore the existence of multiple novel theorised dimensions and integrated dimensions from existing past research to improve and expand our ability to study the mind at rest.

4. Hypotheses
   4.1. Depressed participants will experience more negatively-valenced thoughts and more negatively-valenced higher-order thought interpretations of their mental content than never-depressed participants.
   4.2. Depressed participants will experience greater arousal in their negative thought content than never-depressed participants.
   4.3. Depressed participants will report experiencing greater distress related to their thought content than never-depressed participants.
   4.4. Depressed participants will experience more past-focused thoughts than never-depressed participants.
   4.5. Higher degrees of anxiety in participants will be linked to greater occurrence of future-focused thought content than never-depressed participants.
   4.6. Depressed participants will report ruminating on things they've thought of many times before to a greater extent than never-depressed participants.
   4.7. Depressed participants will experience more self-oriented thoughts than never-depressed participants.
   4.8. Depressed participants will experience a lower degree of perceived control over their thoughts than never-depressed participants.
   4.9. Depressed participants will experience greater immersion into their thoughts relative to a meta-awareness of the thought occurrence compared to never-depressed participants.

4.10. Depressed participants will have report more generalised, broad thoughts relative to never-depressed participants who will report a greater degree of specificity in their thoughts.

Design Plan

5. Study type
   5.1. Observational Study - Data are collected from study subjects that are not randomly assigned to a treatment. This includes surveys.

6. Blinding
   6.1. No blinding is involved in this study.

7. Is there any additional blinding in this study?
   7.1. No.

8. Study design
   8.1. This study is a cross-sectional repeated-measures case-control design of two groups (depressed in episode and healthy controls) with repeated measures (10 survey probes for thought content experienced across study period).

9. Randomization
   9.1. There is no randomization involved in this study design.

Sampling Plan

10. Existing data
    10.1. Registration prior to creation of data: As of the date of submission of this research plan for preregistration, the data have not yet been collected, created, or realized.

11. Data collection procedures
    11.1. We recruit clinical participants that meet depressed group criteria from the Emotion Group clinical volunteer database of the MRC Cognition and Brain Sciences Unit (MRC CBU), and we recruit never-depressed controls from the MRC CBU participant panel and surrounding community. Participants will be paid £6 per hour for their participant in the study.
    11.2. Inclusion criteria for both groups include adults of age 18 and over. For the depressed recruitment, we aim to recruit individuals with current/past Major Depressive Disorder diagnosis currently in a depressive episode. Exclusion criteria for both groups will be current psychosis, current alcohol or substance abuse, current intellectual disabilities, and organic brain damage.

12. Sample size
    12.1. We are planning to test 100 participants in total in this study. We aim to collect data on at least n=50 depressed participants and n=50 healthy participants.

Variables

13. Measured variables

13.1. Depression and anxiety transdiagnostic symptoms as measured by the Inventory of Depression and Anxiety Scale (IDAS).
13.2. Depression symptoms as measured by the Patient Health Questionnaire (PHQ-9).
13.3. Anxiety symptoms as measured by the Generalized Anxiety Disorder Assessment (GAD-7).
13.4. IQ as measured by the Cattell Culture Fair Test.
13.5. Trait mindfulness as measured by the Five Facet Mindfulness Questionnaire (FFMQ).
13.6. Trait attentional mindfulness as measured by the Mindful Attention Awareness Scale (MAAS)
13.7. Current affective state as measured by the Positive and Negative Affect Schedule (PANAS).
13.8. Word-based thought content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
    13.8.1. My experience was a thought with mental words or sentences in it
    13.8.2. My experience felt like I was talking to myself
    13.8.3. I was making plans about something
    13.8.4. I was thinking through the steps to solve a problem I have
13.9. Visual imagery and point-of-view in thought content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
    13.9.1. My experience was a visual image in my mind
    13.9.2. My experience was a visual image seen as if through my own eyes
    13.9.3. My experience was a visual image seen as if through another person's eyes
    13.9.4. My experience was a visual image seen as if from an objective 'fly-on-the-wall' perspective
13.10. Non-visual sensory imagery thought content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) on experiences like imagined touch, imagined smells, imagined sounds, imagined temperature via the following items:
    13.10.1. My experience was a non-vocal sound in my head, like imagined music or noises
    13.10.2. I could hear imagined voices of people
    13.10.3. I experienced imagined scents as if I was smelling something
    13.10.4. My experience was an imaginary sensation (e.g., touch, temperature) in my body that I knew was not real
13.11. Somatosensory awareness during thought content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
    13.11.1. I was aware of physical sensations in my body
    13.11.2. I was aware of my breathing
    13.11.3. I was aware of my heartbeat or pulse
    13.11.4. I was aware of feeling fidgety or restless in my body during this experience
    13.11.5. I was aware of feeling relaxed or calm in my body during this experience

