

**Title:** Examining the Relationship Between Anhedonia Symptoms and Trait Positive  
Appraisal Style in Adolescents: A Longitudinal Survey Study

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**Abstract**

**Introduction:** 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 in adolescents. We know little about the cognitive vulnerability factors that contribute to the development of anhedonia in youth. This cross-sectional and longitudinal survey study investigated the link between anhedonia symptoms and cognitive appraisal of positive affect.

**Methods:** Baseline data were collected from 392 secondary school students in the UK (aged 13-16, 54% Female), 170 of whom went on to complete the three-month follow-up assessment (a 43% response rate). Participants rated their anhedonia symptoms and appraisal styles which were measured in terms of use of amplifying appraisals, dampening appraisals, and fear of positive emotion. **Results:** At baseline, greater anhedonia was significantly associated with increased levels of dampening and reduced levels of amplifying but was not significantly related to fear of positive emotion. Prospectively, greater baseline levels of amplifying uniquely predicted lower anhedonia severity at three-month follow-up, and vice-versa. There was no evidence for reciprocal prospective associations between anhedonia and appraisal styles of dampening and fear of positive emotion. **Conclusion:** 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.

**Keywords:** anhedonia; appraisal style; positive affect; adolescence; depression

## **Introduction**

Major Depressive Disorder (MDD) is a severely impairing condition (Hawton, Saunders, & O'Connor, 2012; Jaycox et al., 2009; 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). The rate of depression in adolescence reaches 5.6%, the first onset often occurs during the same period (Costello, Erkanli, & Angold, 2006) and approximately 40% of depressed teenagers experience at least one more depressive episode in the following years (Birmaher et al., 2004; Dunn & Goodyer, 2006).

Anhedonia, defined as a loss of interest and pleasure in previously enjoyable activities, is one of the two cardinal symptoms required for a MDD diagnosis along with low mood and/ presence of irritability in youth according to the DSM classification system (American Psychiatric Association, 2000; 2013). Presence of anhedonia symptoms in youth is a risk factor for a subsequent onset of depression (Pine, Cohen, Cohen, & Brook, 1999). Anhedonic disturbances in MDD are more resistant to change during and after the treatment compared to low-mood related deficits (Dunn et al., 2020). 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), such that higher intake anhedonia was a sole predictor of increased days to remission (McMakin et al., 2012). Greater anhedonia in adolescent depression predicts increased duration of depressive episodes, elevated suicidal ideation, and a sub-optimal treatment response to both cognitive behavioural therapy (CBT) and anti-depressant medication (McMakin et al., 2012). Anhedonia is a part of underlying disturbances in brain systems that regulate reward (Der-Avakian & Markou, 2012). Reduced responsiveness to positive rewards was demonstrated to be a factor in the development of depression (Kujawa, Hajcak, & Klein, 2019) and interfered with the reduction of depressive symptoms among youth receiving psychotherapy (Barch et al., 2019; Forbes & Dahl, 2005;

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Kujawa, Burkhouse, et al., 2019). Despite its prognostic importance, current treatments neglect anhedonia and instead predominantly focus on reducing elevations in negative mood (Dunn et al., 2020). Treatment outcomes for adolescent depression may be improved if we identify and target underlying mechanisms that cause and maintain anhedonia (an experimental psychopathology approach; Holmes, Craske, & Graybiel, 2014).

These potential changes in appraisal style of positive affect can be seen as a specific instantiation of the appraisal (and broader attentional and memory), reduced positive and enhanced negative processing biases associated with depression (Ingram, 1984; Lau & Waters, 2016; LeMoult & Gotlib, 2018; Mathews & MacLeod, 2005; Platt, Waters, Schulte-Koerne, Engelmann, & Salemink, 2016). A recent study in undergraduate students found that inducing savouring or dampening appraisals altered depressive symptoms even in individuals with reduced reward responsiveness suggesting that positive appraisal style can be modified and that this may improve depression symptoms (Irvin, Bell, Steinley, & Bartholow, 2020). Similarly, changes in how individuals appraise positive emotion experience (either enhanced use of amplifying appraisals or reduced use of dampening appraisals) could be one candidate mechanism underpinning anhedonia (Burr, Javiad, Jell, Werner-Seidler, & Dunn, 2017; Yilmaz, Psychogiou, Javiad, Ford, & Dunn, 2019). 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 think 'I don't deserve this'; Feldman, Joormann, & Johnson, 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 in young people. Bastin et al. (2018) found that greater anhedonia in a

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non-clinical sample of 665 children (mean age=13) was cross-sectionally related to greater dampening and reduced amplifying. These cross-sectional associations held in the same sample followed up 24 months later (Nelis, Bastin, Raes, & Bijttebier, 2018). However, another study on a different sample found that anhedonia was only significantly associated with greater dampening (but not reduced amplifying) appraisals in 81 non-clinical children (mean age=9) recruited on the basis of high familial risk of depression (Gilbert, Luking, Pagliaccio, Luby, & Barch, 2017).

