The Effect of Subclinical Anhedonia on the Association Between Event Pleasantness and Positive Affective Reactivity in Daily Life

Master Thesis

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Abstract

Objective: Anhedonia, a diminished lack of reactivity to pleasurable stimuli, impairs positive affective (PA) functioning in daily life. However, anhedonia's underlying mechanisms influencing the experience of momentary PA reactivity and savouring of daily positive events are yet not fully understood. **Methods:** The experience sampling method (ESM) was chosen to assess whether subclinical anhedonia moderated the association between positive events and momentary PA reactivity and savouring in young adults. The sample consisted of 52 healthy individuals (M_{age} = 23.98, SD_{age} = 3.05; 86.5% female) who were assessed ten times a day over eight consecutive days. **Results:** Linear mixed models (LMM) results revealed that subclinical anhedonia was not associated with average momentary PA over the assessment period. Moreover, a significant interaction was found between event pleasantness and subclinical anhedonia on momentary PA. Lastly, no difference was observed in savouring PA of a positive event between individuals scoring high or low in subclinical anhedonia. **Conclusion:** Contrary to expectation, this implies that the PA reactivity mechanisms of anhedonia are less flat and rather similar in daily life between high and low anhedonic individuals. However, the major implication of the sample's low mean average of subclinical anhedonia needs to be considered while interpreting the results. Future research should combine laboratory and ESM research to capture the dynamic and complex interplay of PA reactivity in subclinical anhedonia and design new depression theories accordingly.

Keywords: subclinical anhedonia, event pleasantness, positive affect, savouring, affect reactivity, ESM

The Effect of Subclinical Anhedonia on the Association Between Event Pleasantness and Positive Affective Reactivity in Daily Life

According to the World Health Organization (2021, September 13), major depression is a worldwide leading cause of disability and a major contributor to the global disease burden. The disorder affects 280 million people worldwide (3.8%), with women being more affected than men (World Health Organization, 2021, September 13). Over the last decade, depressive symptoms increased by 14% among adolescents, and young adults (18-25) are at the highest risk for the disorder's onset (Shorey et al., 2022). Major depression is an affective disorder marked by enduring feelings of sadness, hopelessness, diminished pleasure, alternations in cognitive functions, and physical symptoms (Otte et al., 2016). It is caused by an interplay of genetic vulnerability, biology, family history, depression-fostering attitudes, low self-esteem, and stress factors (Schaub et al., 2013). For the diagnosis, one of the two main symptoms, depressed mood or anhedonia, must be present for two weeks (World Health Organization, 2021, September 13). A major depression diagnosis and subclinical depressive symptoms, such as anhedonia, should be distinguished. The subclinical label is used in the early disease stages, where current symptoms are not severe enough to fulfil the diagnostic criteria (Ji, 2012). In conclusion, these statistics underline that young adults, as a high-risk group, should be monitored to gain a better understanding of the mechanisms of subclinical anhedonia.

Subclinical Anhedonia

Anhedonia is defined as diminished or lack of reactivity to pleasurable stimuli, motivation, and interest in almost all daily activities for two weeks (American Psychiatric Association, 2013; Gorwood, 2008). Approximately 20% of adolescents experience at least one anhedonic episode, whereas most young adult's major depressive episode includes anhedonic symptoms (Bennik et al., 2014; Lewinsohn et al., 2003). Anhedonia forecasts a deficient and chronic disease course, treatment challenges, a high-risk for future episodes, and

suicide (Moos & Cronkite, 1999; Pizzagalli, 2022; Spijker et al., 2001; Wardenaar et al., 2012). Since anhedonia extensively affects daily functioning and reactivity, it is a crucial clinical target (Khazanov et al., 2019; Wang et al., 2021). The mechanisms of anhedonia influencing affective reactivity in daily life are still insufficiently understood and considered a field of inquiry (Cooper et al., 2018; Heininga et al., 2017).

Positive Affective Reactivity

As illustrated above, anhedonia impairs affective reactivity in daily life. Affective reactivity is the momentary intensity with which an individual reacts to an extrinsic event with a positive or negative response (Grosse Rueschkamp et al., 2020; von Klipstein et al., 2023). The positive response termed positive affect (PA) is the experience of pleasurable emotions, including feelings such as gratitude, interest, and joy, among others (Bohlmeijer & Hulsbergen, 2018; Pressman et al., 2019). The experience of PA has many health-improving effects, including counteracting depressive symptoms (Fredrickson, 2013; Gilbert, 2012; Höhn et al., 2013; Okely et al., 2017). Hence, interventions focusing on increasing PA could remedy the impairing effects of anhedonia. Research can enhance understanding of the association between subclinical anhedonia and PA reactivity by unravelling the emotional mechanisms, especially in a subclinical sample. This paves the way for earlier detection, prevention, more accurate diagnoses, tailored treatments, and improved mental health. Thus, examining how anhedonia influences daily immediate PA reactivity in young adults is essential. The PA reactivity in relation to anhedonia has been investigated with different research methodologies.

