Spring 2022

Affective Forecasting and Mood Disorder Symptoms: How Clinical Symptoms Relate to the Prediction of Future Emotions

Madison R. Bouchard-Liporto
University of New Hampshire - Main Campus

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Madison R. Bouchard - Liporto

Department of Psychology, University of New Hampshire

Psychology Honors Thesis

Supervised by Jolie Wormwood

May 10, 2020

Abstract

The ability to accurately predict future feelings and emotions, termed affective forecasting, is an important skill as it has a significant impact on the decisions individuals make throughout daily life. Previous research has suggested that depression and anxiety symptoms may be linked to biases in affective forecasting. Here, we hypothesized that greater symptom severity of depression and anxiety would be associated with increased predictions and experiences of negative affect in response to negative stimuli and decreased predictions and experiences of positive affect in response to positive stimuli among a random sample of undergraduate college students. In the first part of this study, participants read descriptions of 20 affective pictures which varied in terms of their normative valence (pleasantness/unpleasantness) and arousal (activation/deactivation). Based on the provided descriptions, participants rated their predicted affective reaction to each picture in terms of valence and arousal, as well as the extent to which they predicted they'd experience a number of specific emotions while viewing each picture. One week later, participants viewed the pictures and rated their experienced affect and emotion to each. Results revealed that individuals with greater depression or anxiety symptom severity: predicted (but did not experience) more negative affect for negative stimuli and experienced (but did not predict) less positive affect for positive stimuli. In addition, individuals with greater anxiety symptom severity tended to overestimate the extent to which they would feel activated in response to negative stimuli. Taken together, our findings suggest that depression and anxiety symptoms may negatively influence the ability for an individual to make accurate affective forecasts.

Keywords: Affective Forecasting, Depression, Anxiety

Affective Forecasting and Mood Disorder Symptoms: How Clinical Symptoms Relate to the Prediction of Future Emotions

How would you feel if you were to jump out of a plane? How would you feel if you dropped and shattered your favorite mug? What about if you were to adopt a new puppy? The way we think we will feel about an event guides our actions on a day-to-day basis, but it also influences how we prepare for the future. For example, one may choose to study a career path if they predict it will make them happy and satisfied. Or, one may choose to purchase an expensive vehicle if they believe it will make them feel successful. Negative emotions, or predicted negative emotions, can also drive changes in behavior. One might not travel to a foreign country if they predict they will feel anxious or alone in a new environment, or one may end a relationship if they believe they will feel depressed or empty. Emotions guide our behavior and influence our decision making, whether it be conscious or unconscious. Thus, the ability to accurately predict future emotions is an important skill as it has a significant impact on the decisions we make. However, current research suggests our predicted emotions often differ from what we actually feel in the moment (Gilbert et al., 1998).

What is Affective Forecasting?

The term affective forecasting refers to one's ability to predict their emotional reactions to future events (Wilson & Gilbert, 2005). Much of the current research on affective forecasting has explored why predicted emotions and actual emotions differ from one another, and the implications that result from this divergence (Gilbert et al., 1998). Research on affective forecasting has emphasized that predictions may be more or less accurate across four independent components of affective experience, including predictions about: the valence of one's future feelings (i.e., feelings of pleasure/displeasure), the specific emotions that are

expected to be experienced (e.g., whether one will experience anger v. disgust), and the intensity and duration of these predicted affective experiences (Wilson & Gilbert, 2003).

Each of these four aspects of affective forecasting can be more or less accurate when predictions are compared to the experience of emotions in response to the event actually happening (Wilson & Gilbert, 2003). Affective valence refers to how pleasant or unpleasant an event or emotion is. For example, winning the lottery would be a pleasant experience, while losing all your belongings in a house fire would be an unpleasant experience. People may be mistaken when predicting the valence of a future event, however. An individual may be excited about going on a first date, only to express feelings of sadness or regret upon realizing they are not at all compatible with their date once meeting them. Affective forecasting also encompasses the prediction of specific emotions. Individuals may be more or less accurate at predicting which emotion(s) they will experience in response to a future event. While they may be more accurate at predicting whether they are likely to experience relatively dissimilar emotion categories (e.g., whether they will feel angry or sad in response to an insult), they may fail to account for the complexity or variety of emotion categories that describe their experience after an event has occurred, especially if one emotion category is strongly predicted. For example, one may predict that they will feel happy if they were to find out they are having a baby, but then feel excited, anxious, and shocked. Finally, the intensity and duration of affective reactions may also be more or less accurately predicted. Someone who gets into a car accident may feel overwhelmed with their current emotions and predict they will feel guilt or anxiety for months after, only to feel better about the situation within a week or so.

