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Unseen Affective Faces Influence Person Perception Judgments in Schizophrenia

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Abstract

To demonstrate the influence of unconscious affective processing on consciously processed information among people with and without schizophrenia, we used a continuous flash suppression (CFS) paradigm to examine whether early and rapid processing of affective information influences first impressions of structurally neutral faces. People with and without schizophrenia rated visible neutral faces as more or less trustworthy, warm, and competent when paired with unseen smiling or scowling faces compared to when paired with unseen neutral faces. Yet, people with schizophrenia also exhibited a deficit in explicit affect perception. These findings indicate that early processing of affective information is intact in schizophrenia but the integration of this information with semantic contexts is problematic. Furthermore, people with schizophrenia who were more influenced by smiling faces presented outside awareness reported experiencing more anticipatory pleasure, suggesting that the ability to rapidly process affective information is important for anticipation of future pleasurable events.

Keywords

schizophrenia, affect, implicit emotion perception, continuous flash suppression, anticipatory pleasure

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Research over the past two decades has advanced our understanding of emotion deficits in schizophrenia. Among the more interesting revelations from this work has been the discovery of intact areas of emotional responding alongside a broad swath of other deficits. For example, people with schizophrenia experience as much pleasure as do people without schizophrenia in the presence of positive things, yet they have difficulty anticipating that future events will be pleasurable (see Kring & Elis, 2013, for a review). People with schizophrenia appropriately contract their facial muscles in response to emotional pictures or films (e.g., greater zygomatic [cheek] activity to positive compared to negative pictures; Kring, Kerr, & Earnst, 1999; Varcin, Bailey, & Henry, 2010; Wolf, Mass, Kiefer, Wiedemann, & Naber, 2006), yet they exhibit few outwardly observable expressions of emotion (Kring & Moran, 2008). In addition, people with schizophrenia can make accurate rapid yes/no judgments about whether affective faces are showing a particular emotion or valence (Gur et al., 2002; Gur et al., 2007), yet they have difficulty applying an emotion label to faces (Kohler, Walker, Martin, Healey, & Moberg, 2010). To account for these islands of preserved emotion response amidst a sea of deficits, we take a "bottom-up" research strategy to identify the initial building blocks (i.e., early aspects of processing) that constitute and support emotional processing and examine the point(s) at which people with schizophrenia begin to exhibit difficulties. In this article, we examine one early aspect of affective processing, asking whether people with schizophrenia are influenced by affective information in the face presented outside of visual awareness and whether this is associated with known affective deficits in schizophrenia, namely anticipatory pleasure.

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"Seeing" Affective Information in the Face and Linkages to Affective Deficits

Understanding social and emotional signals in the face is important for navigating daily life. Smiling faces can signal warmth, kindness, and trustworthiness, making us more likely to approach, whereas scowling faces can signal distance, mean-spiritedness, and untrustworthiness, making us more likely to avoid. Unfortunately, people with schizophrenia have a couple of key deficits that interfere with this important aspect of social life. First, people with schizophrenia have difficulty perceiving affective information in the face, but primarily if they are asked to apply an emotion label to a face or to discriminate between two affective faces (for meta-analyses, see Chan, Li, et al. 2010; Kohler et al., 2010). The consequences of this problem in affect perception are great for people with schizophrenia as indicated by the linkages among explicit affect perception, social skills, and social functioning in daily life (e.g., Brekke, Kay, Lee, & Green, 2005; Pinkham & Penn, 2006).

Second, people with schizophrenia have deficits in anticipatory pleasure, which are manifest by difficulties in anticipating that future experiences will be pleasurable and difficulties in experiencing pleasure *in anticipation* of things to come (Kring & Elis, 2013). Indeed, behavioral, psychophysiological, and fMRI studies have demonstrated that people with schizophrenia have difficulties with anticipatory pleasure (e.g., Gard, Kring, Germans Gard, Horan, & Green, 2007; Juckel et al., 2006; Trémeau et al., 2010; Wynn, Horan, Kring, Simons, & Green, 2010). Like affect perception, anticipatory pleasure is also linked with social functioning in schizophrenia (Gard et al., 2007) and in healthy people (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). Furthermore, anticipatory pleasure deficits in schizophrenia are linked with diminished motivation to seek out pleasurable experiences, including social interactions (Gard et al., 2007; Garland et al., 2010; Kring & Barch, 2014). Because facial expressions provide potent cues that signal the possibility of forthcoming pleasurable interactions, difficulties in affect perception, particularly of smiling faces, may contribute to problems in anticipatory pleasure.

There is an interesting exception to the otherwise well replicated findings of facial affect perception deficits in schizophrenia. Studies using implicit paradigms, such as affective priming with faces (e.g., Hoschel & Irle, 2001; Suslow, Droste, Roestel, & Arolt, 2005; Suslow, Roestel, & Arolt, 2003) or incidental learning (Van't Wout et al., 2007), have found that some people with schizophrenia exhibit intact implicit processing of affective material. For example, Suslow et al. (2003) found that people with schizophrenia rated Chinese ideographs (i.e., graphical symbols) more negatively when preceded by a sad face (prime) than when preceded by a neutral face. Using an incidental learning paradigm, Van't Wout et al. (2007) found that people with and without schizophrenia were equally slower to rate the gender of rapidly presented affective faces (400 ms) compared to neutral faces. These findings suggest that affective information in the face is perceived, albeit outside of visible awareness. From both a theoretical and empirical standpoint, then, affective information may wield its influence quite early in visual processing, suggesting a possible point of preserved function amidst other significant deficits in affective perception. Moreover, the extent to which people with schizophrenia are able to "see" this affective information, particularly positive affect, may be associated with preserved anticipatory pleasure insofar as the affective information signals the potential for future pleasurable experience.

