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Anticipatory and Consummatory Pleasure and Displeasure in Major Depressive Disorder: An Experience Sampling Study

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Abstract

Pleasure and displeasure can be parsed into anticipatory and consummatory phases. However, research on pleasure and displeasure in major depressive disorder (MDD), a disorder characterized by anhedonia, has largely focused on deficits in the consummatory phase. Moreover, most studies in this area have been laboratory-based, raising the question of how component processes of pleasure and displeasure are experienced in the daily lives of depressed individuals. Using experience sampling, we compared anticipatory and consummatory pleasure and displeasure for daily activities reported by adults with MDD (n=41) and healthy controls (n=39). Participants carried electronic devices for one week and were randomly prompted eight times a day to answer questions about activities to which they most and least looked forward. Compared to healthy controls, MDD participants reported blunted levels of both anticipatory and consummatory pleasure and elevated levels of both anticipatory and consummatory displeasure for daily activities. Independent of MDD status, participants accurately predicted pleasure but overestimated displeasure. These results are the first to provide evidence that, across both anticipatory and consummatory phases, individuals with MDD experience blunted pleasure and elevated displeasure for daily activities. Our findings clarify the disturbances in pleasure and displeasure that characterize MDD and may inform treatment for this debilitating disorder.

General Scientific Summary

Pleasure and displeasure can be separated into two phases: anticipation and experience. This is the first study outside of the laboratory to show that individuals with major depressive disorder (MDD) have deficits in the anticipation *and* the experience of both pleasure and displeasure for everyday activities. Specifically, for both anticipation and experience, individuals with MDD

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reported blunted pleasure and elevated displeasure when compared to reports from healthy individuals.

Keywords

major depressive disorder; pleasure; displeasure; anticipatory; consummatory

Anhedonia is a cardinal symptom of major depressive disorder (MDD; American Psychiatric Association, 2013). It is frequently defined as the reduced ability to experience pleasure from activities that are usually rewarding, such as hobbies or social interactions. Researchers have argued that the experience of pleasure can be parsed into two distinct phases: anticipation of reward (i.e., anticipatory pleasure) and consumption of reward (i.e., consummatory pleasure; Berridge & Robinson, 2003; Gilbert & Wilson, 2007; Schultz, 2002). Anticipatory pleasure involves the prediction of pleasure from future reward and the experience of pleasure associated with a positive prediction; in contrast, consummatory pleasure involves the in-the-moment experience of pleasure in the presence of reward (Gard, Kring, Gard, Horan, & Green, 2007; Kring & Caponigro, 2010). This temporal distinction has led researchers to refine assessments of anhedonia (Gard, Gard, Kring, & John, 2006) and increase our understanding of anhedonia in other psychological disorders. For example, schizophrenia appears to be characterized by deficits in anticipatory, but not in consummatory, pleasure (Barch, Pagliaccio, & Luking, 2015; Kring & Elis, 2013). Although the importance of such a distinction in depression has been emphasized (Treadway & Zald, 2011), research is needed to compare anticipatory and consummatory pleasure in individuals diagnosed with MDD.

In the broader psychological literature, pleasure has been treated as a dimension of positive emotion, and specifically as one end of the pleasure-displeasure (i.e., valence) axis in a dimensional classification of emotions (e.g., Russell, 1980). As such, anticipatory pleasure has been studied in the context of affective forecasting, in which people predict how they will feel during future positive outcomes (Wilson & Gilbert, 2003). Similarly, consummatory pleasure has been examined in the context of emotional reactivity, in which people's emotional experiences change in response to positive stimuli or events. Below we summarize findings from the emotion and reward literatures, as they relate to pleasure in MDD.

Anticipatory and Consummatory Pleasure in MDD

Previous research on anhedonia in MDD has largely focused on consummatory pleasure. For example, almost all self-report measures of anhedonia only assess deficits in consummatory pleasure (Treadway & Zald, 2011; for exception see Gard et al., 2006). Compared to healthy controls, people with MDD self-report lower levels of consummatory pleasure (Berlin, Givry-Steiner, Lecrubier, & Puech, 1998; Fawcett, Clark, Scheftner, & Gibbons, 1983; Nakonezny, Carmody, Morris, Kurian, & Trivedi, 2010), have blunted emotional reactivity to positive stimuli in the laboratory (Bylsma, Morris, & Rottenberg, 2008 for a meta-analysis), and appraise experiences in daily life as less pleasant (Barge-Schaapveld, Nicolson, Berkhof, & deVries, 1999; Bylsma, Taylor-Clift, & Rottenberg, 2011; Peeters,

Nicolson, Berkhof, Delespaul, & deVries, 2003). Furthermore, compared to healthy controls, people with MDD consistently show reduced caudate activation during reward consumption in functional imaging studies (Zhang, Chang, Guo, Zhang, & Wang, 2013 for a meta-analysis), which could be associated with deficits in the experience of consummatory pleasure. Overall, these findings provide evidence that consummatory pleasure is blunted in MDD.

Although less is known about anticipatory pleasure in MDD, a small number of studies suggest that this is also blunted. For example, compared to healthy controls, people with MDD self-report lower levels of anticipatory pleasure (Sherdell, Waugh, & Gotlib, 2012). They also anticipate positive experiences in their future to be less pleasant (MacLeod & Byrne, 1996; MacLeod & Salaminiou, 2001), exhibit blunted emotional reactivity to anticipated reward (McFarland & Klein, 2009), and are less motivated to pursue reward (Treadway, Bossaller, Shelton, & Zald, 2012). Compared to healthy controls, people with MDD show reduced caudate activation during reward anticipation (Zhang et al., 2013 for a meta-analysis). Thus, MDD appears to be associated with deficits in anticipatory pleasure.

