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

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Anticipatory and Consummatory Pleasure and Displeasure in Major Depressive Disorder:
An Experience Sampling Study
by
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A thesis presented to the
Graduate School of Arts and Sciences
of Washington University in
partial fulfillment of the
requirements for the
degree of Master of Arts

August 2016
St. Louis, Missouri

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Dedicated to my parents.

ABSTRACT OF THE THESIS

Anticipatory and Consummatory Pleasure and Displeasure in Major Depressive Disorder:

An Experience Sampling Study

by

Haijing Wu

Master of Arts in Psychology

Washington University in St. Louis, 2016

Renee J. Thompson, Chair

Pleasure and displeasure can be parsed into anticipatory and consummatory phases. However, existing research on pleasure and displeasure in major depressive disorder (MDD), a disorder characterized by anhedonia, has largely focused on deficits in the consummatory phase and most studies have been laboratory-based. Using experience sampling, we compared anticipatory and consummatory pleasure and displeasure for activities in the daily lives of adults with MDD ($n =$ 41) and in healthy controls ($n = 39$). Participants carried electronic devices for one week and were randomly prompted eight times a day to answer questions about activities that they most and least looked forward to. Compared to healthy controls, MDD participants reported lower anticipatory and consummatory pleasure and higher anticipatory and consummatory displeasure for daily activities. Additionally, participants' experiences of anticipatory and consummatory pleasure in daily life were inversely related to trait levels of anticipatory and consummatory anhedonia, respectively. Participants, independent of MDD status, accurately predicted pleasure but overestimated displeasure. These results are the first to provide evidence that, across both anticipatory and consummatory phases, people with MDD experience blunted pleasure and

elevated displeasure for daily activities. Our findings clarify disturbances in pleasure and

displeasure that characterize MDD, which should inform MDD treatment.

<center>**Introduction**</center>

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, exercise, 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; Schultz, 2002). This temporal distinction has led researchers to refine assessments of anhedonia (Gard, Gard, Kring, & John, 2006) and increase our understanding of psychopathology. Although researchers have highlighted the importance of such a distinction in depression (Treadway & Zald, 2011), few studies have compared anticipatory and consummatory pleasure in individuals diagnosed with MDD.

In the broader psychological literature, pleasure has been treated as a component of positive emotion, and specifically as one end of the pleasure-displeasure (i.e., valence) axis in a dimensional classification of emotions (Russell, 1980). In this context, anticipatory pleasure has been studied under the process of affective forecasting, in which people predict how they will feel during future positive outcomes (Wilson & Gilbert, 2003). This element of prediction differentiates anticipatory pleasure from consummatory pleasure (Gard, Kring, Gard, Horan, & Green, 2007). Similarly, consummatory pleasure has been examined under the process 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**

<center>1</center>

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.

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 also show reduced caudate activation during reward anticipation (Zhang et al., 2013 for a meta-analysis). Thus, MDD appears to be associated with deficits in the processing of anticipatory pleasure.

**Anticipatory and Consummatory *Dis*pleasure in MDD**

Importantly, blunted emotional reactivity in depression may not be specific to positive experiences or manifest exclusively as lower levels of pleasure. Focusing on 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 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, studies assessing emotional reactivity in daily life showed equivocal findings. 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), suggesting that they experience higher levels of consummatory displeasure.

Although the avoidance of anticipated negative experiences is posited to maintain MDD (Trew, 2011), little research has examined the role of anticipatory displeasure in MDD. Among the few existing investigations, findings diverge depending on whether the studies are laboratory-based or conducted in daily life (i.e., in the same way that the consummatory displeasure findings diverge). In the laboratory, people with MDD either do not differ from healthy controls or show blunted reactivity during anticipated punishment (Furman & Gotlib, 2016; Knutson, Bhanji, Cooney, Atlas, & Gotlib, 2008; McFarland & Klein, 2009). To date, studies on daily life have not examined anticipatory displeasure in clinically depressed individuals. Depressive symptoms, however, have been found to be associated with higher anticipated negative affect for daily events (Hoerger, Quirk, Chapman, & Duberstein, 2012; Wenze, Gunthert, Ahrens, & Taylor Bos, 2013; Wenze, Gunthert, & German, 2012), which

could suggest that there are higher levels of anticipatory displeasure in MDD. One potential explanation for the divergent findings from laboratory versus daily-life studies is that experiences in daily life may be more salient and contain greater idiographic meaning, thus eliciting higher levels of displeasure (Bylsma & Rottenberg, 2011).