A potential problem with brief affective prime presentations, however, is that the primed stimuli can break through to awareness, thus making it difficult to clearly discern the influence of visual awareness on perception (e.g., Pessoa, Japee, Sturman, & Ungerleider, 2006). A newly introduced paradigm, continuous flash suppression (CFS; Tsuchiya & Koch, 2005), minimizes the potential for breakthrough by keeping images suppressed from awareness for much longer (i.e., up to 3 min; Tsuchiya, Koch, Gilroy, & Blake, 2007; Yang, Zald, & Blake, 2007). In CFS, people are presented with dynamic (flashing) visual images to one eye (e.g., neutral faces), while the other eye is presented with a still image (e.g., affective face). Participants experience seeing only the dynamic images while the still image remains unseen, suppressed from visual awareness (Tsuchiya & Koch, 2005).

Studies using the CFS paradigm have found that healthy people more quickly identified objects that were preceded by the same category of object (especially tools) suppressed from view (Almeida, Mahon, & Caramaa, 2010; Almeida, Mahon, Nakayama, & Caramaa, 2008). CFS studies with affective faces have demonstrated that first impression judgments of visible neutral faces are influenced by the simultaneous presentation of affective faces suppressed from visual awareness. For example, Anderson, Siegel, White, and Barrett (2012) found that college students and community residents rated visible neutral faces as more or less pleasant, likeable, and attractive depending on whether those faces were presented alongside a smiling or scowling affective face that was suppressed from visual awareness. Moreover, affective faces suppressed from visual awareness influenced personality trait judgments such that neutral faces were rated as more or less trustworthy, warm, and competent depending on whether they were presented with a suppressed smiling or scowling face. Personality trait judgments are central to our first impressions of other people (e.g., Bar, Neta, & Linz, 2006), and initial impressions shape our social encounters with others (e.g., Fazio, Effrein, & Falender, 1981; Hall & Andrzejewski, 2008; Uleman, Blader, & Todorov, 2005). Given that social interactions are often fraught with difficulty for people with schizophrenia, understanding how affective information influences personality judgments and impression formation may help to uncover not only one early building block of affective processing but also the precursors to impression formation and social interaction.

Suppressing affective faces using CFS facilitates the quick processing of affective information very early in the course of visual perception, influencing the concurrent perception of otherwise nonaffective faces. Studies of the neuroanatomical connections and pathways that support CFS indicate that this paradigm more strongly activates dorsal "where is it and how do I act on it" visual stream regions (Almeida et al., 2008; Almeida et al., 2010; Fang & He, 2005) than ventral "what is it" visual stream areas, particularly when stimulus presentation time is 200 ms or less (Jiang et al., 2009; Yang, Hong, & Blake, 2010). Low spatial frequency information that travels via the dorsal visual pathway in the brain is processed more quickly than information in the ventral visual stream, and this helps people make an initial "gist" assessment or prediction of the percept (Bar, 2007; Bar et al., 2006). Very quickly (within 100 ms), these areas project to the orbitofrontal cortex thus signaling affective predictions about whether to approach or avoid an object (e.g., Barrett & Bar, 2009; Kveraga, Boshyan, & Bar, 2007).

Although we did not assess neural correlates in this study, the published evidence on neural mechanisms supporting CFS can help to shape and constrain hypotheses about how people with schizophrenia may perform on a CFS task. Specifically, human and animal research indicates that low spatial frequency (e.g., low contrast or low luminance) stimuli preferentially activate neurons in the dorsal (magnocellular) visual stream more so than neurons in the ventral (parvocellular) visual stream, which is preferentially activated in response to high spatial frequency (i.e., fine grained detail) information (e.g., Legge, 1978; Tootell, Silverman, Hamilton, Switkes, & DeValois, 1988). Prior behavioral (e.g., Butler et al., 2005; Butler et al., 2009; Keri, Kiss, Kelemen, Benedek, & Janka, 2005) and fMRI (e.g., Calderone et al., 2013; Martinez et al., 2008) research suggests that people with schizophrenia have more difficulty perceiving stimuli that preferentially activate the dorsal visual stream than stimuli that preferentially activate the ventral visual stream. For example, people with schizophrenia have more difficulty than healthy people in identifying horizontal sine-wave gratings at low spatial frequencies compared to those at high spatial frequencies, suggesting a deficit in early visual processing that is relatively reliant on the dorsal stream (Butler et al., 2005). Furthermore, people with schizophrenia show reductions in the numbers of voxels activated in visual cortex in response to low- but not high-spatial frequency horizontal gratings relative to people without schizophrenia (Martinez et al., 2008). In the realm of affective faces, Butler and colleagues (2009) found that people with schizophrenia required a higher contrast level to correctly label visibly presented happy, sad, and neutral faces at the accuracy level of people without schizophrenia. Taken together, these findings indicate that people with schizophrenia have difficulty in perception that relies more heavily on dorsal visual stream function. To the extent that the CFS task relies relatively more so on dorsal visual stream regions (Almeida et al., 2008; Almeida et al., 2010; Fang & He, 2005), we might expect that people with schizophrenia would have difficulties with this task.