Anticipatory and Consummatory *Dis*pleasure in MDD

Importantly, blunted emotional reactivity in MDD may not be specific to positive experiences or manifest exclusively as lower levels of pleasure. It may also apply to displeasure, a dimension of negative emotion (Russell, 1980), which can be elicited from unpleasant experiences such as punishment (Gray, 1990). With respect to the consummatory phase, emotion context insensitivity theory (Rottenberg, Gross, & Gotlib, 2005) posits that MDD is characterized by blunted emotional reactivity that is valence-independent: people with MDD may experience reduced pleasure for positive experiences *and* reduced displeasure for negative experiences. Support for this theory has been mixed. On the one hand, laboratory-based studies have found that, compared to healthy controls, people with MDD have blunted emotional reactivity to both positive and negative stimuli (Bylsma et al., 2008 for a meta-analysis). On the other hand, naturalistic studies show equivocal findings for emotional reactivity to daily experiences in MDD. In addition, these studies show that people with MDD appraise daily experiences as more unpleasant than do healthy controls (Bylsma et al., 2011; Myin-Germeys et al., 2003; Peeters et al., 2003; Thompson et al., 2012), suggesting that they experience elevated levels of consummatory displeasure.

Although the avoidance of anticipated negative experiences is posited to maintain MDD (Trew, 2011), few studies have examined anticipatory displeasure in MDD. In the laboratory, people with MDD either do not differ from healthy controls (Knutson, Bhanji, Cooney, Atlas, & Gotlib, 2008; McFarland & Klein, 2009) or show blunted reactivity during anticipated punishment (Furman & Gotlib, 2016). Studies on anticipatory displeasure in daily life show a different pattern of findings: depressive symptoms have been associated with higher anticipated negative affect for daily events (Hoerger, Quirk, Chapman, & Duberstein, 2012; Wenze, Gunthert, Ahrens, & Taylor Bos, 2013; Wenze, Gunthert, & German, 2012). This could suggest that MDD is associated with elevated levels of anticipatory displeasure in daily life, but studies on naturalistic contexts have not yet been conducted with clinical samples.

Accuracy of Anticipatory Pleasure and Displeasure Predictions in MDD

Because anticipating future states may influence subsequent actions (Trew, 2011), it is critical to consider the accuracy of anticipatory pleasure and displeasure predictions. A robust finding in the affective forecasting literature is that people overestimate the impact of future experiences on their affect, predicting higher intensities of positive and negative affect for positive and negative experiences, respectively (Wilson & Gilbert, 2005). Accuracy of predictions has not yet been examined in individuals with current MDD, but one study has examined individuals whose MDD was in remission. Compared to healthy controls, people with remitted MDD were similarly accurate in their predictions of positive and negative affect (Thompson et al., 2016). Findings from studies assessing the relation of accuracy to depressive symptoms have been mixed. Depressive symptoms have been associated with both more accurate (Chentsova-Dutton & Hanley, 2010; Wenze et al., 2012) and less accurate (Hoerger et al., 2012; Yuan & Kring, 2009) predictions of positive affect; depressive symptoms have also been associated with less accurate (Hoerger et al., 2012; Wenze et al., 2012), as well as equally accurate (Yuan & Kring, 2009) predictions of negative affect. Research with participants with current MDD may elucidate the relation between accuracy and depression, as greater depressive severity could have a stronger impact on the accuracy of both pleasure and displeasure predictions.

The Current Study

In the current study we used experience sampling, the repeated sampling of experiences in daily life, to compare anticipatory and consummatory pleasure and displeasure for daily activities reported by clinically depressed and healthy control samples. Specifically, for anticipatory pleasure and displeasure, we focused on the prediction of future experiences, which allowed us to address whether individuals with MDD are less accurate in their predictions than are healthy controls. Experience sampling can provide insight into how much people positively and negatively anticipate activities in daily life, while reducing the impact of negatively-biased retrospective recall that characterizes individuals with MDD (Gotlib & Joormann, 2010), making it a particularly valuable tool in studying anticipatory and consummatory phases of pleasure and displeasure. It allowed us to investigate, for the first time, whether individuals with MDD, compared to healthy controls, report elevated anticipatory displeasure in daily life. It also enabled us to determine whether findings from laboratory-based studies of anticipatory and consummatory pleasure in MDD generalize to real life. No study to date has used experience sampling to examine anticipatory and consummatory pleasure or displeasure in MDD.

For *pleasure*, we hypothesized that, compared to healthy controls, participants with MDD would report blunted levels of anticipatory and consummatory pleasure in daily life. For *displeasure*, we hypothesized that, compared to healthy controls, participants with MDD would report elevated levels of anticipatory and consummatory displeasure in daily life, a finding that would be consistent with other naturalistic studies. Finally, for *accuracy*, we hypothesized that, independent of MDD status, participants would report higher levels of pleasure and displeasure during anticipation than during consumption of the same activities, reflecting the effect that people overestimate the amount of pleasure and displeasure they

will experience. Because we did not have hypotheses about group differences in the accuracy of anticipatory pleasure and displeasure predictions, those analyses were exploratory. Through repeated sampling of participants' experiences in daily life, we aimed to clarify the nature and directionality of accuracy of predictions in MDD.

Method

Participants

Participants were 86 adults between 18–55 years of age recruited for a broader study on depression from the surrounding communities of Stanford, California, through advertisements posted online and at local agencies and businesses. The final sample comprised 80 participants after excluding six participants because of equipment failure (n=4) or non-compliance (i.e., carrying the device for fewer than five days; n=2). All participants were fluent English speakers. Individuals were eligible for the study if they could safely undergo functional magnetic resonance imaging. Exclusion criteria included a history of severe head injury, severe learning disorder, current substance abuse or dependence, and current psychotic symptoms. Further exclusion criteria included several factors that affect levels of circulating cytokines (e.g., BMI above 35, current use of immunosuppressants), which were relevant to other research questions examined in the parent study. Based on the Structured Clinical Interview for *DSM-IV* Axis I Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 2001), 41 participants were diagnosed with current MDD as the principal (i.e., most severe) diagnosis, and 39 participants were classified as healthy controls (CTL) without any current or past mental health disorders.

