RECOGNITION OF FACIAL EXPRESSIONS IN
OBSESSIVE-COMPULSIVE DISORDER

by

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B.A., McGill University, 1997

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

(Department of Psychology)

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

July 2002

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Abstract

The ability to recognize facial expressions of emotion appears to be a universal trait among humans. Accurate perception of facial expressions is important for interpersonal communication and social development. Clients with depression and schizophrenia exhibit abnormal recognition of facial expressions of emotions. Sprengelmeyer and colleagues (1997) demonstrated that clients with OCD are also impaired in their ability to recognize facial expressions of emotion. Specifically, clients with OCD were markedly impaired in their ability to recognize the facial expression of disgust. The current study questioned the robustness of this effect, while controlling for several potential limitations.

Sixty participants (20 OCD outpatients, 20 panic disorder controls, and 20 normal controls) took part in the current investigation. Participants were tested on their ability to recognize facial expressions of anger, disgust, fear and sadness. Results revealed that compared to the panic disorder and normal comparison groups, individuals with OCD were impaired in their ability to recognize facial expressions of disgust and anger. Furthermore, OCD participants did not perform as a unitary sample. Rather, two-thirds of the sample achieved normal levels of accuracy for the recognition of disgust, whereas one-third showed marked impairment in the ability to recognize disgust. This study also provides preliminary evidence that OCD symptom severity and general functioning may be related to the accuracy of disgust facial expression recognition.

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Introduction

The recognition of facial expressions is critical to the normal development and regulation of interpersonal relationships (Ekman, 1992a). Facial expressions help us interpret and guide social behaviour and provide us with valuable non-verbal information about others' emotions, thoughts, and possible actions. Adults are remarkably good at recognizing the facial expressions of others (Ekman, 1971, 1973; Izard, 1971; Tomkins & McCarter, 1964). Moreover, by the time we become toddlers, we are already carefully attending to, and gaining important information from, the facial expressions of those around us (La Barbera, Izard, Vietze, & Parisi, 1976; Sorce, Emde, Campos, & Klinnert, 1985; Young-Browne, Rosenfeld, & Horowitz, 1977).

Despite this exceptional ability, individuals with various forms of psychopathology are impaired in their ability to recognize facial expressions. Depressed and schizophrenic individuals are less accurate in the recognition of facial expressions of emotion (Archer, Hay, & Young, 1992; Edwards, Pattison, Jackson, & Wales, 2001; Rubinow & Post, 1992), and these deficits may contribute to the interpersonal difficulties observed in these disorders (Addington & Addington, 1998; Persad & Polivy, 1993).

A recent study is the first to suggest that individuals with obsessive-compulsive disorder (OCD) may also be impaired in the recognition of facial expressions (Sprengelmeyer et al., 1997). In this study, Sprengelmeyer and colleagues reported that individuals with OCD were severely and specifically impaired in the recognition of disgust expressions. This is an intriguing finding, given that disgust may play a role in some forms of OCD, particularly contamination-based OCD (Phillips, Fahy, David, & Senior, 1998; Power & Dalgleish, 1997; Woody & Teachman, 2000).

In order to examine the robustness of this finding, and to improve upon possible limitations in Sprengelmeyer et al. (1997), I conducted a study designed to further investigate the ability of individuals with OCD to recognize facial expressions. Before discussing this experiment I will first review the pertinent literature in related areas of research.

Facial Expression Recognition

Accurate recognition of facial expressions plays an important role in interpersonal communication and development, providing valuable information about what people are feeling and how they are likely to act (Ekman, 1992a). Ekman suggests that “seven different classes of information may be conveyed by a facial expression of emotion: antecedents; thoughts; internal state; a metaphor; what the expresser is likely to do next; what the expresser wants the perceiver to do; or an emotion word” (Ekman, 1997, p.334). However, researchers disagree on the role of facial expressions in communication. While some argue that facial expressions signal underlying emotions and provide information about the emotional states of others (Ekman, 1992b; Izard, 1971), others believe that facial expressions signal behavioural intentions and social motives (Fridlund, 1997; Frijda & Tcherkassof, 1997).

Regardless of theoretical standpoint, the consensus is that facial expressions communicate important information. As Izard (1997) states, “there is agreement across differing theories that at least some facial patterns evolved, whether as adaptations or exaptations, *to communicate information*” (p. 71). Researchers also agree that healthy adults are very good at recognizing facial expressions. Research conducted over the past three

decades provides evidence that the ability to recognize facial expressions is a universal and innate trait among humans.

Cross-cultural Studies on Expression Recognition

A classic series of cross-cultural studies led by Paul Ekman and Carroll Izard established that individuals are remarkably good at recognizing six “basic” facial expressions of emotion: anger, disgust, fear, happiness, sadness, and surprise (e.g. Ekman, 1971, 1973; Izard, 1971). In one early judgment study, Ekman, Sorenson, and Friesen (1969) presented 30 photographs of the six basic emotions to college-educated participants in three different countries (Brazil, Japan, and the US) and to adult members of two preliterate cultures (the Sadong of Borneo and the Fore of New Guinea). Individuals from Brazil, Japan, and the United States achieved high accuracy for the recognition of all facial expressions, with accuracy levels ranging from 63% to 97%. Individuals from the preliterate cultures achieved somewhat lower accuracy levels, but always performed above chance.

Izard (1971) reported similar results in a study in which he examined recognition of facial expressions in nine literate cultures. He found that the average accuracy of recognition across expressions ranged from 50% in the African sample to 83% in the American and Swedish samples. Furthermore, Izard reported that the expression happiness¹ was recognized most accurately, while distress and shame expressions were recognized least accurately. Numerous studies provide additional support for accurate cross-cultural recognition of “basic” facial expressions of emotion (Ekman, 1971; Ekman, Levenson, & Friesen, 1983; Ekman et al., 1969). Furthermore, adults are good at recognizing facial expressions even when presented with more complex judgment tasks, such as when a free-response format

rather than a forced-choice format is employed (Boucher & Carlson, 1980; Izard, 1971; however, see Russell, 1994, for a critique of the forced-choice format), and when spontaneous rather than posed facial expressions are used as stimuli (Ekman, 1971).

Facial Expression Recognition in Psychiatric Conditions

In summary, healthy adults are skilled at recognizing facial expressions. Over the past three decades, the study of facial expression recognition has been extended to psychiatric populations. Researchers have learned that abnormalities in facial expression recognition are present in a wide variety of psychiatric disorders. Such impairments have been found in patients with alcoholism (Kornreich, Blairy, Philippot, Dan et al., 2001; Kornreich, Blairy, Philippot, Hess et al., 2001), Alzheimer's disease (Hargrave, Maddock, & Stone, 2002), anorexia nervosa (Zonnevrijlle-Bendek, van Goozen, Cohen-Kettenis, van Elburg, & van Engeland, 2002), bipolar disorder (Ketter & Lembke, 2002), depression (e.g. Gur et al., 1992; Rubinow & Post, 1992), schizophrenia (e.g. Addington & Addington, 1998; Archer et al., 1992; Heimberg, Gur, Erwin, Shtasel, & Gur, 1992), and social phobia (Simonian, Beidel, Turner, Berkes, & Long, 2001).

