Dampening and Amplifying Cognitive Appraisals in Anhedonia: An investigation of which psychological mechanisms build or hinder positive affect in adolescence.

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: ……..

In loving memory of my father

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Abstract

There is an increasing interest in understanding the psychological mechanisms that drive reduced positive emotion experience in depression (anhedonia). The adult literature has demonstrated that engaging with dampening appraisals during positive events (e.g. think 'this is too good last') reduces positive emotion experience (Burr, Javiad, Jell, Werner-Seidler, & Dunn, 2017; Dunn et al., 2018). Conversely, there is less evidence that the tendency to engage in amplifying appraisals during positive events (e.g. think 'this is a sign of good things to come') increases positive emotion experience. It is less well understood whether positive appraisal style also modulates positive emotion experience in young people. The present thesis investigated this question through four studies. First, a systematic review and meta-analyses were conducted which focused on the role of positive appraisal styles in relation to positive affect (PA) deficits in youth and adults. Second, a survey study examined whether trait levels of dampening and amplifying appraisal styles were cross-sectionally (n = 367) and prospectively (n = 170) associated with anhedonia symptoms in young people. Third, an experimental study (n = 89) sought to establish a causal association between induced use of dampening and amplifying appraisals, and PA during positive memory recall in young people. A final experimental study conducted at naturalistic settings with adolescent participants (n = 24) examined the impact of induced use of dampening and amplifying appraisals on PA during scheduled positive activities over four consecutive days. Findings from this PhD collectively indicated that dampening appraisal style is a potential anhedonia driving mechanism in adolescents. Future studies investigating the role of positive appraisal styles as a mediator of therapeutic change are now needed before developing interventions targeting dysfunctional positive appraisals when working with depressed adolescents.

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Chapter Two: Study One

List of Abbreviations

ACS: Affective Control Scale

ACT: Acceptance and Commitment Therapy

ANOVA: Analysis of Variance

BA: Behavioural Activation

BALES: Brief Adolescent Life Events Scale

BAS: Behavioural Approach System

BD: Bipolar Disorder

BIS: Behavioural Inhibition System

BPI: Brief Psycho-Social Intervention

CBT: Cognitive Behavioural Therapy

CCT: Cognitive Control Training

CDI-C: Children's Depression Inventory

CI: Confidence Interval

CoDEQ: Co-Dampening and Co-Enhancing Questionnaire

CRSQ: Children's Response Style Questionnaire

DSM: Diagnostic Statistical Manual of Mental Disorders

DV: Dependent Variable

EF: Emotion-Focus

EFA: Exploratory Factor Analysis

EMA: Ecological Momentary Assessment

ER: Emotion Regulation

ERP-R: Emotion Regulation Profile Revised

FOH: Fear of Happiness Scale

GAD: Generalised Anxiety Disorder

IPPI-D: The Integrative Positive Psychological Intervention for Depression

IV: Independent Variable

LASS: The Leuven Anhedonia Self-report Scale

MACS-A: Modified Affective Control Scale Adolescent Version

MASQ-AD: Mood and Anxiety Symptom Questionnaire – Anhedonic Depression Subscale

MDD: Major Depressive Disorder

MEDLINE: Medical Literature Analysis and Retrieval System Online

MTT: Mental Time Travel

NA: Negative Affect

NAPAS: Negative and Positive Affect Scale

NICE: National Institute for Health and Care Excellence

NMDA: N-methyl-D-aspartate

NVS: Negative Valence Systems

PA: Positive Affect

PANAS-C: Positive and Negative Affect Schedule for Children

PANAS-G: Positive and Negative Affect Schedule Global

PAT: Positive Affect Treatment

PCIT-ED: Parent-Child Interaction Therapy-Emotion Development

PE: Positive Emotion

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PVS: Positive Valence Systems

QRPs: Questionable Research Practices

RCADS: Revised-Children Anxiety and Depression Scale

RCTs: Randomised Controlled Trials

RDoC: Research Domain Criteria

RPA-C: Responses to Positive Affect Questionnaire for Children

RPA: Responses to Positive Affect Questionnaire

SART: Sustained Attention to Response Task

SBI: Savouring Beliefs Inventory

SD: Standard Deviation

SF: Self-Focus

SHAPS: Snaith Hamilton Pleasure Scale

SHS: Subjective Happiness Scale

SP: Social Phobia

SSRI: Selective Serotonin Reuptake Inhibitor

STPP: Short-term Psychoanalytical Psychotherapy

TADS: Treatment for Adolescents with Depression Study

TORDIA: Treatment of Resistant Depression in Adolescents Trial

UK: United Kingdom

WHO: World Health Organisation

Chapter 1.0: General Introduction

1.1 Overview

Adolescence is a critical life stage that is characterised by increased emotionality and activation of reward circuits while brain areas that are responsible for cognitive control are still maturing (the developmental mismatch model, see Mills, Goddings, Clasen, Giedd, & Blakemore, 2014). These developmental changes co-occur in a period during which the prevalence of psychological disorders characterised by emotion regulation difficulties, such as depression, anxiety, and substance misuse, rapidly increase (Powers & Casey, 2015). Indeed, approximately half of psychological disorders have their first onset during adolescence (Kessler et al., 2007), which makes adolescence a crucial developmental stage to examine mechanisms of psychopathology as well as a vital developmental window to prevent mental health problems from occurring later in adulthood.

Current estimates indicate that there are 350 million people living with depression globally (World Health Organisation, 2012). Major depression is a severely impairing condition (Kessler et al., 2005), that is one of the leading worldwide causes of increased years lived with disability in youth according to the World Health Organisation (Gore et al., 2011). Adolescent depression is a recurrent condition as approximately 40% of depressed teenagers will experience at least one more depressive episode in the following years (Birmaher et al., 2004; Dunn & Goodyer, 2006).

Anhedonia, diminished enjoyment of things that were previously pleasurable at a personal level, is a core symptom of depression (American Psychological Association, 2013) and a potent severity marker for depressive disorder in adolescents (Gabbay et al., 2015). Given the global burden of the disorder, it is necessary to advance our understanding of the precursors and causes of adolescent anhedonia to develop more effective ways to challenge positive affect (PA) deficits for which existing gold-standard therapies do very little (Dunn,

2017). In this PhD, I proposed that one of the potential mechanisms that is likely to underlie adolescent anhedonia is cognitive appraisals of PA, for which there is now preliminary causal evidence in adult samples (Burr, Javiad, Jell, Werner-Seidler, & Dunn, 2017; Dunn et al., 2018).

Therefore, the current work aims to examine PA appraisal styles in relation to anhedonia symptoms in adolescents. In particular, it aims to establish key underlying mechanisms that could inform psychotherapeutic developments in the management of anhedonic deficits in community adolescents. In this chapter, I will provide an overview of the relevant literature and demonstrate the potential significance of this research. First, a descriptive overview of major depressive disorder (MDD) in youth will be provided, including its epidemiology, presentation, and risk factors. Next, the importance of studying depression in adolescents, and the available treatments will be discussed. This will be followed by a general overview of anhedonia in youth. I will first present epidemiological characteristics of anhedonia, and how it manifests in youth. Next, I will demonstrate the significance of studying this topic in adolescents and treatment strategies to target anhedonia. Finally, I will introduce PA appraisal style as a potential mechanism that may underlie anhedonic symptoms in adolescents by summarising the existing evidence demonstrating its links to depression, and more importantly to anhedonic symptoms.

1.2 Depression in youth

1.2.1 Epidemiology.

Rates of depression rapidly increase from 2.8% pre-adolescence to 5.6% in adolescence (Costello, Erkanli, & Angold, 2006), indicating that adolescence is a sensitive period for the first onset of the disorder, especially in girls (Hankin et al., 1998). Costello et al. (2006) proposed that youth depression rates did not significantly increase based on prevalence estimates from 1965 to 1996. However, more recent reports suggest that there

might be a recent increase in depressive symptoms based on data gathered from two US cohorts (Twenge, Joiner, Rogers, & Martin, 2018). Female preponderance in depression rates which first emerges during adolescence is a consistent finding (Piccinelli & Wilkinson, 2000) across different nations (Salk, Hyde, & Abramson, 2017) and broadly remain stable during the majority of the life span (Bebbington et al., 1998). Recent evidence suggests that girls start exhibiting depressive symptomatology as early as 11 to 12-years of age (Breslau et al., 2017; Salk et al., 2017).

1.2.2 Presentation.

Presence of depressed mood (e.g., feeling sad, hopeless, discouraged) and/or anhedonia (e.g., reduced interest and pleasure in hobbies and previously enjoyable activities) for nearly every day over at least a two-week period is required for the diagnosis of a major depressive episode (American Psychological Association, 2013). A parallel diagnostic criteria for depressive disorder were also outlined by the World Health Organisation (World Health Organisation, 2018). Core affective symptoms are usually accompanied by a change in weight, sleep disturbances, psychomotor changes, reduction in energy levels, guilt and worthlessness, concentration problems, and suicidality (American Psychological Association, 2013). Unlike adult diagnostic criteria, depression may manifest with irritable mood instead of sadness in children and adolescents. However, conflicting findings reported in the literature indicate that irritability may not be present (Rice et al., 2019) or is commonly seen without depressed mood (Stringaris, Maughan, Copeland, Costello, & Angold, 2013). This raises questions about the validity of presence of irritable mood as a criterion symptom for the diagnosis of major depression in youth. Although the manifestation of depression in adults and youth is broadly similar, some differences in the clinical presentation of depression between these two groups are shown. Depressed adolescents have more vegetative symptoms of insomnia, appetite changes and loss of energy (Rice et al., 2019). There are

some gender differences reported in the ways depressive disorder manifests in girls and boys as well (Bennett, Ambrosini, Kudes, Metz, & Rabinovich, 2005). Among clinically depressed youth, girls are more likely to have depressed mood whereas boys score higher on anhedonia and morning depressed mood (Bennet et al., 2005). According to Luby et al. (2002), depression in the first years of life is also characterised with sad or irritable mood and anhedonia indicating that the disorder, again, may manifest broadly similar to adult presentation of the disorder, yet conflicting views are noted regarding diagnosing psychiatric conditions in the very young (see Egger & Angold, 2006).

1.2.3 Risk factors for depression.

Multiple risk factors predict vulnerability to depression and may each partly account for significantly increasing prevalence rates during adolescence (Thapar, Collishaw, Pine, & Thapar, 2012). As mentioned earlier, being a female substantially increases the risk for developing a depressive disorder (Hankin et al., 1998) and pubertal hormonal changes in girls correlate with a rapid increase in depression rates (Angold & Costello, 2006). Stress exposure plays a critical role in the aetiology of depression (see for a review Hammen, 2005), as stress predicts future depression in youth (O'Connor, Rasmussen, & Hawton, 2010; Rudolph, Flynn, Abaied, Groot, & Thompson, 2009).

Having a family member with a history of depression is another robust risk factor that considerably increases depression risk in youth, with children of depressed parents and grandparents being the most vulnerable (Orvaschel, Weissman, & Kidd, 1980; Weissman, 2016; Weissman et al., 2016). Stressful life events also interact with the genetic disposition to depression and exacerbate the risk for future depressive episodes particularly in those with parental depression (Zimmermann et al., 2008). Girls experience more stressful life events and engage with increased negative appraisals while processing their negative experiences (Hyde, Mezulis, & Abramson, 2008), which may contribute to the heightened depression

risk. Cognitive vulnerability (e.g. rumination) is a strong predictor of depression onset in youth even when the interpersonal risk is low (e.g. parental conflict), and more common in older adolescents (Hankin, Young, Gallop, & Garber, 2018). Indeed, the role of rumination, passively dwelling on the causes and consequences of negative feelings, as a risk factor for the onset of depression is well-established (Kuyken, Watkins, Holden, & Cook, 2006; Nolen-Hoeksema, 1991; Rood, Roelofs, Bögels, Nolen-Hoeksema, & Schouten, 2009; Watkins, 2008).

Major depression also predicts subsequent increases in levels of trait rumination in youth (Krause et al., 2018). In addition, negative cognitive styles (e.g. self-attribution of negative words such as ugly, lonely) exist in formerly depressed youth, suggesting that they may operate as a relapse vulnerability factor in adolescent depression (Timbremont & Braet, 2004). Importantly, cognitive vulnerability factors of depression occurring during adolescence follow a stable course into adulthood (Romens, Abramson, & Alloy, 2009), which makes the early identification and prevention of these risk factors particularly important.

1.2.4 Importance of depression in youth.

Depression is closely linked to impairments in academic and social functioning, poor mental and physical health (Glied & Pine, 2002; Jaycox et al., 2009) and increased suicidality (Hawton, Saunders, & O'Connor, 2012). Depressed youth are more likely to miss a school day, smoke, exhibit conduct problems (Breslau et al., 2017), binge-eating (Glied & Pine, 2002), and sleep-difficulties (Owens, 2014). Henceforth, it is not surprising that depressive disorder in youth causes a significant economic burden to families, schools, and youth health services (Lynch & Clarke, 2006).

Prospective longitudinal studies show that adolescent depression predicts worsened mental and physical health later in life (Maughan, Collishaw, & Stringaris, 2013; Weissman,

1999). It increases vulnerability to affective disorders, substance misuse, and to some extent suicidality in adulthood (Johnson, Dupuis, Piche, Clayborne, & Colman, 2018; McLeod, Horwood, & Fergusson, 2016). A recent meta-analysis demonstrated that adolescent depression is linked with adverse educational, occupational and psychosocial outcomes later in life that can have enduring effects on quality of life and well-being (Clayborne, Varin, & Colman, 2019). Compared to non-depressed counterparts, for instance, depressed adolescents were more likely to be unemployed, to have longer or recurrent unemployment periods, and less likely to complete secondary school. When the first onset of the disorder occurs during adolescence, depression results in loss of human capital, particularly for females (Berndt, 2000). Given the individual and societal burden of the disorder, the research on depression in youth should be a public health priority.

1.2.5 Treatment of depression in youth.

Contact with mental health services at the age of 14 was linked with reductions in depressive symptoms during the following year (Neufeld, Dunn, Jones, Croudace, & Goodyer, 2017). Importantly, the increased levels of initial depressive symptoms in those with a mental health condition that sought treatment were comparable to the healthy adolescent counterparts after a three-year period. Effective evidence-based psychological treatments for adolescent depression exists (Goodyer & Wilkinson, 2018). Pharmacological treatments are also effective (The TADS Team, 2007) but not advised as a first-line treatment and should be used in combination with psychotherapy in youth with moderate to severe and/or treatment-resistant depression according to the National Institute for Health and Care Excellence (NICE, 2005). Fluoxetine, a selective serotonin reuptake inhibitor (SSRI), is the only psychopharmacological agent that is suggested by NICE (2005) in the UK which is also approved by the US Food and Drug Administration to be used with children and adolescents. However, there are concerns regarding the effectiveness, efficacy (Garland, Kutcher ONS,

Virani, & Elbe, 2016; Tonkin & Jureidini, 2005) and safety (Bridge et al., 2007; Wong, Besag, Santosh, & Murray, 2004) of administration of fluoxetine in paediatric populations.

A number of randomised control trials (RCTs) examined the effectiveness of Cognitive Behavioural Therapy (CBT) to tackle depression in adolescents (Emslie et al., 2010; Goodyer et al., 2008; Goodyer et al., 2017; Kennard et al., 2006). The Treatment for Adolescents with Depression Study (TADS) showed that monotherapy (i.e. fluoxetine alone) was more effective than CBT alone, and the combination of both was superior to all and decreased overall depressive symptom as well as suicidality in comparisons to one another and a placebo group (The TADS Team, 2004). Among those adolescents who received CBT alone, 16% were remitted at 12-weeks, but this rate was statistically comparable to monotherapy and placebo groups (Kennard et al., 2006). Further, 61% of adolescents who received only CBT, no longer met diagnostic criteria for Major Depressive Disorder (MDD) at the end of the treatment, but this rate was again statistically comparable to rates of adolescents in the placebo arm, and inferior to the ones in combination treatment or monotherapy arms (Kennard et al., 2006). In a randomised controlled superiority trial, Goodyer et al. (2017) compared the effectiveness of CBT, short-term psychoanalytical psychotherapy (STPP) and a brief psycho-social intervention (BPI) in moderate to severely depressed adolescents. Results indicated that STPP and CBT were similarly effective, and interestingly these interventions were not superior to the less-costly brief psychosocial intervention in terms of reductions in depressive symptoms measured a year after following the treatment (Goodyer et al., 2017).

Behavioural activation (BA) is a cost-effective alternative to CBT in adults (Richards et al., 2016) and might be a promising intervention for youth depression (Tindall et al., 2017). BA compromises of activity scheduling component of cognitive therapy approaches to promote positive reinforcement and reengagement with avoided activities which may further

maintain or exacerbate depression (Veale, 2008). Pass et al. (2015) adapted BA to be used with adolescents (Pass, Brisco, & Reynolds, 2015), and initial piloting of the treatment showed that BA can be a feasible and acceptable treatment approach for depressed adolescents (Pass, Lejuez, & Reynolds, 2018). Findings indicated that depressive symptoms were significantly reduced at the end of the treatment reported by both adolescents and their parents (Pass et al., 2018; Ritschel, Ramirez, Cooley, & Edward Craighead, 2016). However, conclusions about the efficacy of BA cannot be made due to lack of control groups in these studies. Two RCTs, one conducted in Japan with late adolescents with sub-clinical depression (Takagaki et al., 2016) and another US-based pilot trial that compared BA with evidence-based usual care (McCauley et al., 2016), reported promising findings regarding the efficacy of BA in adolescent depression. BA is recommended by NICE for the treatment of depression in adults (NICE, 2009). However, further research on the effectiveness, cost-effectiveness, and superiority of BA over other gold standard psychotherapies in youth is still needed (Martin & Oliver, 2018; National Institute for Health and Care Excellence, 2019; Tindall et al., 2017).

Collectively, these findings indicate that the combination of medication and psychotherapy may be necessary to achieve satisfactory outcomes in the treatment of adolescent depression, particularly for those with increased illness severity. However, there are concerns regarding the safety of using SSRIs with depressed adolescents, and current psychotherapies are effective but yield modest effects to treat depression in youth (Weisz, McCarty, & Valeri, 2006). These findings emphasise the importance of psychotherapy in treating adolescent depression and indicate that further research is needed to enhance the existing psychological interventions.

1.3 Anhedonia in youth

1.3.1 Epidemiology.

In community samples, the prevalence of anhedonia symptoms in youth reaches 5.6% (Lewinsohn, Rohde, & Seeley, 1998). Among depressed adolescents with a familial history of recurrent depressive disorder, 70.3% had anhedonia symptoms as assessed by a semi-structural diagnostic interview (Rice et al., 2019). When compared with a sample of adults and their adolescent children with recurrent depression, anhedonia appeared to be more common in adults than in adolescents (Rice et al., 2019). Anhedonia, as indexed by a single item "I enjoy very little", peaked at age 11 among boys and girls, followed by a more stable course during mid to late adolescence which showed an overall decline from pre-adolescence to emerging adulthood (Bennik, Nederhof, Ormel, & Oldehinkel, 2014). Anhedonia symptoms measured around mid to late adolescence continued into young adulthood while NA declined in another study (Conway, Zinbarg, Mineka, & Craske, 2017). The discrepancy between the findings regarding the stability of anhedonia symptoms in Bennik et al. (2014) and Conway et al. (2017) might be caused by over-sampling of adolescents with neuroticism, a personality trait that is a correlate of greater depression and suicidality (Chioqueta & Stiles, 2005), in the latter study. Contrary to depressed mood (i.e. sadness, hopelessness), anhedonia might be more common in boys than girls (Freedman, Rock, Roberts, Cornblatt, & Erlenmeyer-Kimling, 1998; Ronald et al., 2014). Further, it was shown that increased anhedonia was predicted by lower socioeconomic status in community samples (Bennik et al., 2014).

1.3.2 Presentation.

Early theorists suggested that the presence of anhedonic deficits are seen in almost half of depression cases, and severe anhedonia manifests in approximately 1 in 5 (Fawcett, Clark, Scheftner, & Gibbons, 1983) and may rather indicate a subtype of depression (i.e.

endogenomorphic depression) (Klein, 1974). The clinical definition of anhedonia remained broadly similar since then, that is markedly diminished interest or pleasure in previously enjoyable activities for most of the day nearly every day (American Psychiatric Association, 2000, 2013) with an emphasis on the attainment of pleasure.

Among clinically depressed youth, depressed mood was the most common characteristic of MDD, the majority of the cases also exhibited anhedonia (88%) with anhedonia severity being greater in adolescents compared to pre-pubertal counterparts in early reports (Ryan et al., 1987). More recent clinical data revealed similar findings showing that 77.3% to 70% of adolescents manifest anhedonia (Lewinsohn, Pettit, Joiner, & Seeley, 2003; Rice et al., 2019), and only a minority, 2.3%, present with anhedonia without depressed mood (Lewinsohn et al., 2003). There is limited research on the very early manifestations of anhedonic symptoms. As an exception, based on parental reports, Luby et al. (2003) postulated that anhedonia (i.e. lack of enjoyment in activities and play) manifests as a highly specific symptom of major depression in pre-school children but was not the case among healthy comparisons (i.e. infinite odd ratios).

Besides its salience for MDD (Shankman, Nelson, Harrow, & Faull, 2010), anhedonia is also implicated in various other psychopathologies including schizophrenia (Gard, Kring, Gard, Horan, & Green, 2007), substance misuse (Cho, Stone, & Leventhal, 2019; Hatzigiakoumis, Martinotti, Giannantonio, & Janiri, 2011), anxiety disorders (Kashdan, 2007), and anorexia nervosa (Boehm et al., 2018), which might partially explain the increased comorbidity between these conditions and MDD. Contrarily to depressed mood being a primary manifestation of depression in girls (Thapar et al., 2012), anhedonia was more common and a unique correlate of a depression diagnosis for boys with MDD (Bennett et al., 2005) in accordance with studies suggesting an anhedonic subtype that is more common in men (Langvik, Hjemdal, & Nordahl, 2016). In summary, anhedonia is present

from the early years of life, might be clinically more prominent in males, implicated in various psychopathological conditions, and its course subsequently becomes more pervasive and severe in adolescence.

1.3.2.1 Reward-related deficits.

Anhedonia is an emergent property of underling disturbances in the system that regulates reward in the brain (Der-Avakian & Markou, 2012). The National Institute of Mental Health's proposal of Research Domain Criteria (RDoC) aims to improve understanding of behavioural and neural underpinnings of psychiatric disorders beyond traditional disorder classifications (Insel et al., 2010). Contemporary neuroscience theories distinguish between different aspects of reward processing, which collectively make up the positive valence system (PVS). Distinctions can be drawn between reward wanting, consumption/liking and learning, which are believed to be regulated by partially distinct neurocircuitry (Berridge & Kringelbach, 2008; D. a Pizzagalli, 2014; Whitton, Treadway, & Pizzagalli, 2015). Reward 'wanting' refers to the willingness and motivation to expend effort to approach a reward. It tends to be measured by effort expenditure rewards task that quantify effort-based decision making towards rewarding stimuli (Treadway, Buckholtz, Schwartzman, Lambert, & Zald, 2009). The 'liking' component refers to pleasure experienced when consummating a reward. It tends to be measured at the moment-by-moment level by subjective, psychophysiological and neural responses when presented with rewarding stimuli (Wacker, Dillon, & Pizzagalli, 2009), viewing positive images (Heller et al., 2009), recalling positive experiences (Keedwell, Andrew, Williams, Brammer, & Phillips, 2005). The longer-term tendency to respond to rewarding stimuli (for example, over a period of weeks) is measured by self-report questionnaires. For example, the Snaith Hamilton Pleasure Scale (SHAPS; Snaith et al. 1995) asks people to judge how much they enjoy different kind of rewards over time. 'Learning' refers to changes in patterns of thinking and behaviour following reward acquisition (making

that behaviour or thought more likely to be repeated in the future). It tends to be measured by signal detection tasks based on responsiveness towards reinforced stimuli (Morris, Bylsma, Yaroslavsky, Kovacs, & Rottenberg, 2015; Pizzagalli, Jahn, & O'Shea, 2005).

While wanting, liking and learning are often considered as distinct processes, they do have some overlap. For example, individuals experience positive affect when anticipating and remembering, as well as when directly experiencing a reward, meaning liking to some extent is also likely to influence wanting and learning. Clinical disorders characterised by anhedonia, in particular depression, are associated with alterations in all three systems (Russo & Nestler, 2013; Smoski et al., 2009; Vrieze et al., 2013).

The present thesis focuses predominantly on the 'liking' component of reward. In survey studies (looking at changes in anhedonia over extended periods of time), the SHAPS (Snaith et al. 1995) was used to measure anhedonia. It is suggested that self-report measures of anhedonia should capture responses toward various types of rewards (i.e. food, sex, hobbies and social activities) and state differences rather than trait levels of anhedonia, be validated in clinical and non-clinical samples and generalisable across cultures (Rizvi, Pizzagalli, Sproule, & Kennedy, 2016). The SHAPS is regarded as the closest to a gold-standard measure of anhedonia and as being sensitive to changes in anhedonic state. It has demonstrated divergent and convergent validity with depression severity and anxiety respectively and has been validated across different cultures (Liu, Wang, Zhu, Li, & Chan, 2012; Martino et al., 2018; Rizvi et al., 2016). The scale has also been well validated in adolescent populations (Leventhal et al., 2015). In experimental studies (looking at changes in anhedonia in response to a particular stimulus at one moment in time), the current thesis instead used self-report measures of positive affect (e.g. happiness ratings) which allowed for the measurement of positive affect reactivity as a response to particular rewards presented during the experiments.

Accumulating evidence on the role of reward functioning in depression suggests that it is implicated in vulnerability to and maintenance of the disorder in adolescents (Davey, Yücel, & Allen, 2008; Forbes et al., 2010; Forbes & Dahl, 2012). Familial high-risk designs provide an opportunity to study vulnerability factors of psychiatric disorders as for instance children of depressed parents are two times more likely to develop depression themselves (Sullivan, Neale, Ph, & Kendler, 2000). Accordingly, it was shown that children of depressed parents with MDD exhibited reduced approach to monetary rewards when the likelihood of getting a positive outcome was high compared to non-depressed adolescent counterparts (Rawal, Collishaw, Thapar, & Rice, 2013). Interestingly, this significant difference in reward-seeking behaviour seemed to disappear between the depressed and non-depressed adolescents when the probability of getting a reward was low. Diminished reward-seeking was also related to later onset of depression among adolescents who were free of the disorder at the intake.

There is evidence showing that reward-related brain regions are effected by social stress in adolescents (Lincoln et al., 2019) which could explain one pathway to reward-related anhedonic deficits seen in youth. Further, processing of social rewards is also an important aspect of adolescent depression that merits further investigation (Forbes & Dahl, 2012). For instance, when adolescents with MDD listened to maternal praise compared to neutral audio recordings, they exhibited blunted activation in reward networks, a difference that was not observed in healthy controls (Silk et al., 2017) showing that depressed adolescents may have difficulty with the attainment of social rewards. Finally, in line with disturbances identified in anticipation and consumption of rewards, learning reward value of a particular stimulus over another by associating the more frequent win trials resulting from the former, may also be blunted in adolescent depression (Morris et al., 2015).

1.3.2.2 Attentional biases and memory deficits.

Anhedonia is a multi-faceted construct that may also relate to PA related information processing deficits that were found in attention and memory domains. Increased attention towards negative emotional stimuli is a common future of MDD (Erickson et al., 2005; Gotlib, Krasnoperova, Neubauer Yue, & Joormann, 2004) and may explain impaired ability to disengage from negative affect (NA) which is associated with vulnerability to depression and maintenance of depressed mood (Nolen-Hoeksema, 1991; Raedt & Koster, 2010). It has been suggested that depressed adults may also lack a positivity bias, that is they turn their attention away from positive stimuli (Joormann & Vanderlind, 2014), which may not be a mere correlate of increased bias towards negative materials (Shane & Peterson, 2007). MDD was shown to be associated with spending less time attending to happy faces, that is reduced fixation-duration, rather than the first-fixation to the positive stimulus (Duque & Vázquez, 2015). This finding is consistent with studies emphasising the importance of anhedonic deficits identified in difficulty sustaining PA (Heller et al., 2009; Horner et al., 2014) that in turn might explain the persistence of anhedonia symptoms. There is also direct causal evidence showing that modification of attentional biases, where remitted depressed adults learn to orient their attention towards positive faces, may improve residual depressive symptoms (Browning, Holmes, Charles, Cowen, & Harmer, 2012). However, the effectiveness of positive bias modification in depressed youth remains unclear (Lazarov & Bar-Haim, 2016).

In the memory domain, there is evidence showing that depression is associated with increased recall of negative words compared to positive ones whereas non-depressed individuals exhibit an enhanced memory for the positive (Mogg, Bradbury, & Bradley, 2006). When depressed adults reported less depressive symptoms, they were more likely to recall happy memories than when their depressive symptoms were high (Clark & Teasdale,

1982). Interestingly, depressed individuals reported increased sad mood after recalling positive memories (Joormann, Siemer, & Gotlib, 2007) indicating they might find the experience rather aversive. On the other hand, a recent study with adolescents exposed to early life adversity showed that positive memory specificity, for instance, might protect against a subsequent increase in depressive symptoms following stressful events by altering cognitive and biological indices of the disorder (Askelund, Schweizer, Goodyer, & van Harmelen, 2019). In summary, individuals with MDD may lack a bias towards positive materials and enhanced retrieval of positive memories which could be potentially targeted to improve depressive symptomatology.

1.3.3 Significance of studying anhedonia in youth.

Anhedonia is a severity marker for depressive illness in both adults (Keller et al., 1995; Pelizza & Ferrari, 2009) and youth (Rubin, 2012). Research on anhedonia in youth has received less attention up to date, yet the scarce literature available shows that it is linked to worsened social functioning, psychological and physical well-being (Cho et al., 2018; Freed et al., 2018; Pine, Cohen, Cohen, & Brook, 1999; Rawal et al., 2013). Elevated levels of anhedonia symptoms in youth are associated with future depression onset as indicated by both retrospective (Wilcox & Anthony, 2004) and prospective evidence (Pine et al., 1999) indicating that it is a vulnerability marker for depression that should be identified early in life. In clinical samples, anhedonia was shown to be a unique correlate of depression severity, more pervasive and increased number of depressive episodes in adolescents over and above irritability symptoms (Gabbay et al., 2015). Anhedonia severity in adolescents was also associated with increased suicidality (Auerbach, Millner, Stewart, & Esposito, 2015; Gabbay et al., 2015). Among depressed adolescents with suicidal ideation, greater anhedonia was associated with suicide attempts beyond the increased levels of suicidal ideation and depressive symptomatology (Nock & Kazdin, 2002).

Presence of anhedonia in adolescent depression has consequences for treatment outcomes. In the Treatment of Resistant Depression in Adolescents trial (TORDIA), increased anhedonic symptoms at baseline was a unique indicator of increased duration until depression remission was achieved (McMakin et al., 2012). It was again greater anhedonia that was the strongest predictor of a decreased period of depression-free days while controlling for factors such as depressed mood, somatic symptoms, and morbid thoughts. There is also evidence showing that reward processing interferes with treatment outcomes in depressed adults (Burkhouse et al., 2016), and there is preliminary evidence that it might be an indicator of treatment response in pre-school children (Barch et al., 2018). These findings underlie the importance of anhedonic deficits for the prognosis of depressive disorder, however, whether these findings would extend to depressed adolescents is still yet to be examined. Nevertheless, cumulatively, evidence indicates that increased anhedonia is a severity marker for depressive disorder, predicts hindered treatment effectiveness and may be associated with life-threatening outcomes in adolescents.

1.3.4 Treatment of anhedonic disturbances.

Currently, there are no approved pharmacological treatments available that primarily aim to treat anhedonic symptoms of depression (Argyropoulos & Nutt, 2013) as established treatments, such as SSRIs, do not target brain reward circuitry (Russo & Nestler, 2013). Interestingly, evidence indicates that SSRI treatment might even deteriorate reward functioning in adults (McCabe, Mishor, Cowen, & Harmer, 2010). Preliminary evidence in adults indicates that ketamine, an N-methyl-D-aspartate (NMDA) receptor antagonist, may be a promising fast-acting treatment (DeWilde, Levitch, Murrough, Mathew, & Iosifescu, 2015; Lally et al., 2014).

Similarly, reducing anhedonia symptoms or building PA is often overlooked in psychotherapy, as reducing depressed mood has been the primary focus until today (Dunn,

2012, 2017). Well-established depression treatments such as CBT primarily aim to target depressive cognitive triad that is negative views about self, world, and one's future, to facilitate change in affect and behaviour (Beck, 1991) with little emphasis on reduced positivity in depression as a therapeutic target. Similarly, behavioural interventions as in the example of BA do not improve anhedonic deficits indexed by trait measures in adults (Dichter et al., 2009). The Positive Affect Treatment (PAT) method was specifically developed to target PVS disturbances observed in depression and anxiety that map onto reward anticipation, consumption and learning (Craske et al., 2016; Dichter et al., 2009). It was designed to facilitate engagement with pleasant experiences (e.g. activities, appraisals, experiential processes) through cognitive and behavioural methods, specifically, with no emphasis on methods to correct for NA deficits. Initial findings now indicate that the PAT may be a potential treatment to improve PA deficits in adults (Craske et al., 2019).

There are also attempts to translate basic science findings into clinical practice. The Parent-Child Interaction Therapy-Emotion Development (PCIT-ED) aims to enhance sustained response towards joy along with adaptive regulation of negative affect in pre-schoolers (Barch et al., 2018). Compared to a wait-list control group, the PCIT-ED was shown to improve anhedonia symptoms and increased reward responsiveness which was indexed by a monetary guessing task consisting of win and loss trials. These promising findings underscore the potential and importance of targeted interventions to address PA deficits and should be replicated in adolescents. Established psychological therapies for depression such as CBT prioritise reducing elevations in NA in adolescents and neglect PA disturbances. Anhedonia as an indicator of illness severity plays a key role in the clinical course and treatment of depression in youth (Gabbay et al., 2015; McMakin et al., 2012). Therefore, it is important to correct for anhedonic deficits in adolescents to achieve a more holistic recovery and enhance the effectiveness of current depression treatments. However,

currently, there are no established psychological and psychopharmacological treatments that primarily target anhedonia in youth (as well as in adults). A small number of treatment approaches that are proposed to address this gap are still in the early stages of development with promising preliminary outcomes in adults and very young children. It will be important for future clinical research to test the PA improving potential of these methods in anhedonic adolescents and specify moderators and mediators of treatment outcomes (e.g. baseline differences and therapeutic changes in specific facets of PVS processes) to facilitate the development of targeted interventions for optimal results.

1.4 Mechanisms driving anhedonia in youth

To be able to repair anhedonia in adolescents, first, we should better understand what mechanisms cause or predict it, which then could be systematically targeted in therapy. PA and NA are two orthogonal dimensions of affect (Diener & Emmons, 1984). According to the tripartite model of depression and anxiety, increased NA (e.g. general distress) appears as a non-specific factor that relates to both depression and anxiety differing from reduced PA (e.g. loss of pleasure) which appears as a specific characteristic of depressive affect (Clark & Watson, 1991; Clark, Watson, & Mineka, 1994; Phillips, Lonigan, Driscoll, & Hooe, 2002; Watson, Clark, & Carey, 1988). There is also evidence supporting the fit of the tripartite model in clinical and non-clinical child and adolescent samples (Chorpita & Daleiden, 2002; T E Joiner & Lonigan, 2000). Although there is a normative reduction in NA levels from adolescence to early adulthood, lowered PA demonstrates a stable course during this period (Conway et al., 2017), and we know very little about the processes that underlie the presence and stability of anhedonic affect in youth before it becomes a relatively steady affective state into the adulthood.

A precise conceptualisation of clinical disturbances through determining correlates, forerunners and causes of psychological dysfunctions are needed to develop more effective

interventions for children and adolescents ("Conceptualization of Dysfunction"; Kazdin, 1997, p.117). While systematically determining causes of PA dysfunctions, it will be important to follow a similar evidence hierarchy and further extend these test of associations into ecologically valid settings before examining whether the change in these processes mediates the treatment effects at a final step (Dunn, 2017).

The emergence of third-wave psychotherapies such as acceptance and mindfulness-based therapies led to an increased research interest in processes like paying attention to the present moment and non-judgmental observation of the ongoing sensory and bodily experiences and their psychological benefits (Fletcher & Hayes, 2005). A number of related mechanisms that could potentially reduce pleasure have been investigated in adult literature such as mind-wandering (Mason et al., 2007).

It has been suggested that we spend 30% of our awake time thinking about things that are unrelated to tasks or activities we engaged with at a given moment, and mind-wandering may be preceding decreased happiness regardless of the valence of the thoughts we have including pleasant ones (Killingsworth & Gilbert, 2010). Similarly, trait measures of mind wandering correlated with lower levels of PA in adults (Carciofo, Du, Song, & Zhang, 2014). At laboratory settings, mind-wandering usually indexed by the Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). During SART participants respond to a non-target stimulus and inhibit responses to a target which was associated with lowered PA, again in an adult sample (Marchetti, Koster, & De Raedt, 2012). Adolescents compared to adults are more likely to be distracted, but their frequency of mind-wandering might be comparable to adults (Stawarczyk, Majerus, Catale, & D'Argembeau, 2014). It has been shown that trait mind-wandering is a correlate of worsened mood which was indexed by the difference between PA and NA total scores in adolescents (Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013). We still do not know much about the

affective consequences of state mind-wandering in adolescents, in particular whether mind-wandering reduces pleasure in youth, due to lack of experimental work in this domain.

Another potential mechanism that may underlie PA deficits is reduced interoceptive awareness which refers to identification and articulation of physical bodily sensations that is implicated in affect regulation (Price & Hooven, 2018). It has been shown that currently depressed women (with no comorbid anxiety disorder) exhibit worsened interoceptive awareness during a heartbeat counting task than healthy controls, and interestingly, only among these depressed women that increased interoceptive awareness was inversely correlated with reduced PA intensity (Furman, Waugh, Bhattacharjee, Thompson, & Gotlib, 2013). Interoceptive sensitivity, as measured by a heartbeat counting task, in youth is also associated with dysfunctional cognitive styles such as depressive rumination (De Witte, Sütterlin, Braet, & Mueller, 2016) a well-established risk factor for depressive disorder (Watkins, 2008). Overall, these studies indicate that interoceptive awareness, particularly in clinically depressed individuals, may partially explain the reduced PA. It will be an interesting avenue for future research studies to examine the link between this construct and anhedonic symptoms in children and adolescents.

Either consciously or unconsciously, we modulate which emotions we want to experience, its timing, course, and expression. These processes are referred as emotion regulation (ER) strategies (Gross, 1998). The influential process model defines five different ER families (Gross, 2013) which are situation selection, situation modification, attentional deployment, cognitive change, and response modulation. Regulation of emotion through cognitive change refers to the modifying an emotion by reappraising the emotional information (Gross & Thompson, 2007) which is a process that is central to cognitive behavioural therapies (Klein, Jacobs, & Reinecke, 2007). Although Gross's model conceptualises ER through cognitive change as a process that is antecedent to emotion

generation (Gross, 1998), it may well also operate as a response modulation ER strategy while an emotion is generated (Dunn et al., 2018). Now there is aggregating evidence that the ways we cognitively respond to positive feelings, how we appraise and make sense of them, may have affective consequences and relate to anhedonia symptoms (Burr et al., 2017; Dunn et al., 2018). The cognitive appraisal style is a particularly promising mechanism that may drive anhedonia and one that could also be tractable to target in therapy. Therefore, the next section of this chapter will review the current stage of knowledge on positive appraisal styles of dampening, amplifying and fear of positive emotion as potential underlying mechanisms of depressive and, in particular, anhedonia symptoms.

1.4.1 The link between positive appraisal style and depression.

Smith and Lazarus (1993) posit that rather than one's knowledge about a given situation, it is the subjective appraisals of the experiences (e.g. evaluation of how harmful or beneficial is the situation) that results in emotion, for instance, negative and positive emotions are typical responses to experiences that are appraised as harmful or beneficial respectively. Emotions generated through the cognitive appraisals, then, leads to a behavioural response of avoiding the harmful or pursuing the beneficial. Although the conventional opinion is that most people would try to maximise positive feelings and minimise the negative ones, there are differences in the ways positive feelings are appraised at an individual (Wood, Heimpel, & Michela, 2003) and a cultural level (Miyamoto & Ma, 2011). For instance, there is evidence showing that positive emotions are highly valued (Ford, Shallcross, Mauss, Floerke, & Gruber, 2014) but feared (e.g. "I think my judgment suffers when I get really happy") by depressed individuals (Beblo et al., 2012; Gilbert, McEwan, Catarino, Baião, & Palmeira, 2014).

