

**Accuracy and Judgment Bias of Low Intensity Emotional Expression Among Individuals  
with Major Depression**

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## Abstract

It has been suggested that depressed individuals have difficulties decoding emotional facial expressions in others contributing to a negative cycle of interpersonal difficulties. Some studies have demonstrated global deficits in the processing of emotional facial expressions compared to non-depressed participants, whereas others have noted differences for specific emotions. Methodological issues, including the operationalization of accuracy and bias and the examination of a limited range of emotion and intensity, can partially explain the mixed findings. The aim of the current study was to examine differences in accuracy in the detection of emotional facial expressions in participants with MDD (currently depressed, partially remitted, and those with a lifetime history of MDD) and non-depressed comparisons. Methodological limitations of previous studies were addressed by: (a) using the unbiased hit rate (Wagner, 1993), which is a more precise measure of accuracy for specific emotion, (b) using a more precise measure of judgment bias, taking into account the overuse or underuse of specific emotion categories, (c) including the six basic emotions, and (d) incorporating expressions ranging from 20%-100% intensity. Of secondary interest was to determine whether transient mood state is predictive of accuracy scores regardless of diagnostic status. Thirty-seven depressed and 34 non-depressed participants recruited from the ROHCG Mood Disorders program and the University of Ottawa took part in this study. Clinical status was assessed using the Structured Clinical Interview for the DSM-IV (SCID-IV) and the Beck Depression Inventory-II (BDI-II). Participants also completed the Profile of Mood States-Bipolar (POMS-BI) form to assess mood state at the time of testing. The facial recognition task consisted of happiness, sadness, anger, fear, disgust, and surprise at 20%-100% intensity, presented for 500 ms. Participants pressed a computer key to identify the emotion that was presented. Results indicated that both groups of

depressed participants were more accurate than non-depressed participants in detecting anger at 20% intensity. Depressed participants also showed a bias away from surprise. Group differences at high intensity were non-significant, however, participants with current depression and partial remission showed a bias towards anger at 50% intensity. Regression analyses were performed using the POMS-Agreeable Hostile (POMS-AH) and POMS-Elated Depressed (POMS-ED) scales to determine whether mood state was predictive of accuracy in the detection of anger and sadness. Regression models predicting accuracy were non-significant. Results of this study are considered in the context of cognitive and cognitive-interpersonal theories of MDD.

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## **Accuracy and Judgment Bias of Low Intensity Emotional Expression among Individuals with Major Depression**

The ability to display emotional reactivity and to accurately interpret social cues in the form of emotional facial expressions is a key factor in maintaining positive and adaptive interpersonal relationships. However, it has been suggested that individuals with major depression (MDD) have difficulty carrying out such tasks which may result in isolation, a bias towards seeking out negative feedback about the self, and decreased social support (Bos, Geerst, & Bouhuys, 2002; Bouhuys, Geerts, & Gordijn, 1999; Swann, Wenzlaff, Krull, & Pelham, 1992a; Swann, Wenzlaff, & Tafarodi, 1992b). Therefore, examining how the presence of negative mood and biases towards the processing of negative information affects the decoding of emotional facial expressions can provide important insight into this disorder and its cognitive correlates.

In order to accurately decode emotional facial expressions, it is important that the decoder attend to a number of facial features at a given time (Ekman, 1982) while using cognitive capacity to appraise the specific emotion accurately. Errors in the appraisal process could lead to faulty interpretation of emotion and subsequent negative interpersonal consequences (Forgas, 1991). Research to date has shown that there are differences between depressed and non-depressed individuals with respect to the decoding of facial expressions. These differences have been explained and conceptualized within cognitive and interpersonal models of depression.

Mood congruency models have relied on the notion that mood affects processing. The presence of negative mood is related to increased attendance to and the processing of negative information, while the presence of positive mood has been shown to lead to biases towards

positive information (Fiedler, Nickel, Muehlfriedel, & Unkelbach, 2001; Rottenberg, Gross, & Gotlib, 2005; Yovel & Mineka, 2005). Cognitive models posit that the presence of negative schemas determines how and what type of information is processed, leading to biases towards the processing of negatively valenced information (Beck, Rush, Shaw, & Emery, 1979).

On the other hand, interpersonal models posit that negative social environment and interpersonal experiences lead to a cycle of decreased social engagement and reduced social skills, thereby adding to negative affect and depression (Joiner & Coyne, 1999). Furthermore, Gotlib and Hammen (1992) have integrated cognitive and interpersonal models to explain depression as arising from a combination of negative expectations about the social environment and negative views of the self within an interpersonal context (Bistricky, Ingram, & Atchley, 2011).

Current research into the examination of judgment biases and accuracy in the recognition of facial expressions in those with major depression has been contradictory. Whereas some studies have found biases for all negative emotions (Bouhuys et al., 1999; Gur, Erwin, Gur, Zwi, Heimberg, & Kramer, 1992), others have found biases for a range of specific emotions (Bhagwagar, Cowen, Goodwin, & Harmer, 2004). These mixed findings can be attributed to the use of an imprecise method of measuring decoding accuracy and bias and the use of a limited range of emotional expressions and intensities. Accordingly, the aim of the current study is to improve on limitations in methodology by using more precise measures of accuracy and bias, incorporating a wider range of emotional expressions, and by offering a range of emotional intensities.

## Theoretical Review of Literature

Individuals with major depression have been shown to have specific interpersonal profiles that inhibit the development of positive interpersonal relationships (Joiner & Timmons, 2002). Specifically, social skill deficits, lack of social reinforcement (Joiner & Timmons, 2002; Lewinsohn, 1974; Segrin & Flora, 2000), negative life events (Bos, Bouhuys, Geerts, Vanos, & Ormel, 2007), and sociotropy or dependency (Beck, 1983; Zuroff, Mongrain & Santor, 2004) are some variables that are thought to maintain interpersonal difficulties such as rejection, dissatisfaction in relationships, and decreased intimacy.

One important factor in the ability to engage in effective communication is the ability to accurately detect emotions in others. Emotions are conceived as behavioural, motivational, and social in nature and are used to guide action within these three domains. The social function of emotion allows for nonverbal communication and the facilitation of interpersonal interaction (Izard, 1991). Thus, further exploring the nature of emotional processing and interpretation of emotion is central to developing insight into the nature of interpersonal communication. Given the fact that depression is typically characterized by difficulties within interpersonal relationships, understanding how emotion is interpreted and decoded within this context can provide some additional insight into some of the factors that may contribute to strained interpersonal relationships in major depression.

Within the cognitive framework, emotion is seen as the mediator between an individual and how they react to their environment. As such, the role of appraisal and information processing models figure prominently as key processes in the perception and interpretation of emotion. Cognitive processes facilitate the interpretation of physiological stimuli or events as being emotional or affective (Gilligan & Bower, 1984; Leventhal, 1974). It is therefore important

to better understand the influence of cognition on depression and vice versa. Specifically, if cognitive processes are hypothesized to be impaired (or at least different) in depressed individuals compared to non-depressed individuals, then we can expect that these same processes be related to the differences that we detect with respect to the decoding of facial expressions.

Accurate social judgments play an integral role in the ability to effectively interact with the world and understand the cues others provide. Matsumoto and colleagues (Matsumoto, LeRoux, Wilson-Cohn, Raroque, Kookan, Ekman, et al., 2000) explain that emotional expressions are an important component of nonverbal communication and that the face provides the most accurate information regarding emotion. Moreover, individuals who are better at judging emotions in others have a higher degree of interpersonal competence, are more attuned to others, and are more aware of their surroundings. Because the ability to distinguish and accurately interpret emotional facial expressions is a central component in interpersonal interaction, examining this process in more detail plays an important role in further understanding interpersonal difficulties in major depression.

The following section will present a review of the cognitive and interpersonal profiles of individuals with depression. A description of cognitive models, the influence of cognitive processes on the development and maintenance of major depression, and findings concerning the differences between general cognitive abilities among depressed and non-depressed individuals will be presented. Additionally, interpersonal models of major depression and the concomitant interpersonal difficulties will be explored to situate the reader with respect to the impact of major depression on the social environment and how deficits in the decoding of emotional facial expressions may influence this process.

Finally, the combined impact of interpersonal and cognitive theories of major depression will be examined. Specifically, many have argued that the difficulties in interpersonal relationships that arise in the social environment are essentially based on the negative interpretation of the responses of others (i.e., reassurance), the desire to maintain a consistent negative view of the self (i.e., self-verification), and negative expectations for interpersonal relationships (i.e., internal working models and anxious attachment). It is hypothesized that these cognitive variables, as well as the process of assigning meaning to specific events, are what perpetuate the negative interpersonal environment and negative response of others within that environment (Bowlby, 1981; Evraire & Dozois, 2011; Flynn, Kecmanovic, & Alloy, 2010; Ibarra-Rovillard, & Kuiper, 2011; Joiner & Timmons, 2002; Marroquin, 2011; Sacco, 1999; Weinstock & Whisman, 2007; Young, 1999).

*Cognition and Information Processing: Variables Related to Processing Biases of Emotional Stimuli*

Research into the cognitive nature of depression has already demonstrated that depressed individuals process information differently than non-depressed individuals. These differences are typically seen with respect to how depressed individuals interpret and attend to various forms of information and stimuli (Gotlib & Joorman, 2010; Mathews & MacLeod, 2005). Beck and colleagues (1979) described a set of negative schemas that are characterized by a persistent and pervasive negative view of the self, the world, and the future – the cognitive triad. Schemas act as filters for incoming information. Consequently, information is attended to and elaborated on in such a way that is consistent with the depressed individuals negative views.

Studies that have examined information processing biases have focused on designs related to memory, attention, and automatic and effortful processing. Within this context, some

studies have found that depressed individuals have lower cognitive capacity, leading to difficulties in processing information that requires effort. Specifically, effortful tasks require a greater amount of concentration and the ability to ignore irrelevant information. Depressed individuals tend to perform better with automatic tasks, as these tasks do not require the same amount of cognitive load (Dannowski, Kersting, Arolt, Lalee-Mentzel, Donges, & Suslow, 2006; Ellis & Ashbrook, 1988; Gotlib & Joorman, 2010).

Other differences with respect to depressed and non-depressed individuals stem from research with memory. Specifically, it has been suggested that depressed and non-depressed participants are similar in terms of performance when provided with structured tasks, which by nature eliminate opportunities for rumination (Gotlib & Joorman, 2010; Hertel, 2004). Several studies have also examined differences for memory relating to specific emotional facial expressions (see Bediou Saoud, Harmer, & Krolak-Salmon, 2009). For example, depression appears to be related to decreased memory for happy faces and greater recognition of angry facial expressions (Gilboa-Schechtman, Erhard-Weiss, & Jeczemien, 2002). However, the aforementioned differences were detected for individuals with comorbid anxiety/depression while using the BDI –II (Beck, Steer, & Brown, 1996) scores as a measure of depression specificity. Other studies have demonstrated that depressed individuals show better recall for sad as opposed to neutral or happy faces compared to non-depressed individuals (Ridout, Astell, Reid, Glen, & O'Carrol, 2003).

It has also been demonstrated that depressed individuals generally do not show automatic biases, which take place at early stages of information processing (as with anxiety). Rather, attentional biases in depression occur at later stages of processing, specifically once the individual has had time to attach meaning to the stimuli. Consequently, individuals with

depression have been found to demonstrate difficulties with disengaging and redirecting attention, thereby making it more likely that this information continues to be processed and elaborated (Gotlib & Joorman, 2010).

Given the above findings, it has been suggested that overall cognitive function is not necessarily impaired in depressed individuals. Rather, differences emerge only under specific conditions (Gotlib & Joorman, 2010). Therefore, it can be assumed that under the optimal methodological conditions, possible differences noted in the ability to detect emotions can be conceived as a result of actual differences in information processing.

Researchers have already alluded to differences in attention and memory for specific emotional stimuli in individuals currently experiencing anxiety or mood disorders (Fiedler et al., 2001; Rottenberg et al., 2005; Yovel & Mineka, 2005). For example, anxiety has been shown to enhance the processing of threat related cues in the form of better memory for and attentional biases towards such cues. In contrast, those with major depression have been shown to exert heightened attention towards, and in some cases, better memory for negative or sad stimuli (Williams, Watts, MacLeod, & Matthews, 1997). Explanations for these differences are grounded in cognitive theories of depression (Beck et al, 1979).

According to Williams and colleagues (1997), information is processed in a mood-congruent context. Specifically, stimuli that have been processed under negative mood state will be more easily accessed and recalled when under the same negative conditions, affecting memory, attention, and reasoning. This phenomenon even extends to situations requiring social judgments (Fiedler et al., 2001; Forgas & Bower, 1987; Johnson & Tversky, 1983; Mayer & Salovey, 1988; Seligman, Abramson, Semmel, & Von Bayer, 1979). Mood or affective state during processing and encoding can thus play a key role in determining what type of information

is processed, attended to, and used in making judgments about the environment or others. For example individuals with major depression have been shown to selectively direct their attention to images depicting sad emotions, compared to those of happiness and anger. This phenomenon was shown to be specific to major depression (Gotlib, Krasnoperova, Yue, & Joorman, 2004). However, some would argue that depression is also related to heightened attention to social threat cues such as rejection, whereas anxiety typically results in biases for physically threatening cues (Bistricky et al., 2003; Mathews, Ridgway, & Williamson, 1996).

Other researchers have demonstrated that non-depressed participants tend to show greater engagement and attention to positive stimuli compared to depressed individuals. This finding suggests that non-depressed participants demonstrate a protective bias by shifting attention away from negative information and increasing attention to positive information. Depressed individuals do not show this bias (Gotlib, McLachlan & Katz, 1988; McCabe & Gotlib, 1995; McCabe, Gotlib, & Martin, 2000). Moreover, following a sad mood induction, McCabe and colleagues (2000) found that participants who were vulnerable to depression no longer showed this protective bias.

Several researchers have noted that individuals with depression generally show lowered levels of reactivity to others' emotions. This is especially problematic for individuals with major depression as the ability to respond to emotion figures prominently in the ability to engage in adaptive behaviours and communicate with others (Hale, 1998). In testing this theory, Rottenberg, Kasch, Gross, and Gotlib (2002) found that depressed individuals who failed to demonstrate any reaction (positive or negative) to others' emotions also showed decreased adaptive psychosocial functioning. The ability to display emotional reactivity and differentiate between emotions is a key factor in understanding the underpinnings and the vicious cycle of

major depression. As such, examining the occurrence of major depression requires the consideration of a number of important social and cognitive variables concurrently.

The role that mood plays in the processing of information can also work to the advantage of depressed individuals. For example, this processing bias can be helpful in situations where one needs to be able to identify negative incoming information. Conversely, being in a situation where one must ignore this information proves more difficult (Gotlib & Joorman, 2010; Siegle, Ingram, & Matt, 2002). This suggests that depressed participants are likely to be more attuned to and aware of emotional displays compared to non-depressed participants.

Although there is strong evidence within the literature for an influence of a mood-congruent processing bias, some studies have questioned the veracity of this effect as being the most relevant explanation for differences in the processing of facial expressions. For example, at least one study examining facial discrimination found that depressed and non-depressed individuals differed in accuracy for neutral faces as opposed to happy or sad faces (Lepannen, Milders, Bell, Terriere, & Hietanen, 2004).

Studies examining memory for emotional stimuli have also shown some evidence that would challenge the idea of a sadness-specific bias for individuals with major depression. As previously mentioned, Gilboa-Schechtman and colleagues (2002) found that depressed participants showed greater recall for faces depicting anger (as opposed to sadness) compared to control or anxious participants. The authors of this research suggest that better memory for angry faces is a result of the social consequences that accompany this emotion. It is therefore likely that a mood-congruency effect is still in effect, but it manifests differently within an interpersonal context or in the context of socially threatening stimuli. Therefore, considering how individuals with major depression interpret others' emotions and make social judgments would assist in

better understanding the impact of the social environment on the development of major depression.

Current findings suggest that the inaccurate interpretation of social cues can lead to important social deficits in individuals with major depression. The current literature suggests that individuals with major depression demonstrate decreased social competence, decreased social support, and greater inability to engage in adaptive and positive social interactions, leading to an increase in isolation and negative mood (Bos et al., 2002; Gotlib et al., 2004; Joorman & Gotlib, 2006). Although cognitive theories of MDD have received considerable empirical support, some questions regarding their ability to fully explain the complex phenomenon of depression still remain.

One major criticism of cognitive models of MDD is that these theories disregard the impact of MDD on one's social environment and the role of others in the maintenance or development of depressive symptoms (Coyne & Gotlib, 1983). Borrowing from Hammen (1991), Joiner and Timmons (2002) argued that a diathesis-stress model could provide more insight into the nature of MDD, insofar as personality, family of origin, intimate relationship issues and negative life events play a defining role in the development of MDD. With this criticism in mind, our conceptualization of MDD would benefit from an understanding of how these processes manifest in relationships. Interpersonal theories of MDD (e.g., Coyne, 1976a) have attempted to rectify this by developing a model that emphasizes the bidirectional impact of MDD within an interpersonal context.

#### *Interpersonal Models of Major Depression and their Relationship to Interpersonal Difficulties*

As noted in the above section, differences between depressed and non-depressed individuals in the processing of emotional information can be understood within the context of

the mood-congruency effect, the role of negative schemas, and differences in cognitive function among depressed and non-depressed individuals. However, some studies have demonstrated that, with respect to facial affect, these differences are not as salient (as will be presented in greater detail in a later section of this literature review). Additionally, Gilboa-Schechtman and colleagues (2002) have alluded to the possibility that the processing of facial affect (and hence, interpersonal information) might follow a different trajectory of processing compared to verbal information. Accordingly, it is necessary to explore some other theoretical explanations for these differences. The following section will consist of a review of interpersonal models of MDD. Although the focus of these theories is related to interpersonal processes, they do to some extent include an element of the role of mood and interpretation bias, but within the context of social judgments.

Contrary to cognitive theories of depression, Coyne (1976a) argued that the development of MDD is a consequence of continuous negative interaction with one's social environment. The central theme of the interpersonal model is the need for individuals with depression and depression-prone individuals to seek feedback from their environment. Coyne's (1976a; Coyne, 1976b) model describes a cycle of increasingly severe depressive symptoms as stemming from the negative response of others following excessive reassurance seeking (ERS). Excessive reassurance seeking is defined as the excessive need of the depression-prone individual to confirm that others accept him or her. However, because this behaviour is excessive it often leads to feelings of irritation, rejection, and sadness from those within the social network. Consequently, positive social experiences become fewer, whereas negative ones become more common, thereby maintaining depressive mood. Depressed individuals tend to perceive this as affirming their initial fears of rejection. As a result, symptoms amplify and a cycle of reassurance

seeking and rejection or frustration emerges as the primary mechanism of relating to others (Coyne, 1976a; Coyne, 1976b). With respect to facial affect processing, the consequences of this cycle may lead to the feeling of others' emotional facial expressions as aversive, regardless of the actual emotion being displayed (Bistricky et al., 2011).

Tests of this theory have confirmed the negative effect that reassurance seeking has on the interactional partner. One study examined the quality of telephone conversations of non-depressed targets with depressed, non-depressed clinical controls and non-depressed participants. The non-depressed targets were assessed on measures of willingness to participate in future communication or interaction, perception of the individual, the amount of time the target engaged in self-focused conversation, and post-conversation mood. Following the conversation, participants who interacted with depressed participants reported negative mood (including feeling more hostile, anxious, and depressed). Additionally, a greater focus was placed on the depressed person in the conversation. The targets reported that they were also likely to reject the depressed person in future engagements and perceived the depressed individual as wanting the conversation partner to see him or her in a more negative fashion.

Coyne and colleagues (Coyne, Kessler, Tal, Turnbull, Wortman, & Greden, 1987) also reported that those living with a currently depressed individual reported more psychological distress than those living with a partner with a lifetime history of MDD. The authors suggested that the psychological distress experienced in significant others may enhance the negative self-views of the depressed individual, thereby increasing their symptoms and reassurance seeking behaviour. Consequently, the interpersonal difficulties in relationships could stem from the combination of excessive reassurance seeking behaviours and induced depression in others (Coyne, 1976a; Joiner, Metalsky, Katz & Beach, 1999).

Excessive reassurance seeking appears to interact with depression and negative interpersonal experiences. Hammen (1991) and Porthof, Holahan, and Joiner (1995) found that depressed individuals are more likely to experience self-generated interpersonal and life stress compared to individuals who experience any other disorder. In the context of excessive reassurance seeking, the continuous need for feedback leads to frustration, which then leads to conflict and stress within the interpersonal domain. There also appears to be a unique relationship between depression and excessive reassurance seeking behaviours. Joiner and Metalsky (1995) reported that reassurance seeking and negative feedback seeking in combination with depression is a significant predictor of rejection. Moreover, other studies have found evidence for diagnostic specificity (Joiner & Metalsky, 2001; Joiner, Metalsky, Gencoz, & Gencoz, 2001)

Individuals with depression also tend to actively seek out confirming negative feedback (negative feedback seeking; NFS) from others through the process of self-verification. In seeking out this feedback, individuals with depression have their self-views confirmed, thereby increasing their sense of confidence in how they view themselves. Negative feedback seeking also permits the depressed person to engage in social interactions that ensure realistic expectations. Specifically, the interactional partner doesn't see the depressed person as more positive than he or she sees him or herself thereby leading to expectations that cannot be fulfilled. In essence, through self-verification processes, the depressed person is able to maintain a sense of control and predictability (Giesler & Swann, 1999; Joiner, 1995; Swann et al., 1992a; Swann et al., 1992b). Depression occurs due to the additive effect of consistent negative feedback (Joiner, 1995) and rejection occurs as a result of frustrations associated with feedback seeking (Evraire & Dozois, 2011; Geisler & Swann, 1999).