Experience Sampling Method

A suitable method to investigate the association between daily PA reactivity to positive events and subclinical anhedonia is the experience sampling method (ESM), which is a structured diary technique (Larson & Csikszentmihalyi, 1983). ESM assesses human behaviour at random occasions in the natural flow of daily life on a within- and between-

person level (Delespaul et al., 2002; Larson & Csikszentmihalyi, 1983; Verhagen et al., 2016). Furthermore, it captures how momentary affect fluctuations and behaviour relate to occasions by digital devices (Myin-Germeys, 2022; van Berkel et al., 2017; Wichers et al., 2012). ESM has several strengths overcoming other method's limitations, including a high ecological validity, immediate real-life change assessment, reduced memory bias, and increased comprehension of behaviour contingencies (Csikszentmihalyi & Larson, 2014; Napa Scollon et al., 2009). Thus making ESM the method of choice to capture the dynamic interplay of positive events and PA reactivity in daily life.

Two distinct lines of research, laboratory and ESM research, found opposing results of PA reactivity in depressed anhedonic individuals, which makes further research imminent (Heininga & Kuppens, 2021). One line of research indicated a decreased PA reactivity. Conceptual models, such as the positive attenuation hypothesis and the emotion context insensitivity theory, postulate that depressed individuals have a blunted emotional reactivity to positive stimuli (Rottenberg et al., 2005). Correspondingly, experimental laboratory research found that depressed individuals are less reactive to positive stimuli and contexts (Bylsma et al., 2008; Canli et al., 2004; Dunn et al., 2004; Rottenberg et al., 2002). Further, Pizzagalli (2022) points to reduced reward responsiveness in anhedonic patients and their non-depressed children. In sum, prior laboratory research expects a blunted PA reactivity to pleasurable stimuli.

While the stream of sparse ESM research depicts the opposite result, an increased PA reactivity in depressed anhedonic individuals. Heininga et al. (2017) examined PA reactivity to pleasurable experiences and its temporal dynamics in anhedonia versus non-anhedonic individuals. Concluding that anhedonic individuals exhibited more variability, less stability, and no 'blunted' PA reactivity in daily life than previously expected (Heininga et al., 2017). Further, a stronger reactivity to pleasurable experiences was found for high-arousal but not low-arousal PA (Heininga et al., 2017). This study outlines that anhedonic individuals are less

blunted and flat, as assumed by laboratory studies (Heininga et al., 2017). In later research, Heininga et al. (2019) investigated the dynamical signature of anhedonia in major depression. Compared to controls, no abnormalities were observed concerning PA dynamics, daily reward, and reward recovery. The researchers found that only lower average PA levels were indicative of major depression. Thus, when investigated by ESM, the underlying reactive mechanisms of anhedonia are more dynamic and complex in daily life than expected by prior laboratory research. No study to date has replicated the negative association between anhedonia and daily momentary PA in a subclinical young adult sample.

Moreover, ESM research studied the affective reactivity to daily positive events in major depression patients compared to controls. Some studies found regarding positive events, no significant decrease of PA in depressed versus healthy controls (Bylsma et al., 2011; Panaite et al., 2019; Thompson et al., 2012), whereas others found a significant increase in PA (Heininga et al., 2017; Khazanov et al., 2019; Peeters et al., 2003). Peeters et al. (2003) first reported the mood-brightening effect in major depression (Peeters et al., 2003). The mood-brightening effect describes the increased PA responsiveness to minor positive events in depressed patients versus healthy controls (Peeters et al., 2003). More research on the mood-brightening effect regarding PA reactivity to positive daily events is required, especially in a young subclinical anhedonic sample. In line with the DSM-5 definition of anhedonia, it is expected that high subclinical anhedonic individuals have a weaker immediate PA increase to positive events. Additionally, next to the immediate PA reactivity to positive events, the longer-lasting PA reactivity, termed savouring, should be explored.

Savouring

Reactive savouring is the spontaneous response to an ongoing externally initiated positive event or feeling (Bryant, 1989; Bryant, 2021). Reactive Savouring is distinct from proactive savouring, a deliberate act of searching for or creating positive experiences to enhance PA (Bryant, 2021). Research suggests that savouring functions as a protective factor

for depressive symptoms and increases psychological well-being (Ford et al., 2017; Smith & Hanni, 2019). Thus, this study adds by considering reactive savouring as a longer-lasting PA reactivity mechanism, prolonging the PA feeling to one moment later. The first ESM study, including savouring, was recently published investigating emotion-regulation strategy use, emotion goals, and emotion-regulation motives to negative affect and PA in current and remitted major depression groups versus healthy controls (Liu et al., 2023). Contrary to laboratory results, the researchers found that the current major depression group regulated emotions more frequently but had a weaker association between offsetting regulation and momentary affect (Liu et al., 2023). In conclusion, depressed individuals used everyday savouring as an emotion-regulation strategy as much as controls (Liu et al., 2023). However, for the current study's context, savouring is not a deliberate emotion-regulation strategy aimed to enhance PA but a passive response. The PA reactivity could therefore be lower in reactive savouring compared to savouring as an emotion-regulation strategy. Hence, it is expected that high anhedonic individuals are less capable to savour, if any occur, the immediate increases in PA.