Correspondingly, it has been shown that depressed individuals engage with increased trait dampening appraisals of PA (e.g. "Remind yourself these feelings won't last") based on

self-reports (Werner-Sadler 2013). Feldman et al. (2008) developed a self-report scale to measure how individuals appraise PA, the Responses to Positive Affect scale (RPA), which consists of the dampening subscale along with two types of PA amplifying subscales, labelled as self-focus positive rumination (SF; e.g. "I am living up to my potential") and emotion-focus rumination (EF; e.g. "I savour this moment").

In community samples of adults, it was shown that increased depressive symptoms correlated with increased use of dampening and decreased use of amplifying of PA at a cross-sectional level (Feldman, Joormann, & Johnson, 2008; McEvoy et al., 2018; Nelis, Holmes, & Raes, 2015). The significant reverse association between depression symptoms and amplifying reported was only evident for use of EF appraisals in some studies (McEvoy et al., 2018; Raes, Daems, Feldman, Johnson, & Van Gucht, 2009) and for SF appraisals in Feldman et al. (2008) across undergraduate students. On the other hand, Nelis et al. (2015) reported that greater depressive symptomatology was both associated with decreased trait levels of SF amplifying and EF amplifying appraisal styles among community volunteers (mean age = 31). When SF and EF amplifying appraisals were collapsed into a single amplifying measure, there was no significant association between the appraisal style and depressive symptoms in a sample of undergraduate students (see Supplementary data in Dunn et al., 2018). In youth samples, greater depression levels were consistently associated with increased use of dampening cross-sectionally (Bijttebier, Raes, Vasey, & Feldman, 2012; Gilbert, Luking, Pagliaccio, Luby, & Barch, 2017; Nelis, Bastin, Raes, & Bijttebier, 2018). A significant correlation between greater depressive symptoms and reduced amplifying appraisals was broadly replicated across samples of children (Bijttebier et al., 2012; Gilbert et al., 2017) and early, middle and late adolescents (Nelis et al., 2018; Nelis, Luyckx, et al., 2016). One interesting exception was that Gilbert et al. (2017), in a sample consisted of

children with and without a parental history of depression, reported that greater depressive symptoms were associated with increased use of amplifying appraisals.

In longitudinal prospective analyses, neither dampening nor amplifying appraisal style was a unique predictor of depressive symptoms over and above baseline symptomatology among adults (Nelis, Holmes, & Raes, 2015). While covarying for brooding and baseline appraisal styles, PA appraisal styles in children and adolescents did not uniquely predict future depressive symptoms at a three-month, one-year, and two-year follow-up assessments (Bijttebier et al., 2012; Nelis et al., 2018). In Bijttebier et al. (2012), decreased use of amplifying appraisals though predicted greater depressive symptoms, when life stress was high, indicating that reduced amplifying may exacerbate the negative impact of stress on depression (Hammen, 2005). Current evidence indicates that the occurrence of positive life events, on the other hand, did not interact with positive appraisal styles to predict depressive symptoms in adolescents (Nelis et al., 2018).

Overall, these findings indicate that increased dampening is concurrently associated with greater depression but not a predictor of future symptomology as consistently replicated in youth and adult samples. Findings regarding the use of amplifying appraisal styles, however, remain broadly inconclusive.

1.4.2 The link between positive appraisal style and anhedonia.

There is now accumulating evidence showing that PA appraisals may be particularly salient for anhedonic symptoms of depression. Cross-sectionally, increased use of dampening appraisals and decreased use of amplifying appraisals were associated with anhedonia in both community (study one; Werner-Seidler, Banks, Dunn, & Moulds, 2013) and clinical adult samples (Nelis, Holmes, & Raes, 2015; Werner-Seidler et al., 2013). The dampening and anhedonia association only remained significant in one of these samples (study three; Werner-Seidler et al., 2013) when non-anhedonic symptoms of depression were ruled-out. It

was shown that EF amplifying was more consistently and uniquely relate to anhedonia symptoms in these studies (Nelis, Holmes, & Raes, 2015; Werner-Seidler et al., 2013) whereas findings regarding the SF appraisal style and anhedonia when covarying for non-anhedonic depressive symptomatology was mixed (study three; Werner-Seidler et al., 2013). Elevated levels of fear of positive emotion in relation to anhedonic symptoms of depression were also examined by Werner-Seidler et al. (2013), and a significant relationship was demonstrated between the appraisal style and anhedonia among community sample of adults.

Studies testing these associations in youth samples demonstrated that, at cross-sectional level, greater anhedonia was consistently associated with increased use of dampening appraisals in children (Gilbert et al., 2017) and adolescents (same cohort used in both, Bastin, Nelis, Raes, Vasey, & Bijttebier, 2018; Nelis et al., 2018). Use of amplifying appraisals, on the other hand, was shown to be associated with greater anhedonia among community adolescents (Nelis et al., 2018), but a significant association was not demonstrated in a mixed sample of pre-adolescent children with and without familial depression history in Gilbert et al. (2017). In the latter study, children's risk status based on parental depression did not interact with amplifying appraisals to predict anhedonia. Interestingly, only for the low-risk children, when there were more positive life events, increased dampening was associated with greater anhedonia, indicating low-risk children might not be profiting from these positive experiences due to increased engagement with dampening appraisals.

In adults, reduced levels of SF amplifying appraisal style, over and above baseline anhedonia symptoms, was the only predictor of greater anhedonia measured at a 5-month follow-up assessment (Nelis, Holmes, & Raes, 2015). In youth, a single study examined the prospective longitudinal associations between anhedonia (i.e. a composite measure of consummatory, anticipatory and motivational facets of anhedonia) and PA appraisals based

on self-report (Nelis et al., 2018). Participants were assessed annually over three years between the ages of approximately 13 to 15. Findings of dampening appraisals were equivocal across data collection waves that is increased use of the appraisal style at 13 years of age only predicted anhedonia measured at the age of 15. However, the use of dampening appraisals was not a predictor of anhedonia symptoms measured a year later, when the adolescents were 14-years old, interestingly, given the relative stability of anhedonia symptoms reported during adolescence (Conway et al., 2017). Nelis et al. (2018) reported that decreased use of amplifying appraisal style, on the contrary, was a constant predictor of greater anhedonia measured across both follow-up assessments. For future studies, it would be interesting to examine whether dampening and amplifying positive appraisal styles uniquely predict different facets of adolescent anhedonia.

Findings of these cross-sectional and longitudinal studies are based on self-reported trait measures of positive appraisal style. There is now also evidence indicating that induced positive appraisal style, state dampening and amplifying appraisals, is likely to alter PA levels as demonstrated in adult samples (Burr et al., 2017; Dunn et al., 2018). Engagement with dampening appraisals while recalling positive autobiographical memories and anticipation of positive future events both decreased PA and increased NA during otherwise PA inducing experiences (Dunn et al., 2018). Further, comparable findings were shown for individuals who use dampening appraisals during a pleasant outdoor activity (i.e. walking), extending the impact of dampening appraisals on PA to ecologically valid contexts (Burr et al., 2017). In both studies, each PA inducing tasks successfully increased PA levels, however, use of amplifying appraisals during these tasks did not enhance the PA levels compared to simply engaging with each task without any appraisal style induction (Burr et al., 2017; Dunn et al., 2018). These findings highlight the importance of a need for further work on this topic

in youth to test whether the positive appraisal styles would underlie anhedonic deficits in adolescents.

1.5 Summary

In summary, adolescence is an important developmental period which is characterised by increased rates of mental health disorders. Most of adulthood MDD cases experience the first onset of the disorder during these years of life. Depression in adolescence is recurrent and may have long-lasting outcomes that would cause burden to individuals, families and the economy. Although, adolescent depression is a debilitating problem, well-established psychotherapies targeting MDD show moderate effects. Also, current evidence indicates that it is not clear whether gold-standard psychological treatments delivered by highly-trained therapists are superior to usual care delivered by non-specialists in treatment of adolescent depression. One of the main arguments of the current work is that this inadequacy, despite the decades of empirical depression research, might be caused by the unmet need of treatment of anhedonia, which is an illness severity marker and related to blunted treatment response, in adolescents. However, before targeting anhedonia in psychotherapy, we need to improve our understanding of the underlying causes of the condition. We need to understand mechanisms of risk, as well as state markers of increased anhedonic severity for prevention and intervention purposes respectively. Existing evidence indicates that cognitive appraisals of PA may be one way forward to better understand why some individuals experience diminished PA, based on evidence broadly coming from those studies of adults. Underlying mechanisms of anhedonia in youth are still poorly understood.

The primary aim of the current research is to test if engagement with increased PA dampening and reduced amplifying appraisals underlie elevations in anhedonia symptoms in adolescents. To answer this question, the first empirical chapter of this PhD (Chapter Two) will demonstrate a systematic review of the current stage of evidence on the associations

between positive appraisal styles and PA/anhedonia, and meta-analyse the relevant available data from both youth and adult studies. By systematically identifying the gaps in the current literature, it would be possible to set up an evidence-driven framework for the following chapters of this PhD. The next chapter (Chapter Three) will present cross-sectional and prospective evidence on the associations between trait use of PA appraisal styles and anhedonia symptoms in adolescents from a survey study. The following chapter (Chapter Four) will demonstrate the direct causal evidence on the associations between induced positive appraisals and PA reactivity during a PA inducing memory recall laboratory task. This study will be followed by an experimental study conducted at ecologically valid settings to demonstrate if induced positive appraisal styles related to PA reactivity during pleasant music listening in adolescents (Chapter Five) which will comprise of the final empirical chapter of this PhD. If a consistent pattern of findings would be gathered from these studies, and the evidence suggests that PA appraisals styles play a role in PA deficits experienced by adolescents, therefore, treatments should be developed to correct for these deficits by challenging the maladaptive PA appraisal styles to promote enhanced affective functioning in youth and healthy transition into adulthood.

1.5.1 Outline of research questions

1. What is the strength of the evidence showing that cognitive positive appraisal styles alter levels of positive affect/anhedonia among clinical and non-clinical youth and adult samples? (Chapter Two)

2. Do trait use of PA appraisal styles of dampening, amplifying and fear of positive emotion uniquely correlate with and predict anhedonia symptoms in a community sample of adolescents? (Chapter Three)

3. Do induced dampening and amplifying appraisals alter PA during a positive memory recall laboratory task in a community sample of adolescents? (Chapter Four)

4. Do induced dampening and amplifying appraisals alter PA during a pleasant positive music listening activity in real-world settings among a community sample of adolescents? (Chapter Five)

Chapter 2.0: Study One

Target Journal: Clinical Psychology Review

Do dampening and amplifying cognitive appraisals influence positive affective experience? A systematic review and meta-analysis.

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2.1 Abstract

It is increasingly claimed that the way positive emotions are appraised may influence subsequent positive emotion experience across the life span. Down-regulating appraisals (e.g. think 'this is too good last') may reduce, while up-regulating appraisals (e.g. think 'this is the sign of good things to come') may enhance, positive affect (PA). The present systematic review and meta-analysis evaluated the current evidence as to whether positive appraisal styles do influence PA in this way. We identified 30 studies, which we classified on the basis of the sample studied (adult or youth) and the research methodology used (cross-sectional, prospective, experience sampling or experimental). In general, increased use of up-regulating appraisals was linked to increased PA in association designs but there was little evidence that manipulating the appraisal styles causally altered PA in experimental designs. In contrast, there was less robust association evidence that increased use of down-regulating appraisals was linked to reduced PA, but there was consistent evidence that manipulating use of dampening appraisals blunted PA in experimental designs. Relatively fewer studies had looked at youth rather than adult samples (particularly using experimental designs), indicating further work is needed. Implications for theoretical understanding and clinical management of positive emotion regulation are discussed.

Keywords (6 words): appraisal style, dampening, amplifying, positive affect, depression, anhedonia.

2.2 Introduction

Positive affect (PA) deficits are evident across various psychiatric disorders (Carl, Soskin, Kerns, & Barlow, 2013; Hechtman, Raila, Chiao, & Gruber, 2013), including depression (Carl et al., 2013; Dichter, 2010), bipolar disorder (Edge et al., 2013), anxiety (Eisner, Johnson, & Carver, 2009; Kashdan, 2007), eating disorders (Tchanturia et al., 2012) and schizophrenia (Gard et al., 2007; Horan, Kring, & Blanchard, 2006). Taking depression as the archetypal example, reductions in PA are characteristic of depression across the life span. For example, anhedonia symptoms in youth predict first onset of depression in adulthood (Pine et al., 1999) and are linked to clinically depressed presentations in adolescents (Gabbay et al., 2015) and adults (Pelizza & Ferrari, 2009). Patients describe improving PA as key to successful recovery from depression (Zimmerman et al., 2003). PA functioning relates to the effectiveness of interventions for depression. For example, early improvements in PA (over and above changes in negative affect; NA) predict symptom repair in clinically depressed populations (Geschwind et al., 2011) and greater intake deficits in PA predict a poorer response to treatment in depressed adolescents (McMakin et al., 2012; see also Husen, Rafaeli, Rubel, Bar-Kalifa, & Lutz, 2016; Spijker, Bijl, de Graaf, & Nolen, 2001).

The case has been made that existing depression research and treatments have primarily focused on reducing NA and largely neglected repairing PA (Dunn, 2012). Treatment outcomes may be enhanced if better understanding is gained of the underlying mechanisms driving PA disturbances, so that these mechanisms can then be systematically targeted in therapy (Dunn & Roberts, 2016; Dunn, in press). One candidate mechanism that may underpin PA disturbances is changes in the way young people and adults appraise positive emotion experience. It has been proposed that individuals may engage with appraisals that amplify positive emotion experience (e.g., think ‘I am living up to my

potential' [self-focus] or 'notice how full of energy I feel' [emotion-focus]). Alternatively, individuals may think in a way that dampens positive emotion experience (e.g., think 'I don't deserve this') (Feldman et al., 2008). A variety of studies have found that dampening and amplifying appraisals are implicated in major depression (Nelis, Holmes, & Raes, 2015; Werner-Seidler, Banks, Dunn, & Moulds, 2013). Similarly, it has been argued that depressed individuals who engage in 'fault finding' in response to positive experiences (Nelis, Quoidbach, Hansenne, & Mikolajczak, 2011), may have a fear of losing control when experiencing positive emotions (Werner-Seidler et al., 2013), and are less likely to savour positive occurrences (Bryant, 2003).

While a clear link has been established between these appraisal styles aiming to reduce or elevate positive feelings and depression, it is less certain whether the positive appraisal styles underpin blunted PA observed in depression. This systematic review aims to evaluate evidence examining whether dampening and amplifying appraisals influence PA experience (and therefore represent a strong candidate mechanism to target in depression therapy). To establish a mechanism as a strong candidate to target in depression treatment, it has recently been proposed that a variety of different kinds of evidence need to be gathered (Dunn, 2017). The mechanism needs to be: cross-sectionally linked to PA deficits (in survey and experience sampling designs); to prospectively predict PA deficits; when the mechanism is manipulated in the laboratory and in real world settings this should alter PA levels; and changes in the mechanism should mediate improvements in PA during treatment. Ideally these effects will be shown in both clinical and non-clinical populations. We will use this framework to evaluate how convincing the evidence is that positive appraisal style in part underpins PA experience in adults and also in young people.

2.3 Methods

2.3.1 Registration

This review followed PRISMA guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009) and was pre-registered on PROSPERO (CRD42018080229).

2.3.2 Eligibility criteria

We included any studies published in English in peer reviewed journals that used human participants and reported original empirical data that we could extract. Studies needed to include both a validated measure of PA/anhedonia and a validated measure of positive appraisal style. We relaxed these criteria for experience-sampling and experimental studies, additionally allowing face-valid (even if not formally validated) measures of PA/anhedonia and positive appraisal style. The focus of the survey studies needed to be on the cross-sectional or prospective association of positive appraisal style with PA/anhedonia. The focus of the experimental studies needed to be on the consequences of manipulating positive appraisal style on PA/anhedonia.

2.3.3 Information sources and search

We searched for terms linked to PA/anhedonia (including positive emotion, positive mood, pleasure, happiness, and anhedonia) and to appraisal style (including appraisal, rumination, dampening, and savouring). In both cases, we used Boolean logic and database specific commands such as wildcards (see Appendix 2.A for an example of the search strategy). We then selected studies that included at least one term linked to PA/anhedonia and at least one term linked to appraisal style. We searched the Cochrane library, MEDLINE/PubMed, EMBASE, PsycINFO, Scopus and Web of Knowledge database. Additionally, a scoping search was used to select well-established measures of positive appraisal style, identifying the Responses to Positive Affect Scale (RPA; Feldman et al., 2008), the PA scale of the Affective Control Scale (ACS; Williams, Chambless, & Ahrens,

1997), the Fear of Happiness Scale (Gilbert et al., 2012), and the Emotion Acceptance Questionnaire (Beblo et al., 2012). We then conducted both forward and backward citation searches in Google Scholar of the key development papers for each of these scales. Finally, we hand searched bibliographies of eligible articles. We implemented the searches on the databases between 27/09/2017 and 29/09/2017.

2.3.4 Study selection

We initially identified 9988 abstracts in the search (see Figure 2.1 for the PRISMA flow diagram; Moher et al., 2009). All records identified were imported to EndNote reference manager and duplicate studies were then removed (leaving 4349 studies). Two reviewers (MY and LP) independently screened all titles and abstracts to identify a pool of 176 relevant studies. A full paper review was then run on this pool of studies (using the pre-specified inclusion and exclusion criteria), classifying them as definitely to be included, definitely to be excluded and undecided. Discrepancies among reviewers at this stage were resolved by a third reviewer (BD). Thirty four studies in 28 articles were eligible for inclusion from this pool, and a further two recent relevant publications were also identified (published after the initial screening; Dunn et al., 2018; Nelis, Bastin, Raes, & Bijttebier, 2018) resulting in 30 articles in total being included in the review. Inter-rater agreement for study inclusion was satisfactory (*Kappa* = 0.84). Any discrepancies were resolved by discussion with a third reviewer (BD).

2.3.5 Data extraction

A data extraction form was developed, piloted on a handful of studies using different designs, and then refined. This data extraction form captured: study aims, country of origin, study design, participant demographic (and if relevant clinical) characteristics, study inclusion and exclusion criteria, recruitment sources, what measures of appraisal style and PA/anhedonia were taken, and also extracted relevant empirical data and effect sizes. Data

extraction was completed by MY, with a random subsample of studies (16%, $n = 5$) being checked by LP for accuracy.

2.3.6 Quality ratings

The quality of cross-sectional, prospective and experience sampling studies was assessed using the modified Newcastle-Ottawa scale (NOS; Modesti et al., 2016). Studies were given a quality rating using a star system (with a maximum of ten stars for high quality studies)[1]. Case-control study quality was assessed using the original Newcastle Ottawa scale (Wells et al., 2011) with a maximum rating of nine stars for high quality studies. The quality of experimental studies and clinical trials was assessed using the Cochrane Risk of Bias Tool (Higgins et al., 2011), which evaluates bias from selection, performance, detection, attrition, reporting and other sources as low, high or uncertain. Quality assessments were carried out by two reviewers (MY and LP) independently, with any discrepancies resolved through discussion with the third reviewer (BD). Inter-rater reliability for study quality assessments was good (intraclass correlations for each ESM, cross-sectional and prospective study types > 0.80; exact agreement on the single case study included; *Kappa* = 0.75 for the experimental studies and trials). No study was excluded based on the results of the quality assessments. Results are summarised in Table 2.2

2.3.7 Evidence synthesis strategy

We classified whether studies were run on: young people (mean sample was less than eighteen years) or adults (mean sample age was greater than eighteen years); clinical populations (selecting participants on basis of elevated symptoms or diagnosis of mental health problems) or non-clinical populations; and what methodology they used (cross-sectional survey, prospective survey, experience sampling, experimental, or randomised controlled trial). We narratively synthesised the study findings for each of these classifications (see Table 2.2).

There was a sufficient number of cross-sectional survey studies to carry out meta-analyses. Sample size and Pearson's r were extracted for each study, with the r values being converted into standardised z scores. We ran separate meta-analyses as a function of appraisal style measure (dampening, amplifying, fear of positive emotion and savouring beliefs) and sample (child and adolescent versus adult), using the metan command in Stata 15 (StataCorp, 2017) to conduct fixed- and random-effect analyses and to generate forest plots of each individual study and pooled effects. Heterogeneity across studies was indexed by Chi^2 and $I^2(100*[X^2 – df / X^2])$ test statistic. An I^2 value of 0% represent no heterogeneity, 25% – 50% low heterogeneity, 50% – 75% moderate heterogeneity, and 75% – 100% high heterogeneity.

2.4 Results

2.4.1 Qualitative synthesis

A variety of measures of appraisal style and PA/anhedonia were found (see Table 2.1 for the full list of the scales). The most commonly used appraisal style measure was the Responses to Positive Affect Scale for adults (RPA; Feldman et al., 2008) and a corresponding child version (Bijttebier et al., 2012). The RPA consists of SF amplifying and EF amplifying subscales (which has been recommended should be collapsed into a single overarching amplifying subscale in youth; e.g., Nelis et al., 2016) and a dampening subscale. The fear of positive emotion subscale of the Affective Control Scale (ACS; Williams, Chambless, & Ahrens, 1997) was also widely used. The Positive and Negative Affect Scale PA subscale (PANAS; Watson, Clark, & Tellegen, 1988) was the most common measure of affect identified, although studies varied as to whether they used a state, past week or trait form (with some studies not stating which version they used). The Mood and Anxiety Symptom Questionnaire anhedonia subscale in adults (MASQ-AD; Clark & Watson, 1991), and the Child Depression Inventory anhedonia subscale (CDI-D; Kovacs, 1985) as well as

the Leuven Anhedonia Self-report Scale in youth (LASS; as described in Bastin, Nelis, Raes, Vasey, & Bijttebier, 2018) were used to measure anhedonic symptoms of depression.

2.4.1.1 PA reducing strategies.

2.4.1.1.1 Cross-sectional studies.

We identified 14 studies in adults and seven studies in child and adolescent samples that looked at cross-sectional associations between PA reducing appraisals and PA experience (See Figures 2.2 and 2.3 for forest plots of effect sizes broken down by age groups for variants of PA reducing appraisal styles). Among these studies, eight used the trait RPA (Gilbert, Nolen-Hoeksema, & Gruber, 2013; Nelis, Holmes, Palmieri, Bellelli, & Raes, 2015; Nelis, Holmes, & Raes, 2015; Olofsson, Boersma, Engh, & Wurm, 2014; Olofsson, Wurm, & Boersma, 2016; Raes, Daems, Feldman, Johnson, & Van Gucht, 2009; Werner-Seidler et al., 2013), one used the state RPA (Burr et al., 2017), one used both state and trait RPA dampening subscales (Dunn et al., 2018), one used the ERP-R (Quoidbach, Berry, Hansenne, & Mikolajczak, 2010), three used the ACS (Arif, 2017; Melka, Lancaster, Bryant, Rodriguez, & Weston, 2011; Werner-Seidler et al., 2013), one used the Fear of Happiness (FOH; Joshanloo, 2018), and one used Gilbert's Fear of Happiness Scale (Gilbert et al., 2012) to measure appraisal style. Anhedonic deficits were indexed by the MASQ-AD in four studies (Burr et al., 2017; Dunn et al., 2018; Nelis, Holmes, & Raes, 2015; Werner-Seidler et al., 2013), PANAS PA in eight studies (Arif, 2017; Gilbert et al., 2013; Joshanloo, 2018; Melka et al., 2011; Olofsson et al., 2014, 2016; Quoidbach et al., 2010; Raes et al., 2009), the Types of PA scale in one study (Gilbert et al., 2012) and one study used bespoke PA ratings (Nelis et al., 2015).

Of the nine studies using variants of the RPA, four found a positive association between elevated levels of dampening and decreased PA/increased anhedonia (Dunn et al., 2018; Nelis, Holmes, & Raes, 2015; Raes et al., 2009; Werner-Seidler et al., 2013), including

two studies with clinically depressed participants (Nelis, Holmes, & Raes, 2015; study three in Werner-Seidler et al., 2013). The remaining five studies found no significant relationship between the variants of state and trait dampening appraisal styles and PA/anhedonia (Burr et al., 2017; Gilbert et al., 2013; Nelis, Holmes, Palmieri, et al., 2015; Olofsson et al., 2014, 2016). In a clinical sample, levels of trait dampening were not related to PA reactivity to a positive mood induction (i.e. imagining a desired future goal) in individuals with remitted MDD or bipolar disorder (Gilbert et al., 2013).

A mixed pattern of results emerged among the five studies that used variants of fear of positive emotion measures. A significant correlation between elevated fear of positive emotion and decreased PA/increased anhedonia was reported in three of them (Gilbert et al., 2012; Joshanloo, 2018; study one in Werner-Seidler et al., 2013); a significant correlation in the opposite direction was found in a clinically depressed sample (Arif, 2017); and a non-significant association was reported in another sample (Melka et al., 2011). Finally, a single study found that elevated levels of fault finding appraisals appraisal style were associated with reduced PA and happiness during pleasant experience (Quoidbach et al., 2010).

All of the seven studies identified in youth samples measured appraisal style using the RPA, either the child version (Bastin, Nelis, Raes, Vasey, & Bijttebier, 2018; Nelis et al., 2018; Nelis, Bastin, Raes, Mezulis, & Bijttebier, 2016; Verstraeten, Vasey, Raes, & Bijttebier, 2012) or the original adult scale (Burke, Anne McArthur, Daryanani, Abramson, & Alloy, 2018; Gilbert, Luking, Pagliaccio, Luby, & Barch, 2017; Hamilton et al., 2017). Anhedonic deficits in these studies were indexed by the LASS (Bastin et al., 2018; Nelis et al., 2018), CDI-D (Gilbert et al., 2017), or PANAS PA (Bastin et al., 2018; Burke et al., 2018; Hamilton et al., 2017; Nelis, Bastin, et al., 2016; Verstraeten et al., 2012).

Among these studies, four reported a positive association between elevated levels of dampening and decreased PA/increased anhedonia (Bastin et al., 2018; Burke et al., 2018;

Gilbert et al., 2017; Nelis et al., 2018). In one of these studies, this association was shown to be restricted only to individuals with a low familial risk of depression with a high number of positive life events (Gilbert et al., 2017). Further, two of these studies with adolescent participants (Bastin et al., 2018; Nelis et al., 2018) from the same cohort revealed this pattern of findings consistently across different data collection waves when participants were approximately 13, 14 and 15 years old. The two remaining studies found no significant association between dampening and PA levels (Hamilton et al., 2017; Nelis, Bastin, et al., 2016) in adolescent samples. One study reported a significant association in the opposite direction, with increased trait levels of dampening appraisals being linked to greater PA in children (Verstraeten et al., 2012).

A single study also investigated dampening appraisal style at the intra-personal level in adolescents (i.e. co-dampening), finding that elevated co-dampening with peers was also associated with increased anhedonia (Bastin et al., 2018).

2.4.1.1.2 Prospective studies.

Four prospective studies were identified, all of which examined how dampening appraisals predicted follow-up anhedonia/PA (while covarying for intake anhedonia/PA). One study found that dampening appraisals did not predict anhedonia at a 5-month follow-up assessment in adults (Nelis, Holmes, & Raes, 2015). Similarly, two studies in youth samples found that baseline dampening appraisals did not significantly predict increase in anhedonia/PA at an approximately one-year follow-up (Nelis et al., 2018; Nelis, Bastin et al., 2016). Interestingly, in one of these studies increased levels of dampening appraisals did go on to predict elevated anhedonia at a two-year follow up (Nelis et al., 2018). Moreover, levels of co-dampening did not predict anhedonia at a one-year follow-up (Bastin et al., 2018

2.4.1.1.3 EMA studies.

We identified two EMA studies investigating links between PA reducing appraisals and PA/anhedonia. In the study by Li, Starr, and Hershenberg (2017), daily use of dampening appraisal styles were recorded once a day for 14 days. Greater Daily PA was not significantly associated with mean daily use of dampening but was associated with lower trait levels of dampening. Daily levels of dampening moderated the link between increased positive daily uplifts (positive events) and increased PA. This relationship was more marked in instances where levels of dampening were low. In another study, PA levels were measured four times a day over a week (Hughes, Gunthert, Wenze, & German, 2015), and the scores on the ACS were not significantly associated with mean daily levels of PA.

2.4.1.1.4 Experimental studies.

We identified two studies that experimentally manipulated dampening appraisal style in adults (Burr et al., 2017; Dunn et al., 2018). Instructions to engage in dampening appraisals lowered PA reactivity (and increased NA reactivity) when anticipating and recalling positive events (Dunn et al., 2018) and when engaging in a pleasant walk (Burr et al., 2017). In both studies, the positive mood inductions became aversive following dampening instructions (in absolute terms lowering levels of PA and increasing levels of NA from pre to post). Baseline levels of anhedonia did not moderate these effects in either study.

2.4.1.2 PA elevating strategies.

2.4.1.2.1 Cross-sectional studies.

There were 21 studies examining the cross-sectional association between amplifying positive appraisals and PA/anhedonia experience, 14 in adults and 7 in children (Figures 2.4 to 2.7 present Forest plots of effect sizes broken down by each age group for variants of PA elevating appraisal styles). Among adult studies, similar to findings reported for cross-sectional associations of dampening appraisals, 10 used the variants of RPA amplifying

scales (e.g. state, trait, both state and trait). Eight measured amplifying appraisals separately as SF and EF amplifying (Burr et al., 2017; Gilbert et al., 2013; Kiken & Shook, 2014; Nelis, Holmes, & Raes, 2015; Olofsson et al., 2014, 2016; Raes et al., 2009; Werner-Seidler et al., 2013), two measured amplifying as a single construct by collapsing the two subscales of the RPA (Dunn et al., 2018; Harding & Mezulis, 2017), and four used the SBI (study four in Bryant, 2003; Carl, Fairholme, Gallagher, Thompson-Hollands, & Barlow, 2014; Ng & Diener, 2009; Smith & Hollinger-Smith, 2015).

In adult samples, of the ten studies using the RPA, eight reported that reduced use of EF, SF appraisals, or global amplifying appraisals was significantly linked to decreased PA/increased anhedonia (Burr et al., 2017; Dunn et al., 2018; Harding & Mezulis, 2017; Kiken & Shook, 2014; Olofsson et al., 2014; Raes et al., 2009; Werner-Seidler et al., 2013), including two studies with clinically depressed participants (Nelis, Holmes, & Raes, 2015; study three in Werner-Seidler et al., 2013). Levels of trait SF and EF amplifying were not significantly related to PA reactivity to positive mood induction in one study (Olofsson et al., 2014). In a remitted clinical sample, PA reactivity to thinking about a future goal in the MDD or bipolar disorder groups was consistently related to trait levels of EF amplifying appraisals across both clinical groups, but was only linked to SF appraisals in the MDD group (Gilbert et al., 2013).

Four studies examined links between savouring beliefs and anhedonia. Reduced savouring beliefs were linked to decreased PA/increased anhedonia (study four in Bryant, 2003; Carl et al., 2014), decreased PA reactivity to a positive mood induction (study two in Ng & Diener, 2009), and decreased happiness in older adults (Smith & Hollinger-Smith, 2015).

Six studies in youth populations found that reduced levels of amplifying appraisal styles either measured as SF and EF or collapsed global amplifying, were consistently

associated with decreased PA/increased anhedonia in child (Verstraeten et al., 2012) and adolescent samples (Bastin et al., 2018; Burke et al., 2018; Hamilton et al., 2017; Nelis et al., 2018; Nelis, Bastin, et al., 2016). Further, Bastin et al. (2018) found that engaging with amplifying appraisals with a peer (i.e. 'co-enhancing') was negatively linked to anhedonia symptoms in adolescents. Only one study failed to find a significant association between amplifying appraisals and anhedonia in a study with healthy children with and without familial history of depression (Gilbert et al., 2017).

2.4.1.2.2 Prospective studies.

We identified four prospective studies examining amplifying, all of which covaried for intake levels of PA/anhedonia. In adults, a single study showed that reduced levels of RPA measured SF amplifying (but not the EF amplifying) at baseline predicted elevated anhedonia levels at a 5-month follow-up assessment (Nelis, Holmes, & Raes, 2015). Similarly, decreased amplifying appraisals at baseline consistently predicted decreased PA/increased anhedonia at one-year and two-year follow-up assessments in youth samples (Nelis et al., 2018; sample one and two in Nelis, Bastin, et al., 2016). In contrast, baseline co-amplifying did not predict anhedonia levels at a one year follow-up (Bastin et al., 2018).

2.4.1.2.3 EMA studies.

We identified two EMA studies examining amplifying, both in adult samples. PA experience was positively associated with amplifying appraisals that were recorded using daily diaries as well as RPA measured trait amplifying appraisals in Li et al. (2017). Daily uplifts moderated the association between PA and amplifying appraisals: when there were fewer daily uplifts, the association between daily PA and amplifying appraisals was stronger. Carl et al. (2014) measured trait savouring beliefs using SBI (Bryant, 2003) and found this was associated with greater daily PA reactivity.

2.4.1.2.4 Experimental studies.

Three experimental studies with adult samples were identified that manipulated amplifying appraisal styles, either distinct SF and EF manipulations (Burr et al., 2017) or as a global amplifying appraisal induction (Diener , Colvin, Pavot, & Allman, 1991; Dunn et al., 2018). These found mixed results. Instructed amplifying did not increase PA reactivity, relative to a no instruction control condition, when anticipating or recalling positive events (Dunn et al., 2018) or when completing a pleasant walk (Burr et al., 2017). In contrast, study one and two in Diener et al. (1991) found that positive reactivity when viewing positive slides was greater when following amplifying instructions.

2.4.2 Quantitative synthesis

2.4.2.1 Meta-analyses.

There were a sufficient number of cross-sectional studies to allow us to run a meta-analysis of the overall association between appraisal style and PA/anhedonia. We present a series of meta-analyses, broken down by which appraisal style measure was used.

2.4.2.1.1 PA reducing strategies.

16 studies from 14 articles that identified reported links between dampening appraisals and PA were included in the meta-analysis (Bastin et al., 2018; Burke et al., 2018; Burr et al., 2017; Dunn et al., 2018; Gilbert et al., 2017; Hamilton et al., 2017; Li et al., 2017; Nelis et al., 2018; Nelis, Bastin, et al., 2016; Nelis, Holmes, & Raes, 2015; Olofsson et al., 2014; Raes et al., 2009; Verstraeten et al., 2012; Werner-Seidler et al., 2013). There was a total participant pool of 5763 (*range across studies*= 43 to 1552).

The association between greater dampening and reduced anhedonia/enhanced PA was significant and negative as indicated by an effect estimate of -0.14, 95% [-0.17, -0.11] for fixed-effects and -0.16, 95% CI [-0.24, -0.08] for random-effects models, with high heterogeneity, Q (15) = 121.17, $p < 0.001$, $I^2 = 87.60\%$. Sub-group analysis for age

categories, revealed a significant and negative association between dampening appraisal style and reduced anhedonia/enhanced PA in adult samples, -0.24, 95% CI [-0.30, -0.18] for fixed-effects and -0.22, 95% CI [-0.31, -0.12] for random-effects models. The heterogeneity among adult studies was moderate, Q (7) = 14.22, p = 0.03, I^2 = 57.8%. For youth studies, both the fixed-effects model, -0.12, 95% CI [-0.14, -0.09], and the random-effects models, -0.12, 95% CI [-0.23, -0.01], were significant in the same direction. The heterogeneity was high among youth studies, Q (8) = 93.08, p < 0.001, I^2 = 91.4%.

We included 6 studies in the meta-analysis focusing on fear of positive emotion and PA experience (Arif, 2017; Gilbert et al., 2012; Hughes et al., 2015; Joshanloo, 2018; Melka et al., 2011; Werner-Seidler et al., 2013). The total participant pool of these studies was 1361 (*range across studies* = 100 to 528). The positive association between fear of positive emotion and enhanced PA/reduced anhedonia was significant when a fixed-effect model was run, -0.15, 95% CI [-0.21, -0.10]. However, the random effects model indicated a null pooled estimate, -0.12, 95% CI [-0.32, 0.08]. There were high levels of heterogeneity among these studies, potentially indicating the presence of moderators, Q (5) = 61.50, p < 0.001, I^2 = 91.90%.

2.4.2.1.2 PA elevating strategies.

10 studies from 8 articles that reported links between overall amplifying appraisals and PA were included in the meta-analysis (Bastin et al., 2018; Dunn et al., 2018; Gilbert et al., 2017; Harding & Mezulis, 2017; Kiken & Shook, 2014; Li et al., 2017; Nelis et al., 2018; Nelis, Bastin, et al., 2016). There was a total participant pool of 4373 (*range across studies* = 81 to 1552).

The meta-analysis revealed a significant positive association between levels of amplifying and enhanced PA/reduced anhedonia, fixed effects model 0.48, 95% CI [0.45, 0.51], random effects model 0.39, 95% CI [0.27, 0.51]. Heterogeneity again was high, Q (9)

= 124.59, $p < 0.001$, $I^2 = 92.80\%$. A sub-group analysis looking at adults and youth samples separately found identical results. PA amplifying was significantly and positively associated with enhanced PA/reduced anhedonia in adults revealed by fixed-effects models, 0.36, 95% CI [0.30, 0.43], and random-effects models, 0.39, 95% CI [0.25, 0.52]. The heterogeneity among adult studies was moderate, Q (3) = 11.62., $p < 0.01$, $I^2 = 74.2\%$. Significant effects in the same direction were found in younger samples indicated by fixed-effects models, 0.51, 95% CI [0.48, 0.54], and random-effects models, 0.39, 95% CI [0.23, 0.55]. The heterogeneity observed among youth studies was again high, suggesting presence of moderators, Q (5) = 98.20, $p < 0.001$, $I^2 = 94.9\%$.

When we examined studies that investigated amplifying appraisals broken down into self-focused and emotion-focused categories (Burke et al., 2018; Burr et al., 2017; Hamilton et al., 2017; Nelis, Holmes, & Raes, 2015; Olofsson et al., 2014; Raes et al., 2009; Verstraeten et al., 2012; Werner-Seidler et al., 2013), parallel significant findings emerged. We found 8 studies focusing on SF and EF appraisals with a total sample of 1870, individual sample sizes ranging from 43 to 590.

The meta-analyses indicated a significant and positive relationship between SF amplifying and enhanced PA/reduced anhedonia, 0.37, 95% CI [0.33, 0.42] by fixed-effects, and 0.31, 95% CI [0.18, 0.44] random-effects models. Again, there was high heterogeneity among studies, indicating possible moderators, Q (7) = 48.61, $p < 0.001$, $I^2 = 85.6\%$. SF amplifying was significantly positively correlated with enhanced PA/reduced anhedonia in adults indicated by fixed-effects, 0.30, 95% CI [0.23, 0.37], but was not significantly associated in random-effects models, 0.23, 95% CI [-0.00, 0.47]. Heterogeneity among studies was high, Q (4) = 38.10, $p < 0.001$, $I^2 = 89.50\%$. In youth, SF amplifying, and enhanced PA/reduced anhedonia was also significantly associated, fixed-effects, 0.43, 95%

CI [0.37, 0.49], and random-effects models, 0.42, 95% CI [0.35, 0.50]. No significant heterogeneity detected among youth samples, Q (2) = 2.77, p = 0.25, I^2 = 27.90%.

EF amplifying was also linked to enhanced PA/reduced anhedonia, both fixed-effects, 0.36, 95% CI [0.32, 0.41], and random-effects models, 0.36, 95% CI [0.29, 0.43], which indicates a significant and positive association. There was no significant heterogeneity in this sample, Q (7) = 13.90, p = 0.05, I^2 = 49.6%. In adults, results were parallel, fixed-effects, 0.41, 95% CI [0.34, 0.49], and random-effects models, 0.39, 95% CI [0.28, 0.51] indicated a positive significant relationship with no significant heterogeneity Q (4) = 8.65, p = 0.07, I^2 = 53.80%. Both fixed-effects, 0.32, 95% CI [0.26, 0.38], and random-effects models, 0.32, 95% CI [0.26, 0.38] revealed a positive significant relationship among EF amplifying and enhanced PA/reduced anhedonia in youth, and there was no heterogeneity among studies, Q (2) = 1.54, p = 0.46, I^2 = 0%.