Impact bias describes the tendency for individuals to overestimate the intensity and duration of their affective reactions to future events (Wilson & Gilbert, 2005). For example,

someone may overestimate how pleased they think they will be if they were to purchase an expensive, high-end car. Someone may also overestimate how upset and disappointed they would be if they were to fail an exam. The impact bias also influences the prediction of the duration of affective reactions to future events, such that someone may predict they will feel lonely for months after a breakup with an intimate partner, but instead feel content and relieved soon after. Wilson and Gilbert (2005) describe one cause of impact bias– focalism, or the tendency to overestimate how much we will think about the future event and to underestimate how much other events will influence emotions and thoughts. One example of focalism at play would be after the death of a beloved pet, as an individual may be consumed with the thoughts of their loss and neglect thoughts of future, happier events that may counter some of the individual's sadness.

Another cause of the impact bias is that individuals tend to underestimate how well prepared they are for future, unexpected events (Wilson & Gilbert, 2005). Four processes are at play when this occurs: attention, reaction, explanation, and adaptation (Wilson & Gilbert, 2005). People are more likely to attend to events that are self-relevant yet poorly understood, and are thus likely to react emotionally to those events (Wilson & Gilbert, 2005). As people attempt to make sense of these events, they adapt emotionally to them (Wilson & Gilbert, 2005). An example of this process occurring is as follows: a teacher receives an unexpected promotion, and feels incredibly happy and successful. As the teacher thinks about the reasoning for the promotion, such as an increased school budget, the event begins to be seen as more expected and understood, and eventually the higher intensity feelings of happiness and success diminish as the event becomes normalized. While the impact bias may influence predicted and initial emotional reactions to an event, humans have the tendency to make sense of what occurred and the intensity of predicted/initial emotional reactions diminishes. Individuals also underestimate their

ability to cope with their feelings in the face of unchangeable events, which has been described as a lack of awareness of one's 'psychological immune system' (Wilson & Gilbert, 2005).

Affective Forecasting and Real-World Decisions

The study of affective forecasting arose from behavioral economics in the 18th century with Daniel Bernoulli (for a discussion, see Pilin, 2020). He suggested a new theory concerning the measurement of risk, and highlighted the importance of considering subjective estimates of monetary value (i.e., utility) for understanding the ways individuals reason during monetary decision making (Pilin, 2020). Bernoulli's work is directly implicated in the emergence of Utility Theory (Friedman & Savage, 1948) and later Prospect Theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1999), which formalized the role of subjective valuation in decision making under uncertainty. These theories outlined the ways in which individuals fail to make 'optimal' economic decisions in many contexts because they use, not the objective value of various potential outcomes, but their predictions for how much pleasure/displeasure potential future gains or losses will cause them. For example, in a recent study, Charpentier et al. (2016) examined how predicted emotions influence choice, and their findings suggested that assessing one's feelings regarding potential outcomes predicted choice more so than value-based models. Moreover, participants in their study were found to place greater weight on feelings associated with losses, or negative outcomes, as opposed to feelings associated with wins, or positive outcomes, while there was no difference in the objective magnitude of the values of losses or gains (Charpentier et al., 2016). These findings suggest that while humans may like to believe they make rational decisions based on objective facts, our predicted emotions may play a larger role in our decision making than expected.

Whilst the origins of affective forecasting came from behavioral economics, affective forecasting has been found to be relevant across a wide variety of real-world decisions and behaviors, including relationship satisfaction (Tomlinson et al., 2010), travel intentions and purchasing decisions (Skard et al., 2021), consumer behavior (MacInnis et al., 2006), and health decisions (Ellis et al., 2018). For example, Ellis et al. (2018) describe how patients often make medical screening and treatment decisions based on their predictions about how their decision will affect their future happiness and well-being, or how much they will regret their choice. Furthermore, both risky and protective health decisions are impacted by affective forecasting, including exercise, weight-loss, smoking, and alcohol use (for a discussion, see Ellis et al., 2018). Other research has suggested that anticipated regret in particular is a better predictor of engagement in health behaviors than attitudes, social norms, and self-efficacy (Sandberg & Conner, 2008).

Further research in health psychology has attempted to understand the importance of affective forecasting in specific instances of health decision making. One such instance is that of medication decision making for women at risk of breast cancer. Hoerger et al. (2016) investigated at-risk women's affective forecasts to examine how affective forecasting influenced their decision to take a chemoprevention medication which can reduce the risk of developing cancer. Hoerger et al. (2016) found that less than 10% of women reported believing that the medication would reduce health-related stress, and most thought that taking the medication would increase stress. This may explain why a vast majority of women at risk for breast cancer opt out of taking chemopreventive medication, even when the 5-year risk of developing breast cancer can be reduced by about 50% by taking the medication (Hoerger et al., 2016). Thus,

understanding the role of predicted emotions in patients' health decisions can have important implications for their physical health.