Procedure

During their first session, participants were administered the SCID-I by graduate and post-baccalaureate students who had received extensive training. Diagnostic reliability was assessed by randomly selecting and re-rating 25% of the recorded interviews. Interrater reliability for an MDD diagnosis was excellent in this sample (k=1.00). In addition, our team has achieved excellent interrater reliability for a major depressive episode (MDE; k=.93) and for classifying participants as nonpsychiatric controls (k=.92; Levens & Gotlib, 2010, 2015). Eligible participants returned to the laboratory for a second session to complete computer tasks and self-report measures. At the end of the session, they were instructed on the experience sampling protocol, which included a full practice trial.

Participants carried a handheld electronic device (Palm Pilot z22) that was programmed using Experience Sampling Program 4.0 (Barrett & Feldman Barrett, 2000). They were prompted with a tone to complete a survey that first assessed consummatory ratings followed by anticipatory ratings (see below). Prompts occurred eight times each day between 10 a.m. and 10 p.m., at random times within eight 90-minute windows each day; thus, prompts could occur as little as two minutes or as much as 180 minutes apart. The mean time between prompts was 94.2 minutes (SD = 39.6). Participants had five minutes to respond to each prompt. The majority of participants carried the device for seven or eight days and were prompted 56 times. Participants provided informed consent and were compensated for their participation, with an extra incentive for responding to more than 90%

of the prompts. The protocol was approved by the Institutional Review Board at Stanford University.

Measures

Anticipatory pleasure and displeasure—To assess anticipatory *pleasure*, at each prompt we asked participants to indicate what they were *most* looking forward to doing in the next 1–2 hours. To do so, they chose from the following list of options: Work/school/study; media/TV/Internet; conversation/socializing; errands/chores; hobby (not physical activity); physical activity; eating/drinking; other; and nothing in particular. To assess anticipatory *displeasure*, at each prompt we asked participants to indicate what they were *least* looking forward to doing in the next 1–2 hours. To do so, they chose from a slightly different list of options: Work/school/study; commuting; conversation/socializing; errands/chores; being alone/bored/not having plans; physical activity; eating/drinking; other; and nothing in particular. Thus, participants had the option of indicating that they were not (most or least) looking forward to an activity by choosing "nothing in particular." If participants chose any option other than "nothing in particular" for the anticipatory pleasure or displeasure items, they rated the extent to which they thought the activity would be pleasant or unpleasant by moving a slider along a visual analog scale anchored with "unpleasant" and "pleasant." The slider's starting point was at the midpoint. The program converted the location of the slider to a 100-point scale, with a value of 1 representing the most unpleasant and a value of 100 representing the most pleasant. Ratings were recoded to make the middle value zero, reflecting a neutral state; thus, negative values (i.e., −1 to −50) reflected anticipatory displeasure, and positive values (i.e., +1 to +50) reflected anticipatory pleasure.

Psychometric information for anticipatory pleasure and displeasure: Reliability for the anticipatory pleasure and displeasure items, averaged across prompts within participants, was .97 and .98, respectively. These reliability estimates are analogous to Cronbach's alpha for items in self-report measures. To establish convergent validity for the anticipatory pleasure item, we examined its relation with the Anticipatory Pleasure subscale of the Temporal Experience of Pleasure Scale (TEPS; Gard et al., 2006). The correlation between aggregated scores on the anticipatory pleasure item and scores on the Anticipatory Pleasure subscale was r=.47, p<.001. To our knowledge, there is not a trait measure of anticipatory displeasure, so we were unable to run parallel analyses for the anticipatory displeasure item.

Consummatory pleasure and displeasure—To assess consummatory *pleasure*, at each prompt we asked participants to indicate which activity they reported as having *most* looked forward to at the preceding prompt; for consummatory *displeasure*, participants indicated which activity they reported as having *least* looked forward to at the preceding prompt. In both cases, participants chose from the same list of options presented for anticipatory pleasure and displeasure, with the additional option "don't remember." For consummatory pleasure and displeasure, if participants chose any option other than "nothing in particular" or "don't remember," they indicated (yes or no) whether they had completed the named activity. If participants had completed the activity, they rated the extent to which the activity was pleasant or unpleasant by moving the slider along the same visual analog scale they used for the anticipatory pleasure and displeasure items. Again, the program

converted the location of the slider to a 100-point scale, and we recoded values to make the middle value zero, reflecting a neutral state; negative values reflected consummatory displeasure, and positive values reflected consummatory pleasure. We analyzed only the prompts for which the named activity matched the activity listed at the preceding prompt, reflecting that participants had correctly remembered the anticipated activity. There were no significant group differences in the percentage of correctly remembered activities to which they had most looked forward, $t(78)=1.62$, $p=.11$, with the MDD group correctly remembering 55% and the CTL group correctly remembering 63% of these activities. Compared to the CTL group, the MDD group correctly remembered significantly fewer activities to which they had least looked forward, $t(78)=3.02$, $p=.003$, with the MDD group correctly remembering 61% and the CTL group correctly remembering 76% of these activities.

Psychometric information for consummatory pleasure and displeasure: Reliability for the consummatory pleasure and displeasure items, averaged across prompts within participants, was .95 and .97, respectively. These reliability estimates are analogous to Cronbach's alpha for items in self-report measures. Convergent validity for the consummatory pleasure item was assessed by examining its association with the Consummatory Pleasure subscale of the TEPS (Gard et al., 2006). The correlation between aggregated scores on the consummatory pleasure item and scores on the Consummatory Pleasure subscale was $r=.48$, $p<.001$. To our knowledge, there is not a trait measure of consummatory displeasure, so we were unable to run parallel analyses for the consummatory displeasure item. The consummatory pleasure and displeasure items were, however, similar to items used in previous experience sampling studies that assessed the pleasantness of daily events (e.g., use of a 100-point scale, Bylsma et al., 2011).

Accuracy of anticipatory pleasure and displeasure—To assess accuracy, we calculated difference scores by subtracting consummatory ratings at one prompt from anticipatory ratings at the preceding prompt, within the same day. This ensured that anticipatory and consummatory ratings corresponded to the same activities. For pleasure difference scores, positive values reflected overestimations, whereas negative values reflected underestimations. For displeasure difference scores, positive values reflected underestimations, whereas negative values reflected overestimations.