**Relation of Pleasure and Displeasure to Anhedonia in MDD**

Investigators have voiced the importance of supplementing our knowledge about traditional diagnostic categories with research that examines how impairments are related to specific symptoms or mechanisms (Insel et al., 2010). In context of consummatory pleasure and displeasure, several laboratory-based studies have found that blunted reactivity is associated with higher state and trait anhedonia in people with MDD and in healthy controls (Chase et al., 2010; Pizzagalli, Iosifescu, Hallett, Ratner, & Fava, 2009; Steele, Kumar, & Ebmeier, 2007; Stoy et al., 2012; Stuhrmann et al., 2013). Although there is preliminary evidence that consummatory pleasure in daily life is inversely related to state anhedonia in late adolescence (van Roekel et al., 2015), no naturalistic study to date has examined this relation in adult or clinically depressed samples. Furthermore, researchers have now parsed anhedonia into anticipatory and consummatory phases, specifically for trait anhedonia (Gard et al., 2006), and there is growing evidence that MDD is associated with elevated trait anhedonia for both phases (Li et al., 2015). Researchers have not yet taken a fine-grained approach to studying whether blunted anticipatory and consummatory experiences are related to higher trait anticipatory and consummatory anhedonia, respectively, in MDD.

**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 tend to 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 MDD. Findings from the few studies that have assessed dysphoric individuals are inconclusive. With respect to pleasure or positive affect, depressive symptoms have been associated with more accurate predictions (Chentsova-Dutton & Hanley, 2010; Wenze et al., 2012), as well as less accurate predictions (Hoerger et al., 2012; Yuan & Kring, 2009). In terms of displeasure or negative affect, depressive symptoms have been associated with less accurate predictions (Hoerger et al., 2012; Wenze et al., 2012), as well as equally accurate predictions (Yuan & Kring, 2009). Research with participants with MDD may elucidate the relation between accuracy and depression, as greater severity of depressive symptoms (e.g., anhedonia) could have a stronger impact on the accuracy of both pleasure and displeasure predictions.

**Goals and Hypotheses for the Current Study**

Knowledge about the experience of pleasure and displeasure in MDD comes largely from research on the consummatory phase; it is equally important, however, to understand these constructs during the anticipatory phase. In the current study we directly compared anticipatory and consummatory phases for experiences of pleasure and displeasure in a clinically depressed sample. This allowed us to address the unresolved questions of whether, like pleasure, displeasure is blunted during anticipatory and consummatory phases in MDD, and whether the accuracy of anticipatory pleasure and displeasure is impaired in MDD, compared to healthy controls. More specifically, we utilized experience sampling, the repeated sampling of experiences in the natural environment, to assess anticipation and consumption for different

types of activities as they unfolded in daily life. Experience sampling can provide insight into which real-life activities people anticipate and experience pleasure and displeasure for, while reducing the impact of negatively-biased retrospective recall that characterizes individuals with MDD (Gotlib & Joormann, 2010). It also enabled us to determine whether findings from laboratory-based studies, such as blunted anticipatory and consummatory pleasure in MDD, generalize to real-life activities. No study to date has used experience sampling to examine anticipatory and consummatory pleasure or displeasure in MDD, or their relations to trait anhedonia.

The primary goal of the present investigation was to examine anticipatory and consummatory pleasure and displeasure for activities in daily life in adults with MDD and in healthy controls. For *pleasure*, we hypothesized that (1) participants with MDD would experience blunted levels of anticipatory and consummatory pleasure, compared to healthy controls. Additionally, we hypothesized that (2) independent of MDD status, participants' levels of anticipatory and consummatory pleasure in daily life would be inversely associated with trait anticipatory and consummatory anhedonia, respectively. For *displeasure*, we hypothesized that (3) participants with MDD would experience elevated levels of anticipatory and consummatory displeasure, compared to healthy controls, a finding that would be consistent with results from studies on daily life. Finally, we hypothesized that (4) 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.

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Finally, we also explored the types of activities for which the depressed and nondepressed groups reported anticipating and experiencing pleasure and displeasure in their daily lives. Among experience sampling studies that have examined different types of activities, investigators have found that, compared to healthy controls, people with MDD report elevated social- and activity-related stress (Myin-Germeys et al., 2003); people with MDD also report experiencing fewer positive social events, accomplished goals, and personal successes, as well as a greater frequency of negative social events and personal failures (Bylsma et al., 2011). Thus, MDD appears to be associated with blunted consummatory pleasure and elevated consummatory displeasure for both social- and goal-oriented activities. These findings fit with the social withdrawal and reduced goal pursuit that often occur with MDD (Barrett & Barber, 2007; Winch, Moberly, & Dickson, 2014). We explored whether these findings also hold for the anticipation of activities.

## 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 needed for other research questions examined in the parent study. Based on Structured Clinical Interview for *DSM-IV* Axis I Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 2001), 41 participants were diagnosed with current MDD, and 39 participants were classified as healthy controls (CTL) without any current or past mental health disorders. A total of 63.4% of participants in the MDD group were diagnosed one or more current anxiety disorders. These anxiety disorder diagnoses 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%).