One of these studies has also examined prospective relationships. Both greater levels of dampening and reduced levels of amplifying at intake predicted a greater increase in anhedonia at 24-month follow-up in Nelis et al. (2018). These relationships held when controlling for daily positive life events and depressive rumination. However, neither amplifying nor dampening at 12-months robustly predicted anhedonia at 24-month follow-up over and above the life events and depressive rumination (Nelis et al., 2018).

There are a number of limitations of the extant literature. First, existing studies have used an anhedonia subscale (Gilbert et al., 2017; Kovacs, 1985) which did not emerge as a distinct sub-factor according to recent factor analytic studies (Logan et al., 2013; Stumper, Olino, Abramson, & Alloy, 2019), that may lack sensitivity, or relatively novel measures of anhedonia that have not been extensively validated (Nelis et al. 2018 used the Leuven Anhedonia Scale; Bastin et al., 2018). It is important to establish if the finding replicates when using the current gold standard self-report measure of anhedonia – the Snaith Hamilton Pleasure Scale (SHAPS; Leventhal et al., 2015; Rizvi, Pizzagalli, Sproule, & Kennedy, 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. Maladaptive cognitive styles are well-established predictors of onset of depression in youth (Abela & Hankin, 2011; Wilkinson, Croudace, & Goodyer, 2013). There is still a need to rule out

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whether baseline psychopathology symptoms also have an impact on future cognitive styles (e.g. the scar hypothesis; Wichers, Geschwind, Van Os, & Peeters, 2010). There is evidence from other domains of these reverse associations being found in adolescents (Calvete, Orue, & Hankin, 2013; McCarty, Stoep, & McCauley, 2007). One study has examined these reverse associations in an adult sample (mean age=31) demonstrated that baseline anhedonia was not a significant predictor of dampening and emotion-focus appraisals but decreased levels of anhedonia did predict greater self-focus amplifying at the level of a non-significant trend (Nelis, Holmes, & Raes, 2015). As far as we are aware, no studies have taken this approach in youth samples. Third, studies to date have exclusively relied on the Response to Positive Affect Scale (RPA; Feldman et al., 2008) as the sole measure of positive appraisal style. However, this is not the only measure of positive appraisal style that exists. In the adult literature, the fear of positive emotion scale from the Affective Control Scale (Williams, Chambless, & Ahrens, 1997) and the Fear of Positive Evolution Scale (Weeks, Heimberg, & Rodebaugh, 2008) have also been linked to elevated levels of anhedonia (Jordan, Winer, Salem, & Kilgore, 2018; Werner-Seidler, Banks, Dunn, & Moulds, 2013). These focus 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 various PA appraisal constructs in a single study.

Therefore, in the present study we examined the cross-sectional and prospective associations between the SHAPS (as a gold standard measure of anhedonia) and levels of amplifying and dampening appraisals and the fear of positive emotion. We focused on both forward and reverse associations in the prospective analyses with a non-clinical sample of adolescents. We examined whether each appraisal style was associated with anhedonia and

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whether each appraisal style construct uniquely predicts anhedonia. In our longitudinal analyses, we controlled for intake depression symptoms as a covariate following previous work (cf Nelis et al., 2015). 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 also 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 (Bastin et al., 2018; Nelis et al., 2018). We had no strong *a priori* predictions as to whether these predictions would uniquely hold in prospective multiple regression analyses (i.e. whether dampening would predict anhedonia over and above amplifying and fear of positive emotion and when controlling for depressive symptoms). Regarding the reverse prospective associations (i.e. whether baseline anhedonia would predict follow-up appraisal styles), we predicted that anhedonia would not predict dampening appraisals (Nelis et al., 2015). We had no strong *a priori* hypothesis as to whether anhedonia would predict amplifying given previous mixed findings in earlier work (Nelis et al., 2015).

## **Methods**

### **Participants**

We initially contacted 14 secondary schools by email in the South West of England which were determined based on location through government websites and contacts of researchers (i.e. schools participated in previous research). Two of these schools agreed to participate in the study. All students who were in year 9 to 10 at the time of recruitment were invited. 618 students from these two schools took part in the study, 392 of whom consented and completed baseline assessment (a 63% response rate of those approached). 170 of these individuals also completed the three-month follow-up assessment (a 43.37% response rate of

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initial responders). The age of participants at baseline ranged from 13 to 16 years ( $M=14.81$ ,  $SD=.43$ ), 54.22 % ( $n=199$ ) of participants were female, and the majority were of white British ethnic origin (90.46%,  $n=332$ ).