Individual Differences in Affective Forecasting

Individual differences exist in terms of how accurately someone is able to predict their future emotions. Emotional intelligence is one aspect that was found to impact one's ability to make accurate affective forecasts (Dunn et al., 2007). Emotional intelligence involves several processes including the perception, understanding, and management of an individual's and other's affective states (Mayer & Salovey, 1997). Dunn et al. (2007) compared participants' scores on the Mayer-Salovey-Caruso Emotional Intelligence Test (intended to measure four emotion-related abilities) with forecast accuracy scores following two affective forecasting (prediction) tasks. One task asked participants to predict their emotions following the election of presidential candidates in an upcoming election, while the other asked them to predict their emotions upon receiving their grade for a term paper they had just handed in. Dunn et al. (2007) compared their predicted emotions with their actual emotions after the events had occurred, and found that individuals who scored higher on the emotional intelligence scale exhibited greater affective forecasting accuracy. Specifically, the emotional management subcomponent of emotional intelligence was found to be the strongest predictor of increased forecasting ability (Dunn et al., 2007). People with a greater ability to manage emotions may recognize how they will regulate their emotions in the face of affective events, allowing them to better assess how they will actually feel after an event. This may occur as individuals with high emotional management have an understanding that "well-being depends less on the objective events one encounters than on how those events are construed, dealt with, and shared with others" (Dunn et al., 2007, p. 91).

Individual differences in personality may also influence affective forecasting and decision making. Hoerger et al. (2016) examined whether individuals higher in neuroticism and extraversion would differ from those lower on these traits when anticipating future emotional reactions. More introverted and neurotic individuals accurately predicted more unpleasant emotional reactions to a variety of events, while more extroverted and less neurotic individuals correctly predicted more pleasant emotional reactions (Hoerger et al., 2016). Hoeger et al. (2016) suggested that 30% of the concordance between predicted and actual emotions was explained by personality.

Individual Differences Related to Clinical Symptomatology

Much research has also examined biases in affective forecasting among individuals with mood disorders like anxiety and depression. Depression is characterized by a series of symptoms that affect mood and information-processing. Mineka & Sutton (1992) described depression as a "backward-looking" emotion. Specifically, depression involves a focus on past situations that have entailed failure, loss, or personal deficit (Wenze et al., 2012). Evidence has also been found to suggest that depression involves a memory bias in which individuals are more likely to recall negative information, especially if it is autobiographical in nature (Mineka & Sutton, 1992). Biases in judgment have also been observed in depressed individuals, specifically regarding their perceptions of control. Depressed individuals are more likely to perceive lower levels of control than non-depressed individuals (Mineka & Sutton, 1992).

Depression also influences how individuals imagine the future. MacLeod & Byrne (1996) found that depressed and dysphoric individuals tend to generate more negative events and fewer positive events when asked to imagine the future as opposed to non-depressed individuals. Depressed individuals are also more likely to rate future negative events as likely to occur and

positive events as unlikely to occur, and these predictions are often automatic (Marroquín & Nolen-Hoeksema, 2015). It is suggested that this lack of anticipated positive experiences in depressed individuals is a result of difficulty accessing mental representations of positive experiences (MacLeod & Salaminiou, 2001).

These symptoms and biases associated with depression likely influence the accuracy of affective forecasting. Indeed, individuals who score higher in depressive symptom severity are not only more likely to predict encountering a higher frequency of negative events, but they also predict they will feel more negatively about future events (Marroquín & Nolen-Hoeksema, 2015). Hoerger et al. (2012) conducted a study examining the influence of depressive symptoms on future expectations by comparing self-rated symptoms of depression, anxiety, and hypomania with affective forecasting accuracy. Hoerger et al. (2012) asked participants to provide predicted and actual emotions to Valentine's Day, an emotionally evocative relational event. Evidence for a dysphoric forecasting bias, or the tendency for individuals in dysphoria states to overpredict negative emotional reactions to future events, was found in individuals who expressed depressive symptoms . Dysphoria, a symptom of depression encompassing a state of feeling discomfort, distress, and generalized unhappiness was associated with both negative predicted and actual reactions to the event of Valentine's Day, and also accounted for 11% more variance in predicted reactions than actual reactions . Anxiety and hypomanic symptoms were also found to be associated with more inaccurate and negatively biased affective forecasting, however upon conducting simultaneous regression analyses only dysphoria was uniquely associated with inaccurate and biased affective forecasting (Hoerger et al., 2012). While prior studies have found that individuals tend to overpredict positive emotions to a pleasant event and negative emotions to an unpleasant event (for a discussion see Wilson & Gilbert, 2005), Hoerger et al. (2012) found

that individuals experiencing dysphoria predicted negative emotions to both pleasant and unpleasant events more so than individuals who did not exhibit these depressive symptoms. These findings are consistent with cognitive theory (Beck, 1976) which suggests that individuals in a dysphoric state are likely to experience a negative bias when interpreting events.

Few studies have examined the unique effects of anxiety on affective forecasting, though depressive and anxiety disorders are often comorbid. Mathersul and Ruscio (2019) conducted a study examining the effects of emotional disorders on affective forecasting and affective memory in participants with generalized anxiety disorder (GAD), major depressive disorder (MDD), comorbid GAD and MDD, or no emotional disorders. All three non-control groups experienced and remembered more negative affect than individuals who had no emotional disorders (Mathersul & Ruscio, 2019). Individuals with no emotional disorders were found to overestimate positive affect (Mathersul & Ruscio, 2019). Important differences between individuals with GAD and MDD were also observed. GAD and MDD were both found to be independently associated with higher levels of predicted negative affect, but only MDD was associated with higher levels of experienced low positive affect (Mathersul & Ruscio, 2019). On the other hand, only GAD was associated with a memory bias for both positive and negative affect, meaning participants better recalled stimuli associated with positive and negative affect (Mathersul & Ruscio, 2019).