The Present Study

Collectively, the published findings suggest two competing hypotheses with respect to affect perception outside visual awareness in schizophrenia. Based on prior behavioral findings showing compromised explicit affective face processing but intact implicit affective processing, we might predict that people with schizophrenia *would* be influenced by affective faces suppressed from visual awareness in a CFS paradigm, such that they would make more positive or negative first impression judgments of visibly neutral target faces. In contrast, based on findings indicating dorsal visual stream deficits in schizophrenia, we might predict that people with schizophrenia would *not* be influenced by affective faces suppressed from visual awareness insofar as the suppressed affective information would preferentially exert its influence via the deficient dorsal visual stream.

In the present study, we asked two questions. First, when an unseen picture of a face contains affective information, will that information influence the experience of a visible picture of a face for people with and without schizophrenia, such that an otherwise neutral face is experienced as having positive or negative personality characteristics consistent with the affective information? To situate our findings from the implicit CFS paradigm alongside the well-replicated findings of an explicit affect perception deficit, we also presented an explicit task, hypothesizing that people with schizophrenia would perform more poorly than people without schizophrenia when they are required to apply a label to visible affective faces.

Second, we asked whether personality trait judgments of visible neutral faces might be associated with affect-related symptoms and affect-related deficits (i.e., anticipatory pleasure) in schizophrenia. Thus far, evidence regarding anticipatory deficits in schizophrenia indicates that this deficit is most notable for positive emotions given its linkages to the symptom of anhedonia (i.e., diminished experience of pleasure). Thus, we expected that reports of anticipatory pleasure would be most strongly related to trait judgments of neutral faces paired with smiling affective faces (rather than scowling or neutral) suppressed from visual awareness. Finding correlates of the anticipatory pleasure deficit is an important precursor to identifying mechanisms.

Method

Participants

Participants were 24 outpatients diagnosed with schizophrenia (n = 16) or schizoaffective (n = 8) disorder and 28 healthy controls. Participants with schizophrenia were recruited from outpatient centers and board and care facilities in the greater San Francisco Bay area. Diagnoses based on the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–IV*) were confirmed using the Structured Clinical Interview Patient Version (SCID/P-IV; First, Gibbon, Spitzer, & Williams, 1994). People with schizophrenia or schizoaffective disorder were taking first-generation (n = 3), second-generation (n = 14), or both (n = 4) types of antipsychotic medication; three were not taking any medication. Exclusion criteria were mood episode within the past month, substance dependence in the past 6 months, substance abuse in the past month, IQ less than 70, history of head injury or neurological disorder, and insufficient English fluency. People with schizophrenia were interviewed for general psychiatric symptoms using the 24-item UCLA expanded version of Brief Psychiatric Rating Scale (BPRS; Lukoff, Nuechterlein, & Ventura, 1986; Overall & Gorham, 1962). We assessed affect-related symptoms using the Clinical Assessment Interview for Negative Symptoms (CAINS; Kring, Gur, Blanchard, Horan, & Reise, 2013), which assesses diminished motivation, anticipatory, and consummatory pleasure across social, work, and recreational domains (Motivation and Pleasure scale) as well as diminished outward expression of emotion (Expression scale). We assessed affect-related deficits using the Temporal Experience of Pleasure Scale (TEPS; Gard, Germans Gard, Kring, & John, 2006), a self-report measure of the propensity to experience anticipatory and consummatory physical pleasure.

Healthy control participants were recruited via fliers posted in the community. Exclusion criteria were personal or family history of schizophrenia spectrum disorder or bipolar disorder, mood episode within the past month, substance dependence in the past 6 months, substance abuse in the past month, estimated IQ less than 70, history of head injury or neurological disorder, and insufficient English fluency. Control participants that were invited to participate were interviewed using the Structured Clinical Interview for DSM-IV, Nonpatient Version (SCID-NP; First et al., 1994) to confirm the lack of current psychiatric diagnoses.

All participants reported normal or corrected-to-normal vision. However, individuals wearing glasses were excluded (2 people with schizophrenia, 2 people without schizophrenia) because glasses can interfere with the proper function of the stereoscope used in the CFS experiment (described in next section). In addition, 3 participants (1 with schizophrenia, 2 without) were excluded for reasons of breakthrough during the task (described later). The final sample comprised 21 people with schizophrenia and 24 people without schizophrenia. As shown in Table 1, the groups did not differ on any demographic variables.

Procedure

Participants first completed clinical interviews and self-report measures. Most participants (17 with schizophrenia, 20 without schizophrenia) completed an explicit affect perception task (see also Campellone & Kring, 2013). For this task, we presented 36 faces (9 happy, 9 surprised, 9 sad, 9 angry) from the Interdisciplinary Affective Science Laboratory (IASLab) Facial Stimulus Set on a 13-inch laptop using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). The faces did not differ in intensity and identification accuracy based on ratings from an independent sample (IASLab). Participants had unlimited time to select a label from six options (happy, sad, anger, surprise, fear, excited) that depicted the emotion displayed on each face. One sad face was removed from analyses because accuracy in both groups was below chance level. Because we found no differences between emotion categories within valences for either group, we computed positive and negative accuracy scores as percentage correct.