## **Procedure**

We first obtained informed consent from headteachers 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 for parents to complete. If the opt-out form was not returned to classroom teachers within two weeks period, 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. Participants were debriefed and given a list of mental health resources after data collection, and compensated for £5 vouchers for their time if they took part in both baseline and three-month follow-up assessments. The study obtained ethical approval from the Ethics Committee of the School of Psychology, University of Exeter (Ref, 2017/1429).

## **Measures**

### **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 the last few days (e.g., “I would enjoy being with my family or close friends”) on a scale ranging from 1 (definitely agree) to 4 (strongly disagree). The scale has been validated for use in adolescents, demonstrating



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acceptable internal reliability (Cronbach's  $\alpha=.87$ ) in this population (Leventhal et al., 2015).

We used the revised continuous 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) which is less vulnerable to range restriction effects. Internal consistency of the SHAPS was adequate in the current sample ( $\alpha=.86$ ).

### **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. It assesses the trait tendency to engage in dampening appraisals (e.g., “think about the things that have not gone well for you”), emotion-focus (EF) amplifying appraisals (e.g., “notice how you feel full of energy”), and self-focus (SF) amplifying appraisals (e.g., “think ‘I am the best I could be.’”). Factor analytic studies suggest that a two-factor model of dampening (8 items) and amplifying (9 items) best fits the data in youth samples (Nelis et al., 2016). Therefore, we pooled EF and SF amplifying scales in the current study. 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. Possible scores ranged from 8-32 for dampening and 9-36 for amplifying subscale. Internal reliability was  $\alpha = 0.79$  and  $\alpha = 0.86$  for dampening and amplifying scales respectively (Bijttebier, Raes, Vasey, & Feldman, 2012). Internal reliability was acceptable for both the amplifying ( $\alpha=.87$ ) and dampening ( $\alpha=.86$ ) subscales in our data.

The 12-item 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 (e.g. “I am afraid that I’ll do something stupid if I get carried away

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with happiness”) on a scale ranging from 1 (very strongly disagree) to 7 (very strongly agree), with a total range of 12 to 84. The reliability of the fear of positive emotion subscale was acceptable in other adolescent samples,  $\alpha = 0.74$  (Geddes et al., 2007). Reliability was also acceptable in the current sample ( $\alpha = 0.79$ ).

### **Confounding variables.**

Depression first emerges around ages 11 to 12 (Breslau et al., 2017; Salk, Hyde, & Abramson, 2017) and follows a stable increase into the emerging adulthood (Costello, Copeland, & Angold, 2011; Maughan, Collishaw, & Stringaris, 2013), particularly in girls (Piccinelli & Wilkinson, 2000; Salk et al., 2017). Therefore, gender and age were investigated as potential covariates in the current study.

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 depressive symptoms. Participants rate how they have felt (e.g., “I feel sad or empty”) on a Likert scale ranging from 0 (Never) to 3 (Always), with a possible total range of 0 to 30. The depression scale has been shown to have satisfactory internal consistency ( $\alpha = 0.87$ ) (Chorpita, Moffitt, & Gray, 2000) was adequate in the present sample ( $\alpha = .80$ ).

The 13-item ruminative response subscale of the Children’s Response Style Questionnaire (CRSQ; Abela, Vanderbilt, & Rochon, 2004) was used to assess ruminative style (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), with a total range of 13 to 52. Internal reliability for this subscale was adequate in other adolescent samples ( $\alpha = 0.74 - 0.75$ ; Abela, Vanderbilt, & Rochon, 2004) and was satisfactory in the current sample ( $\alpha = .93$ ).

The self-report Brief Adolescent Life Events Scale (BALES; Shahar, Henrich, Reiner, & Little, 2003) was used to assess the frequency of negative (e.g. “I argued with a family

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member”) and positive life events (e.g. “I made up with a friend”) 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 (18-item) and negative subscale (18-item) scores ranging from 0 to 54 as a result. The internal reliabilities of the positive and negative life events subscales have been shown to be adequate in adolescents ( $\alpha = 0.88$  and  $\alpha = 0.87$  respectively; Shahar et al., 2003). In the current sample, internal consistencies of the positive ( $\alpha=.86$ ) and negative life events ( $\alpha=.85$ ) subscales were acceptable.

### **Data Analysis Plan**

Alpha was set at .05 and the results of two-tailed tests are reported throughout. We used IBM SPSS version 21 for statistical analyses. 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.

#### **Missing data analysis.**

We examined what proportion of data is missing at each assessment point. We used Little’s MCAR test to see if data is missing completely at random. We imputed missing data using Markov Chain Monte Carlo algorithm (White, Royston, & Wood, 2011). The number of imputations’ runs will be based on the percentage of missing data.