Joiner and colleagues' (1999) review of the literature has demonstrated modest correlations among studies examining the relationship between depression and excessive reassurance seeking. Therefore, it is possible that excessive reassurance seeking acts in combination with other variables that would motivate someone to seek such feedback. Other possible variables include specific personality traits (such as dependency or sociotropy), attachment history, negative life events (Joiner, et al., 1999; Evraire & Dozois, 2011), and perceived social support (Iberra-Rovillard & Kuiper, 2011). For example, Joiner and Timmons (2002) and Joiner (2000; borrowing from Hammen, 1991) describe an integrative model for depression. They explain that individuals with interpersonal vulnerabilities (e.g., interpersonal avoidance or dependency) are at a greater risk of being in situations that will elicit negative interpersonal stress (primarily through self-verification and excessive reassurance seeking). Consequently, fewer opportunities for positive reinforcement arise leading to increased depression, increased symptom severity, and depression maintenance.

As a result of its interpersonal consequences, feedback seeking has been shown to have specific effects on the development and maintenance of MDD. These theories are important in understanding the mechanisms through which the depressed person's environment becomes disrupted. However, many of the factors involved, namely self-verification and excessive reassurance seeking can be cognitively determined. Individuals with depression need to interpret and process the feedback provided to them and evaluate this information in terms of its congruence or incongruence with their specific self-concept (Swann, Hixon, Stein-Seroussi, & Gilbert, 1990). Given the criticisms of a purely cognitive model or purely interpersonal model, it appears that combining the two would provide a more comprehensive approach.

*Interpersonal and Cognitive Theories of Depression: An Integrative Approach*

Variables that have been linked to interpersonal theories of depression can also be understood in the context of cognitive and information processing theories of depression. Specifically, cognitive theory can help explain the basis of the interpersonal behaviours, whereas interpersonal models help understand their consequences. For example, what is the process that drives the depression-prone individual to want to seek feedback in the first place and what are the interpersonal consequences of these motivations?

Intolerance of uncertainty (IUS) refers to the negative reactions that people might have to events that are unpredictable. These manifest as negative beliefs about uncertainty, behavioural avoidance, anxiety, and hypervigilance to threat (Dugas & Robichaud, 2007). Evraire and Dozois (2011) discuss intolerance of uncertainty as one factor driving the need to seek reassurance in relationships. Specifically, individuals with MDD will seek reassurance from others as a means of reducing the anxiety and worry associated with the uncertainty experienced in their relationships. Intolerance of uncertainty therefore can be proposed as cognitive variable that influences feedback seeking in depression.

Rumination, which is a repetitive focus on one's depressive symptoms and consequences of such, has been shown to affect depression severity. Although rumination generally takes the form of an intrapersonal process, it has been suggested that it can lead emotional distress and negative interpersonal consequences as well (Flynn, et al., 2010; Lam, Schuk, Smith, Farmer, & Checkley, 2003). Rumination also has been linked to specific interpersonal styles such as rejection sensitivity and a submissive interpersonal style (Pearson, Watkins, Mullan, & Moberly, 2010).

In testing a cognitive-interpersonal model of depression, Flynn and colleagues (2010) found support for role of rumination in predicting interpersonal stress, while both of these variables were predictive of depressive symptoms over time. The authors suggest that depressed individuals experience significant distress as a result of rumination, thereby prompting them to seek support. However, there are instances where this support is unavailable or perceived as unsatisfactory, thereby leading to interpersonal difficulties. Rumination has also been shown to mediate the relationship between excessive reassurance seeking and depression (Weinstock & Whisman, 2007) and this is what is hypothesized to drive depressed individuals to seek out social support (Flynn et al., 2010).

According to Young (1999), early maladaptive schemas (EMS) are unconditional and self-perpetuating beliefs about the self that develop from adverse childhood experiences and provide a cognitive vulnerability to seeking confirming feedback. In the context of early maladaptive schemas, excessive reassurance seeking behaviours are triggered by the perceived loss of a positive presence in one's environment (Schmidt, Schmidt, & Young, 1999)

In comparing the strictly cognitive models to interpersonal models of MDD one major distinction emerges. Specifically, those relating to the mood congruency effect generally appear to focus on processing biases for stimuli that are related to sadness, whereas interpersonal models of MDD generally focus on the role of social threat. This has different implications for the processing and decoding of facial expressions. It is unclear whether interpersonal models better explain accuracy or biases in the decoding of facial expressions, however, they can provide a theoretical basis for the examination of the differences between depressed and non-depressed individuals with respect to decoding facial expressions. The following section will review the literature specific to the decoding of facial expressions in MDD.

### *Depression and the Decoding of Facial Expressions*

The following section will focus on two main components: (a) the role of non-clinical negative mood and its effect on facial decoding, and (b) the impact of clinical depression (as diagnosed based on DSM-IV criteria) on the ability to decode facial expressions. The review of the literature focused on both aspects of facial affect decoding for several reasons: (a) to highlight the role of mood state and its impact on decoding accuracy and (b) to highlight the similarities and differences between transient mood and MDD with respect to decoding. However, the main focus of the current study was to examine the differences between participants diagnosed with MDD and non-depressed controls and accuracy in decoding facial expressions. Accordingly, the literature pertaining to non-clinical changes in mood was considered because our secondary goal was to examine how these changes affect accuracy in a facial expression recognition task.

It has already been established that some emotions are more easily detected than others. For example, in healthy volunteers, Gosselin and colleagues (Gosselin, Kirouac, & Doré, 1995) demonstrated that there are differences in the ability to decode specific emotions. In particular, it was determined that happiness and sadness were most accurately categorized. This finding is especially important within the context of the current study. Specifically, if it has already been established that certain emotions are recognized differentially within a healthy population, this begs the question of what can be expected from a population in which there are known difficulties with the processing and interpretation of positive, negative, and neutral information.

As discussed in previous sections, mood has been shown to have an effect on how and what kind of information is processed (Beck et al., 1979; Mathews & McLeod, 2005). Individuals with depression also tend to have negative interpersonal experiences (Coyne, 1976a).

Accordingly, examining the role that mood state can play is important in furthering our understanding of the factors that may contribute to accurately detecting facial expressions. Although the literature is generally consistent with findings that examine the role of mood and information processing on different tasks, the findings with facial recognition have been less consistent.

The role of depressed mood, negative affect, and the associated difficulties with identifying emotional cues has been investigated in non-clinical groups. Findings suggest that even within this population, changes in positive and negative mood have an impact on the type of information to which one attends. For example, Csukly and colleagues (Csukly, Czabor, Simon, & Tackas, 2008) examined the role of symptom distress (as measured by the SCL-90) in non-psychiatric participants and the ability to accurately detect emotions. Results demonstrated that greater general distress was related to reduced overall recognition accuracy. Moreover, recognition accuracy was significantly related to severity of depressive, obsessive-compulsive, phobic anxiety, and psychotic scales on the SCL-90. Identification of positive facial expressions did not show a relationship with psychological distress. Although this study included the six basic emotions, analyses on the recognition rates for specific emotion was not examined. Rather, overall recognition was examined (with the exception of happiness) making it difficult to understand the range of deficits with recognition of specific emotions. Moreover, this study begins to provide some insight into the role of psychological distress and its impact on facial recognition, by suggesting that non-clinical levels of depressive symptoms have a negative effect on recognition.

It has been shown that in a non-clinical population, varying degrees of positive and negative affect are able to predict thresholds at which individuals are able to accurately detect

facial emotional expressions of varying intensities and valence. Participants completed the Mood and Anxiety Symptom Questionnaire (MASQ) as a measure of their affective state. When individuals reported low positive affect (anhedonia) the ability to identify happy facial expressions decreased. However, the general distress scale of the MASQ (negative affect shared with depression and anxiety) was associated with greater recognition of disgust. The authors suggested that these findings support the notion that affect can be seen as a “behavioural bias” (p. 33) that influences or directs judgment (Coupland, Sustrik, Ting, Li, Hartfeil, Singh, et al., 2004).

Bouhuys and colleagues (Bouhuys, Bloem, & Groothuis, 1995) demonstrated that inducing negative mood in non-clinical participants led to an increase in the perception of sadness/rejection in faces displaying ambiguous and less intense emotions. In contrast, reduced identification of happiness/invitation was seen in faces displaying clear emotion. Moreover, participants saw more fear in the clear faces when feeling depressed. The authors explained that although the negative mood that was induced was not at the clinical level, these findings do lend some support to the idea that negative mood could affect how emotion is perceived. Specifically, this prompts one to question how this might be different (or similar) in a clinically depressed population, which is characterized by the presence of persistent negative mood.

Given the nature of difficulties with respect to information processing, biases in attention, and the related negative social consequences for individuals with major depression, further investigation into the nature of these communication difficulties warrants special attention. Specifically, examining how individuals with MDD judge and interpret facial expressions can provide some insight into the nature of the types of errors in judgment that those with major

depression may be committing with respect to interpersonal stimuli. To date, the research in this area has been quite contradictory.

Although it is generally agreed that there are some impairments in the processing and identification of facial expressions, the specific nature of these difficulties has been less consistent within the literature. Some studies have shown that individuals with MDD do not decode emotional expressions in the same manner as non-depressed individuals, especially when such expressions are of low intensity. Some researchers have found a deficiency in the ability to accurately decode facial expressions regardless of emotion type (Gur et al., 1992). On the other hand, other studies have found that those with major depression are more accurate in their ability to decode specific emotions (Bhagwagar et al., 2004) or have a greater tendency to detect only negative emotions (Bouhuys et al., 1999).

Research into the area of depression and facial recognition can be divided into two major types of questions. First, are individuals with depression less accurate than non-depressed individuals at decoding emotional facial expressions? Second, what are the specific biases that we see with respect to decoding facial expressions in individuals with depression compared to non-depressed individuals? These two questions represent two important distinctions within the literature. Specifically, accuracy is related to how well depressed and non-depressed individuals decode emotions and whether they can correctly distinguish between the different emotions. On the other hand, judgment biases reflect the tendency for participants to either overuse or underuse specific emotion categories, suggesting that decisions are being guided by pre-determined methods of interpreting information rather than through objective judgments. The ability to accurately identify emotional facial expressions is also affected by the intensity of the emotion. For example, in their study on the judgment of emotional facial expressions of varying

intensities, Hess, Blairy, and Kleck (1997) found a significant linear trend in terms of intensity and accuracy, in that greater intensity led to greater accuracy. The role of intensity also plays a central role in the research related to depression and facial recognition (Csukly, Czabor, Szily, Tackacs, & Simon, 2009; Joorman & Gotlib, 2006; Surguladze, Young, Senior, Brebion, Travis, & Phillips, 2004)

The current section is divided into three parts. The first section discussed research related to decoding accuracy, intensity of emotional expression, and depression. The second section includes studies that examined biases in decoding of emotional facial expressions. The final section includes research relating to depression chronicity and detection of emotional facial expressions.

*Accuracy and the detection of facial expressions.* Persad and Polivy (1993) systematically investigated the extent to which clinically depressed, non-depressed psychiatric controls, never depressed college students, and mildly depressed college students could accurately decode facial expressions of emotions. They examined fear, anger, surprise, contempt/disgust, happiness, sadness, and indifference. The measurement of accuracy used was the number of correct identifications compared to incorrect identifications. The mildly depressed college students and the depressed participants tended to commit more errors compared to non-depressed controls. Examination of mean correct responses for both depressed groups suggested that they were generally very close with respect to accuracy, as measured by the hit rate. Additionally, group differences for specific emotions between depressed and non-depressed participants were non-significant.

Persad and Polivy (1993) explain these findings as support for the idea that deficits in emotional facial recognition are more generalized and do not reflect deficits for specific

emotions. Findings of this study lend some support to the fact that negative mood, regardless of severity, can lead to deficits in accurately detecting emotion. Although the researchers noted that depressed individuals tended to make more errors, there was no systematic examination of such errors making it difficult to fully elucidate the nature of the deficits in accuracy. It is possible that examination of errors would reveal different patterns for both depressed groups compared to the non-depressed group.

The finding that depressed and non-depressed participants appear to be similarly accurate at detecting emotions was also supported by studies integrating the role of intensity. Gollan and colleagues (Gollan, Pane, McCloskey, & Coccaro, 2008) examined group differences for accuracy for sadness, anger, disgust, fear, happiness, surprise, and neutral emotions. However, anger, disgust, and fear were combined to form one category of “harsh” (p. 19) facial expressions. Accuracy was measured using the number of correct hits. Participants were asked to press a computer key when they were able to identify the emotion and then asked to rate the perceived intensity of the emotion. Group differences were non-significant for accuracy, however a trend towards significance was detected for intensity ratings of sadness and harsh (depressed rated as more intense). No differences were detected for intensity ratings of happiness. Moreover, depressed participants demonstrated longer reaction times for sadness compared to non-depressed controls.

Although these findings are somewhat consistent with those of Persad and Polivy (1993), the addition of intensity is an important factor as this has been shown to influence accuracy in the general population (Hess et al., 1997). Based on cognitive theories of depression, the non-significant findings between depressed and non-depressed groups for accuracy are somewhat surprising. Specifically, the trend findings in the Gollan and colleagues’ (2008) study can be

attributed to the fact that negative emotion was combined to form one category of “harsh” (p. 19) emotions. This can be seen as problematic as individuals with major depression may interpret each of these emotions differently. Combining these variables reduces their unique contribution to the understanding of accuracy. Additionally, the researchers did not specify at what baseline intensity the emotional stimuli were presented to participants. As we know from research with decoding of facial expressions, higher intensities generally produce greater accuracy (Hess, et al., 1997). Another explanation for the findings is that many of the studies on information processing involve verbal information as opposed to social cues, which are generally processed differently and could have an impact on how MDD is conceptualized in terms of the different models (Gilboa-Schechtman et al., 2002; Gilboa-Schechtman, Foa, Vaknin, Marom, & Hermesh, 2008).

Building on these findings, Lepannen and colleagues (2004) investigated differences in the ability to recognize happiness, sadness, and neutral faces in depressed and non-depressed individuals. They were particularly interested in determining whether depression would influence recognition speed and accuracy with respect to happy and sad facial expressions. Accuracy was measured using the percentage of correct responses (or hit rate) and false alarms. A facial expression was presented for 200 ms. followed by a blank screen. There was a 1500 ms interstimulus interval, followed by the next trial. A total of 96 trials were presented (32 for each emotion category).

The findings suggested that depression might lead to impairments in the processing of neutral emotional stimuli. Both groups were as accurate in detecting happy and sad faces, but differed with respect to neutral faces. Specifically, depressed participants were less accurate in detecting neutral faces compared to non-depressed participants, who were equally accurate in

detecting all three categories. Concerning reactions time, overall, depressed participants were generally slower at recognizing all emotions. Within-group comparisons showed both groups were quicker at identifying happy compared to sad and neutral faces. However, depressed participants were generally slower at recognizing neutral faces. This study was one of a few to follow up their examination of accuracy with a closer analysis of the types of errors that were made. This line of investigation suggested that depressed individuals tended to misattribute neutral faces as sad more often than non-depressed participants.

Results of the above-mentioned study are significant as they support the notion that the differences between depressed and non-depressed individuals are not as salient as the literature in information processing has already defined. As previously mentioned, differences in the findings can be attributed to the nature of the stimuli being presented (verbal vs. nonverbal). Moreover, these findings show a lack of support for the mood-congruency hypothesis (Lepannen et al., 2004). The finding that both depressed and non-depressed participants demonstrated similar reaction times to happiness is somewhat surprising (a finding that would run contrary to what would be hypothesized given what we know about depression and information processing), especially given that induced negative mood has been shown to affect processing (e.g., Bouhuys et al., 1995). However, Lepannen and colleagues (2004) explain that this particular finding suggests that clinical depression and negatively induced mood could have unique profiles with respect to emotion judgment.

Other studies have examined the combination of emotion, intensity, and group differences in a more systematic way, thereby addressing some but not all of the limitations discussed above. These studies have examined clearly identified varying levels of intensity and, in some studies, a greater range of emotion in order to elucidate the nature of possible

differences between depressed and non-depressed individuals. Emotions at lower intensities are generally more difficult to distinguish. Therefore examining a range of intensity would provide more information with respect to differences between subtle and more obvious expressions.

Surguladze and colleagues (2004) examined the contribution of intensity to the ability to accurately decode happiness and sadness. They used the two-high threshold formula, which takes into account the number of correct responses, false alarms, number of targets, and number of distractors (neutral faces; Corwin, 1994). Accuracy was measured for both emotions separately and defined as the ability to differentiate between neutral vs. emotional faces (sad or happy). Participants diagnosed with MDD and a control group were shown a series of pictures depicting happiness, sadness, and neutral expressions consisting of 50% and 100% intensity, presented for 100 and 2000 ms. Consistent with their hypothesis, Surguladze et al. (2004) found that depressed participants were less accurate compared to non-depressed participants at both intensities and with shorter presentation times. They also showed impairments for both of the emotions, although the greater impairment was for sadness. These findings are consistent with those suggesting that there are significant group differences for specific emotions between depressed and non-depressed participants. The authors suggest that the greater impairment for sadness in the depressed group may be partly responsible for some of the interpersonal difficulties detected in depressed individuals.

One significant limitation to the above mentioned study relates to the authors' suggestion that this represents differences at low and high intensities. A facial expression representing 50% intensity would be considered to have 50% of the prototypical expression, with the other 50% being neutral. This may pose some difficulties with making inferences with respect to low intensity emotions, which is more likely to be encountered in everyday life (Joorman & Gotlib,

2006). In restricting their analysis to 50% and 100%, Surguladze and colleagues (2004) can only draw conclusions about medium and high intensity emotion.

In order to correct for this, Joorman and Gotlib (2006) included facial displays (sadness, anger, fear [included to increase task difficulty], and happiness) that gradually increased in intensity. Participants were asked to press a button as soon as they were able to identify the specific emotion and were asked to indicate which emotion they saw. Participants included individuals with depression, social phobia, and non-clinical controls. Accuracy was operationalized as the mean percentage of correct identifications (hit rate). They did not find significant group differences for accuracy. However, overall, participants were more accurate at identifying happy compared to angry and sad faces, and more accurate in identifying sad than angry faces. With respect to intensity, the MDD group required greater intensity to identify happiness compared to those with social phobia and the control group, suggesting a diagnostic specificity for depression and recognition of emotion.

This study provided some important information with respect to diagnostic specificity and intensity. Specifically, it was concluded that depressed participants have greater difficulties identifying subtle positive emotion, suggesting that the differences between depression and other diagnostic groups and non-depressed individuals are primarily related to positive emotion (Joorman & Gotlib, 2006). This hypothesis was supported in another study that found that depressed participants rated happy faces as having lower intensity (Yoon, Joorman, & Gotlib, 2009).

In examining the mean intensities whereby participants were able to identify the emotions being presented, values were generally below the 50% mark. Accordingly, Joorman and Gotlib (2006) suggest that the ability to detect subtle changes in emotional facial expressions may be

better predictors of interpersonal functioning compared to the accurate detection of high intensity emotion. These findings also underscore the importance of examining facial displays at even lower intensities (e.g., under 50%). However, one limitation of the study is that it is difficult to elucidate whether the ratings for intensity were based on the actual level at which participants were able to detect the emotion or whether this reflected the level of intensity at which participants were sure of their responses (Joorman & Gotlib, 2006).

Other studies that have examined group differences for accuracy at varying levels of intensity have found significant differences at low intensities. For example, Csukly and colleagues (2009) presented facial expressions consisting of happiness, sadness, anger, disgust, fear, and sadness at five different intensities, ranging from 20% to 100%. Accuracy scores were based on percentage of correct responses and calculated for each intensity level. The authors combined disgust and sadness to create a variable of low arousal emotion category, whereas surprise, fear, and anger were combined to form a high arousal emotion category. Overall, depressed participants were less accurate compared to non-depressed participants. Closer examination of group differences showed a significant group difference at 40% intensity for low arousal emotions (disgust and sadness). When emotions were considered separately, depressed individuals also showed decreased accuracy for disgust and sadness compared to non-depressed participants. With respect to errors, depressed participants were more likely to mistake low arousal and neutral emotions for high arousal emotions (which consisted of one positive emotion and two emotions that are generally associated with avoidance of interpersonal situations; Csukly et al., 2009). This is especially surprising given what we know with respect to information processing and MDD.

Although Csukly et al. (2009) study combined the emotions to form two separate categories, the authors also considered each emotion separately in their analysis of accuracy. However, error rates were examined as a function of high and low arousal. Given what we know about information processing in MDD, and the types of emotions that were included in the high arousal category, an analysis of the error rates for specific emotions would have provided a more detailed picture of the patterns of responding.

To summarize, the findings with respect to recognition accuracy have been quite contradictory. Some studies have detected significant group differences, whereas others have not. Including the factor intensity has been advantageous in detecting differences among the groups. Some of the reviewed studies in which there were no significant group differences have questioned the role of mood-congruent processing and depression related difficulties. However, the inclusion of the factor intensity has led to different outcomes suggesting that this does play an important role in determining differences between groups.

*Biases in the identification of facial expressions.* Some of the studies presented in the last section have also included an analysis in which biases were examined. Current studies of judgment bias define this as the increased tendency to evaluate or interpret neutral or ambiguous information as negative (Bourke, Douglas & Porter, 2010; Hale, 1998). Accordingly, the majority of the studies presented examined biases within the context of responses to neutral stimuli. For example, it has been found that depressed individuals were less accurate at detecting neutral expressions and generally tended to label neutral emotions as sad compared to non-depressed participants (Gollan et al., 2008; Lepannen et al., 2008).

