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Schizophrenia decreases guilt and increases self-disgust: potential role of altered executive function

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Abstract

Our knowledge of how the more complex self-conscious emotions (SCEs) are affected in schizophrenia is sparse. SCEs, unlike basic emotions, involve sophisticated frontal-lobe related cognition, impairment of which characterises the neurocognitive profile of schizophrenia. We investigated, in a cross-sectional study, whether SCEs (shame, guilt and self-disgust) are affected in schizophrenia, and the relationship between changes in SCEs and executive (dys)function. Twenty-nine Greek and thirty Arabic patients with schizophrenia were recruited alongside twenty-two Greek and thirty Arabic matched controls. Participants were administered the Self-Disgust Scale (TOSCA for shame and guilt was also administered to the Greek sample), and the Trail Making and Verbal Fluency Tests to measure executive function (EF). Trait levels of self-disgust and guilt were found to be higher and lower, respectively, in patients with schizophrenia relative to control participants; and poorer EF was related with higher trait levels of SD, but lower trait levels of guilt. The pattern of findings was largely unaffected when controlling for anxiety and depression. Given that altered levels of SCEs are closely related to poorer EF, we suggest that the link between EF and emotion regulation, widely established in basic emotions but under-studied in SCEs, may explain the current findings.

Keywords: Self-conscious Emotions; Executive Functions; Schizophrenia

Introduction

Deficits in executive functions (EFs) have been considered a hallmark of cognitive performance in schizophrenia (Buchanan et al., 1994; Galaverna et al., 2014; Heinrichs, & Zakzanis, 1998; Morice, & Delahunty, 1996). Although the exact structure of the EF system is still under debate, one of the most dominant models (Miyake et al., 2000) proposes that it encompasses three main components; *inhibitory control* (the ability to supress irrelevant stimuli or thoughts and dominant responses), *shifting* (also referred to as cognitive flexibility, the ability to switch between different tasks or mental sets) and *updating* (the ability to efficiently monitor context and update information in working memory). In a later revised model, Miyake and Friedman (2012) removed inhibitory control as a separate domain, and suggested that some level of inhibition may be involved in all EF processes. Research supports the contention that all domains of EF are affected in schizophrenia, and that performance in EF measures is among the best predictors of functional performance (see Bowie & Harvey, 2006 for a review). Patients with schizophrenia also show impairments in other frontal lobe-related complex cognitive processes such as self-awareness (Medalia & Lim, 2004; Pini et al., 2001) and the ability to infer others' mental and emotional states (Corcoran et al., 1995; Langdon, 1997; Sarfati et al., 1997).

With regard to emotion, there is substantial research investigating experience, expression and recognition of basic emotions in schizophrenia, which suggests a dissociation of impairments (Kohler & Martin, 2006; Trémeau, 2006). It is generally agreed that patients with schizophrenia are impaired in the facial expression of both negative and positive emotions, which is usually referred to as emotional blunting (Berenbaum & Oltmanns, 1992). However, this does not seem to be the case when using self-report measures of emotional experience (Cohen & Minor, 2010; Gard, & Kring 2009; Herbener et al., 2008). Also, extensive research generally suggests impaired recognition of facial expressions of basic emotions in patients with schizophrenia (e.g., Brüne, 2005; Kohler et al., 2010; Marwick & Hall, 2008).

On the other hand, self-conscious emotions (SCEs) have received little attention in schizophrenia. The term SCEs is used to refer to a set of sophisticated emotions (e.g., pride, embarrassment, and shame) that involve positive or negative self-appraisal in relation to feedback from others, facilitate the attainment of complex social goals, and regulate social behaviour (Tracy et al., 2007). We know, mostly from neuropsychological and neuro-imaging studies that, unlike basic emotions, SCEs depend on higher-order cognitive processes that heavily rely on frontal lobe function (Izard et al., 1999; Lewis, 2000; Tracy et al., 2007). More research is needed though to shed light on the specific cognitive mechanisms underlying these complex emotions. In particular, the negative SCEs of shame, guilt, and self-disgust share a close relationship to the self, bear an evaluative quality, and trigger negative affect; yet, they differ both in terms of focus (the person, the behavior, the inner or physical self), and possible outcomes (i.e. adaptive/maladaptive). Guilt and shame are relatively well studied, and evidence supports the contention that they are two distinct constructs; while shame is directed towards the identity of the self as whole, guilt is attached to a particular behaviour or action (Tangney, 1991, Tangney et al., 1996). In addition, the experience of guilt tends to trigger adaptive reactions/behaviours (e.g, apologizing) to undo the harm that has been done, whereas shame seems to be a more pathogenic emotion without a clear adaptive function (Tangney, 1991; Tangney et al., 1996; Tangney et al., 1992). Furthermore, these two emotions seem to be related differently to self-control, so that poorer self-control is related to lower levels of guilt and higher levels of shame (Tangney et al., 2004; Yi, 2012). Self-disgust, on the other hand, is much less well investigated and understood SCE. This emotion refers to the feeling of internal contamination accompanied by a feeling of inadequacy in fixing this contamination caused by treatment of the 'self' as an object of disgust (Overton et al., 2008; Powell et al., 2015). Like shame, higher levels of self-disgust are associated with poorer self-control and behavioural impulsivity (Tsatali et al., 2019), and maladaptive behaviours such as social avoidance (Powell et al., 2013).