**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 recorded interviews. Our team has achieved excellent interrater reliability for a major depressive episode ($k = .93$) 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 self-report measures, including the trait anhedonia measure detailed below, and computer tasks unrelated to the present study. 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 eight times each day between 10 a.m. and 10 p.m. Prompts occurred at random times within eight 90-minute windows each day; thus, prompts

could occur as soon as two minutes or as long as 180 minutes apart. 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. If participants chose any option other than "nothing in particular" for both the anticipatory pleasure and 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.

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**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 completed the named activity. If participants 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 group differences in the percentage of correctly remembered most-looked-forward-to activities, $t(78) = 1.62$, $p = .11$. Compared to the MDD group, the CTL group correctly remembered significantly more least-looked-forward-to activities, $t(78) = 3.02$, $p = .003$.

**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

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reflected overestimations, whereas negative values reflected underestimations. For displeasure difference scores, positive values reflected underestimations, whereas negative values reflected overestimations.

**Anticipatory and consummatory anhedonia.** Participants completed the Temporal Experience of Pleasure Scale (TEPS), a self-report measure that assesses and distinguishes between trait levels of anticipatory and consummatory anhedonia (Gard et al., 2006). The TEPS consists of 18 items, with 10 items assessing anticipatory anhedonia and eight items assessing consummatory anhedonia. Participants were asked to indicate the degree to which they identified with each statement using a 6-point Likert-type scale (1 = *very false for me*, 6 = *very true for me*). The TEPS has good internal consistency, test-retest reliability, and convergent and discriminant validity (Gard et al., 2006). We scored the TEPS such that higher scores indicate higher levels of anhedonia (CTL: anticipatory subscale $\alpha = .72$, consummatory subscale $\alpha = .80$; MDD: anticipatory subscale $\alpha = .76$, consummatory subscale $\alpha = .79$).

## Statistical Analyses

Because of the nested structure of our data, in which prompts are nested within participants, we used multilevel modeling (MLM) for our analyses unless otherwise noted. 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. The unconditional model allows for estimates of the proportion of variance in the outcome variable accounted for by the between-person level (reflecting individual differences) versus the within-person level (reflecting situational differences). Then, to test our hypotheses, we ran the full models presented below and tested whether predictors (e.g., 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 and included linear and quadratic time-of-day effects (i.e., time in minutes since first prompt of the day) as predictors at Level 1 to control for potential time-of-day fluctuations.

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.

<div style="text-align:center"><strong>Results</strong></div>

**Participant Characteristics**

Demographic and experience sampling information by diagnostic group are presented in Table 1. The MDD and CTL groups did not significantly differ in age, gender, educational attainment, or marital status. One MDD participant did not report her race/ethnicity; among the remaining participants, the MDD and CTL groups did not significantly differ in racial/ethnic

composition. Importantly, the MDD and CTL participants did not differ in the percentage of prompts completed over the experience sampling week.

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

The unconditional models revealed that 40% of the variance in *anticipatory* pleasure was at the between-person level, 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):

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

$\text{Pleasure}_{ij}$ represents pleasure for participant $j$ at prompt $i$, and $\beta_{0j}$ represents the within-person mean pleasure. $\gamma_{00}$ represents the mean pleasure for the CTL group, and $\gamma_{01}$ represents the difference in mean pleasure between the CTL and MDD groups.

Mean levels of anticipatory and consummatory pleasure by diagnostic group are displayed in Figure 1. Mean anticipatory pleasure for the CTL group was significantly different than zero, $\gamma_{00} = 24.67$, $SE = 1.26$, $t(78) = 19.56$, $p < .001$. As hypothesized, the MDD group reported lower levels of anticipatory pleasure than did the CTL group, $\gamma_{01} = -7.30$, $SE = 2.36$, $t(78) = -3.09$, $p = .003$. MDD status significantly improved the model fit for anticipatory pleasure, $\chi^2(1) = 8.87$, $p = .003$, accounting for 10% 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

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consummatory pleasure for the CTL group was significantly different from zero, $\gamma_{00} = 24.68$, $SE$

$= 1.50$, $t(73) = 16.49$, $p < .001$. As hypothesized, the MDD group reported lower levels of

consummatory pleasure than did the CTL group, $\gamma_{01} = -7.82$, $SE = 2.59$, $t(73) = -3.02$, $p = .004$.

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.

      After controlling for potential linear and quadratic time-of-day effects, $\gamma_{01}$ coefficients for

anticipatory and consummatory pleasure remained statistically significant, $p$s $< .05$, indicating

that there were still significant group differences. Mean levels of anticipatory and consummatory

pleasure by diagnostic group were comparable in magnitude to those shown in Figure 1.