13.12. Negative and positive valence of thought and accompanying arousal of content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
  13.12.1. The content of my experience was emotionally negative
  13.12.2. The content of my experience was emotionally positive
  13.12.3. The experience made me feel physiologically alert or aroused
  13.12.4. I enjoyed the content of the experience
  13.12.5. I was distressed or upset by the content of the experience
13.13. The past/future nature of thought content is measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
  13.13.1. My experience was about something from the past
  13.13.2. My experience was about something in the future
13.14. Memory representation of thought content is measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
  13.14.1. I was remembering and re-living personal memories
  13.14.2. I was imagining how things in the past might have gone differently
  13.14.3. My experience was of something I have experienced many times before
13.15. Self and social focus of thought content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
  13.15.1. My experience (thoughts, images, memories etc.) was about myself
  13.15.2. I was thinking about my own motives or preferences for things
  13.15.3. I was thinking about how I view other people
  13.15.4. My experience was about other people
  13.15.5. I was thinking about other people's motives or preferences
  13.15.6. I was thinking about how other people may view me
  13.15.7. I was having thoughts about things that are very important or central to my sense of self or identity
13.16. Perceived control of thought content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
  13.16.1. I was deliberately choosing what I was thinking about or experiencing
  13.16.2. What I was thinking about or experiencing was spontaneous or unexpected
  13.16.3. My experience intruded into my mind and I had little control over it
13.17. Immersion and metacognitive awareness in thought content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
  13.17.1. I felt completely immersed in the what I was experiencing
  13.17.2. I was completely aware that the experience was just a mental event
  13.17.3. I felt mentally detached from my experience
13.18. Specificity of thought content measured by self-report Likert scale (on a scale of 1 being 'not at all' to 7 being 'very much) via the following items:
  13.18.1. My experience was about a very specific and detailed thing
  13.18.2. My experience was very clear and vivid
  13.18.3. My experience was about a very broad and general theme
  13.18.4. My experience felt foggy or hard to describe clearly

13.19. Post-mind wandering resting-state phenotypes as measured by the Amsterdam Resting State Questionnaire (ARSQ).

Analysis Plan

14. Statistical models
    14.1. We will assess descriptive statistics as our main means of summarizing the existence and occurrence of these dimensions in individuals and mental health; the means and variance of each dimension of interest for both groups (healthy and depressed).
    14.2. We will also assess group differences in means using one-way analyses of variance (ANOVA), to determine whether there are any differences between the clinical groups on hypothesized dimensions.

Appendix 7.5. Positive and Negative Affect Schedule (PANAS)

Instructions

Please rate the following items for how you are feeling right now.

Scale & Scorecard

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

#	Score	Feelings/emotion
1		Interested
2		Distressed
3		Excited
4		Upset
5		Strong
6		Guilty
7		Scared
8		Hostile
9		Enthusiastic
10		Proud
11		Irritable
12		Alert
13		Ashamed
14		Inspired
15		Nervous
16		Determined
17		Attentive
18		Jittery
19		Active
20		Afraid

Scoring

Positive Affect Score
Add the scores on items 1, 3, 5, 9, 10, 12, 14, 16, 17 & 19. Scores can range between 10 – 50. Higher scores represent higher levels of positive affect. Mean scores: momentary = 29.7 and weekly = 33.3.

Negative Affect Score
Add the scores on items 2, 4, 6, 7, 8, 11, 13, 15, 18 & 20. Scores can range between 10 – 50. Higher scores represent higher levels of negative affect. Mean scores: momentary = 14.8 and weekly = 17.4.

Appendix 7.6. Study 6: Sensory Deprived Mental Wandering Items

All self-report items are grouped by broader mind wandering dimension. All items were rated on a Likert scale from 1 (not at all) to 7 (very much).