The Present Study

In the present study, we attempt to examine associations between depression and anxiety symptom severity and affective forecasting for relatively mundane or everyday affective events among a population of non-clinical undergraduate students. Our study builds on previous research in several ways. First, our study will not compare affective forecasting ability across

individuals with and without a clinical mood disorder diagnosis, but rather will examine associations between affective forecasting and severity of depression and anxiety symptoms in the general population. By examining how affective forecasting is associated with mood disorder symptoms that are normally distributed in the general population, including amongst sub-clinical populations, our study will enable us to identify more general or generalizable mechanisms underlying biased affective forecasting. In addition, many previous studies have specifically examined individuals' affective predictions for and reactions to single large-scale life events (e.g., a presidential election, a major exam grade). Such studies fail to examine affective forecasting processes in more typical everyday situations, which may involve more mild affective reactions or less evocative or salient affective events. Here, participants will rate predicted and actual reactions to a series of evocative images that vary in terms of their normative valence (i.e., pleasantness/unpleasantness) and arousal (i.e., activation/deactivation). In doing so, we will be able to assess affective forecasting for these arguably more common types of emotionally evocative events in daily life.

Predicted Results

We hypothesize that individuals with higher mood disorder symptom severity (anxiety or depression) will predict and experience greater negative affect in response to negative images and lesser positive affect in response to positive images. We also hypothesize that higher mood disorder severity will be associated with greater negative affective forecasting biases, such that individuals with higher depressive or anxiety symptoms will tend to over-predict the negative affect they will experience for negative images and under-predict the positive affect they will experience for positive images. Finally, we will explore whether we observe differences in these associations specific to depressive or anxiety-related symptom severity. In particular, past

research suggests that anxiety symptom severity may be less strongly associated with predicted and experienced positive affect than depression symptom severity.

Methods

Participants

Eligible participants were at least 18 years of age, fluent in English, and had access to their own personal smartphone. We recruited 186 undergraduate students from the University of New Hampshire aged 18-31 (M_{age}= 19.24, SD_{age}= 1.794). A majority of participants were white (94.1%) and female (74.2%). Participants were recruited through an online platform internal to the University and received up to 2 credit hours toward completion of an undergraduate psychology course of their choosing for their participation. Participants received 1 credit hour for completing the surveys at the beginning and end of the study (Parts 1 and 3 as described below), and 1 credit hour for completing at least 42 out of 56 experience sampling surveys over a one week period (Part 2 as described below).

Materials

Photo Stimuli. Twenty emotionally evocative pictures were taken from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008) to be shown in the Picture Viewing and Rating Task during Part 3 of the study. Pictures are approximately 415 pixels by 396 pixels. Photos were selected on the basis of normed ratings of their valence (pleasantness/unpleasantness) and arousal (activation/deactivation): five pictures normed as positively valenced and low in arousal (Valence *M*= 7.70; Arousal *M*=4.03); five pictures normed as positively valenced and high in arousal (Valence *M*=7.55 Arousal *M*=6.72); five pictures normed as negatively valenced and low in arousal (Valence *M*=3.66; Arousal *M*=3.66); and five pictures normed as negatively valenced and high in arousal (Valence *M*=2.92 Arousal *M*=6.12).

Examples of pictures include a snake hissing, people skydiving, a dirty mop bucket, and a little girl smiling. All photo stimuli are provided in Appendix B.

Photo Descriptions. For each of the photos shown in the Picture Viewing and Rating Task, we developed a brief description of the photo to provide to students in the Affective Forecasting Task during Part 1 of the study. Descriptions were 8 to 18 words long (M=12.4, SD=3.23). Example descriptions include: "An Olympic gymnast raising her hands above her head in triumph"; "A massive dark tornado with a city in front of its path". All descriptions are provided in Appendix A.

Tasks and Measures

Affective Forecasting Task. Participants were told that, at the end of the study protocol in approximately 1 week, they would be asked to view 20 emotionally evocative pictures taken from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1995). In this task, they were presented with a brief description of each picture they would view in Part 3 of the study (e.g., "A little girl hugging and kissing a puppy's cheek"; "A man holding a gun up to the side of his head with his hand on the trigger"), and they were asked to predict how they thought they would feel when actually viewing the photo in the future. Participants were shown one photo description at a time, and after each description, they were asked to predict how much they would feel each of 16 specific emotion terms (i.e., happy, excited, relaxed, focused, content, tired, neutral, sad, nervous, frustrated, stressed, annoyed, proud, grateful, angry, afraid) on 7-point scales, ranging from 1= "Not at all" to 7 "Very Much." Participants were then asked to predict their felt valence (i.e., pleasantness/unpleasantness) on a 7-point scale ranging from 1= "unpleasant" to 7= "pleasant," and their felt arousal (i.e., activation/deactivation) on a 7-point scale ranging from 1="deactivated" to 7="activated".