**Are Levels of Pleasure in Daily Life Associated with Trait Anhedonia?**

      We first examined whether the MDD and CTL groups differed in levels of trait

anticipatory and consummatory anhedonia by running independent sample $t$-tests using SPSS

v22 (IBM SPSS Statistics for Windows, 2013). We did not have anhedonia data for one MDD

participant. The MDD group reported higher levels of anticipatory anhedonia ($M = 37.69$, $SD = $

7.71) than did the CTL group ($M = 22.31$, $SD = 6.42$), $t(77) = -9.62$, $p < .001$. The MDD group

also reported higher levels of consummatory anhedonia ($M = 24.80$, $SD = 8.21$) than did the CTL

group ($M = 15.19$, $SD = 7.71$), $t(77) = -5.98$, $p < .001$.

      To examine whether levels of pleasure in daily life were associated with trait anhedonia

across the whole sample, we tested whether trait anticipatory and consummatory anhedonia

predicted anticipatory and consummatory pleasure, respectively:

    Model 2

    Level 1 Model:

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

Level 2 Model:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} \text{ Anhedonia (anticipatory or consummatory)} + u_{0j}.$$

Pleasure$_{ij}$ represents pleasure for participant $j$ at prompt $i$, and $\beta_{0j}$ represents the within-person

mean pleasure. $\gamma_{00}$ represents the mean pleasure when grand-mean-centered anhedonia is equal to

zero, and $\gamma_{01}$ represents the difference in mean pleasure for a one unit increase in anhedonia.

As hypothesized, trait anticipatory anhedonia was significantly inversely associated with

anticipatory pleasure, $\gamma_{01} = -0.48$, $SE = 0.10$, $t(77) = -4.86$, $p < .001$. Anticipatory anhedonia

significantly improved the model fit for anticipatory pleasure, $\chi^2(1) = 19.50$, $p < .001$,

accounting for 22% of the between-person variance. As hypothesized, trait consummatory

anhedonia was significantly inversely associated with consummatory pleasure, $\gamma_{01} = -0.63$, $SE =$

$0.18$, $t(73) = -3.60$, $p = .001$. Consummatory anhedonia significantly improved the model fit for

consummatory pleasure, $\chi^2(1) = 16.40$, $p < .001$, accounting for 22% of the between-person

variance.

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

The unconditional models revealed that 49% of the variance in *anticipatory* displeasure

was at the between-person level, 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 by diagnostic group are

displayed in Figure 1. Mean anticipatory displeasure for the CTL group was significantly

different from zero, $\gamma_{00} = -7.32$, $SE = 1.83$, $t(78) = -3.99$, $p < .001$. As hypothesized, the MDD

group reported higher levels of anticipatory displeasure than did the CTL group, $\gamma_{01} = -9.18$, $SE =$

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, $\gamma_{00} = -3.75$, $SE = 2.30$, $t(69) = -1.63$, $p = .11$, 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, $\gamma_{01} = -8.41$, $SE = 3.25$, $t(69) = -2.59$, $p = .01$. MDD status significantly improved the model fit for consummatory displeasure, $\chi^2(1) = 6.34$, $p = .01$, accounting for 10% of the between-person variance.

After controlling for potential linear and quadratic time-of-day effects, $\gamma_{01}$ coefficients for anticipatory and consummatory displeasure remained statistically significant, $p$s $< .05$, indicating that there were still significant group differences. Mean levels of anticipatory and consummatory displeasure by diagnostic group were comparable in magnitude to those shown in Figure 1.

**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 unconditional models revealed that 7% of the variance in accuracy for pleasure was at the between-person level, and 12% of the variance in in accuracy for displeasure was at the between-person level. Next, we examined whether MDD status predicted differences in the accuracy of pleasure and displeasure, by running Model 1 with accuracy as the outcome variable.

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Mean accuracy for pleasure for the CTL group was not significantly different from zero, $\gamma_{00} = -1.55$, $SE = 0.96$, $t(73) = -1.61$, $p = .11$, suggesting that the CTL group accurately predicted pleasure. Accuracy for pleasure varied significantly as a function of MDD status, $\gamma_{01} = 3.41$, $SE = 1.57$, $t(73) = 2.17$, $p = .03$. However, accuracy for pleasure for the MDD group ($\gamma_{00} + \gamma_{01} = 1.85$, $SE = 1.24$) was also not significantly different from zero, $t(73) = 1.50$, $p = .14$, suggesting that the MDD group accurately predicted pleasure. Therefore, independent of group status, participants accurately predicted pleasure, which was contrary to our hypotheses. 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.

Mean accuracy for displeasure for the CTL group was significantly different from zero, $\gamma_{00} = -5.43$, $SE = 1.16$, $t(69) = -4.69$, $p < .001$. Accuracy for displeasure did not vary significantly as a function of MDD status, $\gamma_{01} = -0.55$, $SE = 2.37$, $t(69) = -0.23$, $p = .82$. As hypothesized, independent of MDD status, participants overestimated the levels of displeasure that they would experience. 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.