Numerous studies have investigated facial expression recognition in depressed individuals, and the majority report impairments in the recognition of facial expressions (Feinberg, Rifkin, Schaffer, & Walker, 1986; Gur et al., 1992; Mikhailova, Vladimirova, Iznak, Tsusulkovskaya, & Sushko, 1996; Persad & Polivy, 1993; Rubinow & Post, 1992; Zuroff & Colussy, 1986). Some studies found evidence for deficits in the recognition of specific facial expressions (Mikhailova et al., 1996; Rubinow & Post, 1992), while others report general impairment in the recognition of all expressions (Persad & Polivy, 1993). In

addition, one study found that depressed patients had a negative bias in the judgment of facial expressions (Gur et al., 1992). Furthermore, there is evidence that deficits in facial expression recognition improve upon symptom remission (Mikhailova et al., 1996), and that these deficits predict negative treatment outcome in depression (Bouhuys, Geerts, Mersch, & Jenner, 1996; Hale, 1998). Persad and Polivy (1993) suggested that deficits in facial expression recognition might contribute to the poor social functioning and interpersonal difficulties evident in depression.

The recognition of facial expressions has also been studied extensively in individuals with schizophrenia. Relative to normal participants, individuals with schizophrenia show impairment in facial expression recognition (Addington & Addington, 1998; Archer et al., 1992; Lewis & Garver, 1995; Mikhailova et al., 1996; Mueser et al., 1996). However, the precise nature of the deficit has yet to be defined. While some studies report specific deficits in the recognition of negative facial expressions of emotion (Davis & Gibson, 2000; Dougherty, Bartlett, & Izard, 1974; Kucharska-Pietura & Klimkowski, 2002; Muzekari & Bates, 1977; Walker, Marwit, & Emory, 1980), others find impairment in the overall recognition of facial expressions (Lewis & Garver, 1995). Moreover, these deficits may not represent a unique deficit for facial expression recognition, but may rather reflect a general deficit in face processing (Addington & Addington, 1998; Archer et al., 1992; Kerr & Neale, 1993; Mueser et al., 1996; Salem, Kring, & Kerr, 1996) or a general impairment in neurocognitive function (Bryson, Bell, & Lysaker, 1997; Schneider, Gur, Gur, & Shtasel, 1995). One study found no evidence of impairment in schizophrenics (Flack, Cavallaro, Laird, & Miller, 1997).

In addition, impairments in the recognition of facial expressions are more severe in schizophrenia than in depression (Feinberg et al., 1986; Heimberg et al., 1992), and in non-paranoid schizophrenia than in paranoid schizophrenia (Kline, Smith, & Ellis, 1992; Lewis & Garver, 1995). Poor recognition of facial expressions is also evident among first episode schizophrenic patients (Edwards et al., 2001), suggesting that this deficit is present even before prolonged illness. Furthermore, impairments in facial expression recognition do not appear to improve during partial remission of symptoms (Addington & Addington, 1998; Gaebel & Woelwer, 1992).

In summary, studies consistently report impaired recognition of facial expressions among schizophrenic and depressed individuals. However, the specificity of the impairment has not been established; does it occur for all facial expressions? Are the impairments specific to facial expressions, or are they part of a more general deficit in facial processing? The discrepancy in findings is likely the result of differences in methodologies, including differences in sampling, procedure (forced-choice vs. free labelling), and stimuli (posed vs. moving expressions; photographs vs. line drawings, facial expressions selected).

Facial Expression Recognition in OCD

Sprenghelmeyer and colleagues (1997) reported that individuals with OCD were specifically impaired in the recognition of disgust facial expressions. Twelve participants with OCD, 12 with Tourette's Syndrome (five who had prominent obsessive or compulsive behaviours, and seven who did not), 8 anxiety disorder controls, and 40 normal controls were tested on two tasks of facial expression recognition. The first task tested participants on their ability to correctly identify facial expressions of anger, disgust, fear, happiness, sadness, and

surprise that were morphed with features of other emotions to make the task more challenging. The second task tested participants on their ability to recognize pure, rather than morphed, facial expressions. Participants in the OCD group showed a marked deficit in the recognition of facial expressions of disgust in both tasks. Furthermore, participants with Tourette's with obsessive-compulsive behaviours also demonstrated this impairment, while those without obsessive-compulsive behaviors did not. None of the comparison group participants (without obsessive-compulsive problems) showed the deficit.

To examine whether OCD participants' difficulty in facial expression recognition reflected a general deficit in face processing, Sprengelmeyer and colleagues (1997) included face perception and facial identity discrimination control tasks. Participants with OCD were as accurate as anxiety controls on both tasks, suggesting that the deficit in facial expression recognition was not due to general deficits in face processing. In addition, to control for the possibility that individuals with OCD were reluctant to choose the label "disgust" as a response, Sprengelmeyer et al. tested OCD participants on their ability to classify words as synonyms for anger, disgust, fear, happiness, sadness, and surprise. Results of this control task revealed that OCD participants classified all words as accurately as controls, suggesting that their impairment in the recognition of disgust did not reflect an unwillingness to give "disgust" as a response.

The findings presented by Sprengelmeyer and colleagues (1997) are intriguing; they emphasize that *every* individual with OCD (as well as those with Tourette's with obsessive compulsive behaviours) was impaired in the recognition of disgust, while no other participants showed this impairment. Moreover, individuals with OCD were impaired in their ability to recognize disgust, rather than any other expression. These findings are

particularly interesting given that a subset of individuals with OCD may be hypersensitive to the emotion of disgust (Phillips et al., 1998; Power & Dagleish, 1997; Woody & Teachman, 2000). Individuals with certain types of OCD tend to worry excessively about contaminants such as dirt, toxins, or germs, and they often engage in washing compulsions. Moral contaminants, such as sexual or blasphemous thoughts, are another OCD concern that may be relevant to perception of disgust expressions. Two recent studies provide empirical support for a relationship between disgust and OCD symptoms in non-clinical samples (Mancini, Gragnani, & D'Olimpio, 2001; Muris et al., 2000). Thus, it is intriguing that individuals with OCD would be specifically impaired in the recognition of disgust. Further research will help clarify whether this impairment is merely a coincidence, or whether it is functionally related to OCD.