Purpose of the Study

As illustrated above, there is only sparse ESM research on the proposed association of positive events, immediate PA reactivity, and savouring in a sample of subclinical anhedonic young adults. The current study aims to answer the following research question: *"What is the association between positive events and the immediate positive affective reactivity and savouring in subclinical anhedonic individuals?"* To answer this research question, the following hypotheses were formulated and are depicted in Figure 1:

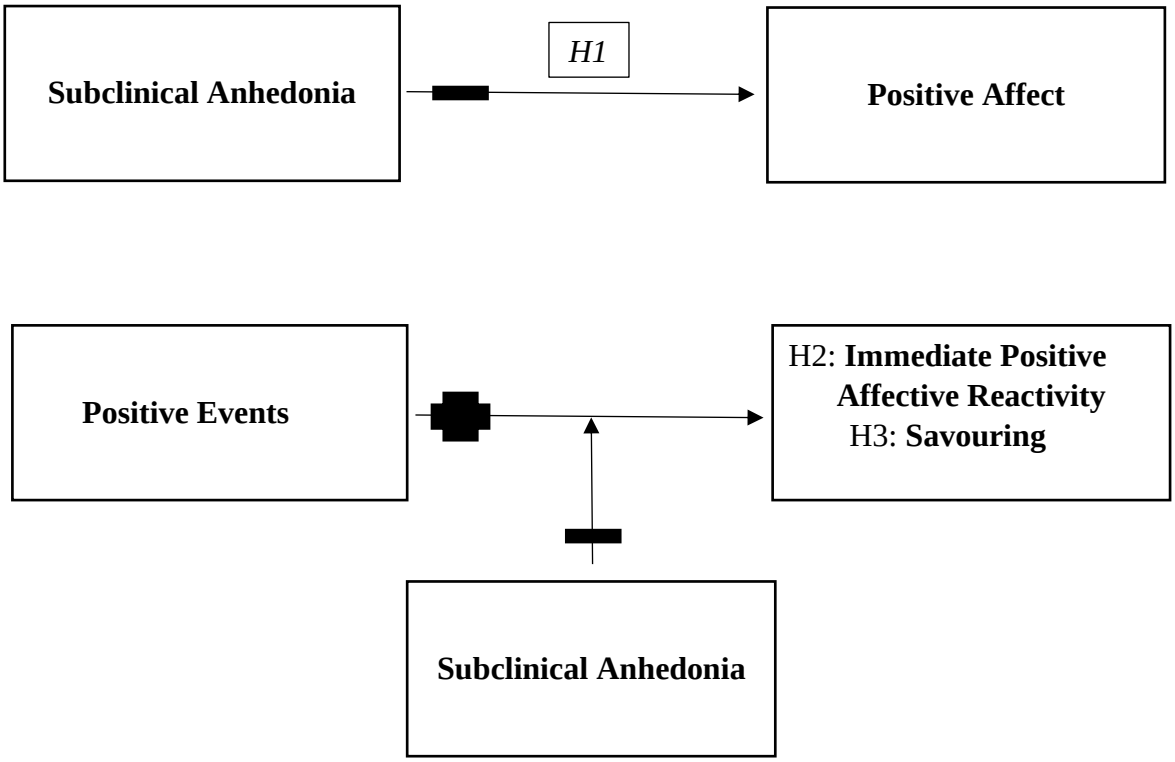
> Hypothesis 1: *Individuals with higher levels of subclinical anhedonia report lower average momentary positive affect over the course of one week than individuals with lower levels of subclinical anhedonia.*

Hypothesis 2: *Positive daily events are associated with immediate increases in momentary positive affect (i.e., reactivity), and this association is weaker for individuals with higher levels of subclinical anhedonia than for individuals with lower levels of subclinical anhedonia.*

Hypothesis 3: *The extent to which increases in momentary positive affect following positive daily events are maintained in the next moment (i.e., savouring) is moderated by the level of subclinical anhedonia, where individuals with higher levels of subclinical anhedonia show on average larger decreases in PA than individuals with lower levels of subclinical anhedonia.*

Figure 1

The Effect of Subclinical Anhedonia on the Association between Positive Events and Positive Affective Reactivity in Daily Life.



Methods

This study is part of more extensive research investigating stress in the laboratory setting and individuals' daily lives. Subsequently, only information relevant to the study's purpose and the ESM design will be discussed.

Sample

Participants were recruited through social media posts and flyers distributed around public hubs throughout the Belgian city of Leuven. The method can be regarded as voluntary response sampling. It was aimed at a sample size of at least 19 participants (van Berkel et al., 2017). The inclusion criterion was Dutch language proficiency, whereas the exclusion criteria were hormonal and/or cardiovascular disorders besides any relevant allergies. The study was granted ethical approval by the *Sociaal-Maatschappelijke Etische Commissie* (SMEC) of KU Leuven.

Procedures

Data acquisition took place between February and September of 2019. On the first day, participants received a research phone and were required to follow the MobileQ application instructions. Furthermore, participants were provided with general information about the study's procedure, including examples of positive events, voluntary participation, and withdrawal rights. The informed consent was digitally signed before the study. Additionally, anonymous and confidential data storage was granted.

Subsequently, participants answered the demographic information questionnaire (age, sex, nationality, education, marital status, and work) and the baseline retrospective trait measure of subclinical anhedonia. This approach ensured that trait measures were not biased by momentary state measures. Participants were assessed ten times a day over eight consecutive days, for the assessments, a time-contingent prompting scheme was used. Prompts were semi-randomly scheduled within the participant's 15-hour waking time, excluding sleeping time (Myin-Germeys, 2022). The 15-hour waking time was divided into

ten blocks, and assessments were between 15 and 90 minutes apart (De Calheiros Velozo et al., 2022). Each beep generated a questionnaire assessing momentary PA and event pleasantness levels. The answer option expired after five minutes, which ensured sequential data acquisition. Researchers contacted participants when they failed to complete the questionnaires on multiple consecutive days. At the end of the study, participants were debriefed and received compensation.