We found three studies with a sample of 414 (*range across studies* = 86 to 164) focusing on savouring beliefs (Bryant, 2003; Carl et al., 2014; Smith & Hollinger-Smith, 2015). When we examined the savouring beliefs in relation to reduced anhedonia/enhanced PA, results indicated significant and positive fixed-effects, 0.68, 95% CI [0.58, 0.77], and random-effects, 0.67, 95% CI [0.41, 0.93]. The heterogeneity among the studies was at the high range, Q (3) = 13.23, p < 0.01, I^2 = 84.90%.

2.4.3 Quality assessment

Overall, results from the quality assessment indicated that the majority of the studies did not exhibit any significant risk that is likely to affect the findings presented (See table 2.2 for summary of the quality assessment findings). When we used variants of the NOS tool to evaluate cross-sectional, prospective, experience sampling and case-control studies (total of 26 studies from 23 articles), the majority of studies used a representative sample, validated tools to measure appraisal style and implemented appropriate statistical tests. Again, most of

them considered more than one confounder variable in their analyses. However, studies seldomly justified their sample sizes, failed to provide a response rate and descriptive characteristics of non-responders. They were also almost exclusively based on self-reports of PA experience. A domain-based evaluation of the studies with experimental designs, including the pre- and post- laboratory tasks, (total of 10 studies from 7 articles) again did not show any significant sources of risk of bias for the majority. Where the domain criteria were applicable, random sequence generation, allocation concealment, blinding of participants, personnel and outcome assessment, and selective outcome reporting did not constitute prominent bias. However, the majority of the studies failed to report information on the attrition and exclusion of participants, so it was not possible to come to a clear conclusion regarding the evaluation of attrition bias for the studies evaluated on the Cochrane Risk of Bias tool.

2.5 Discussion

The findings of the current review present a qualitative and quantitative synthesis of evidence evaluating whether up- and down- regulating appraisals influence PA/ anhedonia. We classified studies based on the methodology used (cross-sectional, prospective, experience sampling, experimental; cf. Dunn, 2017) and whether they focused on child and adult samples. Below we review evidence that down-regulating appraisals reduce, and up-regulating appraisals enhance, PA in turn.

We merged together the various different ways of conceptualising PA reducing appraisals (e.g. dampening appraisal style, fear of positive emotion and fault-finding). When the samples were pooled together in meta-analyses, fixed- and random-effects models showed a significant relationship between increased use of PA reducing appraisals and lowered PA/increased anhedonia in both adult and youth samples. In addition, we also conducted a narrative review of a broader set of findings that were not sufficiently similar to

combine in a meta-analysis (a quantitative and qualitative synthesis). In contrast with the meta-analytic findings, a mixed picture of cross-sectional findings emerged from the qualitative synthesis. Only one third of studies showed a significant association between elevated dampening and reduced PA. However, in many studies that failed to show a significant association, the relationship was in the same direction and was typically of a small to medium effect size. These cross-sectional studies cannot establish causality, or the direction of the relationship observed and did not control for relevant potential confounding variables, meaning they should be classified as weak evidence. When we synthesised the prospective evidence, there was no consistent evidence that dampening predicts subsequent change in PA across studies of adults and youth. These null prospective findings were also broadly mirrored in experience sampling studies, with use of dampening appraisals being not consistently related to daily PA levels. Only one third of studies showed a significant association between elevated dampening and reduced PA. However, in many studies that failed to show a significant association, the relationship was in the same direction and was typically of a small to medium effect. These cross-sectional studies cannot establish causality, or the direction of the relationship observed and did not control for relevant potential confounding variables, meaning they should be classified as weak evidence. When we synthesised the prospective evidence, there was no consistent evidence that dampening predicts subsequent change in PA across studies of adults and youth. These null prospective findings were also broadly mirrored in experience sampling studies, with use of dampening appraisals being not consistently related to daily PA levels.

The cross-sectional and prospective findings reported here diverged in the type of PA they measured (e.g. state PA, trait PA, unclear form of PA) which might have contributed to the mixed findings reported across studies. Prospective studies we identified also varied in follow-up intervals from three-months to two-years that may also resulted in null findings.

Current theorising is unclear of the time scale over which appraisal style would influence PA levels. As a result, it may be the case that positive prospective associations have been missed by choosing a non-optimal follow-up window. It may also be the case there is a developmentally sensitive window for appraisal styles to exert their influence on affective experience in youth samples. Had significant prospective effects been found these would have been able to establish the direction of the relationship observed, but not establish causality. Moreover, most of the studies failed to control for relevant confounding variables, again making this is a relatively weak source of evidence.

The strongest test of the hypothesis that dampening appraisals reduce PA can be provided by randomised experimental designs that manipulate appraisals. These can evaluate a potential causal relationship. In a series of laboratory studies, manipulating dampening did lower PA when adults anticipated and recalled positive events.

This direct causal evidence obtained in laboratory experiments was also extended to the ecologically valid settings as it has been shown that the increased use of dampening appraisal styles also led to reduced PA in adults during everyday pleasant activities. These randomised experimental designs have only been conducted in adults and it remains unclear whether similar effects will emerge in youth samples.

A series of meta-analyses also examined the effects of varying PA elevating appraisal style (SF amplifying, EF amplifying, and savouring). Whether considered separately or pooled together, there was a clear and significant association between reduced use of these enhancing appraisal styles and reduced PA/increased anhedonia in both fixed- and random-effects analyses. The findings from the systematic review also mirrored these quantitative results as a similar pattern of relationships between appraisal style and PA/anhedonia emerged across different study designs. The vast majority of research we covered here demonstrated that reduced use of PA elevating appraisal styles (e.g. SF amplifying, EF

amplifying, savouring) were cross-sectional associated with reduced PA/increased anhedonia in adults and youth. Moreover, in some studies decreased use of amplifying appraisals predicted lower PA/increased anhedonia in adult and youth samples at follow up in prospective survey studies. A similar pattern emerged in experience sampling findings, with reduced use of PA elevating appraisals being linked to lower PA/greater anhedonia. As with the studies evaluating down-regulating appraisals, these studies cannot establish causal evidence and generally failed to control for relevant confounders, so are only a relatively weak source of evidence. Again, it is unclear what is the optimal time window to measure prospective links between appraisal style and PA. In contrast to these cross-sectional and prospective findings, in the experimental domain, manipulation studies in adults found no evidence that instructed amplifying significantly elevated PA reactivity (relative to control conditions). These null findings emerged both when using laboratory designs and more ecologically valid event scheduling designs. One explanation might be that the RPA amplifying measures may not be suitable for measuring or manipulating an adaptive PA upregulating appraisal style (Dunn et al., 2018). The items were originally designed to capture pathological overly positive appraisals in bipolar disorders (Johnson, McKenzie, & McMurrich, 2008) and less extreme positive appraisals may be more beneficial for PA experience. One study did find a positive relationship (Diener et al., 1991), but this did not actually evaluate whether the amplifying manipulation actually increased amplifying appraisals.

The findings showed that observed effects of the appraisals styles on PA functioning may be also moderated by context and individual factors such as familial depression risk status or occurrence of positive life events. However, a systematic evaluation of these factors was not possible given that not all studies collected this information or conducted relevant analyses. Exploration of moderation factors would be particularly important for identifying

who is at greater risk and who is more likely to benefit from interventions that would be developed to target PA deficits (Kazdin, 2000).

There is now also expansion of this literature into the interpersonal domain, examining if 'co-dampening' and 'co-enhancing' are related to PA/anhedonia (Bastin et al., 2018). In adolescents, elevated anhedonia was associated with increased dampening and decreased amplifying with peers, but the use of appraisals at baseline did not uniquely predict anhedonia levels measured after a-year.

A majority of the studies were conducted in non-clinical populations and very few looked at individuals with diagnosed clinical conditions, making it premature to examine whether the relationship between appraisal style and PA varies as a function of clinical status. In the rumination literature, rumination inductions have been shown to have more adverse effects on depressed individuals (relative to control samples) (Donaldson & Lam, 2004) and this possibility is worthy of further examination with regards to positive appraisal style.

One of the aims of the current review was to demonstrate age-based comparison on use of the appraisal styles in relation to PA/anhedonia levels. Overall, findings were comparable across adult and youth studies when data were available such as in the example of cross-sectional studies. However, our review also revealed some avenues for research especially with child and adolescent samples. The cross-sectional and survey studies in youth have almost exclusively relied on the RPA. It would be important to examine if similar effects emerge for other measures of positive appraisal style (e.g. fear of positive emotion, savouring beliefs), ideally including these alongside the RPA in the same study to see how distinct these are while measuring and controlling for relevant confounder variables. Moreover, survey studies of this kind are based on retrospective self-report data that are prone to recall bias. Experience sampling studies that index the momentary use of the appraisal styles and PA can minimise this methodological drawback (Scollon, Kim-Prieto, &

Scollon, 2003), but so far this methodology has not been used with youth samples. The strongest evidence is gathered from experimental studies that manipulate appraisal style, both in laboratory controlled and more naturalistic settings. To date, while three studies have been conducted in adult populations, no such studies have been run in youth samples. The mediation analyses of whether change in appraisal style during treatment accounts for improvements in PA across adult and youth samples will be the final step that needs to be implemented to inform development of effective interventions. These gaps should be filled in subsequent research to more robustly evaluate if appraisals influence positive emotion experience.

The current study is the first systematic review on the association between the cognitive positive appraisal styles and PA functioning across multiple levels of evidence (i.e. cross-sectional, prospective, ESM, and experimental). We used both a qualitative synthesis approach and expanded these findings by meta-analysing the available relevant data. Thus, the current work contributes to the ER models of depressive symptoms (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Gotlib & Joormann, 2010) by emphasising the importance of dysregulated PA that has been historically neglected in depression research (Dunn & Roberts, 2016).

There are also some limitations that should be noted. In the current study, we excluded grey literature therefore unpublished studies with null findings (i.e. missing studies). Further, we did not request additional effect sizes where studies measured the constructs that were the focus of this review but did not report the relevant statistics (i.e. missing effect sizes). The meta-analyses findings suggested increased heterogeneous distribution of effect sizes that were caused by potential moderators that limit the generalisability of our findings. We reported both fixed- as well as random-effects models for increased precision of pooled effect estimates to account for this limitation.

2.6 Conclusions

We have reviewed the strength of evidence of PA appraisal styles as mechanisms to underlie PA/anhedonia. Our findings suggest that there is now preliminary evidence supporting the notion that reducing and elevating appraisals might be an underlying factor that impact PA/anhedonia levels in adults. However, in neither child nor adult populations have the criteria proposed by Dunn et al. (2017) to establish a mechanism as a target for clinical intervention been met. We recommend, especially in child and adolescent populations, that further work is conducted to more robustly evaluate this issue.

2.7 Footnotes

1 In ESM studies, outcome selection was given two stars if a validated tool was used and one star if a bespoke face-valid measure was used.

Tables

Table 2. 1 *Measures of PA appraisal styles and PA/Anhedonia.*

Measure	Authors	Description	Example item
Appraisal style measure			
Response to positive affect scale (RPA)	Feldman et al. (2008)	17-item self-report scale measuring trait tendency to dampen versus amplifying (divided into EF and SF subscales)	"I am living up to my potential"
Response to positive affect scale for children (RPA-C)	Bijttebier et al. (2012)	Slightly re-worded version of the RPA for using with children and adolescents	"I am the best I could be"
Co-Dampening and Co-Enhancing Questionnaire (CoDEQ)	Bastin et al. (2018)	18-item self-report scale measuring dyadic responses to positive affect with a same-sex best friend	"then we talk about how much energy this good news gives us"
Affective Control Scale (ACS) positive emotion factor	Williams et al. (1997)	13-item self-report subscale assess fear of losing control over or of behavioural reactions towards positive emotion	"I think my judgment suffers when I get really happy"
Fear of Happiness Scale (FOH)	Joshanloo, (2013)	5-item self-report scale measuring apprehension toward happiness and fun	"Having lots of joy and fun causes bad things to happen"
Fragility of Happiness Scale	Joshanloo et al. (2015)	4-item self-report scale measuring the fragility of happiness, and affective state that can be easily replaced by negativity	"Something might happen at any time and we could easily lose our happiness"
Gilbert's Fear of Happiness Scale	Gilbert et al. (2012)	10-items measure perception and anxiety around experiencing happiness	"I worry that if I feel good something bad could happen"

Measure	Authors	Description	Example item
Emotion Regulation Profile-Revised (ERP-R) – fault finding subscale	Nelis et al. (2011)	Self-report scale based on 15 vignette-based scenarios measures focus of attention towards negative elements in positive situations	You spend a romantic weekend with your partner. The setting is wonderful. Your partner is on great form and you feel particularly happy! "Despite the weekend being very pleasant, you cannot help resenting the few negative details that prevent your break from being perfect."
Savouring Beliefs Inventory (SBI)	Bryant (2003)	24-item self-report scale measuring perceptions about past, present and future facets of savouring pleasant experiences	"I feel a joy of anticipation when I think about upcoming good things"
Positive Affect measures			
The Positive and Negative Affect Scale – PA factor (PANAS-PA)	Watson, Clark, and Tellegen, (1988)	10/5 – items describing positive emotion words depending on if short or long form is used. It can be in trait, past week, or present moment form.	"happy"
Types of Positive Affect Scale	Gilbert et al. (2008)	12-item self-report measures experience of activated, relaxed and safe positive emotions.	"energetic", "calm", "warm"
Mood and Anxiety Symptom Questionnaire – anhedonia factor (MASQ-AD)	Watson and Clark (1991)	MASQ has a 30-item and 62-item long form. The subscale is 22/10 items self-report subscale measuring anhedonic symptoms of depression.	"I felt like I was having a lot of fun"

Measure	Authors	Description	Example item
Chapman's Anhedonia Scale	Chapman et al. (1976)	61-item self-report physical anhedonia and 40-item social anhedonia scales	Not available
Child Depression Inventory-C anhedonia factor (CDI-C)	Kovacs, (1985)	7 item self-report scale measuring loss of pleasure along with symptoms related to somatic concerns and isolation.	"Nothing is fun at all"
The Leuven Anhedonia Self-report Scale (LASS)	Bastin et al. (2018)	12 item self-report scale measuring consummatory, anticipatory and motivational anhedonia	"I found little pleasure in things that I used to enjoy"
Subjective Happiness Scale (SHS)	Lyubomirsky and Lepper (1999)	4 item self-report scale measuring one's perceptions about considering oneself happy	"In general, I consider myself,…." (e.g. a very happy person, not a very happy person)
The Adult Temperament Questionnaire – PA factor	Evans and Rothbart (2007)	11 item self-report scale measuring overall tendency to experience positive feelings	"I rarely feel happy"

Table 2. 2 *Selected studies, sample characteristics, measure of outcomes and effect size estimates.*

Study (year) ***Bold if included in the meta-analyses***	**Design**	**Population**	**Sample Clinical Status**	**Mean Age**	**Sample Size**	**Appraisal Style Measure**	**Anhedonia/ PA Measure**	**Quality Assessment**	**Effect Sizes and Main findings**
Raes et al. (2009) Study 1	Cross-sectional (survey)	Adult	Non-clinical	20.66	170	RPA	PANAS PA (trait form)	2*, 1*, 2*	Greater PA significantly negatively correlated with dampening (r = -0.19), and positively correlated with SF (r = 0.25) and EF (r = 0.48) appraisals. When depression scores were partialled out, only SF and EF continued to be significantly associated with PA.
Olofsson et al. (2014)	Cross-sectional (survey)	Adult	Non-clinical	24.93	111	RPA	PANAS PA (unclear which form)	2*, 2*, 2*	Greater PA was significantly positively correlated with SF (r = 0.29) and EF (r = 0.34) appraisals but was not significantly associated with dampening appraisals (r = -0.04). When depression scores were partialled out, only SF and EF continued to be significantly associated with PA.
Kiken and Shook (2014) Study 1	Cross-sectional (survey)	Adult	Non-clinical	20.26	159	RPA	PANAS PA (unclear which form)	4*, 1*, 2*	Greater PA was significantly positively correlated with SF appraisals (r = 0.46), EF (r = 0.38) appraisals, and amplifying total score (r = 0.47). Dampening appraisal results were not reported in the study.
Werner-Seidler et al. (2013) Study 1	Cross-sectional (survey)	Adult	Non-clinical	19.14	112	RPA, ACS	MASQ-AD	3*, 1*,2*	Greater anhedonia was significantly positively correlated with ACS fear of positive emotion (r = 0.25) and dampening (r = 0.38), and negatively correlated with EF (r =-0.19) and SF (r = -0.20) appraisals. When controlling for general distress and anxious arousal, EF (r = -0.32) and SF (r = -0.25) appraisals continued to be associated with anhedonia symptoms. However, the dampening and ACS fear of positive emotions relationships with anhedonia no longer held.
Werner-Seidler et al. (2013) Study 3	Cross-sectional survey (as part of broader case-control design)	Adult	Clinical and non-clinical (currently-, recovered- and never-depressed)	42.35	50	RPA	MASQ-AD	(Max 4*, 2*, 3*) 4*, 1*, 2*	Greater anhedonia was significantly positively correlated with dampening (r = 0.52), and negatively correlated with SF (r = -0.31) and EF (r = -0.32) appraisals. When controlling for MASQ anxious arousal and general distress, the EF and

Study (year) *Bold if included in the meta-analyses*	Design	Population	Sample Clinical Status	Mean Age	Sample Size	Appraisal Style Measure	Anhedonia/ PA Measure	Quality Assessment	Effect Sizes and Main findings
									dampening relationships remained significant, but the SF relationship no longer held.
Joshanloo (2018)	Cross-sectional survey	Adult	Non-clinical	20.63	316	FOH, Fragility of happiness scale	PANAS PA (past 30-day form)	3*, 1*,2*	Greater PA was significantly negatively correlated with fear of happiness (r = -0.25) and fragility of happiness (r = -.027).
Gilbert et al. (2012)	Cross-sectional survey	Adult	Non-clinical	27.97	185	Fear of happiness scale	Types of Positive Affect Scale	2*,1*,2*	Greater fear of happiness was significantly negatively correlated with safe (r = -0.46), relaxed (r = -0.27) and active (r = -0.31) PA.
Melka et al. (2011)	Cross-sectional survey	Adult	Non-clinical	19.2	528	ACS	PANAS PA (unclear which form)	3*, ,2*	PA was not significantly associated with fear of PE (r = -0.08).
Arif (2017)	Cross-sectional survey	Adult	Clinical (depressed patients)	NR	100	ACS	PANAS PA (unclear which form)	2*, ,2*	Greater PA was significantly positively correlated with fear of PE (r = 0.39). There was no healthy control group for any group comparison.
Bryant (2003) Study 4	Cross-sectional survey	Adult	Non-clinical	19.4	86	SBI	Chapman's anhedonia scales	2*, ,2*	Greater savouring beliefs were significantly negatively correlated with physical anhedonia (r = -0.56), and social anhedonia (r = -0.57).

Study (year) ***Bold if included in the meta-analyses***	**Design**	**Population**	**Sample Clinical Status**	**Mean Age**	**Sample Size**	**Appraisal Style Measure**	**Anhedonia/ PA Measure**	**Quality Assessment**	**Effect Sizes and Main findings**
Smith and Hollinger-Smith (2015)	Cross-sectional survey	Adult	Non-clinical	Not reported (aged 55 or older)	164	SBI	SHS	3*, ,2*	Greater Savouring beliefs were significantly positively correlated with subjective happiness (r = 0.71) among older adults.
Quoidbach et al. (2010)	Cross-sectional survey	Adult	Non-clinical	33.6	282	ERP-R	PANAS PA (unclear which form), SHS	3*,2*,2*	Greater PA (r = -0.14) and greater subjective happiness (r = -0.31) were both significantly negatively correlated with fault finding. Age and gender did not moderate any of the significant relationships between the appraisal styles and PA.
Harding and Mezulis (2017)	Cross-sectional survey (as part of a broader prospective study)	Adult	Non-clinical	19.03	321	RPA	PA subscale of The Adult Temperament Questionnaire	4*,2*,2*	Greater trait PA was significantly positively correlated with amplifying appraisals (r = 0.27) at baseline. Dampening appraisal results were not reported in the study.
Olofsson et al. (2016)	Cross-sectional (laboratory task)	Adult	Non-clinical	24.51	60	RPA	PANAS (unclear what form) , Bespoke happiness rating	-,?,?,-,?,-	Greater PA was significantly positively correlated with trait EF (r = 0.43). Appraisals style did not predict PA reactivity to a positive (relative to neutral) mood induction task.
Gilbert et al. (2013)	Cross-sectional (laboratory task)	Adult	Clinical (currently remitted BD and MDD groups)	31.31	62	RPA	PANAS	n/a,n/a,n/a,-,-,-	In the BP group, increased PA reactivity to imagining a desired future was significantly correlated with trait EF (r = 0.41) but was not significantly associated with trait SF (r = 0.38) and dampening appraisals (r = 0.21). In the MDD group, increased PA reactivity was significantly correlated with trait EF (r = 0.38) and SF (r = 0.44) but was not significantly associated with dampening (r = -0.25).

Study (year) *Bold if included in the meta-analyses*	Design	Population	Sample Clinical Status	Mean Age	Sample Size	Appraisal Style Measure	Anhedonia/ PA Measure	Quality Assessment	Effect Sizes and Main findings
Ng and Diener (2009) Study 2	Cross sectional (laboratory task)	Adult	Non-clinical	Not reported	236	SBI	Bespoke PE ratings	?,?,-,-,?,-	Greater trait savouring beliefs were significantly positively associated with greater PE reactivity to an anagram task with success feedback immediately afterwards (r = 0.32) and after a three-minute delay (r = 0.26). These relationships remained significant when controlling for trait extraversion.
Nelis, Holmes, and Raes (2015)	Cross-sectional and prospective survey (5-month follow-up)	Adult	Clinical and non-clinical (currently-, formerly- and never-depressed)	31.2	345 (293 at follow-up)	RPA	MASQ-AD	3*,2*,2*	Greater anhedonic symptoms of depression were significantly cross-sectionally positively correlated with dampening (r = 0.31), and negatively correlated with SF (r = -0.44) and EF (r = -0.43) amplifying at baseline assessment. When non-anhedonic depressive symptoms were controlled for, dampening was no longer significantly linked with anhedonia. In prospective analyses, greater levels of SF appraisals at baseline predicted reduced levels of anhedonia at follow-up, over and above baseline anhedonia and history of depression. EF and dampening appraisals did not predict follow-up anhedonia
Li et al. (2017)	EMA (end of the day assessments over 14 days)	Adult	Non-clinical	20.1	157	RPA, Daily Response to PA	PANAS (daily form), Bespoke PA ratings	2*,2*,2*	Greater daily PA significantly positively correlated with daily amplifying (r = 0.80) and trait amplifying (r = 0.48), and negatively correlated with trait dampening (r = -0.18) but was not significantly related to daily dampening (r = 0.09). When daily dampening was low, increased daily uplifts (positive events) were associated with greater daily PA than the days when dampening was high. When daily amplifying was low, daily uplifts were more strongly linked with greater PA then the days that amplifying was high.
Hughes et al. (2015)	EMA (four assessments per day over a week)	Adult	Non-clinical	19.72	120	ACS	Bespoke PA ratings	3*,2*,2*	Greater trait fear of PE was not significantly associated with PA experience (r = -0.03).

Study (year) *Bold if included in the meta-analyses*	Design	Population	Sample Clinical Status	Mean Age	Sample Size	Appraisal Style Measure	Anhedonia/ PA Measure	Quality Assessment	Effect Sizes and Main findings
Carl et al. (2014)	EMA (one daily assessment over 14 days)	Adult	Non-clinical	18.82	164	SBI	PANAS (trait form); Bespoke PA ratings	3*,2*,2*	Greater savouring beliefs were significantly positively correlated with trait PA (r = 0.45) at baseline. Greater savouring beliefs also predicted daily PA reactivity (reactivity to daily uplifts) (β = 0.02) and overall daily PA (β = 0.01).
Nelis, Holmes, Palmieri et al. (2015) Study 1	Experiment (processing mode manipulated during positive memory recall, with dampening appraisals as a moderator variable)	Adult	Non-clinical	21.53	70	RPA	Bespoke PA ratings	-,-,-,-,?,-	Trait dampening did not predict immediate change in PA when recalling a positive memory under either concrete or abstract instructions. Greater trait dampening predicted a smaller decrease in PA after the memory recall in the concrete but not the abstract condition.
Nelis, Holmes, Palmieri et al. (2015) Study 2	Experiment (between subjects, abstract/verbal, concreate/imagery or comparative/verbal processing manipulation during an achievement recall)	Adult	Non-clinical	20.78	159	RPA	Bespoke PA ratings	-,-,-,-,?,-	Trait dampening did not predict immediate PA change not subsequent repair of PA during positive memory recall under concrete, abstract or comparative conditions
Burr et al. (2017)	Cross-sectional and experiment (appraisal style manipulated during pleasant activity scheduling via	Adult	Non-clinical	NR	43	State RPA	Bespoke PA ratings, MASQ-AD	-,-,?,-,-,-	Greater anhedonic symptoms of depression were significantly negatively correlated with state SF (r = -0.33) and state EF (r = -0.33) but not state dampening (r = -0.07) appraisals during the control condition (a pleasant walk while following no particular instructions). PA decreased during the walk when following dampening instructions, relative to an increase in PA in the control, EF and

Study (year) *Bold if included in the meta-analyses*	Design	Population	Sample Clinical Status	Mean Age	Sample Size	Appraisal Style Measure	Anhedonia/ PA Measure	Quality Assessment	Effect Sizes and Main findings
	smart-phone app; a cross-over RCT design)								SF conditions. The SF, EF and control conditions did not differ from one another.
Dunn et al. (2018) Study 1	Cross-sectional and experiment (appraisal style manipulated during positive memory recall, using a mixed-within between subjects design)	Adult	Non-clinical	22.87	90	RPA including a state version	Bespoke happiness ratings, MASQ-AD	-,-,-,-,-,-	Greater anhedonic symptoms of depression were significantly negatively correlated with trait amplifying (r = -0.26) and positively with trait dampening appraisals (r = 0.26). Greater state amplifying and reduced state dampening significantly linked to reduced happiness reactivity during first uninstructed memory recall. Greater trait amplifying, but not reduced trait dampening, significantly linked to happiness reactivity during first uninstructed memory recall. Instructed dampening reduced happiness in the second memory recall, compared to an increase in the control condition. There was no significant difference in happiness reactivity in the control and amplifying condition. These associations were not moderated by anhedonia or trait appraisals styles.
Dunn et al. (2018) Study 2	Cross-sectional and experiment (appraisal style manipulated during positive anticipation using a mixed-within between subjects design)	Adult	Non-clinical	20.36	90	RPA including a state version	Bespoke happiness ratings, MASQ-AD	-,-,-,-,?,-	Reduced state dampening (but not state amplifying) significantly linked to reduced happiness reactivity during first uninstructed anticipation Neither trait amplifying nor dampening significantly linked to happiness reactivity during first uninstructed memory recall. Instructed dampening reduced happiness in the second anticipation, compared to an increase in the control condition. There was no significant difference in happiness reactivity in the control and amplifying condition. These associations were not moderated by anhedonia or trait appraisals styles.

Study (year) *Bold if included in the meta-analyses*	Design	Population	Sample Clinical Status	Mean Age	Sample Size	Appraisal Style Measure	Anhedonia/ PA Measure	Quality Assessment	Effect Sizes and Main findings
Diener et al. (1991) Study 1	Experiment (appraisal style manipulated while viewing pleasant slides using a between subjects design)	Adult	Non-clinical	NR	189	None	Bespoke PA ratings	-,-,-,-,?,-	PA reactivity when viewing positive slides was greater in the amplifying condition than the control condition. There was no significant difference between the control and dampening condition. No check was made as to whether the instructions increased levels of amplifying and dampening.
Diener et al. (1991) Study 2	Experiment (appraisal style manipulated while viewing pleasant slides)	Adult	Non-clinical	NR	109	None	Bespoke PA ratings	-,-,-,-,?,-	PA reactivity when viewing positive slides was greater in the amplifying condition that the control condition, which in turn was greater than the dampening condition. No check was made as to whether the instructions increased levels of amplifying and dampening.
Gilbert et al. (2017)	Cross-sectional survey	Child/ Adolescent	Non-clinical (recruited on basis of low versus high familial risk of depression)	8.91	81	RPA	CDI-C anhedonia subscale	3*,2*,2*	Greater anhedonia was significantly positively correlated with dampening (r = 0.40) but not amplifying (r = 0.21) in zero order correlations. Stepwise regressions went on to examine if these dampening findings were moderated by frequency of positive life events and familial risk for depression. In children at low risk of familial depression and who experienced a high number of positive life events only, greater dampening was associated with more anhedonia.
Verstraetet al. 2012)	Cross-sectional survey	Child/ Adolescent	Non-clinical	10.08	195	RPA-Child	PANAS PA (trait form)	3*,2*,2*	Greater PA was significantly positively correlated with dampening (r = 0.19), SF (r = 0.33) and EF (r = 0.31) appraisals.

Study (year) *Bold if included in the meta-analyses*	Design	Population	Sample Clinical Status	Mean Age	Sample Size	Appraisal Style Measure	Anhedonia/ PA Measure	Quality Assessment	Effect Sizes and Main findings
Burke et al. (2018)	Cross-sectional survey (as part of a broader prospective study)	Child/ Adolescent,	Non-clinical (at least moderate BAS sensitivity)	18.73	590	RPA	PANAS PA (past 30-day format)	2*,1*,2*	Greater PA was significantly negatively correlated with dampening (r = -0.11) and positively correlated with SF (r = 0.44) and EF (r = 0.34).
Hamilton et al. (2017)	Cross-sectional survey (as a part of a broader prospective study)	Child/ Adolescent	Non-clinical (at least moderate BAS sensitivity)	18.02	304	RPA	PANAS PA (past 30-day form)	2*,2*,2*	Greater PA was significantly positively correlated with SF (r = 0.38) and EF appraisals (r = 0.26) but was not significantly related to dampening appraisals (r = -0.21) at time one.
Bastin et al. (2018)	Cross-sectional survey (as part of a broader prospective study)	Child/ Adolescent	Non-clinical	12.7	665	RPA- Child, CoDEQ	LASS	3*,2*,2*	Greater Anhedonia was significantly positively correlated with dampening (r = 0.24) and negatively correlated with amplifying (r = -0.34) in time one cross-sectional analyses.
Nelis, Bastin et al. (2016) Study 1	Cross-sectional and prospective survey (12-month follow-up)	Child/ Adolescent	Non-clinical	11.73	371	RPA- Child	PANAS PA (trait form)	3*,2*,2*	Greater PA was significantly cross-sectionally positively correlated with amplifying appraisals (r = 0.54) but was not significantly associated with dampening appraisals (r = -0.08) at intake. Greater intake amplifying appraisals predicted increased follow-up PA in cross lagged analyses (beta=.17), but the reverse relationship was also significant (beta=.16). Dampening was not significantly linked to PA in prospective analyses in either direction.
Nelis, Bastin et al. (2016) Study 2	Cross-sectional and prospective survey (13-month follow-up)	Child/ Adolescent	Non-clinical	12.93	1552	RPA- Child	PANAS PA (trait form)	3*,2*,2*	Greater PA was significantly positively correlated with amplifying appraisals (r = 0.57) but not dampening appraisals (r = -0.01). Greater intake amplifying appraisals predicted increased follow-up PA in cross-lagged analyses (β = 0.1), but the reverse relationship was also significant (β = 0.17). Dampening was not significantly linked to PA in prospective analyses in either direction.

Study (year) *Bold if included in the meta-analyses*	Design	Population	Sample Clinical Status	Mean Age	Sample Size	Appraisal Style Measure	Anhedonia/ PA Measure	Quality Assessment	Effect Sizes and Main findings
Nelis, Bastin et al. (2016) Study 3	Cross-sectional and prospective survey (7-month follow-up)	Child/ Adolescent	Non-clinical	10.83	183	RPA- Child	PANAS PA (trait form)	3*,2*,2*	Greater PA was significantly positively correlated with amplifying appraisals (r = 0.35) abut was not significantly associated with dampening (r = 0.09). Dampening appraisals at intake did not predict follow-up PA or vice versa in cross lagged analyses. Amplifying appraisals were not included in the cross-lagged analysis.
Nelis et al. (2018)	Cross sectional and prospective survey (12 month and 24-month follow-up)	Child/ Adolescent	Non-clinical	12.73	674	RPA- Child	LASS	3*,1*,2*	Greater anhedonia was significantly positively correlated with dampening (r = 0.31) and negatively associated with amplifying appraisals (r = -0.40) in cross-sectional analyses of 24-month data (intake and 12m relationships not reported) . These relationships held when controlling for daily uplifts (positive life events) and negative. Increased amplifying and decreased dampening at intake predicted a greater decrease in anhedonia at 24 months. These relationships held when controlling for daily uplifts and negative rumination. However, neither amplifying nor dampening at 12-months robustly predicted anhedonia at 24-months when controlling for uplifts and rumination.

Notes. Mean age was reported for the baseline assessments in the prospective studies. Summary of the quality assessment of cross-sectional, prospective and EMA studies represent selection (max-5 stars), comparability (max-2 stars), and outcome (max-3 stars) domains. It represents selection (max-4 stars), comparability (max-2 stars) and exposure (max-2 stars) for case-control studies. Experiments were evaluated based on selection (random sequence generation, allocation concealment), performance, detection, attrition, reporting bias domains; (-), (+), (?) and n/a representing low risk, high risk, unclear risk and not applicable respectively.

Abbreviations: PA = Positive Affect, PE=Positive Emotion, SF = Self-Focus amplifying, EF = Emotion-Focus amplifying, BAS = Behavioural Approach System, EMA = Ecological Momentary Assessment, MTT = Mental Time Travel, N/A = Not applicable, N/R = Not reported, BD = Bipolar Disorder, MDD = Major Depressive Disorder, IPPI-D = the Integrative Positive Psychological Intervention for Depression, CBT = Cognitive Behavioural Therapy, CCT = Cognitive Control Training, EFA = Exploratory Factor Analysis, NR = Not reported; *Scales:* RPA = Responses to Positive Affect questionnaire, PANAS = Positive and Negative Affect Schedule, ACS = Affective Control Scale, MASQ-AD = Mood and Anxiety Symptom Questionnaire – Anhedonia, FOH = Fear of Happiness Scale, NAPAS = Negative and Positive Affect Scale, SBI = Savouring Beliefs Inventory, ERP-R = Emotion Regulation Profile-Revised, SHS = Subjective Happiness Scale, CDI-C = Children's Depression Inventory, CoDEQ = Co-Dampening and Co-Enhancing Questionnaire, LASS = The Leuven Anhedonia Self-report Scale, PANAS-G = Positive and Negative Affect Schedule-Global.

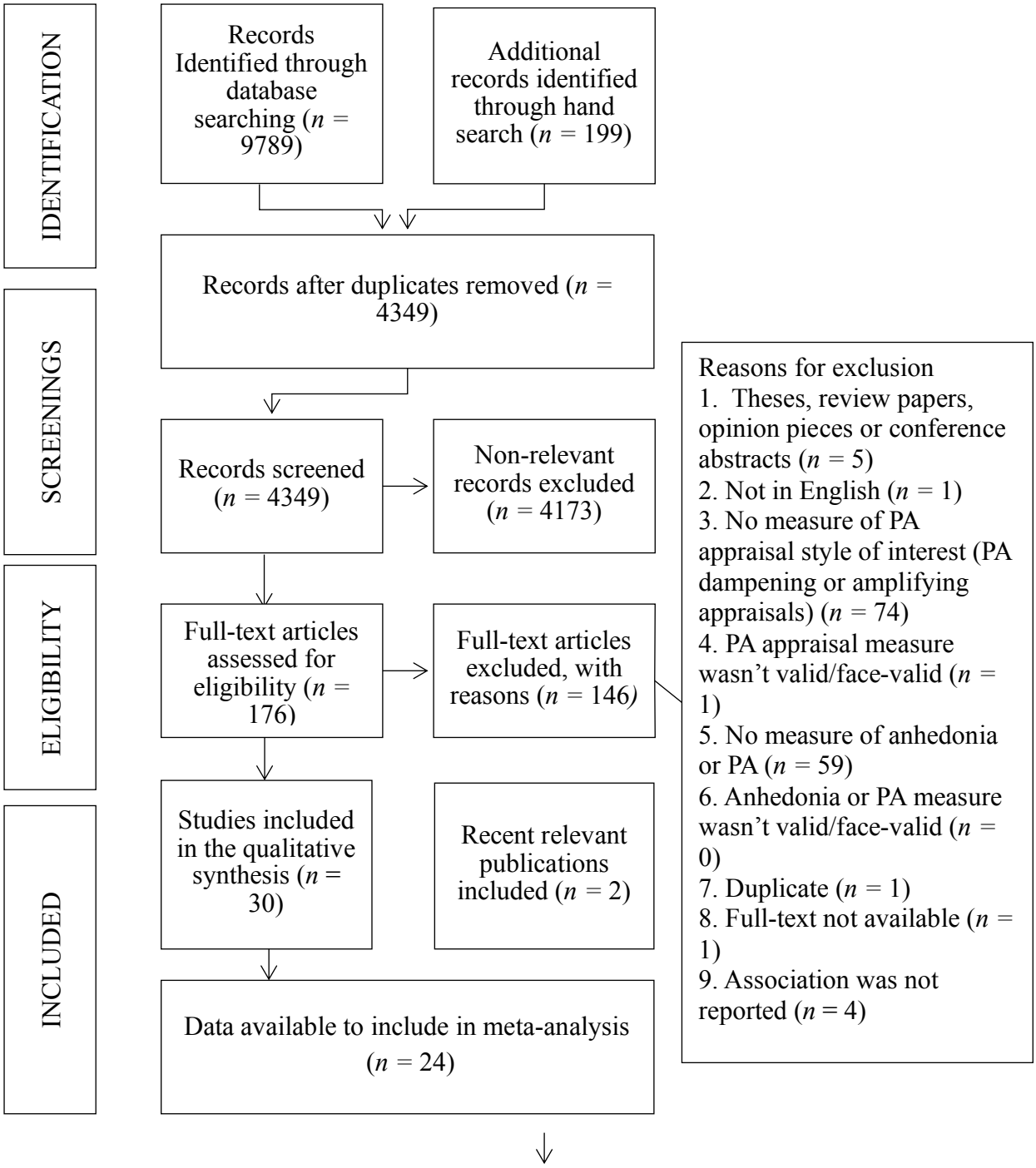

Figure 2. 1 PRISMA flow-diagram of studies meeting eligibility criteria.