Surguladze and colleagues (2004) found that in addition to differences in accuracy, depressed and non-depressed groups differed with respect to the types of labels they were

providing to neutral expressions. In their analysis, they took into account the number of correct identifications and the number false positive responses. Both depressed and non-depressed participants labeled neutral expressions as sad and labeled higher intensity neutral emotions as emotional (regardless of emotion type). Group differences for biases were detected at 50% intensity and longer presentation time (2000 ms). Specifically, depressed participants labeled happy expressions as neutral and correctly labeled neutral expressions. On the other hand, non-depressed participants labeled neutral expressions as happy and also correctly labeled happy expressions. No significant differences were present for sadness.

The findings with respect to bias (as well as accuracy, as discussed in the above section) begin to shed light on the fact that these are two separate constructs that need to be examined separately. Specifically, in the above study, biases were present in conditions in which discrimination was not impaired. Specifically, biases were detected at 50% intensity and for longer durations, whereas differences in accuracy were detected for sadness with shorter presentation times. Moreover, the authors argue that including shorter duration times and less intense emotions permits the study of more subtle differences between depressed and non-depressed individuals (Surguladze et al., 2004).

Although the above-mentioned studies begin to shed some light on whether depressed participants have a tendency to perceive positive or negative emotion when presented with neutral stimuli, there are still some methodological and conceptual errors in how this is measured. First, bias is typically measured as a mean response or misidentification, which is then compared among groups. This method of measurement is not necessarily an accurate measure of a bias. According to the signal detection theory (Green & Swets, 1966; Iverson & Luce, 1998), a response bias reflects the tendency to overuse or underuse a specific emotion category. Second,

these studies examined errors in accuracy with respect to neutral stimuli. What tends to be more consistent is the finding that depressed participants have difficulties identifying neutral emotions or that they mistake neutral emotions for sadness. However, stating that this is a true bias is difficult given how bias is measured and given the fact that many studies focused their examination of bias to neutral vs. happiness and sadness. This limits the ability to detect possible biases with other emotion.

*Detection of facial expressions and remission.* Some studies have shown that memory for positive self-referent verbal stimuli is predictive of symptom improvement (Johnson, Joorman, & Gotlib, 2007), whereas others have found that negative schemas continue to be activated in remission when remitted individuals are presented with stimuli that activates self-referent thoughts (Hedlund & Rude, 1995). One can thus conclude one of two possibilities: (a) the mood-congruency hypothesis is supported given that remitted individuals no longer display negative mood and negative bias towards sadness related stimuli, and (b) that negative schemas are a vulnerability factor for the development of depression. However, these and similar findings have been thought to better explain depression persistence, maintenance or severity (Just, Abramson, & Alloy, 2001). Regardless of the nature of the explanation, it can be concluded that some biases continue to be present during remission when relevant schemas are activated. This has implications for the detection of emotional facial expressions in the sense that one can assume that those in remission may continue to demonstrate difficulties in decoding when faced with a situation that may trigger negative schemas, leading to continued difficulties in interpersonal interactions.

Other researchers have attempted to examine how biases and accuracy in the detection of emotional facial expression may be related to remission and depression persistence. However,

contradictory findings have emerged as a result of methodological shortcomings. For example, Leppanen and colleagues (2004) demonstrated that depressed and non-depressed individuals showed comparable ability to decode happy and sad faces but that depressed participants showed less accuracy in detecting neutral faces. This pattern persisted even after remission. In this study, accuracy was measured using the number of correct judgments and included a limited range of emotions (happy, neutral and sad). Other studies showed that judgment of positive emotions did not show a relationship with depression. Rather a bias in judging negative emotions has been shown to be related to depression persistence and severity. In addition, accuracy ratings for sadness were shown to be the strongest predictors of depression over time. Not surprisingly, depressed participants were more accurate in detecting sadness compared to non-depressed participants (Bouhuys, et al., 1999; Hale, 1998). Bouhuys and colleagues (1999) demonstrated that depressed patients who relapsed tended to detect more negative emotion when presented with ambiguous stimuli.

#### Limitations and Critique of Literature

The research regarding recognition accuracy yields mixed results. Studies of biases have generally been more consistent with the findings (although not completely) and more likely to detect group differences. As discussed in the above sections, these differences can be attributed to the methods used to measure accuracy and bias.

Some studies did not include the intensity variable, which has an important effect on recognition. Studies that have included different intensities have been more consistent with finding group differences with respect to accuracy. However, even the methodology presented in these studies is not consistent. For instance, some have provided a limited range of intensity (50%-100%) and draw conclusions relating to low versus high intensity (Surguladze et al.,

2004). This is problematic as 50% is considered to have a moderate amount of a prototypical expression. Moreover, we know from other studies presented that differences in accuracy are detected at lower intensities (40%), whereas biases are detected at higher intensities (i.e., 50%). Had varying levels of intensity been ignored, a significant subset of the findings would not have been detected (e.g., Csukly et al., 2009; Surguladze et al., 2004). Furthermore, with respect to measurement of intensity, some studies (e.g., Joorman & Gotlib, 2006) noted that they were interested in determining at which point participants are able to detect emotion. Participants were shown an emotional expression that gradually changed. As mentioned previously, this brings to question whether responses for intensity are a measure of confidence or whether they truly reflect the point at which the participant perceives the emotion. Studies in which facial expressions are presented with the desired intensity can provide a more systematic examination of this question (e.g., Csukly et al., 2009; Gollan, McCloskey, Hoxha, & Coccaro, 2010).

Another source of inconsistency exists with respect to the types of emotions being displayed. Some studies used schematic facial expressions (e.g., Bouhuys, 1995; Persad & Polivy, 1993), others have used photographs, whereas others have used changing or dynamic expressions (Joorman & Gotlib, 2006).

The length of the presentation of the stimuli also differed among groups, ranging from 100 ms to 2000 ms. Some researchers argue that longer stimulus presentation times are required as depressed individuals show slower processing of information (Cooley & Nowicki, 1989), however, Surguladze and colleagues (2004) found significant differences at 100 ms and other studies have detected significant results at 500 ms (e.g., Bhagwagar et al., 2004; Feinberg, Rifkin, Schaffer, & Walker, 1986; Suslow, Junghanns, & Arolt, 2001). Similar effect sizes for group differences have also been detected at these intervals (Peckham, McHugh, & Otto, 2010).

It is therefore possible to examine facial recognition accuracy with enough confidence by applying a standard presentation time. Moreover, it is possible that if given unlimited time to make a choice or very long stimulus durations, depressed individuals are more likely to engage in self-referent rumination (Raes, Hermans, & Williams, 2006), which would decrease the ability to detect in the moment processing.

Another important source of conflict in the methodology is the use of a combination of emotions (for example the combination of anger and disgust to form a category of “harsh” emotion). We know from studies on healthy volunteers that different emotions are recognized differentially. For example, happiness is typically the easiest to detect (Hess et al., 1997), whereas participants have been shown to demonstrate biases towards some emotions and not others (Gosselin et al., 1995). It can be argued that combining these emotions can potentially decrease the possibility of finding significant results. Some have argued for examining only happiness and sadness as these are more highly related to depression (e.g., Beck et al., 1979), however, studies have begun to show an attentional bias towards anger in individuals with depression (Leyman, Raedt, Schacht, & Koster, 2007). Additionally, surprise can be characterized as a positive emotion, yet, with the exception of some studies, this is often neglected in the research. Accordingly, examining the six basic emotions (happiness, sadness, anger, fear, disgust, and surprise) as separate constructs, while incorporating various intensities would provide a more complete account of the differences in accuracy and biases that may be present in depressed individuals.

Of particular importance is the operationalization of accuracy and bias. The majority of studies used the hit rate (number of correct responses) as an index of accuracy, or failed to take the utilization of response categories into account (bias). Although the hit rate is valid for

measuring overall accuracy (all emotions confounded), it is an invalid measure for the accuracy of specific emotions because it does not take into account the tendency of the participants to use response categories. The proposed study will measure accuracy by using the unbiased hit rate proposed by Wagner (1993). This index is the joint probability that a stimulus category is correctly categorized, given that it is presented at all, and that a response category is correctly used, given that it is used at all.

Furthermore, although the aforementioned studies explained that judgment biases were being examined, their methodological strategies did not show evidence for doing so effectively. Specifically, in some studies biases were calculated as the number of errors or misidentification of neutral stimuli. However, a judgment bias is defined as the tendency to overuse or underuse a response category. The discrepancy between measurement and theoretical conceptualization of biases presents some difficulties. Specifically, the main question that studies of biases were trying to answer is whether depressed and non-depressed participants were using certain emotion categories more than others. However, the current methods used to detect this do not accurately take into account the use of specific categories. The proposed study will measure biases by comparing participants' tendency to use a response category to the probability of presentation of the emotion stimulus in question.

Another important point to consider is that the research presented tended to use neutral stimuli to determine whether depressed and non-depressed participants were responding in a biased fashion. Although this provides some insight into how the two groups respond, this does not necessarily provide an ecologically valid method of investigating biases. In everyday interactions we are rarely required to judge emotionally neutral expressions when engaging with

others. Therefore, understanding this process as it relates to the range of the basic emotions can provide a better understanding of how depressed and non-depressed individuals may respond.

To summarize, the current status of facial recognition research comparing depressed and non-depressed individuals has been contradictory in nature, with minimal consistencies among the various studies. This is largely in part due to the methodological differences, but mainly in the operationalization of the construct of accuracy and bias. The current study will aim to mend these differences by providing a more precise means of measuring bias and accuracy among depressed and non-depressed participants.

### The Current Study

The theoretical basis of the current study is grounded in Beck's cognitive theory of depression. Interpersonal theories of MDD are discussed as a means of assisting in understanding the overt consequences of possible deficits and biases in the decoding of emotional facial expressions. Moreover, given the extensive research on both models, it is believed that centring the current findings on one model would not provide the most comprehensive approach to understanding the theoretical underpinnings of the detection of emotional facial expressions and major depression.

According to Beck and colleagues (1979) negative schemas develop as a result of early negative interactions that lead to the tendency to process information that is consistent with these negative schemas. This negatively biased information processing mechanism is what maintains depression (Teasdale, 1988). Moreover, a bias toward the processing of negative information may adversely affect interpersonal interactions and increase the amount of perceived negative feedback or behaviours from others (Swann et al., 1992a; Swann et al., 1992b).

The short and long-term objectives included increasing the understanding of the relationship that exists between depressive state and the ability to decode facial expressions, with the primary interest being group differences with respect to accuracy in decoding of facial expressions. This study also examined whether differences in accuracy are better explained by mood state at the time the experimental task was completed. Moreover, the unbiased hit rate was used as the primary measure of accuracy. As already discussed, this provides a more accurate measure as it takes into account correct identifications as well as the tendency to use specific emotion categories. On its own, the hit rate is not sufficient, as it does not account for emotion categories. Moreover, errors and judgment bias were examined with respect to accuracy to identify the possible sources of confusion. The six basic emotions (happiness, anger, disgust, fear, sadness, and surprise) were included separately, at intensities varying from 20% to 100%, in order to obtain a range of difficulty within the task, but also to determine at which intensities group differences are detected. These intensities were chosen to reflect low, medium, and high displays of facial expressions. High intensity emotions were included in the experimental task to vary the level of difficulty in the task.

The current study also examined group differences with respect to judgment biases. As previously discussed, this is different than accuracy as this is the tendency to over use or under use specific emotion categories. Based on current conceptualizations of depression and information processing, this is an important indicator of the unique contribution of differences in emotion perception compared to accuracy (Gilboa-Schechtman et al. 2008). The examination of response biases is secondary to the examination of group differences for accuracy and was used only when group differences for accuracy were detected to help elucidate the nature and source of these differences.

Given that the research to date has demonstrated that group differences are generally subtle and are present at lower intensity emotion, accuracy and judgment bias was first examined at low intensity and then separately at medium and high intensity in order to reduce the number of tests and to keep the analyses in line with the current literature.

Additionally, given that detection of emotion appears to be related to remission (Lepannen et al., 2004) and relapse (Hale, 1998) group differences were first examined in terms of participants presenting with acute MDD and partial remission and non-depressed controls, followed by those with a lifetime history of depression (regardless of depressive status) and non-depressed controls.

Finally, given that some studies have established that transient mood and non-clinical negative affect can have an effect on processing and identifying emotional facial cues, a secondary objective the current study was to investigate this further. Specifically, a measure of positive and negative affect was used to determine whether mood state (regardless of clinical diagnosis of MDD) during completion of the experimental task was predictive of accuracy scores. Questions emerged regarding the uniqueness of a clinical profile of mood related difficulties in detecting emotion versus normal fluctuations in mood state in detecting emotion profiles (Lepannen et al., 2004). Examining accuracy within the context of transient mood state can help determine whether mood state can partially explain potential group differences that emerge between clinically depressed and non-depressed groups.

The hypotheses were limited to general statements, as it was difficult to make more specific predictions when the data are inconsistent among studies. However, the hypotheses were based on existing conceptualizations of the development of major depression as arising from pervasive and persistent negative schemas, which are apparent in the decoding of various forms

of social cues (Beck et al., 1979). Moreover, accuracy and bias were studied using a more systematic approach by using the unbiased hit rate and expanding the conceptualizations of “judgment bias”. The current hypotheses are divided according to method of measurement, facial expression (type and intensity), group status, accuracy, and judgment bias. Seeing as the majority of studies in fact used the hit rate as opposed to more precise measures of accuracy, hypotheses will also be concerned with an examination of this measure of facial discrimination.

*a) Overall Recognition of Emotion*

*Hypothesis 1:* Given that intensity plays an important role in the ability to distinguish between emotions for depressed and non-depressed groups the current study will first attempt to determine whether this notion is supported (Hess et al., 1997). Accordingly, it is hypothesized that there will be an overall effect of intensity for the depressed and non-depressed groups. It is expected that the ability to identify emotional facial displays will increase as intensity of the facial expression increases.

*b) Depressive Status, Accuracy and Low Intensity Emotion*

*Hypothesis 2:* At low intensity, it was expected that participants who were currently depressed or in partial remission and those with a lifetime history of depression would display an overall pattern of reduced accuracy for sadness and happiness compared to non-depressed participants (based on the findings of Csukly et al., 2009, Surguladze et al. 2004, and Joorman & Gotlib, 2006).

*c) Depressive Status and Biases*

*Hypothesis 3:* At low intensity, it was expected that participants who were currently depressed or in partial remission and participants with a lifetime history of MDD would show a greater tendency to overuse or underuse specific emotion categories compared to non-depressed

participants. However, given that findings are more closely related to neutral vs. happiness and sadness, it is difficult to make a more precise prediction with respect to other emotions (Lepannen et al., 2004; Surguladze et al., 2004) However, based on the findings related to happiness and sadness, it was expected that depressed participants would overuse sadness (Gollan et al., 2008; Lepannen et al., 2008) and underuse happiness (Surguladze, 2004; Gotlib & Joorman, 2010; Joorman & Gotlib, 2006)

*d) Prediction of Accuracy Scores Based on Mood State (Regardless of Diagnostic Status)*

*Hypothesis 4:* It was expected that the more an individual endorsed a negative mood, the less accurate they would be at recognizing happiness and sadness expressions (Bouhuys et al., 1995; Coupland et al., 2004).

## Method

### *Participants*

Seventy-one (N = 71) individuals participated in this study. Depressed participants were recruited through their treating physician at the Royal Ottawa Healthcare Group (ROHCG), the ROHCG Mood Disorders Assessment Clinic, and the ROHCG Mood Disorders Clinic inpatient unit. Non-depressed participants were recruited through advertisements at the University of Ottawa. Recruitment of participants was very difficult. Mid-way into the study, recruitment efforts were combined with a larger study in the Mood Disorders Research Unit. Participants were recruited in the same manner. The only difference being that they completed more questionnaires (but the ones pertaining to this study were completed according to the original protocol) and a saliva sample was taken. This significantly helped to increase recruitment. The depressed group data was analyzed based on the presence of an acute depressive episode at the time of testing, partial remission, and a lifetime history of MDD. In order to ensure that all

groups were equivalent on target demographic variables, it was necessary re-select the participants for each level of analysis. The details of the analysis related selections are described in the results section.

*Depressed participants.* Participants recruited at the ROHCG were patients who had been accepted for treatment in the Mood Disorders program. Participants who met the initial inclusion criteria (to be discussed in the following section) were informed of the study (Appendix A). Those who expressed an interest in participating, completed a permission to be contacted for research form (Appendix B) and had their names transmitted to the research assistant in order to be contacted for possible participation. Those recruited from the ROHCG Mood Disorders Assessment Clinic provided the clinic with consent to be contacted for research using the same form as above. All permission to be contacted forms collected from the assessment clinic were transferred to the research unit. A research assistant contacted individuals who met study criteria following the completion of their scheduled feedback session.

The Mood Disorders program has a 20-person inpatient unit. Once per week, the research assistant was provided with a patient list. The researchers then contacted the patients' primary nurse to be introduced to those patients meeting inclusion criteria. Once introduced, the researchers provided the patients with detailed information regarding the study (Appendix A) and they were given the opportunity to participate. Testing sessions were scheduled with the patient's primary nurse for the initial testing session. Participants recruited from the inpatient unit underwent the same treatment as outpatients.

The physicians received a letter describing the study (Appendix C) and information sheets outlining the details of the study (Appendix A).

*Non-depressed participants.* The non-depressed comparison group was recruited from among the students at the University of Ottawa through poster advertisements. Posters were placed in various areas at the University of Ottawa, which briefly described the study and contained a contact number for the laboratory where the testing took place so that interested participants could contact the researchers (Appendix D).

Participants did not receive remuneration, but their bus tickets or parking expenses were reimbursed. The treatment of all participants conformed to the ethical guidelines set out by the University of Ottawa and the ROHCG.

### *Materials*

#### *Independent or Predictor Variables*

Participants completed a number of questionnaires that are designed to assess mood and associated thoughts and behaviours. The goal was to confirm the presence or absence of MDD and other possible comorbid disorders, as well as to get a measure of symptom intensity and severity. MDD was diagnosed using the Structured Clinical Interview for the DSM-IV, patient version (First, Spitzer, Gibbon, & Williams, 2002a), the Structured Clinical Interview for the DSM-IV, non-patient version (First et al., 2002b), the Beck Depression Inventory-II was used as a measure of severity (Beck et al., 1996), and the Profile of Mood Scale–Bipolar Form (Lorr & McNair 1982) measured current mood state.

*Profile of Moods State Bipolar Form (POMS-BI; Lorr & McNair, 1982).* This is a self-report scale intended to measure changes in mood and current mood. It consists of 72 adjectives that tap into a number of different mood states, from the positive to negative pole. Respondents are required to indicate, on a 4-point Likert scale ranging from 0 (*much unlike this*) to 3 (*much like this*), the degree to which the adjective is descriptive of their current mood. The subscales

include, (a) composed-anxious, (b) agreeable-hostile, (c) elated-depressed, (d) confident-unsure, (e) tired-energetic, and (f) clearheaded-confused. For the purpose of the study, only the elated-depressed and agreeable-hostile subscales were used. The scores are converted into *T*-scores, with a mean of 50 and a standard deviation of 10. The greater the *T*-score the more the individual endorsed the positive pole and conversely, the lower the score, the more an individual endorsed the negative pole of the scale. The tool is used to measure current mood for clinical and non-clinical samples. Studies have supported the use of the conceptualization of emotional states as being bipolar in nature. Moreover, the use of the five subscales on the POMS-BI has been supported. Each of the factors significantly loaded onto the bipolar dimensions (Lorr, McNair & Fisher, 1982).

*Beck Depression Inventory (BDI-II; Beck et al., 1996)*: The BDI-II is a 21-item self-report measure of depressive symptom severity. Items range in severity from 0-3 where three is indicative of high severity for a particular item. It consists of a two-factor structure, including cognitive-affective and somatic. All items are based on DSM-IV (APA, 1994) diagnostic criteria. The items are composed of attitudes and symptoms that are frequently endorsed by individuals with depression. These include: (a) depressed mood, (b) pessimism, (c) sense of failure, (d) lack of satisfaction, (e) guilty feelings, (f) sense of punishment, (g) self-dislike, (h) self-accusation, (i) suicidal wishes, (j) crying, (k) irritability, (l) social withdrawal, (m) indecisiveness, (n) distortion of body image, (o) work inhibition, (p) sleep disturbance, (q) fatigability, (r) loss of appetite, (s) weight loss, (t) somatic preoccupation, and (u) loss of libido.

The BDI-II has been shown to significantly correlate with other measures of depression, with values ranging from  $r = .68-.71$ . Additionally, sensitivity ratings were reported at 93% with false positive rates yielding a value of 18% and internal consistency ratings have been shown to

be valued at  $r = .91$  (Beck et al., 1996). Additional studies have shown that the BDI-II is significantly correlated with SCID-I (First, Spitzer, Gibbon, & Williams, 1997) ratings for major depressive episode. The BDI-II has been shown to discriminate between those with and without a current diagnosis for a mood disorder, with similar cut-off and sensitivity (84%) and false positive rates (18%; Sprinkle, Lurie, Insko, Atkinson, Jones, Logan, et al., 2002).

*Structured Clinical Interview for the DSM-IV-I (patient and non-patient version; SCID IV-P/NP*; First et al., 2002a, First et al., 2002b): This structured clinical interview is designed as a diagnostic tool that facilitates the application of DSM-IV diagnoses for a number of different psychological conditions. For the purpose of this study, it was employed in order to confirm the presence of a diagnosis of MDD and other Axis I disorders, including anxiety, psychotic, and substance use disorders.

Inter-rater reliability for Axis I disorders is high with kappa values ranging from .86 to 1.00. Similarly, Kappa values ranging from .84 to .93 suggest good test-retest reliability. Additionally, sensitivity values were calculated to be 67% for all Axis I disorders and specificity was calculated to be  $\geq 96\%$  and negative predictive values of  $\geq 89\%$  (Schneider, Mauer, Sargk, Heiskel, Weber, Frolich, et al., 2004).