For the CFS paradigm, participants viewed stimuli through a mirror stereoscope at a distance of 55 cm. Head movement was minimized with the use of chin and forehead rests on the stereoscope, and the stereoscope was calibrated for each participant. Stimuli subtended approximately 3.5 × 5.0 degrees of visual angle and were presented in grayscale surrounded by a frame. We determined eye dominance for each participant using the Dolman method. Instructions and stimulus presentation were programmed in E-Prime 2 running on a Dell Optiplex 745 computer and presented on a 19-inch Dell flat screen (1024 × 768) monitor.

To facilitate comparisons with CFS studies done with healthy people, we used identical procedures,

Table 1. Demographic, Clinical, and Individual Difference Characteristics

Characteristic	Schizophrenia (n = 21)	Control (n = 24)	p value
Age	44.33 (11.36)	44.50 (8.92)	.96
Education (years)	14.38 (3.12)	15.33 (2.99)	.30
Parental education (years)	15.02 (3.22)	13.31 (3.41)	.09
WTAR	107.14 (13.60)	104.58 (2.89)	.54
Gender (n M/W)	15/6	16/8	.73
Ethnicity/race (n)			.75
African American	6	7	
Caucasian	11	9	
Asian	1	2	
Multiethnic	2	4	
Pacific Islander	0	1	
Spanish, Latino, Hispanic	2	3	
Marital status (n)			.30
Married	2	7	
Widowed	1	0	
Single	14	13	
Divorced/separated	4	4	
Paid job (n)			.19
No	12	9	
Yes	9	15	
Prior hospitalizations (n)	6.33 (6.11)		
Age at first treatment	22.23 (6.45)		
BPRS total	42.92 (11.13)		
CAINS MAP	10.16 (6.20)		
CAINS EXP	3.64 (3.18)		
TEPS Anticipatory	3.98 (0.67)	4.40 (0.71)	.05
TEPS Consummatory	4.32 (1.03)	4.41 (1.00)	.78

Note: Tabled values are means with standard deviations in parentheses, unless otherwise specified. BPRS = Brief Psychiatric Rating Scale; CAINS = Clinical Assessment Interview for Negative Symptoms; EXP = Expression scale; MAP = Motivation and Pleasure scale; TEPS = Temporal Experience of Pleasure Scale; WTAR = Wechsler Test of Adult Reading.

experiment parameters, stimuli, and ratings scales that were used in Anderson et al. (2012). As in Anderson et al., the CFS experiment had three phases: (a) contrast adjustment, (b) face judgment, and (c) objective awareness.

Contrast adjustment phase. The purpose of the contrast adjustment phase was to adjust the contrast of the suppressed image to improve suppression. By doing so, we could determine a priori the contrast level necessary to render the suppressed images invisible for each participant. We used four contrast levels of stimuli (created by reducing contrast and luminance to 75%, 50%, 25%, and 12.5% of the image's original contrast and luminance). We presented houses (upside down or right side up) as suppressed images to the nondominant eye, and a series of three Mondrian-type images (i.e., different colored patches, named after the artist Piet Mondrian who painted similar pictures) to the dominant eye. We began the contrast adjustment phase with 20 trials at the highest contrast (75%). Participants were asked to (a) guess the orientation (right side up or upside down) of the suppressed house on each trial and (b) rate their perceptual experience of the suppressed house using a 4-point scale (1 = *no experience*, 2 = *vague experience*, 3 = *almost clear experience*, 4 = *absolutely clear experience*). If participants correctly guessed the orientation of the suppressed house on 14 or more trials, or they reported "no experience" of the house on fewer than 15 trials, the contrast level was reduced to the 50% level. We repeated this procedure until participants correctly guessed the orientation on 13 or fewer trials and reported no experience on at least 15 trials or until the 12.5% contrast level was reached as done by Anderson et al. (2012). We then set this contrast level for the face judgment phase.

Face judgment phase. On each trial of the face judgment phase (depicted in Figure 1), participants viewed a