**Analysis of confounders.** We used independent sample t-tests (for continuous variables) and chi-squared tests (for categorical variables) to compare systematic differences in participants who did and did not complete the three-month follow-up. To identify potential covariates to include in the analyses, we examined if age, gender, rumination, positive event frequency, negative event frequency and depression were correlated with baseline symptom severity. We reported the zero-order (Pearson) correlations between anhedonia and each

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appraisal style. We compared the magnitude of these dependent correlations using an online calculator that runs an asymptotic z-test (Lee & Preacher, 2013; following Steiger, 1980).

**Cross-sectional analyses.** We ran a series of regression analyses to examine the cross-sectional associations between appraisal styles and anhedonia measured at baseline. Multi-variate regression models were used to identify whether each appraisal style variable (over and above each other) were uniquely associated with anhedonia, entering all three appraisal style variables as the independent variables, and anhedonia as the dependent variable. Next, we tested if the unique associations between each appraisal style and anhedonia symptoms held, when covariate variables were also controlled (i.e. the appraisal styles were linked to anhedonia severity over and above the confounder variables including depressive symptoms) in a series of regression analyses.

**Prospective analyses.** Parallel multivariate regression models were used for prospective analyses. Follow-up anhedonia was the dependent variable and we additionally entered baseline anhedonia as a covariate along with the other predictor variables. Next, a series of regression models were run with the addition of covariate variables (i.e. the appraisal styles were linked to follow-up anhedonia severity over and above the confounder variables including baseline anhedonia and depressive symptoms). We also ran comparable analyses to see if baseline anhedonia predicted change in appraisal style, this time entering follow-up appraisal style as the dependent variable and adjusting for baseline appraisal style.

## **Results**

### **Descriptive Statistics**

Table 1 presents descriptive clinical and demographic data for participants at baseline and follow-up. There was a sufficient spread of scores on all key variables, meaning that range restriction effects were unlikely to be biasing findings.

### **Missing data analysis**

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Multiple imputation was used to account for missing values in data. Little's MCAR test indicated that data were missing completely at random,  $\chi^2(2050)=2023.67, p=.66$ , making unbiased estimations possible. We simulated 50 data sets to impute missing values of all study variables using Markov Chain Monte Carlo algorithm (White et al., 2011).

### **Covariate analyses**

Greater anhedonia was associated with greater depressive symptoms, rumination and lower positive event frequency,  $ps<.01$ , but not with age, gender, and negative event frequency,  $ps>.45$ . We therefore entered depressive symptoms, rumination and positive life events as covariates in subsequent regression analyses.

Systematic differences between participants who did and did not complete the follow-up assessment (see Supplementary Materials Section 1 for details), were from different schools, completed the baseline assessments in January versus November also investigated (see Supplementary Materials Section 2 for details).

### **Cross-Sectional Associations between Appraisal Styles and Symptoms at Baseline**

Table 2 reports the zero-order associations between the appraisal style variables and anhedonia. Greater anhedonia severity was related to reduced use of amplifying and greater use of dampening,  $ps<.001$ . However, anhedonia was not significantly related to fear of positive emotion,  $p=.28$ . The association of anhedonia with amplifying was significantly stronger than with dampening,  $z=3.45, p<.001$ , which in turn was significantly strong than with fear of positive emotion association,  $z=1.81, p=.04$ .

Greater anhedonia severity was uniquely associated with greater dampening, and reduced amplifying, but was not significantly related to fear of positive emotion (see Table 3). These dampening and amplifying unique relationships held if additionally entering rumination, positive event frequency and depressive symptoms as covariates into the regression. The fear of positive emotion association remained non-significant (see Table 3).

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In summary, greater anhedonia was cross-sectionally associated with greater dampening and reduced amplifying in all analyses. Anhedonia was not cross-sectionally associated with fear of positive emotion in any analyses.

### **Longitudinal Associations between Baseline Appraisal Styles and Follow-up Symptoms**

Greater baseline amplifying levels predicted lower anhedonia symptoms at follow-up. Greater baseline dampening levels were not significantly related to subsequent anhedonia symptoms. Greater baseline fear of positive emotion was not associated with subsequent anhedonia (see Table 4). When entering all three appraisal style variables into the same regression to predict anhedonia change, greater baseline amplifying still predicted change in anhedonia, while the dampening relationship and the fear of positive emotion relationship remained non-significant (see Table 4). Additionally, when entering the potential confounder variables, the amplifying association was still significant, and the dampening association and the fear of positive emotion association, remained non-significant (see Table 5).

In summary, there was evidence that greater baseline amplifying consistently predicted subsequent levels of anhedonia at follow-up, over and above baseline anhedonia severity.

### **Longitudinal Associations between Baseline Symptoms and Follow-up Appraisal Styles**

Greater baseline anhedonia severity predicted greater amplifying appraisals at follow-up but was not significantly related to dampening or fear of positive emotion (see Table 6). When additionally entering confounder variables of depressive symptoms, positive event frequency and rumination into the combined regression, amplifying change was still uniquely predicted by anhedonia severity (see Table 6).