#### *Dependent or Outcome Variables*

*Japanese and Caucasian Facial Expressions of Emotion (JACFEE*; Matsumoto & Ekman 1989). The JACFEE is a collection of 56 photos of anger, contempt, disgust, fear, happiness, sadness and surprise. The set of photos is comprised of an equal number of males (two) and females (two) for each emotion. The JACFEE consists of four photos of each of the basic and neutral emotions, consisting of both Japanese and Caucasian posers. In the present study, two

male and two female Caucasian posers for all six emotions (happiness, sadness, fear, anger, disgust and surprise) were selected, with four different intensities (20%, 30%, 50% and 100%).

All stimuli are coded and verified by using the Facial Action Coding System (FACS; Ekman & Friesen, 1978), in order to obtain valid stimuli. Once coded with the FACS (Ekman & Friesen, 1978), observers were asked to identify the emotion and responses were calculated using the hit rate and intensity rating for each slide. Following this, the percent of observers rating the photos with the intended emotion and the highest intensity rating was calculated. The agreement values for the Caucasian photos, as rated by Caucasian participants, are high. The agreement rates are as follows: (a) anger: 85-92%; (b) disgust: 70-90%; (c) fear: 66-76%; (d) happiness: 97-99%; (e) sadness: 88-94%; (f) surprise: 89-95% (Matsumoto & Ekman, 1988).

#### *Procedure*

After indicating an interest in the study, the treating physicians relayed the permission to be contacted form (Appendix A) to the researchers who then contacted the participants by telephone to provide a brief description of the study and to schedule the first session. Similarly, participants recruited through the ROHCG Mood Disorders Assessment Clinic were contacted once the permission to be contacted form was complete and transmitted to the appropriate researchers. Participants recruited from the inpatient unit spoke to the researchers directly. The first testing session was arranged once the patient expressed interest.

Similarly, once potential participants for the non-depressed comparison group contacted the research laboratory, the researcher briefly explained the purpose of the study, and if the individual remained interested an appointment for participation was scheduled.

*Depressed participants.* Participation for this group consisted of two sessions. The majority of participants were receiving psychopharmacological treatment and psychiatric care at

the ROHCG. Prior to beginning the first testing session, participants completed an informed consent form (Appendix E) that outlined the purpose of the study, the time line, what was expected of the participant, an acknowledgment that participation was voluntary, that they were free to discontinue at any time, all individual results will remain confidential, results will be communicated as group means, and that all personal information will be kept confidential.

During the first session of the study, participants' diagnosis was confirmed using the SCID-I/P and a demographic information form was completed. Participants were excluded if they presented with a current substance abuse or dependence disorder, if there was any evidence for the presence of a current or past depressive episode with psychotic features, bipolar I or II disorder, or social anxiety. Participants with social anxiety were excluded as research has suggested that there is a heightened bias towards angry faces, leading to avoidance of these stimuli (Matthews & McLeod, 2005). This bias detected at 500 ms, which is the same length of the presentation of stimuli in the current study (Mogg, Philippot, & Bradley, 2004). Moreover, individuals with comorbid social anxiety and depression have been shown to demonstrate an attentional bias away from anger and showed decreased accuracy in its detection (LeMoult & Joorman, 2012). Participants were included in the study if they were presenting with a major depressive episode at the time of the study, were in partial remission, or if they had a lifetime history of major depressive disorder.

The first session was completed in approximately 1-1.5 hours. Participants recruited from the ROHCG Mood Disorders Assessment Clinic had already undergone a SCID-IV assessment through the clinic as part of a comprehensive psychological assessment. Accordingly, the first assessment session was omitted if they participated within one month of being assessed

at the clinic. If participation in the current study occurred more than one month following the initial assessment, the SCID-IV/P was re-administered to verify for current Axis I disorders.

The second session was scheduled for one week later. During this session, the BDI-II, the POMS-BI, and the experimental task were administered. The task order was varied in order to account for the possibility that completing mood and depression related questionnaires prior to the experimental task would affect scores on facial recognition. However, given that the POMS-BI is a measure of current mood, this tool was always administered prior to the experimental task. The first group completed the BDI-II, followed by the POMS-BI and the facial recognition task. The second group completed POMS-BI and the facial recognition task followed by the BDI-II.

The visual stimuli presented to the participants were derived from the JACFEE (Matsumoto & Ekman, 1989) and was composed of six different emotions (happiness, fear, anger, surprise, sadness, and disgust) from the Caucasian models. Using the Morpheus 7.0 program, software designed to manipulate the visual stimuli. Emotional expressions were altered to represent four levels of varying intensities (20%, 30%, 50% and 100%) for the six different emotions (two male; two female). The visual stimuli were presented on the monitor of a Toshiba Mobile Intel (R) Pentium (R) 4 CPU computer with 2.8 GHz and 448 MB of RAM, with a screen resolution of 1280x800 pixels, using the SuperLab pro: Experimental Lab Software program, version 2.0.4, created by Cedrus. Stimuli were presented for 500 ms in random order. Participants had 15 seconds to identify the emotion that was expressed by the facial expression being presented. Participants were asked to press on one of six keys, on a computer keypad, representing each emotion. A set of instructions for completing the experimental task can be found in Appendix F. The instructions were provided orally.

*Non-depressed participants.* The non-depressed comparison group participated in one session. Prior to beginning the first testing session, participants were asked to complete an informed consent form (Appendix G) that outlined the purpose of the study, what was expected of the participant, an acknowledgment that participation is voluntary and that they are free to discontinue at any time, that all individual results will remain confidential, results will be communicated as group means, and that all personal information will be kept confidential. Participants were asked to complete a demographic questionnaire as well. The researchers at the laboratory at the University of Ottawa interviewed participants using the SCID-NP. These participants also completed two questionnaires (BDI-II and the POMS-BI). The non-depressed comparison group was selected on the basis of no prior history of Axis I disorders as defined by the SCID- NP. They were excluded on the same criteria as the depressed group and if they presented with a current or lifetime history of MDD. The procedure for identifying the visual facial expressions was consistent with the procedure presented for the depressed group. The session was completed in approximately 1-1.5 hours.

## Results

The results are presented in four major sections, divided as follows: (a) examination of group differences in facial recognition at low (20% and 30%) intensities for participants who were currently depressed or in partial remission and non-depressed participants, (b) examination of group differences in facial recognition at low (20% and 30%) intensities for participants with a lifetime history of depression, (c) examination of group differences at medium (50%) and high (100%) intensities for participants who were currently depressed or in partial remission and participants with lifetime history of depression and non-depressed participants, and (d) the

examination of the relationship between mood state and facial recognition accuracy at low and high intensities.

The primary interest of the current study was to determine whether having current mood symptoms affect accuracy in facial recognition. Accordingly, the analyses begin with the examination of group differences at low intensities between participants who were currently depressed or in partial remission. However, research to date has also demonstrated that differences in ability to recognize emotions may be related to a lifetime history of depression. Accordingly, Section 2 of the analysis follows the same pattern of analysis as Section 1, but included all depressed participants (those in full remission as well). The goal was to determine whether the differences detected in Section 1 are specific to the presence of current mood symptoms or a function of a lifetime history of MDD.

Sections 1, 2, and 3 of the analysis followed a very systematic plan taking into account MDD diagnosis, intensity of emotion, and the nature and distribution of the data. The reason for focusing on low intensity first, followed by medium and high intensity is twofold. First, based on previous research, group differences at low intensities were expected to be subtle, and we know from previous research that intensity plays an important role in the ability to accurately recognize emotion (i.e., the stronger the emotion the easier it is to identify). Second, although the focus of the current study was on group differences with respect to accuracy at low intensity emotion, higher intensities were included to offer some variability within the experimental task. However, upon examination of the distribution of the data, it was evident that there was considerable variability among the different scores for each emotion and intensity. Therefore, conducting analyses with all emotions and all intensities included may hinder the ability to detect differences among groups, which are expected to be subtle and may be affected by variability in the data.

Accordingly, the primary analyses were separated between low intensity (20% and 30%), medium (50%) and high (100%) intensity, and diagnosis to ensure that any possible differences are not masked. All tables are presented first with data for 20% and 30% intensity for Section 1 and Section 2 analyses and then presented with 50% and 100% intensities for Section 3 of the analysis.

Of secondary interest was whether mood state (as defined by the POMS-BI), regardless of current diagnosis, would be predictive of recognition accuracy. Accordingly, participants were pooled together in order to examine whether transient mood state had an affect on the ability to accurately detect emotion. The main goal of this analysis was to answer the question of whether any differences that are detected between groups with respect to accuracy are specific to the presence of a mood disorder as opposed to mood state at the time of completion of the experimental task.

Prior to conducting any analyses, data were screened to ensure that criteria were met for the specific tests in question. Data were screened separately for group based analyses and screened together for regression analyses.

### *1.0 Recognition of Low Intensity Facial Expressions in Participants with Current Depression or Partial Remission and Non-Depressed Participants*

*1.1 Selection of participants.* The first step of analysis consisted of ensuring that participants in both groups met study criteria. The original data set consisted of 71 participants. Two participants were eliminated for missing data for the variable age and one participant was eliminated for missing SCID-IV data. The full data set therefore consisted of 68 participants. Based solely on SCID-IV data, 34 participants met criteria for lifetime history of MDD and 34 participants reported no such history. In the depressed group, a total of five participants were

eliminated (one participant was eliminated for current alcohol abuse, three were eliminated on the basis of a diagnosis of social phobia, and one for meeting criteria for bipolar II). Three participants were eliminated in the non-depressed group (two participants for meeting criteria for panic disorder and one participant for meeting criteria for current cannabis abuse).

Because the first phase of analysis concerned participants who were in an acute major depressive episode and those in partial remission, the next phase of eliminations involved excluding those who reported being in full remission or not currently depressed. To this end, 13 participants were eliminated. The sample therefore consisted of 16 depressed and 31 non-depressed participants.

Participants were then divided into depressed and non-depressed groups based on their SCID-IV diagnosis and BDI-II scores. A cut-off score of 10 or more on the BDI-II and a lifetime history of MDD, with either a current or partially remitted episode, had to be present to be considered in the depressed group, whereas the non-depressed group was divided based on a BDI-II score of 9 or less and no prior history of MDD. Based on these criteria, the non-depressed group consisted of 29 participants, whereas the depressed group consisted of 14 participants. A total of four participants did not meet these cut-off criteria and were therefore not considered in this analysis.

The next phase of data analysis consisted of ensuring that both groups were similar in proportion to key demographic variables (e.g., age, gender, and ethnicity). Because age plays an important role in facial recognition, the priority was to first make the groups as equivalent as possible on the basis of this variable. Accordingly, 18 participants were eliminated from the non-depressed group on the basis of age. Additionally, three participants were eliminated on the basis

of gender and ethnicity. Therefore, the sample consisted of a total of 22 participants, with 11 participants in each group.

### *1.2 Demographic Variables*

*1.2.1. Depressed participants.* The depressed group consisted of 36% males and 64% females. Mean age was 47.18 years. The majority of the participants reported speaking English as their first language (82%), whereas 18% reported speaking French as their first language. In terms of ethnicity, the majority of the sample consisted of Caucasian participants (91%) and 9.1% identified themselves as Asian or Oriental.

In terms of Axis I diagnoses, all participants reported a lifetime prevalence of a major depressive episode. Specifically, all participants reported recurrent major depression, without seasonal pattern. Forty percent of participants were in partial remission at the time of testing, whereas 64% reported being currently depressed at the time of testing, of which 38% reported melancholic features. In terms of severity, 11.1% reported mild symptoms, and 44.4% reported moderate symptoms. The mean BDI-II score in the depressed group was 28.27 (SD = 8.18).

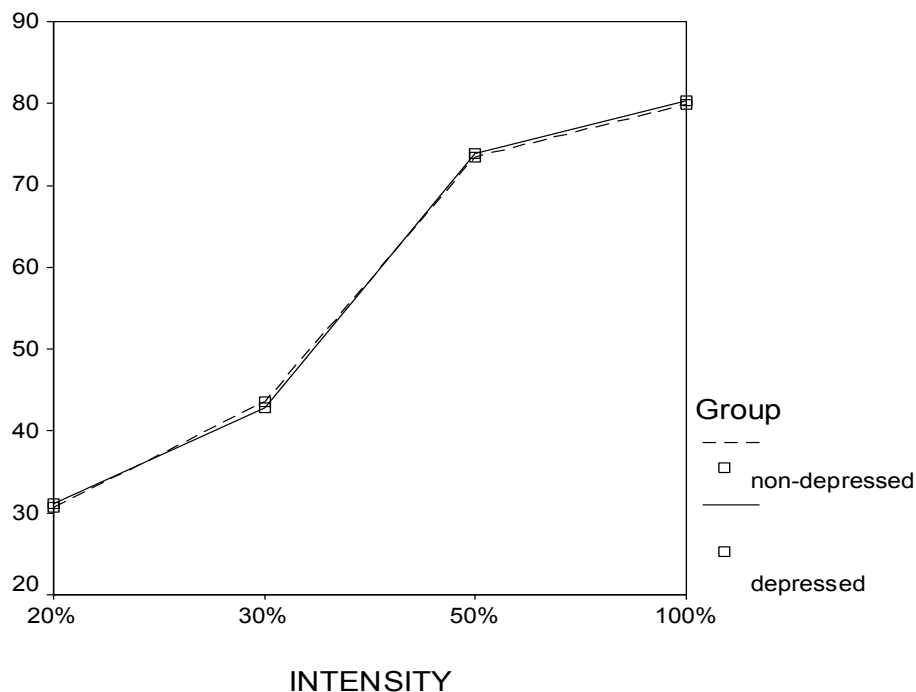
In terms of anxiety, 9.1% met criteria for lifetime history PTSD (not current). In terms of substance use, 10% of participants reported past alcohol abuse, whereas 9.1% reported a lifetime history of Cannabis abuse (not current).

*1.2.2 Non-depressed participants.* The non-depressed group consisted of 36% males and 64% females. Mean age was 44.72 years. Seventy-three percent reported speaking English as their first language, 18.2% of participants reported French as being their first language and 9.1% reported being Bilingual. In terms of ethnicity, the sample consisted mostly of Caucasian participants (81.8%), followed by Semitic or Arab (9.1%) and Black (9.1%) participants. The mean BDI-II score in the non-depressed group was 2.1 (SD = 1.6).

Independent sample *t*-tests (corrected for unequal variance) revealed that both groups did not differ significantly in terms of age,  $t(17.57) = -.358, p = .725$ . Moreover, chi square tests revealed that groups did not differ on key variables including gender,  $\chi^2(1, N = 22) = .00, p = 1.00$  and ethnicity,  $\chi^2(1, N = 22) = 3.05, p = .384$ . The BDI-II scores were significantly different between the depressed and non-depressed group, where depressed participants scored significantly higher than non-depressed participants,  $t(10.76) = -10.37, p = .000$  (equal variances not assumed).

### *1.3 Overall Recognition of Facial Expressions*

Recognition was examined, with all emotions pooled together, as a function of group (depressed and non-depressed) and intensity (20%, 30%, 50%, and 100%). As one can see in Figure 1, recognition accuracy (expressed in terms of hit rate) increased as a function of intensity, with performance in the depressed group almost equivalent to that of the non-depressed group.



*Figure 1.* Overall accuracy (hit rate) as a function of group (currently depressed or partially remitted and non-depressed participants) and intensity.

Prior to examining group differences, the data were inspected to ensure that all assumptions of the ANOVA were met. The assumption of homogeneity of variance (as assessed by the Levene's test, sphericity (as assessed by Mauchly's Test of Sphericity) and covariance of matrices (as assessed by Box's Test of Equality of Covariances) were all met. However, Shapiro-Wilks tests of normality resulted in significance for 30% ( $p = .017$ ) and 100% intensity ( $p = .000$ ) for depressed participants. Data for 30% and 100% intensity were also skewed and kurtotic for the depressed group. According to Tabachnik and Fidell (2007), outliers are considered to be extreme if they are 3 SD above the mean and lie outside of the distribution. Based on these criteria, two extreme outliers were detected in the data. In order to normalize the data, extreme scores were reduced or increased, where necessary, to the next extreme case. This approach was favoured over deletion of cases due to the small sample size. Following this

transformation, there were no longer any extreme outliers and only 100% intensity was approximately normally distributed. Given that all other assumptions were met (the assumption of homogeneity of variance, sphericity and covariance of matrices), and that ANOVA is robust against violations of non-normality, a Repeated Measures ANOVA was used to examine group differences.

A 2 (Group) x 4 (Intensity) ANOVA with repeated measures for the latter factor, indicated a significant effect of intensity only,  $F(3, 20) = 260.798, p < .001$ , accounting for 92.9% of the variance. Significant differences were found between each of the four intensities (Tukey test). A trend analysis revealed that the linear trend was significant,  $F(1, 20) = 503.03, p < .001$ . Additionally, there was no effect for Group,  $F(1, 20) = .05, p = .826$ , or the interaction Group x Intensity,  $F(1, 20) = .068, p = .796$ . A series of one sample  $t$ -tests showed that performance was above chance for each of the four intensities (20%, 30%, 50% and 100%),  $t(22) = 4.31, 13.79, 21.79, 21.94, p < .001$ , respectively.

#### *1.4 Recognition of Specific Facial Expressions at Low Intensities*

Participants' accuracy in recognizing specific emotions at 20% and 30% intensities is reported in Table 1. Note that the index of accuracy reported in this table is the unbiased hit rate, proposed by Wagner (1993). As mentioned earlier, this index is more appropriate than the hit rate because it takes into account participants' use of emotion categories and is thus uncontaminated by response biases. Examination of Table 1 indicates that in general, depressed and non-depressed participants showed a similar pattern of responding. The differences between groups were generally slight, with the exception of anger where the magnitude of difference appeared to be higher, favouring the depressed group.

Table 1

*Recognition accuracy (unbiased hit rate) for low intensity facial expressions as a function of group (currently depressed or partially remitted and non-depressed participants), emotion, and intensity (20% and 30%) (N = 22)*

Emotion	Intensity	Non-Depressed (n = 11)		Depressed (n = 11)	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Anger	20%	0.07	0.12	0.24	0.19
Anger	30%	0.24	0.22	0.31	0.17
Disgust	20%	0.24	0.14	0.18	0.17
Disgust	30%	0.41	0.25	0.32	0.25
Happiness	20%	0.24	0.12	0.20	0.11
Happiness	30%	0.36	0.19	0.37	0.16
Sadness	20%	0.12	0.07	0.11	0.07
Sadness	30%	0.12	0.11	0.17	0.11
Surprise	20%	0.08	0.09	0.04	0.08
Surprise	30%	0.21	0.14	0.19	0.25
Fear	20%	0.02	0.08	0.01	0.03
Fear	30%	0.11	0.11	0.05	0.08

Data were first screened to determine whether assumptions were met for parametric tests. For the depressed group, non-normality (as assessed by Shapiro-Wilks test of normality) was detected for surprise and fear at 20%; and disgust, fear, and surprise at 30%. Similarly, for the non-depressed group, non-normality was detected for anger, fear, and surprise at 20%; and disgust and fear at 30% intensity. Additionally, there were a number of outliers, one of which would be considered extreme. The assumption of homogeneity of variance was respected at 20% and 30% intensity. The data were then transformed using an Arcsine transformation. However,

this did not improve the distribution or the number of outliers. Accordingly, non-parametric tests were used to assess group differences with respect to accuracy.

Data were then examined for group differences with respect to accuracy at low intensity (20% and 30%). In order to provide the most effective course of analysis, consistent with the aforementioned hypotheses, a series of Mann-Whitney U tests was conducted, first at 20% intensity and then at 30% intensity. Due to variability within the data, tests were conducted separately to ensure that this would not mask possible significant differences within the groups.

Six individual tests were conducted using unbiased hit rate data for each emotion (happiness, sadness, anger, surprise, fear, and disgust) at 20% intensity. Significant differences were detected for anger at 20%,  $U(22) = 95.00$ ,  $z = -2.17$ ,  $p = 0.03$ . Specifically, depressed individuals were more accurate ( $M = .24$ ) compared to non-depressed individuals ( $M = .07$ ) at detecting anger at 20% intensity. Following this, a series of six Mann-Whitney U tests was performed at 30% intensity. Consistent with observations in Table 1, results of this analysis demonstrated that there were no significant differences between accuracy scores and group at 30% intensity.

### *1.5 Utilization of Response Categories at 20% and 30% Intensity*

The next step in the analyses consisted of examining to what extent participants were using specific response categories at low intensities in order to determine whether the recognition of facial expressions was affected by judgment biases.

Examination of Table 2 shows an overall similar pattern of responding for the depressed and non-depressed group. However, larger differences are evident for happiness and surprise at 20% intensity, and surprise and sadness at 30% intensity.

Table 2

*Utilization of response categories (expressed in terms of proportion of responses) for low intensity facial expressions as a function of group (currently depressed or partially remitted and non-depressed participants), emotion, and intensity (20% and 30%) (N = 22)*

Emotion	Non-Depressed (n = 11)		Depressed (n = 11)	
	Mean	SD	Mean	SD
20% Intensity				
Anger	0.11	0.13	0.11	0.11
Disgust	0.13	0.09	0.10	0.05
Happiness	0.27	0.13	0.37	0.20
Fear	0.03	0.05	0.03	0.04
Surprise	0.12	0.10	0.03	0.05
Sadness	0.34	0.18	0.36	0.13
30% Intensity				
Anger	0.15	0.13	0.14	0.08
Disgust	0.12	0.08	0.12	0.08
Happiness	0.26	0.10	0.28	0.15
Fear	0.06	0.05	0.06	0.07
Surprise	0.16	0.06	0.08	0.09
Sadness	0.25	0.13	0.32	0.13

Prior to examining group differences, data were inspected to determine suitability for use of parametric tests. At 20% intensity, anger was skewed for the non-depressed group, whereas fear was skewed for the depressed group. Similarly, data were skewed and kurtotic for both groups for fear and surprise. Shapiro-Wilks tests revealed non-normality for the depressed group for fear and surprise at 20% and 30% intensities. Within the non-depressed group, non-normality was evident for anger and fear at 20% and for fear at 30%. Moreover, a number of outliers were present between the groups and the different intensities. Homogeneity of variance was violated

for surprise at 20%. Following an Arcsine transformation, data continued to be non-normally distributed and the outliers remained.