Picture Viewing and Rating Task. In this task, completed during Part 3 of the study, participants viewed the 20 emotionally evocative pictures taken from the IAPS (Lang et al., 1995) described above, and provided ratings of their feelings while viewing each photo. Participants viewed the 20 photos one at a time in a random order, and after each photo they provided the same ratings as they did during the Affective Forecasting Task completed during Part 1 of the study. Specifically, they rated how much they were experiencing each of 16 different emotion terms, their felt valence, and their felt arousal, all on 7-point scales.

Questionnaires

Demographics. Demographic information was obtained from participants with a series of 5 questions. Questions asked participants for their age, if English was their first language, their gender identity, their race and ethnicity, and how much education they have received.

Anxiety Symptom Severity. Anxiety symptom severity was assessed with the General Anxiety Disorder 7 (GAD-7; Spitzer et al., 2006), which includes 7 questions that measure the severity of anxiety symptoms. This survey is frequently used in the clinical diagnosis of generalized anxiety disorder, although it is not used for this purpose in the present study. The questionnaire asks participants to rate how often they have been bothered by 7 symptoms of general anxiety disorder over the past 2 weeks (e.g., "feeling nervous, anxious or on edge"; worrying too much about different things"), with responses rated on a 4-point scale from "not at all" (0) to "nearly every day" (3). Anxiety symptom severity was scored as the sum of responses to the 7 items, with higher values indicating greater symptom severity and lower values indicating lesser symptom severity.

Depression Symptom Severity. Depression symptom severity was assessed with the Personal Health Questionnaire (PHQ-8; Spitzer et al., 1999), which includes 8 statements that

measure the severity of depressive symptoms. This survey is frequently used in the clinical diagnosis of depressive disorders, although it is not used for this purpose in the present study. Participants are asked to rate how often they have been bothered by 8 symptoms of depressive disorder in the past two weeks. Examples of statements include "little interest or pleasure in doing things," "feeling down, depressed, or hopeless," and "trouble concentrating on things, such as reading the newspaper or watching television." Participants are asked to rate these statements on a scale of 0-3, with 0 being "not at all," 1 being "several days," 2 being "more than half the days," and 3 being "nearly every day." The score of this questionnaire is the sum of all 8 items, with higher values indicating more severe depressive symptoms and a lower score indicating less severe depressive symptoms.

Participants also completed additional questionnaires not pertinent to this investigation. Descriptions of all questionnaires completed are provided in the Supplemental Materials.

Procedure

The present study was conducted in three parts. In the first part of the study, participants completed an online session in which they first reviewed an informed consent document and consented to participate in the study. Then they completed part one of the study, which included all of the questionnaires as well as the Affective Forecasting Task described above.

The second part of the study was not relevant to the present investigation, but included 7-days of an experience sampling protocol in which participants reported on their emotions at random times throughout their day using an app on their smartphone. A full description of Part 2 of the study is provided in the Supplemental Materials.

After completing Part 2 of the study, approximately 1 week after they completed Part 1 of the study, participants received a link to complete the final part of the study, which entailed participants completing the Picture Viewing and Rating Task described above.

Results

Valence

All correlations between valence ratings and anxiety and depression symptom severity are reported in Table 1.

Predicted Valence. There were significant weak negative correlations between predicted valence for negative images and both depression symptoms, $r(179)= -.148$, $p = .047$, and anxiety symptoms, $r(179)= -.189$, $p = .011$. Individuals with greater depression or anxiety symptom severity predicted they would feel more negative (or less positive) when viewing images of negative content in the future. There were no significant associations between mood disorder symptom severity and predicted valence for positive images (see Table 1).

Experienced Valence. Contrary to predictions, there were no significant associations found between depression and anxiety symptoms and experienced valence for negative images (see Table 1). However, there were weak negative correlations between experienced valence for positive images and depression symptoms, [($r(134)= -.158$, $p = .066$], and anxiety symptoms, [($r(134)= -.184$, $p =.032$], though this association only reached significance for anxiety symptom severity. Individuals with greater depression and anxiety symptom severity experienced less positive (more negative) affect when viewing images of positive content (see Table 1).

Valence Prediction Error. Prediction error was calculated as a difference score between experienced and predicted valence. Contrary to predictions, there were no significant associations found between depression and anxiety symptoms and the difference in predicted and

experienced valence (see Table 1). However, while the correlations did not reach significance, associations between mood disorder symptom severity and the difference in predicted and experienced valence for negative images were in the predicted direction for both anxiety and depression symptom severity: individuals with greater symptoms of depression or anxiety tended to over-predict how negatively they would feel in response to future negative images. See Table 1.