In summary, greater baseline anhedonia severity clearly predicted greater decrease in amplifying appraisals, over and above baseline levels of the appraisal style.

## **Discussion**

### **Overview of the findings**

The primary aim of the current study was to examine concurrent and prospective associations between anhedonia and the way adolescents appraise positive affect. Partially supporting our hypotheses, 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 adjusting for rumination, frequency of recent positive events, and depressive symptoms. However, contrary to hypotheses, fear of positive emotion was not a significant correlate of anhedonia severity. Also only partially supporting our hypotheses, at the prospective level, greater anhedonia at follow-up assessment was related to reduced baseline amplifying (but not fear of positive emotion or dampening). The amplifying associations held even when adjusting for multiple covariates including baseline depressive symptoms. Reverse analyses revealed that greater baseline levels of anhedonia also predicted a decrease in amplifying appraisals at follow-up, suggesting the association between anhedonia and amplifying is bi-directional.

### **Implications**

#### **Cross-sectional findings.**

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 (Rizvi et al., 2016) – the Snaith Hamilton Pleasure Scale (Snaith et al., 1995). We also reported findings from conservative regression models where variance of potential covariates including depressive symptoms accounted for while predicting anhedonia. Previous findings using the Leuven anhedonia scale (Bastin et al., 2018) found that both dampening and amplifying were related to anhedonia cross-sectionally (Bastin et al., 2017; Nelis et al., 2018) were largely replicated. Our results deviate from Gilbert et al. (2017) using the anhedonia

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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. It is possible this null result could be a false positive, as use of a subscale measure of anhedonia could mean a limited range of anhedonia scores was available to analyse and also the study was powered to detect a medium but not a small effect size.

### **Prospective findings.**

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. It is noteworthy that Nelis et al (2018) only found these associations at 24-month follow-up and not at 12-month follow-up. These mixed findings across studies might be resulted from measures used in these studies such that Nelis et al. (2018) indexed consummatory, anticipatory and motivational anhedonia whereas our focus was on consummatory anhedonia (reactivity to in-the-moment positive stimulus) in the last few days (Snaith et al., 1995) which may function differently over time.

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. This issue has not been explicitly addressed in the extant literature on appraisal styles, where studies (including the present one) are not explicit about why a particular follow up interval where chosen. In many cases, it is conceivable that the decision was pragmatic (as this was when the samples could be accessed without placing undue burden on participants) rather than based on a theoretically informed view about the timescale over which these appraisals might operate. 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



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appraisal style at a particular point in time will predict immediate subsequent change in anhedonia, but not long-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. Not fully considering these issues may explain why relatively unclear and at times contradictory evidence has emerged.

In our view, the hybrid state-trait model is a promising framework to explore the consequences of appraisal style. One way to test this model is to examine the impact of state manipulations of appraisal style on momentary affective experience. Such experimental work has now been done in adolescents (Yilmaz et al., 2019). This work showed that when utilised, dampening appraisals decreased positive affect, however increased trait levels of dampening appraisals was not a vulnerability factor for greater anhedonia as current data suggests. Yilmaz et al. (2019) failed to successfully manipulate amplifying appraisals, precluding any conclusions being drawn about their impact on positive affect. Future research could usefully develop more successful amplifying manipulations to use in experimental designs to demonstrate their role in the development of anhedonia in youth.

### **Reverse prospective findings.**

Another issue with the extant prospective literature in youth (Bastin et al., 2018; Nelis et al., 2018) is that reverse associations have not been examined. Future work should take more frequent assessments of both constructs and examine the notion of iterative feedback of this kind directly. Experience sampling designs where rapid momentary associations between affect and appraisal measured might provide a detailed understanding of the nature of this relationship (Trull & Ebner-Priemer, 2009).

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### **Other theoretical implications.**

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). One explanation of these discrepant findings between the present study in adolescents and the existing literature in adults is that positive appraisal may not be a unitary construct and different features of positive appraisal style may become more prevalent as individuals move from adolescences to adulthood. For example, it might be argued that positive appraisal may not be a unitary construct and different kinds of ‘dampening’ appraisals 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.

### **Clinical implications.**

Previous work has shown that prevention of development of depressive symptoms in youth through targeting depressive rumination is possible (Topper, Emmelkamp, Watkins, & Ehring, 2017). The work to date has largely focused on targeting rumination in response to negative mood, not positive mood. Given the current prospective bi-directional findings

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between greater anhedonia and reduced use of amplifying appraisals in the present study, future work could usefully examine whether training individuals to make use of amplifying appraisal can bolster positive mood in those at risk of or suffering from depression in youth.