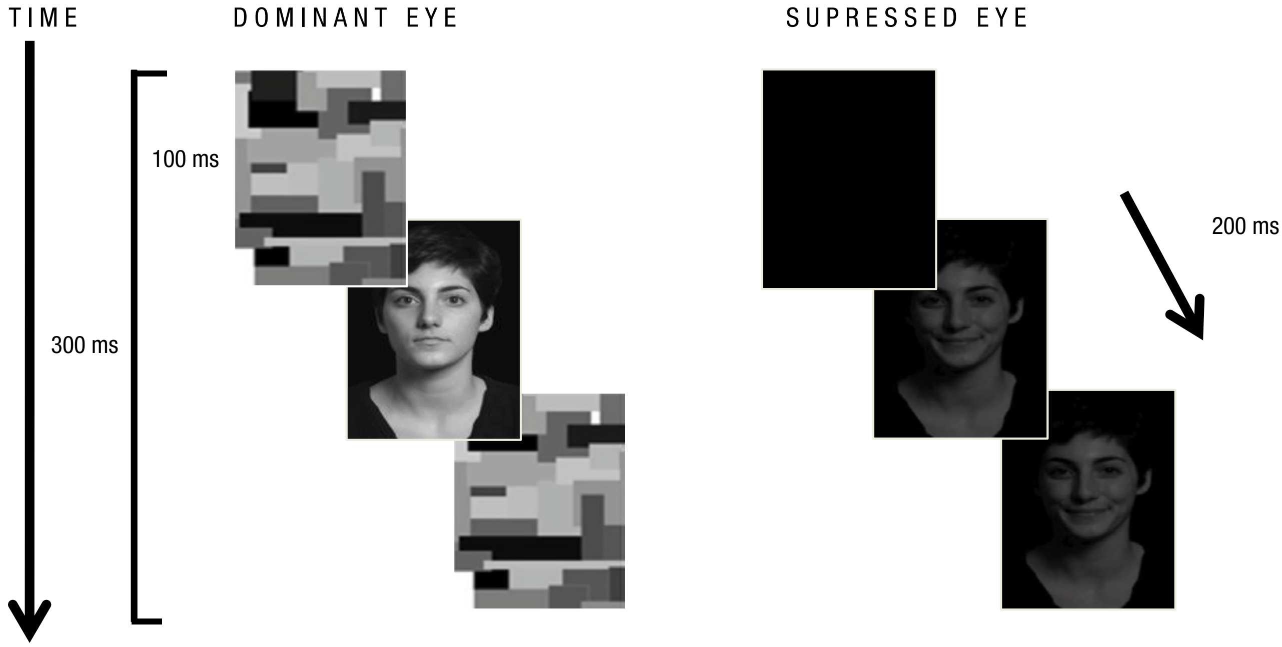

Fig. 1. Trial structure. Following a 500 ms fixation dot, the dominant eye was presented with a "Mondrian" image (100 ms), followed by a structurally neutral face (100 ms), followed by another Mondrian image (100 ms). Concurrently with the presentation of the neutral face to the dominant eye, the suppressed eye was presented with a low contrast low luminance face (smiling, scowling, or neutral) for 200 ms until the offset of the second Mondrian image presented to the dominant eye. Identity of the suppressed and dominant face matched. Following this sequence, a backward mask was presented to both eyes for 500 ms.

500 ms fixation dot and then a series of flashing images, including Mondrian-type image for 100 ms, followed by a neutral face for 100 ms, followed by another Mondrian image for 100 ms in the dominant eye. At the same time, participants were presented with a low-contrast, low-luminance smiling, scowling, or neutral face for 200 ms in the nondominant, suppressed eye. Image presentation offset to the nondominant eye was the same time as the final Mondrian image presentation offset to the dominant eye. We chose to present the suppressed image for 200 ms given evidence that longer presentation times (e.g., 600 ms) may generate ventral stream activation (e.g., Jiang et al., 2009; Yang et al., 2010). Following this sequence, a backward mask was presented to both eyes for 500 ms. For each trial, participants made three trait judgments about the neutral target face presented to the dominant eye using 4-point scales. The first judgment was "How trustworthy is this person?" (from *untrustworthy* to *trustworthy*); the second was "How competent is this person?" (from *incompetent* to *competent*); and the third was "How (interpersonally) warm is this person?" (from *cold* to *warm*). Faces were selected from the IASLab face set and have been used in prior CFS studies (Anderson et al., 2012). The identity of the suppressed and dominant face matched and included men (n = 15) and women (n = 15). A total of 30 unique faces were presented; 10 were paired with each type of suppressed face type (scowling, smiling, neutral) for a total 30 trials. These 30 trials were repeated in two blocks, so each face was shown two times (always with the same suppressed facial expression, counterbalanced across participants) for a total of 60 trials. In a prior CFS study using these stimuli, participants' ratings did not become more or less negative or positive across repeated blocks indicating that there were no "practice" effects (Anderson et al., 2012).

Objective awareness phase. The final phase was an objective awareness test. We included this phase to assess the extent to which the suppressed images were indeed suppressed from visible awareness. Using the same contrast level as the face judgment phase, participants were asked to guess the orientation of a suppressed face (upside down or right side up). These trials were identical to the face judgment trials except that a scrambled face was presented to the dominant eye instead of a neutral face. Participants completed 60 trials (30 right side up, 30 upside down) using the same 30 suppressed faces used in the face judgment phase. Three participants (1 with schizophrenia, 2 without) were removed from analysis because they correctly guessed the orientation at better than chance level, suggesting that they may have experienced breakthrough during the face judgment task.

Table 2. Mean Ratings of Neutral Target Faces

	Suppressed face type					
	Scowling		Neutral		Smiling	
Judgment	Sz	Control	Sz	Control	Sz	Control
Trustworthiness	2.49 (0.63)	2.56 (0.58)	2.64 (0.52)	2.64 (0.58)	2.92 (0.52)	2.93 (0.49)
Competence	2.67 (0.48)	2.70 (0.49)	2.78 (0.48)	2.67 (0.46)	2.86 (0.48)	2.97 (0.42)
Warmth	2.23 (0.58)	2.13 (0.46)	2.40 (0.52)	2.23 (0.52)	2.74 (0.60)	2.76 (0.59)

Note: Tabled values are mean ratings of neutral faces presented to the dominant eye concurrently with either a scowling, neutral, or smiling suppressed face presented to the nondominant eye. Standard deviations are in parentheses. Scale values ranged from 1 (*low on a trait*) to 4 (*high on a trait*). Control = people without schizophrenia; Sz = people with schizophrenia.