Table 1. Associations between Mood Disorder Symptom Severity and Affective Valence Ratings

		Depressive Symptoms	**Anxiety Symptoms**
Predicted	**Negative Description**	-.148*	-.189*
	Positive Description	-.053	-.075
Experienced	**Negative Image**	-.011	-.061
	Positive Image	-.158	-.184*
Prediction Error	**Negative Stimuli**	-.128	-.116
	Positive Stimuli	.106	.102

Note. Cells report Pearson's *r* values. *$p<.05$.

Arousal

All correlations between arousal ratings and anxiety and depression symptom severity are reported in Table 2.

Predicted and Experienced Arousal. There were no significant associations between mood disorder symptom severity and either predicted arousal or experienced arousal for negative or positive images (see Table 2).

Arousal Prediction Error. Prediction error was calculated as a difference score between predicted and experienced arousal. There was a significant weak positive correlation between anxiety symptom severity and the difference in predicted and experienced arousal for negative images, $r(134)= -.184$, $p = .032$. The greater an individual's anxiety symptoms, the more they overestimated how activated they would feel when viewing negative images. This association did not hold for depression symptom severity (see Table 2). There were no other significant associations of arousal prediction error with mood disorder symptom severity (see Table 2).

Table 2. Associations between Mood Disorder Symptom Severity and Affective Arousal Ratings

		Depressive Symptoms	Anxiety Symptoms
Predicted	**Negative Description**	.024	.078
	Positive Description	.030	.050
Experienced	**Negative Image**	.004	-.118
	Positive Image	-.002	.018
Prediction Error	**Negative Stimuli**	.049	.183*
	Positive Stimuli	-.016	-.031

Note. Cells report Pearson's *r* values. *$p<.05$.

Discussion

Overall, individuals with greater symptoms of depression and anxiety demonstrated differential affective forecasting compared to those with lesser symptoms. We find evidence that individuals with greater self-reported depression and/or anxiety symptom severity tended to predict (but not experience) more negative affect in response to negative stimuli. Evidence was also found that individuals with greater self-reported symptoms of depression and/or anxiety

experience (but not predict) less positive affect in response to positive stimuli. Finally, we find evidence that individuals with greater anxiety symptoms tend to overestimate the extent to which they will feel activated in response to negative stimuli.

We hypothesized that greater symptom severity of depression and anxiety would be associated with increased predictions and experiences of negative affect in response to negative stimuli and decreased predictions and experiences of positive affect in response to positive stimuli. Our hypothesis was partially supported. Individuals with greater symptoms of depression and anxiety predicted more negative affect in response to negative stimuli, but contrary to predictions they did not actually *experience* more negative affect. Individuals with greater symptoms of depression and anxiety also experienced less positive affect in response to positive stimuli, but contrary to predictions they did not *predict* less positive affect. Moreover, contrary to predictions, we found limited associations between mood disorder symptom severity and affective forecasting accuracy; the only significant association was that individuals with greater anxiety symptoms were found to overestimate the extent to which they would feel activated in response to negative stimuli.

We found that depression and/or anxiety is associated with increased predictions for negative affect. This is consistent with prior literature. Depression has been described as a "backward-looking" emotion, in which there is a focus on negative situations that have occurred in the past (Mineka & Sutton, 1992). MacLeod & Bryne (1996) also suggested that depressed individuals tend to generate more negative events and fewer positive events when asked to imagine the future. Evidence also suggests that depression involves a memory bias in which individuals are more likely to recall negative information (Mineka & Sutton, 1992). Thus, when individuals with depression are asked to predict affective experiences, this tendency to recall

negative experiences and information may influence their affective forecasts such that individuals with depression predict they will experience more negative affect.

Evidence was also found that individuals with greater self-reported depression and/or anxiety experience less positive affect in response to positive stimuli. This result is consistent with previous literature regarding depression and affect. Varma (2017) found that a clinical population with depression reported less positive affect than a control group, consistent with our findings. Few studies have directly explored the relationship between anxiety and predictions of positive affect, however given that depression and anxiety are often comorbid with each other, we believed they may have similar associations with predicted and experienced positive affect. It is important to note that contrary to our hypothesis, anxiety and/or depression were only found to be associated with experiences of less positive affect and not with *predictions* of less positive affect. Future studies should continue to examine associations between depression and/or anxiety with both the experience and prediction of positive affect.

Finally, we did not find evidence of a significant association between depression and/or anxiety and prediction error for valence. This is not consistent with prior work. For example, Hoerger et al. (2012) found evidence for a dysphoric forecasting bias, or the tendency for individuals in dysphoric states to overpredict negative emotional reactions to future events, in individuals who expressed depressive symptoms. Dysphoria was associated with both negative predicted and actual reactions to the event of Valentine's Day (Hoerger et al., 2012). In our study, depressive symptoms were only associated with greater predictions of negative affect for negative images, and there was no significant correlation between depressive symptoms and experienced affect for negative images, as well as no significant association with prediction error for negative images (though the relationship was trending in the predicted direction). However,

in our study, we did find an association between anxiety symptom severity and arousal prediction error, though this association did not hold for depression symptom severity. Individuals with greater anxiety symptoms tended to overestimate the extent of arousal they would experience when viewing negative images. Future work should further examine associations between mood disorder symptoms and predictions and experiences of the arousal dimension of affective experience, as arousal has received less empirical attention than valence to date.