### **Limitations**

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. Participants who completed the follow-up assessment were more likely to be female, less anhedonic and ruminate less at baseline assessment. Possible reasons for the high rates of attrition are that the measurement burden of the survey was too high (so participants were unwilling to complete it for a second time) and this burden might have been experienced as greater the more ruminative and anhedonic pupils were. Alternatively, some students who had completed the survey at time one may not have been in class on the day that the follow-up survey was completed. Whatever the reason behind this high attrition rate, this limits the generalisability of our findings (in particular we have underrepresented individuals with more severe anhedonia and who were ruminative). Current prospective findings from a short-term follow-up assessment (i.e. three months) may not be generalizable to longer periods, meaning this data should be interpreted tentatively. We had intended to estimate socioeconomic status of the participating children by asking them about the highest level of education of their parents. However, less than a third of participants provided this information, meaning we could not reliably estimate socioeconomic status. This means we cannot be sure if the sample is representative of the UK general child population in this regard. Our sample consisted of predominantly White participants limiting the generalisability of findings reported here to other cultural or ethnic groups. It may be that

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there are cultural differences in the consequences of different positive appraisal styles (cf. Miyamoto & Ma, 2011).

Further, we have focused on consummatory anhedonia in this study. Evidence suggests that anhedonia in adults also extends into the anticipatory and memory domain. Depressed adults have difficulty anticipating positive-future events and positive outcomes (MacLeod & Salaminiou, 2001; Thompson et al., 2017) and remembering past positive events (Foland-Ross, Cooney, Joormann, Henry, & Gotlib, 2014). Dampening appraisals in adult samples get in the way of experiencing positive emotions when anticipating and recalling future rewarding experiences (Dunn et al., 2018) in addition to impairing consummatory pleasure during rewarding activities (Burr et al., 2017). Future research could examine if positive appraisal styles in youth also influence anticipatory anhedonia (looking forward to future positive events). 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).

## **Conclusions**

Overall, these data are consistent with the view that positive appraisal style may be one risk factor underpinning anhedonic experience in youth. If this is replicated in further work using more robust methods and clinical samples, this would suggest effective prevention and interventions that systematically target positive appraisal styles could be designed for depression and related conditions characterised by anhedonia.

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## Tables

Table 1

*Demographic and Clinical Variables at Baseline (non-treated data).*

|                     | Mean (SD)     | Range |
|---------------------|---------------|-------|
| Age                 | 14.80 (.39)   | 13-16 |
| Gender (Female %)   | 54.22 %       | -     |
| Ethnicity (White %) | 90.46 %       | -     |
| <b>Baseline</b>     |               |       |
| 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  |
| <b>Follow-up</b>    |               |       |
| 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 2

*Zero-Order Correlations Between Baseline Variables*

| Intake          | Dampening | Amplifying | Fear of PE | Rumination | Positive Events | Negative Events | Anhedonia | Depression |
|-----------------|-----------|------------|------------|------------|-----------------|-----------------|-----------|------------|
| Dampening       | -         |            |            |            |                 |                 |           |            |
| Amplifying      | .02       | -          |            |            |                 |                 |           |            |
| Fear of PE      | .35***    | -.03       | -          |            |                 |                 |           |            |
| Rumination      | .65***    | -.04       | .23***     | -          |                 |                 |           |            |
| Positive Events | .06       | .42***     | .003       | .01        | -               |                 |           |            |
| Negative Events | .49***    | -.08       | .19***     | .41***     | .27***          | -               |           |            |
| Anhedonia       | .19***    | -.41***    | .06        | .15**      | -.29***         | .09             | -         |            |
| Depression      | .57***    | -.27***    | .33***     | .68***     | -.13*           | .45***          | .31***    | -          |

*Note.* N=392, PE=Positive Emotion. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$



Table 3

*Hierarchical Regression Analyses Examining Unique Associations of Each Appraisal Style with Baseline Anhedonia Symptoms.*