**Do MDD and CTL Groups Differ in Anticipatory and Consummatory Pleasure and Displeasure for Different Activity Types?**

Finally, to examine whether there were group differences in anticipatory and consummatory pleasure and displeasure for different activity types, we aggregated ratings by diagnostic group and activity type and ran independent sample *t*-tests using SPSS v22 (IBM SPSS Statistics for Windows, 2013). Mean levels of anticipatory and consummatory pleasure by diagnostic group and activity type are displayed in Table 2. Compared to the CTL group, the MDD group reported lower *anticipatory* pleasure for conversation/socializing, errands/chores,

and "other" activities, $t$s > 2.91, $p$s < .01. Compared to the CTL group, the MDD group reported lower *consummatory* pleasure for "other" activities, $t(32) = 2.35$, $p = .03$.

Mean levels of anticipatory and consummatory displeasure by diagnostic group and activity type are displayed in Table 3. Compared to the CTL group, the MDD group reported higher *anticipatory* displeasure for conversation/socializing, errands/chores, work/school/study, commuting, and being alone/bored/not having plans, $t$s > 2.17, $p$s < .05. There were no group differences in *consummatory* displeasure for any activity type, $t$s < 2.04, $p$s ≥ .05.

## Discussion

Anhedonia is a core symptom of MDD that may influence the experience of pleasure and displeasure for activities in daily life. The present study used experience sampling to investigate anticipatory and consummatory pleasure and displeasure for the daily activities of people with MDD and healthy controls. We found that MDD was characterized by disturbances in both pleasure and displeasure across anticipatory and consummatory phases. Specifically, pleasure was blunted and displeasure was elevated during anticipation *and* consumption of daily activities. Blunted pleasure in daily life was associated with higher trait anhedonia. Our findings clarify disturbances in pleasure and displeasure and elucidate the role of anhedonia in the daily lives of those with MDD.

As hypothesized, compared to healthy controls, people with MDD experienced blunted anticipatory and consummatory pleasure for activities in daily life. These findings are consistent with the research literature showing blunted consummatory pleasure in MDD (Bylsma et al., 2008 for a meta-analysis) and with the growing research literature showing 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

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consummatory pleasure in MDD, providing evidence that laboratory-based findings on blunted anticipatory and consummatory pleasure generalize to activities in daily life.

Anticipatory and consummatory pleasure are related to key constructs (i.e., approach motivation and reward responsiveness, respectively) in the positive valence system proposed by the Research Domain Criteria initiative (RDoC; Insel et al., 2010). In addition to MDD, anticipatory and consummatory pleasure has been examined in people with schizophrenia, in both laboratory and daily-life studies (Barch, Pagliaccio, & Luking, 2015). Like in MDD, schizophrenia is characterized by blunted *anticipatory* pleasure (Gard et al., 2007); however, MDD, but not schizophrenia, is also characterized by blunted *consummatory* pleasure, suggesting that deficits in pleasure are more pervasive in those with MDD. Our anticipatory pleasure findings add to the growing literature documenting the transdiagnostic nature of various emotion constructs (e.g., emotional instability; Farmer & Kashdan, 2014; Thompson et al., 2012; Trull et al., 2008). It will be important for future research to examine the experience of anticipatory and consummatory pleasure in other disorders. For example, we expect that substance use disorder will be characterized by elevated anticipatory pleasure for substances when compared to consummatory pleasure for the same substances.

As hypothesized, compared to the healthy controls, people with MDD experienced elevated anticipatory and consummatory displeasure for activities in daily life. Therefore, our findings do not support 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). In addition, the present study was the first to use experience sampling to examine

anticipatory displeasure in MDD, extending previous findings that showed relations between depressive symptoms and higher anticipated negative affect in daily life (Hoerger et al., 2012, Wenze et al., 2012). Compared to traditional stimuli used in the laboratory, negative experiences in daily life may have greater idiographic meaning for individuals (Bylsma & Rottenberg, 2011), eliciting elevated anticipatory and consummatory displeasure for those with MDD. Additional empirical work is needed to test whether this is systematically supported in context of MDD.

As hypothesized, independent of MDD status, participants' experiences of anticipatory and consummatory pleasure in daily life were inversely related to trait anticipatory and consummatory anhedonia, respectively. Therefore, trait anhedonia may be one mechanism through which pleasure in daily life becomes blunted. These findings align well with previous studies showing relations between blunted experience in the laboratory and anhedonia, in people with MDD and healthy controls (Chase et al., 2010, Pizzagalli et al., 2009; Steele et al., 2007; Stoy et al., 2012; Stuhrmann et al., 2013). Of note, some of these studies found that displeasure was also blunted in MDD (Chase et al., 2010, Steele et al., 2007; Stoy et al., 2012); because we found evidence for *elevated* displeasure in MDD, we did not test whether displeasure was associated with anhedonia. In fact, elevated displeasure may be differentially associated with depressed mood, the other cardinal symptom of MDD (Luking, Pagliaccio, Luby, & Barch, 2015; Saxena, Luking, Barch, & Pagliaccio, under review), but this has not yet been examined in clinically depressed samples or parsed into anticipatory and consummatory phases. Due to the heterogeneous nature of MDD, future research may benefit from continuing to examine relations to symptoms, which can offer insights into potential mechanisms through which pleasure and displeasure are impaired.