Measures

Subclinical Anhedonia

Subclinical anhedonia was measured with the short version of the Depression, Anxiety and Stress Scale (DASS-21) consisting of 21 items by Lovibond (1995). The retrospective scale consists of three self-reported subscales, each with seven items, measuring the emotional states of depression, anxiety, and stress (Lovibond, 1995). The scale has a dimensional conception of psychological disorders. To assess subclinical anhedonia, the single anhedonia item of the depression subscale was used, quoting "*I couldn't seem to experience any positive feeling at all*", assessing retrospectively the past week (Lovibond & Lovibond, 1995, p. 339). Participants indicated their answer on a 4-point Likert scale (0 = *did not apply to me at all*; 3 = *applied to me very much or most of the time*). Subclinical anhedonia was treated as a continuous variable throughout the data analysis.

Event-Related Pleasantness

Participants were asked at each prompt to think about *the most important event since the last beep* and to answer "*How pleasant was the event?*" rating the events un-/pleasantness on a 7-point bipolar scale (-3 = *very unpleasant;* 3 = *very pleasant*"). Events scored from -3 to 0, marked an unpleasant or neutral event, and were in the following recoded to 0. For the current study, only event pleasantness was relevant and indicated by an ascending scoring of 0, 1, 2, and 3, where higher values indicated more pleasant events. Event-related pleasantness was treated as a continuous variable.

Positive Affective Reactivity

Momentary PA states were assessed via a self-reported 14 adjectives questionnaire scored on a 7-point Likert scale (1 = *not at all*; 7 = *very much*). For the current study, only PA items were regarded: "*relaxed*", "*satisfied*", and "*cheerful*", which were phrased as: "*At this moment, I feel…(relaxed, etcetera).*" Cronbach's alpha for these items was .80 (Oorschot et al., 2012). Positive_affect was only calculated when there was no missing value of one of the three PA items of the measurement occasion. All three PA items were averaged into the variable positive_affect per measurement point.

Savouring. Savouring, the longer-lasting PA reactivity, was not measured by a scale but as the difference in positive affect between two measurement points. A lagged variable of positive_affect, termed lag_PA, was created to compare the participant's average PA of the current measurement (t_{+1}) to the average PA of the previous measurement (t_0). The savouring variable (t_{+1}-t_0) was assessed by calculating lag_PA at the current measurement (t_{+1}) minus positive_affect at the previous measurement (t_0).

Statistical Analysis Plan

To process the data, IBM SPSS Statistics 28 was used, and linear mixed models (LMM) were chosen for data analyses. Prior to the analysis, the dataset was checked for missing values of the variables of interest, and the model's assumptions were inspected. To ensure sufficient measurement points, a cut-off of 30% was applied. Hence, participants answering fewer than 24 prompts of 80 were excluded (Delespaul et al., 2002). LMM analyses account for similarities in the measurements of the subject while taking the dependency within this subject into account (Aarts et al., 2014). For a sample overview, the descriptive statistics were calculated. ESM data are hierarchical data sets with multiple data levels per individual (Myin-Germeys, 2022). To clarify, repeated observations (level one/ beep level) were nested within a participant (level two/ subject level) (Myin-Germeys, 2022). The analyses allowed for random intercepts and slopes.

For all hypotheses, age and gender were included as covariates, controlling for their potential effect on the outcome variables to increase the models' internal validity. To test the first hypothesis, the analysis included subclinical anhedonia as a predictor of momentary PA reactivity as the dependent variable. The second model tested for the interaction of subclinical anhedonia and event pleasantness predictors on the outcome variable momentary PA reactivity (t_0). Lastly, the third model investigated the interaction of subclinical anhedonia and event pleasantness on savouring (t_{+1}-t_0) as the outcome variable. In addition, this model included PA at t_0 as a covariate to control for individual variability, participants with very high or moderate increases in PA, who might influence the outcome.

Results

After data collection and eliminating partial responses, the final sample consisted of *N* = 52 healthy participants, with 7 (13.5%) males and 45 (86.5%) females. The sample had a mean age of 23.98 years (*SD* = 3.05) from 19 to 35 years. The majority of the sample was Belgian (86.5%). The sample presented on average a PA score of 4.61 (*SD* = 1.31), savoured on average -0.01 (*SD* = 1.28), and rated positive events on average 0.94 (*SD* = 1.36) as pleasant. The average subclinical anhedonia score was 0.42 (*SD* = 0.57), falling between 0 = *did not apply to me at all* and 1 = *applied to me to some degree or some of the time*, interpreting this value on a scale from 0 to 3, falling below the 1.5 midpoint and being closer to 0, indicates a lower anhedonia level in this sample. Unfortunately, no reference values or norm scores of another sample were available as comparison point. The 52 participants rated the level of event un-/pleasantness in 3.188 measurement occasions, 856 (26.9%) as mildly pleasant, 607 (19%) as moderately pleasant, and 503 (15.8%) as very pleasant events. The demographic information and the sample characteristics of the variables of interest are illustrated in Table 1.