1. Affect
    a. The content of my experience was emotionally negative
    b. The content of my experience was emotionally positive
    c. I felt physiologically alert or aroused during the content
    d. I enjoyed the content of the experience
    e. I was distressed or upset by the content of the experience
2. Temporal Content
    a. My experience was about something from the past
    b. My experience was about something in the future
3. Memory Representations
    a. I was remembering and re-living memories
    b. I was imagining things in the past had gone differently
    c. I have had this thought many times before
4. Self
    a. My experience (thoughts, images, memories etc.) was about myself
    b. I was thinking about my own motives or preferences for things
    c. I was thinking about how other people may view me
    d. I was having thoughts about things that are very important or central to my sense of self or identity
5. Others
    a. I was thinking about how I view other people
    b. My experience was about other people
    c. I was thinking about other people's motives or preferences
6. Perceived Control
    a. I was deliberately chose what I was thinking about or experiencing
    b. What I was thinking about or experiencing was spontaneous or unexpected
    c. My experience intruded into my mind and I had little control over it
7. Immersion-Metacognitive Awareness
    a. I felt completely immersed in what I was experiencing
    b. I was completely aware that the experience was just a mental event
    c. I felt mentally detached from my experience
8. Specificity
    a. My experience was about a very specific and detailed thing
    b. My experience was very clear and vivid
    c. My experience was about a very broad and general theme
    d. My experience felt foggy or hard to describe clearly
9. Word-based/Self-talk Content
    a. My experience was a thought with mental words or sentences in it
    b. My experience felt I was talking to myself
    c. I was making plans about something
    d. I was thinking through the steps to solve a problem I have
10. Visual Imagery
    a. My experience was a visual image in my mind

b. My experience was a visual image seen as if through my own eyes
c. My experience was a visual image seen as if through another person's eyes
d. My experience was a visual image as if from an objective 'fly-on-the-wall' perspective

11. Non-visual Sensory Imagery
    a. I could hear non-vocal sounds in my head, like imagined music or noises
    b. I could hear imagined voices of people
    c. I experienced imagined scents as if I was smelling something
    d. I experienced imagined sensations (e.g., touch, temperature) to my body
12. Somatic Awareness
    a. I was aware of physical sensations in my body
    b. I was aware of my breathing
    c. I was aware of my heartbeat or pulse
    d. I felt fidgety or restless in my body during this experience
    e. I was aware of feeling relaxed or calm in my body experience

Appendix 7.7. Study 6: Provided Explanation for Mental Phenomenology Dimensions

Text explanation

In this part of the study, we are interested in understanding mind wandering by studying aspects of how people's minds represent thoughts or mental experiences when they mind wander.

After the mind wandering portion of this experiment, you will answer questions about dimensions of random thoughts you experienced. Please watch the following video for a brief explanation of what these dimensions are:

Voiceover explanation

Your thoughts may represented in different forms in your mind. A thought experience might come up as words, or self-talk as if you're making plans or have statements in your mind.

Or, they might be visual in nature and you may "see" things in your mind's eye.

These visual images might be in first-person, like if you're imagining yourself reading at the beach through your own point of view.

Your perspective might be in second-person, or imagining how you might look from someone else's point of view.

You might see things in a birds-eye view, as if your vantage point is from a distance looking over a scene.

You might have other sensory imagery as well in your thought, maybe you hear the sound of waves while mind wandering about the beach. You might also feel imagined temperatures like warmth or imagined touch sensations in your mind during the thought.

The thought content might be quite positive or quite negative, and have an accompanying arousal level. Like for example, a positive mind wandering to an old fun birthday in a calm energy way.

Or maybe negatively mind wandering to a test you failed when younger with a heightened energy feeling of stress associated with it.

You might also feel different ways about these experiences than their positive or negative content, like maybe even though the test fail was a negative memory, maybe thinking about it now you realise it wasn't so bad and find it not as stressful looking back.

Your thought content may be about the past or the future, or you might find yourself reliving memories like from when you were a kid playing for example, maybe just as it happened, or reimagining the memory in new ways.

Your thoughts might be self-focused, like about your own thoughts, feelings, motives or experiences.

Or they might be more focused on others, like thinking about what other people might be thinking of you or what their motives or feelings might be.

Your thought experience might feel controlled, in that you feel you chose to think about it.

Or it might feel spontaneous and be unexpected to you that the thought you had came up.