Given the nature of the distribution of the data, non-parametric tests were used to examine group differences in utilization of response categories. The Mann-Whitney U test revealed significant group differences for surprise at 20%,  $U(22) = 26.50, z = -2.31, p = .021$ , and at 30%,  $U(22) = 29.50, z = -2.10, p = 0.04$ . Specifically, at 20% intensity, non-depressed participants tended to use more surprise ( $M = 0.12$ ) compared to depressed participants ( $M = 0.03$ ). Similarly, at 30% intensity, non-depressed participants also used more surprise ( $M = 0.16$ ) compared to depressed participants ( $M = 0.08$ ).

The data was then analyzed to determine whether this group difference was related to a bias in the use of surprise. A one-sample Wilcoxon Signed Rank test showed that depressed participants were significantly underusing surprise ( $Mdn = 0.00$ ) at 20% ( $Z = -2.99, p = .003$ ), compared to the non-depressed participants ( $Z = -1.51, p = .130$ ), with a median score of 0.08. A similar pattern emerged at 30% intensity. Specifically, depressed participants showed a bias away from the use of surprise ( $Mdn = 0.04$ ) compared to the non-depressed group ( $Mdn = 0.17$ ). Specifically, one-sample Wilcoxon Signed Rank tests showed a significant difference for the depressed group ( $Z = -2.42, p = .016$ ) compared to the non-depressed participants ( $Z = -1.072, p = .284$ ).

### *1.6 Types of Errors in Recognizing Anger at 20%*

The next step in the analysis was to further examine the nature group differences for anger. Accordingly, a confusion matrix analysis, with proportion of error, was performed to determine if participants were mistaking other emotions for anger when presented with the various emotion stimuli. Table 3 presents the proportion of times participants mistook anger for

another emotion at 20%. As one can see from Table 3, depressed and non-depressed appeared to be making similar errors with respect to anger. However, greater differences were detected for surprise and sadness, where non-depressed participants appeared to confuse anger with surprise and sadness more often than depressed participants.

Table 3

*Proportion of errors in recognizing facial expressions of anger at 20% intensity as a function of group (currently depressed or partially remitted and non-depressed participants) (N = 22)*

Type of error	Depressed (n = 11)		Non-Depressed (n = 11)	
	Mean	SD	Mean	SD
Surprise	0.05	0.10	0.14	0.26
Fear	0.02	0.08	0.05	0.10
Happiness	0.25	0.30	0.23	0.18
Disgust	0.07	0.16	0.07	0.16
Sadness	0.25	0.19	0.34	0.34

Inspection of the data revealed that with the exception of error for sadness, all variables were non-normally distributed. Data were skewed and kurtotic for the confusion of fear, disgust and surprise for anger for both groups. Moreover, several outliers were detected and heterogeneity of variance was detected for the confusion of anger for surprise, happiness and sadness. Because the data did not meet the assumptions necessary to conduct parametric tests, even following Arcsine transformations, non-parametric tests were used to determine whether group differences existed with respect to errors.

Mann-U tests revealed no significant differences between groups, suggesting that depressed and non-depressed participants were making the same errors with respect to anger.

This is somewhat of a surprising finding, given the large differences noted for sadness and surprise as seen in Table 3.

## *2.0 Recognition of Low Intensity Facial Expressions in Participants with a Lifetime History of Major Depression and Non-Depressed Participants*

In the second part of the analysis, differences in accuracy for low intensity emotion between those with a lifetime history of depression (including currently depressed participants and those in full or partial remission) and non-depressed participants were examined.

*2.1 Selection of participants.* The selection of participants followed the same strategy as in Section 1.1 of the analysis, however, participants were also included if they reported a lifetime history of depression, regardless of current status. Participants were once again eliminated based on whether or not they met criteria for inclusion into the study. As such, the same participants were eliminated as in Section 1 of the analysis.

Participants were then selected based on whether they had a lifetime history of depression. This included participants who were currently depressed, partially remitted, or in full remission. The same participants that were included as currently depressed or in partial remission in the first part of the analysis were included and those who were also in full remission were added to the dataset. At this phase of elimination, the total sample consisted of 60 participants, including 29 depressed and 31 non-depressed.

The groups were then divided taking into account their SCID-IV diagnosis and their BDI-II scores. As in the analysis presented in Section 1.1, participants were considered depressed if they presented with a lifetime history of depression and obtained a score of 10 or more on the BDI-II. In contrast, participants were considered non-depressed if they did not have a lifetime history of MDD and they obtained a score of 9 or less on the BDI-II. Using these criteria, a total

of eight participants were eliminated. The data set therefore consisted of 29 non-depressed and 23 depressed participants.

Consistent with the first phase of analyses, the next priority was to ensure that both groups were equivalent on key demographic variables known to affect facial recognition. These included, age, gender, and ethnicity. To this end, a total of 12 participants were eliminated on the basis of age within the non-depressed group (same participants as the first phase of analysis), whereas six participants were eliminated on the basis of age and gender in the depressed group. The sample for this analysis consisted of 34 participants, including 17 depressed and 17 non-depressed participants.

## *2.2 Demographic Variables*

*2.2.1 Depressed participants.* The depressed group consisted of 35.3% males and 64.7% females. The mean age was 40 years. Eighty-two percent of participants reported speaking English as their first language, followed by French at 11.8%, whereas 5.9 % reported speaking another language other than French and English. The majority of participants were Caucasian (82.4%), whereas 5.9% reported being Asian or Oriental, 5.9%, Hispanic, and 5.9% reported being Semitic or Arab.

All participants reported a lifetime history of major depression. In particular, 20% reported single episode and 80% reported recurrent MDD, all without seasonal pattern. With respect to remission, 26.7% reported partial and full remission (respectively) whereas 46.7% were currently depressed at the time of testing. Of those who were experiencing an acute episode, 6.7% reported mild symptoms, whereas 33.3% reported moderate symptoms.

With respect to other Axis I diagnoses, 11.8% reported a lifetime history of dysthymic disorder. In terms of substance use, 12.5% reported alcohol abuse, not current. A total of 11.8%

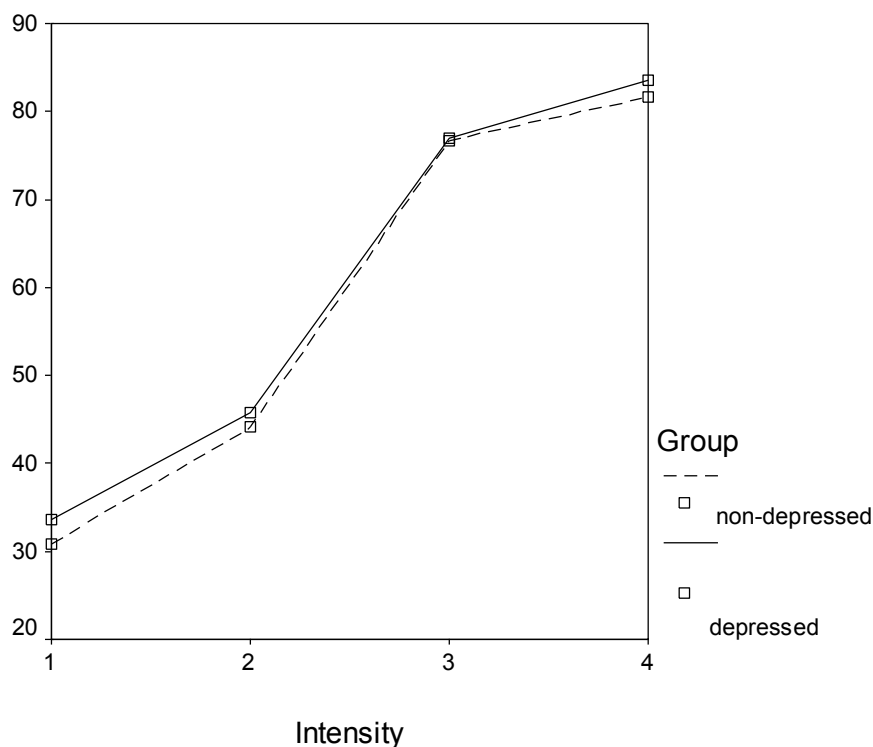
of participants reported cannabis abuse, not current. Moreover, 6.3% reported abuse of stimulants, 5.9% reported opioid dependence, 5.9% cocaine abuse, and 4.5% PCP abuse, all not current. In terms of anxiety, 5.9% reported a lifetime history of panic disorder. Current specific phobia was reported by 5.9% of participants and 5.9% reported a lifetime history of post-traumatic stress disorder. Finally, 5.9% reported a lifetime history of generalized anxiety disorder. The mean BDI-II score in the depressed group was  $M = 25.23$  ( $SD = 8.98$ ).

*2.2.2 Non-depressed participants.* The non-depressed group consisted of 29.4% males and 70.6% females. Mean age was 36.52 years. Approximately 53% of participants reported speaking English as their first language, 41.2% of participants reported French being their first language, and 5.9% reported being Bilingual. In terms of ethnicity, the majority of the sample consisted of mostly Caucasian participants (88.2%), followed by Semitic or Arab (5.9%) and Black (5.9%). The mean BDI-II score for the non-depressed group was  $M = 2.1$  ( $SD = 1.6$ ).

Independent sample *t*-tests (equal variances not assumed) revealed that both groups did not differ significantly in terms of age,  $t(32) = -.603$ ,  $p = .551$ . Moreover, chi square tests revealed that groups did not differ on key variables including gender,  $\chi^2(1, N = 34) = .134$ ,  $p = .714$  and ethnicity,  $\chi^2(4, N = 34) = 3.03$ ,  $p = .552$ . Additionally, the depressed group scored significantly higher than the non-depressed group on the BDI-II,  $t(17.28) = -10.41$ ,  $p = .000$ .

### *2.3 Overall Recognition of Facial Expressions*

Following the same procedure as described in Section 1.3, data were first examined with respect to intensity (20%, 30%, 50% and 100%) and group (depressed vs. non-depressed). Using the hit rate as the index of accuracy, a similar pattern of recognition emerges compared to what was detected in Section 1.3. In particular, one can note from Figure 2 that both groups are very similar in terms of recognition, with accuracy increasing as a function of intensity.



*Figure 2.* Overall accuracy (hit rate) as a function of group (lifetime history of depression and non-depressed participants) and intensity.

The next step in the analysis was to determine whether group differences existed with respect to recognition and intensity. The assumption of homogeneity of variance (as assessed by the Levene's test), sphericity (as assessed by Mauchly's Test of Sphericity) and covariance of matrices (as assessed by Box's Test of Equality of Covariances) were all met. Data were skewed and kurtotic for the non-depressed group for 30% intensity and for the depressed group at 100%. Non-normality was present for both the depressed and non-depressed group at 100%, at 50% for the non-depressed group, and 30% for the depressed group. One extreme outlier (+3.3 SD above the mean) was detected, and changed to the next extreme score. Following this transformation, only 30% and 50% intensities were non-normally distributed. However, given that ANOVA has been demonstrated to be robust against violations of non-normality, and there were no other

extreme outliers, a Repeated Measures ANOVA was used to examine group differences with respect to Hit Rate x Intensity.

A 2 (Group) x 4 (Intensity) ANOVA with repeated measures for the latter factor was conducted. Compared to Section 1.3, a similar trend emerged. Specifically, there was a significant effect for intensity,  $F(3, 32) = 377.55, p < .001$ , accounting for 92% of the variance. Significant differences were also detected between each of the four intensities (Tukey test). A trend analysis revealed that the linear trend was significant,  $F(1, 32) = 1037.82, p < .001$ . As with the above analysis, there was no significant effect for group,  $F(1, 32) = .445, p = .510$ , or the Group x Intensity interaction,  $F(3, 32) = .204, p = .655$ . A series of one sample *t*-tests showed that performance was above chance for each of the four intensities (20%, 30%, 50% and 100%),  $t(33) = 6.22, 10.55, 29.00, 30.34, p < .001$ , respectively.

#### *2.4 Recognition of Specific Facial Expressions at Low Intensities*

The next step in the analysis was to examine group differences with respect to emotion, intensity, and accuracy. Comparable to the analysis in Section 1.4, the unbiased hit rate (Wagner, 1993) was used as an index of accuracy for the same reasons outlined previously. Table 4 presents the accuracy scores for both depressed and non-depressed participants. Similar to Section 1.4 of the analysis, at 20% intensity, the largest differences between groups were observed for anger, where depressed participants appeared to be more accurate. Performance between groups appeared very similar for the other emotions.

Table 4

*Recognition accuracy (unbiased hit rate) for low intensity facial expressions as a function of group (lifetime history of depression and non-depressed participants), emotion, and intensity (20% and 30%) (N = 34)*

		Non-Depressed (n = 17)		Depressed (n = 17)	
Intensity		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Anger	20%	0.09	0.12	0.27	0.21
Anger	30%	0.26	0.27	0.31	0.18
Disgust	20%	0.24	0.17	0.22	0.19
Disgust	30%	0.39	0.25	0.40	0.25
Happiness	20%	0.25	0.10	0.24	0.13
Happiness	30%	0.40	0.22	0.40	0.17
Sadness	20%	0.11	0.07	0.13	0.07
Sadness	30%	0.14	0.13	0.21	0.17
Surprise	20%	0.08	0.08	0.06	0.13
Surprise	30%	0.22	0.16	0.22	0.23
Fear	20%	0.01	0.06	0.00	0.20
Fear	30%	0.08	0.10	0.04	0.08

Prior to investigating group differences, the data were first inspected to ensure that criteria for parametric tests were met. In the depressed group, data were non-normally distributed for disgust, fear, surprise at 20% and 30% intensity; and for sadness at 20% intensity. For the non-depressed group, Shapiro-Wilks tests were significant for anger and surprise at 20%; and for anger, disgust, and fear at 30% intensity. Numerous outliers were detected for both groups. Data were also skewed and kurtotic for anger, disgust, and happiness at 30%; and fear at 20% within the non-depressed group. In the depressed group, data were skewed and kurtotic for fear and surprise at 20% and fear at 30% intensity. The assumption of homogeneity of variance was met

for all variables. The data was then transformed using an Arcsine transformation, however, this did not help normalize the distribution and outliers were still detected.

Due to similar limitations with respect to variability and normality, the same strategy of analysis was used as in Section 1.4. Specifically, a series of non-parametric tests (Mann-Whitney U) was used to determine whether group differences existed, first at 20% and then at 30% intensity. Six Mann-Whitney U tests were performed using the unbiased hit rate for each emotion at 20% intensity. Consistent with the analysis in Section 1.4, group differences were detected for anger at 20%,  $U(34) = 72.5$ ,  $z = -2.57$ ,  $p = .01$ , where depressed participants were more accurate ( $M = .27$ ) at detecting anger compared to non-depressed comparisons ( $M = .09$ ).

As one can also see from Table 4, at 30%, performance in the two groups was very similar with little variability amongst the scores. The largest differences were between fear and sadness. A series of six Mann Whitney U tests was then performed for each emotion at 30% intensity using the unbiased hit rate. Consistent with the analysis in Section 1.4, no group differences emerged.

### *2.5 Utilization of Response Categories for Low Intensity Facial Expressions*

The next step in the analysis consisted of examining whether participants tended to use specific emotion categories more than others. In keeping with the main line of analysis examining low intensities, biases at 20% intensity were examined first, followed by those at 30% intensity.

As one can see from Table 5, the pattern of responding is similar to what was observed in Section 1.5; however, the magnitude of differences among the groups is smaller. Depressed and non-depressed participants show the same pattern in terms of the use of categories; however, the

greatest magnitude of difference is present for anger, surprise, and happiness at 20%; and for surprise at 30% intensity.

Table 5

*Utilization of response categories (expressed in terms of proportion of responses) for low intensity facial expressions as a function of group (lifetime history of depression and non-depressed participants), emotion, and intensity (20% and 30%) (N = 34)*

Emotion	Non-Depressed (n = 17)		Depressed (n = 17)	
	Mean	SD	Mean	SD
20% Intensity				
Anger	0.09	0.11	0.14	0.13
Disgust	0.12	0.08	0.12	0.07
Happiness	0.28	0.13	0.33	0.17
Fear	0.03	0.05	0.03	0.04
Surprise	0.11	0.10	0.04	0.05
Sadness	0.37	0.16	0.34	0.13
30% Intensity				
Anger	0.14	0.09	0.17	0.11
Disgust	0.12	0.08	0.14	0.07
Happiness	0.26	0.10	0.26	0.13
Fear	0.04	0.05	0.05	0.05
Surprise	0.14	0.07	0.08	0.07
Sadness	0.30	0.13	0.30	0.13

Within the depressed group, the data were skewed and kurtotic for anger and fear at 20% intensity. Within the non-depressed group, data were skewed and kurtotic for anger, fear and surprise at 20%; and anger and fear at 30% intensity. Homogeneity of variance was met for all variables. The data were subsequently transformed using an Arcsine transformation; however, this did not improve the distribution.

Due to non-normality of the data, non-parametric tests were used to examine group differences in utilization of response categories. Mann-Whitney U tests revealed significant group differences for surprise at 20%,  $U(34) = 79.50, z = -2.30, p = .02$ , and at 30%,  $U(34) = 70.00, z = -2.60, p = .01$ . More specifically, non-depressed participants tended to use surprise more often at 20% and 30% compared to depressed participants. This is similar to the findings in Section 1.5.

Follow up one-sample Wilcoxon Signed Rank tests demonstrated that depressed participants showed a significant negative bias towards surprise ( $Mdn = .04$ ) at 20% intensity ( $Z = -2.09, p = .004$ ) whereas non-depressed participants showed a trend with respect to a negative bias ( $Mdn = .08; Z = -1.024, p = .054$ ). A significant negative bias was also detected for the depressed group at 30% intensity, ( $Mdn = .08; Z = -3.22, p = .001$ ).

### 2.6 Proportion of Errors in Recognizing Facial Expressions of Anger at 20% Intensity

Given that group differences were detected for anger at 20% the next step in the analysis was to determine the nature of these errors, specifically, whether participants were confusing anger. Table 6 presents the proportion of errors for anger at 20% intensity.

Table 6

*Proportion of errors in recognizing facial expressions of anger at 20% intensity as a function of group (lifetime history of depression and non-depressed participants) (N = 34)*

	Non Depressed (n = 17)		Depressed (n = 17)	
	Mean	SD	Mean	SD
Confusion of anger (20%)				
For other emotions				
Surprise	0.09	0.21	0.04	0.10
Fear	0.04	0.10	0.03	0.08
Happiness	0.24	0.20	0.21	0.25
Disgust	0.04	0.13	0.07	0.15
Sadness	0.40	0.30	0.24	0.18

Examination of Table 6 suggests that, with the exception of sadness, depressed and non-depressed individuals demonstrated a similar pattern with respect to the types of errors that they were making. Specifically, the greatest differences were detected for sadness, and both groups appeared to have a tendency to confuse anger with sadness the most, while disgust and fear were least likely to be confused for anger.

The data was then analyzed to determine whether group differences in error were present. Non-normality was detected for all emotions, except for sadness for the non-depressed group. A total of 14 extreme outliers were detected. Data were skewed and kurtotic for the confusion of anger for fear, disgust, and surprise within both groups. Levene's test showed that the assumption of homogeneity of variance was violated for sadness. Transformations did not improve the distribution.

Due to non-normality of the data and number of outliers, non-parametric tests were used to determine whether group differences existed for both anger. To this end, the Mann Whitney U test did not reveal any significant group differences. This result is consistent with the analysis presented in Section 1.6, suggesting that depressed and non-depressed participants were committing the same types of errors.

### *3.0 Recognition of Medium (50%) and High (100%) Intensity Facial Expressions in Participants with Current Depression or Partial Remission, Lifetime History of Depression, and Non-Depressed Participants*

The next phase of the analysis consisted of examining recognition accuracy among the different groups for medium (50%) and high (100%) intensity facial expressions. Although the focus of the study was on low intensity, examining group differences for high intensity emotions could provide information concerning the extent of the differences between groups (i.e., are the

differences were noted specific to low intensity, or are similar differences for accuracy at higher intensities present as well?).

The next section of the analysis followed a similar pattern to Sections 1 and 2. Specifically, group differences for accuracy, the nature of the errors, and the use of specific emotion categories were considered. These differences were also examined with respect to diagnostic group (currently depressed or partially remitted participants, those with a lifetime history of depression, and non-depressed comparisons).

### *3.1 Recognition of Specific Facial Expressions*

*3.1.1 Currently depressed or partially remitted participants and non-depressed participants.* The next step in the analysis was to examine group differences with respect to emotion and intensity. Once again, the unbiased hit rate (Wagner, 1993) was used as an index of accuracy. Table 7 presents the accuracy scores for both depressed and non-depressed participants for medium (50%) and high intensity (100%). Examination of this table suggests that both groups were very similar with respect to accuracy at both medium and high intensity.