Table 1

Descriptive Statistics, Means, and Standard Deviations of the Variables of Interest

Participant characteristics	*N (%)*	*M (SD)*
Age	52	23.98 (3.05)
Gender		
Female	45 (86.5)	
Male	7 (13.5)	
Nationality		
Belgian	45 (86.5)	
Dutch	3 (5.8)	
Greek	1 (1.9)	
Other	3 (5.8)	
Marital status		
Single	12 (23.1)	
Relationship	30 (57.7)	
Married	9 (17.3)	
Other	1 (1.9)	
Education		
Secondary school or less	13 (25)	
Higher education	38 (73.1)	
Other	1 (1.9)	
Employment		
Employed	20 (38.5)	
Student	31 (59.6)	
Other	1 (1.9)	

Variables of interest		
Subclinical anhedonia	52	0.42 (0.57)
Positive affect		4.61 (1.31)
Event pleasantness		0.94 (1.36)
Moderately unpleasant	145 (4.5)	
Mildly unpleasant	286 (9.0)	
Neutral	791 (24.8)	
Mildly pleasant	856 (26.9)	
Moderately pleasant	607 (19.0)	
Very pleasant	503 (15.8)	
Savouring		-0.01 (1.28)

Note. $N = 52$. *M* = mean respondents; *SD* = standard deviation of respondents; *%* = percentage of the respondents; Other = no answer provided/participant did not want to disclose this information.

Association Between Subclinical Anhedonia and Momentary Positive Affect

None of the analyses showed concern for violation of the LMM assumptions. No significant evidence was found for subclinical anhedonia as a predictor of momentary PA over the assessment period, $B = -.12$, $SE = .19$, $t(47.61) = -.65$, $p = .518$, *CI* [-.50, .25]. The covariates age and gender did not contribute to a significant association on the outcome variable. This finding indicated that subclinical anhedonia was not associated with average momentary PA over the assessment period. The statistical results of the hypothesis testing are illustrated in Table 2.

Table 2

Regression Coefficients of Subclinical Anhedonia, Gender, and Age on Momentary Positive Affect

Variables	*B*	*SE*	*df*	*t*	*p*	95% CI
Intercept	4.16	.86	47.56	4.82	<.001	[2.43, 5.90]
Subclinical anhedonia	-.12	.19	47.61	-.65	.518	[-.50, .25]
Age	.20	.04	47.60	.58	.564	[-.05, .09]
Gender	-.01	.31	47.57	-.03	.975	[-.64, .62]

Note. CI = confidence interval.

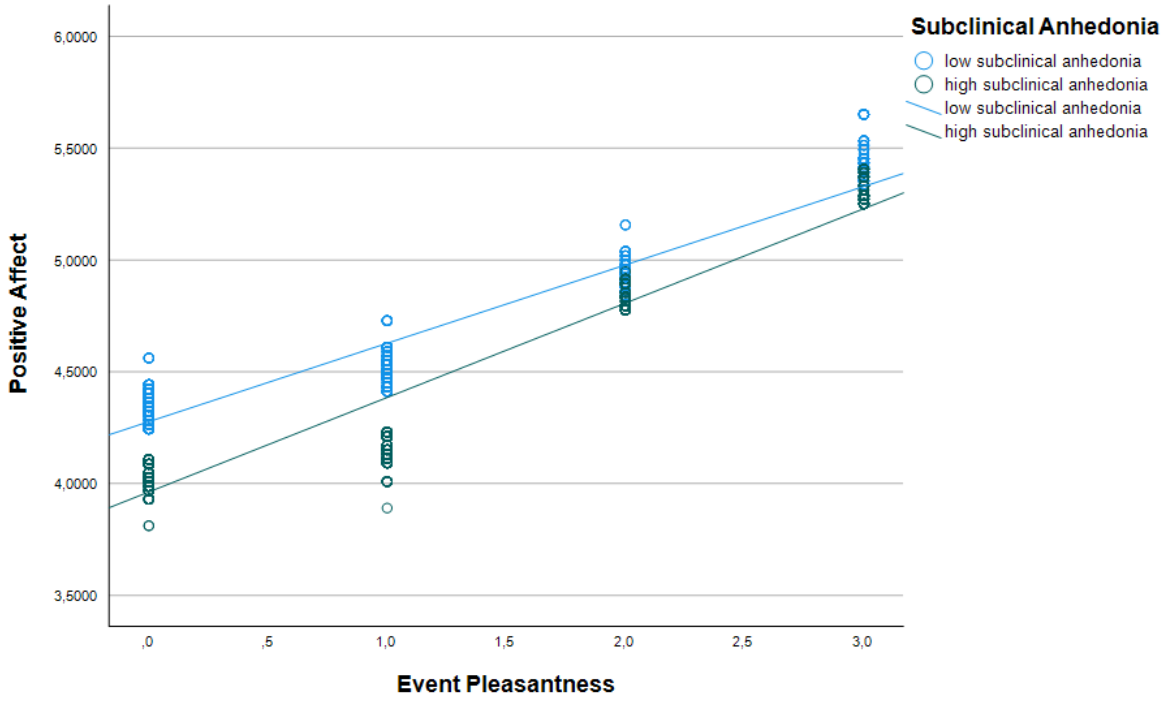
Event Pleasantness and Subclinical Anhedonia Predicting Momentary Positive Affective Reactivity