Independent of MDD status, participants accurately estimated pleasure but overestimated displeasure for future activities, which partially supported our hypotheses and existing literature that both pleasure and displeasure would be overestimated. Our findings are generally inconsistent with previous studies using samples of dysphoric individuals, which typically show that depressive symptoms are associated with decreased accuracy in at least one pleasure/displeasure domain. In the present study, participants predicted their pleasure and displeasure for daily activities (e.g., work or school), whereas in previous studies on dysphoria, participants predicted their emotions for specific events (e.g., Valentine's Day) or emotions that were not linked to events. Another difference between the present study and existing research is the time frame examined: other research has typically assessed predictions over next few days or weeks (Chentsova-Dutton & Hanley, 2010; Hoerger et al., 2012; Wenze et al., 2012; Yuan & Kring, 2009). Finally, the low proportion of variance in accuracy accounted for by individual differences could be one reason that findings on accuracy have been inconsistent, even among studies on dysphoria. Additional studies on the daily activities of clinically depressed samples are needed to see if our accuracy findings replicate.

In exploratory analyses of pleasure and displeasure by activity type, we did not detect group differences in *consummatory* pleasure and displeasure, with the exception that people with MDD reported blunted consummatory pleasure for "other" activities, compared to healthy controls. Although the absence of group differences could suggest that consummatory pleasure and displeasure are not distorted for specific activity types, these findings should be interpreted with caution because we had decreased statistical power to detect group differences. Participants completed fewer activities than they anticipated, resulting in fewer consummatory data points per activity type. Moreover, the findings are inconsistent with previous experience sampling

studies that found blunted consummatory pleasure and elevated consummatory displeasure for social- and goal-oriented activities in MDD (Bylsma et al., 2011; Myin-Germeys et al., 2003). In contrast, we did find evidence for blunted *anticipatory* pleasure and elevated *anticipatory* displeasure for social- and goal-oriented activities in MDD. Specifically, compared to controls, people with MDD had blunted anticipatory pleasure for social interactions, errands or chores, and "other" activities, and had elevated anticipatory displeasure for social interactions, errands or chores, work or school, commuting, and being alone or bored. These findings suggest that the social withdrawal and reduced goal pursuit characteristic of MDD (Barrett & Barber, 2007; Winch et al., 2014) are also impacting the anticipation of activities in daily life.

Our findings should be interpreted in light of the following study limitations. First, our assessment of pleasure and displeasure relied on participants' subjective reports. Therefore, we cannot rule out the possibility that people with MDD anticipated and experienced activities that were objectively less pleasurable or more displeasurable than did healthy controls. Future studies could ask participants to report details of all activities and code the degree to which the activities were objectively pleasant and unpleasant. Collecting details for all activities would also allow researchers to gain potentially valuable insights on "other" activities (for which we found group differences in pleasure). Second, our assessment of anticipatory pleasure focused on the prediction of future pleasure. Anticipatory pleasure has been described as also involving the concurrent experience of pleasure when predicting future pleasure—that is, the pleasure that is experienced in-the-moment when expecting pleasure to occur in the future (Gard et al., 2007). To minimize participant burden, we focused on prediction in this study, which allowed us to assess the accuracy of anticipatory pleasure predictions. For a more comprehensive assessment

of anticipatory pleasure, researchers should assess both prediction and concurrent pleasure, and possibly create a composite score from the two components.

The results of this study have implications for the treatment of MDD, particularly for behavior-oriented therapies such as Cognitive Behavior Therapy (CBT; Beck, 2011). First, blunted *anticipatory* pleasure and elevated *anticipatory* displeasure in MDD are critical to acknowledge as potential barriers to behavioral activation. Therapists may want to devote special attention to the anticipation of social- and goal-oriented activities, through cognitive restructuring for thoughts related to these activities. Second, blunted *consummatory* pleasure and elevated *consummatory* displeasure in MDD may challenge the notion that clients will feel better upon engaging in activation. Therapists should consider carefully examining clients' consummatory reactions to activities because clients may experience distortions in pleasure and displeasure from self-critical thoughts (Beck, 2011). If this is the case, CBT techniques may be supplemented by mindfulness approaches (Segal, Williams, & Teasdale, 2002) to help individuals connect with their experiences in-the-moment. Furthermore, pleasure may be enhanced and displeasure may be minimized in the long-term through loving-kindness meditation, which has been shown to increase positive affect, decrease negative affect, and lead to reductions in depressive symptoms over time (Hofmann, Grossman, & Hinton, 2011).