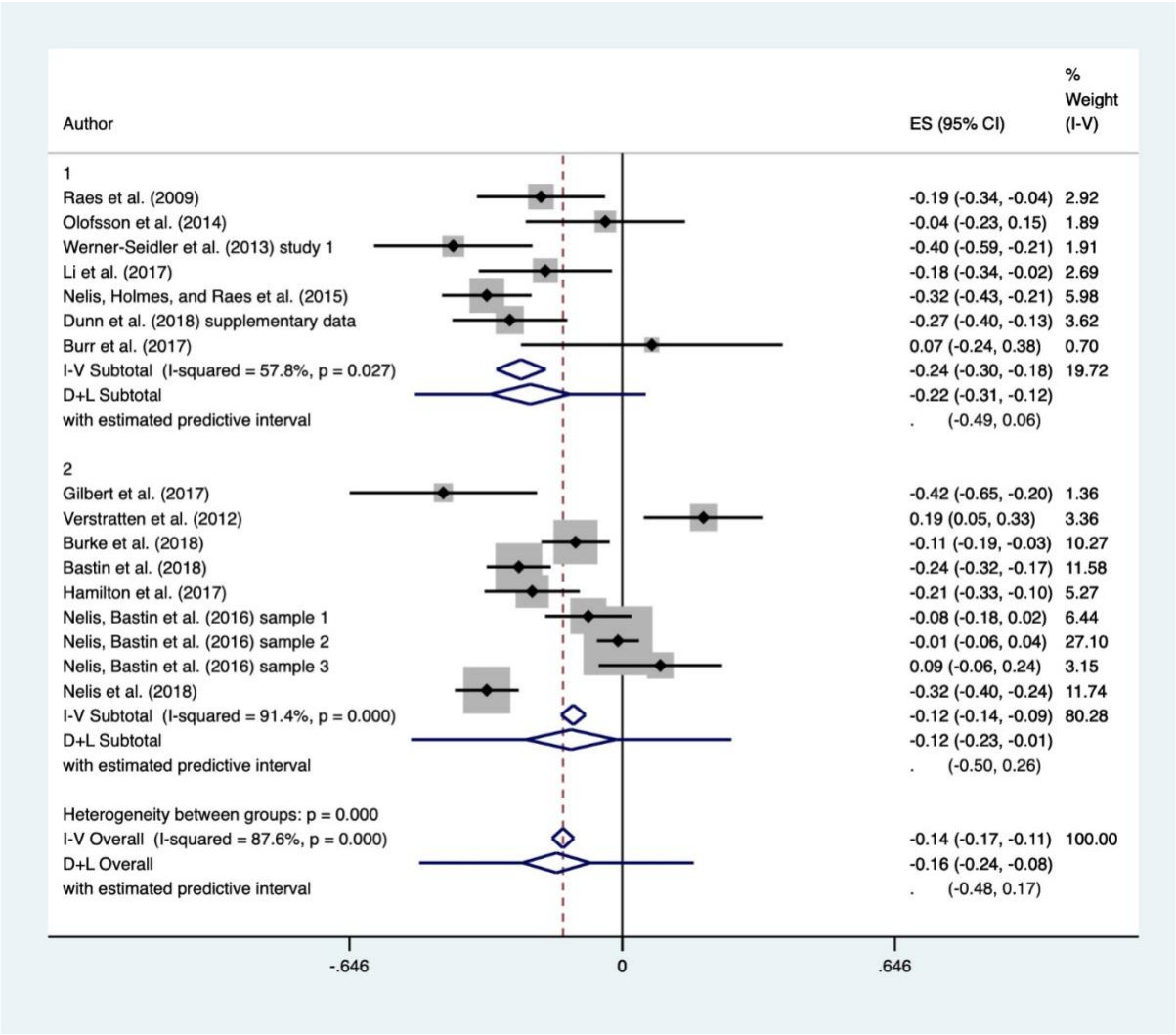

Figure 2. 2 Forest plot showing the association between dampening appraisal style and PA/anhedonia levels broken down by age. 1 = adult studies, 2 = child and adolescent studies. I-V Subtotal line represents fixed-effects model. D+L Subtotal line represents random-effects model.

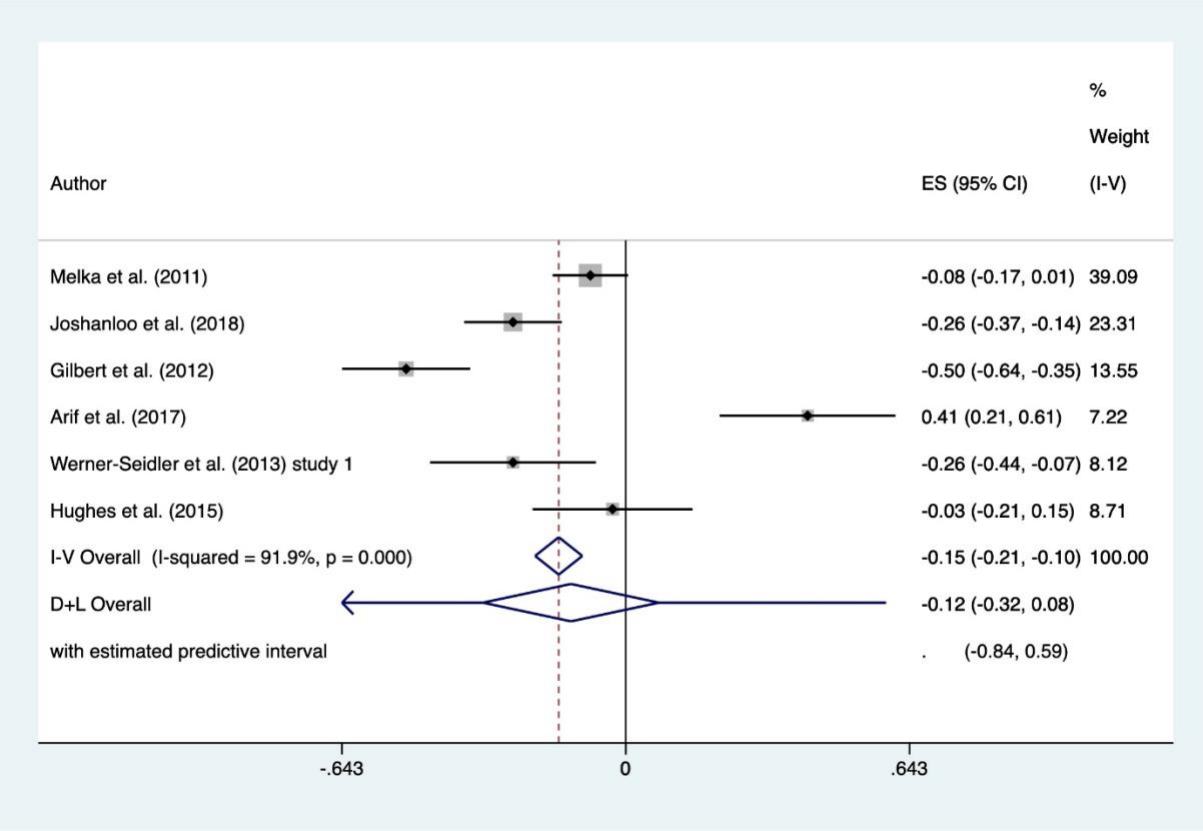

Figure 2. 3 Forest plot showing the association between the fear of positive emotion and PA/anhedonia levels. I-V Subtotal line represents fixed-effects model. D+L Subtotal line represents random-effects model.

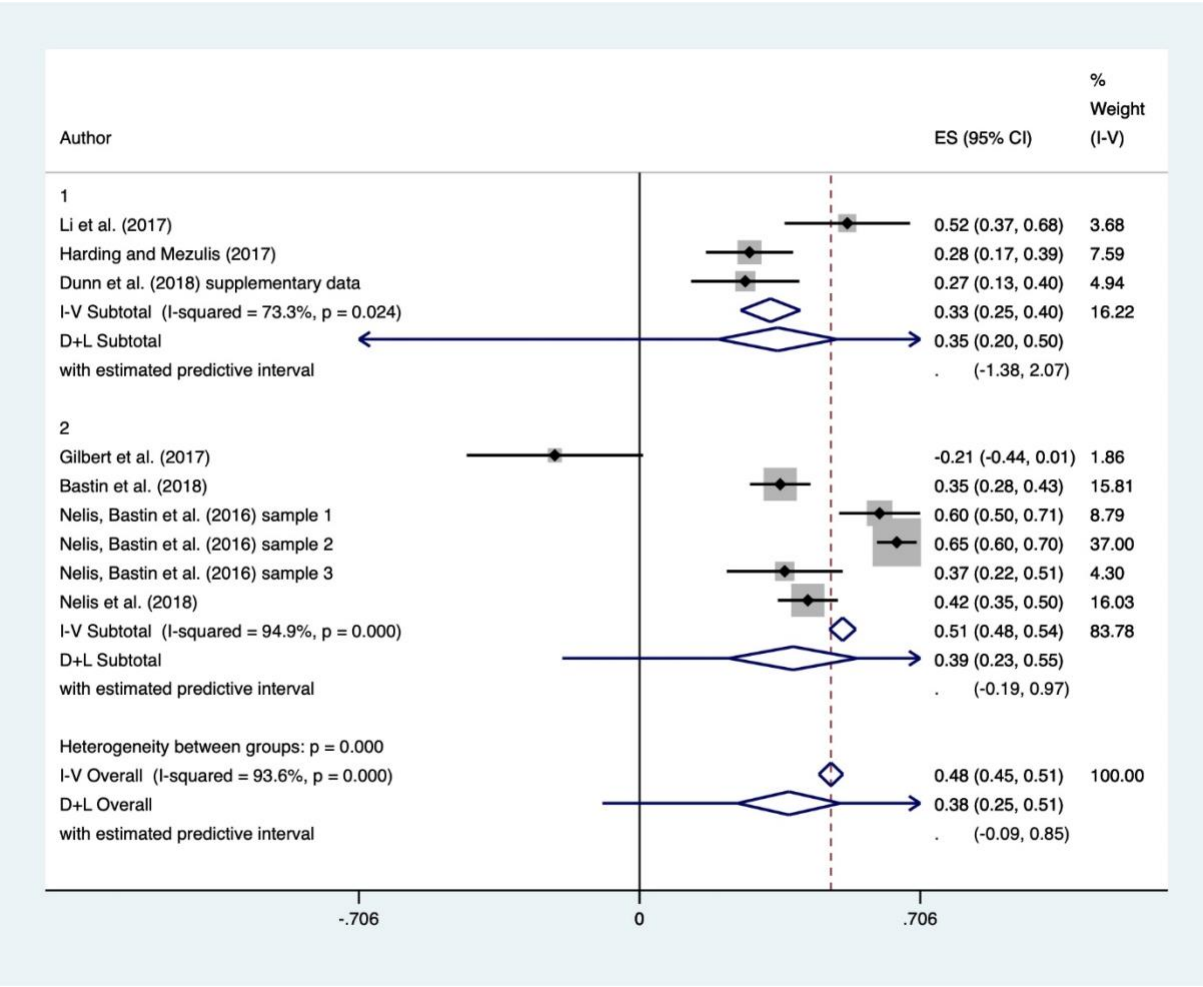

Figure 2. 4 Forest plot showing the association between the amplifying appraisal style and PA/anhedonia levels broken down by age. 1 = adult studies, 2 = children and adolescent studies. I-V Subtotal line represents fixed-effects model. D+L Subtotal line represents random-effects model.

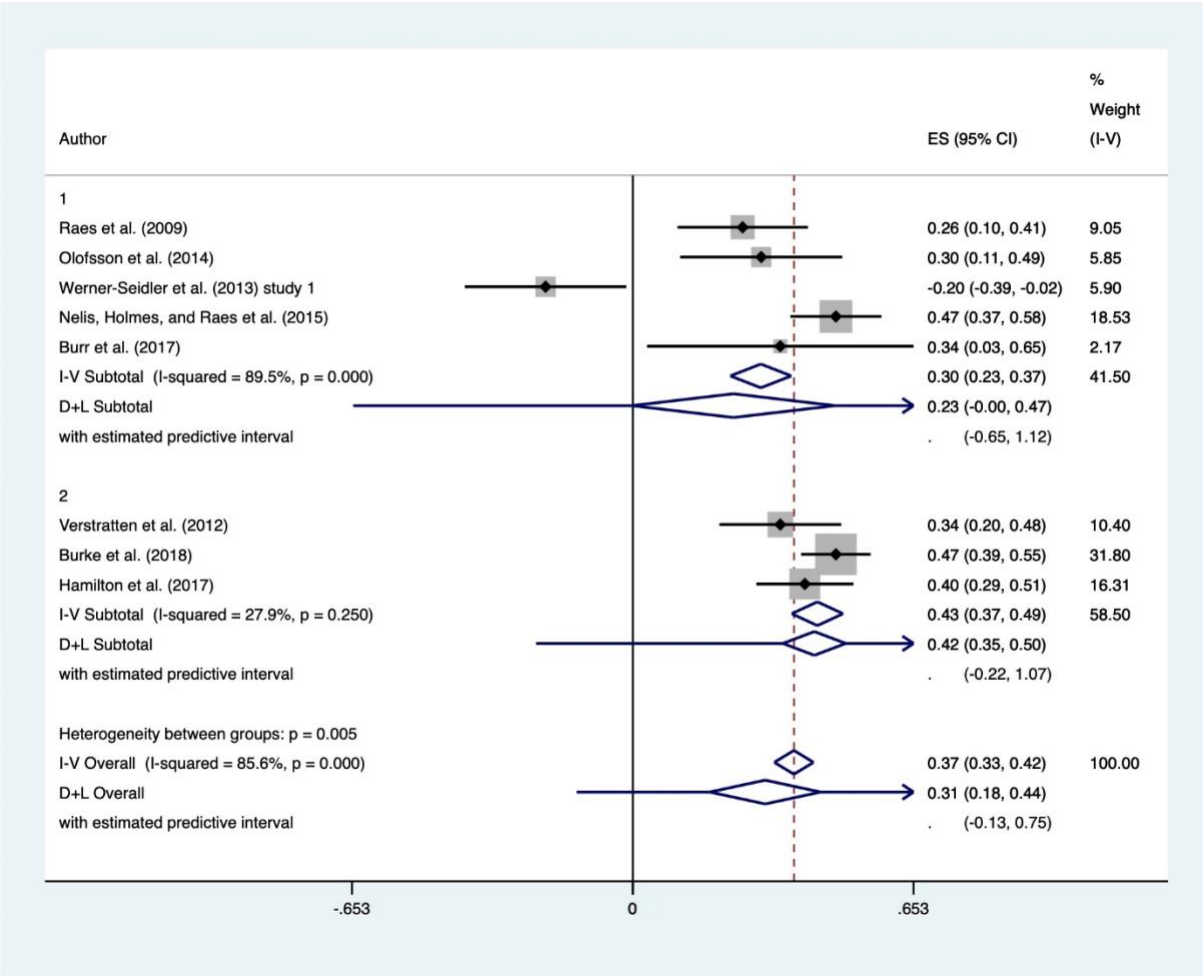

Figure 2. 5 Forest plot showing the association between the SF amplifying appraisal style and PA/anhedonia levels broken down by age. 1 = adult studies, 2 = children and adolescent studies. I-V Subtotal line represents fixed-effects model. D+L Subtotal line represents random-effects model.

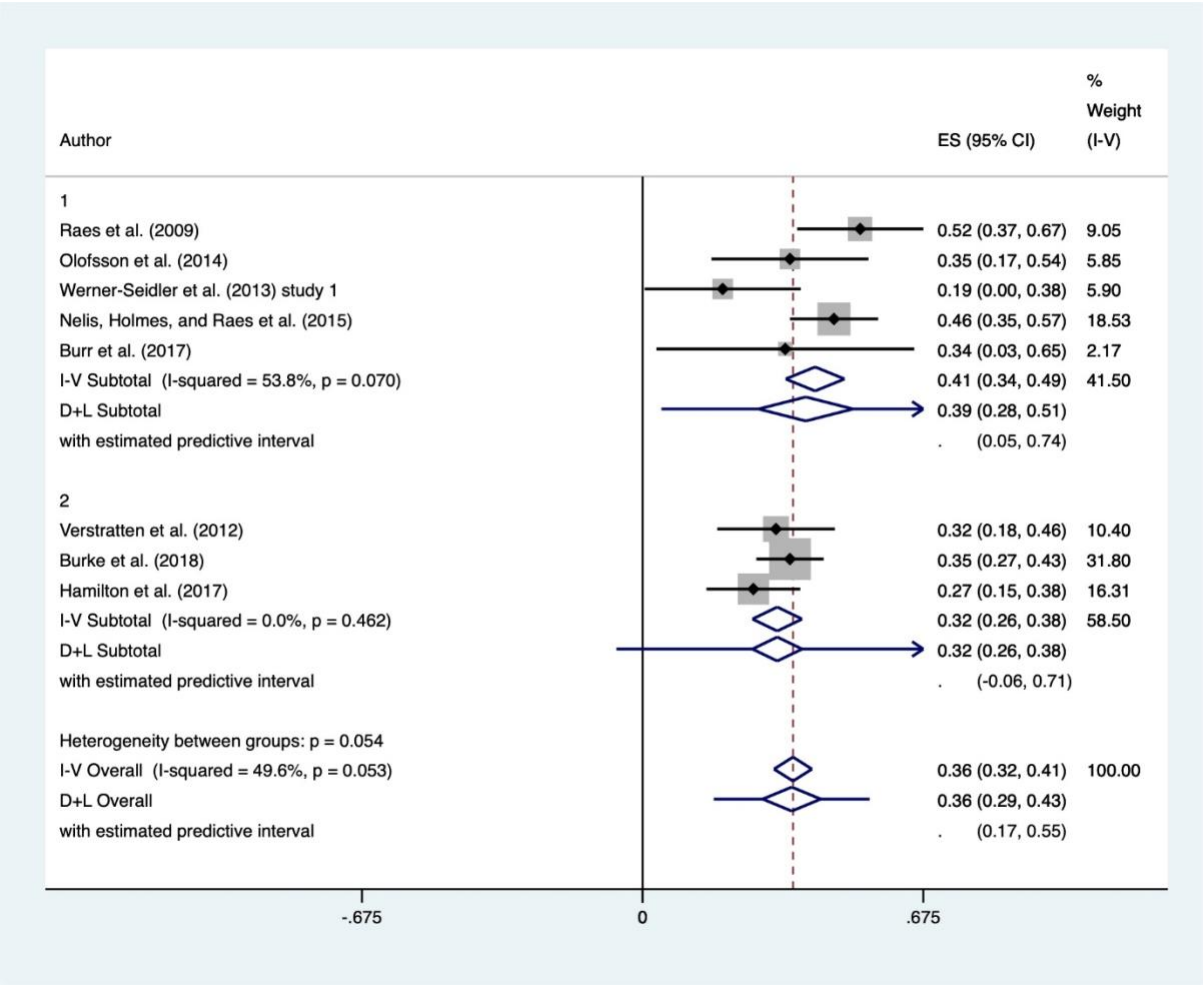

Figure 2. 6 Forest plot showing the association between the EF amplifying appraisal style and PA/anhedonia levels broken down by age. 1 = adult studies, 2 = children and adolescent studies. I-V Subtotal line represents fixed-effects model. D+L Subtotal line represents random-effects model.

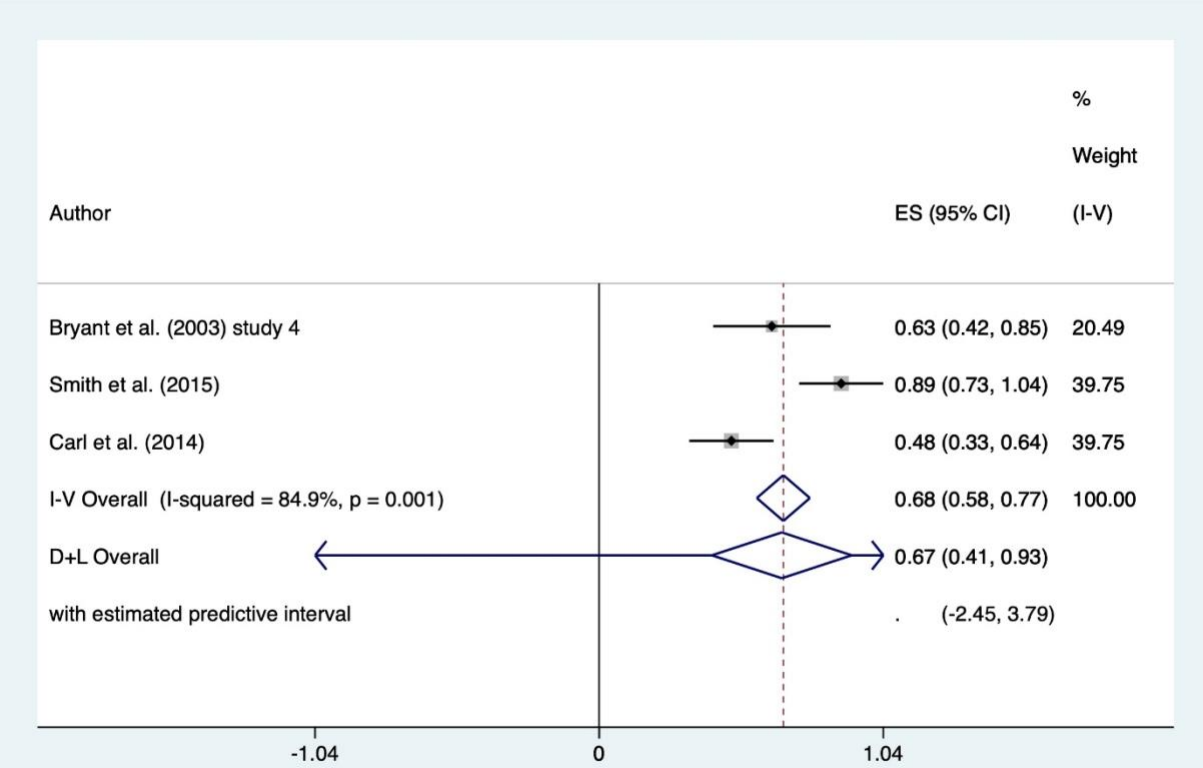

Figure 2. 7 Forest plot showing the association between the savouring beliefs and PA/anhedonia levels broken down by age. 1 = adult studies, 2 = children and adolescent studies. I-V Subtotal line represents fixed-effects model. D+L Subtotal line represents random-effects model.

Appendix 2. A *Example search strategy*

PsycINFO (via OvidSP)

Concept A: ((Emotion or Affect or Mood) adj2 positive). ti,ab.) AND ((Apprais* or Ruminat* or Fear or Dampen* or Savo?r).ti,ab.) OR ((Pleasure or Happiness).ti,ab.) AND ((Apprais* or Ruminat* or Fear or Dampen* or Savo?r).ti,ab.) OR "Responses to Positive Affect Questionnaire.ti,ab." OR "Affective Control Scale.ti,ab." OR "Fear of Happiness Scale.ti,ab." OR "Emotion Acceptance Questionnaire.ti,ab."

Concept B: (((Emotion or Affect or Mood) adj2 positive). ti,ab.) OR ((Pleasure or Happiness).ti,ab.) OR (Anhedoni*.ti,ab.)

Final Search: Concept A AND Concept B

1. ((Emotion or Affect or Mood) adj2 positive). ti,ab.
2. (Pleasure or Happiness).ti,ab.
3. Anhedoni*.ti,ab.
4. 1 or 2 or 3 {outcome related terms}
5. (Apprais* or Ruminat* or Fear or Dampen* or Savo?r).ti,ab.
6. 1 and 5 {positive appraisal mechanisms}
7. 2 and 5 {positive appraisal mechanisms}
8. Responses to Positive Affect Questionnaire.ti,ab.
9. Affective Control Scale.ti,ab.
10. Fear of Happiness Scale.ti,ab.
11. Emotion Acceptance Questionnaire.ti,ab.
12. 6 or 7 or 8 or 9 or 10 or 11{all mechanism related terms}
13. 4 and 12

2.8 Highlights

- Greater use of dampening appraisals is cross-sectionally associated with lowered PA/Greater Anhedonia in adult and child/adolescent samples.
- Decreased us of amplifying appraisals is cross-sectionally and to some extend prospectively associated with lowered PA/Greater Anhedonia in adult and child/adolescent samples.
- There is preliminary evidence that increased dampening diminishes PA in adults, but the impact of amplifying appraisals on PA is inconclusive.
- Studies are needed to examine direct causal links between the appraisal styles and PA/Anhedonia in clinical and non-clinical child and adolescent populations.
- Overall, studies are needed to examine whether change in positive appraisal styles alter PA levels and mediate the treatment outcomes in clinical settings.

Chapter 3.0: Study Two

Target Journal: Personality and Individual Differences

Title: Examining the relationship between anhedonia symptoms and positive appraisal style in adolescents: A Longitudinal survey study.

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Compliance with Ethical Standards

The study obtained ethical approval from the Ethics Committee of the School of Psychology, University of Exeter (Ref, 2016/999).

Conflict of Interest

Authors has no conflict of interest to declare.

Informed consent

Informed consent procedures were followed in accordance with the ethical standards of the responsible committees on human experimentation at the University of Exeter School of Psychology (Reference No: 2017/1429). Informed consent was obtained from all individual subjects participating in the study.

Animal rights

No animal studies were carried out by the authors of this article.

3.1 Abstract

Anhedonia, defined as a loss of interest and pleasure in previously enjoyable activities, is a core symptom of depression that predicts a poor treatment response and a worse future prognosis. We know little about the cognitive vulnerability factors that contribute to the development of anhedonia. This longitudinal survey study investigated the link between self-reported anhedonia symptoms and cognitive appraisal of positive affect (measured in terms of use of amplifying appraisals, dampening appraisals, and fear of positive emotion scales). Baseline data were collected from 367 Year 9 and 10 students in the UK (aged 13-16), 170 of whom went on to complete the three-month follow-up assessment (a 46% response rate). At baseline, greater anhedonia severity was cross-sectionally significantly associated with increased trait levels of dampening and reduced trait levels of amplifying but was not significantly related to fear of positive emotion. Prospectively, greater baseline levels of amplifying predicted lower anhedonia severity at three-month follow-up (when covarying for baseline anhedonia severity and a range of relevant covariates). Neither dampening appraisals nor fear of positive emotion longitudinally predicted three-month anhedonia severity. Conversely, greater intake anhedonia predicted lowered use of amplifying at the follow-up (when covarying for baseline amplifying levels) but was not significantly related to follow-up dampening. These results indicate that cognitive appraisal of positive affect is associated with concurrent and to some extent can predict future symptoms of anhedonia in youth, and vice-versa.

Key words: anhedonia; appraisal style; positive affect; adolescence; depression

3.2 Introduction

Unipolar Major Depression is a debilitating, chronically recurrent disorder that is among the leading causes of disability worldwide according to the World Health Organisation (Lopez, Mathers, Ezzatti, Jamison, & Murray, 2006). First onset of depression often occurs in adolescence (Costello, Erkanli, & Angold, 2006) and is associated with impairments in academic and social functioning, lower quality of life, poorer physical health, self-harm and suicide (Hawton et al., 2012; Jaycox et al., 2009). If left untreated adolescent depression can lead to a complex clinical picture, with increased illness severity, suicidality and multiple comorbidities that extend into adulthood (Jonsson et al., 2011). It is therefore important to develop more effective treatments to both prevent and treat first onset depression before a chronic, relapsing course is established.

Anhedonia, defined as a loss of interest and pleasure in previously enjoyable activities, is one of the two cardinal symptoms required to be diagnosed with Major Depressive Disorder (American Psychiatric Association, 2013), and it is experienced by over 75% of depressed adolescents (Lewinsohn et al., 1998). Greater anhedonia in adolescent depression predicts increased duration of depressive episodes, elevated suicidal ideation, and a sub-optimal treatment response to both CBT and anti-depressant medication (Auerbach et al., 2015; McMakin et al., 2012; Uher et al., 2012). Despite its prognostic importance, current treatments neglect anhedonia and instead predominantly focus on reducing elevations in negative mood. Treatment outcomes may be improved if we identify and target underlying mechanisms that cause and maintain anhedonia (an experimental psychopathology approach (Holmes, Craske, & Graybiel, 2014).

One candidate mechanism underpinning anhedonia is the way in which individual appraise positive emotion experience. Individuals may either engage in amplifying appraisals that enhance and extend the positive emotion (e.g. think ‘this is the sign of good things to

come) or make use of dampening appraisals that reduce and shorten positive emotion (e.g "I don't think I deserve this") (Feldman et al., 2008). Trait levels of these amplifying and dampening appraisal styles can be measured using the Response to Positive Affect Scale (Feldman et al., 2008), which has also been validated in young people (Verstraeten, Vasey, Raes, & Bijttebier, 2012).

A handful of recent studies have begun to examine links between positive appraisal style and anhedonia or positive affect (PA) specifically in young people. Bastin, Nelis, Raes, Vasey, and Bijttebier (2018) found that greater anhedonia in a non-clinical sample of 665 children (mean age = 12) was cross-sectionally related to greater dampening and reduced amplifying. These finding were replicated in another study which looked at cross-sectional relationships in the same sample at 24m follow-up (Nelis et al., 2018). However, Gilbert, Luking, Pagliaccio, Luby, and Barch (2017) found that anhedonia was only significantly associated with greater dampening (but not reduced amplifying) appraisals in 81 non-clinical children recruited on the basis of high familial risk for depression. Findings are more equivocal with regards to levels of PA. In another non-clinical sample of 590 adolescents (Burke, Anne McArthur, Daryanani, Abramson, & Alloy, 2018), it was found that greater levels of PA were cross-sectionally related to greater amplifying and reduced dampening appraisals. However, Hamilton et al. (2017) in a single sample and Nelis, Bastin, Raes, Mezulis, and Bijttebier (2016) across three samples found that only amplifying but not dampening appraisals were linked to PA (304 non-clinical adolescents reported by Hamilton et al. (2017); 371, 1552 and 183 non-clinical children reported by Nelis et al. (2016). Some of these studies have also examined prospective relationships. Increased amplifying at intake predicted greater subsequent increases in PA in non-clinical children across two samples (Nelis et al., 2016 study one and two). Greater levels of dampening and reduced levels of dampening at intake predicted a greater increase in anhedonia at 24 month (but not at 12

month) follow-up in non-clinical children (Nelis et al., 2018). In summary, amplifying and dampening are both fairly consistently linked cross-sectionally and prospectively to anhedonia levels, but only amplifying is consistently cross-sectionally and prospectively linked to trait PA.

There are a number of limitations of the extant literature. First, studies have used the Leuven Anhedonia Scale (LASS; as mentioned in Bastin et al., 2018), a promising but not yet extensively validated measure of anhedonia in young people. It is important to establish if the finding replicate when using the current gold standard self-report measure of anhedonia – the Snaith Hamilton Pleasure Scale (Leventhal et al., 2015; Rizvi et al., 2016; Snaith et al., 1995). Second, to make claims about the direction of the relationship observed in prospective studies, it is also important to examine reverse associations (i.e. examine whether intake anhedonia predicts subsequent change in appraisal style). As far as we are aware, no studies have taken this approach in youth samples. We are aware of one study that has examined these reverse associations in an adult sample (mean age = 31.20), which demonstrated that intake anhedonia did not significantly predict subsequent change in dampening and emotion-focus appraisals but did predict self-focus amplifying at the level of a non-significant trend (Nelis, Holmes, & Raes, 2015). Third, studies to date have exclusively relied on the Response to Positive Affect Scale (Feldman et al., 2008) as the measure of positive appraisal style. However, this is one of only a handful of measures of appraisal style that exist. In particular, in the adult literature the fear of positive emotion scale from the Affective Control Scale (Williams et al., 1997) has also been linked to elevated levels of anhedonia (Werner-Seidler et al., 2013). This focuses much more on anxiety about being out of control in response to positive emotions, while the RPA dampening subscale focuses more broadly on themes of deservedness, social judgement, and negative future consequences of feeling positive. It is

useful to examine whether it is particular kinds of appraisals that may be linked to anhedonia in adolescence by including both scales in a single study.

Therefore, in the present study we examined in a sample of community adolescents cross-sectional and prospective associations between the SHAPS (as a gold standard measure of anhedonia) and levels of amplifying and dampening appraisals measured by the RPA and the fear of positive subscale of the ACS. We focused on both forward and reverse associations in the prospective analyses. We examined whether each measuring of amplifying was associated with anhedonia in zero-order analyses and whether these effects held when simultaneously entering all three appraisal variables in the same analyses (i.e. assessing whether each appraisal style construct uniquely predicts anhedonia). Given previous links of positive appraisal style to both depressive rumination (Hudson, Harding, & Mezulis, 2015) and the frequency of everyday positive events that young people encounter (Gilbert et al., 2017), we included measures of these constructs as covariates.

We predicted that decreased amplifying, increased dampening, and increased fear of positive emotion appraisals would be concurrently and prospectively associated with greater anhedonia symptoms. We had no strong *a priori* predictions as to whether these predictions would uniquely hold in multiple regression analyses (i.e. whether dampening would predict anhedonia over and above amplifying and fear of positive emotion).

3.3 Methods

3.3.1 Participants

A priori power analysis using G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009) to detect a medium effect (assuming 80% power and alpha<0.05) suggested a sample size of 84 for cross-sectional correlation and 92 for linear multiple regression analyses with 5 predictor variables. Allowing for 20% attrition during follow-up, the minimum target sample size was 101 for correlational and 110 participants for linear multiple regression analyses.

We initially approached 14 secondary schools in the South West of England to take part in the study, two of whom eventually agreed. 618 students from these schools were invited to take part, 367 of whom consented and completed baseline assessment (a 59% response rate of those approached). 170 of these individuals also completed the three-month follow-up assessment (a 46.32% response rate of initial responders; see Figure 3.1 for participation flow chart). The age of participants at baseline ranged from 13 to 16 years (M = 14.81, SD = 0.43), 54.22 % (n = 199) of participants were female, and the majority were of white British ethnic origin (90.46%, n = 332).

3.3.2 Measures

3.3.2.1 Anhedonia.

The Snaith—Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995) was used to assess anhedonia symptom severity. This 14-item self-report inventory asks participants to estimate their capacity to experience pleasure over in the last few days. Participants rate their agreement with 14 statements (e.g., "I would enjoy being with my family or close friends"), on a scale ranging from 1 (strongly agree) to 4 (strongly disagree). The scale has been validated for use in adolescents has acceptable internal reliability (Cronbach's α = 0.87) in this sample (Leventhal et al., 2015). We used the revised continious scoring method for the SHAPS, summing individual item scores to generate a score ranging from 14 (not at all anhedonic) to 56 (extremely anhedonic) (see Franken, Rassin, & Muris, 2007; Leventhal et al., 2015). This method is less vulnerable to range restriction effects in community samples than the original dichotomous coding recommended by Snaith et al. (1995). Internal consistency of the SHAPS was adequate in the current sample (α = 0.86).

3.3.2.2 Depression.

The 10-item self-report major depressive disorder subscale from the Revised-Children Anxiety and Depression Scale (RCADS; Chorpita, Yim, Moffitt, Umemoto, &

Francis, 2000) was used to index depression severity. Participants rate how they have felt the way described in each statement (e.g., "I feel sad or empty"), on a Likert scale ranging from 0 (Never) to 3 (Always), and scores for each item are summed to create a subscale score. The depression scale has been shown to have satisfactory internal consistency (α = 0.87) (Chorpita, Moffitt, & Gray, 2005), and consistency was also adequate in the present sample (α = 0.80).

3.3.2.3 Positive Affect Appraisal Styles.

The Responses to Positive Affect Scale for Children (RPA-C; Verstraeten, Vasey, Raes, & Bijttebier, 2012) was used to index how individuals appraise their positive emotion experience. This 17-item self-report scale assesses the trait tendency to engage in dampening appraisals (eight items; e.g., "think about the things that have not gone well for you"), emotion-focus (EF) amplifying appraisals (five items; e.g., "notice how you feel full of energy"), and self-focus (SF) amplifying appraisals (four items; e.g., "think 'I am the best I could be."). Participants are asked to judge how often they appraise positive emotions in the way each statement describes on a scale ranging from 1 (almost never) to 4 (almost always), and ratings are summed to create total scores for each subscale. Higher scores reflect increased tendency to engage with each appraisal style. Factor analytic studies suggest that a two-factor model of dampening (eight items) and amplifying (nine items combining emotion-focus and self-focus appraisals) best fits the data in youth samples (Nelis, Luyckx, et al., 2016). Internal reliability was α = 0.79 and α = 0.86 for dampening and amplifying scales, respectively (Bijttebier et al., 2012). We adopted this two-factor scoring procedure here. In the present study, internal reliability was acceptable for both the amplifying (α = 0.87) and dampening (α = 0.86) subscales.

The 12-item self-report fear of positive emotion subscale from the Modified Affective Control Scale Adolescent Version (MACS-A; Geddes, Dziurawiec, & Lee, 2007) was used to

assess fear of positive emotion. For each item participants are asked to rate to what extent they agree with a statement describing how they respond to positive emotion (e.g. "I am afraid that I'll do something stupid if I get carried away with happiness"), on a scale ranging from 1 (very strongly disagree) to 7 (very strongly agree). Higher scores reflected higher perceived fear of positive emotions. The reliability of the fear of positive emotion subscale has been found to be acceptable in other adolescent samples, $\alpha = 0.74$ (Geddes et al., 2007). Reliability was also acceptable in the current sample ($\alpha = 0.79$).

3.3.2.4 Confounding variables.

Previous research has shown that levels of anhedonia and depression are influenced by the extent to which individuals ruminate and the frequency of positive and negative life events encountered (Bijttebier et al., 2012; Gilbert et al., 2017; Michl et al., 2013). Therefore, we measured these constructs to enter as covariates in our analyses.

The 13-item self-report ruminative response subscale of the Children's Response Style Questionnaire (CRSQ; Abela, Vanderbilt, & Rochon, 2004) was used to assess ruminative style. For each item participants are asked to judge how often they feel the way described (e.g. "When I am sad, I think about how alone I feel"), on a scale ranging from 1 (almost never) to 4 (almost always). The scores for the 13 items are summed together, with a higher score indicating a greater tendency to engage in ruminative thinking. Internal reliability for this subscale has been found to be adequate in other adolescent samples (α = 0.74 – 0.75; Abela, Vanderbilt, & Rochon, 2004) and was also adequate in the current sample ($\alpha = 0.93$).

The 36-item self-report Brief Adolescent Life Events Scale (BALES; Shahar, Henrich, Reiner, & Little, 2003) was used to assess the frequency of negative (18 items; e.g. "I argued with a family member") and positive life events (18 items; e.g. 'I was invited to join in with a group event' encountered over the past four weeks) across different life

domains. Participants rate how often each event occurred on a scale ranging from 0 (never) to 3 (a lot), with the positive and negative subscale scores ranging from 0 to 54 as a result. Higher scores indicated increased frequency of the life events. This scale allowed us to examine effects of the given life events on predicting anhedonia symptoms over and above appraisal of PA. The internal reliabilities of the positive and negative life events subscales have been shown to be adequate in adolescents (α = 0.88 and α = 0.87 respectively; Shahar et al., 2003). In the current sample, internal consistencies of the positive (α = 0.86) and negative life events (α = 0.85) subscales were also acceptable.

3.3.3 Procedure

We first obtained informed consent from head teachers in each school to carry out the study. Following this consent, students were given a study pack to take home that included an information sheet and opt-out consent form. If the opt-out form was not returned to classroom teachers within two weeks, parental consent was inferred. For the subset of adolescents who had not been opted out, we then sought their written informed consent to take part. Baseline data collection took place in two waves (January 2016 and November 2016). Participants completed the survey measures in pen and paper format during tutorial periods in the school day. They completed the survey again three months later during tutorial periods. Classroom teachers assisted the data collection. The survey included additional secondary outcome measures that are not reported further here for the sake of brevity[1].

Participants were debriefed and given a list of mental health resources after data collection and compensated for their time if they took part in both baseline and three-month follow-up assessments. If a student answered the RCADS item "How often do you think about death" as "Always", safeguarding officers in each school were notified about the student latest at the end of the next workday along with student's depression scores and information about how to interpret these information.

3.3.4 Data Analysis Plan

Participants who did not complete the anhedonia measures were excluded from the final dataset (see Figure 3.1 for flow of participation). Alpha was set at .05 and the results of two tailed tests are reported throughout. We inspected all variables to see if they were normally distributed and to identify the presence of any outliers. There were no marked outliers and variables were satisfactorily normally distributed, so no additional data cleaning steps were required.

To identify if there were systematic differences in participants who did and did not complete the three-month follow-up, we used independent sample t-tests (for continuous variables) and chi-squared tests (for categorical variables) to compare these participants.

To identify potential covariates to include in the analyses, we examined if age, gender, rumination, positive event frequency, and negative event frequency were correlated with intake symptom severity. If significant correlations were found, these variables were then entered as additional covariates in subsequent analyses.

We report the zero-order (Pearson) correlations between anhedonia and each appraisal style. We compared the magnitude of these dependent correlations using an online calculator that computes asymptotic covariance and then runs an asymptotic z-test (Lee & Preacher, 2013; following Steiger, 1980). We report the partial correlations between anhedonia and each appraisal style when covarying for the relevant covariate variables. For prospective analyses, we used linear regression models. Time two anhedonia was the dependent variable and we additionally entered time one anhedonia as a covariate along with the other predictor variables. We also ran comparable analyses to see if intake anhedonia predicted change in appraisal style, this time entering time two appraisal style as the dependent variable and covarying for time one appraisal style. We report partial correlations in all cases. Parallel

cross-sectional and prospective analyses were run using depression severity instead of anhedonia severity as the dependent variable.