The following examined the associations between the predictors, subclinical anhedonia and event pleasantness with the outcome variable momentary PA reactivity. Subclinical anhedonia showed a non-significant negative association with PA, B = -.29, SE = .16, t(55.59) = -1.80, p = .077, *CI* [-.61, .03]. Further, a significant positive main effect of event pleasantness, B = .34, SE = .02, t(3104.53) = 14.37, p <.001, *CI* [.30, .39], on momentary PA was revealed. Thus, there was a stronger linear relationship between event pleasantness and PA. Therefore, a higher event pleasantness rating resulted in a higher momentary PA reactivity. Moreover, a significant interaction was discovered between event pleasantness and subclinical anhedonia on momentary PA reactivity, B = .08, SE = .03, t(3100.38) = 2.41, p = .016, *CI* [.02, .14]. Event pleasantness led to changes in PA, and subclinical anhedonia moderated this relationship. It follows that higher subclinical anhedonia strengthened the effect regarding momentary PA reactivity. Thus, for lower pleasant events, the higher subclinical anhedonia group had a lower momentary PA reactivity whereas with increasing pleasantness, there was no more difference in PA reactivity between groups. The

statistics of Hypothesis 2 are displayed in Table 3, whereas Figure 2 provides a graphical illustration.

Figure 2

Event Pleasantness and Subclinical Anhedonia Predicting Momentary Positive Affective Reactivity



Note. The grouping of subclinical anhedonia is based on a median split. Figure 1 displays the association of subclinical anhedonia and event pleasantness for the outcome variable momentary positive affective (PA) reactivity. The increasing positive association between event pleasantness and PA is depicted, with very pleasant events resulting in the highest momentary PA reactivity. The significant interaction was observed between participants being categorised as having ‘low subclinical anhedonia’ and ‘high subclinical anhedonia’, with the relationship becoming stronger (smaller difference) when subclinical anhedonia increased, too.

Table 3

*Regression Coefficients of Event Pleasantness, Subclinical Anhedonia, and Event Pleasantness*Subclinical Anhedonia on Momentary Positive Affect*

Variables	*B*	*SE*	*df*	*t*	*p*	95% CI
Intercept	3.80	.72	47.15	5.31	<.001	[2.36, 5.23]
Age	.02	.03	47.06	.68	.500	[-.04, .08]
Gender	.01	.26	47.08	.05	.958	[-.51, .53]
Subclinical anhedonia	-.29	.16	55.59	-1.80	.077	[-.61, .03]
Event pleasantness	.34	.02	3104.53	14.37	<.001	[.30, .39]
Subclinical anhedonia* event pleasantness	.08	.03	3100.38	2.41	.016	[.02, .14]

Note. CI = confidence interval.

Event Pleasantness and Subclinical Anhedonia Predicting Savouring

Hypothesis 3 explored the extent to which increases in momentary PA of positive daily events were savoured in the next moment and whether subclinical anhedonia moderated this association. It was predicted that individuals with higher versus lower levels of subclinical anhedonia show on average less savouring. A third LMM analysis was conducted to test this hypothesis, including the predictors subclinical anhedonia and event pleasantness, on savouring as the outcome variable. Gender, age, and PA at t_0 were included as control variables. The results of the statistical analysis are summarised in Table 4. Subclinical anhedonia was not significantly related to savouring, B = -.12, SE = .13, t(59.80) = -.91, p = .368, CI [-.38, .14]. A significant positive main effect was observed for event pleasantness on savouring, B = .08, SE = .03, t(2353.07) = 2.87, p = .004, CI [.03, .14]. This main effect implies that very pleasant events result on average in greater PA savouring.

Subsequently, the interaction between subclinical anhedonia and event pleasantness was examined. There was no significant interaction of subclinical anhedonia and event pleasantness, B = .01, SE = .04, t(2283.12) =.20, p = .841, CI [-.06, .08], on savouring. In conclusion, the extent to which increases in momentary PA following a positive daily event are savoured is not moderated by subclinical anhedonia.

Table 4

*Regression Coefficients of Event Pleasantness, Subclinical Anhedonia, and Event Pleasantness*Subclinical Anhedonia on Savouring*

Variables	*B*	*SE*	*df*	*t*	*p*	95% CI
Intercept	2.95	.56	44.86	5.30	<.001	[1.83, 4.07]
Age	.01	.02	43.02	.36	.718	[-.04, .05]
Gender	.01	.20	42.68	.03	.975	[-.39, .41]
Positive affect at t_0	-.70	.02	2337.08	-34.12	<.001	[-.74, -.66]
Subclinical anhedonia	-.12	.13	59.80	-.91	.368	[-.38, .14]
Event pleasantness	.08	.03	2353.07	2.87	.004	[.03, .14]
Subclinical anhedonia* event pleasantness	.01	.04	2283.12	.20	.841	[-.06, .08]

Note. CI = confidence interval.