Obsessive-Compulsive Disorder

OCD is not as well understood or treated as many of the anxiety disorders. Although a number of treatments have been developed for OCD (Riggs & Foa, 1993; Steketee, 1996; Van Oppen & Arntz, 1994), they have not proven to be as successful as treatments for other anxiety disorders, such as panic disorder (Barlow, Craske, Cerny, & Klosko, 1989; Margraf, Barlow, Clark, & Telch, 1993; Telch et al., 1993). OCD can be debilitating, with a lifetime prevalence of approximately 2 – 3% (Regier et al., 1988; Robins et al., 1984; Wittchen, 1988). It is characterized by the presence of obsessions and compulsions, either alone or in combination. Obsessions are defined as recurrent and persistent thoughts, impulses or images that are experienced as intrusive and inappropriate, while compulsions involve repetitive behaviours or mental acts performed in order to reduce the distress caused by the

obsessive thoughts (American Psychiatric Association, 1994). These behaviours and mental acts include such things as washing, checking, counting, ordering, and arranging. OCD often leads to significant distress and impairment in occupation, relationships, and overall quality of life (Antony, Roth, Swinson, Huta, & Devins, 1998; Khanna, Rajendra, & Channabasavanna, 1988; Koran, Thienemann, & Davenport, 1996). Thus, further research on OCD is necessary in order to help develop a better understanding of the disorder, and to develop better treatments.

One avenue of research that may prove useful in this endeavor is the study of impairments in facial expression recognition in OCD. Specifically, studies of facial expression recognition may help inform our understanding of brain functioning in OCD. Recently, a number of researchers proposed that specific brain regions might be responsible for the accurate recognition of disgust. For example, in a functional magnetic resonance imaging (fMRI) study conducted with healthy participants with no history of mental illness, Phillips and colleagues (1997) reported activation in the right anterior insula and to some extent the basal ganglia and the medial frontal cortex when participants viewed facial expressions of disgust. In a similar study, Sprengelmeyer, Rausch, Eysel and Przuntek (1998) reported neural activation of the basal ganglia (anterior putamen and pallidum) of the right hemisphere, the left anterior insula, and the inferior parts of the left frontal cortex when normal participants viewed facial expressions of disgust. This pattern of neural response was distinct from the pattern observed when subjects viewed facial expressions of anger and fear. Thus, these two studies provide preliminary evidence that the basal ganglia and anterior insula may be involved in the processing of facial expressions of disgust in healthy

participants. Further examination of facial expression recognition in individuals with OCD may contribute to a better understanding of abnormalities in brain functioning in OCD.

The Current Study

The Sprengelmeyer et al. (1997) results are intriguing, but the study had a number of limitations. The current study aimed to examine the robustness of the impairment for disgust facial expressions in a group of OCD patients, while controlling for a number of possible limitations.

Sprengelmeyer et al. (1997) did not provide sufficient information on participant characteristics and diagnosis to inspire confidence. While the authors reported that all OCD participants had checking compulsions, they offered no details about other OCD symptoms, severity of symptoms, or the method of diagnostic evaluation. The current study uses standard clinical psychology research methods by using a structured diagnostic interview. A trained interviewer carefully diagnosed each participant using the Structured Clinical Interview for the DSM-IV (SCID-I; First, Spitzer, Gibbon, & Williams, 1997). The interviewer assessed severity of OCD symptoms using the Yale-Brown Obsessive-Compulsive Scale (Goodman, Price, Rasmussen, Mazure, Fleishmann et al., 1989).

Sprengelmeyer et al. (1997) also did not control for comorbidity of depression. Given that individuals with depression show deficits in the recognition of facial expressions (Archer et al., 1992; Persad & Polivy, 1993; Rubinow & Post, 1992), and that many clients with OCD are diagnosed with comorbid depression (Brown, Campbell, Lehman, Grisham, & Mancill, 2001; Sanderson, DiNardo, Rapee, & Barlow, 1990), it is important to control for depression when examining facial expression recognition in an OCD population. Therefore,

the current study included comorbidity of depression as a factor in order to examine the possibility that deficits in recognition of facial expressions might be due to depression rather than to OCD.

The stimuli used by Sprengelmeyer et al. (1997) presented some interpretive problems. Participants with OCD most often chose anger as a response in place of disgust, a result also found in normal samples (Ekman & Friesen, 1976). Sprengelmeyer et al. used morphed photographs of disgust and anger, and disgust and sadness, but not disgust and fear. In order to examine the pattern of errors more thoroughly, the stimuli in the current study included all possible combinations of disgust, anger, fear and sadness.

In addition, Sprengelmeyer et al. (1997) used only one model from the Ekman and Friesen (1976) Pictures of Facial Affect. There may have been something unusual about this model that some participants found particularly confusing, making it difficult for OCD participants to accurately recognize disgust expressions. The current study improves upon this by using two models, one male and one female. These two models were different than the model used in Sprengelmeyer et al.

Method

Participants

The sample consisted of three different groups of 20 participants each: an obsessive-compulsive disorder group, a panic disorder group to serve as an anxiety disorder comparison group, and a normal comparison group. Clients with OCD were recruited from the Anxiety Disorders Unit (ADU) of the University of British Columbia Hospital, where they were scheduled to receive treatment for their OCD. Participants were invited to participate in the

study if they received a primary diagnosis of OCD based on a structured clinical interview. Clients with panic disorder were also recruited from the ADU if they received a primary diagnosis of panic disorder and had no history of OCD.

Participants in the normal comparison group were recruited through advertisements located throughout the University of British Columbia campus. They were selected to balance the OCD sample for age and gender, and were excluded from participation if they had a history of anxiety disorders or psychosis, or current mood disorders.

A total of 71.7% of the participants were women, and the gender ratio was similar across groups, $\chi^2_{(2)} = .16, p > .50$. The mean age of the participants was 31.6 years ($SD = 9.7$), and the diagnostic groups did not differ in age, $F_{(2, 57)} = 2.12, p > .10$. The majority of participants were Caucasian (71.7%), with the remainder made up of Asians (16.7%) and other ethnic backgrounds (11.7%). The groups did not differ on ethnic composition, $\chi^2_{(2)} = 2.13, p > .25$.

Measures

Diagnostic interview.

The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; First et al., 1997) was used to diagnosis prospective OCD clients, as well as to provide information regarding the presence of specific OCD concerns (such as washing and checking) and age of onset of OCD. The SCID-I is a semi-structured interview that provides information allowing for DSM-IV diagnoses. It is the most widely used diagnostic interview in North American psychiatric research (Antony & Barlow, 2002). Most of the psychometric properties of the SCID-I were derived from research conducted with an earlier version of the instrument. The

earlier version showed adequate interrater reliability for current diagnosis ($\kappa = .59$) and lifetime diagnosis ($\kappa = .67$) of OCD (Williams et al., 1992).

The Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV; Gessler, Cutting, Frith, & Weinman, 1989) was used to diagnosis clients with panic disorder. The ADIS-IV is a semi-structured interview designed to allow for diagnosis of the anxiety disorders, as well as mood, somatoform, and substance abuse disorders. The ADIS-IV has good to excellent interrater reliability, with $\kappa = .72$ for panic disorder and $\kappa = .77$ for panic disorder with agoraphobia (Brown, DiNardo, Lehman, & Campbell, 2001). The principal diagnostician on staff at the ADU conducted the diagnostic interviews for the OCD and panic disorder clients. This diagnostician was a well-trained master's level technician who had worked at the ADU in the capacity of principal diagnostician for the previous five years.

Prospective participants in the normal comparison group were interviewed with screening questions from the SCID-I. These interviews were conducted by a trained master's level student with four years experience using the SCID-I. All intake interviews were supervised by doctoral-level psychologists.

Obsessive-compulsive symptoms.

The Yale-Brown Obsessive-Compulsive Scale (Goodman, Price, Rasmussen, Mazure, Delgado et al., 1989; Goodman, Price, Rasmussen, Mazure, Fleishmann et al., 1989) was used to measure the presence and severity of obsessions and compulsions. The YBOCS is the most widely used interview for assessing the severity of OCD. The YBOCS yields three severity scores: Obsessions, Compulsions, and Total severity of symptoms. The YBOCS has demonstrated excellent interrater reliability (Goodman, Price, Rasmussen,

Mazure, Fleishmann et al., 1989) and adequate internal consistency (Woody, Steketee, & Chambless, 1995). It has also demonstrated good convergent validity with other OCD measures, although it has not yet demonstrated good discriminant validity (Woody et al., 1995). The ADU diagnostic technician administered the YBOCS following the SCID-I interview.

Stimuli

Facial expression pictures were selected from a set of black and white photographs developed by Ekman and Friesen (1976), shown to elicit reliable responses in normals. Two photographs were selected for each of four expressions (anger, disgust, fear and sadness). The photographs were of the same two models, one male and one female. The expressions happy and surprise were not used in the present study in order to reduce the number of trials necessary to have a fully crossed design. The expressions happy and surprise are well recognized and are rarely confused with disgust (Ekman, 1971; Tomkins & McCarter, 1964), and therefore were not included in the present study.

Morphed stimuli for this study were created using a computer interpolation program, which produced morphed photographs of each combination of the expressions. Each facial expression was blended with every other expression at four different levels (25%, 50%, 75% and 100%), yielding 24 pictures for each model (6 combinations with 4 pictures in each combination). The resulting morphed faces for the female model are shown in Figure 1. The facial expression recognition task was controlled by a customized software program that presented stimuli to the participants and recorded their answer choices and response times.

Procedure

Prospective participants were initially screened by telephone to assess suitability for the study. Clients with OCD or panic disorder completed their diagnostic interview and questionnaires at their initial meeting at the ADU. These clients then completed the computerized facial recognition task at their initial meeting or soon thereafter at a subsequent visit to the clinic. Participants in the normal comparison group completed the SCID-I screening interview in the UBC Department of Psychology before beginning the computer task.

Participants completed the facial expression recognition task in a quiet room. They were seated in a comfortable chair facing a 17-inch Hewlett Packard colour monitor. The experiment was controlled by a customized software program running on a Hewlett Packard Pentium II computer. After reading the initial instructions that appeared on the screen, participants clicked a "Test" button to begin the experiment. The first few participants completed a practice trial before beginning the actual experiment. However, the practice trial was discontinued because it became apparent that participants did not require practice to become competent with this simple task.

The computerized task involved four blocks of experimental trials, each block consisting of the same 60 individual facial expression decision tasks: 24 pure emotional expressions and 36 morphed expressions. The 240 pictures were presented to participants one at a time in randomized order. The facial expression stimuli occupied a 6.3 cm by 9.0 cm rectangular area on the computer screen, located 0.5 cm from the top of the screen. Participants were asked to determine whether each expression most resembled anger, disgust,

fear or sadness. These four answer choices were located in response boxes 1.5 cm below the photographs, and took up an area equal to 8.0 cm by 0.5 cm. Participants selected their responses by clicking on the appropriate response box with the computer mouse. The response boxes were interfaced with the computer program such that participants' answers and response times were recorded for each decision task. The order of the answer choices was counterbalanced across blocks of trials. The facial expression stimuli remained on the computer screen until a response was made. After completing each response, participants had to click on a button labelled "Next," which appeared 1.2 cm below the response boxes. An example of the computer screen is depicted in Figure 2. The entire facial expression recognition task took approximately 20 minutes to complete.

Results

The frequency of correct facial expression identifications was tabulated for each participant, across trials for each of the four pure facial expressions, and for the morphed expressions. The 50% morphed expressions were dropped from the analysis, as "correct" response cannot be defined. The frequency of correct responses was then expressed as the percentage of the total number of responses. Table 1 presents the percentage of correct responses to all expressions (excepting the 50% morphed photographs) broken down by diagnostic group.

Table 1 presents the percentage of trials in which the participant correctly selected the emotion being displayed. However, percentage of correct responses, or hit rate (H), is insufficient as a measure of performance because it does not take into account false alarms or bias (Wagner, 1993). False alarms (F) are the proportion of trials in which the participant

chose a target emotion (e.g., anger) when another emotion was being displayed. Bias involves choosing a particular response more or less often than any other response, regardless of the facial expression being presented. An example will clarify the inadequacy of the hit rate. If a participant selects the response “anger” for every facial expression presented, the hit rate for anger would be $H = 1.0$ (100%) despite the fact that expressions of disgust, fear, and sadness would have been mistakenly classified as anger. This performance is obviously very different from a participant who selects “anger” only when presented with anger stimuli, yet the hit rate would be the same ($H = 1.0$).

Wagner (1993; 1997) proposed using the *unbiased hit rate* (H_U) to correct for the inadequacies of the traditional hit rate. This index takes into account both hit rate (the proportion of facial expressions of one category that were correctly identified) and differential accuracy (the proportion of times the response category was correctly applied). The unbiased hit rate is calculated by multiplying the hit rate by the differential accuracy rate, yielding a value in the form of a proportion. Thus, an H_U value of 1.0 represents perfect performance on the task (100% “hits”) while an H_U value of zero represents no correct judgments (0% “hits”). This calculation can be best illustrated by referring to the confusion matrix (see Table 2). The confusion matrix represents response frequencies. The frequencies along the diagonal (values a , f , k , and p in Table 2) represent the traditional hit rate, while the frequencies located on the off-diagonal represent errors. In order to calculate the unbiased hit rate, for example, for the stimulus/response category anger:

$$H_U (\text{anger}) = \frac{a}{a + b + c + d} \times \frac{a}{a + e + i + m}$$

The unbiased hit rate, H_U , for each of the four facial expressions was used for the statistical analyses outlined below.