| <b>Amplifying analysis</b> |          |             |          | <b>Dampening analysis</b> |          |             |          | <b>Fear of PE analysis</b> |          |             |          |
|----------------------------|----------|-------------|----------|---------------------------|----------|-------------|----------|----------------------------|----------|-------------|----------|
| Predictor                  | <i>B</i> | <i>SE B</i> | <i>p</i> | Predictor                 | <i>B</i> | <i>SE B</i> | <i>p</i> | Predictor                  | <i>B</i> | <i>SE B</i> | <i>p</i> |
| <b>Step 1</b>              |          |             |          | <b>Step 1</b>             |          |             |          | <b>Step 1</b>              |          |             |          |
| Fear of PE                 | .22      | .07         | <.01     | Fear of PE                | .04      | .04         | .33      | Dampening                  | .23      | .06         | <.001    |
| Dampening                  | -.01     | .04         | .87      | Amplifying                | -.48     | .06         | <.001    | Amplifying                 | -.48     | .05         | <.001    |
| <b>Step 2</b>              |          |             |          | <b>Step 2</b>             |          |             |          | <b>Step 2</b>              |          |             |          |
| Amplifying                 | -.48     | .05         | <.001    | Dampening                 | .24      | .06         | <.001    | Fear of PE                 | -.02     | .04         | .62      |
| <b>Step 1</b>              |          |             |          | <b>Step 1</b>             |          |             |          | <b>Step 1</b>              |          |             |          |
| Depression                 | .29      | .06         | <.001    | Depression                | .19      | .06         | <.01     | Depression                 | .15      | .06         | .01      |
| Rumination                 | -.09     | .05         | .07      | Rumination                | -.01     | .04         | .83      | Rumination                 | -.05     | .05         | .26      |
| Positive events            | -.21     | .04         | <.001    | Positive events           | -.11     | .04         | <.01     | Positive events            | -.12     | .04         | <.01     |
| Fear of PE                 | -.04     | .04         | .36      | Fear of PE                | -.01     | .04         | .78      | Dampening                  | .16      | .07         | .02      |
| Dampening                  | .13      | .08         | .10      | Amplifying                | -.39     | .06         | <.001    | Amplifying                 | -.40     | .06         | <.001    |
| <b>Step 2</b>              |          |             |          | <b>Step 2</b>             |          |             |          | <b>Step 2</b>              |          |             |          |
| Amplifying                 | -.40     | .06         | <.001    | Dampening                 | .18      | .07         | <.01     | Fear of PE                 | -.03     | .04         | .41      |

*Note.* PE=Positive Emotion.

Table 4

*Hierarchical Regression Analyses Predicting Follow-up Anhedonia Symptoms.*

| <b>Amplifying analysis</b> |          |             |          | <b>Dampening analysis</b> |          |             |          | <b>Fear of PE analysis</b> |          |             |          |
|----------------------------|----------|-------------|----------|---------------------------|----------|-------------|----------|----------------------------|----------|-------------|----------|
| Predictor                  | <i>B</i> | <i>SE B</i> | <i>p</i> | Predictor                 | <i>B</i> | <i>SE B</i> | <i>p</i> | Predictor                  | <i>B</i> | <i>SE B</i> | <i>p</i> |
| <b>Step 1</b>              |          |             |          | <b>Step 1</b>             |          |             |          | <b>Step 1</b>              |          |             |          |
| T1 Anhedonia               | ,43      | ,09         | <.001    | T1 Anhedonia              | ,43      | ,09         | <.001    | T1 Anhedonia               | ,43      | ,09         | <.001    |
| <b>Step 2</b>              |          |             |          | <b>Step 2</b>             |          |             |          | <b>Step 2</b>              |          |             |          |
| Amplifying                 | -,23     | ,10         | ,03      | Dampening                 | -,13     | ,10         | ,17      | Fear of PE                 | -,06     | ,06         | ,36      |
| <b>Step 1</b>              |          |             |          | <b>Step 1</b>             |          |             |          | <b>Step 1</b>              |          |             |          |
| T1 Anhedonia               | ,45      | ,09         | <.001    | T1 Anhedonia              | ,36      | ,10         | <.01     | T1 Anhedonia               | ,37      | ,10         | <.001    |
| Fear of PE                 | -,03     | ,06         | ,64      | Fear of PE                | -,06     | ,06         | ,35      | Dampening                  | -,11     | ,10         | ,25      |
| Dampening                  | -,12     | ,10         | ,25      | Amplifying                | -,23     | ,11         | ,03      | Amplifying                 | -,22     | ,11         | ,04      |
| <b>Step 2</b>              |          |             |          | <b>Step 2</b>             |          |             |          | <b>Step 2</b>              |          |             |          |
| Amplifying                 | -,22     | ,11         | ,04      | Dampening                 | -,09     | ,10         | ,37      | Fear of PE                 | -,04     | ,06         | ,58      |

*Note.* PE=Positive Emotion. T1=Baseline.

Table 5

*Hierarchical Regression Analyses Predicting Follow-up Anhedonia Symptoms.*

| Amplifying analysis |          |             |          | Dampening analysis |          |             |          | Fear of PE analysis |          |             |          |
|---------------------|----------|-------------|----------|--------------------|----------|-------------|----------|---------------------|----------|-------------|----------|
| Predictor           | <i>B</i> | <i>SE B</i> | <i>p</i> | Predictor          | <i>B</i> | <i>SE B</i> | <i>p</i> | Predictor           | <i>B</i> | <i>SE B</i> | <i>p</i> |
| Step 1              |          |             |          | Step 1             |          |             |          | Step 1              |          |             |          |
| T1 Anhedonia        | .45      | .10         | <.001    | T1 Anhedonia       | .37      | .11         | <.01     | T1 Anhedonia        | .38      | .11         | <.001    |
| T1 Depression       | .08      | .09         | .33      | T1 Depression      | .01      | .09         | .95      | T1 Depression       | .02      | .09         | .85      |
| Rumination          | .01      | .08         | .90      | Rumination         | -.02     | .07         | .82      | Rumination          | .03      | .08         | .73      |
| Positive events     | .02      | .06         | .79      | Positive events    | .05      | .07         | .45      | Positive events     | .05      | .06         | .34      |
| Fear of PE          | -.04     | .07         | .55      | Fear of PE         | -.06     | .06         | .38      | Dampening           | -.17     | .14         | .24      |
| Dampening           | -.18     | .14         | .21      | Amplifying         | -.25     | .11         | .02      | Amplifying          | -.24     | .11         | .03      |
| Step 2              |          |             |          | Step 2             |          |             |          | Step 2              |          |             |          |
| Amplifying          | -.24     | .11         | .03      | Dampening          | -.15     | .15         | .31      | Fear of PE          | -.04     | .06         | .55      |