3.4 Results

3.4.1 Descriptive Statistics

Table 3.1 presents descriptive clinical and demographic statistics for participant at baseline and three-month follow up. Inspection of this data reveals that there was sufficient spread in depression, anhedonia, amplifying appraisals, dampening appraisals, and fear of positive emotions, meaning that range restriction effects were unlikely to be leading to false negative results.

To identify which variables need to be entered as covariates in subsequent analyses, we examined whether intake depression and anhedonia severity were significantly associated with potential confounder variables. Greater anhedonia was associated with greater rumination and lower positive event frequency, *ps* < 0.01, but not with age, gender, and negative event frequency, *ps* > 0.37. Greater depression was associated with greater rumination, lower positive event frequency, greater negative event frequency, older age, and female gender, *ps* < 0.02. Given all potential confounder variables were associated with one or both of anhedonia and depression severity, we decided to enter them all as covariates in subsequent analyses.

Given the relatively high rates of attrition between baseline and follow-up, we examined if there were systematic differences in participants who completed versus did not complete the follow-up survey. Those who completed were more likely to be female, χ_2 = 18.26, $p < 0.001$, have lower intake anhedonia severity, $t = 2.22$, $p = 0.03$, and ruminate less, $t = 2.20$, $p = 0.03$. There was no significant difference in terms of age, $t = 1.63$, $p = 0.10$, intake depression severity, $t < 1$, frequency of positive events, $t < 1$, frequency of negative events, $t = 1.63$, $p = 0.10$, use of amplifying appraisals, $t = 1.68$, $p = 0.09$, use of dampening

appraisals, $t < 1$, or fear of positive emotion, $t = 1.12$, $p = 0.26$. We did not have sufficient group size of non-White British individuals ($n = 10$) to meaningfully examine whether ethnic status related to follow-up completion rates.

3.4.2 Cross-Sectional Associations between Appraisal Styles and Symptoms at Baseline

Table 3.2 reports the zero order associations between the appraisal style variables and the depression and anhedonia outcomes. Largely as predicted, greater anhedonia severity was related to reduce use of amplifying and greater use of dampening, $ps < 0.001$. However, contrary to prediction, anhedonia was not significantly related to fear of positive emotion, $p = 0.28$. The association of anhedonia with amplifying was significantly stronger than with dampening, $z = 3.29$, $p < 0.01$, which in turn was significantly stronger than with fear of positive emotion association, $z = 2.16$, $p = 0.03$.

As predicted, greater depression severity was related to greater use of dampening, greater fear of positive emotion, and reduced use of amplifying, $ps < 0.001$. The association of anhedonia with dampening was significantly stronger than with amplifying, $z = 4.71$, $p < 0.001$, and with fear of positive emotion, $z = 4.70$, $p < 0.001$. The magnitude of the anhedonia association did not differ between amplifying and fear of positive emotion, $z < 1$.

We then ran a series of regression analyses to examine whether each appraisals style variable (over and above each other) were uniquely associated with depression and anhedonia, entering all three appraisal style variables as the independent variables, and anhedonia and depression as independent variables. Greater anhedonia severity was uniquely associated with greater dampening, $r_p = 0.19$, $p < 0.001$, and reduced amplifying, $r_p = -0.46$, $p < 0.001$, but was not significantly related to fear of positive emotion, $r_p = -0.02$, $p = 0.71$. These dampening and amplifying unique relationships held if additionally entering depression severity and the confounder variables (rumination, positive event frequency, negative event frequency, age and gender) as covariates into the regression (i.e. the appraisal

styles were linked to anhedonia severity over and above depression severity), *ps* < 0.01. The fear of positive emotion association remained non-significant, $p = 0.52$.

Greater depression severity was uniquely associated with greater dampening, $r_p = 0.54$, $p < 0.001$, reduced amplifying, $r_p = -0.34$, $p < 0.001$, and elevated fear of positive emotion, $r_p = 0.16$, $p < 0.01$. The amplifying and fear of positive emotion relationships held if additionally entering anhedonia severity and the confounder variables as covariates into the regression (i.e. the appraisal styles were linked to depression severity over and above anhedonia severity and the other confounder variables), *ps* < 0.01. However, the dampening relationship was no longer significant, $p = 0.10$.

In summary, greater dampening was cross-sectionally associated with greater depression and anhedonia (although the depression relationship did not hold when entering the confounder variables). Greater amplifying was cross-sectionally associated with lower depression and anhedonia in all analyses. Greater fear of positive emotion was not cross-sectionally associated with anhedonia in any analyses but was robustly associated with greater depression severity.

3.4.3 Longitudinal Associations between Baseline Appraisal Styles and Follow-up Symptoms

Greater intake amplifying levels predicted a greater decrease in anhedonia symptoms at follow-up at the level of a non-significant trend, $r_p = -0.16$, $p = 0.054$, but were not significantly related to change in depression symptoms at follow-up, $r_p = -0.15$, $p = 0.72$. Greater intake dampening levels were not significantly related to change in anhedonia symptoms, $r_p = -0.11$, $p = 0.21$, but did predict a greater increase in depression symptoms at follow-up, $r_p = 0.22$, $p < 0.01$. Greater intake fear of positive emotion was not associated with change in anhedonia, $r_p = 0.13$, $p = 0.12$, nor depression, $r_p = -0.06$, $p = 0.51$.

When entering all three appraisal style variables into the same regression to predict anhedonia change, greater intake amplifying still predicted change in anhedonia at the level of a non-significant trend, r_p = -0.17, p = 0.06, while the dampening relationship, r_p = -0.07, p = 0.45, and the fear of positive emotion relationship, r_p = -0.05, p = 0.56, remained non-significant. When entering the potential confounder variables (age, gender, positive event frequency, negative event frequency, and rumination), the amplifying association was now fully significant, r_p = -0.18, p = 0.047, and the dampening association, r_p = -0.07, p = 0.41, and the fear of positive emotion association, r_p = -0.05, p = 0.58, remained non-significant.

Similarly, we went on to examine whether each appraisal style uniquely predicted change in depression. Greater intake dampening uniquely predicted a greater increase in depression, r_p = 0.21, p = 0.01, and greater intake amplifying uniquely predicted a greater decrease in depression, r_p = -0.18, p = 0.03. Fear of positive emotion did not significantly uniquely predict change in depression, r_p = 0.08, p = 0.36. When entering the potential confounder variables into the regression, the dampening association was no longer significant, r_p = 0.12, p = 0.18, the amplifying association only held at the level of a non-significant trend, r_p = -0.15, p = 0.08, and the fear of positive emotion association remained non-significant, r_p = 0.08, p = 0.39.

In summary, there was some evidence that greater intake amplifying predicted greater reduction in anhedonia (albeit only fully significant in one analyses) and greater reduction in depression (albeit only fully significant in one analyses). Moreover, there was some evidence that greater intake dampening predicted increase in depression (although this did not hold when entering the confounder variables into the regression). Anhedonia did not reliably predict change in anhedonia in any of the analyses. Please see Table 3.3 for a summary.

3.4.4 Longitudinal Associations between Baseline Symptoms and Follow-up Appraisal Styles

We also looked at whether intake anhedonia severity predicted subsequent change in appraisal styles at follow-up (i.e. the reverse relationship). We used an identical analytic framework as above, except appraisal style changes were the dependent variables and intake anhedonia severity was the predictor variables (see Table 3.4).

Greater intake anhedonia severity predicted a greater decrease in amplifying appraisals at follow-up, r_p = -0.20, p = 0.01, but was not significantly related to change in dampening, r_p = 0.03, p = 0.69, or fear in positive emotion, r_p = 0.11, p = 0.19. When additionally entering the confounder variables (age, gender, positive event frequency, negative event frequency and rumination) into the combined regression, amplifying change was still uniquely predicted by anhedonia severity, r_p = -0.24, $p < 0.01$.

In summary, greater intake anhedonia severity clearly predicted greater decrease in amplifying appraisals.

3.5 Discussion

The primary aim of the current study was to examine concurrent and prospective associations between anhedonia and the way adolescents appraise PA. Partially supporting our predictions, at the cross-sectional level increased anhedonia was significantly related to reduced use of amplifying appraisals and increased use of dampening appraisals. These results held when controlling for rumination and frequency of recent positive and negative life events. However, contrary to prediction, fear of positive emotion was not significantly associated with anhedonia in either zero order analyses or when controlling for rumination and life events. Also, only partially supporting our predictions, at the prospective level a greater increase in anhedonia from time one to time two was related to reduced time one amplifying (but only when controlling for relevant covariates). Reverse analyses revealed

that lower time one levels of anhedonia also predicted a greater increase in amplifying appraisals, meaning we cannot make any strong conclusions about the direction of the relationship between anhedonia and amplifying. Moreover, against prediction, neither intake dampening nor fear of positive emotion predicted change in anhedonia over time.

These findings extend previous work by looking at two measures of positive appraisal style concurrently and using the current gold standard self-report measure of anhedonia – the Snaith Hamilton Pleasure Scale (Snaith et al., 1995). We largely replicate previous findings using the Leuven anhedonia scale (as described in Bastin et al., 2018), which found that both dampening and amplifying were related to anhedonia cross-sectionally (Bastin et al., 2018; Nelis et al., 2018). Our results deviate from Gilbert et al. (2017) using the anhedonia subscale of the Child Depression Inventory – Child Version (Kovacs, 1985), who found dampening but not amplifying was cross-sectionally linked to anhedonia. However, Gilbert et al. (2017) had a small sample size (n = 81) and also used only a subscale of a larger depression scale to measure anhedonia. Therefore, this null result may represent a false negative due to a lack of power.

The prospective findings are only partially consistent with previous research. Nelis et al. (2018) report that both dampening and amplifying predicted future change in anhedonia, whereas in the present study we found only amplifying was a significant predictor (and only when we controlled for a range of relevant covariates). It is noteworthy that Nelis et al. (2018) only found these associations at 24-month follow-up and not at 12-month follow up. In our view, a critical issue with all prospective analyses of this kind is to have a clear sense over the time frame a mechanism is likely to operate. None of the extant literature explicitly justifies why particular follow-up intervals were chosen. It is conceivable that positive appraisal style may be a genuine trait, in which case intake levels may predict distal follow-up a number of years later. However, it may also to some extent be a state phenomenon

(meaning that appraisal style at a particular point in time will predict immediate subsequent change in anhedonia, but no longer-term levels of anhedonia). There is also a hybrid position, where there is a trait disposition to appraise in a particular way more of the time, but this only modifies anhedonia at the particular moments this appraisal style is utilized (i.e. an underlying trait moderating state influences). There is a need for greater conceptual clarity in prospective survey work on dampening and amplifying appraisals as to which of these positions people are adopting. The failure to consider these issues may explain why such unclear and at times contradictory evidence has emerged from prospective studies in youth (and adult) studies to date.

In our view, the hybrid state-trait model is the most credible account of those outlined above. If this is true, then a better way to test the consequences of appraisal style than long term prospective studies is to instead examine the impact of state manipulations of appraisal style on momentary affective experience. Such work has been done in adults and shows that manipulations which encourage dampening exacerbate momentary anhedonia (Burr et al., 2017; Dunn et al., 2018). It will be interesting to examine whether such findings hold in adolescence.

Another issue with the extant prospective literature in youth (Nelis et al., 2018) is that reverse associations have not been examined, meaning it is premature to make claims about the direction of relationships observed between anhedonia and positive appraisal style. In the present study, we show that amplifying predicts subsequent change in anhedonia and vice versa. This mirrors a trend level association between intake anhedonia and change in self-focused amplifying observed in adults (Nelis, Holmes, & Raes, 2015). Given these amplifying findings in the present study, it is premature to make any strong conclusions about the direction of the relationship. Conceptually, it seems likely to us that there is an iterative feedback loop between appraisal style and anhedonia, which again means classic

prospective designs with a limited number of measurements point may not be the optimal method to examine the time course of these associations. Future work should take more frequent assessments of both constructs and examine the notion of iterative feedback of this kind directly.

To our knowledge, this is the first study to examine the association between fear of positive emotion and anhedonia in adolescents. There was no evidence of either a cross-sectional or prospective association between anhedonia and this construct, in contrast to adult samples where fear of positive emotion has been linked to anhedonia (Werner-Seidler et al., 2013; see also Beblo et al., 2012). This suggests that positive appraisal may not be a unitary construct and that different kinds of 'dampening' appraisal may be particularly salient in adolescence. For example, it is conceivable that 'undeserving' appraisals drive anhedonia in adolescents, but not 'fear of losing control' appraisals. It is interesting to consider why there is a difference between adolescents and adults with regards to the consequences of dampening appraisals. It may be that adults have had more learning experiences of where positive experiences can turn 'sour', which may make them more avoidant and fearful of them. Adolescents may yet to have experienced these unexpected adverse consequences in positive scenarios, so are yet to develop anxiety around them. Alternatively, it may be that the adolescent version of this scale is less psychometrically sound than the version used in adults. This issue requires further examination.

Here we have focused on consummatory anhedonia. Future research could also examine if positive appraisal styles in youth also influence anticipatory anhedonia (looking forward to future positive events) and mnemonic anhedonia (recalling past positive events) (see work by Dunn et al., 2018 in adults). It would also be interesting to examine the impact of positive appraisal style on motivational and learning components of anhedonia (cf. Gard, Gard, Kring, & John, 2006; McFarland & Klein, 2009; Treadway & Zald, 2011).

Overall, these data are consistent with the view that positive appraisal style may be one mechanism underpinning anhedonic experience, both in community and clinical populations. If this is replicated in further work using more robust methods and clinical samples, this would suggest treatment outcomes for depression and related conditions characterised by anhedonia could be increased if dampening and amplifying appraisals are systematically targeted.

A number of limitations with the present study should be held in mind should be noted. Most importantly, the attrition rate at the follow-up assessment was high in the present study. This drop-out may not have been completely at random and also reduced the power of the prospective analyses, meaning this data should be interpreted tentatively. Further, our sample consisted of predominantly White participants limiting the generalisability of findings reported here to other cultural or ethnic groups. It may be that there are cultural differences in the consequences of different positive appraisal styles (cf. Miyamoto & Ma, 2011).

In summary, our findings extend existing research on the development of anhedonia symptoms in youth by demonstrating that reduced amplifying and increased dampening are cross-sectionally linked to anhedonia.

3.6 Footnotes

[1] The Strengths And Difficulties Questionnaire (SDQ; Goodman, 1997), The Positive And Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), The Leuven Anhedonia Self-Report Scale (LASS; Nelis et al., 2018), The Children's Savouring Beliefs Inventory (CSBI; Cafasso, 1994 as cited in Bryant & Veroff, 2007), The Mental Health Continuum- Short Form (MHC-SF; Keyes, 2006), The Child And Adolescent Mindfulness Scale (CAMS; Greco, Baer, & Smith, 2011).

Tables

Table 3. 1 *Demographic and clinical variables at intake.*

	Mean (SD)	Range
Age	14.80 (0.39)	13-16
Gender (Female %)	54.22 %	-
Ethnicity (White %)	90.46 %	-
Intake		
Anhedonia	27.37 (6.70)	14-52
Depression	9.60 (7.34)	0-30
Amplifying	20.31 (5.78)	9-36
Dampening	15.22 (5.67)	8-32
Fear of PE	41.15 (8.70)	18-72
Rumination	25.35 (9.63)	13-52
Positive Events	28.68 (9.21)	0-53
Negative Events	18.21 (9.17)	0-51
Follow-up		
Anhedonia	27.28 (6.70)	14-47
Depression	10.63 (7.24)	0-30
Amplifying	20.86 (6.22)	9-36
Dampening	15.20 (5.67)	8-32
Fear of PE	41.95 (10.05)	18-72

Note. PE = positive emotion.

Table 3. 2 *Hierarchical Regression Analyses Examining Unique Associations of each Appraisal Style with Intake Anhedonia Symptoms.*

Amplifying analysis					Dampening analysis					Fear of PE analysis				
Predictor	*B*	*SE B*	*β*	*p*	Predictor	*B*	*SE B*	*β*	*p*	Predictor	*B*	*SE B*	*β*	*p*
Step 1					Step 1					Step 1				
Rumination	.02	.05	.03	.70	Rumination	.08	.04	.12	.02	Rumination	.01	.04	.02	.76
Positive events	-.24	.04	-.33	<.001	Positive events	-.12	.04	-.17	<.01	Positive events	-.12	.04	-.16	<.01
Negative event	.08	.04	.11	.07	Negative event	.04	.04	.06	.29	Negative events	.01	.04	.01	.87
Fear of PE	-.01	.04	-.01	.81	Fear of PE	.01	.04	.02	.71	Dampening	.23	.08	.19	<.01
Dampening	.18	.08	.15	.04	Amplifying	-.39	.06	-.34	<.001	Amplifying	-.41	.06	-.35	<.001
Step 2					Step 2					Step 2				
Amplifying	-.41	.06	-.36	<.001	Dampening	.23	.08	.20	<.01	Fear of PE	-.01	.04	-.02	.72

Note. PE = positive emotion.

Table 3. 3 *Hierarchical Regression analyses Predicting Follow-up Anhedonia Symptoms.*

Amplifying analysis					Dampening analysis					Fear of PE analysis				
Predictor	*B*	*SE B*	*β*	*p*	Predictor	*B*	*SE B*	*β*	*p*	Predictor	*B*	*SE B*	*β*	*p*
Step 1					Step 1					Step 1				
T1 anhedonia	.48	.09	.44	< .001	T1 anhedonia	.38	.10	.35	< .001	T1 anhedonia	.39	.10	.36	< .001
Age	.23	1.36	.01	.87	Age	-.16	1.33	-.01	.91	Age	-.09	1.34	-.01	.95
Gender	1.51	1.23	.10	.22	Gender	1.67	1.22	.12	.17	Gender	1.62	1.22	.11	.18
Rumination	.05	.08	.07	.51	Rumination	.03	.07	.04	.71	Rumination	.06	.08	.09	.43
Positive events	.01	.07	.01	.90	Positive events	.05	.07	.07	.47	Positive events	.06	.07	.07	.41
Negative event	.03	.07	.04	.64	Negative event	-.03	.07	-.04	.71	Negative event	-.02	.07	-.03	.78
Fear of PE	-.02	.07	-.03	.75	Fear of PE	-.05	.06	-.07	.43	Dampening	-.13	.13	-.11	.32
Dampening	-.14	.14	-.12	.30	Amplifying	-.26	.12	-.21	.04	Amplifying	-.24	.12	-.19	.05
Step 2					Step 2					Step 2				
Amplifying	-.25	.12	-.20	.047	Dampening	-.12	.14	-.10	.41	Fear of PE	-.04	.07	-.05	.58

Note. PE = positive emotion. T1 = Time 1.

Table 3. 4 *Hierarchical Regression analyses Predicting Follow-up Appraisal Styles.*

Amplifying analysis					Dampening analysis					Fear of PE analysis				
Predictor	*B*	*SE B*	*β*	*p*	Predictor	*B*	*SE B*	*β*	*p*	Predictor	*B*	*SE B*	*β*	*p*
Step 1					Step 1					Step 1				
T1 amplifying	.61	.07	.55	< .001	T1 dampening	.57	.07	.54	< .001	T1 fear of PE	.67	.08	.58	< .001
Step 2					Step 2					Step 2				
T1 anhedonia	-.19	.07	-.19	.01	T1 anhedonia	.02	.06	.03	.69	T1 anhedonia	.14	.11	.09	.19

Note. PE = positive emotion. T1 = Time 1.

Figures

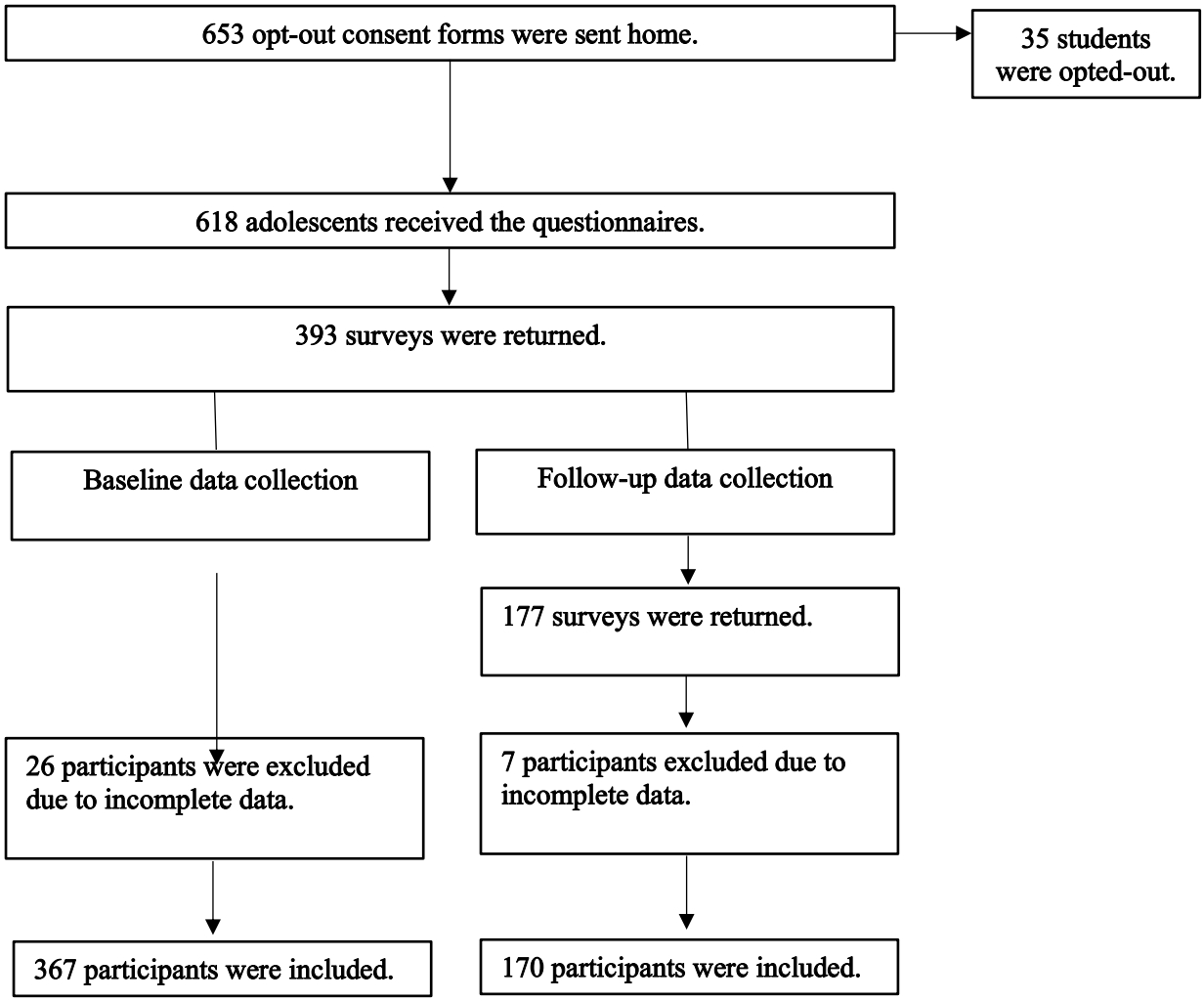

Figure 3. 1 Flowchart showing flow of participation at baseline and follow-up assessments.

Chapter 4.0: Study Three

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Making the worst of a good job: Induced dampening appraisals blunt happiness and increase sadness in adolescents during pleasant memory recall.

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4.1 Abstract

Previous work has shown that dampening appraisals (e.g. thinking "this is too good to last") reduce happiness and enhance sadness when adults are asked to recall positive events. In contrast, amplifying appraisals (e.g. thinking "this is the sign of good things to come") do not significantly alter happiness and sadness experience during the same task. The present study examined whether a similar pattern holds in adolescence. Eighty-nine adolescents completed an uninstructed positive recall task before being randomized to either dampening, uninstructed control or amplifying instructions during a second positive recall task. Participants experienced a significantly smaller increase in happiness and a significantly less marked reduction in sadness when recalling a positive memory under dampening instructions, relative to both the amplifying and no instruction control conditions. There was no significant difference between the amplifying and control conditions for either happiness or sadness. This broadly replicates adult findings, but the detrimental effects of dampening were less marked in adolescents than adults. Nevertheless, given that elevated dampening appraisals are associated with depressed mood, dampening may partly account for why depressed adolescents struggle to experience positive emotions, and represents a promising target for clinical intervention.

Keywords: Positive affect, appraisal style, anhedonia, depression, adolescence.

4.2 Introduction

Depression is a prevalent, chronic and recurrent disorder that is the leading cause of disability in young people (Dunn & Goodyer, 2006; Murray & Lopez, 1996; Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015). Adolescent depression is associated with several psychiatric comorbidities; poor social, education and physical outcomes (Jaycox et al., 2009; Maughan et al., 2013); and heightened risk of major depression, anxiety, substance disorders and suicidality in adulthood (Jonsson et al., 2011; McLeod et al., 2016). The core symptoms required to make a diagnosis of major depressive disorder are the presence of depressed mood and loss of interest or pleasure (anhedonia). These reflect underlying disturbances in two partly dissociable systems regulating withdrawal from punishing stimuli (the negative valence system; NVS) and approach to rewarding stimuli (the positive valence system; PVS). The PVS primarily shapes positive affect (PA) experience, while the NVS primarily determines negative affect (NA) experience (Carver & White, 1994; Gray, 1987; Insel et al., 2010; Paulus et al., 2017; David Watson et al., 1988). To date, depression research has focused on trying to understand and repair elevation in the NVS, while the PVS has been relatively neglected (Dunn, 2012, 2017; Dunn & Roberts, 2016), including in young people (Forbes & Dahl, 2012; Gilbert, 2012).

Anhedonia and associated PVS disturbances are highly prevalent among clinically depressed adolescents of both genders (Bennett et al., 2005). Anhedonia typically first emerges in early adolescence (Sørensen, Nissen, Mors, & Thomsen, 2005) and becomes increasingly prognostically important as individuals age (Bennik et al., 2014). Elevated symptoms of anhedonia in teenagers predate adult-onset major depression (Pine et al., 1999; Wilcox & Anthony, 2004), predict a poor response to anti-depressant and psychological treatment (McMakin et al., 2012), are a significant marker of suicidal thoughts and chronicity (Gabbay et al., 2015), and differentiate suicide attempters from the ideators (Auerbach et al.,

2015). While it has yet to be empirically tested, it is conceivable that enhancing positive emotions in adolescents will protect them from future depression, given links between positive emotionality and resilience (cf. Broaden and Build Hypothesis; Fredrickson, 1998). In particular, positive affect (PA) may trigger creativity, effective problem solving and social connection, therefore making adolescents more resilient in the face of future life setbacks.

There is a clear need to better understand and develop more effective ways to target PVS disturbances in adolescent depression. One way forward is to follow an experimental psychopathology approach, examining which underlying psychological mechanisms cause and maintain anhedonia (Holmes et al., 2018). There is a burgeoning literature in adult populations evaluating mechanisms driving anhedonia and broader positive emotion regulation (Bryant, Chadwick, & Kluwe, 2011; Carl, Soskin, Kerns, & Barlow, 2013; Dunn, 2017; Quoidbach, Mikolajczak, & Gross, 2015). We should not assume that the same mechanisms influence anhedonia in adolescence, and therefore need to test this empirically.

One anhedonia mechanism examined in adults is alterations in how individuals appraise any positive emotions they experience (Feldman et al., 2008). Dampening appraisals have been identified (e.g., think "this is too good to last") that inhibit positive emotion experience. These dampening appraisals can be contrasted to two forms of amplifying appraisals that enhance positive emotion. Self-focus appraisals involve thinking about the beneficial consequences of the positive situation (e.g. think "I am getting everything done"), whereas emotion focus (EF) appraisals involve focusing on the positive feeling (e.g. "think about how happy you feel"). EF and SF appraisals are highly correlated with one another and factor analysis suggests they form a single underlying dimension (see Nelis et al., 2016), so EF and SF are frequently collapsed into a single amplifying category.

In adults, there is good evidence that elevated use of dampening and reduced use of amplifying appraisals characterises depression (Dempsey, Gooding, & Jones, 2011; Nelis, Holmes, & Raes, 2015; Raes et al., 2009). Elevated dampening and reduced amplifying are consistently associated with increasing anhedonia severity cross-sectionally (Nelis, Holmes, & Raes, 2015; Werner-Seidler et al., 2013) and, to some extent, prospectively (Nelis, Holmes, & Raes, 2015). There is also experimental evidence that induced use of dampening appraisals leads to reduced PA and increased NA experience when engaging with positive material. Following instructions to dampen leads to reduced happiness and elevated sadness when anticipating positive events and remembering positive events (Dunn et al., 2018). Similarly, participants reported reduced PA and enhanced NA when utilising dampening appraisals during positive activity scheduling (a series of walks in pleasant locations; Burr, Javiad, Jell, Werner-Seidler, & Dunn, 2017). Findings regarding amplifying are more equivocal, with amplifying manipulations often not successfully increasing reported use of amplifying, and when they do, failing to robustly influence affective experience during anticipation, recall or direct experience of positive activities (Burr et al., 2017; Dunn et al., 2018).

While there is robust evidence that dampening drives anhedonia in adults, it is less well established in adolescence. A recent systematic review we have conducted has identified only three studies examining the link between positive appraisal style and anhedonia levels in child and adolescent populations (Yilmaz et al., in preparation; protocol registration number: CRD42018080229). The findings seem similar to studies in adults; increased levels of dampening appraisals and decreased amplifying appraisals are cross-sectionally associated with elevated depressive symptoms (Bijttebier et al., 2012; Raes, Smets, Nelis, & Schoofs, 2012). Dampening, and to a lesser extent amplifying, are also cross-sectionally associated with more marked anhedonia symptoms (Bastin, Nelis, Raes, Vasey, & Bijttebier, 2018;

Gilbert, Luking, Pagliaccio, Luby, & Barch, 2017; Nelis, Bastin, Raes, & Bijttebier, 2018). Nelis et al. (2018) found that elevated dampening and reduced amplifying predicted greater levels of depressive and anhedonia symptoms at two-year follow-up (although results were not significant at one-year follow-up).

While this cross-sectional and prospective association evidence is promising, what is lacking is robust causal evidence to demonstrate that manipulation of positive appraisal style when processing positive stimuli alters affective experience in adolescence. Therefore, the current study aims to preliminarily assess if the consequences of manipulating dampening and amplifying appraisals found in adult samples also extend to adolescents. In particular, we examined if manipulating positive appraisal style alters affective experience when recalling positive memories in the laboratory (replicating and extending the method used in Dunn et al., 2018 in adults). We used a mixed within-between subjects design, with all participants recalling a first memory under no particular instructions and then being randomised to recall a second memory when following dampening, amplifying or control instructions. This design makes it possible to control for individual differences in affective response to the memory recall task; to determine whether amplifying and dampening manipulations increase or decrease affective response in absolute terms; and also enables examination of how spontaneous use of each appraisal style during the first uninstructed recall relates to affective experience.

Based on findings reported in Dunn et al. (2018) in adults, we predicted that greater spontaneous use of dampening during the first uninstructed memory would be linked to a greater decrease in happiness and a greater increase in sadness (Hypothesis One) and that greater spontaneous use of amplifying during the first uninstructed memory would be linked to a greater increase in happiness and a greater decrease in sadness (Hypothesis Two). Moreover, we expected that the dampening condition (relative to the control condition)

would lead to reduced happiness reactivity and increased sadness reactivity during the second memory recall (Hypothesis Three). In particular, when following the dampening instructions during the second recall in absolute terms there would be a decrease in happiness and an increase in sadness from before to after the memory recall. This would contrast to an increase in happiness and a decrease in sadness in absolute terms during the second memory recall in the control condition. Given previous null findings regarding the effects of manipulating amplifying appraisals (cf. Dunn et al., 2018), we made no a priori predictions regarding the impact of the amplifying conditions. In exploratory analyses, we also examined whether trait use of each appraisal style, trait anhedonia, and trait symptoms of depression and anxiety modified the effects of the experimental manipulations.

4.3 Methods

4.3.1 Participants

We invited 15 secondary schools and sixth-form colleges from the Southwest area of England to participate via e-mail. We aim to recruit 90 participants to detect a medium effect size ($f = 0.25$, $\alpha = 0.05$, $\beta = 0.80$) for mixed between- and within-subjects design analyses. Five schools agreed to take part, and we initially recruited 92 students from four of these schools. Two were excluded due to potential suicidal risk, meaning 90 students were allocated to the experimental conditions (dampening $n = 31$; amplifying $n = 30$; control $n = 29$) based on a predetermined randomisation list. One participant's the data (in the amplifying condition) were lost due to experimenter error, leaving a final sample size of 89 for subsequent analyses. Participants were aged from 13 to 18 years ($M_{age} = 15.85$, $SD_{age} = 1.37$), and the majority of the sample were female (71.9 %) and White Caucasian (93.3 %). Participants were predominantly from families where both parents were currently employed (70.1 %) and were educated to at least GSCE or equivalent level qualifications (53.4 % of

mothers and 50.5 % of fathers). Participants were given a £10 high street voucher for taking part. Participants and their parents gave written, informed consent and the study was approved by the local university ethics committee (Ref, 2017/1429).

4.3.2 Questionnaire Measures

4.3.2.1 Anhedonia.

The Snaith—Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995) was used to index anhedonia. This is a 14-item measure of ability to experience pleasure from hobbies, social interactions, sensory experience, and food in the last few days (e.g., "I would find pleasure in my hobbies or pastimes"). Participants rate to what extent they agree with each statement on a scale ranging from 1 (Strongly agree) to 4 (Strongly disagree). The SHAPS has been validated for use in adolescents aged 14 to 16 (Leventhal et al., 2015). Total anhedonia scores were computed by summing up individual item scores (following the continuous scoring method developed by Franken, Rassin, & Muris, 2007), with higher scores indicating increased levels of anhedonia. Psychometric studies indicate the scale is moderately correlated with other measures of PA and has acceptable reliability in adolescent samples (Cronbach's α = 0.87; Leventhal et al., 2015). In the present sample the reliability was broadly comparable (α = 0.84).

4.3.2.2 Positive appraisal style.

The Responses to Positive Affect Scale for Children (RPA-C; Verstraeten, Vasey, Raes, & Bijttebier, 2012) was used to measure trait appraisal style in response to PA. This consists of 17 self-report items examining the extent to which individuals respond to PA by using emotion-focus amplifying appraisals (five items; e.g., "notice how you feel full of energy"), self-focus amplifying appraisals (four items; e.g., "think 'I am the best I could be.'"), and dampening appraisals (eight items; e.g., "think about the things that have not gone well for you"). Participants rate the extent to which they appraise positive emotion

experience in the way described by each item on a scale ranging from 1 (Almost never) to 4 (Almost always). Responses to subscale items were summed to create total scores for each, with higher scores reflecting greater engagement with the given appraisal style. We collapsed the EF and SF scales into a single amplifying dimension. In the present data, internal reliability was adequate (α = 0.84 for amplifying and α = 0.82 for dampening subscales).

The RPA-C was also modified to measure state appraisal style during each memory recall. Instructions were altered to ask participants to judge for each statement "When just recalling that memory, to what extent did you think or feel the following way?" We followed the two-factor amplifying and dampening structure reported for the state-RPA in Dunn et al. (2018). Reliability of the both state scales was adequate (amplifying: first memory α = 0.82, second memory α = 0.89*;* dampening*:* first memory α = 0.71, second memory α = 0.79).

4.3.2.3 Depression and anxiety measures.

The Revised—Children Anxiety and Depression Scale (RCADS*;* Chorpita, Yim, Moffitt, Umemoto, & Francis, 2000) was used to index levels of mood disorder symptoms. Participants completed the 10-item major depressive disorder (MDD: e.g., "I feel sad or empty"), nine-item social phobia (SP; e.g., "I worry what other people think of me"), and six-item generalised anxiety disorder (GAD; e.g., "I worry that bad things will happen to me") subscales. Participants rate how often they had felt the way described in each item on a Likert scale ranging from 0 (Never) to 3 (Always). We created total subscale scale scores by summing up the scores from each item. The instrument has satisfactory internal consistency (MDD: α = 0.80; SP: α = 0.81; GAD: α = 0.85; Chorpita et al., 2009). In the present sample, internal consistency was also good (MDD: α = 0.87; SP: α = 0.89; GAD: α = 0.82).

4.3.3 Experimental Task

The experimental task was based on the methodology described by Dunn et al. (2018), but adapted for adolescents. The task was piloted with four adolescents prior to the

experiment starting to check it was acceptable and feasible. The task was programmed in Microsoft Visual Studio Express and run on a laptop with a 15" screen in a quiet testing room. The experimenter guided each participant through on-screen instructions that were shown at different stages of the task.

At the beginning of the testing session, participants identified two positive autobiographical memories and chose a cue word that could be used to prompt recall of each memory (see Supplementary Materials for full details). The age or intensity of the memories to be recalled were not restricted. The computerised task prompted and guided recall of these memories. The cue words were entered into the task, which randomly chose one to prompt recall of the first (uninstructed) memory and one to be used to prompt recall of the second (instructed) memory.

To assess mood before recalling the uninstructed memory, participants were asked to relax for 30 seconds. Participants rated their happiness and sadness experience on average during this resting period, using 100 point sliding visual analogue scales ranging from 1 (not at all) to 100 (extremely)[1]. Participants were then shown one of their two cue words and asked to recall that memory "as you naturally would and as vividly as possible in your mind" for two minutes while writing down their stream of consciousness (adapting method reported by Dalgleish, Yiend, Schweizer, & Dunn, 2009). Participants then rated their average happiness and sadness experience during the memory recall and completed the state modified RPA to measure spontaneous use of amplifying and dampening appraisals during the first memory.

Next, participants watched a three-minute video of moving abstract shapes (Gross & Levenson, 1995). This was intended as a neutral mood 'washout' task to return participants to baseline before recalling the second memory. To assess baseline mood prior to the second recall, participants again relaxed for 30 seconds and rated their levels of happiness and

sadness when doing so. They were then given instructions about how to recall the second memory.

Participants who were randomised into the amplifying condition were told: "*As you recall this memory, think about any positive feelings as the start of good things to come, think about how you are living up to your potential and concentrate on how happy you feel*". Along with the cue word, the following prompts were presented on the screen for the duration of the two-minute recall period "*Focus on your positive emotion experience during this memory recall; Attend to: How happy you feel, how strong you feel, how you feel up to doing anything, try to focus on enjoying this moment*".

Participants who were randomised into the dampening condition were told: "*As you recall this memory, think about any feelings of positivity experienced are too good to last, why you don't deserve these positive feelings and what could go wrong as a result of these positive feelings*". A cue word was presented on the screen along with the following prompts for the two minutes recall period "*Dampen your positive experience during this memory recall. Focus on why any positive feelings you are experiencing are: Too good to be true, won't last, are undeserved, and will make things go wrong*".

Participants in the control condition received identical instructions during the second memory as during the first memory. Participants again wrote down their stream of consciousness during the memory, rated their mood as described above, and completed the modified RPA to assess their appraisal style during the second memory.

At the end of the experiment, all participants watched a two-minute amusing clip from the movie *Bruce Almighty* (as described in Uhrig et al., 2016). This was intended to ensure all participants were in a positive frame of mind before finishing the testing session. Content and suitability of both videos to the target population were piloted prior to data collection on four adolescents.

An independent rater, blind to which condition participants had been allocated to, inspected each cue word and the written narratives to determine if the memories recalled were positive in nature. All memories were judged to be linked to positive events, so no participants were excluded on this basis. The kind of memories participants chose to recall included holidays, activities with family and friends, pets and academic achievements.

4.3.4 Procedure

Students in years 9 (aged thirteen) to year 13 (aged eighteen) were given an information sheet and opt-in consent form to take home. If parents were happy for their child to participate, they were asked to return a permission slip to a designated member of staff in their school. The experimenter contacted each parent by telephone or email to confirm their consent. Each participant read the study information sheet at the beginning of the testing session and then gave written informed consent in a face-to-face meeting with the experimenter. Testing took place in a quiet testing room. Participants first provided demographic information on age, gender, ethnicity, parental education, and occupation status by filling in a short questionnaire. Next, participants completed the RCADS, RPA-C, and SHAPS one after the other. If participants indicated a potential suicidal risk, they did not complete the experimental task and to avoid any possible harmful effects of the dampening appraisal manipulations but were invited to complete a parallel survey study (data not reported further here). Six participants with increased depressive symptoms (scoring 11 and above on RCADS MDD subscale; Chorpita, Moffitt, & Gray, 2005) and thoughts about death went through the risk screening conducted by the experimenter on plans, actions and prevention of suicide (two of whom were excluded from the subsequent experiment as this screening procedure indicated some risk).