Or it might be possible that the thought feels intrusive, and even though you didn't want to think about it, it keeps coming up.

When you mind wander, some thoughts you might be completely immersed in feeling like you are really there in that thought

Whereas other times you might feel very meta-aware that you are having a thought and watching it come and go.

And finally, your thought experience might be very specific and detailed, like remembering the exact way you spent new year's for 2020.

Or you may find your thought experience to be quite general and broad like a theme, like perhaps remembering various times you didn't enjoy parties or celebrations across the years rather than something specific.

Thank you so much for your attention and participation! That is a brief overview of the kinds of dimensions you'll answer via questionnaire after the mind wandering portion.

Appendix 7.8. Study 6: Clinical Information about the Sample

Clinical scales		***M (SD)***		**Group differences**	
	Cronbach's α	Depressed	Healthy	Wilcoxon *p*	Effect Size *r* *95% CI [LL, UL]*
PHQ-9	.95	16.81 (6.07)	2.38 (2.74)	<.001***	.83 [.78,.86]
GAD-7	.95	12.06 (5.22)	1.24 (1.95)	<.001***	.84 [.80,.87]
IDAS subscales					
General Depression	.96	65.27 (12.81)	32.73 (7.61)	<.001***	.84 [.80,.86]
Dysphoria	.95	33.83 (8.02)	14.73 (4.36)	<.001***	.83 [.79,.86]
Panic	.83	13.75 (4.12)	9.10 (2.28)	<.001***	.68 [.56,.79]
Lassitude	.88	18.62 (5.51)	9.97 (3.64)	<.001***	.70 [.61,.78]
Appetite Loss	.91	6.62 (3.34)	3.81 (1.35)	<.001***	.47 [.32,.62]
Appetite Gain	.81	7.25 (3.36)	6.17 (2.78)	.99	.16 [.01,.34]
Euphoria	.48	5.98 (1.63)	6.40 (1.64)	.99	.17 [.01,.35]
Mania	.81	9.63 (4.33)	6.24 (1.36)	<.001***	.42 [.26,.57]
Insomnia	.84	14.96 (5.56)	10.24 (4.23)	<.001***	.45 [.30,.59]
Traumatic Avoidance	.85	8.96 (3.72)	5.14 (1.63)	<.001***	.60 [.46,.72]
Traumatic Intrusions	.88	10.12 (3.99)	4.52 (0.95)	<.001***	.78 [.69,.85]
Social Anxiety	.85	13.15 (5.36)	7.56 (2.89)	<.001***	.65 [.53,.76]
Ill-temper	.89	10.77 (4.72)	6.11 (1.68)	<.001***	.61 [.48,.72]
Well-being	.96	11.75 (4.32)	23.95 (7.05)	<.001***	.73 [.63,.81]
Cleaning	.84	10.83 (5.00)	9.41 (3.13)	.99	.13 [.01,.32]
Ordering	.82	8.85 (4.17)	6.49 (2.24)	.01*	.32 [.15,.50]
Checking	.92	6.56 (3.60)	4.19 (1.87)	.005**	.34 [.17,.51]
Claustrophobia	.82	6.83 (3.23)	5.24 (1.011)	<.001***	.45 [.30,.59]
Suicidality	.88	12.17 (5.32)	6.29 (0.63)	<.001***	.75 [.64,.84]

Table A7.8. Mean and standard deviation of all clinical subscales per group in Study 6, with Cronbach's α measure of internal consistency and group difference *p*-value and effect size.

Appendix 7.9. Study 6: Sensory Deprived Mental Wandering Dimensions Descriptive Summary and Analysis of Variance (ANOVA)