Discussion

The current ESM study was the first to examine the association between daily positive events and immediate PA reactivity and savouring in a subclinical young adult sample. LMM results revealed that subclinical anhedonia was not associated with average momentary PA over the assessment period. Moreover, no difference was observed in savouring PA of a positive event between individuals scoring high or low in subclinical anhedonia. Lastly, a

significant interaction was found between event pleasantness and subclinical anhedonia on momentary PA reactivity. Hence, individuals with a higher level of subclinical anhedonia experienced a stronger increase of momentary PA to the increasing event pleasantness level.

Association Between Subclinical Anhedonia and Positive Affective Reactivity

According to the current study's results, subclinical anhedonia was not associated with average PA over the assessment period, which was both contrary to the expectation and prior findings. Prior ESM research established that anhedonia was related to less intense pleasurable experiences during the day and a lower level of PA in depressed adolescents and an anhedonic sample (Heininga et al., 2017; van Roekel et al., 2015). Likewise, the current study results contrast the DSM-5 definition of anhedonia, which describes a reduced ability to experience pleasure in almost all daily activities for two weeks (American Psychiatric Association, 2013). Multiple explanations exist for this nonsignificant association between subclinical anhedonia and average PA reactivity. One possible explanation is the methodological differences. Heininga et al. (2017) assessed anhedonia by three criteria of the Domains of Pleasure Scale: a pleasure rating below 25%, a less or much less than normal pleasure self-reported rating, and two months of persistent loss of pleasure (Masselink et al., 2019). Additionally, anhedonic individuals were matched to non-anhedonic counterparts. In sum, the usage of a different anhedonia scale, the pre-screening of anhedonia, which functioned as inclusion criteria, and the matched-group design are three main differences to the current study (Heininga, 2017). In contrast, the current study assessed anhedonia only over the past week, had no inclusion or pre-screening of anhedonia, adopted a single-item to assess anhedonia, and used a voluntary response sampling method. Especially the different anhedonia assessment could have resulted in the relatively "low" mean average of 0.42 subclinical anhedonia in the current sample. This contrasts the high prevalence and high-risk of young adults age group to experience anhedonia and major depression, as outlined in the introduction. These methodological differences are potential explanations for why the current

study did not find a significant association between subclinical anhedonia and average momentary PA. Another point could be that not enough depressed people were included in this sample. Moreover, an alternative explanation for the insignificant finding could be that this is the main difference between an anhedonic and a subclinical anhedonic sample. Thus, more research with a larger sample is recommended.

Another finding was that subclinical anhedonia did not moderate the extent to which momentary PA initiated by a pleasant event was savoured. Put simply, there was no observable group difference. Since reactive savouring is not a deliberate act of up-regulation, this finding is puzzling and opposes anhedonia's expected diminished PA reactivity (American Psychiatric Association, 2013). However, this result corresponds with Heininga (2017), who found no difference in the moment-to-moment transfer of PA in anhedonic versus non-anhedonic individuals. Concluding that anhedonic versus non-anhedonic individuals might possess, if any, similar self-efficacy abilities to regulate their affect, taking place in the 90 minutes between the assessments (Heininga, 2017). Another reference study found no group differences between major depression, remitted depression and the control group of the emotion-regulation strategy of everyday savouring (Liu et al., 2023). The researchers concluded that all groups used everyday savouring to the same extent. This further aligns with the finding that major depressed patients with anhedonia had not a faster baseline return after a reward-related PA increase (Heininga et al., 2019). In conclusion, when controlling for differences in the initial PA level (t_0), individuals with high or low subclinical anhedonia levels seem to engage similarly in reactive savouring. Thus, there is no observable group difference, whether the PA level stayed or decreased to the same extent in high versus low anhedonia should be investigated by future ESM research.

Mood-Brightening Effect in Subclinical Anhedonia

In Hypotheses 2 and 3 a significant association between event pleasantness and PA was found, where greater event pleasantness was associated with higher momentary PA. This

finding is consistent with prior ESM research on an adolescent sample (Chun et al., 2022). Another result revealed that subclinical anhedonia significantly moderated the association between event pleasantness and momentary PA reactivity. Individuals with a higher level of subclinical anhedonia experienced a stronger increase in momentary PA to the increasing event pleasantness level. Hence, the high and low anhedonic groups became equally happy after a very pleasant event, but this did not apply to minor pleasant events. This finding only partly aligns with prior research on the mood-brightening effect in an anhedonic sample (Heininga et al., 2017) and clinical major depression samples (Khazanov et al., 2019; Peeters et al., 2003). It only partly aligns since the mood-brightening effect, in these, already occurred in minor positive events, whereas in the current study, it was only observable for moderate or higher event pleasantness. As outlined above, a possible explanation could be the different samples used by the named studies. Implying that they had a higher symptom severity of anhedonia compared to the current study's sample, which could be the reason why the effect already occurred in minor positive events in the other studies. This reasoning aligns with the finding that the mood-brightening effect was even more pronounced in severely depressed patients (Khazanov et al., 2019). Nevertheless, the mood-brightening effect occurred for moderate to very pleasant events in the current study. However, the differences between groups occurred when no pleasant events happened, where high anhedonic individuals scored lower on PA. Previous research has ruled out the possibility of a higher threshold for pleasurable experiences in depressed patients as an explanation for the mood-brightening effect (Bylsma et al., 2011). Thus, follow-up research is needed and should extend to the association between neutral and negative events on momentary PA reactivity.