Converging evidence from neuropsychological and neuroimaging studies suggests that these complex social emotions rely on a frontal network. Sturm et al. (2006) found that patients with frontotemporal lobar degeneration (FTLD), showed significantly less embarrassment, relative to control participants, in reaction to an acoustic startle stimulus. The authors hypothesized that this specific deficit could be associated with the impaired frontal network in the patients, which links higher-order cognitive processes with monitoring processes of internal physiological states (anterior cingulate cortex and anterior insula). Similarly, Beer et al. (2003) reported that a group of five orbitofrontal patients failed to generate embarrassment reactions that matched their socially inappropriate behaviour. For instance, they showed less embarrassment but more pride than control participants, for undeserved overpraise. The authors concluded that although orbitofrontal damage did not eliminate the capacity to generate SCEs, it did impair the ability to appropriately connect them with behaviour. Thus, intact frontal lobe function may be a pre-requisite to generate SCEs, or link their experience with the regulation of actual behaviour. The involvement of the frontal cortex in SCEs is supported by the neuroimaging literature, where shame, guilt and embarrassment are all associated with increased activation in the frontal cortex (Fourie et al., 2014; Michl et al., 2014; Moll et al., 2007; Roth et al., 2014; Takahashi et al., 2004; Wagner et al., 2011). Self-disgust however may be slightly different, since neuroimaging data suggest that self-disgust is heavily reliant on the insular cortex (Schienle & Wabnegger, 2019).

Despite the potential relevance of the neuropsychological deficits in patients with schizophrenia for our understanding of SCEs, to our knowledge there is only one study in this population investigating embarrassment reactions. Bailey et al. (2009) employed the same procedure as Sturm and colleagues and found that a group of 27 patients with schizophrenia and control participants had similar physiological response and embarrassment reactions to an acoustic startle stimulus. As discussed by the authors, executive dysfunction is a key impairment in patients with schizophrenia, but there is great individual variability as well. Thus, their null results may have been due to the particular patients' neurocognitive profile, and so it is an unresolved question whether EF in patients with schizophrenia may contribute to SCE impairments in this disorder. Furthermore, another study with psychiatric patients, including 20 patients with psychotic disorders, suggests that shame, a more pathogenic emotion than embarrassment, may be increased in schizophrenia (Averill et al., 2002).

In the present study we investigated whether the experience of negative SCEs (shame, guilt and self-disgust) is altered in schizophrenia. Furthermore, we tested the hypothesis that the extent of executive dysfunction in the patients may contribute to the changes in SCEs. From the literature on basic emotions we know that all aspects of EF play a role in emotional regulation (von Hippel & Gonsalkorale, 2005; Schmeichel & Tang, 2014, 2015; Schmeichel, Volokhov, & Demaree, 2008 for disgust), however performance on verbal fluency, which requires planning, self-monitoring, self-initiation and inhibition, appears to be the best predictor (Gyurak, Goodkind, Kramer, et al., 2012). In addition, verbal fluency along with the Trail Making Test (in particular Part B), which requires inhibition and attentional shifting, are among the most frequently used neuropsychological tests to assess frontal lobe dysfunction

(Davidson, et al., 2007). Thus, in the present study we employed both neuropsychological tests to assess several components of EF.