Table 7

*Recognition accuracy (unbiased hit rate) as a function of group (currently depressed or partially remitted and non-depressed participants), emotion, and intensity (50% and 100%) (N = 22)*

		Non-Depressed (n = 11)		Depressed (n = 11)	
Intensity		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Anger	50%	0.68	0.31	0.73	0.16
Anger	100%	0.72	0.25	0.84	0.16
Disgust	50%	0.70	0.19	0.60	0.31
Disgust	100%	0.75	0.15	0.66	0.19
Happiness	50%	0.70	0.10	0.78	0.17
Happiness	100%	0.98	0.08	0.95	0.10
Sadness	50%	0.54	0.33	0.59	0.27
Sadness	100%	0.72	0.37	0.77	0.35
Surprise	50%	0.58	0.23	0.60	0.22
Surprise	100%	0.68	0.29	0.73	0.26
Fear	50%	0.43	0.35	0.47	0.30
Fear	100%	0.66	0.32	0.53	0.35

The values for the unbiased hit rate in Table 7 are indicative of a somewhat different pattern of accuracy for the two groups at the different intensities. Specifically, with the exception of disgust and fear, depressed participants were generally better at recognition at 50% intensity. At 100% intensity, depressed participants were more accurate for anger, sadness, and surprise; whereas non-depressed participants better recognized fear, happiness, and disgust (although these differences appear to be minimal).

The data were first screened to determine whether all assumptions of parametric tests were respected. Non-normality, as assessed by the Shapiro-Wilks test, was detected for surprise

(depressed group) and for happiness and fear (non-depressed group) at 50%, and for anger (depressed and non-depressed), disgust and happiness (depressed), and sadness (depressed and non-depressed) at 100% intensity. Data were skewed and kurtotic for happiness and anger at 100% for both groups and kurtotic for disgust within the non-depressed group. Several outliers were detected for anger, disgust, and happiness, at 100% intensity. Levene's tests demonstrated that homogeneity of variance was respected for all variables. The data were then transformed using an Arcsine transformation. The data continued to be non-normally distributed and contaminated by outliers. Accordingly, non-parametric tests were used to examine group differences in recognition accuracy at medium and high intensity.

Given that the data were drawn from the same data set as in Section 1 and 2 of the analysis the same limitations were present with respect to the distribution of the data, requiring a conservative approach to the analysis. Accordingly, a series of Mann-Whitney U tests was used to determine whether group differences existed, first at 50% and then at 100% intensity. Results indicated that there were no significant group differences at medium and high intensities with respect to accuracy. This is not surprising given the pattern of results observed in Table 7.

### *3.1.2 Participants with lifetime history of depression and non-depressed participants.*

The unbiased hit rates for depressed and non-depressed participants are summarized in Table 8. Consistent with the above analysis, depressed participants were generally more accurate at 50% intensity compared to non-depressed controls (with the exception of disgust and fear). At 100% intensity, with the exception of surprise (favouring depressed participants), performance was very similar for both groups and showed very minor differences between each emotion.

Table 8

*Recognition accuracy (unbiased hit rate) as a function of group (lifetime history of depression and non-depressed participants), emotion, and intensity (50% and 100%) (N= 34)*

		Non-Depressed (n = 17)		Depressed (n = 17)	
Intensity		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Anger	50%	0.70	0.27	0.73	0.16
Anger	100%	0.80	0.23	0.85	0.15
Disgust	50%	0.70	0.22	0.62	0.28
Disgust	100%	0.77	0.19	0.74	0.20
Happiness	50%	0.79	0.16	0.83	0.17
Happiness	100%	0.96	0.10	0.96	0.10
Sadness	50%	0.64	0.30	0.66	0.27
Sadness	100%	0.79	0.32	0.82	0.28
Surprise	50%	0.64	0.22	0.68	0.23
Surprise	100%	0.67	0.31	0.79	0.23
Fear	50%	0.32	0.18	0.29	0.16
Fear	100%	0.65	0.31	0.66	0.34

Prior to investigating group differences with respect to accuracy, data were screened to determine suitability for parametric tests. Shapiro-Wilks tests were violated for happiness at 50% (for both groups); for anger, disgust, happiness, sadness, and fear at 100% intensity (both groups); and for surprise at 100% for the depressed group. Several outliers were detected. The assumption of homogeneity of variance was met (as assessed by the Levene test). A number of outliers were also present.

Due to the fact that data did not meet assumptions of normality and there were a number of extreme outliers, Mann-Whitney U tests were used to examine group differences with respect

to accuracy at medium and high intensities. Results indicated that there were no significant group differences. This is consistent with the very small magnitude of group differences observed in Table 8.

### *3.2 Utilization of Response Categories for Medium and High Intensity Facial Expressions*

*3.2.1 Currently depressed or partially remitted participants and non-depressed participants.* The next step in the analysis included examining the use of specific emotion categories at 50% and 100% intensities. As one can see from Table 9, non-depressed and depressed participants showed similar patterns with respect to use of categories. However, notable differences are those for anger at 50% and 100% intensity, where depressed participants appeared to use anger more often than non-depressed participants. Moreover, non-depressed participants appeared to be using more disgust at 100% compared to non-depressed participants.

Table 9

*Utilization of response categories (expressed in terms of proportion of responses) for medium and high intensity facial expressions as a function of group (currently depressed or partially remitted and non-depressed participants) and emotion (N = 22)*

Emotion	Non-Depressed (n = 11)		Depressed (n = 11)	
	Mean	SD	Mean	SD
50% Intensity				
Anger	0.14	0.06	0.19	0.06
Disgust	0.19	0.07	0.16	0.04
Happiness	0.17	0.04	0.17	0.05
Fear	0.13	0.07	0.11	0.06
Surprise	0.22	0.05	0.20	0.11
Sadness	0.15	0.08	0.17	0.06
100% Intensity				
Anger	0.15	0.06	0.19	0.03
Disgust	0.21	0.09	0.16	0.06
Happiness	0.16	0.01	0.16	0.02
Fear	0.13	0.05	0.12	0.07
Surprise	0.21	0.07	0.22	0.05
Sadness	0.14	0.04	0.15	0.03

Examination of the data revealed non-normality at 50% intensity for the following emotions: disgust (depressed and non-depressed) and surprise (non-depressed). At 100% intensity, non-normality was detected for anger, happiness, and sadness (depressed and non-depressed); disgust, fear, and surprise for the non-depressed group; and surprise for the depressed group. A total of six extreme outliers were detected. Disgust and happiness were skewed and kurtotic at 100%, whereas disgust was skewed and kurtotic at 50% intensity. Following an Arcsine transformation, there were six extreme outliers and the data continued to remain non-normally distributed.

Due to limitations with respect to the distribution of the data, Mann-Whitney U tests were used to further examine group differences. Results revealed significant group differences for anger at 50%,  $U(22) = 31.00, z = -1.98, p = .047$ , whereas differences were nearing significance at 100%,  $U(22) = 33.00, z = -1.87, p = .060$ . Specifically, depressed participants ( $M = .19$ ) were using more anger at 50% intensity compared to non-depressed participants ( $M = .14$ ).

One-sample Wilcoxon signed rank tests revealed that compared to non-depressed participants ( $Mdn = 0.17$ ), depressed participants demonstrated a positive bias towards anger at 50% intensity ( $Mdn = 0.21; Z = 1.97, p = .049$ ). At 100% intensity, there was a trend towards significant group differences. However, examination of the biases within each group revealed that the depressed group showed a significant positive bias towards anger ( $Mdn = 0.17; Z = 2.99, p = .003$ ) compared to the non-depressed group ( $Mdn = 0.12; Z = .181, p = .857$ ).

### *3.2.2 Participants with lifetime history of depression and non-depressed comparisons.*

The use of specific response categories was examined for participants presenting with a lifetime history of depression and non-depressed controls. Table 10 presents the proportion of use of specific emotion categories at medium and high intensities. Depressed and non-depressed groups showed a very similar pattern with minute differences between emotion categories and intensities (with the exception of anger at 50% intensity).

Table 10

*Utilization of response categories (expressed in terms of proportion of response) for medium and high intensity facial expressions as a function of group (lifetime history of depression and non-depressed participants) and emotion (N = 34)*

Emotion	Non-Depressed (n = 17)		Depressed (n = 17)	
	Mean	SD	Mean	SD
50% Intensity				
Anger	0.16	0.06	0.20	0.06
Disgust	0.17	0.07	0.15	0.05
Happiness	0.17	0.04	0.16	0.04
Fear	0.14	0.08	0.13	0.07
Surprise	0.20	0.06	0.19	0.09
Sadness	0.16	0.07	0.17	0.06
100% Intensity				
Anger	0.16	0.05	0.19	0.04
Disgust	0.19	0.07	0.16	0.05
Happiness	0.16	0.02	0.16	0.02
Fear	0.15	0.06	0.14	0.06
Surprise	0.19	0.07	0.20	0.05
Sadness	0.15	0.04	0.15	0.03

Prior to investigating group differences for uses of specific emotion categories, data were inspected to determine whether assumptions were met to conduct parametric tests. At 50% intensity, non-normality was detected for disgust (both groups); happiness and surprise (non-depressed); and sadness (depressed). At 100% intensity, non-normality was detected for anger, happiness, fear, surprise, and sadness (both groups); and disgust (non-depressed). There were a total of eight outliers. Upon completing an Arcsine transformation, the data remained non-normally distributed on several variables and there continued to be extreme outliers.

Accordingly, non-parametric tests were used to examine group differences in the use of categories. Mann-Whitney U tests confirmed that the differences observed in Table 10 were non-significant. However, a trend towards significance emerged for anger at 50%,  $U(34) = 92.00, z = -1.86, p = .064$ . Examination of the group biases using the one sample Wilcoxon signed rank test revealed that depressed participants demonstrated a positive bias towards anger at 50% intensity ( $Mdn = .21; Z = 2.84, p = .005$ ), compared to non-depressed participants ( $Mdn = .17, Z = .78, p = .461$ ).

#### *4.0 Examination of the Relationship Between Mood State and Recognition Accuracy*

The next step in the analysis consisted of examining to what extent accuracy in detecting emotions was related to mood state. Research to date has been unclear as to whether depressed mood would suggest a bias towards negative or positive emotional signals. In order to investigate this relationship, a regression analysis was used to determine whether accuracy could be predicted based on participants' mood state during the experimental task. Of particular interest was the POMS elated-depressed scale (POMS-ED), which measured the degree to which participants were experiencing positive mood (i.e., joy and elation) on one pole, and negative mood (i.e., dejection and loneliness) on the negative pole. The agreeable-hostile subscale (POMS-AH) was included. This scale measures the degree to which participants endorsed feeling "friendly, kind, sympathetic" on the positive pole and "grouchy, annoyed, angry" (Lorr & McNair, 1982) on the negative pole. Given that these scales are bipolar, we can make predictions with respect to positive or negative mood state.

The depressed-elated scale was selected as it relates to negative and depressed mood, which is consistent with the primary hypotheses of the current study. The agreeable-hostile scale was selected as another independent variable because significant group differences for anger at

low intensity were detected. Examining this scale would assist in determining whether these differences might be better explained by this mood state.

Happiness, sadness, and anger were considered as the emotion categories for this analysis. The reasons for choosing these specific emotions are twofold. First, happiness and sadness are the closest conceptually to the elated-depressed scale of the POMS-BI. Secondly, anger was chosen as the current study has already detected a group difference with respect to accuracy, where depressed individuals appear to be more accurate than non-depressed participants.

Prior to conducting the regression analyses, data were first inspected to ensure that criteria were met in order to proceed with a linear regression analysis. It is important to note that each of the emotion categories consisted of four trials. As a result, similar issues with respect to the distributions that were encountered in Sections 1, 2, and 3 were expected. The problem with the small number of trials is that it can jeopardize the assumptions of the regression analysis. To correct for this, the intensities were combined in order to increase the number of trials per emotion, thereby increasing the normality of the distributions.

#### *4.1 Regression Analysis with POMS Elated-Depressed Scale and POMS Agreeable-Hostile Scale*

*4.1.1. Low intensity emotion.* In keeping with the main hypotheses, ungrouped data for happiness, sadness, and anger were first considered at low intensity (20% and 30%). The POMS elated-depressed scale (POMS-ED) was also screened to ensure that all criteria were met. At 20% intensity, anger was moderately skewed. Anger was also non-normally distributed (Kolomogrov-Smirnov tests). Both anger and sadness and the POMS-ED scale had one extreme outlier each. Initial frequencies were also run on the POMS agreeable-hostile variable

(POMS-AH). The POMS-AH was slightly skewed. One outlier was detected and was increased to the next extreme score. Re-examination of frequencies and distribution demonstrated that the variable no longer had any outliers and was normally distributed. At 30% intensity, sadness was moderately skewed and kurtotic. Moreover, happiness and sadness were non-normally distributed (Kolmogorov-Smirnov tests). Three outliers were detected for happiness and two were detected for sadness. These were once again reduced or increased to the next extreme score. These transformations improved the distribution of the variables. However, anger at 20% continued to remain non-normally distributed ( $p = .026$ ). Next, Mahalanobis distances were examined and there were no multivariate outliers at  $p < .001$ .

Inspection of residuals was then conducted to determine whether regression assumptions had been satisfied. The assumption of homoscedasticity was met through visual inspection of the data as well as the Breusch-Pagan test ( $p > .05$ ) for all variables. Visual inspection and lack of fit tests demonstrated that the assumption of linearity had been satisfied, as was the assumption of normality of errors (visual inspection and Kolmogorov-Smirnov tests).

However, given that anger at 20% remained non-normally distributed, even following transformation, this could not be included in the regression analysis. As such, variables at 20% and 30% intensities were combined to form three separate low intensity variables, rather than six.

Data were then screened using the combined low intensity variables. All distribution assumptions were met for the combined happiness variable. One outlier was detected for the combined sadness variable, however examination of standard scores revealed that this was not extreme and was therefore maintained in the analysis. All assumptions were met for the combined anger variable as well. Mahalanobis distances continued to reveal no multivariate outliers. Examination of residual plots and the Breusch-Pagan test revealed that the assumption

of homoscedasticity was respected ( $p > .05$ ). Moreover, lack of fit tests and visual inspection of the graphs demonstrated that the assumption of linearity was also satisfied, as was the assumption of normality of errors.

Separate regression analyses were then performed for each emotion separately (happiness, sadness, anger) and the POMS-ED and POMS-AH scales entered as the independent variables. The primary interest was examining whether accuracy can be predicted based on mood state. Table 11 presents a summary of the regression analyses for low intensity emotion.

*4.1.1.1 Combined happiness 20% and 30%.* Using the Enter method, a standard regression was run with POMS-AH, POMS-ED, and combined low intensity happiness. The overall  $R$  for regression was non-significant,  $F(2, 43) = .075, p = .928$ . Moreover, none of the criterion variables contributed significantly to the model.

*4.1.1.2 Combined sadness 20% and 30%.* Regression analyses with POMS-AH, POMS-ED and the combined sadness variable also emerged as non significant,  $F(2, 43) = 1.582, p = .217$ . Additionally, POMS-AH and POMS-ED did not significantly contribute to the model.

*4.1.1.3 Combined anger 20% and 30%.* The POMS-AH and POMS-ED scales also did not appear to be significant predictors of accuracy for low intensity anger. Specifically, the regression model also emerged as non-significant,  $F(2, 43) = .512, p = .603$ . Moreover, the two mood scales did not independently contribute to the prediction of accuracy.

The present results suggest that at low intensity emotion, mood state does not play a significant role in the ability to predict accuracy scores for happiness, sadness, and anger.

Table 11

*Summary of multiple linear regression analysis for variables predicting accuracy scores for low intensity emotion for happiness, sadness, and anger (N = 46)*

Low Intensity Happiness			
Variable	<i>B</i>	<i>SE B</i>	$\beta$
POMS-AH	.001	.003	.085
POMS-ED	.000	.002	-.047
Low Intensity Sadness			
Variable	<i>B</i>	<i>SE B</i>	$\beta$
POMS-AH	.003	.002	.392
POMS-ED	-.002	.001	-.258
Low Intensity Anger			
Variable	<i>B</i>	<i>SE B</i>	$\beta$
POMS-AH	.001	.003	.086
POMS-ED	-.002	.002	-.206

*Note:* POMS ED = POMS Elated-Depressed; POMS AH = Agreeable Hostile;  $R^2$  for happiness = .003;  $R^2$  for sadness = .069;  $R^2$  for anger = .023

#### *4.1.2 Medium and High Intensity Emotion*

Next, the relationship between medium (50%) and high (100%) intensity emotion and the POMS-ED scale was examined. At 50% intensity, all variables were normally distributed. One extreme outlier was detected for anger. Value transformations reduced the extremeness of this

outlier and variables were all normally distributed. At 100% intensity, happiness and sadness were significantly skewed and kurtotic. Two outliers were detected for anger, whereas happiness and sadness had many outliers. Non-normality was also detected for happiness and sadness. Accordingly, value transformations were used for anger, whereas happiness and sadness were arcsine transformed. The arcsine transformation did not improve the distribution. Mahalanobis distances revealed that there were no multivariate outliers for 50% and 100% intensity at  $p < .001$ .

Given the nature of the distributions at 100% intensity, the values for 50% and 100% intensities were combined for each of the emotion variables to form three different independent variables (combined anger, happiness, and sadness). Normality checks were and initial frequencies were re-examined. The combined happiness and anger variables appeared to have a normal distribution and did not have any outliers. There were no multivariate outliers at  $p < .001$ . The assumptions of homoscedasticity were met (through visual inspection and Breusch-Pagan test,  $p > .05$ ). Visual inspection of the data suggested that the assumption of normality of errors was met and lack of fit tests suggested that the assumption of linearity was respected.

The combined sadness variables revealed some important issues with respect to the distribution. First, the combined sadness variable revealed some moderate skewness (skewness =  $-.703$ , SE =  $.350$ ). No outliers were detected. The assumption of homoscedasticity was not met (visual inspection and Breusch Pagan test,  $p > .05$ ). The assumption of linearity was met and there were no multivariate outliers. Accordingly, data was then Arcsine transformed to improve normality. Initial frequencies and normality tests revealed that the transformed data was no longer skewed. All other assumptions were met, however, the residuals were no longer linear. As such, the decision to use the non-transformed data was made. According to Tabachnik and

Fidell (2007), violations in homoscedasticity are less serious than those of linearity. The regression summary table is presented in Table 12.

*4.1.2.1 Combined happiness 50% and 100%.* A regression analysis with POMS-ED and POMS-AH as independent variables and happiness at high intensity was performed. Using the Enter method, results suggested that the overall model was non-significant,  $F(2, 43) = 1.052, p = .358$ . Moreover, POMS-AH and POMS-ED did not significantly contribute independently to the model.

*4.1.2.2 Combined sadness 50% and 100%.* Next, a regression analysis with the combined sadness variable and the two POMS scales was conducted. Due to the fact that the data was heteroscedastic, the alpha was corrected to .001 (Tabachnik and Fidell, 2007). This revealed a non-significant model as well,  $F(2, 43) = .949, p = .395$ . Moreover, none of the criterion variables significantly contributed to the model.

*4.1.2.3 Combined anger 50% and 100%.* Finally, the combined anger variable and POMS-AH and POMS-ED were entered into the regression analysis. The overall  $R$  for regression was non significant,  $F(3, 42) = .420, p = .379$ . However, inspection of the criterion variables indicated a significant contribution of the POMS-AH in predicting accuracy,  $t = 2.12, p = .04$ . The POMS-AH scale revealed a near significant correlation with the combined anger variable [ $R(46) = .222, p = .069$ ]. Additionally, the POMS-ED scale revealed a non-significant relationship with the accuracy scores [ $R(46) = .025, p = .434$ ]. When entered into the regression equation, it becomes evident that the POMS-ED is somehow affecting the contribution of the POMS-AH scale. Specifically, partial correlations revealed that POMS-AH is contributing approximately 6% of the variance, and POMS-ED contribution increases to approximately 4%.

The combination of the POMS-ED with the POMS-AH adds some predictability to accuracy, but only for the POMS-AH scale.

Based on these results, one cannot make predictions with respect to accuracy at high intensity and mood state. However, although the whole model was non-significant, it appears that there is some evidence of a relationship between the combination of agreeable-hostile scale of the POMS and the POMS elated-depressed scale and accuracy for anger. Specifically, higher scores on the POMS-AH were predictive of greater accuracy.

Table 12

*Summary of multiple linear regression analysis for variables predicting accuracy scores for high intensity emotion for happiness, sadness, and anger (N = 46)*

High Intensity Happiness			
Variable	<i>B</i>	<i>SE B</i>	$\beta$
POMS-AH	.002	.002	.228
POMS-ED	-.002	.002	-.325
High Intensity Sadness			
Variable	<i>B</i>	<i>SE B</i>	$\beta$
POMS-AH	.006	.005	.290
POMS-ED	-.005	.004	-.291
High Intensity Anger			
Variable	<i>B</i>	<i>SE B</i>	$\beta$
POMS-AH	.007	.003	.464*
POMS-ED	-.004	.002	-.322

*Note:* POMS-ED = POMS Elated-Depressed; POMS-AH = Agreeable Hostile;  $R^2$  for happiness = .047;  $R^2$  for sadness = .042;  $R^2$  for anger = .095

\* $p < .05$

Taken together, these analyses suggest that although group differences emerged for the depressed and non-depressed group, predictions with respect to accuracy based on happy vs. depressed or agreeable vs. hostile mood states (regardless of depressive status) and low intensity

emotion cannot be made. However, at high intensity, a relationship between anger and accuracy begins to emerge. This finding is interesting, as in Sections 1 and 2, significant group differences were detected for accuracy at low (20%) intensity.

### Discussion

The main goal of the current study was to examine the nature of group differences between depressed and non-depressed individuals with respect to accuracy in the decoding of emotional facial expressions. Of secondary interest was the examination of whether group differences were related to judgment biases and whether one can predict accuracy based on mood state ratings. Past research has yielded contradictory results. These mixed results can be attributed to methodological issues, primarily with respect to measurement of accuracy (hit rate) and bias (typically expressed as errors). To correct for this, accuracy was measured using unbiased hit rate, a more precise measure of accuracy, and a more precise measure of biases proposed by signal detection theory (Green & Swets, 1966) was incorporated. The range of intensity was also expanded and the six basic emotions were considered. Explanations for differences in the literature have also primarily been rooted in cognitive models of MDD, however other models such as interpersonal and cognitive-interpersonal can also provide some insight into the nature of these discrepancies.