Statistical Analyses

Because of the nested structure of our data, in which prompts are nested within participants, we used multilevel modeling (MLM) for our main analyses (for analyses on descriptive data, we used SPSS v22, IBM SPSS Statistics for Windows, 2013). MLM is an extension of the regression approach. It simultaneously analyzes data at the level of prompts and at the level of participants, allowing estimation of within- and between-person effects without assuming independence of the data. MLM accommodates missing data for unanswered prompts and for varying time intervals between prompts. We used the program HLM 7.01 (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011) for the MLM analyses and estimated parameters with robust standard errors.

Before running models to test our hypotheses, we first ran unconditional models in HLM (i.e., containing no Level 1 or Level 2 predictors) with pleasure, displeasure, or accuracy as the outcome variable. From the unconditional models we computed intraclass correlation coefficients (ICCs) to estimate the proportion of variance in the outcome variable accounted for by the between-person level, which reflects individual differences (versus the within-person level, which reflects situational differences). Then, to test our hypotheses, we ran the full models presented below and tested whether MDD status significantly improved the model fit and accounted for additional variance. These steps are comparable to running omnibus tests and generating R^2 statistics in multiple regression. Finally, we re-tested the full models with pleasure or displeasure as the outcome variable in the following two ways: (1) we included linear and quadratic time-of-day effects (i.e., time in minutes since the first prompt of the day) as predictors at Level 1 to control for potential time-of-day fluctuations; and (2) we restricted analyses to the MDD group only and included anxiety comorbidity as a predictor at Level 2 (dummy coded with no comorbid anxiety disorder = 0, and one or more comorbid anxiety disorder = 1) to investigate whether the findings held for the MDD group irrespective of anxiety disorder status.

In the model equations, $_i$ represents prompts and $_j$ represents participants. MDD status was dummy-coded, with the CTL group = 0 and the MDD group = 1. Unless otherwise noted, values of outcome variables for the MDD group were significantly different from zero. r_{ij} represents the Level 1 (within-person) random effect, and u_{0j} represents the Level 2 (between-person) random effect.

Results

Participant Characteristics

Demographic and clinical characteristics by diagnostic group are presented in Table 1. The MDD and CTL groups did not significantly differ in age, gender, race/ethnicity, educational attainment, or marital status. For clinical characteristics, we present the MDE severity for participants in the MDD group, global assessment of functioning (GAF), current comorbid anxiety disorder, and use of psychotropic medication. The majority of participants with MDD had MDEs that were moderately severe. As expected, compared to the CTL group, the MDD group had lower GAF scores, had a greater frequency of current anxiety disorder diagnoses, and were more likely to be taking psychotropic medication. Current comorbid anxiety disorder diagnoses for the MDD group included social anxiety disorder (39.0%), generalized anxiety disorder (26.8%), specific phobia (17.1%), agoraphobia (9.8%), post-traumatic stress disorder (7.3%), panic disorder (4.9%), and obsessive-compulsive disorder (2.4%).

Frequency of Experience Sampling Items

Frequency information for completed prompts, anticipated activities, and completed activities is presented in Table 2. Importantly, MDD and CTL participants did not differ in the percentage of prompts completed over the experience sampling week. There were no significant group differences with regard to the frequency of *most*-looked-forward-to activities or their completion. In contrast, compared to CTL participants, MDD participants

more frequently reported *least*-looked-forward-to activities and less frequently reported completing these activities.

Relations among Anticipatory and Consummatory Pleasure and Displeasure

Within- and between-person correlations among anticipatory and consummatory pleasure and displeasure for each diagnostic group are presented in Table 3. For both MDD and CTL groups, within-person correlations between anticipatory and consummatory *pleasure* were positive and significant, and within-person correlations between anticipatory and consummatory *displeasure* showed a positive pattern. For both MDD and CTL groups, between-person correlations between anticipatory and consummatory *pleasure*, and between anticipatory and consummatory *displeasure*, were positive and significant.

Do MDD and CTL Groups Differ in Anticipatory and Consummatory Pleasure?

The ICCs from the unconditional models revealed that 38% of the variance in *anticipatory* pleasure, and 28% of the variance in *consummatory* pleasure, was at the between-person level. Next, we examined whether MDD status predicted differences in anticipatory and consummatory pleasure:

Model 1

Level 1 Model (level of prompts):

$$\text{Pleasure}_{ij} \text{ (anticipatory or consummatory)} = \beta_{0j} + r_{ij}.$$

Level 2 Model (level of participants):

$$\beta_{0j} = \gamma_{00} + \gamma_{01} \text{ MDD status} + u_{0j}.$$

Pleasure_{ij} represents pleasure for participant *j* at prompt *i*, and β_{0j} represents the within-person mean pleasure. γ_{00} represents the mean pleasure for the CTL group, and γ_{01} represents the difference in mean pleasure between the CTL and MDD groups.

Mean levels of anticipatory and consummatory pleasure reported by each diagnostic group are displayed in Figure 1 (top panel). Mean anticipatory pleasure for the CTL group was significantly different than zero, γ_{00}=24.67, *SE*=1.26, *t*(78)=19.56, *p*<.001. As hypothesized, the MDD group reported lower levels of anticipatory pleasure than did the CTL group, γ_{01}=−7.30, *SE*=2.36, *t*(78)=−3.09, *p*=.003. MDD status significantly improved the model fit for anticipatory pleasure, $\chi^2(1)$=8.87, *p*=.003, accounting for 8% of the between-person variance.

Data for consummatory pleasure were not available for five participants (two CTL, three MDD) because they did not report completing any most-looked-forward-to activities. Mean consummatory pleasure for the CTL group was significantly different from zero, γ_{00}=24.68, *SE*=1.50, *t*(73)=16.49, *p*<.001. As hypothesized, the MDD group reported lower levels of consummatory pleasure than did the CTL group, γ_{01}=−7.82, *SE*=2.59, *t*(73)=−3.02, *p*=.004.[1] MDD status significantly improved the model fit for consummatory pleasure, $\chi^2(1)$=8.94, *p*=.003, accounting for 12% of the between-person variance.