Limitations and Future Directions

The current study has several limitations. Our participant pool consisted of undergraduate college students who were majority female and white. This study would benefit from utilizing a larger and more diverse group of participants, as it is unknown if these results would generalize to the broader US population. Moreover, this study did not specifically recruit individuals with clinical level symptom severity, so it is unclear how results concerning sub-clinical symptom severity may extend to individuals with clinical diagnoses of depression or anxiety. It is predicted that utilizing a clinical group in comparison to a non-clinical group would result in more pronounced differences in the prediction and experience of affect.

In addition, most prior research on affective forecasting has asked participants to make predictions about relatively singular and/or highly evocative future events (e.g., outcome of a presidential election). Here, participants rated their predicted and experienced affect in response to relatively mundane affective stimuli, namely a series of photos. We specifically selected these stimuli to assess whether associations between mood disorder symptom severity and affective forecasting extended to more typical or everyday kinds of affective experiences. It is possible that utilizing more emotionally evocative stimuli results in more pronounced associations

between mood disorder symptom severity and predicted and experienced affect, similar to prior work which has used more evocative events (e.g., Hoeger et al., 2017).

Finally, our procedure included a week-long intermission between the time that participants read the description of pictures and when participants actually saw the pictures. It is possible that reducing or extending this duration would have an impact on the results of this study.

Conclusion

Affective forecasting drives decision making and behavior across many domains of life. We choose our career paths as we predict they will make us feel happy and satisfied. We end relationships with others if we believe that we will feel depressed or empty. Emotions guide our behavior and influence our decision making, whether it be conscious or unconscious. Thus, the ability to accurately predict our future affective experiences is an important skill as it has a significant impact on the decisions we make. Here we show that depression and anxiety symptoms may be linked to biases in affective forecasting among a non-clinical sample of participants. These findings lay the foundation for future work to further examine the relationship between depression and/or anxiety and affective forecasting biases.

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Appendix A: Photo Descriptions

1. A baby seal with a fluffy white coat in the snow
2. A young antelope drinking water from a stream
3. A young girl with a flower in her hair smiling
4. A toddler hugging and kissing a puppy's cheek
5. A middle-aged couple riding their bikes together smiling.
6. A woman sitting by herself at a table for two people, staring into the distance and frowning
7. A close-up photo of a person getting fingerprinted
8. An older man holding a pot full of food in a kitchen
9. A person locked in a jail cell holding a cigarette through the bars
10. A mop and a mop bucket filled with brown dirty water
11. A group of people doing synchronized skydiving, holding hands in a circle while free falling above the water
12. A skier at the top of a steep long-distance ski jump
13. An Olympic gymnast raising her hands above her head in triumph
14. People on a moving roller coaster raising their hands above their head while screaming and smiling
15. A large pile of money with various bills, including fifty-, twenty-, five- and one-dollar bills.
16. A snake hanging off a branch, posed to strike with its jaws open
17. A man driving a car while holding an open bottle of beer
18. A massive dark tornado with a city in front of its path.
19. A man holding a gun up to the side of his head with his finger on the trigger
20. A ship sinking into the ocean with more than half of it submerged under the water

Appendix B: Photo Stimuli

Low Arousal, Positive Affect:

ID1440; valence: 8.19, arousal: 4.61

ID1620; valence: 7.37, arousal: 3.54

ID2035; valence: 7.52, arousal: 3.69

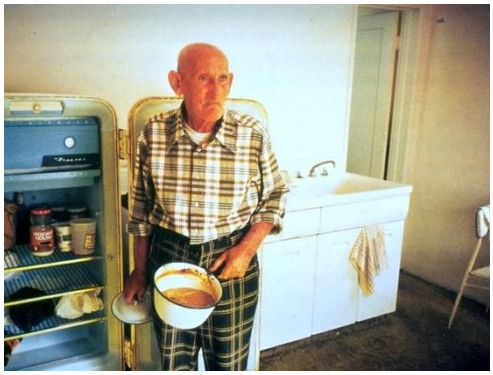
ID2332; valence: 7.64, arousal: 4.30

ID2530; valence: 7.80, arousal: 3.99

Low Arousal, Negative Affect:

ID2039; valence: 3.65, arousal: 3.46

ID2206; valence: 4.06, arousal: 3.71



ID2490; valence: 3.32, arousal: 3.95

ID2722; valence: 3.47, arousal: 3.52

ID7078; valence: 3.79, arousal: 3.69

High Arousal, Positive Affect:

ID5621; valence: 7.57, arousal: 6.99

ID8030; valence: 7.33, arousal: 7.35

ID8470; valence: 7.74, arousal: 6.14

ID8490; valence: 7.20, arousal: 6.68

ID8501; valence: 7.91, arousal: 6.44

High Arousal, Negative Affect:

ID1113; valence: 3.81, arousal: 6.06

ID2751; valence: 2.67, arousal: 5.18

ID5971; valence: 3.49, arousal: 6.65

ID6570; valence: 2.19, arousal: 6.24

ID9600; valence: 2.48, arousal: 6.49

Supplemental Materials

Supplemental Questionnaires

Somatic Symptom Severity. Transdiagnostic somatic symptom severity was assessed with the Patient Health Questionnaire-15 (PHQ-15; Kroenke et al., 2002), which includes 15 items intended to assess somatic symptoms over the past 4 weeks. Participants were asked to rate the severity of 15 symptoms (eg. stomach pain; headaches; shortness of breath) as 0 ("not bothered at all"), 1 ("bothered a little"), or 2 ("bothered a lot). Higher scores indicate greater somatic symptom severity.

Situational Test of Emotion Management. Emotional management was assessed with the Brief Situational Test of Emotion Management (STEM- Brief; Weissman et al., 2014), which includes 18 items intended to assess emotion management, a key component of emotional intelligence. Participants were asked to select the most effective response to 18 different emotional situations (eg. "Michelle's friend Dara is moving overseas to live with her partner. They have been good friends for many years and Dara is unlikely to come back. What action would be the most effective for Michelle?"). The STEM ordinarily uses partial scoring, with scoring weights determined by the proportion of experts who select each option as the best answer. In the present study, dichotomous scoring is used in order to conduct 3-PL IRT analyses, with the best option scored as "1" and the other options as "0". High scores are correlated with better emotional management, while lower scores are correlated with worse emotional management.

Situational Test of Emotion Understanding. Emotional understanding was assessed with the Brief Situational Test of Emotion Understanding (STEU- Brief; Weissman et al., 2014), which includes 19 items intended to assess emotion understanding, a key component of emotional intelligence. Participants are asked to choose which of five emotions is most likely to

result from an emotional situation (eg. “Xavier completes a difficult task on time and under budget. Xavier is most likely to feel?”). Emotions presented for each question vary, but include emotions such as “surprise,” “pride,” “relief,” “hope,” and “joy.” Scores are based on the sum of accurate answers for each question, with a correct answer resulting in a +1 score and an incorrect answer resulting in a +/- 0 score. Higher scores are indicative of a higher emotional understanding, while lower scores are indicative of a lower emotional understanding.

Body Awareness Questionnaire. Body awareness was assessed with the Body Awareness Questionnaire (BAQ; Shields et al., 1989), which includes 18 statements that measure sensitivity to normal, non-emotive body processes. Examples include “I notice differences in the way my body reacts to various foods" and “I can predict how much sleep I will need at night in order to wake up refreshed.” Participants are asked to select a number from 1-7 for each statement, with 1 being “not at all true of me” and 7 being “very true of me.” Body awareness was scored as the sum of all 18 items, with higher values indicating greater body awareness and lower values indicating less body awareness.

Supplemental Methods: Part 2

At the end of Part 1 of the study, participants were given instructions for how to download the app ‘RealLife Exp’ to their smartphone and sign-up for the second part of the study.

The second part of the study began the morning after participants completed Part 1 of the study. During part 2 of the study, participants received prompts at quasi-random times throughout the day on their smartphone via the ‘RealLife Exp’ app for 7 consecutive days. Participants received 8 prompts each day between the hours of 9am and 9pm (their local time). They were alerted to a prompt via a notification on their smartphone. Prompts were received

similar to other notifications participants already receive on their phone (e.g., text notifications, Facebook status notifications, etc.). Notifications say the name of the app and the phrase "Please check in". Clicking on the notification took participants directly to the 'RealLife Exp' app and the experience sampling survey for our study, which was a short (1-2min) survey.

At each experience sampling prompt, participants were asked to rate how much they were currently feeling each of 16 emotion terms (i.e., happy, excited, relaxed, focused, content, tired, neutral, sad, nervous, frustrated, stressed, annoyed, proud, grateful, angry, afraid). For each term, participants self-reported how much they were currently experiencing each emotion on a 5-point scale, ranging from 0= "Not at all" to 4 "Very Much." Participants were also asked to rate their current awareness of sensations from their body on a 5-point scale ranging from 0= "Not at all aware" to 4="Very much aware."

Participants were asked to respond within 20 minutes to each prompt. For each prompt, a notification was sent every 5 minutes until the participant responded or 20 minutes had been reached, at which point participants were no longer able to respond to that particular prompt.

Calculation of Emotional Granularity. Ratings of emotions across Part 2 of the study were used to calculate a measure of emotional granularity for each participant. Specifically, intra-class correlation coefficients (ICCs) were calculated from each participant's experience sampling data as a measure of emotional granularity for each subject. ICCs measure consistency in responses to multiple emotion terms (e.g., ratings of happy, excited, relaxed) across multiple experience sampling moments; high ICCs (high consistency) indicate the person fails to discriminate between similar emotion terms when reporting their feelings. Thus, higher ICCs are indicative of lower levels of emotional granularity.