The current findings were consistent with studies that found that accuracy increases as a function of intensity for both depressed and non-depressed participants. Significant group differences were detected for accuracy at low intensity (20%) for anger. Specifically, both depressed groups (currently depressed and partially remitted participants and those with a lifetime history of depression) were more accurate in detecting anger in comparison to non-depressed participants. Additionally, both depressed (currently depressed and partially remitted

participants and those with a lifetime history of depression) and non-depressed groups made similar errors. However, the non-depressed group tended to use surprise (at 20% and 30% intensity) significantly more than both of the depressed groups. This difference was characterized by a bias away from surprise at low intensity for the depressed groups.

At medium and high intensity (50% and 100%) depressed and non-depressed participants demonstrated similar levels of accuracy. However, the currently depressed and partially remitted group tended to overuse anger at 50%. This was characterized by a bias towards anger for the depressed group. At 100% intensity, a positive bias towards anger for the depressed group resulted in a trend.

In terms of the regression analysis, which aimed to determine whether one could predict accuracy based on mood state, all models were non-significant. The only exception was the model for predicting accuracy for anger at high intensity as a function of the POMS-AH scale. The overall model was non-significant, however the criterion variable POMS-AH was significant, but only in the presence of the POMS- ED scale suggesting that this may be a suppressor variable. The implications of these findings are presented below.

The finding that depressed individuals are more accurate at detecting anger highlights the differences between studies that use the hit rate vs. using the unbiased hit rate (a more precise measure that accounts for the use of categories of emotions). This has implications in terms of how we conceptualize the processing of interpersonal stimuli in depressed compared to non-depressed individuals. In conjunction with these findings, including a range of emotion and intensities also adds to the understanding of these differences. The results of this study are novel for several reasons; (a) depressed individuals were found to be more accurate compared to non-depressed participants, (b) anger appears to be the emotion that emerges as significant, rather

than the hypothesized sadness or happiness expressions, and (c) applying a more sensitive measure of accuracy is essential in assessing group differences in decoding facial expressions.

#### *Accuracy and Judgment Biases at Low Intensity Emotion*

The current study found that depressed individuals were more accurate than non-depressed participants at detecting anger. This is a particularly surprising result. First, this runs contrary to what would be expected based on cognitive theories of depression and studies examining the decoding of facial expression. Moreover, this finding puts to test the notion that MDD is characterized by deficits in processing socially related information.

From a theoretical standpoint, the differences in accuracy for anger begin to support emerging literature on the role of interpersonal stimuli, in particular social threat, to the development and maintenance of MDD. The biases that were detected at 50% intensity for the currently depressed group suggest that acute stages of MDD lead to greater biases with respect to socially threatening information. This leads one to believe that chronicity plays a role in the types of biases that emerge in MDD. Greater intensity in emotion could lead to a greater awareness of threatening information, contributing to the activation of negative interpersonally related thoughts. This could then lead to the acutely depressed individual having a negative bias towards processing of socially threatening information.

The findings related to anger are also surprising given that the processing of threat related information is typically characteristic of anxiety as opposed to depression. However, some studies have already begun to examine the role of social threat (namely anger) in MDD. Mathews and colleagues (1996) demonstrated that depressed individuals show evidence of an attentional bias towards socially threatening words (i.e., inept and friendless) compared to those with anxiety. Although some of the studies that examine anger often do so to determine

specificity between anxiety and depression in terms of attentional biases or memory (Gilboa-Schechtman et al., 2002; Joorman & Gotlib, 2006), some have found that anger does appear to play a role in the expression or maintenance of depression. Leyman and colleagues (2007) found that depressed individuals showed greater attention to angry compared to neutral faces, whereas non-depressed individuals generally displayed decreased attention to the former. Moreover, other studies have found that depressed individuals show better memory for angry faces compared to non-depressed individuals (Gilboa-Schechtman, et al., 2002; Wells, Beevers, Robison, & Ellis, 2010). Additionally, the finding that dysphoric individuals process angry faces differently than non-dysphoric individuals maintains that interpersonal sensitivity may be an overlapping variable between depressed mood and anxiety (in this case, social anxiety; Wells et al., 2010). However, the current study ruled out participants presenting with social anxiety disorder.

It has been suggested that those high in rejection sensitivity are able to quickly allocate and divert their attention to signals of possible rejection, thereby activating defensive and protective behaviours that may lead to withdrawal or avoidance of relationships. In testing this, Berenson and colleagues (Berenson, Gyurak, Ayduk, Downey, Garner, Mogg et al., 2009) supported the notion of disrupted attention. However, they did not find that this was specific to depression, but rather to borderline personality disorder. Nevertheless, rejection sensitivity is a variable that has been implicated in the disruption of interpersonal relationships and is what appears to drive excessive reassurance seeking behaviours (Coyne, 1976a). Therefore, it could be hypothesized that in the context of MDD the disruption of attention caused by social rejection leads to checking in behaviours rather than avoidance behaviours to alleviate the fear associated with possible rejection.

The biases detected at 50% intensity could partially be explained by the role of rumination. Anger related events have been shown to elicit greater feelings of anger when participants are asked to think about why a specific event occurred. Rumination has also been shown to have an effect on depressive severity. Accordingly, if one is already prone to engage in rumination and one is faced with triggers of previous experiences with anger (i.e., facial expressions of anger) then it could be hypothesized that these events were already primed, leading to a greater bias in detecting anger (Nolen-Hoeksma, 1991; Wimalaweera & Moulds, 2008). The current study adds to this literature by demonstrating greater accuracy in the detection of facial expressions at low intensity and judgment biases at higher intensity. The emerging literature on MDD and social threat highlight the importance of taking a cognitive-interpersonal approach to the conceptualization of MDD.

As mentioned earlier, the findings concerning anger appeared to run counterintuitive to current cognitive conceptualizations of MDD. Cues related to the self, sadness, and loss are generally hypothesized to be the driving force behind the development of MDD. However, the findings that are detected in terms of anger are not that surprising when examined through an interpersonal lens. As Coyne (1976a) and others have suggested, individuals with depression demonstrate an excessive tendency to elicit feedback and to seek reassurance from others. This process becomes frustrating leading to anger and hostility in those involved. From an interpersonal perspective, it is very likely that depressed individuals are more accurate in decoding anger, especially at low intensity, because they are faced with these emotional reactions significantly more than the non-depressed individuals. It is important for the depressed person's maintenance of his or her interpersonal relationships to be accurate when faced with hostility so that they can engage in protective behaviours and avoid loss – by seeking

reassurance. As such, a heightened awareness to socially threatening emotions is necessary for the depressed person in maintaining relationships. It appears that the interpersonal behaviours become the outward expressions of the underlying cognitions.

Because the current study was directed at examining the automatic process of decoding emotional facial expressions, the methodology reflected a more cognitive approach. These findings give some support to other studies examining underlying cognitive factors such as rumination, memory, and attention. As such, studies related to the cognitive correlates of social threat and MDD can assist in informing interpersonal models of depression and vice versa. For example, the findings could also lend support to the idea that the processing of interpersonal stimuli has the potential to be characteristically different than the processing of other stimuli, thereby lending some support to the interpersonal models of depression. Some authors (Gilboa-Schechtman et al., 2002; Leyman et al., 2007) explain that sadness differs from anger in the sense that it would be consistent with the depressed persons mood, whereas anger produces specific emotions in depressed individuals (related to rejection) or is primarily perceived as a sign of required action (related to threat; Hortsman, 2003). The findings of the current study also add to the possibility that interpersonally related information (specifically anger) may be recognized differently in those with MDD compared to non-depressed individuals.

In contrast to cognitive and interpersonal theories of MDD, the current findings can also be explained through evolutionary theories, such as the involuntary defeat strategy (Sloman & Gilbert, 2000). This theory would suggest that humans are programmed to engage in defeat strategies when faced with aggression or threat in situations where defeat from conspecifics is inevitable. This strategy is generally adaptive, in that it allows the individual to accept the defeat, it reduces aggression and hostility, increases the chances of survival, and permits the allocation

of resources for the pursuit of more adaptive goals. Within the context of the involuntary defeat strategy, individuals become depressed when they cannot accept defeat or when they feel that they cannot engage in adaptive behaviours such as fight or flight. Specifically, depressed individuals often feel that they cannot fight or leave a negative situation. This lack of fight or flight ability develops as a result of the negative consequences of being in hostile or aggressive environments during the developmental years, resulting in views of the self as inferior. This leads the depressed person to feel as though they simply cannot fight back, or to feel that there is no place to which they can escape. Consequently, depressed individuals will often find themselves in hostile environments, while feeling defeated and inferior to others. The combination of the arrested fight or flight strategies and defeat contribute to the onset of depression. The harder it is to accept the defeat, the greater the severity of the depression. This occurs as a result of increased anger and aggression over inability to fight back coupled with the need to inhibit these feelings for survival. Anger and aggression are generally provoked in situations of interpersonal conflict, frustration, and feelings of inability to reach one's goals. In response to this feeling of defeat and blocked fight, the depressed individual sometimes turns this fight inward and sees the self in a hostile and negative manner. Others engage in social withdrawal to avoid interpersonal conflict. These findings suggest that depression, hostility, aggression and negative social environment are all intertwined. (Gilbert, 2001; Sloman, 2001)

From this evolutionary perspective, it could be hypothesized that facial expressions of anger would signify irritation or physical threat and remaining vigilant to this expression would be adaptive, as the depressed individual would know when they are at risk and when to retreat. Specifically, accuracy and bias allows for better and more cautious attention to signals of social threat and the ability respond accordingly.

From a methodological standpoint, when the hit rate is used several different findings emerge. Some find non-significant differences between groups (e.g., Joorman & Gotlib, 2006; Lepannen et al., 2004; Persad & Polivy, 1993), whereas others do find significant differences (e.g., Surguladze et al., 2004; Yoon et al., 2009). Others tend to find differences in patterns of responding (e.g., Gollan et al. 2008; Lepannen et al., 2004). One study found significant group differences at subtle intensities where depressed participants were less accurate at detecting disgust and sadness, and low arousal emotions (combination of disgust and sadness) at 40% intensity compared to high arousal emotions (combined surprise, fear; Cskuly et al., 2009). It appears that taking the use of specific emotion categories as well as correct responses into account provides a more sensitive measure of accuracy. Accordingly, it can be suggested that in considering measures of accuracy, one must also consider how participants are using specific emotion categories. Another study (Surguladze et al., 2004) found group differences, but with respect to sadness and happiness. This also suggests that the hit rate alone is possibly an insufficient measure of accuracy.

Although depressed participants were more accurate in detecting anger, there were no group differences detected with respect to types of errors. The most common errors were made for sadness and happiness, for both groups. However, it is important to mention that non-depressed participants tended to mistake anger for surprise and sadness more often than currently depressed participants (these differences were much less evident when comparing those with lifetime history of MDD and non-depressed participants). The biases and error patterns can be used to explain the differences in accuracy to some extent. It is possible that with a larger sample, group differences would have emerged more clearly.

At higher intensities, only currently depressed participants used anger significantly more than non-depressed participants at 50% intensity (with a trend for significance at 100% intensity). This difference was also characterized by a significant bias towards the use of anger in currently depressed participants. Given that biases are present at higher intensities, a possible pattern of differential recognition becomes evident. Specifically, given that biases were detected in the absence of group differences suggests that if the sample had been larger it is likely that significant differences would have been detected.

It appears that at low intensity, biases are characterized by decreased use of positive emotion (surprise), whereas at high intensity the bias is related to overusing negative emotion that is by nature socially threatening. The bias related to anger is specific to participants who were currently depressed. These findings support the idea that, in terms of mood-congruency and information processing models, MDD may be more likely to be characterized by a bias away from positive information (and not towards negative) at low intensity (similar to the findings cited in Joorman & Gotlib, 2006) and towards negative information at high intensity. The current results appear convergent with Surguladze and colleagues' (2004) suggestion that MDD may have a unique profile of interpersonally related schemas that contribute to interpersonal difficulties.

It is curious that in the current study the negative bias for surprise and not happiness was detected. Although this appears to be a positive emotion, surprise can arise from the experience of both positive and negative events or appraisals (Kirkland & Cunningham, 2012). This uncertainty might lead the depressed individual to have more difficulty tolerating this ambiguity, thereby contributing to the avoidance of surprise. Support for this hypothesis stems from the fact

that this bias is detected at low intensity (20% and 30%) levels at which it is more difficult to discriminate between emotions.

The current study also took intensity into account. Although low intensity emotion was the focus, a range of intensities (20%-100%) was included to vary the task. Consistent with previous research (Cslusky et al., 2009; Hess et al., 1997; Joorman & Gotlib, 2006; Lepannen et al., 2004), the current findings were able to further elucidate the differences between depressed and non-depressed individuals with respect to decoding of facial expressions. Furthermore, the current study was able to corroborate the findings that differences between groups are best represented at low intensity. The lack of attention to intensity in some studies can partially explain the null results. This study revealed group differences at low intensity, which is consistent with the Cskuly and colleagues' study (2009). However, they found differences at 40% intensity, whereas the current study found differences at 20% intensity. Moreover, they found differences for disgust and sadness (low arousal), whereas this study detected group differences for anger. The findings at 40% intensity could be due in part to the use of the hit rate, but could also be related to the fact that Csukly and colleagues (2009) combined their emotions to form low arousal and high arousal emotions making it more difficult to detect differences among specific emotions.

Taken together, it seems that the unbiased hit rate is a more sensitive measure of detecting significant group differences (at low intensity) in terms of accuracy. It appears that the differences detected in using the hit rate revealed differing patterns of responding as opposed to true differences related to accuracy. Differences between groups are subtle and detected at low intensity and thus require a more precise measure. Moreover, research into differences between depressed and non-depressed groups should examine emotions as separate constructs, as it has

already been shown that they are processed differently and are categorical in nature. Future studies should also include a variety of intensities to capture the fact that differences appear to emerge only when the various facial expressions are difficult to detect. To date, the majority of the research examining facial expression discrimination in depressed and non-depressed groups primarily focuses on examining differences between neutral, happy, and sad facial expressions. Those that examine other emotions (i.e., anger, disgust surprise, and fear) are fewer, thereby making it difficult to detect differences and compare findings among studies. Given what we know about interpersonal models of depression, and the current findings, it would be important to consider socially threatening emotions as well in better understanding the decoding of emotional facial expressions and MDD.

#### *Prediction of Accuracy Scores Based on Mood State*

The current study also examined the possibility that negative mood state is predictive of accuracy scores, regardless of the participants' depressive status. It was predicted that the more an individual endorsed negative mood the less accurate they would be at detecting happiness and sadness. Also, given the significant findings with respect to anger and accuracy, the agreeable-hostile scale (POMS-AH) of the POMS-BI was included in the regression analysis. These hypotheses were not supported. The overall findings suggested that transient mood state is not predictive of accuracy scores. However, at high intensity, even though the overall model was not significant, the criterion variable, agreeable-hostile, showed a significant relationship with accuracy for anger but only when accounting for the effects of the elated-depressed scale of the POMS-BI. Specifically, the higher the score on the POMS-AH scale the more accurate the participant was in detecting anger. In contrast, the higher the score on the POMS-ED, the less accurate the participant became at detecting facial expressions of anger (this was

non-significant). This only occurred when the elated-depressed continuum was accounted for in the model.

This was somewhat of a surprising finding, given that analyses for group differences showed that depressed participants were found to be more accurate in detecting anger. There are some explanations that could account for these findings, however, these are highly speculative given that the results of the regression should be considered conservatively. According to emotion theorists (e.g., Hortsman, 2003), anger is an emotion that generally elicits action. Additionally, anger is an emotion to which individuals need to be more attuned. Generally, anger is recognized more readily than other emotions, which serves as an adaptive function. Being aware of one's own anger response can provide information in terms of whether to react to it or ignore it, depending on the situation (Ekman, 2003).

In the case of the current findings, it is likely that when disregarding depressive status, the contribution of positive mood becomes more evident. Specifically, in individuals with MDD, greater accuracy might be related to the fact that there is a heightened awareness to negative interpersonal reactions (i.e., rejection) leading to the activation of related negative schemas and possible avoidance or reassurance seeking. However, when considering mood state regardless of clinical diagnosis, accuracy appears to be related to a behavioural pattern of approach as this provides us with incentive to change a negative situation into a more positive one and engage in problem solving (Ekman, 2003). In the face of social threat, these questions can be helpful in either adjusting one's goals within that situation if their attainment becomes compromised or this might lead to the need adjust one's reactions in an effort to engage in problem solving to appease the situation (Carver, 2003).

Given that the overall models were non-significant, the findings also support to the idea that transient, in the moment mood state, cannot better explain the differences that were detected between depressed and non-depressed individuals with respect to accuracy and biases. Rather, accuracy appears to be related to processes that are more highly linked to a clinical depressive state.

### *General Conclusions*

When the current findings are considered in terms of theoretical models of MDD, an interpersonally related stimulus (anger) emerges as potentially having a role in understanding MDD. Additionally, the underutilization of surprise for both depressed groups emerges as well. It appears that this study provides some support for models that incorporate the notion that socially related information such as perceived threat, social rejection, or negative expectations about interpersonal interaction plays a role in the expression of MDD. Limiting the investigation of emotional facial expressions in depression to variables related to sadness and happiness does not accurately reflect the whole picture.

The current study found that depressed participants showed significant underuse of surprise compared to non-depressed participants, which is consistent with studies that have found a bias away from positive stimuli. If the results are examined with respect to the current findings for accuracy and biases, the evidence appears to point to the importance of the combination of interpersonal and cognitive models. Specifically, there appears to be differential processing of positive and negative stimuli, which is consistent with cognitive models. Although the results of the current study also support the notion that social threat and interpersonally related information is a necessary component in the examination of differences among depressed and non-depressed

individuals, it does not rule out the role of cognitive factors in explaining the interpersonal challenges in MDD.

Related to models of MDD, another explanation of this finding can be related to Beck's (1983) revision of his cognitive model of depression to include the personality variable of sociotropy. Specifically, he argued that those high in sociotropy crave interpersonal relationships and inclusion; however, depression ensues when individuals either perceive rejection or are rejected by others. It is therefore possible that depressed individuals tend to be higher on this construct, thereby contributing to the differences between groups. It is possible that individuals with MDD display a unique personality profile.

Another important factor to consider in the current study is that attentional biases were not examined. The primary measures were accuracy, which is related to identification of emotional facial expression, and judgment of facial expressions in the form of biases. Within these contexts, the results of the current study can assist in expanding the knowledge of the cognitive processes involved in detection of facial expression. However, drawing similarities between this study and those that examine attentional bias cannot be made directly.

On a more general level, the process of rumination or cognitive load cannot better explain the results of the current study. First, depressed participants were more accurate than non-depressed individuals. Moreover, a structured and automatic task was used. A 500 ms stimulus presentation time was used, which is sufficient enough to process without elaboration, although some elaboration had to be present in order to identify the emotion being presented (Gotlib & Joorman, 2010). Although it is possible that providing a longer response time might have produced a different pattern of results, the primary interest was the automatic process of

identification and bias. However, this would be an important avenue of further study in the context of facial expressions.

The results of the current study underscore the complexity of this line of research. First, the sample was significantly reduced to ensure that it was as pure of a sample as possible with respect to Axis I diagnoses, while also controlling for other extraneous variables known to affect the decoding of facial expressions (e.g., age, gender, and ethnicity). It is relatively safe to conclude that the current findings are not necessarily a result of the presence of these specific extraneous variables. Having controlled for these variables provides more substance to the differences that were detected, especially given that they were unexpected and counterintuitive.

Given the circumstances under which these participants were tested, the main findings in this study demonstrate that depressed individuals do not display a dysfunction in decoding; rather, they demonstrate greater accuracy. This also begs the question of whether this may be a sign that depressed individuals display better functioning compared to non-depressed individuals. Results showed that biases in decoding did not better explain the differences in accuracy, in that to be more biased would mean being less accurate. Rather, the differences that were detected for accuracy were related to the fact that depressed individuals were genuinely more accurate at detecting anger. It can also be hypothesized that depressed individuals are more attuned to signs of interpersonal rejection or threats to the self.

McCabe & Gotlib (1995) suggested that depressed individuals attend equally to negative and positive information whereas non-depressed individuals have a tendency to avoid negative stimuli, suggesting that non-depressed individuals display a protective bias away from negatively valenced information. Based on this, one alternative explanation for the group differences may be related to the fact that non-depressed individuals tend to turn their attention away from

negative stimuli during the processing stage. This makes it less likely that the negative information is being attended to, resulting in decreased accuracy. However, this is unlikely the case given the current results. Specifically, the group differences that were detected with respect to surprise were characterized by a bias away from this specific emotion for the depressed group and not towards surprise in the non-depressed group. On the other hand, studies that examined protective bias in depressed and non-depressed individuals (e.g., Ellis, Beevers, & Wells, 2011; Gotlib et al., 1988; McCabe & Gotlib, 1995) examined this in the context of attention and memory. It is likely that in the context of facial expression discrimination this protective bias expresses itself in a slightly different manner.

This study also begins to shed some light on the interaction of depression and anger. For example, it has been suggested that depressed individuals tend to suppress their anger more often (Goldman & Haaga, 1995) and that depressed individuals are more likely than non-depressed individuals to experience anger (Goldman & Haaga, 1995; Riley, Treiber, & Woods, 1989). Wenzel and colleagues (Wenzel, Gunthert, Forand, & Laurenceau, 2009) argued that anger and depression are intertwined in the sense that depressed individuals may be more likely to react to interpersonal difficulties with more anger, or they may have a heightened recall for interpersonal situations that were perceived as negative. Wenzel and colleagues (2009) examined how dysphoric individuals experience anger on a moment-to-moment basis. They found that the feeling of anger was dependent on the level of depressed mood. Specifically, dysphoric individuals experienced greater anger compared to non-dysphoric participants and the feelings of anger affected subsequent situations. This has implications for the pattern of results that emerge in this study, related to both accuracy and the prediction of accuracy. It appears that there is an interdependent relationship between anger and depression. It would be important that future

studies examine this relationship more closely as one can inform the expression or maintenance of the other.

