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# Facial Emotion Recognition and Facial Affect Display in Schizotypal Personality Disorder

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Dickey: designed the study, wrote the protocol, performed statistical analyses, wrote the manuscript
Panych: reviewed the manuscript
Voglmaier: interviewed all subjects
Niznikiewicz: contributed to the manuscript
Terry: organized photograph ratings and raters
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## Abstract

**Background**—Patients with schizophrenia have deficits in facial affect expression and detection that hinder social interactions. The goal of this study was to examine whether or not epidemiologically-related antipsychotic-naïve schizotypal personality disorder (SPD) subjects would have similar deficits as patients with schizophrenia.

**Methods**—Matched SPD and healthy comparison (HC) subjects were asked to identify the eight classic emotions (SPD N=55, HC N=67) and to discriminate gender. Subjects (SPD N=22, HC N=17) were also photographed while displaying the same emotional expressions. Raters scored the subjects' facial expressions along several dimensions.

**Results**—SPD subjects compared with HC were slower and less accurate in identifying facial expressions. This may have been driven by deficits in identifying gender. Although raters were able to identify correctly SPD and HC subjects' expressions equally well, raters found SPD subjects' facial expressions to be more odd, more ambiguous, and the subjects less attractive in general compared with HC subjects. Raters were less confident in their ability to correctly interpret SPD subjects' facial expressions and raters were less comfortable with the idea of spending time with the SPD subjects compared with HC subjects.

**Conclusions**—SPD subjects face two hurdles in terms of daily social interactions. They have problems both in correctly interpreting others' facial expressions and in generating socially attractive and unambiguous facial expressions.

## Introduction

In semi-structured interviews with subjects meeting DSM-IV criteria for schizotypal personality disorder (SPD), one is struck by the lack of social reciprocity exhibited by the subjects. One can smile at them, but they usually don't smile back as one would expect in the course of daily human interactions. Indeed, little affect may be displayed at all. Are these subjects able to show recognizable emotions on their faces? Do they appreciate that someone is smiling at them? These two simple yet clinically important questions drive this study.

Blunted or flat affect is a hallmark feature of schizophrenia, with descriptions dating back to Bleuler, (Bleuler 1911). "Affective impoverishment" was also described in the early literature as a fundamental aspect of SPD (Rado 1953, Meehl 1962), which is epidemiologically related to schizophrenia (Kendler et al. 1993). As a result, two of the nine DSM-IV criteria for SPD focus on subjects' presentation of themselves to others, specifically: inappropriate or constricted affect and odd/eccentric/peculiar behavior or appearance. These disturbances have been shown to impact negatively SPD subjects' lives (Skodol et al. 2002, Dickey et al. 2005). Understanding the sources of these behaviors could inform treatment approaches directed toward enhancing their success navigating the social world. Social cognition research has shown schizophrenic subjects to have emotion recognition deficits (Hooker and Park 2002, Green, Williams and Davidson 2001, Gur et al. 2007). Although the hallmark features of schizophrenia are hallucinations and delusions, severity of psychotic symptoms were not shown to correlate with functional outcome (Green 1996). Instead, social impairment was seen to be more significant. Furthermore, impoverished social interactions were found to be treatment resistant, were more burdensome for families than were the psychotic symptoms, contributed to an increased rate

of relapse, and may have explained patients' low socioeconomic status (Malaspina and Coleman 2003, Perlick et al. 1992, Hooker and Park 2002, Doop and Park 2009).