We also had access to two different ethnic sample populations – Greek and Arabic samples. And thus we were able to test whether the experience of self-disgust and its relationship with executive dysfunction was modulated by culture. Given that SCEs are thought to have evolved to regulate social behaviour according to moral/cultural norms (Fishbach et al., 2010; Williams & DeSteno, 2008), the extent to which they are experienced can differ across cultures (Bierbrauer, 1992; Furukawa, Tangney, & Higashibara, 2012; Sznycer, Takemura, Delton et al, 2012; Wong, & Tsai, 2007; Edelmann, 1989). Several cultural differences between the two ethnic samples may lead to variations in SCEs levels. One of the most widely researched dimensions used to account for cultural differences in cognition, emotion and motivation is the individualism-collectivism distinction (see Hong & Chiu, 2001 for a review). For instance, substantial evidence supports the idea that more collectivist cultures (e.g., Arabs), relative to more individualistic western cultures, tend to make external attributions for social events (Morris & Peng, 1994), have a more holistic cognitive style (Qutub, 2008) and consequently contextual information has a greater influence on their perceptions and judgments. Given that (internal) attribution processes are key for the generation of SCEs (Tracy & Robins, 2004), cultural-related variations on casual attribution of social events may lead to differences in SCEs. In a relevant study, Birenbaum et al. (1995) found that Arab students, as compared to Jewish students, had a greater discrepancy in attribution for success versus failure. That is, they tended to place greater weight on success, and show lower endorsement levels for academic failure. The authors concluded that this could be due to the Arabic culture having particular social norms regarding honour and shame (e.g., greater face-saving to protect honour). Other studies have reported variations in the expression of negative emotions across the individualism-collectivism dimension (Feghali, 1997; Fessler, 2004). Specifically, more collectivistic cultures tend to attenuate the expression of negative basic emotions such as disgust, in the presence of other people, and judge them as less intense when expressed by other people (see Matsumoto, 2006 for a review). Finally, studies have also reported differences in cognitive processes such as attention, memory, and decision making across this cultural dimension, which have been mostly attributed to the more prevalent analytical cognitive style in more collectivistic cultures (Qutub, 2008). However, to our knowledge no studies have reported differences in EF in Arabic culture relative to Western culture, although for other East Asian cultures (e.g, Japanese), variations relating to parenting style and school practices have been reported (Lewis et al, 2009).To assess the degree to which differences between a collectivist culture (Bahrein) and a more individualistic (Greece) culture might be relevant in schizophrenia, we investigated the two groups of patients relative to their corresponding non-clinical control groups. Given the previous findings with frontal lobe-related disorders, we expect SCEs to be affected in patients with schizophrenia, who should also show impaired EF relative to control participants. In addition, we expect executive (dys)function to be related to altered levels of SCEs. However, since research evidence supports a dissociation between the three emotions studied here, particularly between adaptive (guilt) versus non-adaptive (shame and self-disgust) ones, we also expect that specific emotions may be affected, and related to EFs, differently. The potential influence of culture was left to be explored.

Materials and Methods

Participants

Twenty-nine Greek patients and thirty Arabic patients with schizophrenia, diagnosed by a psychiatrist via clinical interviews and according to the DSM-IV (American Psychiatric Association, 1994), were recruited from the inpatient Psychiatric Clinic of "Agia Fotini" in Larissa and the outpatient University General Hospital "AHEPA" in Thessaloniki (Greece), and from an inpatient Psychiatric hospital from the Kingdom of Bahrain, respectively. All the patients were in the stable phase of illness and received antipsychotic medication during the assessment period (see Tables 1 & 2). The psychologist or psychiatrist of the clinic/hospital approached the patients in the inpatient's setting, or contacted the outpatients by phone, who were judged fit for participating in the study, and asked them if they wanted to participate. The patients who positively responded were recruited for the study, and assessed in the clinic/hospital. The prescribed drugs, which were available to the researcher only for the Arabic sample, taken by each patient were converted to chlorpromazine equivalent dose in mg (CPZE, Andreasen et al., 2010).

Twenty-two Greek and thirty Arabic control adults were recruited from the staff of the clinic/hospital and from universities. Exclusion criteria for the control participants were; i) history of a diagnosed psychiatric disorder and a family member diagnosed with schizophrenia; ii) history of drug or alcohol abuse; and iii) being medicated with psychoactive drugs at the time of the study.

-Insert Tables 1 & 2 about here-

The Greek and Arabic samples did not differ overall in the percentage of males/females (χ^2=.13, p = .346), but the Arabic sample was significantly younger (32.42 versus 44.94 years of age; $t(109) = 5.88$, $p < .001$] and had more years of education (13.98 versus 12.24 years; $t(109) = 3.87$, $p < .001$).

The study was approved by the University of Sheffield Ethics Committee, and was therefore performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Informed written consent was obtained from all the participants.

Measurements and Procedure

Executive function was measured with two neuropsychological tests. The Greek validated version of the *Trail Making Test part A (TMT-A) and part B (TMT-B)* (Vlachou & Kosmidou, 2002). TMT-A is a timed test that requires participants to draw a line connecting 25 consecutive numbers. TMT-B requires connecting consecutive numbers and letters, alternating between the two sequences. The time to complete (in seconds) is thought to be an index of speed of processing (part A), cognitive flexibility and set-shifting (part B; for a review, see Hester et al., 2005). For the Arabic sample, the Arabic validated version (Stanczak et al., 2001) was employed.

The Greek validated version of the *Verbal Fluency Test* (Kosmidis et al., 2004) was also employed to measure EFs. The test consists of two parts, phonemic (letters X, Σ, A) and semantic (Animals, Fruits, and Objects). Participants are instructed to generate as many words as possible in a 60 s window. There are three different ways to score performance, the most frequently used being the number of correct non-repeated words. The Verbal Fluency Test is thought to be a measure of EF, memory and language, which reflects prefrontal cortex function (Gawda & Szepietowska, 2016; Thompson-Schill et al., 2005). For the Arabic sample, the Arabic validated version (Khalil, 2010) was employed. The phonemic part does not differ from the Greek and English version, and includes three letters (W/R/G), but the semantic part the Arabic validated version includes only one category (animals).