In conclusion, the present investigation represents an important contribution to the MDD literature because it compared pleasure and displeasure during anticipatory and consummatory phases in the same sample of people with MDD and healthy controls. Furthermore, we used a highly ecologically valid method to assess pleasure and displeasure for activities that are frequently encountered in daily life, and offered insights into how these constructs relate to trait levels of anhedonia. A fundamental understanding of how individuals diagnosed with MDD

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anticipate and react to daily activities could lead to advances in treatment that help enhance

pleasure and minimize displeasure.

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Table 1

*Demographic and Experience Sampling Information by Diagnostic Group*

| Variable | CTL (*n* = 39) | MDD (*n* = 41) | Difference Test |
|---|---|---|---|
| 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 | | | $\chi^2(5) = 3.89$, $p = .56$ |
| 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% | |
| Percentage of completed prompts (*M*, *SD*) | 74.5 (17.8) | 67.7 (19.8) | $t(78) = 1.61$, $p = .37$ |

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

Table 2

*Anticipatory and Consummatory Pleasure by Diagnostic Group and Activity Type*

| Activity Type | Anticipatory Pleasure | | | Consummatory Pleasure | | |
|---|---|---|---|---|---|---|
| | CTL | MDD | Difference Test | CTL | MDD | Difference Test |
| Work/school/study | 11.73 (18.76) | 8.49 (20.88) | $t(37) = 0.51, p = .62$ | 22.67 (18.43) | -2.08 (26.97)[a] | $t(11) = 1.95, p = .08$ |
| Media/TV/Internet | 21.89 (12.16) | 17.04 (15.78) | $t(73) = 1.46, p = .15$ | 23.61 (11.78) | 16.74 (16.04) | $t(36) = 1.47, p = .15$ |
| Conversation/socializing | 29.00 (8.58) | 19.86 (17.23) | $t(70) = 2.91, p = .005$ | 29.12 (12.48) | 27.72 (15.92) | $t(41) = 0.32, p = .75$ |
| Errands/chores | 14.69 (12.60) | 0.43 (17.22) | $t(44) = 3.11, p = .003$ | 18.39 (10.13) | 8.50 (27.91) | $t(9) = 0.87, p = .41$ |
| Hobby (not physical activity) | 25.53 (12.15) | 18.09 (15.29) | $t(36) = 1.65, p = .11$ | 25.06 (15.30) | 12.55 (18.74) | $t(18) = 1.57, p = .13$ |
| Physical activity | 24.02 (15.14) | 21.42 (13.11) | $t(46) = 0.63, p = .54$ | 21.57 (19.57) | 24.49 (15.92) | $t(26) = -0.33, p = .74$ |
| Eating/drinking | 24.17 (11.05) | 18.04 (17.42) | $t(70) = 1.77, p = .08$ | 26.07 (11.42) | 19.16 (18.71) | $t(31) = 1.29 p = .21$ |
| Other | 27.33 (10.94) | 15.66 (14.75) | $t(65) = 3.65, p = .001$ | 24.09 (11.52) | 10.33 (21.24) | $t(32) = 2.35, p = .03$ |

*Note*. Values represent *M* (*SD*). Increasingly positive values reflect higher levels of pleasure. Degrees of freedom vary for *t*-tests because participants did not report anticipatory and consummatory pleasure for every activity type. CTL = healthy control; MDD = major depressive disorder.

[a] This mean rating is negative (reflecting displeasure) but is listed here because it was given for an activity that was most-looked-forward to.

Table 3

*Anticipatory and Consummatory Displeasure by Diagnostic Group and Activity Type*

| Activity Type | Anticipatory Displeasure | | | Consummatory Displeasure | | |
|---|---|---|---|---|---|---|
| | CTL | MDD | Difference Test | CTL | MDD | Difference Test |
| Work/school/study | -7.80 (12.99) | -18.05 (15.98) | $t(48) = 2.50, p = .02$ | -9.35 (10.26) | -18.81 (19.32) | $t(27) = 1.63, p = .12$ |
| Commuting | -6.92 (11.09) | -14.66 (14.77) | $t(54) = 2.24, p = .03$ | -3.62 (19.94) | -6.82 (14.87) | $t(22) = 0.40, p = .69$ |
| Conversation/socializing | 6.86 (16.57)[a] | -19.76 (19.02) | $t(37) = 4.38, p < .001$ | -3.33 (5.77) | -3.19 (22.19) | $t(9) = -0.01, p = .99$ |
| Errands/chores | -4.38 (11.99) | -14.40 (9.77) | $t(60) = 3.63, p = .001$ | 1.10 (15.36)[a] | -9.09 (13.30) | $t(31) = 2.04, p = .05$ |
| Being alone/bored/not having plans | -13.34 (6.72) | -19.67 (10.12) | $t(40) = 2.17, p = .04$ | -14.43 (12.55) | -24.51 (8.11) | $t(9) = 1.60, p = .14$ |
| Physical activity | -4.56 (9.55) | -7.64 (14.97) | $t(17) = 0.53, p = .60$ | -23.00 (5.66) | -9.40 (18.93) | $t(5) = -0.95, p = .38$ |
| Eating/drinking | 26.40 (26.02)[a] | -4.00 (31.47) | $t(6) = 1.22, p = .27$ | -22.00[b] | --- | --- |
| Other | -2.98 (15.37) | -9.24 (14.39) | $t(35) = 1.27, p = .21$ | -6.68 (12.75) | -7.50 (33.30) | $t(7) = 0.04, p = .97$ |