Two important aspects of social cognition or social reciprocity are the ability to correctly and quickly interpret another's facial expression and the ability to display an interpretable emotional expression on one's face. Facial emotion recognition and its pathophysiological underpinnings have received much attention. Facial emotion recognition deficits have been shown with schizophrenia subjects using varied approaches (Schneider et al. 1995, Hooker and Park 2002, Mandal, Pandey and Prasad 1998, Kee et al. 2004, Green et al. 2001) (Gur et al. 2007, Kerr and Neale 1993). To understand the pathophysiology, researchers have demonstrated evidence supporting the existence of deficits along the complicated and intertwined pathway toward facial emotion identification. These include; evidence for abnormalities in neuronal structure or functioning (Enticott et al. 2008b, Di Rosa et al. 2009); evidence for morphometric / functional abnormalities in regions considered critical to face processing including the fusiform gyrus and limbic regions (Seiferth et al. 2009, Walther et al. 2009, Johnston et al. 2005) (Onitsuka et al. 2003, Gur et al. 2002); evidence of primary deficits of visual sensory processing (Butler et al. 2009, Butler, Silverstein and Dakin 2008) (Norton et al. 2009); evidence for neurocognitive deficits such as executive control / attention (Kohler et al. 2000, Gold et al. 2007, Heinrichs and Zakzanis 1998, Addington and Addington 1998), slow processing speed (Poole, Tobias and Vinogradov 2000), and impaired memory(Sachs et al. 2004, Linden et al. 2010); as well as other abnormalities (Johnston et al. 2005, Turetsky et al. 2007, Norton et al. 2009, Schneider et al. 2006, Gur et al. 2007, Kee, Kern and Green 1998). Of particular interest is that schizophrenic patients also have difficulties determining subtle gender distinctions (Bigelow et al. 2006). The multitude of deficits currently defies a single comprehensive model accounting for all the data. What is plain, however, is that the process of interpreting another's facial affect is a complex, non-linear path, and that path does not function optimally in schizophrenia.

Compared with schizophrenics, less work has been performed with SPD subjects' ability to recognize facial emotions but four studies are of note. Waldeck and Miller (2000) demonstrated SPD subjects' inability to correctly identify facial emotions given brief exposure times (10 sec) (Waldeck and Miller 2000). In another study of clinically diagnosed SPD subjects co-morbid for major depression, Mikhailova et al (1996) demonstrated mild deficits in emotional recognition, again with brief exposures (80msec). When the depression remitted, the impairment remained, suggesting a trait deficit (Mikhailova et al. 1996). In a large internet sample of subjects scoring high for psychosis-proneness as measured by self-report Schizotypal Personality Questionnaire responses, facial emotion identification but not gender identification was impaired (Germine and Hooker 2010). In a second study subjects who scored high on measures of schizotypy had more difficulty with facial affect and face recognition than subjects with low scores (Poreh et al. 1994). Note that in neither of these last two studies did the subjects meet full clinical criteria for SPD, but the findings nonetheless support the hypothesis that along the schizophrenia spectrum there may be problems with facial affect recognition.

Social reciprocity requires not only the facial affect recognition but also the unequivocal facial display of emotions. As commented above, schizophrenic patients are known for frequently exhibiting flat affect clinically and in the laboratory (see review (Kring and Moran 2008) (Kohler et al. 2008a) (Kohler et al. 2008b). Schizophrenic patients may display microexpressions, but these are difficult to detect in everyday life (Kring and Moran 2008). Even when asked to look at a canonical expression and copy that expression onto their own faces, schizophrenic subjects have difficulty (Putnam and Kring 2007). Interestingly, emotional display does not correlate with the schizophrenic patients' experience of a

situation, that is, patients may experience an emotion as strongly as a healthy person, but not show it (Kohler et al. 2008a, Kring et al. 1993) (Kohler et al. 2008b, Earnst and Kring 1999). One conclusion is that schizophrenia subjects can display facial affect, but perhaps not all of the emotions and that the effectiveness of those expressions in terms of promoting social communication is inadequate.

Accurate interpretation of facial affect and an adaptive facial response are crucial to successful daily interactions and longevity (Lieberman and Rosenthal 2001, Frith 2007, Avlund, Damsgaard and Holstein 1998, Dekowska, Kuniecki and Jaskowski 2008). These aspects of social cognition and social reciprocity may be of particular importance in SPD as they are odd, exhibit unusual affect, and fail to meet expected life milestones (Dickey et al. 2005).