The Greek validated version of the *Hospital Anxiety and Depression Scale* (HADS; Zigmond & Snaith, 1983; Michopoulos et al., 2008) was employed to assess anxiety and depression symptoms, since it is suitable for the general population (Bjelland, Dahl, Haug, et al., 2002). The HADS includes 14 items, with a scale ranging from 0 (not at all) to 3 (most of the time). The maximum score in the anxiety and depression sub-scales is 21. The Cronbach's alphas for the current Greek sample were α=.89 and α=.79 for the anxiety and depression subscales, respectively. The Arabic validated version (Terkawi et al., 2017) has also good reliability and validity. The Cronbach's alphas for the present Arabic sample were α=.86 and α=.89 for the anxiety and depression subscales, respectively.

The *Test of Self-Conscious Affect-3* (TOSCA-3; Tangney, Dearing,Wagner, & Gramzow, 2000; Gouva, Kaltsouda & Paschou, 2012) assesses proneness to shame, guilt, pride (alpha and beta), externalization and detachment. The tool consists of sixteen scenarios, with a scale, from one (not likely) to five (very likely). For this study only the scores for the shame and guilt scenarios were included in the analyses. There is not a validated version of TOSCA-3 for the Arabic population, and since this tool consists of culturally sensitive scenarios, a translation from Greek to Arabic would not be an appropriate approach. A cultural adaptation of TOSCA-3 was beyond the scope of this study, and thus this measure was only employed with the Greek sample.

The *Self-Disgust Scale* (SDS; Overton et al., 2008) was employed to measures disgust directed towards the self. The validated Greek version (SDS-G; Tsatali, et al., 2019) has shown good reliability and validity. It consists of 18-items (with 6 filler items), and scores can range from 12 to 84. The Cronbach's alpha for the current Greek sample was α=.81. There is not a validated Arabic version of the SDS. Thus, the English version was translated according to Hambleton's guidelines (Hambleton, 2001), by two English-Arabic bilinguals, for the purpose of this study. The first translation and the back-translation versions were compared for consistency, relevance and meaning of the content. The Cronbach's alpha for the SDS-A in the current Arabic sample was very high α=.94. SDS-A scores were also significantly correlated with depression scores [r =.660, p<.001], as do those in the English version (Overton et al., 2008).

Results

The mean scores for Self-Disgust were submitted to a 2 x 2 MANOVA with Sample (Greek and Arabic) and Group (patients with schizophrenia and control participants) as the between subject factors (see Figure 1). The result showed a significant main effect of Group [$F(1, 107) = 71.56$, $p < .001$, $\eta p^2 = .401$] and a significant Sample by Group interaction [$F(1, 107) = 15.34$, $p < .001$, $\eta p^2 = .125$]. The main effect of Sample did not reach statistical significance, [$F(1, 107) = .77$, $p = .381$, $\eta p^2 = .007$]. Self-disgust levels were overall higher in the group of patients than in the group of healthy controls. In addition, the analysis of the interaction showed that Arabic control participants had significantly lower levels of self-disgust than Greek control participants [$t(50) = 5.97$, $p < .001$]; whereas Arabic and Greek patients did not significantly differ [$t(57) = 1.76$, $p = .09$]. Patients with schizophrenia had significantly higher levels of self-disgust than control participants in both samples, [$t(58) = 10.36$, $p < .001$] and [$t(49) = 2.75$, $p = .008$] for the Arabic and Greek sample, respectively.

-Insert Figure 1 about here-

Since the groups and the samples differed in anxiety and depressive symptoms, and both measures correlated with self-disgust scores, we then conducted a 2 x 2 ANCOVA with HADS Total scores as a co-variate. The main effect of Group continued to be significant

[$F(1, 96) = 8.69$, $p = .004$, $\eta p^2 = .083$]. That is, after adjusting for the influence of depressive and anxiety symptoms, the group of patients (adjusted mean = 34.07) had overall significantly higher levels of self-disgust than the group of controls (adjusted mean= 25.13). However, the interaction Sample by Group was no longer statistically significant, [$F(1, 96)= 3.34$, $p = .071$, $\eta p^2 = .036$]. The main effect of Sample emerged significant [$F(1, 96) = 5.69$, $p = .019$, $\eta p^2 = .056$]. That is, the Greek sample (adjusted mean = 32.36) had overall significantly higher levels of self-disgust than the Arabic sample (adjusted mean = 26.83). Finally, since the two samples differed in mean education, and this variable also correlated with self-disgust scores, we conducted a further ANCOVA with education in years as co-variate. The main effect of Group [$F(1, 106) = 69.09$, $p <.001$, $\eta p^2 = .395$] and the Sample by Group interaction [$F(1, 106) = 14.26$, $p <.001$, $\eta p^2 =.119$] remained significant after adjusting for the effect of education. The main effect of Sample remained non-significant, [$F(1, 106) = .15$, $p =.698$, $\eta p^2=.001$].