*Note*. Values represent *M* (*SD*). Increasingly negative values reflect higher levels of displeasure. Degrees of freedom vary for *t*-tests because participants did not report anticipatory and consummatory displeasure for every activity type. CTL = healthy control; MDD = major depressive disorder.

[a] This mean rating is positive (reflecting pleasure) but is listed here because it was given for an activity that was least-looked-forward to. [b] Only one person reported displeasure for this activity type; therefore, it was not possible to run a difference test.
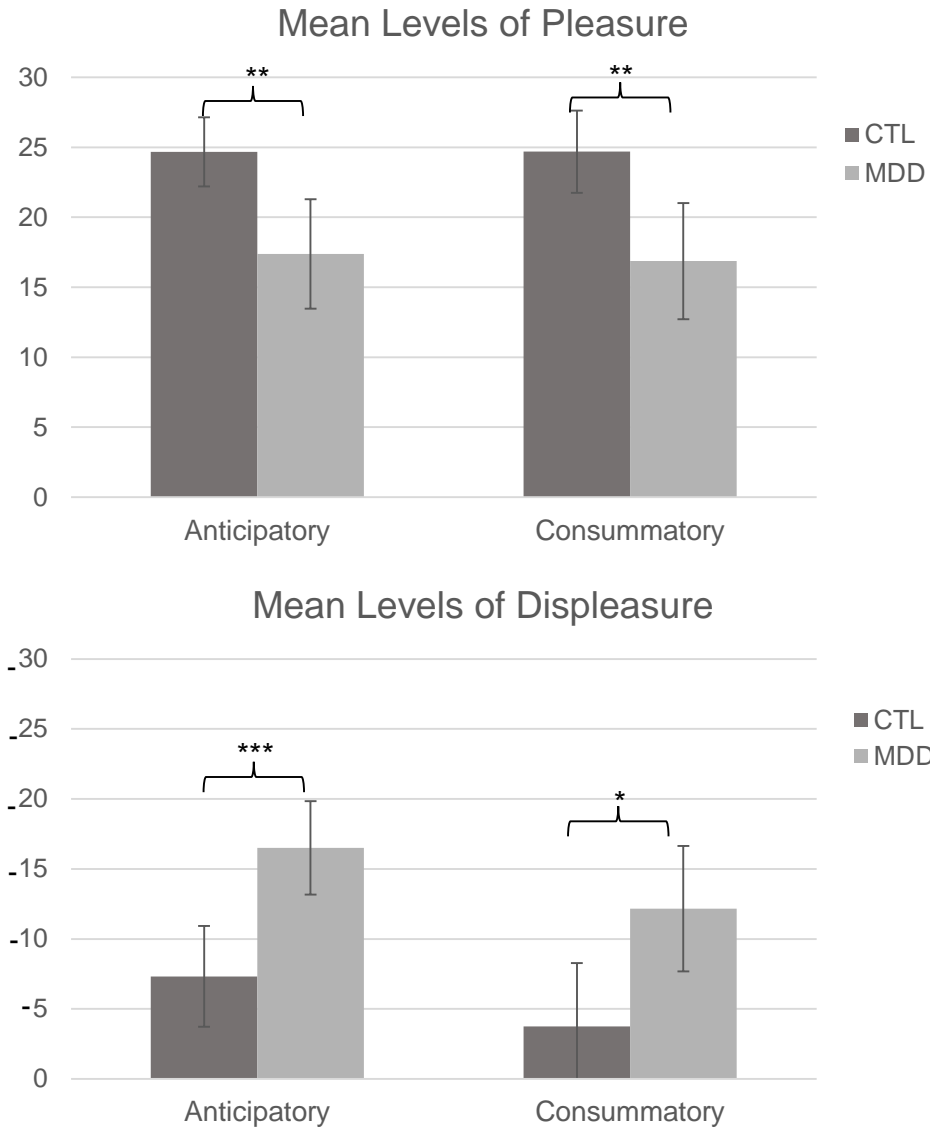
*Figure 1*. Mean levels of anticipatory and consummatory pleasure (top panel) and anticipatory and consummatory displeasure (bottom panel) reported by each diagnostic group during the experience sampling week. Bars represent 95% confidence intervals. CTL = healthy control; MDD = major depressive disorder.

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