Confusion Matrices

Tables 3 - 5 are confusion matrices of participants' responses on the facial expression task. The entries in the tables represent mean percentages of responses. The diagonals represent the hit rate (how often participants selected the correct expression), while the off-diagonals represent errors in judgment (how often participants selected an incorrect expression). A comparison of these tables shows that participants with OCD were generally less accurate at recognizing facial expressions compared to the normal comparison and panic disorder participants. In addition, across all three groups, the expression of fear was recognized most accurately while disgust and anger were recognized less accurately. Furthermore, the tables show that the most common error made by all three groups was in selecting the response "anger" when presented with disgust expressions.

Planned Analyses

The primary question of interest in this study is whether clients with OCD differ in their ability to recognize the facial expression of disgust. Unbiased hit rates for the pure and morphed facial expressions were used as the dependent variable in a 3 x 4 repeated measures analysis of variance (ANOVA), with one within-subjects factor and one between-groups factor². The within-subjects factor was stimulus expression (anger, disgust, fear or sad), and the between-groups factor was diagnostic group (OCD, panic disorder, or normals). If clients

with OCD are specifically impaired at recognizing the expression of disgust, the analysis should show an interaction of expression with diagnostic group, with significantly lower accuracy scores for the OCD group for the expression of disgust.

A box-plot analysis of the unbiased hit rates revealed four outliers, and these outliers were winsorized accordingly. The Greenhouse-Geisser adjustment was used to correct for violation of the assumption of sphericity for the repeated measures factor.

Results of the ANOVA revealed a significant main effect of stimulus expression, $F_{(2, 110)} = 41.52, p < .0001, \eta_p^2 = 0.42$. Tukey's method of post-hoc comparisons on the main effect of stimulus expression revealed that each of the four expressions was significantly different than every other expression, with participants showing the least accuracy for anger ($M = .71, SD = .20$), followed by disgust ($M = .79, SD = .21$), sadness ($M = .86, SD = .08$) and fear ($M = .92, SD = .12; 3.80 \leq q \leq 14.10, p < .05$).

Results of the ANOVA also revealed a significant main effect of diagnostic group, $F_{(2, 57)} = 3.26, p = .046, \eta_p^2 = .10$. Tukey's method of post-hoc comparisons on the main effect of diagnostic group did not reveal any significant differences between the groups. However, post-hoc comparisons using the least significant difference method (LSD) revealed that the OCD group was significantly less accurate at the overall facial expression recognition task ($M = .76, SD = .24$) than either the normal ($M = .85, SD = .12$) or the panic disorder comparison groups ($M = .84, SD = .14$). While the LSD method is a less conservative method of post-hoc comparisons, it does not control for Type-I errors.

Results of the ANOVA before the Greenhouse-Geisser correction revealed a significant interaction of expression and diagnostic group, although the effect was small, $F_{(6, 171)} = 2.40, p = .03, \eta_p^2 = 0.08$. This interaction was due to the OCD participants making

significantly more errors on the expressions anger and disgust than either the panic or the normal comparison group. However, this difference was no longer statistically significant after correcting for the violation of sphericity, $F_{(3, 110)} = 2.40, p = .057, \eta_p^2 = 0.08$ (see Figure 3). Tests that violate the assumption of sphericity have been shown to be liberally biased (Box, 1954).³

Planned Contrasts

Four planned nonorthogonal contrasts were conducted in order to test specific hypotheses not tested directly by the omnibus ANOVA. Whereas the overall F test yields information about whether there are *any* differences among the groups, planned contrasts permit specific predictions to be tested with relatively strong statistical power. The number of contrasts was limited to four to maintain control over Type I error (Rosenthal & Rosnow, 1985). These contrasts involved comparisons among the twelve group means (four expressions for each of the three groups). The weights for the four planned contrasts are presented in Table 6.

The first planned contrast compared the mean unbiased hit rate for disgust expression recognition of the OCD group to the two comparison groups. This contrast tested one of the primary questions of this study: whether clients with OCD are impaired (compared to other diagnostic groups) in their ability to recognize the facial expression of disgust. Results of the contrast indicated that OCD participants were significantly less accurate at recognizing disgust than were the normal comparison and panic disorder participants ($F_{(1, 57)} = 4.47, p = .039, r = 0.27$).

The second planned contrast compared the mean unbiased hit rate for anger expression recognition of the OCD group to the two comparison groups. Sprengelmeyer and colleagues (1997) reported that anger was the expression most often confused with disgust, and this contrast was conducted in order to explore the possibility that clients with OCD may be less accurate in the recognition of anger as a consequence of this confusion. This contrast compared anger accuracy for the OCD group with the anger accuracy scores for the normal control and panic disorder groups considered together. Results of the contrast indicated that OCD participants were not significantly less accurate at recognizing anger than the control participants ($F_{(1, 57)} = 3.71, p = .059, r = .25$).

The third contrast tested whether participants with OCD were specifically less accurate than other diagnostic groups at recognizing disgust in comparison to the other expressions. This contrast compared the mean unbiased hit rate for recognition of disgust for the OCD group with the other eleven unbiased hit rates considered together. Results of this contrast revealed that accuracy rate was significantly lower for OCD participants rating disgust expressions than for other emotions and other diagnostic groups ($F_{(1, 57)} = 10.57, p = .002, r = .40$).

The final contrast tested whether participants with OCD were less accurate at recognizing anger in comparison to the other expressions and the two comparison groups. This contrast compared the mean unbiased hit rate for recognition of anger for the OCD group with the other eleven unbiased hit rates taken together. Participants with OCD recognized anger expressions with significantly less accuracy than the other expressions and than the other diagnostic groups ($F_{(1, 57)} = 24.87, p < .001, r = .55$).

Exploratory Analyses

The results of the planned analyses (the omnibus ANOVA and the four planned comparisons) revealed that clients with OCD were significantly less accurate at recognizing the facial expressions of disgust and anger, as compared with the normal and panic disorder comparison groups. These results only partially confirmed the initial hypotheses. First, although the participants with OCD were less accurate at recognizing the expression of disgust, the magnitude of this effect was much smaller than that observed by Sprengelmeyer et al. (1997). Second, in addition to being less accurate in the recognition of disgust, OCD participants were significantly less accurate in the recognition of anger.

A comparison of the results of the current study to those of Sprengelmeyer et al. (1997) provides valuable information to help understand the differences between the two studies. As shown in Figure 4, the results of the two studies are similar, with the one exception that the OCD participants' performance differs on the disgust task. This figure shows that the OCD sample from Sprengelmeyer et al. (1997) had a mean accuracy rate of 25.85% for the expression of disgust, whereas the current OCD sample had a mean accuracy rate of 77.50%. It is also informative to compare the OCD groups' accuracy for the anger expression. Here we see that the two OCD samples performed almost identically, with the OCD sample from Sprengelmeyer et al. achieving a mean accuracy of 78.35%, and the current OCD sample achieving a mean accuracy of 78.44%. Thus, the fundamental difference between the two studies is in the accuracy of the OCD groups for the expression of disgust.

Thus, while the results of the current investigation lend some support to the claim of Sprengelmeyer et al. (1997) that clients with OCD show impairment in their ability to

recognize disgust, they do not show anywhere near the same magnitude of impairment.