Participants then practiced how to rate their mood on the experimental task and practiced use of the write-out-loud procedure. Next, participants completed the experimental

task as described above. The laboratory experiment lasted approximately 25 minutes. Participants were also invited to take part in a subsequent Experience Sampling (ESM) study over the following weekend (not reported further here). They were debriefed, given a list of mental health resources should they need them, and compensated for their time after they completed the ESM study.

4.4 Results

Alpha was set at 0.05 and statistical tests were two-tailed. Data were inspected for normality, outliers, and missing data prior to analysis. As data met all the required assumptions for parametric analyses, no additional steps were taken to correct the data prior to analysis.

4.4.1 Participant characteristics

Table 4.1 reports baseline clinical and demographic characteristics of participants in each condition (31 in the dampening condition, 29 in the amplifying condition, and 29 in the control condition). Analyses (one-way ANOVA for continuous variables and chi-square for categorical variables) found no significant group differences on any variables, *p*s > 0.35.

4.4.2 Mood induction manipulation check

To examine if the positive memory task had the expected impact on affective experience, we performed paired sample t-tests between pre- and post-first memory recall happiness, sadness and anxiety mood ratings (collapsing across conditions). As expected (and replicating Dunn et al., 2018), there was a significant increase in happiness ratings, *mean*Δ = 25.61, *SD* = 18.30, $t = 13.20$, $p < 0.001$, $d = 1.40$, and no significant changes in sadness ratings, *mean*Δ = -1.92, *SD*Δ = 19.34, $t = -0.94$, $p = 0.35$, $d = 0.10$, from before to after the first memory recall. This indicates that the recall task, in general, had the intended impact on affective experience. For all subsequent analyses, residual change scores were used (regressing resting task ratings onto memory ratings and then saving the unstandardized

residuals). Residual change scores better accounted for individual differences at baseline in happiness and sadness that could otherwise confound the pattern of findings.

4.4.3 Associations between spontaneous appraisal and affective experience during memory one

Next, Pearson's correlations were conducted to examine the association between residual change in happiness and sadness ratings from baseline to memory and spontaneous use of each appraisal style during the first (uninstructed) recall. There was a sufficient spread of amplifying and dampening scores, meaning range restriction effects were not leading to false positive conclusions. Overall sample mean for state dampening was 10.88 (*SD* = 3.54, range = 7 - 21) and for state amplifying was 15.51 (*SD* = 5.03, range = 7 - 27). Greater spontaneous use of dampening was not significantly associated with happiness reactivity, r = -0.21, p = 0.85, but was associated with a less marked decrease in sadness, r = 0.44, p < .001, when recalling a positive memory. In contrast, greater spontaneous use of amplifying was associated with a greater happiness increase, r = 0.25, p = 0.02, and a greater sadness decrease, r = -0.26, p = 0.02, when recalling a positive memory. When entering both dampening and amplifying into the same regression model, greater happiness reactivity continued to be linked to greater spontaneous amplifying, r_p = 0.26, p = 0.02, but not reduced spontaneous dampening, r_p = 0.04, p = 0.70. Greater sadness reduction was significantly predicted by lower levels of dampening, r_p = 0.41, p < 0.001, but not greater use of amplifying, r_p = -0.17, p = 0.11.

4.4.4 Appraisal style manipulation check

Table 4.2 reports use of each appraisal style during the first and second memory recall. As intended, there were no significant group differences in use of amplifying appraisals, F (2, 86) = 0.30, p = 0.75, η_{p2} = 0.01, or dampening appraisals, F (2, 86) = 0.87, p = 0.42, η_{p2} = 0.02, during the first, uninstructed memory.

Next, we tested whether appraisal style changed as a function of manipulation instructions. We computed a simple difference score to capture the change in each appraisal style in the first versus second memory and then examined if these varied between conditions using a series of one-way ANOVAs. Where a significant main effect of condition was found, this was resolved using t-tests.

Conditions significantly differed on amplifying change scores, F (2, 86) = 10.00, p < 0.001, η_{p2} = 0.19. Pairwise comparisons found that the dampening condition significantly differed from the control and amplifying conditions, ps < 0.01, but there was no significant difference between the control and amplifying conditions, p = 0.45. One sample t-tests on the simple difference scores were then run on each condition separately to interpret the direction of change. There was a significant increase in amplifying scores in the amplifying, *mean*Δ = 2.21, *SD* = 4.45, t = 2.67, p = 0.01, d = 0.50, and control, *mean*Δ = 1.34, *SD* = 2.69, t = 2.69, p = 0.01, d = 0.50, conditions. Amplifying scores significantly decreased in the dampening condition, *mean*Δ = -2.48, *SD* = 5.37, t = -2.57, p = 0.02, d = 0.46.

Dampening change scores also significantly differed across conditions, F (2, 86) = 9.82, p < 0.001, η_{p2} = 0.19. Pairwise comparisons indicated that the dampening condition significantly differed from the control and amplifying conditions, ps < 0.01, while the amplifying and control conditions did not significantly differ, p = 0.38. One sample t-tests revealed a non-significant increase in dampening scores in the amplifying condition, *mean*Δ = 0.03, *SD* = 2.83, t = 0.07, p = 0.95, d = 0.01, a non-significant decrease in dampening in the control condition, *mean*Δ = -0.76, *SD* = 3.20, t = -1.28, p = -0.21, d = 0.24, and a significant increase in the dampening condition, *mean*Δ = 2.97, *SD* = 4.12, t = 4.01, p < 0.001, d = 0.72.

In summary, the dampening manipulation significantly increased levels of dampening and decreased levels of amplifying, relative to both of the other conditions. There were no

differences between the control and amplifying manipulation arms for either levels of dampening or amplifying. This indicates the dampening, but not the amplifying, manipulation was successful.

4.4.5 Impact of appraisal style manipulations on affective experience

Table 4.2 reports mean happiness and sadness ratings at each phase of the experiment for participants in each condition. While all statistical analyses used residual change scores from rest to recall of each memory (regressing baseline ratings onto memory ratings) to index emotional reactivity, for ease of visual interpretation we plotted simple change in happiness and sadness ratings during each memory recall for each condition (see Figures 4.1 and 4.2).

One-way ANOVAs examined if groups were comparable during the first, uninstructed memory recall. As intended, there were no group differences in happiness residual change, F (2, 86) = 0.56, p = 0.58, η_{p2} = 0.01, or sadness residual change, F (2, 86) = 1.33, p = 0.27, η_{p2} = 0.03, for the first uninstructed memory.

To examine the effect of the appraisal style manipulation on affective experience, we computed a simple difference score between reactivity to the first and second memories. We compared conditions using a series of one-way ANOVAs. There was a significant effect of condition on happiness reactivity, F (2, 86) = 15.88, p < 0.001, η_{p2} = 0.27. The dampening condition significantly differed from the control and amplifying conditions, ps < 0.001, but there was no significant difference between the control and amplifying conditions, p = 0.34. There was a significant increase in happiness reactivity from the first to the second memory in both amplifying, *mean*Δ = 7.14, *SD* = 18.19, t = 2.11, p = 0.04, d = 0.40, and control, *mean*Δ = 13.04, *SD* = 11.96, t = 5.87, p < 0.001, d = 1.09, conditions. In the dampening condition, happiness reactivity significantly decreased from the first to the second memory, *mean*Δ = -18.88, *SD* = 33.68, t = -3.12, p < 0.01, d = 0.56.

There was also a significant difference in change in sadness reactivity between conditions, F (2, 86) = 13.59, $p < 0.001$, $\eta_{p2} = 0.24$. Again, the dampening condition significantly differed from the control and amplifying conditions, ps < .001, but the amplifying and control conditions did not differ, $p = 0.83$. The sadness change scores significantly increased from the first to the second memory in the dampening condition, *mean*Δ = 17.48, *SD* = 32.7, $t = 2.98$, $p = 0.01$, $d = 0.53$, and significantly decreased from the first to the second memory in the control condition, *mean*Δ = -8.71, *SD* = 13.61, $t = -3.45$, $p = 0.002$, $d = 0.64$. In the amplifying condition, there was a non-significant decrease in sadness reactivity from the first to the second memory, *mean*Δ = -9.98, *SD* = 17.75, $t = -3.03$, $p = 0.01$, $d = 0.56$.

Finally, we examined whether the dampening manipulation had turned the positive memory recall task into a negative mood induction. In particular, Dunn et al. (2018) in adults found that recalling a positive memory when following dampening instructions led to a reduction in happiness and an increase in sadness from immediately before to after the recall. We assessed if a similar pattern held in adolescents. To replicate analysis in Dunn et al. (2018), paired sample t-tests examined the simple change to the second memory in the dampening condition. In contrast to findings from Dunn et al. (2018), the dampening condition did not lead to a significant decrease in happiness from the rest task to during the memory recall, *mean*Δ = -1.30, *SD* = 33.04, $t = -0.22$, $p = 0.83$, $d = 0.04$. However, sadness did significantly increase, *mean*Δ = 20.03, *SD* = 30.78, $t = 3.62$, $p < 0.01$, $d = 0.65$, consistent with Dunn et al. (2018).

Following Dunn et al. (2018), we conducted exploratory analyses on the dampening condition to examine if it was the change in dampening appraisals and/or amplifying appraisals that were most robustly linked to change in happy and sad mood. The differences in absolute amplifying and dampening appraisals and in happiness and sadness residual

change from the first memory to the second memory for participants in the dampening condition were computed and then correlated with one another (using Pearson's correlation coefficients). A greater increase in dampening was related to a greater happiness reduction, $r = -0.68$, $p < 0.001$, and greater sadness increase, $r = 0.71$, $p < 0.001$. A greater reduction in amplifying was associated with reduced happiness change, $r = 0.62$, $p < 0.001$, and greater sadness change, $r = -0.46$, $p < 0.01$.

4.4.6 Exploratory analyses

Exploratory analyses examined if the effect of the amplifying and dampening manipulations on happiness and sadness was moderated by severity of baseline psychopathology levels. There was sufficient spread in SHAPS anhedonia (*M* = 31.81, *SD* = 5.46, 19 - 42), RCADS depression (*M* = 8.31, *SD* = 5.03, 0 - 24), RCADS social phobia (*M* = 13.64, *SD* = 6.29, 0 - 27) and RCADS generalized anxiety disorder scores (*M* = 5.84, *SD* = 3.54, 0 - 15) for these analyses. We ran a series of moderation analyses using Model 1 of the PROCESS macro created by (Hayes, 2017). A significant interaction effect of each variable would indicate that the relationship between the condition and affective response to the appraisal manipulations varies as a function of these variables. Moderation analyses revealed that none of the interactions were significant, *F*s < 2.60, *p*s > 0.08.

4.5 Discussion

The present study examined the consequences of instructed use of dampening and amplifying appraisals when adolescents were asked to recall positive memories (attempting to replicate finding in adults reported by Dunn, 2018 in an adolescent population). Greater spontaneous use of dampening appraisals during the first uninstructed memory was significantly related to altered sadness reactivity (less of a reduction when recalling positive memory) but was not significantly related to happiness reactivity. This only partly supports Hypothesis One and differs from findings in adults where spontaneous dampening was linked

to happiness but not sadness reactivity (Dunn et al., 2018). Greater spontaneous use of amplifying was significantly linked to sadness reactivity (more of a reduction when recalling a positive memory) and happiness reactivity (more of an increase when recalling a positive memory), fully consistent with Hypothesis Two but slightly deviating from previous findings in adults (where amplifying was linked to happiness but not sadness reactivity; Dunn et al., 2018). As intended, the dampening manipulation elevated use of dampening appraisals during the second recall relative to the first recall, to a more marked degree than the control and amplifying conditions. However, the amplifying manipulation did not increase the use of amplifying appraisals during the second recall relative to the first recall to a greater extent in the amplifying than the control condition. Instead, there was a reduction in amplifying appraisals in the dampening condition relative to the control condition. Therefore, the dampening manipulation worked similarly in adolescents as in previous adult studies (Dunn et al., 2018) but the amplifying manipulation was not successful (failing to replicate adult findings; Dunn et al., 2018).

Largely supporting Hypothesis Three, the dampening condition led to altered happiness reactivity and sadness reactivity, compared to both the control and the amplifying condition. As with findings reported in adults (Dunn et al., 2018), there was an increase in sadness reactivity and a decrease in happiness reactivity from the first to the second memory recall in the dampening condition. Moreover, in terms of sadness reactivity, the second positive memory recall under dampening conditions was an active negative mood induction (sadness experience increased from pre to post the recall). However, a slight difference to previous adult findings reported by Dunn et al. (2018) was that there was not a significant drop in happiness from pre to post the second memory recall in the dampening condition in the present adolescent sample.

Replicating the null findings in adults (Dunn et al., 2018), there was no significant difference between the amplifying and control conditions in terms of sadness and happiness reactivity. However, an important caveat in interpreting these findings is that the amplifying manipulation did not significantly alter amplifying appraisals, meaning it is inappropriate to draw strong conclusions about the impact of amplifying on the basis of the present data. It is possible that if the amplifying manipulation had been successful in changing amplifying appraisals, this would have altered affective experience in adolescents. Interestingly, the amplifying manipulation was unsuccessful in the second study in Dunn et al. (2018) focusing on anticipatory processing in adults.

None of these findings were influenced by trait anhedonia levels and symptoms of depression, social phobia and generalized anxiety disorder (similar to the null pattern of moderation findings reported by Dunn et al., 2018).

The spontaneous analyses reveal a somewhat different pattern of findings to those observed in adults (Dunn et al., 2018), with spontaneous dampening being less clearly toxic in adolescents relative to adults, as it was only related to increased sadness but not increased happiness. It is interesting to consider why these differences emerge. It may be that with age individuals 'rehearse' dampening appraisals and they become more potent. Alternatively, it may be that adolescents spontaneously engage in different dampening themes relative to adults. For example, it is possible that adults make more marked use of 'undeservedness' themes (e.g. "I don't deserve to feel happy") that may have more potent effects on happiness as well as sadness experience. This possibility requires further examination using more sensitive assays of dampening that can tease apart different appraisal themes.

The dampening manipulation findings largely replicate results in adults showing that dampening reduces happiness and increases sadness when processing positive material (Burr et al., 2017; Dunn et al., 2018). To our knowledge, this is the first time this has been

demonstrated in adolescents. As in the adult literature, it is an open question as to whether the dampening manipulation acts by decreasing dampening appraisals, decreasing amplifying appraisals or a combination of the two. In particular, change in amplifying and dampening in the dampening condition both correlated with change in affective experience during the second memory recall in the present study, which mirrored the results in adults; Dunn et al., 2018). It seems plausible that when making dampening appraisals, amplifying appraisals will reduce and vice versa, with both of these processes leading to changes in the affective experience.

The present results provide slightly equivocal support for the strong form of the dampening hypothesis put forward in adults by both Dunn et al. (2018) and Burr et al. (2017). In particular, while use of dampening during positive memory recall did lead to an absolute increase in sadness from pre to post recall, there was not a significant reduction in happiness from pre to post recall. As discussed above, this may reflect the fact that adolescents are less practised at applying dampening appraisals (so they are less potent) or may focus on different kinds of appraisal themes that have less impact on positive mood. Alternatively, it may be that adolescents were less willing to follow the dampening manipulation instructions at the point this started to impact detrimentally on their mood. The magnitude of increase in dampening appraisals in the dampening condition in the present study was comparable to that observed in previous studies looking at adults, which suggests that the latter explanation is unlikely, (Dunn et al., 2018). Further work is needed to understand why the strong form of the dampening hypothesis may not hold to the same extent in adolescents.

These findings strengthen the current cross-sectional and prospective evidence that dampening appraisal style is a candidate mechanism driving altered emotional reactivity to positive stimuli in adolescents and may therefore contribute to anhedonia for those affected by clinical levels of depressive symptoms (see Bastin et al., 2018; Bijttebier et al., 2012;

Nelis et al., 2018; Raes et al., 2012). In particular, this is the first evidence from randomised experimental designs to show that the manipulation of dampening alters affective experience, allowing causal inferences to be made. However, this causal evidence has only been established in the memory domain and using controlled laboratory methods that lack ecological validity. Further work is needed to examine if dampening alters affective experience when anticipating and during positive activities, including using more ecologically valid methods. For example, the event scheduling design utilised in adults (Burr et al., 2017) could be adapted for use in adolescents.

It is important to reflect on why the amplifying manipulation was unsuccessful. One possibility is that adolescents spontaneously make use of amplifying appraisals, so were close to ceiling prior to the amplifying manipulation. However, amplifying scores were not at maximum during the uninstructed first memory recall, making this is unlikely. Another possibility is the kind of amplifying appraisals captured by the scale are not relevant to the positive memories participants recalled. In particular, many of the amplifying appraisals focus on achievement themes (e.g. "I am living up to my potential") that may be less relevant to a scenario like recalling a pleasant holiday or time spent with friends. Finally, the amplifying items were originally designed to identify pathological appraisals that characterise manic states (Feldman et al., 2008). It may be that items need to be phrased differently to capture more 'adaptive' forms of amplifying (see Dunn et al., 2018).

The present results may be of clinical relevance, given the increasing recognition that anhedonia is often a precursor to adolescent clinical depression and is often a debilitating and distressing feature of adolescent depression once established. Dampening appraisals may be one factor maintaining anhedonia in adolescents that could be targeted in treatment, for example using conventional cognitive challenge techniques from cognitive behavioural therapy (CBT; e.g. Goodyer et al., 2017) or cognitive defusion techniques from Acceptance

and Commitment Therapy (ACT; see Hayes, Boyd, & Sewell, 2011). Dampening appraisals may also explain why conventional therapy techniques like positive activity scheduling, a central component of Behavioural Activation approaches (Martin & Oliver, 2018; Pass et al., 2018; Tindall et al., 2017) can sometimes backfire. If an individual engages with a positive activity but thinks about it in a dampening way throughout the experience is likely to be aversive, further driving behavioural withdrawal and avoidance. Helping adolescents notice and step away from dampening appraisals during positive activity scheduling may prevent this from occurring. Some caution is warranted here, given that the present sample was not clinically depressed; care should not be taken to over generalise findings from healthy adolescents to clinical populations. However, there was no evidence to suggest depression or anhedonia severity moderated the impact of dampening manipulations on affective experience, which may indicate that the same consequences of instructed dampening would be likely to emerge in clinically depressed groups. Moreover, there is increasing acceptance that analogue findings of the present kind can be generalised across the severity spectrum in many cases (see Abramowitz et al., 2014).

As with our previous adult studies, there are a number of limitations with the present work. We indexed affective experience solely in terms of self-report and using single item visual analogue scales. These findings should be replicated using other self-report scales and also using other methods to assess emotional response (for example, psychophysiology or neuroimaging) to see if the results triangulate. In addition, the experimental demand may be vulnerable to demand effects, given the absence of elaborate cover stories to disguise our predictions. However, if demand effects were an issue we would have expected to also see significant effects for instructed amplifying, which did not emerge in the present study. Future research should also investigate other elements of anhedonia beyond subjective affective experience, for example including the motivation to work for rewards (‘wanting’)

and changes in behaviour/thinking following rewards ('learning') (see Berridge & Kringelbach, 2008). Finally, all of the causal tests of dampening as a mechanism driving anhedonia have merged from our laboratory and these results now ideally require independent replication.

In summary, the present study provides the first evidence that dampening appraisals may drive altered affective experience to positive material in adolescents. This replicates and extends work finding similar results in adult populations and tentatively suggests that treatments aiming to repair anhedonic symptoms in adolescents may be enhanced if they target dampening appraisals.

4.6 Footnotes

[1]Dunn et al. (2018) additionally included pleasantness ratings in a parallel study with adult participants. To minimise participant burden for a younger age group, we did not include this measure in the current study.

4.7 Acknowledgements

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Tables

Table 4. 1 *Demographic and clinical characteristic of participants and baseline mood ratings per condition.*

	Experimental Condition			
	Amplifying *n* = 29	Dampening *n* = 31	Control *n* = 29	Group comparison
Age	15.72 (1.38)	15.69 (1.36)	16.15 (1.37)	$F = 1.04$, $p = 0.36$
Gender (Female %)	76	77	62	$X_2 < 1$
Ethnicity (White %)	90	94	97	$X_2 < 1$
Anhedonia	31.17 (6.21)	31.61 (5.16)	32.66 (5.03)	$F < 1$
MDD	9.28 (6.12)	8.2 (3.98)	7.48 (4.82)	$F < 1$
SP	14.07 (6.14)	13.39 (7.02)	13.48 (5.79)	$F < 1$
GAD	5.97 (3.59)	5.45 (3.50)	6.14 (3.61)	$F < 1$
Trait-Amplifying	21.52 (5.56)	22.58 (4.46)	21.69 (5.44)	$F < 1$
Trait-Dampening	15.62 (5.30)	14.55 (4.57)	14.52 (4.45)	$F < 1$

Note. Data are mean (one standard deviation) values unless otherwise stated.

Table 4. 2 *State-appraisal and mood ratings before and after each memory broken down by condition.*

		Experimental Condition		
	Time	Amplifying	Dampening	Control
Amplifying	First memory	15.07 (5.23)	15.39 (4.35)	16.07 (5.30)
	Second memory	17.28 (5.77)	12.90 (5.28)	17.41 (4.73)
Dampening	First memory	11.59 (3.98)	10.58 (3.37)	10.48 (3.26)
	Second memory	11.62 (4.57)	13.55 (4.67)	9.72 (2.51)
Happiness	Rest - Recall 1	49.69 (22.58)	53.97 (23.09)	55.03 (20.10)
	Post - Recall 1	78.45 (19.06)	79.77 (15.99)	77.28 (16.15)
	Rest - Recall 2	46.17 (23.78)	44.29 (25.90)	50.34 (22.49)
	Post - Recall 2	73.14 (26.33)	45.58 (31.06)	77.52 (18.33)
Sadness	Rest - Recall 1	10.76 (18.4)	15.90 (20.83)	10.00 (11.20)
	Post - Recall 1	13.38 (16.95)	10.06 (13.65)	7.72 (11.35)
	Rest - Recall 2	15.48 (20.74)	16.23 (20.54)	9.86 (15.92)
	Post - Recall 2	12.86 (18.02)	36.26 (28.56)	6.03 (9.018)

Note. Data are mean (one standard deviation) values.

Figures

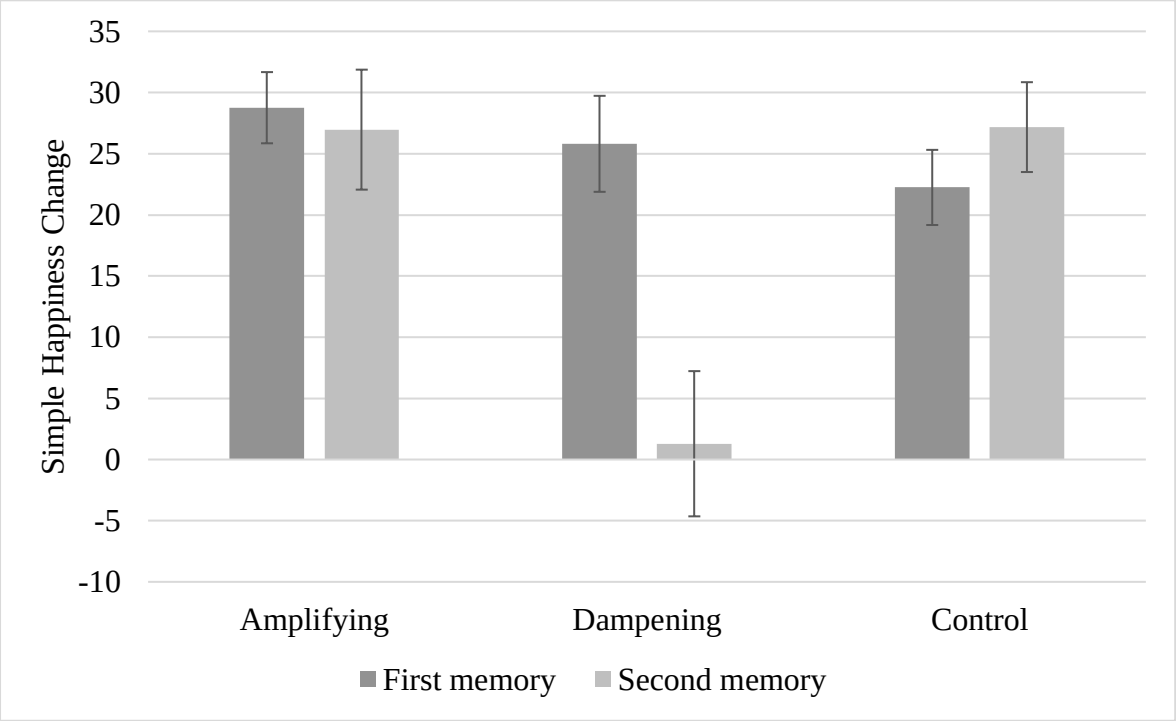

Figure 4. 1 Change in happiness during first and second memory recall broken down by the condition.

Data represented are mean (one standard error of the mean) values.

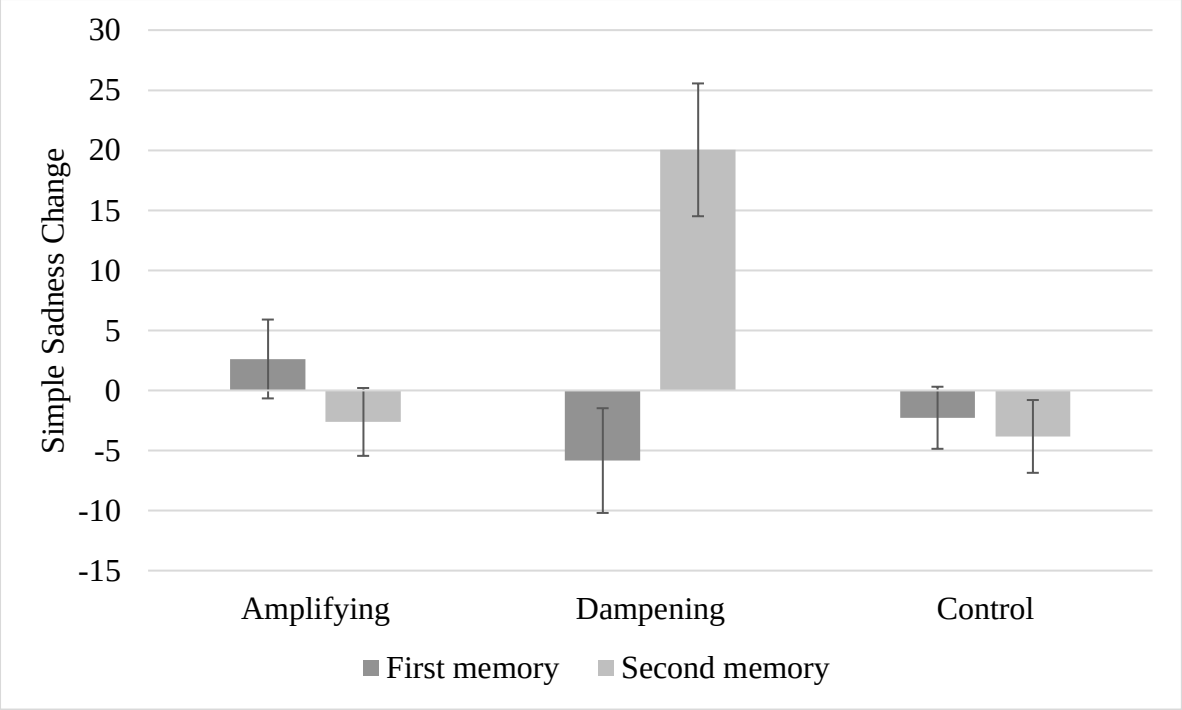

Figure 4. 2 Change in sadness during first and second memory recall broken down by the condition.

Data represented are mean (one standard error of the mean) values.

Chapter 5.0: Study Four

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Do rain on my parade: Induced dampening appraisals blunt positive affect while listening to happy music in adolescents.

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5.1 Abstract

Previous work has shown that dampening appraisals (e.g. thinking "this is too good to last") reduce positive affect and enhance negative affect when adolescents are asked to recall positive memories in the laboratory. The present study examined whether a similar pattern holds during a more ecologically valid, naturalistic task (listening to positive music). Using a bespoke smartphone application, 24 adolescents were randomised to listen to a positive playlist of their choice over four consecutive days while following dampening, amplifying-control, or no-instruction control instructions (a crossover randomised controlled trial design). They rated their levels of positive and negative affect before and after listening to each playlist. Participants experienced a significantly smaller increase in positive mood and a smaller decrease in negative mood during the dampening condition, relative to both the amplifying and no instruction control conditions. Given that elevated dampening appraisals are associated with depressed mood, dampening may partly account for why depressed adolescents struggle to experience positive emotions and represents a promising target for clinical intervention.

Keywords: Positive affect, appraisal style, anhedonia, depression, adolescence, activity scheduling

5.2 Introduction

Peak first age of onset for major depressive disorder occurs in adolescence (Kessler et al., 2007), results in significant functional impairment, and predicts poor social, educational and physical outcomes (Dunn & Goodyer, 2006; Murray & Lopez, 1996; Polanczyk, Salum, Sugaya, Caye & Rohde, 2015). Moreover, if not treated early, depression often follows a chronic, relapsing course in later life. Consistent with this, adolescent depression confers heightened risk of adult depression, anxiety, substance abuse and suicidality in adulthood (Jonsson et al., 2011; McLeod et al., 2016; Wilson, Hicks, Foster, McGue, & Iacono, 2015).

A core component of depression is a loss of interest or pleasure (anhedonia). Anhedonia reflects an underlying disturbance in the positive valence system (Insel et al., 2010) that regulates approach to rewarding stimuli and generates positive affect (PA) experience. Anhedonia is prognostically important in adolescence. Anhedonia symptoms predict subsequent onset of depression (Pine, Cohen, Cohen & Brook, 1999; Wilcox & Anthony, 2004), a sub-optimal response to depression treatments (McMakin et al., 2012), and elevated suicidal thoughts and attempts (Auerbach, Millner, Stewart & Esposito, 2015; Gabbay et al., 2015). Anhedonia becomes an increasingly important prognostic feature in later adolescence (Bennik, Nederhof, Ormel & Oldehinkel, 2014). Conversely, it is plausible that individuals with high levels of PA (i.e. the inverse of anhedonia) may be less vulnerable to depression, given links between positive emotions and personal resilience (cf. Broaden and Build Hypothesis; Fredrickson, 1998).

Despite the importance of anhedonia, existing preventative and acute treatments for depression in adults and adolescents have tended to neglect it, instead focusing predominantly on reducing elevations in negative mood and thinking (Dunn, 2012, 2017; Dunn & Roberts, 2016; Forbes & Dahl, 2005, 2012; Gilbert, 2012). There is a need to enhance understanding of the underlying psychological mechanisms causing and maintaining

anhedonia so that treatments can more effectively target it (cf. experimental psychopathology approaches; see Holmes et al., 2018). Such an approach is starting to be followed in adult populations, where a growing body of work has identified and evaluated mechanisms linked to reduced PA (e.g. Bryant, Chadwick & Kluwe, 2011; Carl, Soskin, Kerns & Barlow, 2013; Dunn, 2017; Quoidbach, Mikolajczak & Gross, 2015). A logical next step to be able to better manage anhedonia in adolescence is to evaluate whether the same mechanisms are central to PA disturbances in young people.

One promising anhedonia mechanism identified in adults is alteration in the way individuals appraise any positive emotions they experience (Feldman, Joormann & Johnson, 2008). It has been proposed that anhedonic individuals are more likely to engage in appraisals that lead to blunting and premature termination of PA (so-called dampening appraisals; e.g., thinking positive things are too good to last or are not deserved). Conversely, they are less likely to engage in emotion-focus (e.g. focus on how positive people feel) and self-focus (e.g. focus on a sense of achievement) amplifying appraisals that enhance and extend positive emotions. Consistent with these claims, enhanced dampening and reduced amplifying appraisals are linked to elevated anhedonia and depression in adults, using both cross-sectional and prospective survey designs (for example, Nelis, Holmes & Raes, 2015; Werner-Seidler, Banks, Dunn & Moulds, 2013). There is also robust evidence that when individuals are instructed to use dampening appraisals this leads to reduced PA and enhanced negative affect (NA) when anticipating positive events, during positive events, and when remembering positive events in adults (Burr, Javiad, Jell, Werner-Seidler & Dunn, 2017; Dunn et al., 2018). In contrast, when amplifying appraisals are manipulated, this has generally failed to alter affective experience during event anticipation, event completion, and event recall (Burr et al., 2017; Dunn et al., 2018).

There is now an emerging body of work examining whether dampening and amplifying appraisals have the same impact in adolescent samples. Increased dampening appraisals and decreased amplifying appraisals are consistently associated with elevated depressive and anhedonia symptoms in adolescents cross-sectionally, although findings are less consistent prospectively (Bastin, Nelis, Raes, Vasey, & Bijttebier, 2018; Bijttebier, Raes, Vasey & Feldman, 2012; Gilbert, Luking, Pagliaccio, Luby & Barch, 2017; Nelis, Bastin, Raes & Bijttebier, 2018; Raes, Smets, Nelis & Schoofs, 2012). Manipulating the use of dampening appraisals in the laboratory reduces happiness levels and increases sadness levels during positive memory recall, relative to a control condition (Yilmaz, Psychogiou, Ford, Javiad & Dunn, submitted). There is, however, no clear evidence that the instructed use of amplifying appraisals impacts on affective experience in the same task. This memory recall paradigm can be criticised on the grounds of low ecological validity. There is a difference between how individuals feel when artificially recalling a memory in a controlled laboratory environment, compared to how they feel when encountering real world, more naturalistic positive events or stimuli.

An important next step is to examine whether the consequences of manipulated appraisal style hold in more ecologically valid settings. Therefore, in the present study, we explored the causal impact of positive appraisal styles on affective experience during every day pleasant activities performed in daily life. We based the study on the methodology used in adults by Burr and colleagues (2017), where individuals completed four pleasant walks whilst following dampening, emotion-focus amplifying, self-focus amplifying, or control instructions delivered via a bespoke smartphone application (a crossover randomised controlled trial design). This design makes use of positive activity scheduling that is core to many treatments of depression as a 'vehicle' for experimentation. Rather than asking adolescents to complete a series of pleasant walks, we instead asked participants to listen to

positive music for four consecutive days. Piloting with adolescents suggested a walk was frequently considered not to be a pleasurable activity. In contrast, adolescents rate listening to music as their favourite indoor activity and listen to music for almost three hours per day (North, Hargreaves & O'Neill, 2000). Music listening provides a way for adolescents to regulate their affect, often with the intention to enhance or restore positive feelings (Saarikallio & Erkkilä, 2007).

A bespoke smartphone application was designed to collect affect ratings and manipulate appraisal style while listening to the music. Smartphone technology of this kind provides an ecologically valid way to examine mechanisms driving psychopathology, especially in 'digital native' adolescent populations (Dahl, Allen, Wilbrecht & Suleiman, 2018). If the same findings emerge in real-world settings of this kind as in our previous laboratory study (Yilmaz et al., submitted), this suggests they are most likely robust and generalizable.

We hypothesised that the dampening manipulation would lead to decreased PA and increased NA, relative to the control condition, and replicate findings in adult samples; Burr et al., 2017. Given previous null findings regarding the effects of manipulating amplifying appraisals (cf. Burr et al., 2017) we made no a priori predictions regarding the impact of the amplifying conditions. In exploratory analyses, we also examined whether trait use of each appraisal style, trait anhedonia, and trait symptoms of depression and anxiety modified the effects of the experimental manipulations.

5.3 Methods

5.3.1 Design

We used a crossover randomised trial design in which participants listened to music and rated their affective experience on four consecutive days, each day being randomised to follow different appraisal instructions in response to any positive emotion they were feeling.

5.3.2 Participants

We identified three secondary schools and sixth form colleges who were willing to take part in the study, one of which subsequently withdrew. From these remaining two schools (both in Devon, UK), we initially recruited 55 school students aged between 13 and 17. Fifteen participants did not complete all four days of the event scheduling application, leaving a sample of 40 participants available for subsequent analyses[1]. No power analyses were conducted prior to the experiment to calculate a sample size. However, the sample size is comparable to the ones used in previous studies with a similar experimental paradigm (Burr et al., 2017). These 40 participants had a mean age of 14.95 (*SD* = 1.16) and were predominantly female (75 %) and White (93 %). A majority came from households where both parents were currently employed (90%) and with at least GSCE or equivalent secondary school level qualifications based on child report (62.50 % of mothers and 51.30 % fathers). Schools, participants, and their parents gave written, informed consent and the study was approved by the University of Exeter ethics committee (Ref, 2017/1580). Participants received a £10 high street voucher for taking part.

5.3.3 Materials

5.3.3.1 Questionnaire measures.

Anhedonia was indexed using the Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995), a 14-item self-report scale measuring ability to experience pleasure from hobbies, social interactions, sensory experience, and food in the last few days (e.g., “I would find

pleasure in my hobbies or pastimes"). For each item, participants rated to what extent they agreed with that statement on a scale ranging from 1 (Strongly agree) to 4 (Strongly disagree). We used the continuous scoring method developed by Franken, Rassin, and Muris (2007), adding together individual item scores. The SHAPS has been validated for use in adolescents (Leventhal et al., 2015) and been found to have acceptable reliability (Cronbach's α = 0.87) in this population. In the present sample, the reliability was broadly comparable (α = 0.80).

How individuals appraise positive emotion experience was assessed using the Responses to Positive Affect Scale for Children (RPA-C; Verstraeten, Vasey, Raes & Bijttebier, 2012). This trait measure consists of 17 self-report items examining the extent to which individuals use emotion-focus amplifying appraisals (five items; e.g., "notice how you feel full of energy"), self-focus amplifying appraisals (four items; e.g., "think 'I am the best I could be'"), and dampening appraisals (eight items; e.g., "think about the things that have not gone well for you"). Participants judged how often they appraise their experience in the way described by each item on a scale ranging from 1 (Almost never) to 4 (Almost always). In the present data, internal reliability was adequate for emotion-focus amplifying and dampening (α = 0.70 and 0.86 respectively) and borderline adequate for self-focus amplifying (α = 0.67).

Depressed and anxious mood was indexed using the Revised—Children Anxiety and Depression Scale (RCADS*;* Chorpita, Yim, Moffitt, Umemoto & Francis, 2000). We administered the 10-item major depressive disorder subscale (MDD: e.g., "I feel sad or empty"), nine-item social phobia subscale (SP; e.g., "I worry what other people think of me"), and six-item generalised anxiety disorder subscale (GAD; e.g., "I worry that bad things will happen to me"). Participants were asked to rate how often they feel the way described in each statement on a scale ranging from 0 (Never) to 3 (Always). The instrument has been found to have satisfactory internal reliability (MDD: α = 0.76; SP: α = 0.81; GAD: α = 0.80;

Chorpita et al., 2000). In the present sample, internal consistency was also good (MDD: α = 0.84; SP: α = 0.88; GAD: α = 0.80).

5.3.3.2 Smartphone application

A bespoke smartphone application was developed for the purposes of this experiment, based on that used by Burr et al. (2017). The application played music to participants while delivering audio instructions about how to appraise their experience and asking them to rate how they felt at various time points. All participants were loaned a mobile phone and (if required) headphones to run this application. During a preparatory session with the experimenter, participants were asked to identify four or five songs of their choice that made them feel happy and to identify a time each day they would be able to listen to this playlist (lasting approximately 15 minutes). These songs were then downloaded into the application by the experimenter and the time each day the playlist was to be listened to was also entered.