Finally, we re-ran the full models to (1) control for time-of-day effects, and (2) investigate the influence of anxiety comorbidity. After controlling for potential linear and quadratic time-of-day effects, γ_{01} coefficients for anticipatory and consummatory pleasure remained statistically significant, *p*s<.05. Mean levels of anticipatory and consummatory pleasure for both diagnostic groups were comparable in magnitude to those shown in Figure 1. For the anticipatory pleasure model, there was a small but statistically significant main effect of linear time-of-day, γ_{10}=0.008, *SE*=0.002, *t*(2121)=3.30, *p* = .001, suggesting that there was a small, linear increase in anticipatory pleasure as the day progressed. There were no other statistically significant time-of-day effects or interactions between time of day and diagnostic group for either model, *p*s>.07.[2] After restricting our analyses to the MDD group, anxiety disorder comorbidity was not a significant predictor of anticipatory or consummatory pleasure, *p*s>.45. Mean levels of anticipatory and consummatory pleasure were comparable for MDD participants with and without comorbid anxiety disorder.

Do MDD and CTL Groups Differ in Anticipatory and Consummatory Displeasure?

The ICCs from the unconditional models revealed that 49% of the variance in *anticipatory* displeasure, and 40% of the variance in *consummatory* displeasure, was at the between-person level. Next, we examined whether MDD status predicted differences in anticipatory and consummatory displeasure by running Model 1 with displeasure as the outcome variable.

Mean levels of anticipatory and consummatory displeasure reported by each diagnostic group are displayed in Figure 1 (bottom panel). Mean anticipatory displeasure for the CTL group was significantly different from zero, γ_{00}=−7.32, *SE*=1.83, *t*(78)=−3.99, *p*<.001. As hypothesized, the MDD group reported higher levels of anticipatory displeasure than did the CTL group, γ_{01}=−9.18, *SE*=2.50, *t*(78)=−3.67, *p*<.001. MDD status significantly improved the model fit for anticipatory displeasure, $\chi^2(1)=12.50$, *p*<.001, accounting for 14% of the between-person variance.

Data for consummatory displeasure were not available for nine participants because one MDD participant did not correctly remember any least-looked-forward-to activities and the other eight participants (two CTL, six MDD) did not report completing any least-looked-forward-to activities. Mean consummatory displeasure for the CTL group was not significantly different from zero, γ_{00}=−3.75, *SE*=2.30, *t*(69)=−1.63, *p*=.11, suggesting that mean consummatory ratings for least-looked-forward-to activities were neutral. As hypothesized, the MDD group reported higher levels of consummatory displeasure than did the CTL group, γ_{01}=−8.41, *SE*=3.25, *t*(69)=−2.59, *p*=.01.[1] MDD status significantly

[1]At each experience sampling prompt, we asked participants to indicate what activity they were currently engaged in and to provide a rating of the extent to which the activity was pleasant (by moving a slider along a 100-point visual analog scale with anchors of “unpleasant” and “pleasant”). When these current pleasantness ratings were added as a Level 1 predictor to the models with MDD status predicting anticipatory or consummatory ratings (i.e., in Model 1 with pleasure or displeasure as the outcome), the current ratings were significantly positively associated with both anticipatory and consummatory ratings (*p*s<.05). Importantly, MDD status remained a significant predictor of anticipatory and consummatory ratings in the expected directions (*p*s<.05). The interaction between current ratings and MDD status was not significant in predicting anticipatory or consummatory ratings (*p*s>.33).

[2]There were small but statistically significant linear time-of-day effects for both anticipatory and consummatory pleasure (γ_{10}=0.006 and γ_{10}=0.02, respectively) when MDD status was excluded from the models (*p*s<.01). There were no significant quadratic time-of-day effects for either anticipatory or consummatory pleasure (*p*s>.58). This suggests that, when MDD status was not accounted for, there were small, linear increases in both anticipatory and consummatory pleasure as the day progressed.

improved the model fit for consummatory displeasure, $\chi^2(1)=6.34$, $p=.01$, accounting for 10% of the between-person variance.

Finally, we re-ran the full models to (1) control for time-of-day effects, and (2) investigate the influence of anxiety comorbidity. After controlling for potential linear and quadratic time-of-day effects, γ_{01} coefficients for anticipatory and consummatory displeasure remained statistically significant, $ps<.05$. Mean levels of anticipatory and consummatory displeasure for both diagnostic groups were comparable in magnitude to those shown in Figure 1. There were no statistically significant time-of-day effects or interactions between time of day and diagnostic group for either model, $ps>.24$.[3] After restricting analyses to the MDD group, anxiety disorder comorbidity was not a significant predictor of anticipatory or consummatory displeasure, $ps>.12$. Mean levels of anticipatory and consummatory displeasure were comparable for MDD participants with and without comorbid anxiety disorder.

Do MDD and CTL Groups Differ in the Accuracy of Their Anticipatory Pleasure and Displeasure Predictions?

To examine accuracy of anticipatory ratings for pleasure and displeasure, we subtracted consummatory ratings from anticipatory ratings corresponding to the same activities. The ICCs from the unconditional models revealed that 7% of the variance in accuracy for pleasure, and 12% of the variance in accuracy for displeasure, was at the between-person level. Next, we examined whether MDD status predicted differences in the accuracy of reported pleasure and displeasure, by running Model 1 with accuracy as the outcome variable.

Accuracy for pleasure differed significantly as a function of MDD status, $\gamma_{01}=3.41$, $SE=1.57$, $t(73)=2.17$, $p=.03$. MDD status significantly improved the model fit for accuracy for pleasure, $\chi^2(1)=4.71$, $p=.03$, accounting for 12% of the between-person variance. The MDD group overestimated pleasure (positive deviation), $\gamma_{00}+\gamma_{01}=1.85$, $SE=1.24$, compared to the CTL group's estimation of pleasure (negative deviation), $\gamma_{00}=-1.55$, $SE=0.96$. This group difference, however, should be interpreted with caution because neither group's mean accuracy for pleasure was significantly different from zero, $ts<1.50$, $ps>.11$, suggesting that both groups accurately predicted pleasure. Therefore, independent of MDD status, participants accurately predicted pleasure, which was contrary to our hypothesis that participants would overestimate the levels of pleasure they would experience.