Exploratory and graphical analyses were conducted to search for clues to understanding the failure to replicate the strong results shown in the Sprengelmeyer et al. study. The percentage of correct responses on the disgust task was used in these analyses, rather than the unbiased hit rate (H_U). This alternate measure was used because the unbiased hit rate takes into account participants' pattern of errors across all four expressions (not just the accuracy for the individual expressions), and thus somewhat masks OCD participants' poor accuracy for disgust.

Graphical analysis of participants' recognition accuracy for disgust as measured by the percentage of correct responses shows the lower mean accuracy rate for the OCD sample (that had been evident in the ANOVA). However, the OCD participants also had more variability within the sample (Figure 5). Of particular interest is that the OCD group forms two separate groups: participants who performed normally on the task (as defined by falling within 1.5 standard deviations of the mean of the normal comparison group), and participants who performed poorly (those who fell below 1.5 standard deviations of the mean of the normal comparison group). Figure 6 shows two distinct sub-samples within the OCD group: those who performed normally ($M = 91.35\%$, $SD = 6.52\%$, $n = 13$), and those who performed poorly ($M = 51.78\%$, $SD = 7.83\%$, $n = 7$). There is no overlap between these subgroups.

A series of *t*-tests was conducted in an effort to discover descriptive or illness-related factors that could help explain the difference between those OCD participants who performed normally and those who were impaired in disgust recognition. Pearson product-moment correlations were also computed. The illness factors employed in these analyses were: 1) global assessment of functioning (GAF; a measure of general functioning and illness severity

gleaned from the diagnostic interview); 2) total item score from the YBOCS, a measure of OCD severity; 3) age of onset of OCD; and 4), number of years with OCD. Participants' current age was also explored as a possible variable, as age has been found to be related to performance on facial expression judgment tasks (McDowell, Harrison, & Demaree, 1994). In addition, the relationship between comorbid diagnosis of depression and performance on the disgust task was explored using chi-square analysis. One-tailed tests were used for *t*-tests and chi-square analyses because of the *a priori* hypotheses that performance would be negatively affected by increased severity of symptoms and increased age.

Results of the *t*-tests reveal that the OCD participants who performed normally on disgust recognition were significantly more functional and less symptomatic than those who were impaired in their recognition of disgust (see Table 7). Results of the *t*-tests on age of onset, number of years since OCD diagnosis, and current age did not reveal significant differences. The chi-square analysis comparing comorbid diagnosis of depression with performance on the disgust task did not yield a significant result ($\chi^2_{(1, N=20)} = 0.29, p > .50, r_{\Phi} = -.12$; see Figure 8)⁴.

Discussion

This study examined the accuracy of facial expression recognition in individuals with OCD. If individuals with OCD were found to be specifically less accurate in the recognition of facial expressions of disgust, these results would replicate the remarkable findings of Sprengelmeyer and colleagues (1997). To examine this hypothesis, individuals with OCD were tested for their recognition of facial expressions of anger, disgust, fear and sadness. Accuracy of facial expression recognition was compared among individuals with OCD, panic

disorder, and those with no psychiatric disorder. The OCD group was expected to recognize the facial expression of disgust less accurately than they recognized other emotional expressions and less accurately than the other diagnostic groups recognized disgust.

The results revealed that across all three groups, the expression of fear was recognized with the greatest accuracy, followed by sadness, disgust, and anger. It is informative to compare these accuracy scores with those typically found in facial expression recognition studies among normal samples. Among the four facial expressions used in the current study, American observers typically recognize sadness most accurately (86.9%), followed by anger (83.9%), disgust (83.6%), and fear (79.8%; Russell, 1994). It is notable that fear is not typically recognized as well as it was in this study. However, the higher accuracy for fear in the current study may be explained by that fact that “surprise” was not included as a response choice. Respondents often confuse fear and surprise in facial expression studies (Tomkins & McCarter, 1964). Thus, when both expressions are included in a study (as in the studies summarized by Russell, 1994), accuracy scores for both expressions will be lower than when only one expression is included (as in the current investigation).

In the present study, individuals with OCD were less accurate at recognizing facial expressions in general than were the panic disorder and normal comparison groups. This apparent general deficit may, however, be misleading. First, the OCD participants were as accurate as the comparison groups in recognizing fear and sadness. Furthermore, careful examination of the ANOVA and the planned comparisons suggests a small interaction effect between diagnostic group and stimulus expression.

The main goal of this study was to investigate whether individuals with OCD would have a specific deficit for the recognition of facial expressions of disgust. The results of this study only partially replicate those reported by Sprengelmeyer et al. (1997). As predicted, individuals with OCD were less accurate at recognizing facial expressions of disgust. However, the magnitude of this effect was smaller than that observed by Sprengelmeyer et al. Subsequent examination of the performance of the OCD sample revealed large within-group variability in disgust recognition. The OCD participants showed a clear bimodal distribution: two-thirds of the sample recognized disgust with accuracy rates indistinguishable from normals, whereas one-third were significantly impaired in the ability to recognize disgust. The groups were clearly delineated, with one group achieving accuracy rates above 80%, and the other group achieving accuracy rates below 62%. This intriguing finding suggests that only a subset of individuals with OCD may be impaired in their ability to recognize disgust. Importantly, whereas Sprengelmeyer et al. reported that *all* participants with OCD were impaired in the recognition of disgust, only one third of the current sample demonstrated any impairment.

In order to better understand the variability within the OCD sample, I examined the relationship between a number of participant characteristics and the recognition of disgust. Only a limited number of variables were available for this analysis because the discovery of a subgroup of poor performers was unexpected. The variables examined included current age, severity of symptoms, general level of functioning, duration of illness, age of onset, and presence of depression. These variables have been found to be predictive of facial expression recognition accuracy in some studies conducted with depressed and schizophrenic individuals.

Disgust expression recognition was significantly related to two measures of severity: general level of functioning and OCD symptom severity. Measures of illness chronicity (age of onset of OCD, length of illness) and age were not related to performance. Importantly, there was no significant relationship between presence of major depression and recognition of disgust expressions. Participants who were impaired in their ability to recognize disgust were no more likely to be depressed than were those who performed well on the task. These results provide preliminary evidence that severity of symptoms and general functioning may be related to recognition of facial expressions of disgust in OCD patients.

Another important finding from this study is that participants with OCD were also impaired in their ability to recognize facial expressions of anger, a result not found in Sprengelmeyer et al. (1997). However, when the results of the current study are compared with those of Sprengelmeyer et al., the OCD samples are found to perform almost identically on recognition of anger expressions. Furthermore, while not significant, OCD participants in Sprengelmeyer et al. did show a trend toward impairment in the recognition of anger expressions. Thus, the current study provides additional evidence that individuals with OCD are impaired in the recognition of anger, as well as in the recognition of disgust.