Given the literature on schizophrenia and, to a more modest extent, SPD, the questions remain: can persons with SPD correctly and rapidly identify emotional facial expressions and whether, when prompted, they display an unambiguous facial expression? In an attempt to answer these questions in this study, a traditional emotion recognition task was coupled with a novel task of asking subjects to display classic emotional facial expressions. The initial hypotheses stemmed from the schizophrenia literature: SPD subjects would be slow and inaccurate in their interpretation of facial expressions; subjects would have flat or odd affect such that raters would have trouble interpreting correctly their expressions. Finally, as SPD subjects have not been prescribed antipsychotic medications known to diminish facial expression (Sharafi 2005), they may represent an ideal population of subjects along the schizophrenia spectrum to study clinical features of face processing.

## Methods

### Subjects

Subjects were recruited from the community via advertisements. After signing an informed consent form consistent with local IRB guidelines, subjects participated in SCID and SCID-II interviews and SPD subjects met DSM-IV criteria for SPD based on these interviews. All subjects were between 18–55 years old; they were right-handed; and they were antipsychotic and psychotropic-naïve. Subjects had no history of psychosis, bipolar disorder, ECT, neurologic disorders, or substance-dependence for five years or abuse for one year. Comparison subjects had two additional requirements; they had no first-degree relative with mental illness (per their report); they had no personal history of mental illness or personality disorder (per SCID and SCID II).

Subject number differed among tasks depending on when the task was introduced in the course of recruitment, since SPD subjects did not necessarily remain in contact with the laboratory. In order to maximize the number of subjects while maintaining appropriate group matching, the matching process occurred separately for the two main tasks, Facial Emotion Recognition task (FER) and Facial Emotion Expression task (FEE). In both cases subjects were 1:1 matched on age, and group matched on gender, parental socio-economic status (PSES), and estimated IQ (Block Design). As a result of the matching process, all subjects included in the FEE task were also in the FER task with the exception of two SPD subjects.

### Facial Emotion Recognition

**FER task—**Subjects were shown 64 picture cards of classic emotions (eight faces each displaying eight emotions: happy, sad, angry, fear, surprise, disgust, contempt, and neutral) (Matsumoto and Ekman 1988). The entire set of these well-studied and classic expressions

was included. Subjects were asked to verbally specify the emotion depicted on the cards. They were informed that it was a timed task and that they should work as quickly as possible without sacrificing accuracy. A written list of the potential answers was provided to reduce working memory demands. Accuracy (number correct) and time (to completion) were the dependent variables and compared using an ANOVA.

Secondary analyses on individual emotions were performed in order to be consistent with the schizophrenia literature and to provide guidance for future work. There were no a priori hypotheses regarding individual emotions.

**Gender Task—**In order to ascertain whether face processing deficits were restricted to affect processing or were more wide-ranging, an additional task was included, the Gender Task. Gender perception has been shown to influence affect perception (Hess et al. 2009a) and schizophrenic subjects have difficulty making subtle gender distinctions (Bigelow et al. 2006). The question was whether some SPD subjects also display difficulty in determining gender.

In the Gender task the subject had to verbally state whether two faces (Gur et al. 2001) were of the same or different gender (Fig 1). They were asked to work as quickly and as accurately as possible. There were 24 pairings of neutral faces. This task had the advantage of using color photographs of neutral faces, stimuli similar to the FER task, with the only difference being that the emotion displayed in the color photographs was neutral. Note that this is a new application of these well-described faces (Gur et al. 2001). Accuracy and time were the dependent variables, and again were compared using an ANOVA.

## Facial Emotion Expression

**FEE Task—**In normal daily social situations people occasionally need to "put on a happy face" when they aren't feeling happy, or try not to appear angry when they are indeed experiencing anger (Mann 1999). Social engagement requires the manipulation of facial expression to meet social expectations (Carroll and Russell 1996, Adolphs 2009) and the ability to use one's facial expressions in a socially effective manner has been shown to predict success in life (Papa and Bonanno 2008).

Here the question was whether SPD subjects could produce an unambiguous facial expression upon request, regardless of the actual presence or absence of the associated emotional feeling. In this novel task subjects were asked to, "make a happy face" and have their photograph taken. The process was repeated for each of the same eight classic expressions as in FER with order randomized across subjects.