Accuracy for displeasure did not differ significantly as a function of MDD status, $\gamma_{01}=0.55$, $SE=2.37$, $t(69)=-0.23$, $p=.82$. MDD status did not significantly improve the model fit for accuracy for displeasure, $\chi^2(1)=0.07$, $p=.80$, accounting for 0% of the between-person variance. Mean accuracy for displeasure for the CTL group, $\gamma_{00}=-5.43$, $SE=1.16$, and for the MDD group, $\gamma_{00}+\gamma_{01}=-5.98$, $SE=2.07$, was significantly different from zero, $ts>-2.89$, $ps<.01$. As hypothesized, independent of MDD status, participants overestimated the levels of displeasure that they would experience.

[3]There were no statistically significant linear or quadratic time-of-day effects for anticipatory or consummatory displeasure when MDD status was excluded from the models ($ps>.31$).

Discussion

In efforts to elucidate the nature of anhedonia, researchers are beginning to investigate anticipatory and consummatory phases of pleasure and displeasure. In the present study we used experience sampling to investigate these two phases of pleasure and displeasure for the daily activities of people with MDD and of healthy controls. We found that MDD was characterized by disturbances in both self-reported pleasure and displeasure across anticipatory and consummatory phases. Specifically, pleasure was blunted and displeasure was elevated during anticipation *and* consumption of daily activities. Our findings help to clarify disturbances in pleasure and displeasure in the daily lives of those with MDD.

As hypothesized, compared to healthy controls, people with MDD reported blunted anticipatory and consummatory *pleasure* for activities in daily life. Importantly, there were no significant group differences in the frequencies with which MDD and CTL participants reported most-looked-forward-to activities and completion of these activities, suggesting that pleasure-related deficits in MDD primarily concern the capacity to experience pleasure. These findings are consistent with research showing blunted consummatory pleasure in MDD (Bylsma et al., 2008 for a meta-analysis) and with the growing literature documenting blunted anticipatory pleasure in MDD (MacLeod & Salaminiou, 2001; McFarland & Klein, 2009; Sherdell et al., 2012). The present study was the first to use experience sampling to compare anticipatory and consummatory pleasure in MDD, providing evidence that laboratory-based findings of blunted anticipatory and consummatory pleasure in MDD generalize to activities in daily life. Blunted *anticipatory* pleasure appears to characterize both MDD and schizophrenia, highlighting the transdiagnostic nature of this construct. However, because schizophrenia is not also characterized by blunted *consummatory* pleasure (Barch et al., 2015; Kring & Elis, 2013), as is MDD, deficits in pleasure appear to be broader in individuals with MDD.

Supporting our hypotheses, people with MDD reported elevated anticipatory and consummatory *displeasure* for activities in daily life, compared to healthy controls. Furthermore, compared to controls, people with MDD more frequently reported least-looked-forward-to activities and less frequently reported completing these activities, suggesting that displeasure-related deficits in MDD concern not only elevated levels, but also increased frequency and behavioral avoidance, which fit with conceptualizations of MDD (e.g., Trew, 2011). Our main findings on elevated levels of displeasure in MDD are contrary to predictions from emotion context insensitivity theory (Rottenberg et al., 2005), which has been primarily supported by laboratory-based research. Our findings are consistent with other experience sampling studies showing that people with MDD appraise experiences as more unpleasant than do healthy controls (Bylsma et al., 2011; Myin-Germeys et al., 2003; Peeters et al., 2003; Thompson et al., 2012). In addition, the present study was the first to use experience sampling to examine anticipatory displeasure in MDD, extending previous findings relating depressive symptoms to higher anticipated negative affect in daily life (Hoerger et al., 2012, Wenze et al., 2012). One potential explanation for the divergent findings from laboratory-based versus naturalistic studies is that negative experiences in daily life contain greater idiographic meaning than do traditional laboratory stimuli (Bylsma & Rottenberg, 2011). It is possible that, as a result of leading more stressful

lives (Hammen, 2005), individuals with MDD have different thresholds for what they consider to be displeasurable—a threshold that is met by negative experiences in daily life but not by laboratory stimuli. Further research is required to test this hypothesis more explicitly and systematically.

Reported levels of pleasure and displeasure were comparable for people with MDD independent of comorbid anxiety disorders, providing evidence that our findings were not driven by the presence of anxiety disorders. This is particularly critical in the context of our anticipatory displeasure findings, as there is evidence that anxiety disorders are characterized by a heightened sensitivity to threat (Craske et al., 2009). What, then, can potentially explain the blunted pleasure and elevated displeasure, across anticipatory and consummatory phases, reported by people with MDD? In the vein of examining specific mechanisms or processes as they relate to mental health disorders (Insel et al., 2010), researchers have found that the two cardinal symptoms of MDD, anhedonia and depressed mood, are differentially associated with reported experiences of consummatory pleasure and displeasure. Specifically, whereas anhedonia is related to blunted reports of consummatory pleasure and displeasure, depressed mood is related to elevated reports of consummatory displeasure (Luking, Pagliaccio, Luby, & Barch, 2015; Saxena, Luking, Barch, & Pagliaccio, 2016). Future research will benefit from examining relations of *anticipatory* pleasure and displeasure to symptoms of MDD, which can offer further insights into disturbances in pleasure and displeasure in MDD.