Each day participants were randomised to follow different instructions while listening to the music (emotion-focused amplifying, self-focused amplifying, dampening and control). The phone rang 15 minutes before the scheduled time slot to notify participants. They were given an option to postpone the activity for 15 minutes up to two times if they were not ready to complete it. Immediately before listening to the music, participants received the instruction "Before completing the activity, please rate how you have been feeling on average over the last five minutes" and rated their mood using the short Positive and Negative Affect Schedule for Children (PANAS-C; Ebesutani et al., 2012) on a scale ranging from 1 (Not at all) to 100 (Extremely). This consisted of five items measuring PA (joyful, cheerful, happy, lively, proud) and five items measuring NA (miserable, mad, afraid, scared, sad). The five items on each scale were averaged to create NA and PA scores. These PA and NA scales had adequate internal reliability in the present sample (baseline ratings in control condition: α = 0.88 for PA and α = 0.86 for NA).

Participants then received instructions to put on their headphones and start listening to their playlist. Every 45-second interval, the music was cross-faded, and audio statements were played to manipulate their appraisal of any positive emotion they experienced. Participants were instructed to think about their experience in the way each statement described. During the control condition, participants listened to the statement "Please continue with this activity". During the experimental conditions, participants listened to relevant items for that condition selected from the RPA-C subscales adapted to present tense format and played at random (see supplementary material Section 5.1 for transcripts of audio files). For example, dampening items included "Remind yourself that these feelings won't last", emotion-focused amplifying items included "Focus on enjoying the moment", and self-focused amplifying items included "Think 'I am getting everything done'". After participants had finished listening to the playlist, they were instructed to "Please now rate how you felt on average during the activity" using the PANAS-C as described above. They were also asked "When you experienced positive feelings during the activity, to what extent did you think about them in the following way?" and provided answers on a sliding visual analogue scale ranging from 1 (Not at all) to 100 (Extremely). This statement was followed by "Thought about them in a way that 'dampened' positive mood" in the dampening condition, "Thought about how positive you were feeling" in the emotion-focus and "Thought about how well you were doing" in the self-focus conditions. Examples for each appraisal styles were also provided (see supplementary material Section 5.2 for the full instructions given to participants).

5.3.4 Procedure

Students from year 9 (age 13 - 14) to year 13 (age 17 - 18) in these schools attended an in-class presentation about the study given by the experimenter (MY) and took an information sheet and opt-in consent form home to indicate if they were interested in

participating. If the student and their parents were happy for their child to participate, students returned opt-in permission slips to a designated member of staff in their school. After receiving the opt-in slips, the experimenter contacted each parent by telephone or email to confirm their consent.

Participants attended an initial one-to-one meeting with the experimenter in a quiet room at their school (lasting approximately 40 minutes). Each participant read the study information sheet at the beginning of the meeting and then gave written informed consent. Participants first completed a demographic information sheet about age, gender, ethnicity, and parental education and occupational status. Participants then completed the RCADS, RPA-C, and SHAPS in turn. If there was any evidence of thoughts of death or suicidality, a more detailed risk screen was conducted. Given potential adverse mood effects of the dampening manipulation, our protocol excluded any participants from the study with significant risk. In fact, no participants displayed elevated risk when screened and so no exclusion was necessary. Participants selected music on a music streaming service and then identified time slots to listen to this music for 15 minutes over four days. The experimenter saved the playlist to the phone (all songs were available for download) and entered the agreed times and dates. Participants then received instructions about how to use the study application along with listening to their playlists. They were asked to be in a quiet environment when listening to their playlists and answering the study questions. They were then loaned an android smartphone and a pair of headphones to complete music listening activities. The following week all participants met the experimenter for a debriefing session, returned the study materials, received a list of mental health resources and were reimbursed for their time.

5.4 Results

Alpha was set at 0.05 and statistical tests were two-tailed. Data were inspected for normality, outliers, and missing data prior to analysis. All variables were normally

distributed, and there were no obvious outliers, therefore we proceeded with parametric analyses.

A series of one-way repeated measure of ANOVAs was conducted to determine effects of condition (emotion-focused amplifying, self-focused amplifying, dampening and control). In the manipulation check analyses, dependent variables (DVs) were the extent of emotion-focused, self-focused and dampening appraisal usage. In the primary analyses, baseline PA and NA followed by a simple change in PA and NA (subtracting affect during each baseline rest period from affect during each music listening period) were the DVs. In each case, the DVs were tested in separate ANOVAs. We used simple change scores rather than residual change scores for the primary affect analysis due to the selection of a within-subjects design (residual change scores would all have a mean of zero and therefore obscure any condition differences). Where Mauchly's test of sphericity was violated, we report the Greenhouse-Geisser (if Epsilon < 0.75) or Huynh-Feldt (if Epsilon > 0.75) corrections (see Field, 2009, p. 461).

5.4.1 Mood induction manipulation check

A prerequisite of this experimental design is that listening to music reliably induces positive mood (or else there is no positive mood for participants to appraise their reaction to). We first checked if listening to the music in the control (no instruction) condition reliably served as a positive mood induction (i.e. increased positive mood). Contrary to our expectations, from baseline to post-activity there was no significant group level increase in PA, *mean* Δ = -4.40, *SD* = 21.64, t = -1.29, p = 0.21, d = 0.20, indicating that the task was not a successful positive mood induction across all participants.

One possibility for the null manipulation results for a subset of control participants is that there is an order effect, whereby the control music listening condition became a less potent positive mood induction if randomisation meant it was delivered later in the

experiment. To examine this possibility, we ran a one way-ANOVA on the control condition data, with the order in which the control condition was administered (first, second, third, fourth) as the between-subjects factor. This found no effect of order on either PA change, F (1, 38) = 1.14, p = 0.29, or NA change, F (1, 38) = 0.01, p = 0.91, ratings. This indicates the failure of the positive mood induction is unlikely to be an artefact of participants habituating to the music listening task.

The failure of the positive mood induction at the group level would have contaminated subsequent interpretation of the appraisal style manipulations. Therefore, we focused the analysis on the subsample of participants who reported a numerical increase in positive mood from baseline to post-activity in the control condition (i.e. those participants whose simple change score was greater than zero). Twenty-four participants met this criterion[2]. Paired-sample t-tests were run to confirm the effect of mood induction in this sub-sample, and results indicated a significant increase in positive mood *mean* Δ = -17.70, *SD* = 14.22, t = -6.10, $p < 0.001$, d = 1.24. All the subsequent primary analyses were run solely on this subsample of 24 participants.

These 24 participants had a mean age of 14.88 years (*SD* = 1.06) and were predominantly female (71 %) and of White Caucasian background (92 %). A majority (91.30 %) came from households where both parents were currently employed (91%) and with at least GSCE or equivalent secondary school level qualifications based on child report (63 % of mothers and 52 % fathers). For the sake of completeness, we also repeated all analyses on the entire sample of 40 participants to check that this did not substantively alter our conclusions.

5.4.2 Appraisal style manipulation check

Next, we examined if the appraisal instructions altered how individuals thought about positive emotion experience in each condition. Figure 5.1 reports levels of emotion-focus,

self-focus and dampening appraisals in each condition. Repeated measures ANOVA was used to test if there were significant differences between conditions for each appraisal type separately. Use of dampening appraisals significantly differed between conditions, F (2.41, 55.52) = 3.62, p = 0.03, n_{p2} = 0.14 (Huynh-Feldt correction applied). Pair-wise comparisons indicated that dampening appraisals were significantly higher in the dampening condition compared to the control, $p < 0.01$, and self-focus, p = 0.02, conditions, but no difference was observed between the dampening and emotion-focus conditions, p = 0.20. There was no significant difference in the use of dampening appraisals between the emotion-focus, self-focus, and control conditions, ps > 0.24.

There was also a significant difference in use of emotion-focus appraisals between conditions, F (3, 69) = 3.81, p = 0.01, n_{p2} = 0.14. The dampening condition led to reduced emotion-focus appraisals compared to all other conditions, ps < 0.04. There were no other significant differences between conditions in the use of emotion-focus appraisals, ps > 0.51.

Finally, there was also a significant difference between conditions in use of self-focus appraisals, F (3, 69) = 4.11, p = 0.01, n_{p2} = 0.15. Pair-wise comparisons showed that the dampening condition led to reduced use of self-focus appraisals compared to the control and self-focus conditions, ps < 0.01, but did not differ from the emotion-focus condition, p = 0.18. Again, there were no other significant differences between the emotion-focus, self-focus and control conditions in the use of self-focus appraisals, ps > 0.09.

In summary, the dampening condition led to enhanced levels of dampening as intended, but also led to reduced levels of self-focus and emotion-focus, relative to the control condition. Therefore, the dampening manipulation was partly successful. The emotion-focus and self-focus conditions did not lead to a significantly altered use of any appraisal type compared to the control condition.

5.4.3 Impact of appraisal style manipulations on affective experience

Table 5.1 presents levels of PA and NA before and during the music listening task in each condition. As intended, repeated measures ANOVAs found no difference between conditions in baseline levels (immediately prior to each music listening task) of PA**,** F (3, 69) = 0.39, p = 0.76, n_{p2} = 0.02, or NA, F (2.42, 55.73) = 1.21, p = 0.31, n_{p2} = 0.05 (Huynh-Feldt correction applied).

We then analysed if there were differences in PA and NA simple change scores from baseline to the music listening task as a function of condition. There was a significant condition effect for PA change score (see Figure 5.2), F (3, 69) = 6.18, p < 0.01, n_{p2} = 0.21. Pair-wise comparisons revealed that the dampening condition showed lower levels of PA change, compared to all other conditions, ps < 0.04. All other comparisons were non-significant, ps > 0.07. Following Burr et al. (2017), we examined the absolute direction of change in PA from baseline to during the task in the dampening manipulation. There was a non-significant increase in PA during the music listening task, *mean* Δ = 3.63, *SD* = 19.65, t = 0.90, p = 0.36, d = 0.18. This suggests that the dampening manipulation has reduced the potency of the music listening task as a positive mood induction but has not turned into an actively positive mood lowering induction.

There was also a significant condition effect for NA change score (see Figure 5.3), F (1.92, 44.07) = 6.24, p < 0.01, n_{p2} = 0.21 (Greenhouse-Geisser correction applied). Pair-wise comparisons revealed that NA decrease during the music task was significantly less marked in the dampening condition compared to the emotion-focused and control conditions, p < 0.05, and there was a non-significant trend in the same direction for the self-focused condition, p = 0.05. No other comparisons were significant, ps > 0.19, except that the self-focused arm significantly differed from the control condition, p = 0.02 (self-focused amplifying resulted in a smaller reduction in NA). As with PA, we examined the absolute

direction of change in NA from baseline to during the task in the dampening condition. There was a numerical but non-significant NA increase, *mean* Δ = 3.56, *SD* = 12.83, *t* = 1.36, *p* = 0.19, *d* = 0.26.

5.4.4 Secondary analyses

Given that the dampening manipulation both increased dampening and decreased emotion-focused and self-focused appraisals, and that a significant difference in affect reactivity only emerged in the dampening condition, we conducted further analyses to look at which of these were most clearly associated with a change in positive and negative mood in that condition. We computed the change in mood reactivity and appraisal between the dampening and control condition for each variable and then correlated these with each other (using Spearman's non-parametric correlations as these difference scores were not all normally distributed). A smaller increase in positive mood was significantly associated with a more marked increase in dampening appraisals, $r = -0.53$, $p < 0.01$, as well as a more marked decrease in emotion-focus, $r = 0.45$, $p < 0.05$, and self-focus appraisals, $r = 0.46$, $p < 0.05$. Change in use of emotion-focus, self-focus and dampening appraisal usage was not significantly related to negative mood change, *p*s > 0.34.

We performed exploratory regression analyses to determine if the impact of appraisal styles on positive and negative mood change was moderated by trait anhedonia, depression, generalised anxiety disorder, and social phobia symptoms. There was a reasonable range in SHAPS anhedonia (*M* = 31.66, *SD* = 4.94, range 20 - 40), RCADS depression (*M* = 7.50, *SD* = 4.01, range 1 - 16), RCADS social phobia (*M* = 13.04, *SD* = 7.78, range 2- 26) and RCADS generalised anxiety disorder (*M* = 5.75, *SD* = 3.11, range 1 - 11) in the sample, indicating range restriction is unlikely to be confounding these analyses. We repeated the primary analyses examining the impact of appraisal style on mood reactivity, additionally including mean-centred clinical symptoms as a covariate. For PA, there were main effects of

anhedonia, F (2.47, 54.26) = 4.30, p = 0.01, n_{p2} = 0.16, and generalised anxiety disorder severity, F (2.43, 53.53) = 3.61, p = 0.03, n_{p2} = 0.14, with greater levels of anhedonia and generalised anxiety disorder severity leading to a smaller increase in PA overall. There were also non-significant trend effects for depression, F (2.37, 52.06) = 2.93, p = 0.05, n_{p2} = 0.12, and social phobia severity, F (2.35, 51.62) = 2.86, p = 0.06, n_{p2} = 0.12, on PA change in the same direction. For NA, there was a significant main effect of anhedonia severity, F (2.53, 55.57) = 3.81, p = 0.02, n_{p2} = 0.15, with greater anhedonia predicting a smaller reduction in NA during the listening task. There was no significant main effect on NA for depression, social phobia, or generalised anxiety disorder symptom severity, Fs < 2.64, ps > 0.08. No interactive effects of the covariates were detected in any of the analyses for PA or NA, ps > 0.10 (Huynh-Feldt corrections applied), providing no evidence these variables are moderating the impact of the appraisal style manipulations on affective experience.

Finally, we repeated all primary analyses when using the complete original sample of 40 participants (see supplementary materials Section 5.3). A broadly similar pattern of conclusions emerged, albeit the dampening condition findings were less clear cut. While dampening led to significantly smaller PA increases and NA decreases relative to the two amplifying conditions, there was no longer a significant difference on either PA or NA change in the dampening relative to the control condition. This change in results was driven by a change in the response to the control condition in the two samples and the pattern of response to three experimental conditions was strikingly similar (see Supplementary Figures S5.1 and S5.2).

5.5 Discussion

The present study examined the emotional impact of instructed dampening and amplifying appraisals while listening to pleasant music in adolescents using a bespoke smartphone application. A crossover randomised controlled trial design was used, where all

participants completed all conditions on different days (with the order of conditions randomised).

The music listening task did not successfully increase PA from baseline to post-listening in the control condition in all of the original 40 participants who took part. A prerequisite for the appraisal manipulation in the other conditions is that participants are experiencing some degree of PA during the music listening task that they can then reappraise, so we focused our primary subsequent analyses on the subset of 24 participants who did show an increase in PA during the control music listening task.

The dampening manipulation findings largely replicate results showing that dampening reduces PA and increases NA when processing positive material in adults in both laboratory and real-world settings (Burr et al., 2017; Dunn et al., 2018) and in adolescents in laboratory settings (Yilmaz et al., submitted). The one slight exception in the present data was that in the dampening versus self-focus condition comparison, the NA difference was in the expected direction but was only significant at the level of a trend. As far as we are aware, this is the first demonstration using an ecologically valid, real-world task in adolescents that dampening causally alters affective experience.

Replicating the null findings in adults (Burr et al., 2017; Dunn et al., 2018) and adolescents (Yilmaz et al., submitted), there was no significant difference between either amplifying condition and the control conditions for either PA or NA change. However, given that neither amplifying manipulation significantly increased amplifying appraisals, it is not possible to draw strong conclusions about the impact of amplifying on the basis of the present findings. Interestingly, the instructed self-focus amplifying during the music activity resulted in a significantly smaller decrease in NA, compared to the control condition. In other words, the music task was less effective at lowering NA when participants were utilising self-focus

amplifying appraisals. Therefore, the self-focus condition is at best ineffective and at worst actively unhelpful.

While largely replicating the extant literature, the present data do not support the strong form of the dampening hypothesis put forward in adults (see Burr et al., 2017; Dunn et al., 2018). In particular, the music task even under dampening conditions still led to a significant increase in PA from before to after (albeit significantly diminished relative to the other conditions). While there was a numerical increase in the dampening condition in NA from before to after, this was not statistically significant. This may reflect that adolescents are less practised than adults at deploying dampening appraisals (so they are less powerful). Alternatively, it may be that adolescents were less willing to continue following the dampening appraisal themes when this detrimentally impacted on their mood. It is noteworthy that our previous study manipulating dampening in the laboratory in adolescents also failed to provide support to the strong form of the dampening hypothesis (Yilmaz et al., submitted). Further work is needed to understand why the strong form of the dampening hypothesis does not hold in adolescents.

As in the extant adult and adolescent literature, it remains unclear whether instructed dampening acts by reducing dampening appraisals, increasing amplifying appraisals or a combination of both of these appraisals. Greater reported use of dampening and reduced use of emotion-focus and self-focus appraisals were all significantly associated with greater reduction in PA in the dampening condition. Change in appraisal style was not significantly linked to NA change in the dampening condition, however. This deviates from event scheduling findings in adults reported by Burr et al. (2017), where it was elevations in dampening that were most clearly associated with both positive and negative affect change. However, it parallels findings in our previous adolescent laboratory study (Yilmaz et al., submitted) and adult laboratory study (Dunn et al., 2018). It makes conceptual sense that

when the use of dampening appraisals is increasing, amplifying appraisals will be down-regulated (and vice versa). This possibility requires further empirical examination.

None of these findings was influenced by trait anhedonia levels and symptoms of depression, social phobia and generalised anxiety disorder (similar to the null pattern of moderation findings reported by Dunn et al., 2018 in adults and by Yilmaz et al., submitted in adolescents). We failed to replicate the non-significant trend finding reported by Burr et al. (2017) that those with greater anhedonia at intake are less reactive to the self-focus manipulation in terms of NA repair. The parsimonious conclusion at the present time is that individual differences do not moderate the impact of positive appraisal style manipulations, although it is important to acknowledge that none of the extant studies (including the present data) have been optimally powered to test for moderation (Burr et al., 2017; Dunn et al., 2018; Yilmaz et al., submitted).

A critical issue to consider when interpreting the present findings is whether the subgroup analyses we have reported are valid. There is an emerging literature on questionable research practices (QRPs) in psychology, one of which is conducting post hoc analyses on a subgroup if the original hypotheses are not supported in the full sample and then reporting this subgroup analysis in the resulting publication as though this was an a priori plan (Simmons, Nelson & Simonsohn, 2011). This is likely to exacerbate the problem of false positive findings that cannot be subsequently be replicated in the psychology literature (Open Science Collaboration, 2015). We need to be clear here that the decision to run subgroup analyses was made post hoc, based on an initial analysis of the data showing the control condition did not perform as intended in reliably increasing PA in all participants. However, it was made for a clear theoretical reason (it is not logically possible to dampen positive affect if you are not experiencing any). Moreover, to be fully transparent we also present in the supplementary materials the analyses on the original sample of 40 participants.

The conclusions that emerged from these analyses were broadly comparable to those reached on the subset of 24 participants, except that the differences between the control and the dampening conditions for NA change and PA change were no longer significant. On inspection, the pattern of responses in the two samples to three experimental conditions was strikingly consistent; what was different was the response to the uninstructed control condition. In particular, the position of the control condition in the NA change and PA change distributions in the overall sample had shifted closer to the dampening condition and further away from the two amplifying conditions. This accounted for why there was no longer a significant difference between the dampening and the control conditions.

In our view, the conclusion that following dampening instructions makes the music listening task less effective at increasing PA and decreasing NA stands however the data are analysed. Nevertheless, given that our primary analyses are exploratory and post hoc, the present results should be considered as hypothesis-generating not confirmatory and require direct replication or conceptual replication using a task that is a more potent mood induction (for example, allowing participants to select their own positive activities ideographically rather than using the same task for all).

It is also important to point out that the QRP literature does not advocate that exploratory, post hoc subgroup analyses should never be conducted. It simply recommends that these analyses are reported honestly and transparently, which is the stance we take in the present work.

The crossover randomised controlled trial design used in the present study gives a high degree of statistical power and also minimises individual differences confounds (as each participant effectively serves as their own control for each active condition). However, these designs can be vulnerable to contamination between conditions. Crossover contamination between conditions is unlikely to be a significant issue in the present data as each condition

was delivered on a different day and it is improbable that the brief instructions used in the manipulation would persist for a full 24 hours. While we do not have the statistical power to examine fully order effects, we did check whether there was an order effect for PA response to the control condition. Reassuringly, there was no significant difference in PA reactivity as a function of which day the control task was administered, which provides no evidence of significant contamination between conditions.

It is interesting to reflect on our choice of music listening as the positive mood induction, given this only successfully increased positive mood for 24 out of 40 participants. We moved away from the walking task we used with adult samples (cf. Burr et al., 2017), as in the piloting phase feedback from young people was that a walk was not universally perceived as pleasurable. We selected music listening, as this is a high frequency and meaningful activity that is easily accessible to most adolescents (North et al., 2000) and that has previously been linked to regulation of wellbeing and positive mood in adolescent (e.g., Laiho, 2004; Saarikallio, 2008; Saarikallio & Erkkilä, 2007) and adult populations (Juslin, Liljeström, Västfjäll, Barradas & Silva, 2008).

It is unclear why the music task did not induce positive mood in a subset of adolescents. One possibility is that these adolescents may have chosen music that induced ambivalent emotions. Given the idiosyncratic impact of music on listeners, it was not possible for the experimenter to check whether the music chosen by each participant would induce purely positive emotions (as opposed to more intense, ambivalent emotions). This finding might also reflect the fact that teenagers do not like to be told when to do something: listening to music when you have to is different to listening to music when you want to. The present findings should ideally be replicated using a more universally potent form of positive mood induction (for example, social inclusion or positive social feedback; Dalgleish et al., 2017).

It is also useful to reflect on why the emotion-focus and self-focus manipulations were unsuccessful in altering appraisal style use in adolescents, given that they worked with adults in Burr et al. (2017). It may be that baseline levels of these appraisal styles were closer to ceiling in the adolescent sample (i.e. adolescents spontaneously make greater use of these appraisal styles, which then means instructions to increase their use are vulnerable to ceiling effects). To explore this possibility, we examined the mean use of each appraisal style in the control (uninstructed condition). In the Burr et al. (2017) adult sample, mean levels of spontaneous emotion-focus and self-focus appraisals in the control condition were around 45 and 30 respectively on a 100 point scale. In the present sample, mean levels of emotion-focus and self-focus appraisals were around 58 and 15 respectively. Therefore, it is plausible that the emotion-focus manipulation failed in the present study due to ceiling issues (given spontaneous use of emotion-focus in the control condition was far higher in the present adolescent sample than the Burr et al. adult sample). However, this explanation cannot account for the self-focus results (given spontaneous use of self-focus in the control condition was lower in the present adolescent sample than the Burr et al. adult sample). With regards to the self-focus condition, it may simply be the case that these appraisals are not appropriate to use in the music listening context given their focus on achievement themes (e.g. notice how proud you feel, notice how you are living up to your potential). Further, these amplifying items were originally designed to capture the kind of pathological amplifying appraisals shown in manic states (Feldman et al., 2008) and are quite extreme in nature. They may need modifying to capture a more adaptive, less extreme form of positive appraisal. Finally, we used simple instructions with no prior practice to manipulate appraisal style. It may be that individuals require more systematic training to be able to utilise emotion-focus and self-focus appraisals.

The emerging evidence that dampening causally drives reduced PA experience may be clinically relevant, given a growing weight of evidence showing that anhedonia can be a precursor to adolescent clinical depression and is a distressing and debilitating feature of adolescent depression once established. Dampening appraisals could be targeted in treatment, for example via cognitive challenge techniques from cognitive behavioural therapy (CBT; e.g. Goodyer et al., 2017) or cognitive defusion techniques from acceptance and commitment therapy (ACT; see Hayes, Boyd & Sewell, 2011). It may also be useful for clinicians to be vigilant for the use of dampening appraisals in their clients when using positive activity scheduling techniques in behavioural activation approaches (Pass, Lejuez & Reynolds, 2018; Tindall et al., 2017). If individuals engage in dampening appraisals, this may mean positive activities do not induce the intended positive mood lift, further motivating hopelessness and withdrawal from future positivie activities in depressed adolescents.

Care should be taken not to over generalise the present findings from a predominantly healthy adolescent sample to clinically depressed groups, however. While there is increasing acceptance of the value of analogue models of psychopathology for testing clinical mechanisms (Abramowitz et al., 2014) and anhedonia and depression did not moderate participants' response to the appraisal style manipulations, it nevertheless remains possible that the impact of dampening versus amplifying may vary as a function of clinical status. This should be investigated in future research.

Other limitations should also be held in mind when interpreting these results. First, as a result of using a subset of participants for analyses, we had a modest sample size (n = 24). This means it is important to consider if lack of power might explain the failure to detect increases in PA and decreases in NA in the amplifying conditions, compared to the control conditions. The effect sizes in the amplifying-control condition comparisons were mostly small or negligible, so it seems unlikely that a different pattern of findings would have

emerged had we had a significantly greater sample size. Moreover, the direction of the effects was for the emotion-focus and self-focus conditions to be *less* potent than the control condition, meaning if anything that significant effects with a larger sample size would go in the opposite direction to theoretical predictions. Second, while the music listening task itself has high ecological validity, it is slightly artificial to have asked people to listen to and follow appraisal prompts while doing so. It will be helpful to establish if the same findings emerge using more naturally occurring appraisals. Third, we relied solely on self-report measures of affective experience, which may be vulnerable to demand effects. Future work should consider measuring more objective outcomes (for example, ambulatory psychophysiology variables linked to affect; Trull & Ebner-Priemer, 2014).

In summary, the present study demonstrates for the first time in an ecologically valid context that the use of dampening appraisals blunts the capacity of positive activities to enhance positive and reduce negative mood. Elevated use of dampening appraisals may underlie PA disturbances in clinical conditions like depression and it may be useful for treatments to target positive appraisal style systematically to enhance their capacity to repair anhedonia.

5.6 Footnotes

[1] There were no significant differences in age, gender ratio, trait positive appraisal style, anhedonia severity, depression severity, or generalised anxiety disorder severity, *p*s > .09, between the 40 participants who fully completed the task and the 15 participants who did not. However, those who did complete the task had significantly greater social phobia than those who failed to complete the task, $p = 0.03$.

[2] Individuals for whom the music listening task reliably worked as a positive mood induction in the control condition had significantly higher depression scores, $p = 0.01$, and significantly higher trait levels of dampening appraisals, $p = 0.02$, than those for whom the task did not work. There were no significant differences between those for whom the task did and did not work in terms of age, gender ratio, levels of PA immediately prior to the music listening task, anhedonia severity, social phobia severity, generalised anxiety disorder severity, or use of amplifying appraisals, *ps* > .06.

5.7 Acknowledgements

We gratefully thank all the adolescents, parents, and schools for taking part in the study. Merve Yilmaz's PhD is funded by the Turkish Ministry of National Education. Barnaby Dunn's time on this project was funded by a Career Development Fellowship awarded by the National Institute for Health Research in the UK, grant number CDF-2014-07-10. The views expressed in this protocol are those of the authors and not necessarily those of the NHS, the NIHR, or the Department of Health.

Tables

Table 5. 1 *Affect ratings before and after the music listening activity in each condition.*

Condition	Positive Affect		Negative Affect	
	Before	During	Before	During
Control	40.85 (22.86)	58.55 (22.37)	13.88 (15.94)	6.32 (9.48)
Dampening	43.32 (24.19)	39.69 (26.99)	10.76 (12.72)	14.32 (14.54)
Emotion-Focus	41.40 (23.63)	52.67 (22.90)	14.33 (16.88)	9.58 (12.47)
Self-Focus	45.43 (25.16)	55.05 (23.93)	9.00 (9.12)	6.02 (6.01)

Note. Data are mean (one standard deviation) values.

Figures

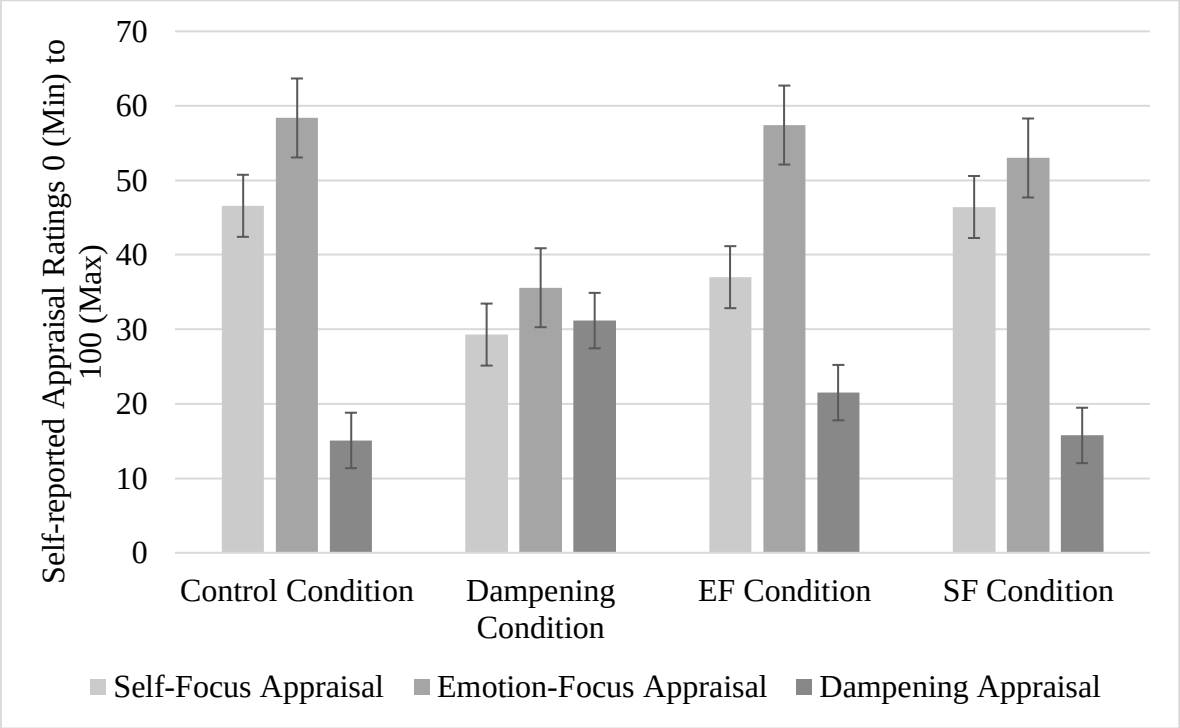


Figure 5. 1 Self-rated appraisal styles in each condition.

Data are mean (one standard error of the mean) values.

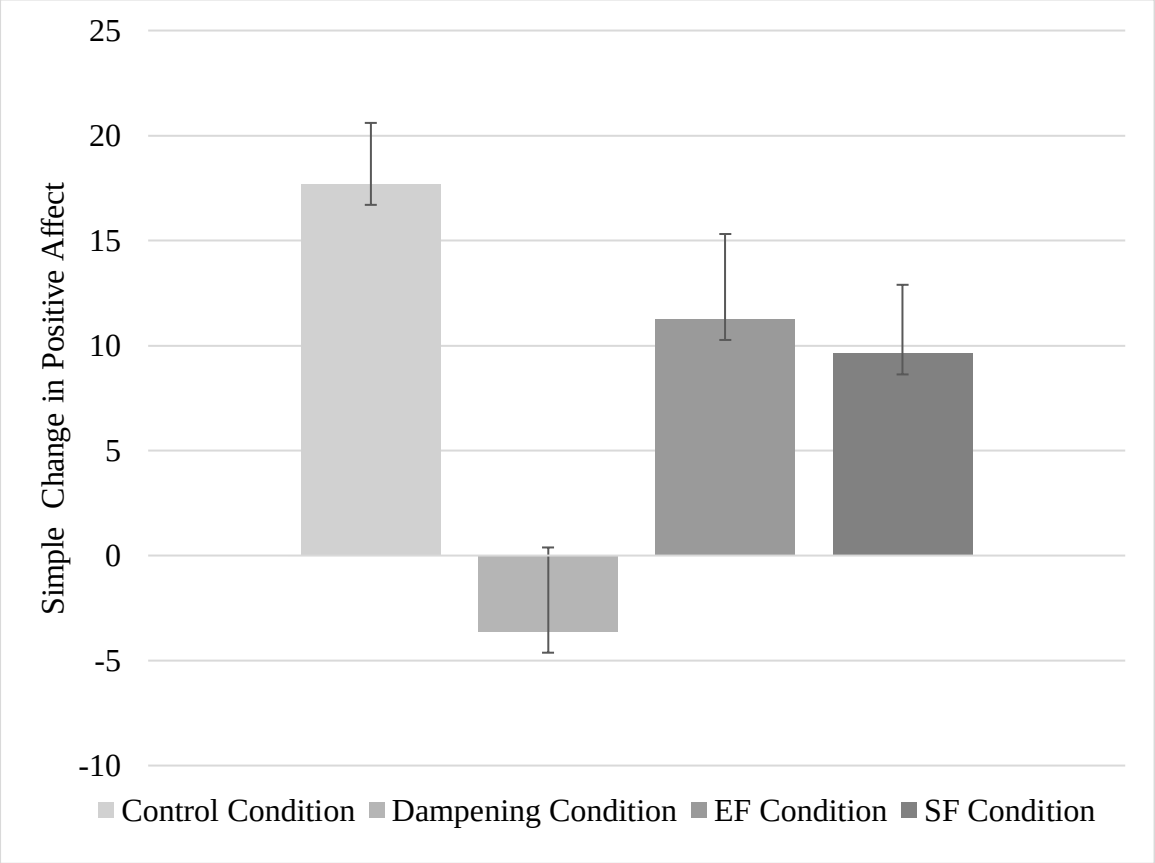


Figure 5. 2 Change in positive affect when listening to music in each condition.

Data are mean (one standard error of the mean) values.

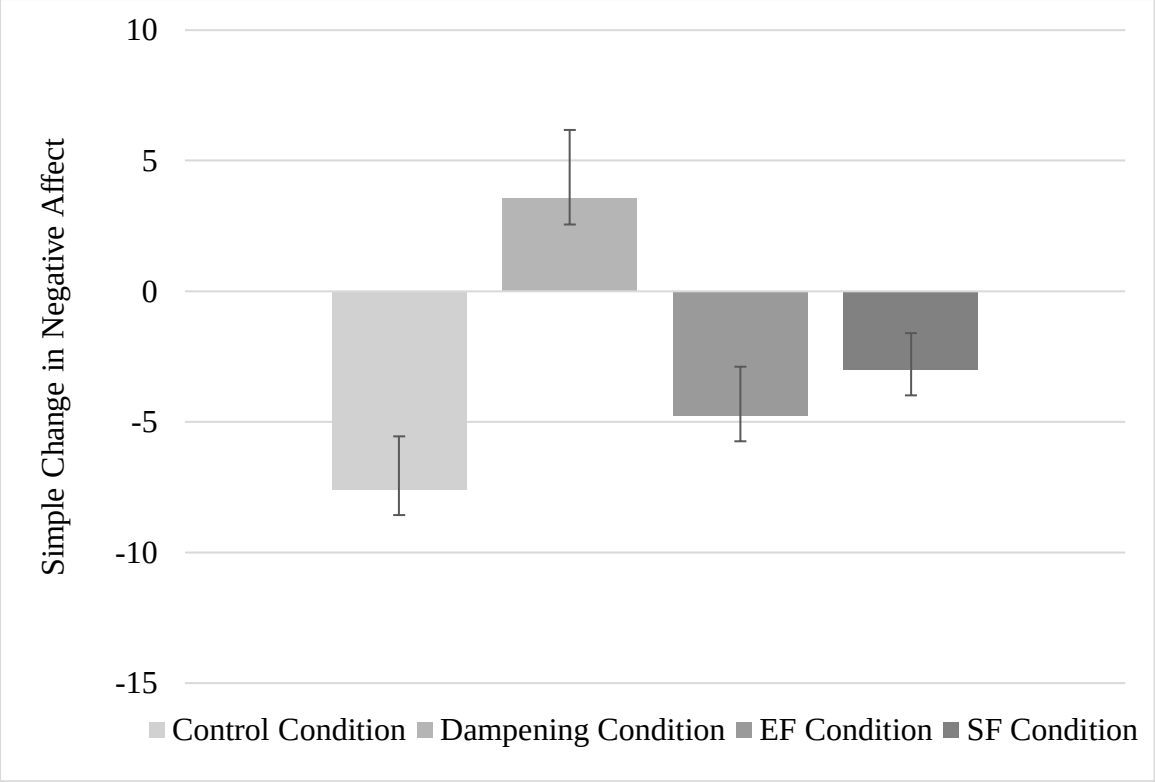


Figure 5. 3 Change in negative affect when listening to music in each condition.

Data are mean (one standard error of the mean) values.

5.8 Supplementary material

5.8.1 Transcript of audio-files used to manipulate each appraisal style

(….. = 45s interval between statements)

5.8.1.1 Dampening condition.

You are now going to hear a number of statements, please try to think about your experience in these ways. Each statement will be read once and will then be followed by about 45 seconds of silence. During those 45 seconds, we want you to try to think about your experience in the way that the statement describes. Think "I am lucky for now, but it will end soon"….. Remind yourself these feelings won't last….. Think about how hard it is to concentrate…. Think "I don't deserve this"…… Think about things that have not gone well for you….. Think "people will think I'm bragging"…...Think about things that could go wrong….. Think "This is too good to be true"…..Think about things that could go wrong….. Think "I don't deserve this"……Think about how hard it is to concentrate…. Remind yourself these feelings won't last…... Think about things that have not gone well for you….. Think "I am lucky for now, but it will end soon"….. Think "people will think I'm bragging"

5.8.1.2 Emotion-focused condition.

Think how you feel ready to do anything..... Think about how happy you feel….. Think about how strong you feel….. Notice how you feel full of energy….. Focus on enjoying this moment…..Think about how strong you feel….. Focus on enjoying this moment….. Think how you feel ready to do anything..... Notice how you feel full of energy….. Think about how happy you feel….. Think about how strong you feel..... Focus on enjoying this moment.....Think about how happy you feel..... Notice how you feel full of energy..... Think how you feel ready to do anything..... Notice how you feel full of energy

5.8.1.3 Self-focused condition.

You are now going to hear a number of statements, please try to think about your experience in these ways. Each statement will be read once and will then be followed by about 45 seconds of silence. During those 45 seconds we want you to try to think about your experience in the way that the statement describes..... Think “I am getting everything done”.....Think “I am achieving everything I could want”..... Think about how proud you are of yourself..... Think “I am the best I could be”..... Think about how proud you are of yourself..... Think “I am achieving everything I could want”..... Think “I am the best I could be”..... Think “I am getting everything done”..... Think “I am the best I could be”..... Think about how proud you are of yourself..... Think “I am achieving everything I could want”..... Think “I am getting everything done”..... Think “I am achieving everything I could want”..... Think “I am the best I could be”.....Think about how proud you are of yourself..... Think “I am getting everything done”

5.8.1.4 Control.

Please now complete this activity..... Please continue with this activity..... Please continue with this activity..... Please continue with this activity..... Please continue with this activity..... Please continue with this activity..... Please continue with this activity..... Please continue with this activity..... Please continue with this activity..... Please continue with this activity..... Please continue with this activity

5.8.2 Mobile instructions to measure each appraisal style before or during the music listening activity

5.8.2.1 Dampening ratings.

(before the activity) = When you experienced positive feelings in the past 5 minutes, to what extent did you think about them in the following way:

(during the activity) = When you experienced positive feelings during the activity, to what extent did you think about them in the following way:

Thought about them in a way **that 'dampened' positive mood** (e.g. thoughts such as "this is too good to be true", "I don't deserve this", and "people will think I'm bragging").

5.8.2.2 Emotion-focused ratings.

(before the activity) = When you experienced positive feelings in the past 5 minutes, to what extent did you think about them in the following way:

(during the activity) = When you experienced positive feelings during the activity, to what extent did you think about them in the following way:

Thought about **how positive you were feeling** (e.g. focused on how happy, strong and energetic you were feeling).

5.8.2.3 Self-focused ratings.

(before the activity) = When you experienced positive feelings in the past 5 minutes, to what extent did you think about them in the following way:

(during the activity) = When you experienced positive feelings during the activity, to what extent did you think about them in the following way:

Thought about **how well you were doing** (e.g. thoughts such as "I am achieving everything", "I am living up to my potential", and "I am getting everything done").

5.8.3 Supplementary Analyses

We repeated the primary analyses when using the original sample size of 40 (i.e. including those who did not experience the control condition as a positive mood induction). Data for the entire sample are summarised in supplementary Table S1.