Note that no attempt was made during the photography sessions to induce a particular mood other than feeling at ease with experimental procedures. Evidence from the schizophrenia literature suggests a disconnect between the experience and expression of an emotion (Kring et al. 1993, Kring and Moran 2008) (Kohler et al. 2008a). The paradigm used in this study was designed to isolate the expression of affect. To our knowledge this is the only data set of SPD subjects' facial expressions and, thus, represents a unique opportunity to explore this aspect of social cognition in SPD.

**FEE Ratings—**Photographs of the subjects were randomly divided into groups of 60 and presented to six raters; three men and three women who were all college-educated and from our laboratory. Laboratory members were selected as raters in order to maintain subjects' photographs within the laboratory in accordance with IRB requirements. The presentation order of these groups of photographs differed among the raters to control for potential priming effects.

Each photograph was rated on the degree to which the expression displayed each of the eight major emotions. Restated, for each photograph, each rater scored the degree to which the expression appeared happy, sad, angry, etc. A seven-point Likert scale was used ranging from 1=not at all expressed to 7=extremely expressed. Raters were blind to which emotion had been requested for each of the photographs. Raters also indicated which of the eight major emotions they thought was being depicted and their degree of confidence of their selection along a Likert scale. Raters also specified how odd the facial expression appeared given the SPD criteria of odd appearance; how ambiguous the expression was; how attractive did the rater find the person; how comfortable the rater would be in meeting the person; and how approachable the subject appeared to the rater, again along a Likert scale. The mean value across raters for each variable was compared between groups using an ANOVA.

The inter-rater reliability for the six raters was determined using an intra-class correlation (ICC) alpha. All subjects were included in the analysis. The extent along the seven point Likert scale for the *degree* to which the rater thought the subject displayed the requested emotion was used. For example: for happy, the alpha was calculated for the ratings from the six raters of the degree of happiness using the photograph in which the subject had been asked to appear happy. Note that, with this evaluation of inter-rater reliability, the reliability of the degree of the expressed emotion, was more stringent than simply asking if raters agreed on which emotion was displayed.

**PANAS-X**—To determine if there was a group difference in shyness during the photography session, the PANAS-X (Watson and Clark 1994) was given with the instruction, "Indicate to what extent you feel shy right now" on a 1–5 scale (1=very slightly or not at all; 5=extremely). This test was included to measure if (according to self-evaluation) the procedure itself caused more social anxiety in SPD subjects than controls. Note that interpretation of results of this questionnaire was restricted to subjects' shyness during the photography session, not whether there was a difference in subjects' shyness in general. The degree to which the subjects felt shy was the dependent variable in an ANOVA.

## Results

### Facial Emotion Recognition

SPD subjects when compared with HC subjects made more errors and were slower in identifying emotional facial expressions overall (Table 1, Fig. 2a, effect size = . 2 and .4, respectively). On the gender task SPD subjects were also less accurate and slower than HC subjects (effect size < .8 and < .7, respectively). This result was mostly driven by four subjects (15%) (Table 1, Fig. 2b). Even if one removed the lowest performing SPD subject, the SPD subjects remained less accurate and slower than HC subjects (accuracy: $F(1,53) = 5.258$, $p < 0.03$; time: $F(1,53) = 6.824$, $p = 0.01$).

In order to determine whether the difference between groups on the ability to correctly identify emotions (FER task) was solely due to difficulty interpreting emotions and not due to trouble processing faces in general, accuracy scores on the Gender task were used as a regressor for scores on FER. When the unstandardized residuals for accuracy were compared between groups, there was no longer a difference between groups on FER ($F(1,52) = 1.414$, $p = 0.2$). When time from the Gender task was used as a regressor for FER time and compared between groups, there was no longer a statistically significant difference between groups on FER ($F(1,52) = 3.586$, $p = 0.06$). These more refined examinations of the data suggest that processing of faces in general may have accounted for some of the variance between groups in the processing of emotional faces.