Results

Explicit affect perception task

To assess whether the groups differed in their ability to apply the correct label to visibly presented affective faces, we conducted a 2 (Group: Schizophrenia, Control) × 2 (Valence: Positive, Negative) repeated measure MANOVA (Misangyi, LePine, Algina, & Goeddeke, 2006) with percentage correct scores on the explicit affect perception task. Consistent with prior studies, we found a significant main effect for group, $F(1, 35) = 4.24$, $p = .047$, $\eta_p^2 = .11$, indicating people with schizophrenia performed more poorly than people without schizophrenia in the explicit perception task. The valence main effect was also significant, $F(1, 35) = 12.91$, $p = .001$, $\eta_p^2 = .27$, indicating that all participants were more accurate in labeling positive faces compared to negative. The Group × Valence interaction approached significance, $F(1, 35) = 3.64$, $p = .065$, $\eta_p^2 = .10$; we opted to conduct between-group follow-up tests separately for each valence. People with schizophrenia ($M = 0.86$, $SD = 0.14$) did not differ from people without schizophrenia ($M = 0.88$, $SD = 0.02$) in correctly labeling positive faces, $t(35) = 0.54$, *ns,* $d = 0.18$ but were significantly worse (schizophrenia group: $M = 0.73$, $SD = 0.16$; control group: $M = 0.84$, $SD = 0.10$) at correctly labeling negative faces, $t(35) = 2.63$, $p = .012$, $d = 0.89$. In sum and consistent with prior research, people with schizophrenia performed more poorly than controls on the explicit affect perception task, and this was particularly true for negative faces.

CFS task

For the CFS task, we first examined whether the groups differed in the individualized contrast levels set during the contrast adjustment phase. The groups did not significantly differ with respect to contrast levels at the highest (75% contrast; 11 with schizophrenia, 10 controls), lowest (12.5% contrast; 8 with schizophrenia, 8 controls), and second lowest (25% contrast: 2 with schizophrenia, 6 controls) levels, $\chi^2(2, N = 45) = 1.86$, *ns*. None of the participants were set at the 50% contrast level. Thus, people with schizophrenia did not need a different contrast level than controls to achieve suppression.

Next, we conducted three repeated measures MANOVAs, one each for ratings of trustworthiness, warmth, and competence with valence of the suppressed face (positive, negative, neutral) as the repeated measure and group as a between-subjects factor. Descriptive statistics are presented in Table 2. The valence main effect was significant for trustworthiness ratings, $F(2, 42) = 10.52$, $p < .001$, $\eta_p^2 = .33$, warmth ratings, $F(2, 42) = 9.59$, $p < .001$, $\eta_p^2 = .31$, and competence ratings, $F(2, 42) = 6.02$, $p = .005$, $\eta_p^2 = .22$, replicating the findings from Anderson et al. (2012) that implicit affective influences are a part of first impressions of other people. Follow-up *t* tests indicated that all participants rated visible neutral faces presented concurrently with suppressed smiling faces as more trustworthy than visible neutral faces presented concurrently with suppressed scowling faces, $t(44) = 4.66$, $p < .001$, $d = 0.70$, or suppressed neutral faces, $t(44) = 4.21$, $p < .001$, $d = 0.62$. All participants rated neutral faces presented concurrently with suppressed smiling faces as more warm than neutral faces presented concurrently with suppressed scowling faces, $t(44) = 4.51$, $p < .001$, $d = 0.68$, or suppressed neutral faces, $t(44) = 4.08$, $p = .001$, $d = 0.60$. All participants also rated neutral faces presented concurrently with suppressed smiling faces as more competent than neutral faces presented concurrently with suppressed scowling faces, $t(44) = 3.35$, $p < .01$, $d = 0.50$, or suppressed neutral faces, $t(44) = 3.39$, $p < .01$, $d = 0.50$.

For all three ratings, neither the group main effect nor the Group × Valence interaction was significant, although the Group × Valence interaction approached significance for the competence ratings, $F(2, 42) = 2.75$, $p = .076$, $\eta_p^2 = .12$. Nevertheless, we opted to conduct comparisons within the schizophrenia group to confirm that the control group did not drive the significant valence main effects. For trustworthy and warmth ratings, people with schizophrenia rated visible neutral faces presented with suppressed smiling faces as more trustworthy and warm than visible neutral faces presented with suppressed scowling faces, trustworthy: $t(20) = 2.93$, $p = .008$, $d = 0.74$; warmth: $t(20) = 2.63$, $p = .016$, $d = 0.86$, or suppressed neutral faces, trustworthy: $t(20) = 2.51$, $p = .021$, $d = 0.54$; warmth: $t(20) = 2.55$, $p < .019$, $d = 0.61$. For competence ratings, however, the comparisons between visible neutral faces presented with suppressed smiling faces were not significantly different, visible neutral/suppressed scowl: $t(20) = 1.78$, $p = .09$, $d = 0.39$; visible neutral/suppressed neutral: $t(20) = 0.98$, $p = .34$, $d = 0.18$.

Correlations with affect related symptoms and anticipatory pleasure

Trustworthy, competence, and warmth ratings of neutral faces were not significantly correlated with the BPRS total, BPRS positive symptoms (including suspiciousness and other positive symptoms), or CAINS Motivation and Pleasure or Expression scales, suggesting that performance on the CFS task was not related to general or affect-related schizophrenia symptoms. Similarly, performance on the explicit affect perception task was not related to any of the symptom measures.