With respect to the accuracy of anticipatory pleasure and displeasure predictions, we expected that participants would overestimate both pleasure and displeasure for future activities. Although the depressed and nondepressed participants differed significantly in their predictions of pleasure, their difference scores did not differ from zero, indicating that they both accurately estimated pleasure. In contrast, consistent with our hypothesis, participants overestimated displeasure. The absence of meaningful group differences is generally inconsistent with previous studies of dysphoric individuals, which have shown that depressive severity is associated with decreased accuracy in at least one domain of pleasure/displeasure. Our findings may diverge from these studies due to differences in the time horizon or event type involved: whereas we assessed predictions of pleasure for daily activities occurring within a couple of hours, other researchers have assessed predictions for specific events occurring over the next few days or weeks (e.g., Valentine's Day; Hoerger et al., 2012). Our findings are consistent, however, with a study by Thompson and colleagues (2016) who found in an independent sample that people with remitted MDD and healthy controls were similarly accurate in predicting their positive and negative affect over the next day and week. Our findings extend the MDD literature, showing that *accuracy* of pleasure and displeasure is intact for people who are in a major depressive episode, despite disturbances in their reported *experience* of pleasure and displeasure. It will be valuable for future research to investigate whether accuracy of predictions has different consequences for people with MDD than it does for healthy controls (e.g., whether overestimations of displeasure for activities lead to avoidance of those activities).

We should note three limitations of this study. First, we assessed subjective experiences of pleasure and displeasure. Given that pleasure and displeasure can be experienced

unconsciously, ratings of pleasure and displeasure in our study were likely shaped by participants' conscious awareness of these experiences (Schooler & Mauss, 2010), for which healthy and depressed individuals may differ. For example, people with MDD may have restricted awareness of pleasurable experiences, which could lead them to report lower levels of pleasure for these experiences. Further, our repeated assessments of pleasure and displeasure may have influenced participants' subjective reports. These factors represent challenges in studying affective experience more broadly; our understanding of pleasure and displeasure in MDD will be refined by studies that assess other features of pleasure and displeasure, including psychophysiological aspects (Berridge & Kringelbach, 2013; Mauss & Robinson, 2009). Second, our assessment of anticipatory pleasure and displeasure focused on the prediction of future experiences. It will be important for future researchers to investigate whether the experience of pleasure and displeasure associated with positive and negative predictions, respectively, is also disturbed in the daily lives of individuals with MDD. Third, although participants correctly remembered the majority of activities to which they had most and least looked forward, to avoid memory constraints future researchers could use more advanced experience sampling technology to automatically populate subsequent items with participants' previous responses (e.g., "Did you complete [previously indicated activity]?"). Future research should also explore the intriguing finding that, compared to controls, people with MDD remembered fewer least-looked-forward-to activities, which could reflect experiential avoidance (Hayes et al., 2004) of thoughts and emotions related to these activities.

The results of this study have important implications for the treatment of MDD, particularly for behavior-oriented therapies such as cognitive behavior therapy (CBT; Beck, 2011). For example, blunted *anticipatory* pleasure and elevated *anticipatory* displeasure in MDD are critical to acknowledge as potential barriers to behavioral activation. Therapists may consider devoting special attention to distorted anticipation for activities, through cognitive restructuring for thoughts related to those activities. In addition, our findings of blunted *consummatory* pleasure and elevated *consummatory* displeasure in MDD may challenge the notion that clients will feel better, or as good as nondepressed individuals, after engaging in activation. It is important to note, however, that our study assessed multiple anticipated activities throughout participants' daily lives, whereas behavioral activation involves activities that are planned and intentionally engaged in by the client, which may result in higher levels of consummatory pleasure and lower levels of consummatory displeasure. Nonetheless, it may be helpful to supplement CBT techniques with loving-kindness meditation, which has been shown to increase consummatory pleasure and decrease consummatory displeasure, as well as lead to reductions in depressive symptoms over time (Hofmann, Grossman, & Hinton, 2011).

In conclusion, the present investigation represents a significant contribution to the MDD literature by comparing self-reported pleasure and displeasure during anticipatory and consummatory phases in the same sample of people with MDD and healthy controls. Furthermore, we used a within-subject, ecologically valid method to assess pleasure and displeasure for activities that are frequently encountered in daily life. Gaining a better understanding of how individuals diagnosed with MDD anticipate and react to daily

activities could lead to advances in treatment that will help them to enhance pleasure and minimize displeasure.

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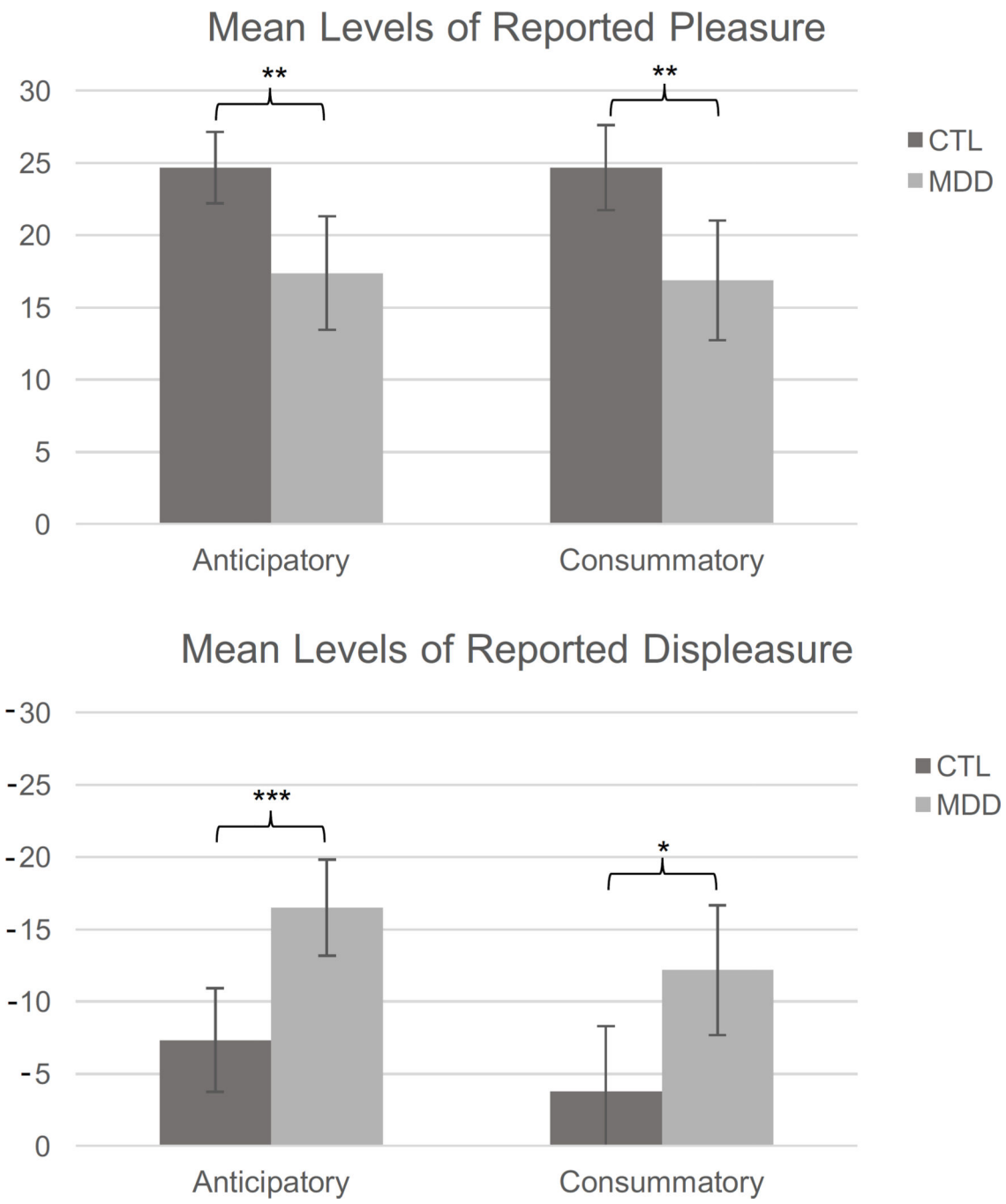