For the dampening manipulation check analyses, there was a main effect of condition, F (3, 117) = 3.11, p = 0.03, n_{p2} = 0.07, with pairwise comparisons showing the dampening condition had significantly greater levels of dampening than the emotion-focus condition, p =

0.04, and the self-focus condition, $p = 0.01$, and showed a non-significant pattern in the same direction relative to the control condition, $p = 0.12$. No other comparisons were significant, $ps > 0.21$.

For the emotion-focus manipulation check analyses, there was also a main effect of condition, F (3, 117) = 5.86, $p < 0.01$, $n_{p2} = 0.13$, with pairwise comparisons showing the dampening condition made lower use of emotion-focus appraisals than all other conditions, $ps < 0.04$. No other comparisons were significant, $ps > 0.11$. For the self-focus manipulation check analyses, there was a main effect of condition at the level of a non-significant trend, F (3, 117) = 2.48, $p = 0.06$, $n_{p2} = 0.06$. The only significant condition difference in pairwise comparisons was lower use of self-focus appraisals in the dampening relative to self-focus condition, $p = 0.01$. All other comparisons were non-significant, $ps > 0.07$.

In summary, the manipulation check analyses were broadly identical to those found when focusing on subsample of 24 individuals, with the dampening manipulation increasing dampening relative to two out of three conditions (but also lowering emotion-focus and self-focus appraisals). Neither the emotion-focus nor the self-focus conditions successfully induced dampening appraisals. The only difference from the subgroup analysis was that the dampening versus control comparison regarding levels of dampening did not reach significance.

Supplementary Figures 5.1 and 5.2 plot the PA change and NA change data for each condition, presenting the data for both the subset of 24 individuals and the original sample of 40 individuals. We repeated the PA and NA change analyses on the original sample of 40 individuals. For the primary PA change analyses, there was a main effect of condition, F (3, 117) = 2.98, $p = 0.04$, $n_{p2} = 0.07$. Pairwise comparisons revealed that the dampening condition had greater PA change than the emotion-focus condition, $p = 0.01$, showed a non-significant trend for greater PA change than the self-focus condition, $p = 0.08$, and showed a

non-significantly greater PA change than the control condition, $p = 0.24$. No other comparisons were significant, $ps > 0.11$.

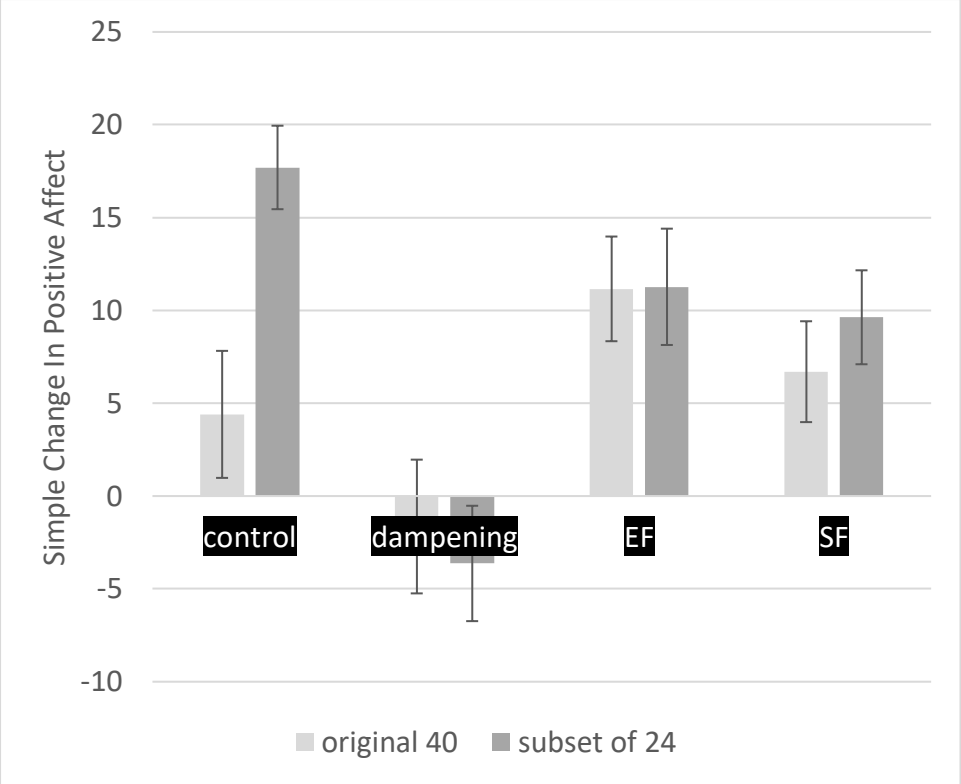
For the primary NA change analyses, there was also a main effect of condition at the level of a non-significant trend, F (3, 117) = 2.68, $p = 0.05$, $n_{p2} = 0.06$. Pairwise comparisons found the dampening condition had a smaller decrease in NA relative to the EF condition, $p = 0.02$, a smaller decrease in NA relative to the self-focus condition at the level of a non-significant trend, $p = 0.09$, and showed a non-significantly smaller decrease in NA relative to the control condition, $p = 0.21$. No other comparisons were significant, $ps > 0.09$.

This is broadly comparable to the findings on the subsample of 24 individuals, except that the dampening versus control comparison (while heading in the same direction) did not reach significance for either PA change or NA change. Visual inspection of supplementary Figures S1 and S2 reveals that the patterns of responses for both PA and NA change show a strikingly similar pattern in both samples for the three experimental conditions. However, there are differences in the control condition pattern of response. In the original sample of 40, the control condition was not effective at either increasing PA or decreasing NA, but in the subsample of 24 it both increased PA and decreased PA. In other words, the subtle differences between the original sample and the subsample are all driven by the control condition response varying and not the experimental conditions. The interpretation of the results (that dampening impairs the capacity for music listening to enhance PA and decrease NA) does not substantively change on this basis, although the conclusions reached should be more tentative given the null control condition results.

Supplementary Table 5. 1 Manipulation and affect outcomes for the original sample of 40 participants.

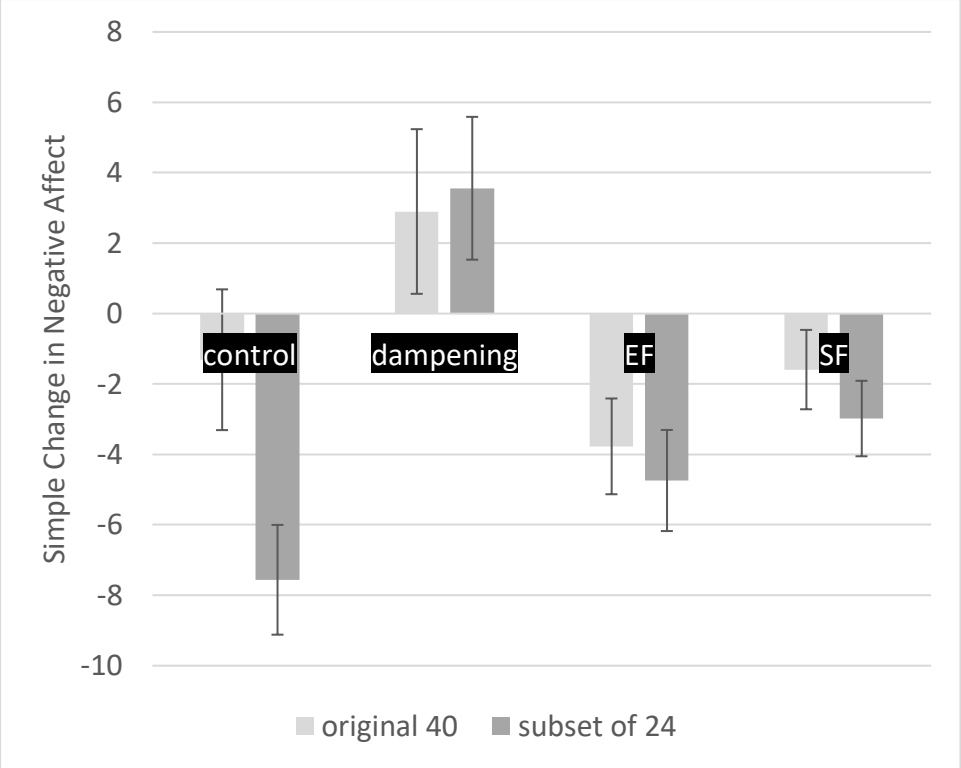
	Control condition	Dampening condition	Emotion-Focus condition	Self-Focus condition
Dampening appraisals	21.85 (29.66)	29.80 (26.51)	18.70 (24.16)	16.00 (21.83)
Emotion-focus appraisals	48.58 (34.07)	36.95 (29.42)	59.53 (28.92)	53.95 (31.01)
Self-focus appraisals	38.93 (29.65)	34.50 (28.43)	38.60 (27.39)	47.48 (30.24)
PA change	4.40 (21.64)	-1.64 (22.78)	11.16 (17.83)	6.70 (17.18)
NA change	-1.31 (12.64)	2.90 (14.79)	-3.77 (8.60)	-1.59 (7.13)

Note. Data are mean (one standard deviation) values.



Supplementary Figure 5. 1 PA Change in each condition in original sample (n=40) and subsample (n = 24).

Note. Data are mean (one standard error of the mean) values.



Supplementary Figure 5. 2 NA change in each condition in original sample (n=40) and subsample (n = 24).

Note. Data are mean (one standard error of the mean) values.

Chapter 6.0: General Discussion

The present thesis examined the role of positive affect (PA) dampening and amplifying appraisals in the development of anhedonia symptoms in adolescents. The current chapter of this PhD will first provide a summary of the rationale behind this research followed by a summary of the aims and main findings of four studies. The theoretical and clinical implications of the findings will be considered along with a discussion of the limitations of the research. The final section of this chapter will focus on suggestions for future directions.

6.1 Summary of the rationale

Adolescence is a crucial developmental period with increased rates of first onset of emotional disorders (Kessler et al., 2007). The rates of depression substantially increase in adolescents, however the current treatments targeting adolescent depression is far from revealing optimal outcomes (Weisz et al., 2006). Even after full recovery is achieved, depression in adolescents is prone to recurrence (Curry et al., 2011). One approach to enhance the efficacy of depression therapy in youth might be developing a better understanding of the processes that lie behind symptomatology and illness severity such as anhedonia (Gabbay et al., 2015). In the present thesis, it was proposed that the cognitive appraisal of PA that is related to anhedonic disturbances in adults may also underpin anhedonia symptoms in adolescents. This thesis sought to investigate a potential causal pathway between the positive appraisal style and anhedonic disturbances in adolescents by stepwise examination of the strength of evidence across cross-sectional, prospective, and experimental studies. If the positive appraisal style is a mechanism that may drive anhedonia in youth, then it could be evaluated as potential mechanisms of therapeutic change by future studies and targeted in therapy.

6.2 Summary of aims and findings

This section will briefly revisit the aims and summarise relevant findings of each empirical chapter of the current thesis.

Chapter 2.

Aims.

The second chapter of this PhD aimed to systematically synthesise and further meta-analyse the available evidence on the association between positive appraisal style and anhedonic disturbances in both adults and youth. By identifying the key gaps in the literature, it also sought to provide a research agenda for the remaining empirical chapters of this PhD.

Findings.

Findings from the qualitative review of 30 studies and meta-analysis of 24 of them indicated that increased use of PA up-regulating appraisals was more consistently associated with increased PA/reduced anhedonia based on non-experimental evidence, whereas experimental evidence was inconclusive. In contrast, down-regulating appraisals were not consistently associated with anhedonia in non-experimental studies, but manipulation studies found that instructed dampening consistently blunted PA. More studies had focused on adult than youth samples and as a result, there are gaps that need to be filled. In particular, non-experimental evidence in youth focused solely on the RPA and it remains to be seen if findings replicate use other methods. Moreover, no manipulation studies have been conducted in youth samples.

Chapter 3.

Aims.

The third chapter of this PhD aimed to examine the cross-sectional and prospective associations between trait positive appraisal styles of dampening, amplifying and fear of positive emotion in relation to anhedonia symptoms in a community sample of adolescents. It

tested if these positive appraisal styles were unique correlates of intake anhedonia symptoms and vulnerability factors of anhedonia symptoms longitudinally. It also examined if baseline symptoms of anhedonia would predict appraisal styles at a three-month follow-up assessment.

Findings.

Results revealed that, based on self-reports of 367 adolescents, elevated anhedonia was significantly correlated with decreased levels of amplifying appraisals and increased levels of dampening appraisals. These associations emerged even after co-varying for age, gender, depressive rumination, frequency of positive and negative life events. However, contrary to our prediction, fear of positive emotion did not significantly relate to anhedonia symptoms in youth. At the prospective level, based on self-reports collected from 170 adolescents (46% of the baseline sample) showed that it was only decreased levels of amplifying appraisals among the three positive appraisal styles that was associated with risk of increased anhedonia symptoms three-months later. This association was evident while controlling for confounders considered in the cross-sectional analyses as well as baseline symptoms of anhedonia. When we examined reverse prospective associations, findings showed that elevated anhedonia measured at baseline was a risk factor for increased levels of amplifying appraisals but not for increased levels of dampening appraisals while controlling for the intake levels of appraisal style.

Chapter 4.

Aims.

Following the cross-sectional and prospective associations demonstrated in Chapter Three, the fourth chapter of this PhD aimed to examine the direct causal impact of induced use of dampening and amplifying appraisals on PA levels in adolescents with a mixed within-between subjects laboratory experiment.

Findings.

Among 89 community sample of adolescents, recalling positive memories successfully increased happiness levels and decreased sadness. The dampening induction increased use of dampening appraisals but the amplifying condition did not reliably increase amplifying appraisals (both relative to the control condition). When we examined the spontaneous state use of appraisals styles and PA reactivity during the memory recall tasks,

In the first uninstructed memory recall, increased spontaneous amplifying appraisals were significantly and positively correlated with a greater increase in happiness reactivity and decrease in sadness reactivity. Greater spontaneous use of dampening appraisals was not associated with reduced happiness reactivity but was linked to greater sadness reactivity. When the impact of the appraisal style manipulations on happiness and sadness reactivity was examined, results showed that inducing dampening appraisals during the memory recall blunted happiness reactivity and also inhibited the sadness reducing impact of the memory recall task (relative to a no instruction control condition). In contrast, instructed amplifying did not alter happiness or sadness reactivity relative to the control condition. When we further examined whether induced dampening appraisals turned the positive mood induction to a significantly aversive experience, no evidence for a significant decrease in happiness was found from a pre-memory recall rest task to during the manipulated recall task. However, there was a significant increase in sadness levels.

Chapter 5.

Aims.

The fifth chapter of this PhD aimed to extend the experimental findings presented in Chapter Four into ecologically valid settings with a pleasant event scheduling study that used a cross-over randomised controlled design. It investigated the impact of induced appraisal

styles of dampening, SF amplifying and EF amplifying during everyday music listening tasks in adolescents.

Findings.

Initially, 40 adolescent participants listened to their individualised happy music over four consecutive days. The music listening task reliably increased PA levels (and decreased NA) for only 24 of them. This subsample was used for all the subsequent analyses. The dampening induction increased use of dampening appraisals compared to a control condition. The EF amplifying and SF amplifying appraisal style inductions did not differ from the control condition in terms of using of positive appraisal styles. When the affective consequences of these appraisal styles were examined, it was shown that the dampening condition blunted PA reactivity compared to all other conditions. It also inhibited the NA decreasing impact of the happy music listening task compared to all other conditions. Induced use of amplifying appraisals did not differ from the control condition and one another regarding their impact on PA reactivity. However, induced use of SF amplifying appraisals resulted in decreased NA change compared to the control condition. When we further examined whether induced dampening appraisals turned the positive mood induction to a significantly aversive experience, PA levels were numerically (but non-significantly) lower and NA levels were higher during the music listening task compared to the baseline rating.

6.3 Theoretical implications of findings

This section will discuss the theoretical implications of the integration of key findings of this PhD. The major contribution of the current thesis to the field was demonstrating that a dampening appraisal style may be an anhedonia driving mechanism in adolescents.

Anhedonia is a multi-layered construct that is characterised by deficits in reward anticipation, motivation, consumption and learning (Der-Avakian & Markou, 2012). The focus of the current thesis was predominantly on how dampening mechanisms impair the

consummatory phase of reward (i.e. positive affect experienced when attaining a reward). This deficit in consummatory processing is most aligned to the DSM-V definition of anhedonia in depression as a loss of interest and pleasure in previously enjoyable activities' (American Psychological Association, 2013; see also World Health Organisation, 2018). The results suggest that positive appraisal style does impact on consummatory pleasure in adolescents. However, it is premature on the basis of the current results to assume the findings will generalise to other aspects of anhedonia like wanting and learning. These consummatory deficits were measured in the survey study using the Snaith Hamilton Pleasure Scale (Snaith et al., 1995), which indexes how much participants think they would have enjoyed a variety of rewarding activities over the past week. This measure is potentially vulnerable to memory bias and also assumes reward processing would be constant over the past few days. In the experimental studies, the focus was on changes in momentary positive affect from before to during reward consummation. This is less prone to memory bias and does not assume reward experience is stable over periods of time. However, it is limited by focusing only on composite positive emotions (and not distinguishing between potentially distinct forms of positive affect). All of these measures are vulnerable to demand effects. Future research should consider a broader range of measures, including physiological and neural indices of positive affect (for example, heart rate variability or activation of the nucleus accumbens) that are less prone to demand effects.

Before experimentally examining the direct causal association between the positive appraisal styles and anhedonic disturbances, a systematic review of current findings was conducted. Results revealed that the field is progressing towards establishing a mechanistic link between positive appraisal styles and anhedonia symptoms in adults. However, there is a major research gap in the literature that examines cognitive appraisals of PA in adolescents and particularly studies using experimental paradigms that manipulate appraisal styles. The

non-experimental evidence reviewed found no clear prospective association between trait use of dampening appraisals and PA/anhedonia. However, these negative findings may be due to the studies using variants of PA/anhedonia measures, variable time frames to assess prospective associations, and a failure to control for relevant confounding variables. Under controlled laboratory settings using randomisation designs, induced state use of dampening appraisals in adults was shown to reduce PA levels (state PA).

Following the key gaps systematically identified in the youth literature, this thesis then went on to examine cross-sectional and prospective associations in youth samples, using a broader array of appraisal measures (the RPA and the related construct of fear of positive emotion) than in previous studies. The findings revealed that increased trait levels of dampening and reduced amplifying appraisals were cross-sectionally correlated with elevated anhedonia, as indexed by a well-established gold standard measure (Leventhal et al., 2015; Rizvi et al., 2016; Snaith et al., 1995). These results were broadly consistent with the majority of studies in the adolescent literature (Bastin et al., 2018; Burke et al., 2018; Nelis et al., 2018; although see Gilbert et al., 2017). It is likely that the small sample size of Gilbert et al. (2017) and the index of anhedonia (CDI-D; Kovacs, 1985) that also includes items to assess somatic problems, sleep disturbances and social isolation in children may have resulted in this discrepancy.

The prospective analyses in Chapter Three also shed some light on the etiological associations between amplifying appraisals style anhedonia in youth. Consistent with the wider adult and youth literature (Nelis et al., 2018; Nelis, Bastin, et al., 2016; Nelis, Holmes, & Raes, 2015) and the systematic review presented in Chapter Two, prospective findings showed that reduced amplifying appraisals might increase risk for elevated anhedonia symptoms in adolescents. A unique contribution of the Chapter Three to the adolescent literature was that it also showed, in turn, elevated levels of anhedonia symptoms predicted

decreased trait levels of amplifying appraisals. This for the first time demonstrates a reciprocal relationship between amplifying appraisals and anhedonia in youth, which might be one mechanism that explains the stability of anhedonic disturbances (Conway et al., 2017). However, the association between the amplifying appraisal style and PA experience still needs further testing in manipulation designs that could elucidate the direction of the association between the two while controlling for potential unmeasured covariates. Chapter Three, could not find any prospective evidence that dampening and fear of positive emotion were risk factors for change in anhedonia symptoms and vice versa. Previously, data from one adolescent cohort demonstrated that there was a positive prospective association between dampening appraisals and anhedonia at a two-year but not at a one-year follow-up assessment whereas amplifying appraisals consistently predicted anhedonia (Nelis et al., 2018).

This thesis did not find any evidence showing that fear of positive emotion is a unique correlate or predictor of anhedonia symptoms in youth, contrary to significant cross-sectional associations found in adult samples (Werner-Seidler et al., 2013; Beblo et al., 2012). Elevated fear of positive emotion rather emerged as a correlate of increased depression severity in adolescents. Developmental theories are lacking that could explain whether there are variations of PA appraisal style which are more prominent in adolescents than children or adults and how they relate to PA functioning across life span. This thesis is the first to examine the fear of positive emotion construct in adolescents in relation to anhedonia symptoms. The null findings s may implicate that apprehension of positive emotions might be learned (for example, through life experience of positive situations and feelings back-firing) and become increasingly impairing later in the development.

Following the framework suggested by Dunn (2017) to determine mechanisms of therapeutic change, this PhD first examined cross-sectional and prospective associations between positive appraisal styles and PA in adolescents. Mixed-findings across cross-

sectional and prospective evidence did not fully conform to the criteria proposed to establish a robust association between the appraisal style and PA functioning. The key aim of the current thesis was, however, to seek causal evidence that can provide more robust evidence and is less prone to methodological weaknesses of such survey designs.

The promising pattern of findings that linked amplifying appraisals to anhedonic deficits in non-experimental studies could not be replicated in manipulation designs. Similarly to studies conducted in adult samples (Burr et al., 2017; Dunn et al., 2018), study three and four failed to reliably elevate use of amplifying appraisals, making this data hard to interpret.

One divergent finding emerged from study four was that engaging with SF amplifying appraisals during the music listening task impeded NA decrease in adolescents (i.e. the music listening task was a less effective form of negative mood repair in this condition). However, given that a reliable amplifying appraisal style induction could not be achieved, drawing any conclusion on the impact of the appraisals on PA levels would be misleading based on the findings of the current thesis.

On the other hand, instructed dampening appraisal style inhibited PA levels during a controlled laboratory task while adolescent participants asked to recall positive memories compared to the control condition. This result from study three was broadly comparable to findings that emerged from experimental work with adults (Dunn et al., 2018). Study four used a more ecologically valid event scheduling design to demonstrate that dampening appraisals again hindered PA inducing and NA improving ability of listening to happy songs in adolescents. These findings were consistent with the effect that was previously shown in adults during a pleasant outdoor walking activity (Burr et al., 2017).

It is noteworthy that there is an inconsistency between the association and experimental findings in the current thesis. Amplifying is robustly linked to PA levels in

association designs but not causal designs, whereas dampening is robustly linked to PA levels in causal but not association designs. As highlighted in the review, a better understanding of critical developmental phases during which the positive appraisal styles have a significant impact on the affective functioning is needed to unpack these mixed findings. Moreover, taken together the current findings and non-experimental findings of wider literature, amplifying appraisal style might present more of a dispositional trait tendency, whereas dampening may be more of a state phenomenon which influences PA when induced (Burr et al., 2017; Dunn et al., 2018). This dampening appraisal style may be more frequently activated in the course of MDD (Werner-Seidler et al., 2013) rather than predicting PA functioning consistently (Bastin et al., 2018).

Consistent across both a controlled laboratory task and pleasant everyday event scheduling, induced dampening appraisals during positive mood inductions, in contrast to adult findings, did not significantly decrease PA levels within the condition. This was a potential developmental difference that emerged between those studies of adults (Burr et al., 2017; Dunn et al., 2018). This suggests that while still hindering PA levels in youth, dampening appraisals are yet not as detrimental as the effects detected in adults. In laboratory settings, induced dampening increasing sadness levels (i.e. made the task a negative mood induction) among adolescents. However, this detrimental effect of dampening appraisals did not extend to more naturalistic settings when adolescents were asked to listen to their happy music of choice in study four. NA levels still numerically increased but this increase was not statistically significant. There is still limited research on down-regulating and up-regulating of PA in youth as previously discussed in Chapter Two. Positive affect dampening might be a slightly distinct phenomenon in adolescents compared to adults which may explain why the appraisal style has less influence on PA in youth. Young people, for instance, might be engaging with down-regulating appraisals that were not particularly covered in the scope of

this thesis. It may also be that the use of dampening appraisals may start emerging during adolescence and on-going engagement with the appraisal style over the years might strengthen its impact on affective functioning.

Study three and four demonstrated a significant negative impact of induced dampening appraisals on PA in adolescents. However, one further finding was that dampening manipulations not only increased use of dampening but also reduced the use of amplifying appraisals in adolescents. These findings were similar to the impact of the induced dampening appraisals in adults (Burr et al., 2017; Dunn et al., 2018). It is noteworthy that, within the dampening condition, both increased levels of dampening appraisals and decreased use of amplifying appraisals correlated with reduced levels of PA. These findings provide a more nuanced picture of the impact of engaging with dampening appraisals on positive cognitive styles, however it is still not entirely clear whether it is the change in the levels of dampening appraisals or amplifying appraisals that accounted for the altered PA in youth. Future work should examine the dynamic interplay between dampening and amplifying appraisals, to examine the possibility that they reciprocally inhibit one another.

The current PhD investigated whether positive appraisal style underpins PA in youth, following the step-wise approach suggested by Dunn (2017) to demonstrate what is robust evidence to establish a mechanistic link across series of non-experimental and experimental studies. In the light of evidence gathered in this thesis, dampening appraisals emerged as a candidate mechanism to may underlie anhedonic deficits in adolescents and robust causal evidence demonstrated here should be considered in the theoretical models of emotion dysregulating in youth (Young, Sandman, & Craske, 2019).

6.4 Clinical implications of findings

Depression in youth is a debilitating problem (Gore et al., 2011) with increased rates of onset during adolescence (Costello, Erkanli, & Angold, 2006) that causes life-long socio-

economic difficulties (Clayborne et al., 2019). However, therapies targeting the disorder in youth reveal weak treatment effects overall (Weisz et al., 2006). Clinically, results gathered from this thesis might be important in a number of ways to inform the development of more effective prevention and intervention approaches that target adolescent depression.

Although evidence presented in this thesis were not based on clinical youth samples, its findings are still noteworthy given that the subsyndromal levels of anhedonia in community samples is an indicator of risk for MDD in adulthood (Pine et al., 1999). This also highlights the importance of preventing the development of symptomatology before the occurrence of a subsequent full-blown depressive episode.

As summarised in the first chapter, anhedonia is a severity marker of adolescent depression (Gabbay et al., 2015), linked with suicidality (Auerbach, Millner, Stewart, & Esposito, 2015) and follows a stable trajectory in adolescence (Conway et al., 2017). Overall, prevention of anhedonia in youth should be a major area of clinical interest also given the weak evidence supporting the effectiveness of psychotherapy (Weisz et al., 2006) and concerns around potential suicidal side-effects of SSRIs in the treatment of adolescent depression (Bridge et al., 2007; Wong et al., 2004). Evidence from the systematic review and the prospective survey study reported in Chapter Three revealed that decreased trait use of amplifying appraisals may precede anhedonia symptoms in adolescents. Correspondingly, the prospective evidence from Chapter Three also showed that increased anhedonia might be a vulnerability factor for a subsequent decrease in the use of amplifying appraisals in community adolescents. Previous work has demonstrated that prevention of emotional disorders in young people through programs that target particular information processes such as depressive rumination is possible (Topper, Emmelkamp, Watkins, & Ehring, 2017). Hence, the potential of promoting increased use of amplifying appraisals for prevention of

anhedonic deficits in adolescents should be evaluated for the development of effective preventative interventions.

The direct causal evidence demonstrated in this thesis provides initial confirmation for the proposal that dampening appraisals style are a candidate underlying mechanism of adolescent anhedonia. Individual differences in anhedonia, depression or anxiety symptom levels did not moderate this association as demonstrated in study three and four similar to the published work in adults (Burr et al., 2017; Dunn et al., 2018). Nonetheless, the data presented in this thesis were not powered enough to capture these interactions. If the present findings are also confirmed in clinical youth samples, dampening appraisal style might be a potential process that should be corrected to achieve therapeutic change in clinical settings.

Cognitive behavioural therapy, a well-established first line treatment of adolescent depression (NICE, 2005), aims to achieve improvement in mood by modifying dysfunctional information processes (Blagys & Hilsenroth, 2002). For depressed adolescents who present with increased engagement with dampening appraisals when experiencing positivity, challenging these maladaptive appraisal styles using CBT principles might be beneficial to build positive mood and improve overall symptomatology. BA as described in Chapter One in the treatment of depression is a cost effective alternative to the gold-standard CBT (Richards et al., 2016) which aims to reinforce re-engagement with pleasurable activities demonstrated promising effects in symptom improvement as well as reduction in anxiety levels in young people (Pass et al., 2018; Tindall et al., 2017). The event scheduling study that reported in Chapter Five tentatively suggested that when adolescents engage with dampening appraisals during everyday pleasant activities, this may inhibit PA. When depressed adolescents could not benefit from positive activity scheduling, identifying and challenging PA dampening cognitive styles that get in the way, while keeping the focus on rewarding events, should be considered for enhancing the effectiveness of BA approaches.

Finally, positive emotions are sources of psycho-social resilience (Fredrickson, 1998) and, in young people, linked with various adaptive outcomes including flexible thinking and better coping abilities (Gilbert, 2012). Besides the potential improvements that may be gained in symptom reduction, enhancing positive mood by targeting dampening appraisals may also improve a range of secondary outcomes in youth therapy such as pro-social competence which will in turn augment long-term resilience (Kazdin, 2000).

6.5 Limitations of the research

The current thesis addressed various research gaps identified in the youth literature regarding the PA appraisals in youth. It followed a stepwise approach to investigate this topic across various study designs that provided multiple levels of evidence before concluding whether the positive appraisal style in adolescents is a potential anhedonia driving mechanism. Particularly, randomised controlled experiments conducted in the scope of this thesis allowed for the establishment of direct causal evidence. By the help of new mobile technologies, this evidence was even extended to naturalistic settings with increased ecological validity of the effects found. However, a number of limitations raised from the current PhD should also be noted.

Given that establishing a causal evidence was the overarching aim of the present thesis, it is important to underlie the shortcomings faced in the manipulation studies.

First of all, similar to the findings reported in studies with adults (Burr et al., 2017; Dunn et al., 2018), the experimental induction of amplifying appraisal style was not successful in study three and four. The spontaneous use of amplifying appraisals occurred in control conditions was comparable to the levels of amplifying appraisals in amplifying conditions. PA amplifying cognitive styles studied in this PhD (Feldman et al., 2008) was previously shown to be elevated with increased hypomania symptoms (Dempsey et al., 2011). Items such as “I am living up to my potential” or “I am feeling full of energy” may be

reflecting a pathological form of PA up-regulating appraisal styles (Dunn et al., 2018), and thus might result in manipulation to fail in non-clinical samples. Further, the amplifying appraisals used in the manipulations, such as the ones about personal achievement, might not always be applicable to use during the positive mood inductions if participants did not recall memories or listen to songs that had achievement themes. Therefore, along with the bi-directional associations reported in Chapter Three, it remains unclear whether engaging with amplifying appraisals alter positive mood or vice versa.

Secondly, in the initial sample that completed the event scheduling study, listening to happy music failed to induce positive mood as reported in study four. Instead of using a global positive mood induction task, this study involved participants to create their own playlists aiming to increase the ecological validity of the task. However, intended manipulation could not be achieved. As a result, a sub-sample of participants was then selected based on a numerical increase in PA reaction to mood induction in post-hoc analyses. Primary analyses in study four were based on this selected sub-sample of adolescents. Participants who comprised of the final study sample were comparable to the ones that were excluded in terms to their demographic characteristics, anhedonia levels, trait use of amplifying appraisals and PA levels before the mood induction. Excluded participants, however, rated low on depression symptoms and use of trait dampening appraisals. Therefore, the overall findings should be interpreted cautiously, and it should also be considered that participants in the final sample were more depressed and engaging with elevated use of dampening appraisals which might have strengthened the observed PA reducing ability of the dampening appraisals.

Further, one criticism of the current manipulation designs might be that demand characteristics may influence their findings, that is participants would anticipate the aim of the manipulation and provide responses accordingly. As reported before, the amplifying

manipulations failed to increase the use amplifying appraisals compared to the control conditions, which suggests that demand characteristics are not likely to explain the successful induction of dampening appraisals across experimental studies.

Another limitation of the manipulation studies is the reliance solely on self-report data, using a single 'happiness' rating (as in Study Three) or by averaging across a variety of positive adjectives in the PANAS (as in Study Four). Such self-report measures are vulnerable to demand effects and it would be better to supplement them with more objective physiological or behavioural ratings (for example, heart rate variability indices; facial EMG; activation of reward circuitry like the nucleus accumbens measured using functional MRI; or patterns of EEG activity linked to positive affect). Moreover, it is increasingly realised that, like negative affect, positive affect is not a unitary construct and can be meaningfully fractionated into subtypes (for example, joy, awe, contentment, amusement, love and pride captured by the Dispositional Positive Emotions Scale; Shiota, Keltner, & John, 2006). It is conceivable dampening and amplifying appraisals will have different effects on different positive emotions. Finally, we have focused here solely on consummatory anhedonia (subjective liking when attaining rewards) and future research needs to look also at the impact of appraisal style on anticipation, wanting and learning.

An important issue to consider is our choice of analytic method to quantify change and how this differs across studies. There is an ongoing debate in the literature as to whether use of simple change scores, residualised change scores, or an ANCVOA approach are the optimal way to analyse such data (Gottman & Rushe, 1993; Kisbu-Sakarya, MacKinnon, & Aiken, 2013; Schoemann, Gallagher, & Little, 2015). Across the experimental chapters in the thesis, we use a variety of different analytic methods. In Chapter Three, (a longitudinal survey study) intake anhedonia symptoms were covaried while predicting subsequent anhedonia symptoms in regression analyses. The theoretical assumption behind this choice

was that intake anhedonia was likely to impact anhedonia levels measured at a three-months follow-up. Thus, removing the variance explained by the intake anhedonia in subsequent anhedonia levels would provide a more conservative estimate of variance explained in future anhedonia levels from use of positive appraisal styles (Thomas E. Joiner, 1994; Nunes et al., 2011). This choice was also guided by the fact that previous appraisal style survey studies have used the ANCOVA approach (Bastin et al., 2018; Nelis et al., 2015) and we wanted to be able to consider to what extent our findings aligned with these previous studies. In Chapter Four (a laboratory experiment with three between-subjects conditions), residualised change scores were first computed and then these were entered into the analyses. The key comparison here is between residual change scores across the three conditions. It would not have been possible with a classic ANCOVA approach to generate and then compare these three separate scores. Mathematically, this method is nevertheless broadly similar to ANCOVA and simulation studies show there is little difference between them (Kisbu-Sakarya et al., 2013). In Chapter Five (a real-life experiment with four within-subjects experimental conditions using a cross-over RCT) we used a simple change score rather than residual change scores. This is because the key comparisons are within-subject ones and a residual change score approach would have transformed each condition to have the same mean and SD (leading to spurious completely null findings). While we are able to justify our use of each analytic approach in the above studies, we nevertheless cannot rule out that the different analytic methods may have introduced an additional source of noise into the data and this should be taken into account when interpreting the findings.

A priori sample size calculations have been conducted in study two (longitudinal survey study) and study three (laboratory experiment) and the required sample sizes were achieved for both studies. However, in study four (a cross-over RCT), the sample size was based on a prior study by Burr et al. (2017) rather than on the basis of a formal power

calculation. Further, as mentioned above, initial sample size in study four was reduced due to the music manipulation failing to increase PA, meaning that core analyses were run in a subsample where the manipulation had worked. This meant the study had reduced power to detect a true effect (i.e. increasing the likelihood of Type I error). The diminished sample size (and the failure to conduct an a priori power analysis) is a significant limitation of study four.

There were other sources of methodological drawbacks in the current research that may also influence the reported findings. The evidence reported in the systematic review and meta-analyses in Chapter Two, relied on published research studies and reported effect sizes within these studies, therefore null findings that are less likely to be reported or published were not included in the review. The survey study reported in Chapter Three, only had one follow-up which was conducted three-months after the baseline assessment and could not contribute to the discussion of mixed prospective associations reported for prediction of anhedonia at different time scales. Also, almost half of the baseline sample did not participate in the follow-up assessment. Participants who remained in the study did not differ in their self-reported levels of positive appraisal style and reported increased levels of anhedonia at baseline. Nonetheless, findings from the prospective analyses should be interpreted cautiously given the missing data might induce bias due to the high attrition rate.

6.6 Future directions

This section will suggest avenues for future research that arise from the findings of this PhD.

There were number of gaps identified in the youth literature by the systematic review reported in Chapter Two that have not been addressed by the current thesis. The main outcome of the current work is that dampening appraisal style may underpin anhedonic deficits in adolescents. As outlined by Dunn (2017), the next step should be determining whether a reduction in dampening appraisal style account for therapeutic change and

therefore mediate treatment effectiveness. The systematic review conducted in the scope of this PhD did not identify any studies that explored the role of positive appraisals in terms to PA improvement in a clinical setting neither in youth nor in adult samples. Future clinical trials should address this gap, and if positive change in appraisal style enhances treatment outcomes, targeted interventions should be developed that will correct for these deficits to improve mood.

All the studies that examined positive appraisal styles in youth so far were based on non-clinical samples. In adults, evidence indicated that positive appraisal styles are implicated in MDD (Nelis, Holmes, & Raes, 2015; Werner-Seidler et al., 2013) and BD (Edge et al., 2013). Future research should investigate whether positive appraisal styles are implicated in adolescent depression.

As identified by the systematic review, there is also a need for experience sampling studies that will demonstrate more dynamic associations between the momentary use of appraisal style and anhedonic disturbances. ESM methodologies will provide a more ecologically valid observations about how often and to what extent young people engage with positive appraisal style in daily life, whether these influence the strength of the associations between appraisal style and PA, as well as information on other contextual factors (e.g. such as being with a friend, engaging with certain daily tasks) that may also influence the use of appraisal styles. Moreover, ESM evidence of this kind will be less prone to recall bias that is an issue in traditional survey studies (see Scollon, Kim-Prieto, & Scollon, 2003).

In the experimental studies of this thesis, the focus was to assess consummatory PA (i.e. state PA) and whether the appraisal styles would enhance or diminish PA reactivity induced by pleasurable experiences. There is evidence demonstrating that depressed adults struggle to anticipate positive-future events (MacLeod & Salaminiou, 2001) and exhibit reduced PA expectancies (Thompson et al., 2017). In an adult sample, Dunn et al. (2018)

demonstrated that the dampening appraisals also get in the way when anticipating pleasure and reduced PA levels. It will be an important next step to investigate this association in the anticipatory pleasure domain in adolescents to extend the current findings into other information processing domains.

Moreover, some of the limitations arise from the current thesis also require further research to address these issues. Given that the experimental studies in the current thesis failed to successfully manipulate the amplifying appraisal style in youth as disused previously in this chapter, future studies may benefit from examining and inducing more adaptive forms of amplifying appraisal styles that may have desired positive effects on positive mood. Pleasant memory recall task was a potent mood induction in the current study that could be utilised by future studies that will examine positive emotion regulation in young people. However, studies that will design to induce positive mood at more naturalistic settings may avoid tasks that are likely to evoke mixed-feelings in youth such that the music listening task which did not deliver in this thesis. Although there is evidence showing that adolescents listen to music to attain positive mood (Saarikallio & Erkkilä, 2007), the current data could not find support for this finding. Future studies may consider positive mood inductions, for instance, that may involve receiving feedback on academic or social achievements (e.g. social inclusion; Dalgleish et al., 2017).

6.7 Conclusion

Collectively, the evidence presented in the current PhD extends the findings of similar empirical work conducted with adults and adds to the current literature by demonstrating that dampening appraisal style is an anhedonia driving mechanisms in adolescents. To my knowledge, this research is the first to examine positive appraisal styles in adolescents using a mixture of association and causal designs in both laboratory and everyday settings. While use of dampening appraisal styles did blunt PA in adolescents, its impact on mood may not be as

damaging as effects that were previously reported in adults. Further work that examines whether dampening appraisal style is a mechanism of change in psychotherapy is needed. If improvements in positive appraisal style in part mediate symptom improvement, then developing interventions that more explicitly correct for dampening appraisals could help augment psychological interventions by enhancing their capacity to repair anhedonia.

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