### Facial Emotion Expression

**FER Task—**Raters were able to identify SPD and HC subjects' facial expressions equally well (Table 1, Fig 3a). However, raters were less confident in their determinations of SPD subjects' expressions (Table 1, Fig 3b). Raters found SPD subjects' expressions to be more odd (reflecting subject selection bias), more ambiguous (Fig 3c), less attractive, and less approachable (Table 1). These findings are unlikely due to a difference in "shyness" during the photographing session itself as there were no group differences on PANAS-X (Table 1).

These factors may have culminated in raters being less comfortable in the prospect of meeting the SPD subjects as compared to the HC subjects (Table 1, Fig. 3d). Indeed, the rater's comfort level at the prospect of meeting *any* of the HC subjects was higher than the mean of their comfort with meeting the SPD subjects (i.e. the mean level of comfort in meeting a SPD subject was 3.0, which is below any of the individual ratings for the HC subjects) (Fig. 3d). Interestingly, this seemed to be related to how attractive the SPD subject was to the rater ($F_{(1,41)}=4.548$, $p = 0.04$): not how odd the expression ($F_{(1,41)}=.127$, $p = 0.7$); nor how ambiguous was the expression ($F_{(1,41)} = 2.164$, $p <0.2$). This can be further substantiated by examining the raters' response to neutral expressions. Raters did not find SPD subjects' neutral expressions to be less attractive ($F_{(1,42)} = 3.801$, $p < 0.06$); more odd ($F_{(1,41)} = 1.113$, $p < 0.3$); nor more ambiguous ($F_{(1,41)} = 1.031$, $p = 0.3$).

As odd appearance is a SPD criteria, one question was whether the degree of oddness affected raters' ability to identify emotions. To address that issue the number of correctly identified emotions was regressed for "oddness" rating with unstandardized residuals used to compare the two groups with ANOVA. Oddness did not affect the ability of the raters' to identify emotions ($F_{(1,41)}=2.362$, $p = 0.1$). The ability to identify emotions was not dependent on the ambiguity of the emotion ($F_{(1,41)}=3.708$, $p = 0.06$). Therefore, in this limited sample, for the raters' comfort with meeting an SPD subject, attractiveness mattered; but for raters' ability to correctly identify an emotion, ambiguity may have mattered. In neither case did oddness matter statistically.

Inter-rater reliability of the raters' opinion of the *degree* to which a requested emotion was expressed was high (intra-class correlation = .868) (Table 2).

For neither group was there a correlation between FER and FEE total correct (SPD r = .33, p < 1.4; HC r=− .016, p < 1.0) nor was there a difference in correlation coefficients between groups (Fisher Z = 1.02, p = .3). Note that this study did not measure social mimicry or interpersonal interaction, indeed, FER and FEE were separate tasks given on the same day but not directly linked.

## Discussion

The initial hypotheses was that SPD subjects compared with HC subjects would have dual deficits in facial affect identification and production, similar to what has been shown in schizophrenia. The data supported the first part of the hypothesis: SPD subjects were slow and inaccurate in identifying others' facial emotions. Some SPD subjects even had difficulty comparing the gender of two individuals. Deficits in visually identifying gender explained some of the deficits in indentifying emotion for SPD subjects. For the second half of the hypothesis, that SPD subjects would not be able to generate effective facial emotions, the story was also complicated. Raters were able to guess which emotion was being expressed on the SPD subjects' faces. However, raters' confidence in their guesses was low and they didn't wish to spend more time with the SPD subjects. Therefore, although SPD subjects were physically able to express classic emotions on their faces, their expressions were not effective socially. Here "effective" is defined as raters being confident in their ratings of the

expressions and wanting to spend more time with subjects. Raters found SPD subjects to be less attractive, with more ambiguous expressions, and did not want to spend more time with them.