Dimension	*M (SD)*	*M (SD), standardized*		One-way repeated measures ANOVA		
	All	Depressed	Healthy	(DFn, DFd)	*F*	*p*
Negative	2.65 (2.06)	0.37 (.65)	–0.30 (.51)	(7.28,830.18)	0.77	.62
Positive	3.90 (2.13)	–0.32 (.64)	0.27 (.56)	(7.69,876.79)	1.59	.13
Arousal	2.68 (1.90)	–0.02 (.77)	0.01 (.68)	(7.77,885.22)	1.25	.27
Enjoyed	3.82 (2.13)	–0.29 (.62)	0.24 (.59)	(9.00,1026.0)	2.28	.02*
Distressed	2.25 (1.91)	0.40 (.70)	–0.33 (.44)	(7.35,838.33)	2.70	.008**
Past	4.22 (2.57)	0.03 (.66)	–0.02 (.64)	(8.08,920.74)	2.11	.03*
Future	2.66 (2.28)	–0.10 (.59)	0.08 (.64)	(7.91,902.30)	0.65	.73
Rumination	3.79 (1.93)	0.06 (.70)	–0.05 (.67)	(8.06,918.95)	1.43	.18
Changing past	2.11 (1.89)	0.30 (.78)	–0.24 (.52)	(7.87,897.63)	2.71	.006**
Self	3.44 (1.70)	0.19 (.75)	–0.16 (.69)	(7.34,837.18)	1.61	.12
Others	2.52 (1.92)	0.09 (.63)	–0.08 (.64)	(9.00,1026.0)	2.69	.004**
Control	3.43 (1.60)	–0.20 (.68)	0.16 (.76)	(7.07,805.42)	4.48	<.001***
Aware-Immersed	4.21 (1.28)	0.12 (.75)	–0.10 (.67)	(7.59,865.77)	1.01	.43
Specificity	5.13 (1.51)	–0.08 (.70)	0.06 (.57)	(7.49,854.08)	1.50	.16
Words	2.70 (2.26)	0.13 (.77)	–0.10 (.71)	(7.76,884.32)	1.76	.08
Self-talk	2.86 (2.33)	0.21 (.83)	–0.18 (.67)	(7.49,853.47)	1.22	.28
Planning	2.37 (2.07)	–0.02 (.58)	0.02 (.61)	(7.66,873.59)	1.18	.31
Problem solving	2.04 (1.81)	0.06 (.65)	–0.05 (.55)	(7.68,875.11)	2.24	.03*
Visual imagery	4.97 (2.23)	–0.06 (.68)	0.05 (.66)	(7.95,906.34)	2.20	.03*
1st person POV	4.60 (2.48)	–0.11 (.69)	0.08 (.61)	(7.93,904.00)	1.01	.43
2nd person POV	1.56 (1.39)	–0.05 (.44)	0.04 (.83)	(7.57,863.05)	0.37	.93
3rd person POV	2.42 (2.13)	–0.12 (.57)	0.10 (.70)	(7.95,906.30)	0.57	.80
Sounds	2.35 (2.14)	0.07 (.61)	–0.06 (.69)	(7.51,855.90)	3.36	.001*
Voices	2.28 (1.99)	0.01 (.64)	–0.01 (.66)	(8.05,918.19)	0.97	.46
Scents	1.77 (1.67)	–0.04 (.66)	0.03 (.78)	(7.47,851.74)	0.49	.85
Sensations	2.34 (2.07)	–0.02 (.66)	0.02 (.75)	(7.71, 878.91)	0.43	.90
Somatic Awareness	2.34 (1.72)	0.26 (.90)	–0.22 (.63)	(7.12,811.27)	1.58	.14
Fidgety-Calm	4.52 (1.56)	–0.37 (.68)	0.30 (.59)	(7.59,864.82)	0.96	.46

Table A7.8. Summary descriptive statistics of whole sample and groups across all mind wandering dimensions for Study 6. Whole sample *M, SD* on raw data units of Likert scale (1-7), with group *M, SD* on standardized units. One-way repeated measures ANOVA results for dimensions collapsed across group listed with degrees freedom of numerator (DFn), denominator (DFd), *F*-statistic, and *p*-value

Descriptive summary. The descriptive summary of mean and standard deviation of each mind wandering dimension are listed in Table S4. A one-way repeated measures analysis of variance (ANOVA) was assessed with both groups collapsed (see Table S4). There were significant effects for several dimensions across time when collapsing groups, including on enjoyed ($F(9,1026)=2.28$, $p=.02$), distressed ($F(7.35,838.33)=2.70$, $p=.008$), past ($F(8.08,920.74)=2.11$, $p=.03$), others ($F(9,1026)=2.69$, $p=.004$), control ($F(7.07,805.42)=4.48$, $p<.001$), changing the past ($F(7.87,897.63)=2.71$, $p=.006$), problem solving ($F(7.68,875.11)=2.24$, $p=.03$), visual ($F(7.95,906.34)=2.20$, $p=.03$), and sounds ($F(7.51,855.90)=3.36$, $p=.001$).