Figure 1.

Mean levels of anticipatory and consummatory pleasure (top panel) and anticipatory and consummatory displeasure (bottom panel) reported by each diagnostic group during the experience sampling week. For displeasure (bottom panel), increasing negative values reflect higher levels of displeasure. CTL = healthy control; MDD = major depressive disorder. Bars represent 95% confidence intervals.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 1

Demographic and Clinical Characteristics by Diagnostic Group

Variable	CTL (*n* = 39)	MDD (*n* = 41)	Difference Test
Demographic characteristics			
Age (*M, SD*)	31.8 (9.7)	35.4 (9.8)	$t(78)=-1.67$, $p=.10$
Gender (% women)	82.1%	78.0%	$\chi^2(1)=0.20$, $p=.66$
Race/Ethnicity[a]			$\chi^2(5)=3.89$, $p=.56$
African American	2.6%	5.0%	
American Indian/Alaska Native	2.6%	0%	
Asian American	15.4%	20.0%	
Caucasian	59.0%	62.5%	
Hispanic/Latino	5.1%	7.5%	
Other/Multiracial	15.4%	5.0%	
Education			$\chi^2(3)=5.89$, $p=.12$
High school or lower	0%	7.3%	
Some college	33.3%	34.1%	
Bachelor's degree	48.7%	29.3%	
Professional degree	17.9%	29.3%	
Marital Status			$\chi^2(2)=4.62$, $p=.10$
Never married	56.4%	39.0%	
Married or cohabiting	38.5%	41.5%	
Previously married	5.1%	19.5%	
Clinical characteristics			
Current MDE severity[b]			
Mild	n/a	5.0%	
Moderate	n/a	75.0%	
Severe	n/a	20.0%	
Global assessment of functioning[c]	87.3 (6.4)	55.4 (7.6)	$t(75)=19.80$, $p<.001$
Current comorbid anxiety disorder	0%	63.4%	$\chi^2(1)=33.10$, $p<.001$
Taking psychotropic medication	2.6%	31.7%	$\chi^2(1)=11.76$, $p=.001$

Note. CTL = healthy control; MDD = major depressive disorder; MDE = major depressive episode; n/a = not applicable.

[a] One MDD participant did not report her race/ethnicity.

[b] Percentages reported for MDE severity correspond to data from 40 out of 41 MDD participants.

[c] Means reported for global assessment of functioning correspond to data from 37 out of 39 CTL participants and 40 out of 41 MDD participants.

Table 2

Frequency of Experience Sampling Items by Diagnostic Group

Variable	CTL (*n* = 39)	MDD (*n* = 41)	Difference Test
Total completed prompts	74.5%	67.7%	$t(78)=1.61$, $p=.37$
Completed prompts during which:			
An activity was MOST looked forward to	75.8%	73.8%	$t(78)=0.44$, $p=.66$
An activity was LEAST looked forward to	50.0%	67.3%	$t(78)=-3.06$, $p=.003$
Completed activities that were:			
MOST looked forward to	67.4%	61.6%	$t(78)=0.95$, $p=.34$
LEAST looked forward to	62.6%	46.1%	$t(78)=2.48$, $p=.02$

Note. CTL = healthy control; MDD = major depressive disorder.

Table 3

Within- and Between-Person Correlations Among Reported Pleasure and Displeasure by Diagnostic Group

Measure	1	2	3	4
CTL Group:				
1. Anticipatory Pleasure	---	.57***	.01	.49
2. Consummatory Pleasure	.75***	---	.44	.44
3. Anticipatory Displeasure	.02	.07	---	.30
4. Consummatory Displeasure	.02	.14	.76***	---
MDD Group:				
1. Anticipatory Pleasure	---	.45***	.07	−.23
2. Consummatory Pleasure	.78***	---	−.01	−.36
3. Anticipatory Displeasure	−.21	−.21	---	.19
4. Consummatory Displeasure	.05	−.14	.59***	---

Note. CTL = healthy control; MDD = major depressive disorder. Correlations above the diagonal are within-person correlations obtained from MLM analyses (Nezlek, 2012). Correlations below the diagonal are between-person correlations calculated using mean pleasure and displeasure scores.

*** $p < .001$.