The finding of SPD subjects being slow and inaccurate in face emotion recognition is consistent with the schizophrenia literature (Schneider et al. 1995, Hooker and Park 2002, Mandal et al. 1998, Kee et al. 2004, Green et al. 2001, Gur et al. 2007, Kerr and Neale 1993). Moreover, the deficit in visual processing exhibited by this sample of SPD subjects does not seem to be restricted to the domain of emotion processing, but, for some SPD subjects, was broader to encompass gender discrimination as well (medium effect size). In schizophrenia studies the effect sizes for emotion identification in schizophrenia are large, =. 85, and somewhat less large for control conditions (such as gender discrimination, − .7) (Chan et al. 2010) . Gender identification accuracy explained the variance in affect recognition in this SPD sample. This later finding was in direct contrast to what was found by Germine et al., (2010)(Germine and Hooker 2010). However, subjects in that study were not clinically assessed. Instead, subjects self-rated themselves on measures of schizotypy over the Internet, so that a direct comparison between the two samples is complicated. Understanding at which stage(s) of visual processing(Tsao and Livingstone 2008) the SPD subjects had difficulties is beyond the scope of the data. For example, many studies of schizophrenic subjects have demonstrated that visual processing problems extend beyond simple affect processing (Bozikas et al. 2006, Mueser et al. 1997, Feinberg et al. 1986, Hellewell, Connell and Deakin 1994). Processing speed may also be important for both schizophrenic and SPD subjects. The effect size for time for affect identification in this sample of SPD subjects was medium, larger than that for accuracy. Slow processing speed has been demonstrated also in schizophrenia with a meta-analysis suggesting a large effect (Knowles, David and Reichenberg 2010) . Across the schizophrenia spectrum, therefore, there is convergence of data suggesting deficits in facial affect recognition due, in part, to upstream visual processing and processing speed deficits (Butler et al. 2009, Butler et al. 2008) (Norton et al. 2009).

With respect to the expression of facial affect in SPD subjects, our data suggest another intricate story. The hypothesis was that raters would have more difficulty in correctly identifying a facial expression on the face of a SPD subject compared with a healthy comparison subject. That hypothesis was not substantiated: raters were able to identify SPD subjects' expression equally well compared to the HC subjects'. However, simply being able to identify an expression is insufficient for social interactions. It is also important for individuals that others will want to spend time with them and, unfortunately for the SPD subjects, raters did not want to spend more time with them.

Moreover, one would have expected that the SPD subjects' inherent "oddness" would be problematic for the identification of their emotional expressions. That was not the case. Only an SPD subject's attractiveness mattered to the raters. Perhaps this should not be surprising given the complex interaction of gender, ethnicity, presumed personality and social grouping can have on affect identification (Hess, Adams and Kleck 2009b). "Oddness" also did not account for raters' confidence in their ability to identify SPD subjects' expressions, instead, ambiguity mattered. These findings may be clinically useful in working with SPD persons as efforts can be directed toward enhancing awareness of impact of attractiveness and affect ambiguity on others.

Interestingly, in neither group was there a correlation between affect recognition and expression. One might have expected a correlation given everyday experience and research on mirror neurons and their role in affect (Enticott et al. 2008a, Enticott et al. 2008b) (Tsao

and Livingstone 2008). However, the experimental design of having separate experiments for perception and display limit the meaningfulness of that finding.

There were several limitations to this study. First, in order to identify facial emotions, visual scanning of the stimulus must occur. Future work should include visual scan path analyses as research in schizophrenia has suggested deficits in top-down regulation of visual search in schizophrenia(Gold et al. 2007). Second, social reciprocity has been shown to be highly affected by gender. There were not sufficient numbers of female subjects to examine the effect of gender with these measures (Hess et al. 2009a, Hess et al. 2009b). Third, there was a trend toward a difference in IQ between groups on the FEE task. However, the SPD subjects were educated with an average of two years of college and were similar to HC in terms of the socio-economic status of the family of origin. Fourth, the alpha level for ascertaining significance was not lowered to correct for the number of tests performed given the exploratory nature of this study. Finally, this study did not investigate reciprocity or social imitation or mirroring, which may be the most clinically meaningful aspects of facial affect. Instead, this work sought to address the initial question of whether SPD subjects can identify and display classic emotions.