Strengths and Limitations

There are several noteworthy vital strengths. First, the ESM approach allowed for high ecological validity, investigating positive affect fluctuations in the participant's natural environment, enabling a better assessment of real-life PA functioning and reactivity in

subclinical anhedonic young adults (Napa Scollon et al., 2009). Adhering to the ESM design also allowed for high validity, easy replicability, and high generalizability of momentary behaviour to the participants' real-life functioning and behaviour (Myin-Germeys, 2022; van Berkel et al., 2017). The present research is subject to several limitations, too. To begin, the referred comparison studies did not solely examine anhedonia but investigated anhedonia primarily as part of major depression samples. These studies were used to compromise the limited anhedonia literature on PA reactivity. Another concern is the voluntary response sampling method, which led to a relatively homogenous sample, the majority being young female Belgian students. Consequently, this limits the generalizability to other ethnicities and the elderly. Another limitation is the high participant burden of the ESM design (Napa Scollon et al., 2009). The dense data collection, with repeated measures throughout the day and over days, can be experienced as burdensome for the participant, leading to attrition (Napa Scollon et al., 2009). Participants who experienced a higher burden and already struggled to cope with the requirements of daily functioning might have dropped out. Finally, the single-item assessment of subclinical anhedonia should be cautiously considered. The single-item usage provides the least assurance of the construct's reliability and validity, and a multi-item measure would be favourable (Wanous & Hudy, 2001).

However, in sum, there is no one-method-fits-all approach to understand the mechanisms of anhedonia and its complex interplay with PA reactivity. The ESM as a research method enables establishing an association between pleasant events and daily PA functioning in young anhedonic adults. The ESM over laboratory research allows to catch emotions' dynamic, complex and temporal resolution, but it does not solely create the bigger picture. Association does not imply causation nor vice versa, if research wants to acquire a bigger picture of PA reactivity in anhedonic individuals, the cause-and-effect assessment of laboratory research is needed, too. Thus, instead of searching for the one-method-fits-it-all approach, future research should combine methods to create a holistic picture of the

relationship between positive events and PA reactivity in a subclinical anhedonic young adult sample. In conclusion, the strengths, limitations, and considerations mentioned above should be considered when interpreting the results and designing future research.

Practical Implication for Future Research

Future research should take into consideration a variety of practical implications. First, research should aim for a bigger, more heterogeneous sample, including a wider age range, educational levels, equal gender distribution, and different ethnicities. This can be accomplished using diverse recruitment channels and targeted outreach, e.g., collaborations with communities of other ethnicities, universities, companies, sports clubs, etcetera. Second, a matched-group design concerning the anhedonia level would be favourable to keep confounding variables low and to attribute causality better when comparing the groups. However, this comes at a payoff requiring more time, effort, and financial investment from researchers. Third, the participant burden and hence the attrition rate can be mitigated by adhering to design recommendations. This can be accomplished by a user-friendly interface of the used device, a pilot study, reminders, keeping the minimum of assessment days, and a short ESM questionnaire (Eisele et al., 2022; van Berkel et al., 2017). Nevertheless, the combination of ESM and laboratory research is always burdensome to the participant. Fourth, examining the frequency and which types of pleasant events (e.g. inter- or intra-personal factors, etcetera) lead to a higher pleasantness rating is worthwhile. The individual's pleasantness rating of events could help practitioners tailor ESM and eHealth interventions to the patient's needs and equip them with this feedback to deliberately foster their PA (Chun et al., 2022). This would be a benefit since many clinically depressed patients cannot retrospectively reply to the questions about which activities or events they enjoy/-ed. Fifth, more research is needed on investigating savouring as an emotion-regulation strategy in an ESM design. The current study investigated reactive savouring, whereas future research should investigate proactive savouring (Bryant, 2021). Points four and five could be

combined in a single study, with the first assessing the associations while this knowledge could be used, and the second, to create an emotion-regulation savouring intervention tailored to the individual's pleasantness rating. Lastly, a shorter close-meshed measurement interval, less than 90 minutes, after the reactive or proactive savouring event used to assess the moment-to-moment transfer of PA in more detail. It would be promising to consider these suggestions for future research.

Conclusion

Major depression is a worldwide leading disability cause, with anhedonia at its core, which is itself an increasing health concern. For the treatment of major depression, it is essential to unravel anhedonia's mechanisms influencing PA reactivity to gain an understanding of daily functioning in anhedonic individuals, which the current study aimed at. It intended to extend the sparse ESM research by being the first to investigate these associations in a subclinical sample. Overall, subclinical anhedonia did not reduce PA reactivity to daily positive events in young adults. High anhedonic levels even indicated the opposite, a PA-brightening effect. Furthermore, no group difference in savouring was found. Overall, this implies that the PA reactivity mechanisms of anhedonia are less flat and rather similar in high versus low anhedonic individuals in daily life than expected by prior laboratory research. However, the major implication of the sample's low mean average of subclinical anhedonia needs to be considered while interpreting the results. Follow-up research with a bigger sample is required, which would benefit from the combination of laboratory and ESM research to capture the dynamic and complex interplay of PA reactivity in subclinical anhedonia and design new depression theories accordingly. This combined knowledge can help professionals create tailored PA preventions and interventions, which could counteract the deficient disease course forecasted by anhedonia.

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