The results of this study differ somewhat from those of Sprengelmeyer et al. (1997). Reasons for the discrepant results are not immediately clear. The discrepancy in findings may stem from a difference in participant characteristics. The results of this study suggest that severity of OCD and general functioning may be related to accuracy of recognition of disgust expressions. Thus, one possibility is that the present sample had less severe symptoms than those in Sprengelmeyer et al. (1997). However, this explanation seems unlikely given that the OCD participants in this study were seen at a tertiary care center

specializing in the treatment of difficult anxiety disorders. Most clients referred to that clinic have failed several previous attempts at treatment. Furthermore, correlations between OCD severity and recognition of disgust were not large, explaining only a small proportion of the variance in disgust recognition.

Another possibility is that the discrepancy in findings stems from differences in methodologies. Notably, only one model was used in Sprengelmeyer et al. (1997). As described earlier, there may have been something unusual about this model that made it difficult for some participants to accurately recognize disgust. Sprengelmeyer et al. (1997) report that anger was the expression most often chosen in place of disgust. The unique facial characteristics of the one model may have made it difficult for participants to distinguish disgust from anger, thus leading to poor recognition scores for disgust. In order to address this problem, the current study design included two models. Therefore, it is possible that the larger effect found in Sprengelmeyer et al. was the result of facial characteristics unique to the one model in their study.

It is also possible that the task employed in Sprengelmeyer et al. (1997) was more complex than the task in the current study. The recognition task in Sprengelmeyer et al. included all six basic facial expressions (anger, disgust, fear, happiness, sadness, and surprise) whereas the current study included only the four negative expressions. Perhaps reducing the response choices and stimulus set to four expressions decreased the task difficulty, making it easier for participants in the current study to accurately recognize facial expressions of disgust. However, this difference is not an adequate explanation for the discrepancy in findings because expressions of happiness and surprise are well discriminated

from disgust and anger (Tomkins & McCarter, 1964), and should not affect participants' recognition of anger and disgust.

This study has several limitations that require mention. First, the small sample size limited power to adequately test the interaction effect, particularly given the reduction in power associated with corrections for violation of sphericity. The observed power (Cohen, 1977) was sufficient to test for the main effect of emotion (power = 1.0), but was low for testing the main effect of diagnostic group (power = 0.59) and the interaction effect (0.66). However, given the large effect size reported in Sprengelmeyer et al. (1997), the current sample size would have provided sufficient power to test the interaction had all OCD participants shown the effect, as they did in the earlier study.

A second limitation of this study is that the sample included too few men to allow statistical analyses on the effect of participant gender and performance on the disgust task. Previous studies report sex differences in the accuracy of facial expression recognition (Buck, 1976; Thayer & Johnsen, 2000), with women generally performing better than men (c.f. Gessler et al., 1989). In the current study, three of the six male participants in the OCD sample were impaired in their ability to recognize expressions of disgust, compared to four of the fourteen women. Whether participant gender is related to the accuracy of recognition of disgust facial expressions remains unclear.

Future Directions

This study provides evidence that some individuals with OCD are very impaired in their ability to recognize facial expressions of disgust and anger. There are several important avenues for further research. The most pressing question, obviously, is how to explain that a

subset of individuals were impaired in their ability to recognize facial expressions of disgust. One possibility is that individuals with particular symptoms of OCD are more likely to be impaired in disgust recognition. OCD is a heterogeneous disorder, and a number of different subtypes have been proposed (Baer, 1994; Calamari, Wiegartz, & Janeck, 1999; Leckman et al., 1997; Summerfeldt, Richter, Antony, & Swinson, 1999; van Oppen, Hoekstra, & Emmelkamp, 1995). In a large factor-analytic study, Leckman and colleagues (1997) found that symptoms of OCD could be best explained by four factors: obsessions and checking; symmetry and ordering; cleanliness and washing; and hoarding. Moreover, in their recent review, Power and Dagleish (1997) proposed that disgust might play a role in the development and symptomatology of OCD, particularly contamination-based OCD. As described earlier, individuals with contamination obsessions tend to be hypersensitive to disgust. Thus, it would be informative to examine facial expression recognition in different subtypes of OCD, in order to explore whether this impairment is only evident in specific subtypes.

It is also possible that poor performance on the disgust task is due to a secondary factor, such as severity of symptoms, cognitive abilities, level of education, or medication. The current study provided evidence that symptom severity may be related to the ability to recognize facial expressions of disgust. Future studies should examine other illness and background factors in order to clarify the nature of this deficit.

These findings could also provide an important lead for neurophysiological studies. While it has been well established that there is a link between facial expression recognition and the limbic system, particularly the amygdala, recent research suggests that the basal ganglia may be important for accurate recognition of disgust (Phillips et al., 1997;

Sprenghelmeyer et al., 1998). Abnormalities in the basal ganglia and orbito-frontal cortex are believed to be involved in obsessive and compulsive symptoms (Abbruzzese, Ferri, Bellodi, & Scarone, 1993; Hoehn-Saric & Greenberg, 1997; McGuire, 1995; Rapoport, 1988). Thus the present findings lend some support to the conclusion that the basal ganglia may be involved in recognition of disgust expressions, and suggest that this will be an important area of research. However, the current results also suggest that future studies should attend not only to overall group performance, but also to possible within-group variability on tasks of facial expression recognition in OCD populations.

Future studies could also examine possible clinical implications of the deficits in facial expression recognition. One possibility is that these deficits may contribute to poor social functioning. Two recent studies explored the relationship between facial expression recognition and social competence in schizophrenic patients (Mueser et al., 1996; Penn, Spaulding, Reed, & Sullivan, 1996) and found that the ability to recognize facial expressions was related to social competence and social interest. It would be informative to examine this relationship in an OCD sample.

In summary, the results of this study provide evidence that a subset of individuals with OCD are impaired in the recognition of facial expressions of anger and disgust. These results, while consistent with Sprenghelmeyer et al. (1997), suggest that we need to question the specificity and generality of the effect. This study tentatively explored the relationship between participant characteristics and disgust recognition. The results suggest that OCD symptom severity and general functioning are related to recognition of disgust expressions. Further research is necessary to understand the subset of individuals with OCD who are impaired in their ability to recognize facial expressions.

Endnotes

¹ The expression term used by Izard was “enjoyment” rather than “happy.”

² Proportion data are often negatively skewed, which they were in this sample. Wagner (1993; 1997) suggests transforming the data using an arcsine transformation. However, more recent research suggests that this transformation is unnecessary as it makes little difference to the results (H. L. Wagner, personal communication, June 10, 2002). The data in this study were analyzed once using raw scores and then again using transformed scores. Both methods yielded similar results, and therefore the results of the raw data are presented.

³ The same analyses were run using only the pure facial expressions (100% expressions). This method of analysis yielded similar results to those presented.