In sum, this preliminary study examined simple tasks of facial affect recognition and display in a matched sample of antipsychotic-naïve DSM-IV SPD subjects and HC subjects. SPD subjects demonstrated deficits of facial affect and gender identification in that they were slow and inaccurate. They also demonstrated deficits in effective affect display. More work is needed to parse out the determinants of these deficits so that targeted social remediation programs can be designed. Regardless of the underlying mechanisms of these deficits, however, these data may be quite clinically useful. For a given patient with SPD symptoms it may be valuable if they were aware of these deficits so that they could be mindful during their daily interactions with others and work their therapists to learn to interpret and display effective facial affect.

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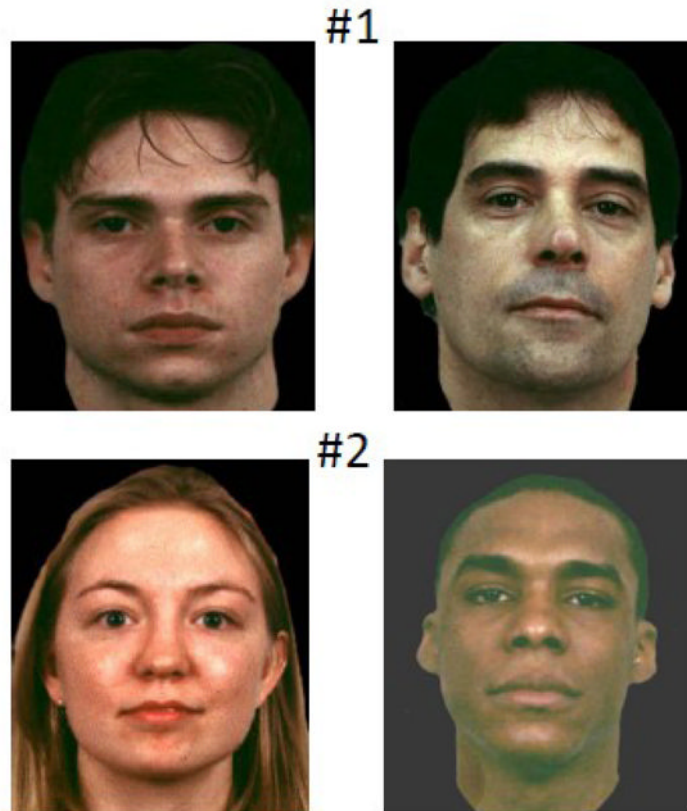**Figure 1.**
Gender Task. For face pair #1 the subject would correctly indicate that subjects were of the same gender by saying, "same"; for face pair #2 the subject would say, "different".
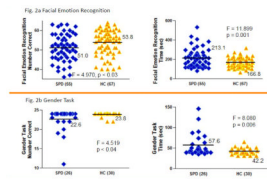
**Figure 2.**
Results for (a) Facial Emotion Recognition Task, Scatterplot on left shows the total number of correctly identified facial expressions out of 64; plot on right shows the time to complete the task. (b) Gender Task. Scatterplot on the left shows total number of correctly matched pairs of faces out of 24 and the plot on the right shows time to complete the task. Note that the SPD outliers were not the same subjects in Figure 2a & 2b. The means are indicated numerically and with horizontal bars.
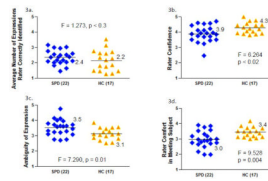
**Figure 3.**
(a–d) Results for Facial Emotion Expression Task, with (a) mean number of expressions per subject each rater correctly identified, (b) raters' confidence in their guess of the expressed emotion, (c) how ambiguous the raters found the expressions and (d) how comfortable the rater would be if they met the subject.

**Table 1**

Subject Demographics and Results for Facial Emotion Recognition Task (FER) and Facial Emotion Expression (FEE) Task. ANOVA tests were performed between groups with resultant F and p values given. The main focus of the FER task was to examine whether SPD subjects were able to correctly identify the classic emotions as a group. Secondary analyses on individual emotions are reported to guide future work. Happy (F(1,120)= 1.193, p < 0.3); sad (F(1,120)= 1.024, p = 0.3); anger (F(1,120)= 1.072, p = 0.3); surprise (F(1,120)= .295, p < 0.6); contempt (F(1,120)= 2.842, p = 0.09); disgust (F(1,120) = 7.367, p = 0.008); fear (F(1,120)= .001, p <1.0, note that this was the only emotion for which SPD scored higher than HC subjects); or neutral (F(1,120)= 1.521, p = 0.2). M = male; F = female; subject N for each task given in bold font; standard deviations in parentheses.