*Note.* PE=Positive Emotion. T1=Baseline.

Table 6

*Hierarchical Regression Analyses Predicting Follow-up Appraisal Styles.*

| Amplifying analysis |          |             |          | Dampening analysis |          |             |          | Fear of PE analysis |          |             |          |
|---------------------|----------|-------------|----------|--------------------|----------|-------------|----------|---------------------|----------|-------------|----------|
| Predictor           | <i>B</i> | <i>SE B</i> | <i>p</i> | Predictor          | <i>B</i> | <i>SE B</i> | <i>p</i> | Predictor           | <i>B</i> | <i>SE B</i> | <i>p</i> |
| <b>Step 1</b>       |          |             |          | <b>Step 1</b>      |          |             |          | <b>Step 1</b>       |          |             |          |
| T1 Amplifying       | ,55      | ,09         | <.001    | T1 Dampening       | ,48      | ,09         | <.001    | T1 Fear of PE       | ,58      | ,09         | <.001    |
| <b>Step 2</b>       |          |             |          | <b>Step 2</b>      |          |             |          | <b>Step 2</b>       |          |             |          |
| T1 Anhedonia        | -,18     | ,08         | ,022     | T1 Anhedonia       | ,01      | ,07         | ,85      | T1 Anhedonia        | ,12      | ,12         | ,33      |
| <b>Step 1</b>       |          |             |          | <b>Step 1</b>      |          |             |          | <b>Step 1</b>       |          |             |          |
| T1 Amplifying       | .55      | .09         | <.001    | T1 Dampening       | .32      | .09         | <.001    | T1 Fear of PE       | .56      | .08         | <.001    |
| T1 Depression       | -.04     | .09         | .62      | T1 Depression      | .27      | .07         | <.001    | T1 Depression       | .27      | .13         | .04      |
| Rumination          | .01      | .06         | .81      | Rumination         | .07      | .06         | .23      | Rumination          | .09      | .09         | .34      |
| Positive events     | .06      | .06         | .30      | Positive events    | .03      | .043        | .43      | Positive events     | -.03     | .08         | .66      |
| <b>Step 2</b>       |          |             |          | <b>Step 2</b>      |          |             |          | <b>Step 2</b>       |          |             |          |
| T1 Anhedonia        | -.20     | .08         | <.01     | T1 Anhedonia       | .002     | .06         | .98      | T1 Anhedonia        | .08      | .11         | .47      |

*Note.* PE=Positive Emotion. T1=Baseline.

## Supplementary Materials

### Section 1. Supplementary Analyses of Attrition Rates.

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 the follow-up were more likely to be female,  $\chi^2(1)=18.26, p < .001$ , have lower baseline anhedonia severity,  $t=2.22, p=.03$ , and ruminate less,  $t=2.20, p=.03$ . There was no significant difference in terms of age,  $t=1.63, p=.10$ , baseline depressive symptoms,  $t<1$ , frequency of positive events,  $t<1$ , frequency of negative events,  $t=1.63, p=.10$ , use of amplifying appraisals,  $t=1.68, p=.09$ , use of dampening appraisals,  $t<1$ , or fear of positive emotion,  $t=1.12, p=.26$ .

### Section 2. Supplementary Analyses of School and Baseline Assessment Time Effects.

We investigated the systematic differences between participants who were from different schools and completed the baseline assessments in January versus November. Participants from different schools did not differ in terms to gender  $\chi^2(1)=0.22, p=.64$ , or age, baseline anhedonia severity, depressive symptoms, appraisal styles, rumination, and frequency of positive and negative life events, all  $ps >.08$ . Participants who completed the baseline assessments in January versus November did not differ in terms to gender,  $\chi^2(1)=0.15, p=.70$ . As expected, participants who completed the assessments in January were younger,  $t=4.49, p < .001$ . There were no systematic differences in terms to baseline anhedonia severity, depressive symptoms, appraisal styles, rumination, and frequency of positive and negative life events among the groups, all  $ps >.07$ .