To test for the relationship between EF capacity and self-disgust levels, we then conducted Pearson correlations between the neuropsychological tests and the self-disgust scores in the overall sample (Greek and Arabic patients and controls; see Table 3). Self-disgust positively correlated with TMT-B time, [$r=.411$, $p< .001$], and negatively with verbal fluency scores, both the animal-semantic category and phonemic [$r=-.533$, $p<.001$ and $r=-.458$, $p<.001$, respectively]. That is, worse EF performance (higher time in TMT-B and lower scores in verbal fluency) was significantly related with higher self-disgust. Since anxiety and depression symptoms significantly correlated with the neuropsychological measures, we then conducted partial correlations controlling for HADS total scores. The negative correlation between self-disgust and animal-semantic fluency remained significant [$r=-.390$, $p < .001$], whereas the correlations with TMT-B and phonemic fluency were no longer significant. In addition, self-disgust scores did not significantly correlate with age [r=-.038, p=.690] but correlated negatively with education in years [r=-.202, p =.034].

-Insert Table 3 about here-

A moderated regression analysis was run to examine the possible moderating role of Sample in the relationship between EF (sematic verbal fluency) and self-disgust levels. The analysis was conducted in two steps (see Table 4): the predictors were entered firstly (i.e. the standardized Animal Fluency values, and the dummy coded Sample variable, with Arabic coded as 1 and Greek as 0), followed by the computed Sample X Animal Fluency interaction term, added in the second step (see Field, 2013; Frazier et al., 2004). Relevant coefficients are presented for each step and model in Table 4. It is noted that the assumptions for moderated regression analyses were examined and found satisfactory (Field, 2013; Frazier et al., 2004; Wilcox, 2017). Moreover, moderation analyses were conducted with bootstrapping procedures to increase confidence in the derived results (see Field, 2013). These procedures were used to calculate main and interaction effects (on 1000 bootstrap samples), along with their significance levels and a 95% confidence interval. The cross product of the predictors (Sample X Animal Fluency) failed to significantly increase the amount of variance explained by the regression model, thus, not indicating significant moderation.

-Insert Table 4 about here-

For the Greek sample, the mean scores for the TOSCA were submitted to a one-way MANOVA with group (patients with schizophrenia and control participants) as the between subject factor and scores from the subscales of shame and guilt as dependent variables (see Figure 2). According to Pillai's Trace there was a significant main effect of group on SCEs, [V = .175, F(2, 48) = 4.99, p = .011, ηp^2 = .175]. Univariate analyses showed that patients with schizophrenia had significantly lower levels of guilt [F(1, 48) = 4.09, p = .049, ηp^2 = .078]. There were no significant differences between the groups on shame scores [F(1, 48) = 1.24, p =.271, ηp^2=.025].

-Insert Figure 2 about here-

To test for the relationship between EF capacity and SCEs (TOSCA shame and guilt) levels, we then conducted Pearson correlations between the neuropsychological tests and the TOSCA subscores in the overall Greek sample (patients and controls; see Table 5). Guilt negatively correlated with TMT-B time, [r=-.400, p=.026]. That is, worse EF performance was significantly related with lower Guilt. Shame did not significantly correlate with any of the neuropsychological measures. Since anxiety and depression symptoms significantly correlated with the neuropsychological measures, we then conducted partial correlations controlling for HADS total scores. The negative correlation between Guilt and TMT-B remained significant [r=-.520, p=.002], and a new positive correlation between Guilt and Semantic fluency emerged [r=.374, p= .046].That is, worse EF (higher time in TMT-B and lower scores in verbal fluency) was associated with lower levels of guilt. The correlations with Shame remained non-significant.

-Insert Table 5 about here-

Discussion

SCEs, unlike basic emotions, involve sophisticated frontal-lobe related cognition (Izard et al., 1999; Lewis, 2000; Tracy et al., 2007), impairment of which characterises the neurocognitive profile of schizophrenia. Patients with schizophrenia also have impaired recognition and expression of basic emotions (Kohler & Martin, 2006; Trémeau, 2006).

However, our knowledge of how SCEs are affected in schizophrenia is sparse. In this study we investigated whether SCEs (in particular self-disgust, but also shame and guilt) are affected in schizophrenia, and the relationship between changes in SCEs and executive (dys)function. Furthermore, given the social nature of this set of emotions (Tracy & Robins, 2004), we aimed at exploring if the pattern of findings would be further modulated by culture. Consequently, we tested Greek and Arabic samples of patients with schizophrenia. As expected and in line with previous studies (Laere, Tee, & Tang, 2018; Morrens, Hulstijn, & Sabbe, 2007), both samples of patients with schizophrenia showed impaired EF in the Verbal Fluency Test and Trail Making Test.