| Facial Emotion Recognition Task | SPD= 55 | | HC = 67 | | F | p |
|---|---|---|---|---|---|---|
| Gender (M, F) | 33, 22 (60% male) | | 38, 29 (57% male) | | | |
| | mean | s.d. | mean | s.d. | | |
| Age | 32.3 | (9.9) | 29.9 | (10.3) | 1.640 | 0.2 |
| Education (years) | 15.0 | (2.4) | 16.2 | (2.7) | 7.170 | 0.008 |
| PSES | 3.8 | (1.1) | 4.1 | (.9) | 2.522 | 0.1 |
| SES | 3.0 | (1.3) | 3.6 | (1.2) | 6.342 | 0.01 |
| IQ (Block Design) | 11.5 | (5.0) | 12.3 | (2.8) | 1.266 | <0.3 |
| Accuracy | 51.1 | (6.9) | 53.8 | (6.4) | 4.970 | <0.03 |
| Time | 213.1 | (94.7) | 166.8 | (50.6) | 11.899 | 0.001 |
| **Gender Task** | **SPD =26** | | **HC = 30** | | | |
| Accuracy | 22.6 | (3.0) | 23.8 | (.5) | 4.519 | <0.04 |
| Time | 57.6 | (28.0) | 42.2 | (7.9) | 8.080 | 0.006 |
| **Facial Emotion Expression Task** | **SPD= 22** | | **HC = 17** | | **F** | **p** |
| Gender (M, F) | 19, 3 (86% male) | | 14, 3 (82% male) | | | |
| Age | 37.5 | (10.6) | 31.5 | (11.4) | 2.481 | 0.1 |
| Education (years) | 14.2 | (2.7) | 16.0 | (3.0) | 3.855 | <0.06 |
| PSES | 3.8 | (1.1) | 3.9 | (1.0) | .253 | 0.6 |
| SES | 3.3 | (1.0) | 4.1 | (.6) | 7.883 | 0.008 |
| IQ (Block Design) | 9.4 | (3.7) | 11.4 | (2.7) | 3.513 | <0.07 |
| Rater average correct | 2.4 | (.5) | 2.2 | (.7) | 1.273 | <0.3 |
| Rater confidence | 3.9 | (.5) | 4.3 | (.4) | 6.264 | <0.02 |
| Rater comfort | 3.0 | (.6) | 3.4 | (.3) | 9.528 | 0.004 |
| Odd expression | 2.7 | (4.6) | 2.2 | (.3) | 12.476 | 0.001 |

| Facial Emotion Recognition Task | SPD= 55 | | HC = 67 | | F | p |
|---|---|---|---|---|---|---|
| Ambiguity of expression | 3.5 | (.5) | 3.1 | (.4) | 7.290 | 0.01 |
| Attractive expression | 2.0 | (.4) | 2.3 | (.4) | 4.872 | 0.03 |
| Approachable expression | 1.3 | (.2) | 1.5 | (.2) | 3.640 | 0.06 |
| PANAS-X | SPD = 17 | | HC = 15 | | | |
| Self-rating of shyness | 1.3 | (.1) | 1.3 | (.1) | .001 | <1.0 |

**Table 2**

Inter-rater Reliability: Intra-class correlation alpha. Raters were asked the extent of a particular facial expression along a seven-point Likert scale. For example, if the requested facial expression was "happy", the extent to which each rater rated the particular face as "happy" was entered into this calculation. Calculation was based on six raters and involved their ratings on all of the subjects.

| EMOTION | alpha |
|---|---|
| Angry | 0.816 |
| Contempt | 0.783 |
| Disgust | 0.868 |
| Fear | 0.880 |
| Happy | 0.919 |
| Neutral | 0.853 |
| Sad | 0.916 |
| Surprise | 0.912 |
| **Average** | **0.868** |