Consistent with prior studies (e.g., Chan, Wang, et al., 2010; Gard et al., 2006) and shown in Table 1, people with schizophrenia differed from controls on the TEPS Anticipatory scale, $t(43) = 2.23$, $p = .031$, $d = 0.68$, but not the consummatory scale, $t(43) = 0.28$, *ns*, $d = 0.09$. For those in the schizophrenia group (but not the control group), scores on the TEPS Anticipatory scale were significantly correlated with trait ratings of neutral faces paired with suppressed smiling faces (competent: $r(20) = .46$, $p = .04$; trustworthy: $r(20) = .44$, $p = .05$; warmth: $r(20) = .47$, $p = .04$) but not neutral faces paired with suppressed neutral or scowling faces. Furthermore, the schizophrenia group's trait ratings of neutral faces paired with suppressed smiling faces were not significantly correlated with scores on the TEPS Consummatory scale (*r*s of −.01, .04, and −.20), and the correlations with the trait ratings and TEPS Anticipatory scale were significantly different (following r to z transformation) from the correlations with the TEPS Consummatory scale (*p*s of .03, .05, and .004). That the correlations between TEPS Anticipatory scores and trait ratings were not significant for the control group (*r*s of .06, −.10, .04) indicates that only people with schizophrenia whose trait ratings of neutral faces were more influenced by smiling affective faces presented outside of visual awareness reported experiencing greater anticipatory pleasure. Performance on the explicit affect perception task was not related to either TEPS scale for either group.

Discussion

Using the CFS paradigm, we found that people with schizophrenia rated visible affectively neutral faces as more or less trustworthy and warm depending on whether smiling or scowling faces were concurrently presented outside of visual awareness, and their ratings were indistinguishable from the ratings of the healthy control participants. These effects are not likely due to participants "seeing" the affective faces suppressed from view given that contrast levels were individually set for each participant, people with and without schizophrenia did not differ in initial contrast levels, and participants included in the final analyses did not show evidence of breakthrough on an objective awareness test. Furthermore, our findings are not likely due to our particular sample of people with schizophrenia who may have excelled at affect perception tasks because this group performed more poorly than the group of people without schizophrenia on an explicit affect perception task.

One point of departure between those with and without schizophrenia on the CFS task was in their judgments of competence. Here, the control group rated visible neutral faces as more or less competent when paired with a suppressed smiling or scowling face, respectively, but the schizophrenia group did not. It may have been the case that judging competence was more challenging for those in the schizophrenia group. Indeed, a small number of people with schizophrenia asked for a definition of competence prior to beginning the study. Although other studies have found explicit smiles to be associated with competence in healthy people (e.g., Harker & Keltner, 2001; Reiss et al., 1990), it may be the case that people with schizophrenia do not as readily associate competence with smiles and this would be an interesting direction for future research.

These findings suggest at least two important things about affect perception deficits in schizophrenia. First, from a "bottom-up" research perspective, it appears that one of the very early building blocks supporting affect perception is behaviorally intact. Indeed, affective images completely suppressed from visual awareness were nevertheless impacting the perception of structurally neutral faces. From a broader affective science perspective, these findings indicate that affect can importantly influence how people with schizophrenia experience the world, even when the reaction comes from a seemingly irrelevant source (a neutral face) and they are unaware of the affective changes. Stated differently, people with schizophrenia are just as likely to *mis*attribute affect during perception as are people without schizophrenia. One interesting extension of these findings is the possibility that people with schizophrenia who experience suspiciousness may be even more prone to misattribute affect, particularly negative affect, to other people (cf. Anderson et al., 2012). Although we did not find that positive symptoms, including suspiciousness, were related to performance on the CFS task, our sample comprised stable outpatients with a relatively low level of current symptoms. Thus, it will be informative to examine the linkage between symptoms such as suspiciousness and CFS performance among people with more severe symptoms.

Second, our findings indicate that early processing of affective information in faces may not be effectively translated to explicit judgments as on tasks that require participants to apply an emotion label to a visible face. Indeed, we found that people with schizophrenia performed more poorly than people without on the explicit perception task, particularly for negative faces, a finding that is consistent with reams of prior literature. Studies of healthy people indicate that rapid, early processing of low spatial frequency information (processed via the dorsal visual stream) is essential to making judgments about whether to approach or avoid (Barrett & Bar, 2009), and our findings suggest that this ability is intact among people with schizophrenia given their performance on the CFS task. However, explicit perception of affect requires not only the rapid processing of affective information, but also the perception of surrounding contextual information and the integration of this information with other signals to make sense of what is being observed and to provide an appropriate label (Kring & Campellone, 2012; Trope, 1986).