The main findings were that trait levels of self-disgust and guilt were higher and lower, respectively, in patients with schizophrenia relative to control participants. Self-disgust levels were also modulated by culture, so that they were higher in the Greek controls relative to the Arabic controls, when there were no differences between the two patient samples. Moreover, as predicted poorer EF was related with higher trait levels of self-disgust, but lower trait levels of guilt. Importantly, the pattern of findings was largely unaffected when adjusting for the influence of anxiety and depression. Finally, the association between poorer EF and higher levels of self-disgust was not moderated by culture (Arabic versus Greek).

Our finding of altered SCEs in patients with schizophrenia is not in agreement with the findings of Bailey et al., (2009), but converge with a number of studies in different populations of patients with frontal lobe dysfunction (Sturm et al., 2006; Beer et al., 2003; Tsatali et al., 2019). Bailey et al., (2009) also concluded that their null results could be related to the particular neurocognitive profile of the sample examined. Interestingly, there is not a consistent pattern of impairment in frontal lobe-related disorders across the SCEs investigated. Thus, embarrassment responses appear to be decreased in orbitofrontal patients

(Beer et al., 2003), and in those with FTLD (Sturm et al., 2006), but self-reported and experimentally induced self-disgust is increased in Parkinson's disease patients (Tsatali et al., 2019). Although comparison across different disorders should be done with caution, the pattern of findings suggests that frontal lobe dysfunction may affect specific SCEs differently. This is not surprising, since research evidence suggests that SCEs should not be treated as a unitary construct. For instance, although SCEs, as a category, appear to be associated with a distributed brain network that underlies self-awareness and social cognition, studies have reported differential brain activations associated with shame, guilt, embarrassment and self-disgust (Michl et al., 2014; Schienle & Wabnegger, 2019; Takahashi et al. 2004; Wagner et al., 2011). A further important distinction may be whether SCEs are likely to trigger adaptive behaviours, as with the case of embarrassment and guilt, or maladaptive ones, as with shame and self-disgust (Tangney et al., 1992; Tracy & Robins, 2007; Powell et al., 2013). Alternatively, it could be that the differential influence of frontal-lobe related disorders on specific SCEs could be related to particular deficits associated with each disorder (e.g., schizophrenia symptoms in the present case), given also that frontal lobe dysfunction in neurological/neuropsychiatric disorders is an umbrella term for various deficits.

Nevertheless, our study not only supports previous findings of altered self-reported SCEs in frontal lobe dysfunction, but goes beyond by showing for the first time a link between SCEs and EF. SCEs have received considerably less attention compared to basic emotions (Tracy & Robins, 2007), and our understanding of how these emotions are constructed and developed, and which processes or factors underlie them, is still in its infancy. We know though, from the literature on basic emotions, that EF and emotional regulation are closely related. Individual differences in executive functioning significantly predict differences in the successful regulation of basic emotions (Schmeichel & Tang, 2015), with working memory capacity being the most reliable predictor. There is some evidence to suggest that other aspects of EF (inhibition, memory updating and shifting) may also play a role in the regulation of basic emotions (von Hippel & Gonsalkorale, 2005; Schmeichel & Tang, 2014, 2015; Schmeichel, Volokhov, & Demaree, 2008 for disgust). Relevant to our study, and from a different theoretical approach, it has been proposed that verbal fluency, which requires a combination of planning, activation, and monitoring processes, may be the best predictor of successful emotion regulation (Gyurak, Goodkind, Kramer, et al., 2012). However, knowledge of how specific aspects of EF may contribute to the regulation of SCEs is practically non-existent. Nevertheless, in line with the evidence from basic emotions, our finding of a positive correlation between semantic fluency scores with guilt scores, and of a negative correlation with self-disgust scores, even after controlling for depression and anxiety, suggests that the differences between patients with schizophrenia and control participants may be explained in terms of impaired emotion regulation.

Impaired emotion regulation at the functional level may produce an emotional bias away from adaptive emotions like guilt and towards maladaptive emotions like shame and self-disgust. At the neural level, that may manifest as a disruption in the relationship between the frontal cortex and the amygdala, an area intimately linked with negative emotion (e.g. LeDoux, 1996). Previous research into emotion regulation has converged on a top-down model whereby neural responses to emotional stimuli in the amygdala are down regulated by prefrontal regions (Ochsner, Bunge, Gross, & Gabrieli, 2002; Urry, Reekum, Marije et al., 2006; Johnstone, van Reekum, Urry, et al., 2007). This arrangement may be especially true for the ventro-medial prefrontal cortex (VMPFC; Urry et al., 2006; Johnstone et al., 2007), which has been implicated in self-related judgements (Denny, Kober, Wager, & Ochsner, 2012). As a consequence, frontal dysfunction may lead to a reduction in adaptive emotions like guilt, whilst at the same time the amygdala may be released from top-down control, leading to an enhancement of maladaptive emotions like shame and self-disgust. Indeed, neuroimaging evidence suggests that there is a positive relationship between amygdala activation and shame (Pulcu, Lythe, Elliott et al., 2014), and SD (Schienle, Leutgeb, & Wabnegger, 2015).