Group differences. We also conducted two-way repeated measures ANOVA to look at group differences across time. Groups were significantly different in how much their thought experiences were negative ($F(1,113)=38.02$, $p<.001$), positive ($F(1,113)=27.61$, $p<.001$), enjoyable ($F(1,113)=21.18$, $p<.001$), distressing ($F(1,113)=46.80$, $p<.001$), controlled ($F(1,113)=7.14$, p=.009), self-focused ($F(1,113)=6.93$, $p=.01$), changing the past ($F(1,113)=19.53$, $p<.001$), self-talk ($F(1,113)=7.78$, $p=.006$), somatosensory awareness ($F(1,113)=11.49$, $p<.001$), and fidgety vs. calm ($F(1,113)=31.82$, $p<.001$). The same dimensions were significantly different at the different probe times as in the one-way rmANOVA results described above (see Table S4).

There were significant interactions in how groups experienced the following dimensions over time; enjoyed ($F(9,1017)=2.00$, $p=.04$), distressed ($F(7.36,831.32)=2.01$, $p=.04$), changing the past ($F(7.90,892.37)=2.09$, $p=.004$), and 1st person POV ($F(7.94,897.03)=2.40$, p=.02).

No significant group differences between arousal during thoughts ($F(1,113)=0.05$, $p=.82$) past ($F(1,113)=0.16$, $p=.69$), future thoughts ($F(1,113)=2.59$, $p=.11$), rumination ($F(1,113) = 0.64$, $p=.42$), others-focused ($F(1,113)=2.01$, $p=.16$), immersion ($F(1,113)=2.72$, $p=.10$), specificity ($F(1,113)=1.39$, $p=.24$), words ($F(1,113)=2.72$, $p=.10$), planning ($F(1,113)=0.10$, $p=.75$), problem-solving ($F(1,113)=0.88$, $p=.35$), visuals ($F(1,113)=0.89$, $p=.35$), 1st person POV ($F(1,113)=2.52$, $p=.12$), 2nd person POV ($F(1,113)=0.57$, $p=.45$, 3rd person POV ($F(1,113)=3.26$, $p=.07$), sounds ($F(1,113)=1.20$, $p=.28$), voices ($F(1,113)=0.05$, $p=.83$), scents ($F(1,113)=.31$, $p=.58$), or imagined sensations ($F(1,113)=0.08$, $p=.78$).

Appendix 7.10. Study 6: Group Differences in Sensory Deprived Mental Wandering Dimensions Multilevel Model Estimates

	b (*SE*)	*t*(95)	*p*		*b* (*SE*)	*t*(95)	*p*
Valence (Negative)				**Rumination**			
Depressed	3.40 (.17)	20.60	<.001***		3.90 (.18)	21.45	<.001***
Healthy	–1.37 (.22)	–6.17	<.001***		–0.20 (.25)	–0.80	.42
Valence (Positive)				**Changing the Past**			
Depressed	3.21 (.18)	18.07	<.001***		2.67 (.17)	15.63	<.001***
Healthy	1.26 (.24)	5.26	<.001***		–1.02 (.23)	–4.42	<.001***
Arousal				**Self-focus**			
Depressed	2.65 (.19)	13.88	<.001***		3.76 (.17)	22.29	<.001***
Healthy	0.06 (.26)	10.69	.82		–0.60 (.23)	–2.63	.01
Distress				**Perceived Control**			
Depressed	3.02 (.15)	19.94	<.001***		3.11 (.16)	19.37	<.001***
Healthy	–1.40 (.20)	–6.84	<.001***		0.58 (.22)	2.67	.009
Temporal (Past)				**Meta-awareness**			
Depressed	4.28 (.23)	18.58	<.001***		4.36 (.13)	34.67	<.001***
Healthy	–0.12 (.31)	–0.40	.69		–0.28 (.17)	–1.65	.10
Temporal (Future)				**Specificity**			
Depressed	2.44 (.19)	13.09	<.001***		5.01 (.13)	37.55	<.001***
Healthy	0.41 (.25)	1.61	.11		0.18 (.18)	1.18	.24

Table A7.10. Model estimates for diagnostic group differences on sensory deprived mental wandering dimensions from Study 6. Model estimates reported are for intercepts of each clinical group along these various dimensions representing group differences. A Bonferroni-corrected alpha of .004 was applied to indicate significance.