Even the task of labeling an emotion provides a (semantic) context (Barrett, Lindquist, & Gendron, 2007), and studies with healthy people show that lowering the accessibility of emotion words (via semantic satiation) decreases accuracy in facial affect perception (Lindquist, Barrett, Bliss-Moreau, & Russell, 2006) and actually changes the initial representation of affective faces (Gendron, Mesquita, & Barrett, 2013). Of interest, most studies that find affect perception deficits in schizophrenia are studies that require participants to provide an emotion label to the face (Kohler et al., 2010), and this is true even for studies that explicitly examine how different types of contextual information (sentences, scenes) may influence affect perception. Two studies found that people with and without schizophrenia similarly rated the valence of affective faces when preceded by either sentences (Lee et al., 2013) or scenes (Chung & Barch, 2011), suggesting that people with schizophrenia were just as influenced by the preceding context as controls. However, two other studies found that people with schizophrenia were less accurate than controls in describing the affective state (Green, Waldron, Simpson, & Coltheart, 2008) or applying an emotion label to affective faces embedded within contextual scenes (Bigelow et al., 2006; Green et al., 2008). One feature that distinguished these studies is whether or not participants were required to integrate a semantic context (i.e., emotion terms) with the affective faces, with deficits observed only in studies that required such integration. In sum, our findings suggest that early processing of affective information is intact in schizophrenia and that affect perception deficits in schizophrenia may be more a deficit of integrating perceptual information about the face with semantic context information rather than a deficit in the perception of affect per se.

Performance on the CFS task was not related to current schizophrenia symptoms. However, we found that people with schizophrenia who were more influenced by smiling faces presented outside awareness also reported experiencing more anticipatory pleasure, but not consummatory pleasure. Notably, this was not the case for people without schizophrenia. As noted earlier, accumulating evidence indicates that people with schizophrenia have a deficit in anticipatory pleasure, which encompasses both the anticipation of future pleasurable experiences as well as the experience of pleasure *in anticipation* of future events (Gard et al., 2007; Juckel et al., 2006; Trémeau et al., 2010; Wynn et al., 2010). Anticipatory pleasure, but not consummatory or “in-the-moment” pleasure, is linked to social functioning (family, friends, and extended social networks) among people with schizophrenia (Gard et al., 2007), emphasizing the impact of anticipatory pleasure in domains beyond the experience of pleasure. Consistent with prior studies, we found that people with schizophrenia reported less anticipatory pleasure experience on the TEPS than people without schizophrenia but did not differ in reported consummatory pleasure experience.

Why might anticipatory pleasure be linked with a greater propensity to attribute affective traits to neutral faces when paired with unseen smiling faces? It may be that people who are better able to rapidly process positive affective information are better able to use this information when prospecting about future pleasurable events. According to theoretical accounts about prospection, “seeing” oneself enjoying a future event requires the ability to experience affect when thinking about the future event, and this ability to “pre-experience” affect for future events relies on a network of brain regions, including the medial PFC and other areas within the “default” or “mentalizing” network (Gilbert & Wilson, 2007; Schacter, Addis, & Buckner, 2007).

Our findings suggest the intriguing possibility that there are conditions under which dorsal visual stream processing may be intact among people with schizophrenia. Although we did not assess neural correlates in this study, other fMRI and electrophysiological studies have demonstrated that CFS effects rely primarily on the dorsal visual stream (Almeida et al., 2008; Almeida et al., 2010;

Fang & He, 2005). In addition, given research showing that suppressed images presented at longer presentation times also activates ventral visual stream regions (e.g., Jiang et al., 2009; Sterzer, Haynes, & Rees, 2008; Yang et al., 2010), our decision to present suppressed images for 200 ms rather than for a longer duration bolsters confidence that task performance relied more heavily on the dorsal visual stream. Nevertheless, it is possible that people with schizophrenia were able to do the task without strong support from the dorsal stream. Indeed, a recent study found that people with schizophrenia were just as accurate and fast at making a forced choice decision about the stimuli (object or abstract sculpture) as were people without schizophrenia (Calderone et al., 2013). However, people with schizophrenia failed to show differential activation in PFC regions between low- and high-spatial frequency shapes, suggesting that they were not using the same neural network (i.e., dorsal stream regions) to support their behavioral responses. Mapping behavioral findings onto brain networks that interact to create those behaviors is clearly an avenue of future research that must be pursued, and our suppositions regarding possible boundary conditions of dorsal stream processing in schizophrenia in the realm of affect will be strengthened with addition of fMRI or electrophysiological measures.

It is important to acknowledge that all but three participants with schizophrenia were taking antipsychotic medication. However, other studies of visual and affect perception have found similar patterns of behavior regardless of medication status of the participants (Braff & Saccuzzo, 1982; Kohler et al., 2010), suggesting that medication is not likely a strong moderator of performance. Furthermore, our sample sizes were relatively small, and thus it is possible that the failure to find group differences in ratings on the CFS task and other significant correlations was due to insufficient power. However, we had sufficient power to detect valence effects on this task as well as group differences on the explicit affect perception task.

In conclusion, we found striking evidence that unseen affective information in the face influences participants' trait judgments of structurally neutral faces, and this was true for both people with and without schizophrenia. Yet, people with schizophrenia also exhibited a deficit in explicit affect perception. Taken together, these findings suggest that early processing of affect is intact in schizophrenia, yet it is not integrated with the semantic context central to many explicit affect perception tasks. Furthermore, people with schizophrenia who were more influenced by unseen smiling faces were more likely to report greater experience anticipatory pleasure, suggesting that rapid processing of affect is associated with prospection of pleasure among people with schizophrenia.

Author Contributions

All authors contributed to the study design; E. H. Siegel and L. F. Barrett designed the experimental stimuli and protocol; A. M. Kring collected study data, analyzed data with E. H. Siegel, and wrote the first draft of manuscript. All authors contributed to writing of the manuscript and approved the final version of the paper for submission.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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