### *Limitations*

Although the current study did produce some significant and novel findings, it is not without its limitations. These are discussed below.

The first limitation involves the small sample size, which reduces power, the ability to detect other possible group differences, and the strength of the current findings. At the outset of the study, the sample included 72 participants but had to be reduced quite significantly due to age, gender, and ethnicity matching. This was necessary, as these variables have been shown to have an affect on the ability to detect emotional facial expressions. In addition to the matching on demographics, strict criteria for Axis I diagnoses were used. In order to provide a more conservative approach to the diagnosis of MDD, two measures of MDD (SCID-IV and BDI-II) were included, therefore further reducing the number of participants. However, despite the small sample size and reduced power, significant differences were detected. This suggests that had the sample been larger differences with respect to other emotions (i.e. sadness and happiness) might have emerged. In addition, it is possible that with a greater sample size, significant differences would have been detected with respect to errors. Specifically, the current study identified the greatest differences for surprise, yet this was not significant. However, biases for surprise were detected between groups. Research into the decoding of facial expressions typically finds that participants tend to confuse anger with disgust. This was not the case in the current study but this could have been related to the small sample size and low intensity.

Related to this, the current study was limited by the small number of trials. A total of 96 stimuli were presented, consisting of six basic emotions, four intensities, and two male and two

female faces. Therefore, the task included only four trials for each intensity level. This had implications for the distribution of the data, leading to greater variability and uneven distributions. Moreover, by increasing the number of trials per intensity, it is possible that a greater sampling of decoding accuracy would have been obtained. This would have increased the power as well. However, despite this, significant findings were detected.

Another important factor to consider is the effect of using a large number of statistical tests to test the hypotheses. Analyses were separated based on diagnostic category and intensity. As a result, it is possible that experiment-wise error may have been inflated as the same variables were used to conduct several tests. Additionally, because of the variability due to the small number of trials, analyses had to be divided by intensity as well, thereby adding to the number of tests. However, this is only an issue for tests that examined group based analyses.

In sum, the small number of trials and small sample size led to a reduction in the power of the current study. It also led to question whether significant group differences with respect to errors, accuracy at high intensities (where biases were detected), or accuracy for different emotions (i.e., happiness and sadness) would have emerged as significant. However, despite these limitations, significant group differences for anger were detected, a finding that was new and counterintuitive to current theoretical models of MDD. Moreover, this also leads us to believe that the current findings are solid, given that demographic and diagnostic variables had to be controlled for in a stringent manner.

Another limitation involves the use of medication and treatment. The individuals in the depressed group were currently under treatment at the Royal Ottawa Healthcare Group. It is possible that this may have had an effect on the processing of emotional facial expressions.

However, the majority of studies reviewed did not control for this variable and so this caveat is generally consistent among the various studies reviewed.

The current study was initially designed to test participants at different stages of their depressive episode. The aim was to begin the study as participants were beginning treatment and then follow-up while they were in remission. Unfortunately, only four participants returned for a second session, making it impossible to compare the two stages of the MDD episode. With that said, it is also possible that those who did participate in the study were generally higher functioning than those who were approached and declined participation in the study. Accordingly, the current results could be partially explained by the fact that the group of depressed individuals who were tested were generally higher functioning and motivated, suggesting that these findings might not be generalizable to individuals with more severe depression.

Given the caveats mentioned above, it would be important for future studies to attempt to replicate these findings with a larger sample, using matching at the outset. Including a greater number of trials and following participants from the beginning of treatment to remission would be important for determining how accuracy and biases may develop or change over the course of the depressive episode. Some studies (Bouhuys, et al., 1999; Hale, 1998) have already demonstrated a stable pattern of biases and accuracy over the course of the depressive episode. Moreover, controlling for the effects of medication could provide a more pure sample of MDD.

The reliance on retrospective data is another caveat of the current study. The SCID-IV was used one of the primary measures of Axis I disorders. Some participants reported having difficulties recalling exact details of their depressive episodes, especially when there were many recurrent episodes. However, the SCID-IV has been used in a variety of studies to assess for

MDD and has been shown to have sound psychometric properties. To counteract some of these difficulties the BDI-II was also used in determining diagnostic status and group membership.

### *Future Directions*

One important avenue for future research would involve examining the robustness of the current study. This is the first study to incorporate the use of the unbiased hit rate as a measure of accuracy in the context of the decoding of facial expression and depression. Accordingly, it would be important to replicate and extend the current findings to determine whether these differences are a result of measurement or related to other constructs or methodology. The same reasoning applies to the measurement of judgment biases. In particular, future studies could include more trials of all emotions as well as more trials dedicated to anger, with a concentration at low intensity (20%-50%). High intensity emotion was included in the current study to vary the task and to decrease the chances of participants becoming discouraged given that recognition is more difficult at low intensity. However, the results of the current and other studies have shown that group differences are better detected at low, subtle displays of emotion. Therefore concentrating on including more trials at low intensities could provide a more precise measure of these differences.

The current study also revealed novel information concerning anger. The finding that depressed participants were more accurate in decoding anger has not yet been corroborated in the research. As previously discussed, this might provide some evidence that social information, in particular anger, is processed in a characteristically different manner than other types of information. Given this, future studies would benefit from better understanding the underlying processes with respect to decoding information in this way. This study examined one small process (decoding of facial expressions) within a larger picture. Specifically, given that

depressed individuals have been shown to have poor social skills resulting in social isolation and difficulties in relationships, it would be helpful to learn exactly what occurs following the decoding stage of interactions. For example, do individuals with MDD accurately process the type of message being delivered through facial expressions (appraisal) and can they accurately interpret the social message (i.e., the conveyor's intentions)?

Scherer (2005) and Hortsmann (2003) proposed that emotions consist of different components and require different levels of processing, of which initial decoding is one step. More specifically, Scherer (2005) and Scherer and Grandjean (2008) posit that accurate recognition of emotional facial expressions is based on the integration and knowledge of four criteria: (a) the emotional signal, (b) the appraisal process, (c) the message, and (d) the individual's behavioural intentions. The current study revealed that depressed individuals are more accurate in one stage of emotion processing. However, given the fact that MDD is characterized by the presence of negative self-referent schemata, are individuals with depression able to accurately process emotions beyond just recognition? In other words, based on the current findings, if there are social skill deficits in MDD, it is not at the decoding level. Future studies would benefit from examining at which stages the processing and understanding of interpersonal processes are problematic.

Although Hortsmann (2003) agreed with Scherer's (2005) position on how emotional facial expressions are processed, he found that specific emotions are processed differentially. More precisely, Scherer (2005) and Scherer and Grandjean (2008) argued that the four components mentioned above are processed hierarchically, with emotion being first and behavioural intentions last. However, Hortsmann (2003) found that participants tended to rate anger as being the only emotion that was first and foremost a behavioural intention or action

related emotion. In comparison, disgust, fear, sadness, happiness, and surprise were rated primarily as emotional signals. This underscores the notion that emotions depicting social threat are processed differently (Hortsmann, 2003), in that anger may elicit a specific emotion within the individual (Gilboa-Schechtman et al., 2002; Leyman, et al., 2007) or lead to particular action. Other emotions are more likely to be processed as being consistent with the individuals' mood (Gilboa-Schechtman et al., 2002). Given the fact that anger appears to be unique from other emotions, systematically studying the components of the processing of emotional facial expressions can provide more information with regards to how anger (and other emotions) are decoded in MDD and where the hypothesized difficulties lie in the process.

Another avenue of future research could involve examining accuracy and judgment bias as a function of personality characteristics. As we have seen, sociotropy or dependency has been theorized to play a role in the expression of MDD. Other personality variables, such as introversion and extroversion, may play a mediating role in the ability to detect emotional facial expressions.

Future studies might also benefit from incorporating measures of interpersonal functioning and cognitions. Given that depressed individuals have been shown to have difficulties when it comes to making social judgments and generally show social skills deficits, it would be helpful to better understand the nature of these deficits and how they relate to the current group differences with respect to accuracy and biases for anger and surprise. Additionally, assessing both interpersonal and self-referent negative schemas could also help elucidate the nature and contribution of cognitive and interpersonal components of MDD with respect to judgment of emotional facial expressions. For example, are the differences that were

detected related solely to interpersonal variables, cognitive schemas, or the combined effects of the two?

Finally, another related avenue would be to explore reactivity to anger and surprise in those with MDD and those without. This could also help elucidate some of the differences between bias and accuracy. Specifically, Persad & Polivy (1993) have already alluded to the fact that depressed individuals had lower tolerance for emotions elicited by others. This could contribute to some of the biases that were detected, in particular with surprise.

To conclude, the current study provided some novel findings with respect to accuracy and judgment biases. By using the unbiased hit rate and conceptualizing biases as the overuse or underuse of emotion categories, a different picture of facial affect decoding emerges. Moreover, in line with current research, this study highlighted the importance of including intensity and a range of emotion in order to better understand these differences. Additionally, this study has also added to the current conceptualization that group differences in the detection of facial affect are more prominent at low intensity.

It is necessary to replicate these findings, but the current study does lend some support to both cognitive and interpersonal theories. Specifically, it is hypothesized that depression is possibly maintained by heightened processing of interpersonal stimuli, in particular social threat, which elicit negative schemas that are consistent with ones mood and negative expectations about their interpersonal interactions. Perhaps MDD is best conceptualized as relating to cognitive-interpersonal theories.

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## Appendix A

### Information form for depressed participants

#### ***Recruitment Protocol for Participants at the Royal Ottawa Hospital Mood Disorders Clinic***

The Royal Ottawa Hospital Mood Disorders Clinic has agreed to collaborate on a study that examines the perception of emotions among clinically depressed individuals. This research will be conducted under the direction of Dr. Jean-Claude Bisseurbe, director the Mood Disorders Clinic at the Royal Ottawa Hospital and Dr. Pierre Gosselin, professor at the University of Ottawa in the School of Psychology.

The goal of the study is to obtain an understanding of the thoughts, behaviours and perceptions of emotion that are associated with major depression. Participating in this study will consist of two sessions, which will last 60 and 30 minutes respectively.

During the course of the first session, a doctor or a psychologist will ask you some questions regarding some thoughts and behaviours that are typically associated with depression. This will last 30 minutes. You will then be asked to complete a short questionnaire, which will last about 10-15 minutes. You will then be shown a series of photographs on a computer screen, and you will be asked to identify the emotion that is being portrayed in the photographs by pressing on key that corresponds to that emotion on a keyboard. This task will take approximately 15 minutes to complete.

The second session will take place two weeks later, and will take 15 minutes. During this session, you will be asked to look at photographs of facial expressions and identify the emotion being expressed in the same manner as the first session. The third and fourth session will take approximately 45-60 to complete, and will take place 3 and 6 months later respectively. They will be of the same format as the second session.

This study will help facilitate an understanding of certain phenomena related to depression. Research in this area is important for developing more effective treatments for individuals who suffer from depression.

I would like to know if you would be interested in participating in this study. It will take place here, and at the Royal Ottawa Hospital, in a designated room situated near the Mood Disorders Clinic.

**Should you choose not to participate in this study, this decision will not influence your current or any future treatments that you may receive at the clinic.**

If you are interested, **please call XXX-XXX ext. XXX**. Your name will be forwarded to the Clinic, where one of our researchers will contact you within the next few days. **Our research team would be happy to answer any questions you might have.**

Thank You!

## Appendix B

## Permission to be contacted form



**University of Ottawa Institute of Mental Health Research  
Institut de recherche en santé mentale de l'Université d'Ottawa**

**Permission to be Contacted for Future Research**

I give permission to have my contact information released to other research teams affiliated with the Royal Ottawa Hospital. By giving permission, I am allowing the other research teams to contact me about participating in other research studies. When contacted, I can choose whether or not I am willing to participate, and my decision will have no effect on the treatments I am receiving here at the Royal Ottawa Hospital.

\_\_\_ **YES**, I give permission to have my contact information released to other research personnel associated with the Royal Ottawa Hospital for purposes entirely related to research participation.

\_\_\_ **NO**, I do not wish to have my contact information released to anyone.

Full Legal Name (Print): \_\_\_\_\_

Date (MM/DD/YYYY): \_\_\_\_\_

Signature: \_\_\_\_\_

## Appendix C

### Information sheets for physicians

Dear Colleagues,

I would like to take this opportunity to inform you of a new study that I am currently embarking on. In collaboration with Dr. Pierre Gosselin from the University of Ottawa, we are beginning an innovative research program that will examine the role of social cognition in the development of Major Depression.

One important method of relaying social and emotional information is through emotional facial expressions. This plays a central role in the ability to regulate social interactions. Because individuals with depression have a bias towards negative stimuli, understanding how these biases affect the ability to decode emotional facial expressions is an important method to help understand how social cues are processed among these individuals. Specifically, we are interested in the way people perceive and interpret other people's emotions. By examining this phenomenon more closely, we can develop a framework from which we can begin to understand the role of emotions in the expression of Major Depression.

This study will be carried out at the Royal Ottawa Hospital Mood Disorders Clinic. Our sample will consist of individuals with Major Depression as well as non-depressed individuals.

We would greatly appreciate any assistance that you can provide in the recruitment of participants for our study. We are looking for individuals who may have a diagnosis of Major depression and who would be interested in participating in our study. If you have any interested patients, you can ask them to contact us at the following number: One of our researchers will then be in contact with them in order to set up an appointment.

We would like to thank you in advance for your assistance.  
Thank you for your time,

Dr. J-C. Bisserbe

## Appendix D

Recruitment posters for non-depressed participants



University of Ottawa Institute of Mental Health Research  
Institut de recherche en santé mentale de l'Université d'Ottawa

## ***Participate in a Study on the Perception of Emotions***

We are currently beginning a study that examines the differences in the perception of emotions among depressed and non-depressed individuals, under the direction of Dr. Jean-Claude Bisserte, Director of the Mood Disorders Clinic at the Royal Ottawa Hospital and Dr. Pierre Gosselin, Director and Professor at the School of Psychology at the University of Ottawa. We are currently recruiting non-depressed participants who would like to take part in this study.

Your participation will consist of a 75-100 minute session, which will take place at the University of Ottawa. During this session, you will be asked to provide some socio-demographic information and will be asked questions relating to thoughts and behaviours that are typically associated with a depressive state. You will then be shown a series of photographs of a variety of facial expressions, and will be asked to identify the emotion that is being displayed by pressing on the corresponding key on a computer keyboard.

This study will help us understand certain phenomena that are associated with depression and that are important for developing effective ways of treating individuals with mood disorders.

Your participation will be greatly appreciated. If you are interested, **please contact us at XXX-XXXX ext. XXXX** to arrange a session time

***Thank You for Your Interest!***



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## Appendix E

## Informed consent for depressed group



University of Ottawa Institute of Mental Health Research  
 Institut de recherche en santé mentale de l'Université d'Ottawa



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Research Director: Jean-Claude Bisserbe, M.D., Mood Disorders Program, Royal Ottawa Hospital, XXX XXX Ave., Ottawa, Ontario, XXX XXX, Tel: (XXX) XXX-XXXX, extension XXXX and Pierre Gosselin, Ph.D., Director, School of Psychology, University of Ottawa, XXX XXX Street, Ottawa, Ontario XXX XXX, Ottawa, Ontario, XXX XXX, Tel: (XXX) XXX-XXXX, extension XXXX

I, \_\_\_\_\_, agree to participate in the research study directed by Dr. J-C Bisserbe and Dr. Pierre Gosselin. I have been informed of the following conditions regarding my participation in this study.

This study will examine the perception of emotions among clinically depressed individuals. The goal of the study is to obtain an understanding of the thoughts, behaviours and perceptions of emotion that are associated with major depression. Participating in this study will consist of four sessions. The first session will last approximately 1-1.5 hours and subsequent sessions will last approximately 45-60 minutes.

During the course of the first session, a trained researcher will ask me some questions regarding some thoughts and behaviours that are typically associated with depression and I will complete a demographic form. This will last approximately 1 to 1.5 hours. One week later, I will then be asked to complete three short questionnaires, which will last about 10-15 minutes each. Then I will be shown a series of photographs on a computer screen, and will be asked to identify the emotion that is being portrayed in the photographs by pressing on a key that corresponds to that emotion on a keyboard. This task will take approximately 15 minutes to complete.

Three months later, and then six months following, I will be called back to the Clinic, where I will participate in two more sessions. These sessions will directly resemble the second session.

My participation is strictly voluntary. I have the right to discontinue my participation at any time, and will not be penalized for doing so. I have been assured that anonymity and confidentiality will be respected. Specifically, any information, including any identifying information and individual results from any questionnaires that will be acquired throughout the course of the study will remain confidential. Only those directly involved in the study, including the research directors and research assistants will have access to any information I provide, and this information will be held under lock and key. In order to maintain anonymity, my name will

not appear on any questionnaires. Data obtained from this study will be used solely for research purposes, and all data will be reported as group means. The data will be kept for 10 years, and will then be subsequently destroyed.

I will have the option of obtaining a copy of the results by completing the form below. There are two copies of the consent form, one of which will be kept by the research directors, and one that I may keep.

**To be completed by participant:**

Name: \_\_\_\_\_ Signature: \_\_\_\_\_

Date: \_\_\_\_\_

I would like to receive a copy of the results at the following address:

Civic Number: \_\_\_\_\_ Street: \_\_\_\_\_ City: \_\_\_\_\_

Postal Code: \_\_\_\_\_

**To be completed by Researcher:**

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

## Appendix F

### Verbal instructions for experimental task

#### **Instructions**

In the present study, we are interested in the way people perceive and interpret other people's emotions. This is important to investigate as it can provide us with important information about how people interact with one another and the processes that involved in such interactions. I will be showing you will see a series of pictures of faces that will be expressing different types of emotions. These pictures will appear on the computer screen right here (show participant the computer).

For each expression, I would like you to identify the emotion that you believe the face expresses. More specifically, I would like you to specify the emotion that you perceive by using the keys of the numerical keyboard that are identified by different emotion labels. The face will be presented for a short amount of time. When the face disappears from the screen, you are to press on the key that corresponds to the emotion that you believe the face demonstrated. Each key corresponds to a different emotion (Show the participant the keys, and the emotions that are associated with it). Use only one key for each expression.

The keys are labelled as follows:

Anger	Happiness	Sadness
Fear	Surprise	Disgust

Again, it is important to note that each expression will appear for a brief period of time. It is therefore important to remain concentrated on the task given that it will not be possible to see the expression twice. You must also wait for the expression to disappear completely from the screen before indicating your answer, as the computer will not be able to record your answer while the picture is still on the screen. Finally, from the moment that you indicate your answer, there will be a waiting period of 3 seconds before the next expression appears.

Before you begin the experiment, you will have the opportunity to get acquainted with the task through a practice session comprising 6 expressions. Following this practice session, you can begin the main experiment, which contains 96 expressions.

If you have any questions, please do not hesitate to ask me at any time during the experiment

Thank you for participating in this study.

## Appendix G

## Informed consent form for non-depressed group



University of Ottawa Institute of Mental Health Research  
 Institut de recherche en santé mentale de l'Université d'Ottawa



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Research Director: Jean-Claude Bisserbe, M.D., Mood Disorders Program, Royal Ottawa Hospital, XXXX XXXX Ave., Ottawa, Ontario, XXX XXX, Tel: (XXX) XXX-XXXX, extension XXXX and Pierre Gosselin, Ph.D., Director, School of Psychology, University of Ottawa, XXX XXX Street, Ottawa, Ontario XXX XXX, Ottawa, Ontario, XXX XXX, Tel: (XXX) XXX-XXXX, extension XXXX

I, \_\_\_\_\_, agree to participate in the research study directed by Dr. J-C Bisserbe and Dr. Pierre Gosselin. I have been informed of the following conditions regarding my participation in this study.

My participation will consist of a 75-100 minute session, which will take place at the University of Ottawa. During this session, I will be asked to provide some socio-demographic information and an interview assessing different thoughts and behaviours associated with mood (this will last about 30-40 minutes) and to complete three short questionnaires relating to thoughts and behaviours that are typically associated with a depressive state. Each questionnaire will take approximately 10-15 minutes to complete. I will then be shown a series of photographs of a variety of facial expressions and asked to identify the emotion that is being portrayed in the photographs by pressing on a key that corresponds to that emotion on a keyboard. This task will take approximately 15 minutes to complete.

My participation is strictly voluntary. I have the right to discontinue my participation at any time, and will not be penalized for doing so. I have been assured that anonymity and confidentiality will be respected. Specifically, any information, including any identifying information, and individual results from any questionnaires that will be acquired throughout the course of the study will remain confidential. Only those directly involved in the study, including the research directors and research assistants will have access to any information I provide, and this information will be held under lock and key. In order to maintain anonymity, my name will not appear on any questionnaires. Data obtained from this study will be used solely for research purposes, and all data will be reported as group means. The data will be kept for 10 years, and will then be subsequently destroyed.

I will have the option of obtaining a copy of the results as by completing the form below. There are two copies of the consent form, one of which will be kept by the research directors, and one that I may keep.

**To be completed by participant:**

Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

I would like to receive a copy of the results at the following address:

Civic Number: \_\_\_\_\_ Street: \_\_\_\_\_ City: \_\_\_\_\_

Postal Code: \_\_\_\_\_

**To be completed by Researcher:**

Signature: \_\_\_\_\_ Date: \_\_\_\_\_