We did not replicate, in a sample of patients with schizophrenia, the finding of higher levels of shame in psychiatric patients, including those with psychosis, reported by Averill et al. (2002). Similarly, Tsatali et al., (2019) have recently reported no differences in shame levels in patients with Parkinson's disease after controlling for anxiety and depression. In the current study, shame was also not significantly correlated with executive function. Shame is strongly associated with depression (Kim, Thibodeau, & Jorgensen, 2011), a condition of high prevalence in schizophrenia (Samsom & Wong, 2015). Higher levels of shame in psychiatric and clinical populations have also been related to self-stigmatization (Averill et al., 2012; Persons, Kershaw, Sikkema et al., 2010). Future research is needed to understand the mediating effect of comorbidities and self-stigmatization in elevated levels of shame in psychiatric populations.

One novel aspect of the study was the inclusion of two samples of patients and controls from two different populations, Greek (more individualistic) and Arabic (more collectivistic), the latter being under-represented in the particular field investigated here. The association between executive dysfunction and levels of self-disgust was not moderated by the sample, making this finding culturally independent. However, we found that the experience of self-disgust was modulated by culture, so that Greek control participants reported higher levels than Arabic control participants. And this was still the case when we controlled for the potential confound of education (years) in the analyses. The two samples also significantly differed in age, with the Greek sample being older. At least one study has also reported lower self-disgust levels with increasing age (Powell et al., 2013). In our study, age did not significantly correlate with self-disgust scores, and the older sample had greater scores. Thus, it is unlikely that the difference in age between the two samples may account for the higher levels of self-disgust in the Greek sample. On the other hand, this result appears to be in agreement with studies that report that collectivistic cultures, relative to individualistic cultures, attenuate the expression of negative emotions, such as disgust, in the presence of the experimenter; and judge negative emotions in others as less intense (see Matsumoto, 2006 for a review). That is, it has been suggested that collectivistic cultures may discourage the free expression of negative emotions (shame being an exception, Feghali, 1997; Fessler, 2004), which may result in lower attention to and recognition accuracy of these emotions. This in turn may affect the development and expression of self-disgust, which requires decoding emotional reactions of others in relation to the self (physical image and behaviour; Powell et al., 2015). This finding is also in agreement with the study of Birenbaum et al. (1995), which concluded that Arab students to defend themselves more than Jewish students by placing greater weight on success, and less on failure. This cultural difference in attribution could also explain why our Arabic sample reported overall lower levels of negative SCEs (self-disgust). Future studies may systematically investigate cultural differences in self-disgust taking into account specific social/cultural dimensions that impact decoding and expression of emotions and attribution processes of failure.

One limitation of the study is that we employed a non-validated Arabic translation of the English original SDS. However, our Arabic version of the SDS (the SDS-A) was found to have very high internal reliability. Scores on the SDS-A correlated significantly with depressive symptoms as do those in the English version (Overton et al., 2008), providing some evidence for construct validity. The correlations with the neuropsychological measures and self-disgust (SDS-G and SDS-A) were also not moderated by the sample, which suggests that our findings were relatively independent of language and culture. Since there is not currently any validated self-report measure of SCEs in Arabic, we believe that the present study is a stepping stone to a future full validation study. A second limitation is that performance on the EF measures employed in this study have been suggested to be influenced by processing speed, which is known to be affected in schizophrenia (Fioravanti et al., 2012).Thus future studies may employ other measures less affected by processing speed such as the Wisconsin Sorting Card Test to study the relationship between executive function and SCEs.

To conclude, our study shows for the first time that guilt and self-disgust levels are decreased and increased, respectively, in patients with schizophrenia. Furthermore, altered levels of SCEs are closely related to poorer EF, which was impaired in the two samples of patients examined here. We suggest that the link between EF and emotion regulation, widely established in basic emotions but under-studied in SCEs, may explain the current findings. Further research is needed to understand how executive dysfunction may affect regulation of specific SCEs in patients with schizophrenia, using experimental methods to manipulate these emotions. Finally, given the direct link between SCEs and the regulation of social behaviour (Beer et al., 2003), and between the embarrassment response and social functioning in schizophrenia (Bailey et al., 2009), our finding of altered self-disgust and guilt may be a first step in understanding the well documented deficits in social behaviour in patients with schizophrenia.

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Table 1. Demographic and neuropsychological measures for the patients with schizophrenia (N=29) and the control group (N=22) in the Greek sample.