⁴ Three other chi-square analyses were attempted; however, in each case more than 20 percent of the cells had expected frequencies below 5. The three analyses compared the normally-performing OCD participants with the abnormally-performing participants on the following measures: 1) the presence of washing compulsions and/or contamination obsessions; 2) the presence of checking compulsions and/or doubting obsessions; and 3) participant gender. None of the analyses reached significance.

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Table 1: Percentage of Correct Responses to Facial Expression Exemplars

Group	Expression	Mean	<i>SD</i>
OCD	Anger	78.44	28.22
	Disgust	77.50	20.52
	Fear	93.65	14.36
	Sad	89.69	11.93
Normal Control	Anger	86.25	12.80
	Disgust	89.79	12.01
	Fear	97.29	3.45
	Sad	91.98	6.87
Panic Control	Anger	86.56	11.05
	Disgust	87.92	17.97
	Fear	98.54	2.15
	Sad	92.29	8.17

Table 2: A 4 x 4 Confusion Matrix

Stimulus	Response				
	Anger	Disgust	Fear	Sadness	Total
Anger	a	b	c	d	a + b + c + d
Disgust	e	f	g	h	e + f + g + h
Fear	i	j	k	l	i + j + k + l
Sadness	m	n	o	p	m + n + o + p
Total	a + e + i + m	b + f + j + n	c + g + k + o	d + h + l + p	N

Note: All entries are frequencies.

Calculations:

$$H_U(\text{Anger}) = \frac{a}{a + b + c + d} \times \frac{a}{a + e + i + m}$$

$$H_U(\text{Disgust}) = \frac{f}{e + f + g + h} \times \frac{f}{b + f + j + n}$$

$$H_U(\text{Fear}) = \frac{k}{i + j + k + l} \times \frac{k}{c + g + k + o}$$

$$H_U(\text{Sad}) = \frac{p}{m + n + o + p} \times \frac{p}{d + h + l + p}$$

Table 3: Confusion Matrix of Obsessive Compulsive Disorder Group Means and Standard Deviations for Average Percentage of Correct Responses to Facial Expression Stimuli

		Response Percentage				
Stimulus		Anger	Disgust	Fear	Sad	Total
Anger	<i>M</i>	78.44	8.44	4.90	8.23	100
	<i>SD</i>	28.22	11.91	9.87	14.02	
Disgust	<i>M</i>	20.31	77.50	0.94	1.25	100
	<i>SD</i>	19.13	20.52	3.73	5.12	
Fear	<i>M</i>	0.52	2.92	93.65	2.92	100
	<i>SD</i>	0.93	7.89	14.36	6.14	
Sad	<i>M</i>	6.15	2.08	2.08	89.69	100
	<i>SD</i>	8.54	4.97	3.70	11.93	
Total		105.42	90.94	101.56	102.08	400

Table 4: Confusion Matrix of Normal Comparison Group Means and Standard Deviations for Average Percentage of Correct Responses to Facial Expression Stimuli

Stimulus	Response Percentage					
	Anger	Disgust	Fear	Sad	Total	
Anger	<i>M</i>	86.25	4.69	4.17	4.90	100
	<i>SD</i>	12.80	7.82	5.45	7.13	
Disgust	<i>M</i>	10.10	89.79	0.00	0.10	100
	<i>SD</i>	12.04	12.01	0.00	0.47	
Fear	<i>M</i>	0.00	0.52	97.29	2.19	100
	<i>SD</i>	0.00	1.64	3.45	2.83	
Sad	<i>M</i>	5.52	1.46	1.04	91.98	100
	<i>SD</i>	7.13	1.67	1.43	6.87	
Total		101.88	96.46	102.50	99.17	400

Table 5: Confusion Matrix of Panic Disorder Comparison Group Means and Standard Deviations for Average Percentage of Correct Responses to Facial Expression Stimuli

Stimulus	Response Percentage					
		Anger	Disgust	Fear	Sad	Total
Anger	<i>M</i>	86.56	4.38	5.63	3.44	100
	<i>SD</i>	11.05	7.15	7.50	4.98	
Disgust	<i>M</i>	10.42	87.92	0.73	0.94	100
	<i>SD</i>	16.57	17.97	1.40	2.29	
Fear	<i>M</i>	0.10	0.83	98.54	0.52	100
	<i>SD</i>	0.47	2.07	2.15	0.93	
Sad	<i>M</i>	4.58	1.88	1.25	92.29	100
	<i>SD</i>	6.25	2.78	1.96	8.17	
Total		101.67	95.00	106.15	97.19	400

Table 7: Relationship Between Illness and Background Factors and Percentage of Correct Responses on Disgust Task

Variable	Disgust Task Performance		Statistic			
	Normal (n = 13) <i>M (SD)</i>	Impaired (n = 7) <i>M (SD)</i>	<i>t</i>	<i>df</i>	<i>p</i> ^a	<i>r</i>
Age	28.77 (7.50)	32.71 (15.29)	0.64 ^b	8	0.270	-.06
GAF	56.92 (6.89)	50.00 (6.66)	2.17	18	0.022	.37
YBOCS	24.15 (5.06)	27.00 (2.16)	1.75 ^b	19	0.048	-.30
Age of Onset	19.08 (7.20)	19.57 (6.60)	0.15	18	0.441	.03
Years with OCD	9.69 (6.82)	13.14 (11.87)	.71 ^b	9	0.248	-.10

Note. GAF = Global Assessment of Functioning (SCID-I); YBOCS = Yale-Brown Obsessive Compulsive Scale – Total Score.

^a Reported *p*-values are based on one-tailed tests. ^b Welch's *t'*-test and adjusted degrees of freedom were used to correct for heterogeneous variances.

Figure 1: Facial Expression Stimuli (Female Model)

Figure 1: Facial expression stimuli used in task. From left to right, the columns show 0%, 25%, 50%, 75%, and 100% morphs. From top to bottom, the rows represent: anger – sadness, disgust – anger, disgust – fear, disgust – sadness, fear – anger, and fear – sadness.

Figure 2: Sample Computer Screen

Figure 3: Recognition of Facial Expressions by Diagnostic Group

Figure 4: Comparison Between Sprenghelmeyer et al. (1997) and Current Investigation for Mean Proportion of Correct Responses

Note: In Sprenghelmeyer et al (1997), sample sizes for the three groups were: OCD (n = 12), Anxiety Controls (n = 8), Normal Controls (n = 40).

^a In Sprenghelmeyer et al. (1997), anxiety controls consisted of 6 individuals with panic disorder patients and 2 individuals with generalized anxiety disorder. The anxiety disorder comparison group in the current study comprised 20 individuals with panic disorder.

Figure 5: Percentage of Correct Responses on Recognition of Disgust Facial Expressions

Figure 6: Percentage of Correct Responses to Disgust Task in OCD Sample

Figure 7: Effect of Depression Diagnosis on Percentage of Correct Responses on Disgust Task