Variables	Schizophrenia Patients		Control Group			
	Mean	S.D.	Mean	S.D.	t	p
Age (years)	44.93	8.94	44.45	9.65	.182	.856
Men %	59%		64%		χ^2=.13	.778
Women %	41%		36%		--	--
Education in years	12.34	3.24	12.18	3.01	.183	.855
HADS-D	6.10	5.56	2.77	2.33	2.63	.011
HADS-A	7.90	6.39	3.32	2.99	.004	.005
TMT-A	91.47	42.63	35.93	13.06	4.84	<.001
TMT-B	270.82	117.52	73.13	34.12	6.28	<.001
VF-Semantic	33.70	10.64	50.45	6.39	6.03	<.001
VF-Phonemic	24.00	11.87	31.65	9.18	2.28	.028
Age of Onset	25.45	9.88	--	--		
Duration illness (years)	19.32	11.32	--	--		

HADS = Hospital Anxiety (A) & Depression (D) Scale; TMT-A = Trial Making Test-version A, time of completion in seconds TMT-B = Trial Making Test-version B, time of completion in seconds; VF-Semantic= Verbal Fluency total number of words in the semantic part; VF-Phonemic = Verbal Fluency total number of words in the phonemic part.

Table 2. Demographic and neuropsychological characteristics for patients with schizophrenia (N=30) and the control group (N=30) in the Arabic sample.

Variables	Schizophrenia Patients		Control Group			
	Mean	S.D.	Mean	S.D.	t	p
Age (years)	31.17	10.89	33.67	14.07	.77	.445
Men %	57%		47%		χ^2=.61	.606
Women %	43%		53%		--	--
Education in years	13.15	1.40	14.47	1.33	2.73	.008
HADS-D	13.27	4.96	3.70	3.17	8.89	<.001
HADS-A	14.10	3.55	4.96	3.29	10.33	<.001
TMT-A	78.07	21.44	29.61	7.43	11.69	<.001
TMT-B	209.73	93.62	68.10	15.00	8.18	<.001
VF-Semantic[a]	13.53	5.91	26.73	8.33	7.07	<.001
VF-Phonemic	16.07	7.32	28.73	6.67	6.98	<.001
Age of Onset	25.20	7.55	--	--		
Duration illness (years)	5.97	5.91	--	--		
CPZE in mg	252.50	206.61	--	--		

a= The Arabic validated version includes only one category (animals). HADS = Hospital Anxiety (A) & Depression (D) Scale; TMT-A = Trial Making Test-version A, time of completion in seconds TMT-B = Trial Making Test-version B, time of completion in seconds; VF-Semantic= Verbal Fluency total number of words in Animal category; VF-Phonemic = Verbal Fluency total number of words in the phonemic part; CPZE = chlorpromazine equivalent dose in mg

Table 3. Correlations between neuropsychological measures and self-disgust in the overall sample of Greek and Arabic participants.

	1.HADS-A	2.HADS-D	3.TMT-B	4.VF-ANIMAL	5. VF-P	6.SDS
2.	.669**					
3.	.454**	.478**				
4.	-.416**	-.353**	-.460**			
5.	.437**	.509**	-.240*	.406**		
6.	.619**	.622**	.411** **.088**	-.533** **-.390****	-.458** **-.172**	

Note: *p< .05; **p< .001; HADS = Hospital Anxiety (A) & Depression (D) Scale; TMT-B = Trial Making Test-version B, time of completion in seconds; VF-ANIMAL= Number of words in Animal category of verbal Fluency; VF-P = Verbal Fluency Phonemic, total number of words; SDS= Self-disgust total scores, Arabic and Greek versions; coefficients in bold are from partial correlations controlling for HADS-Total scores

Note: *p< .05; **p< .001

Table 4. Examination (employing bootstrapping) of the moderating effect of country on the relationship between executive function (animal fluency) and SD levels.

Step and variables		*B*	*SE B*	*95% CI*	*β*	*ΔR²*
1	Animal Fluency	- 8.88	1.23	-11.43,-6.38	-.57**	
	Country	3.53	2.89	-2.28,9.11	.11	.295**
	$F(2,97) = 20.34$, $p < .001$					
2	Animal Fluency	- 10.24	4.31	-18.49,-1.66	-.65*	
	Country	3.96	2.87	-2.02,9.35	.12	
	Animal Fluency × Country	1.55	4.43	-7.59,9.80	.09	.001
	$F(3,96) = 13.48$, $p <.001$					

Table 5. Correlations between neuropsychological measures and TOSCA subscales of shame and guilt in the Greek sample.

	1.HADS-A	**2.HADS-D**	**3.TMT-B**		**4.VF-S**		**5.VF-P**		**6.Shame**	**7. Guilt**
2.	.697**									
3.	.322	.341								
4.	-.381*	-.386**	-.415*							
5.	.244	-.290	-.071		.656**					
6.	.540*	.404**	.053	**-.172**	-.272	**.065**	-.159	**.119**		
7.	.071	.013	-.400*	**-.520***	.248	**.374***	.080	**.216**		

Note: *p< .05; **p< .001; HADS = Hospital Anxiety (A) & Depression (D) Scale; TMT-B = Trial Making Test-version B, time of completion in seconds; VF-S= Verbal Fluency Semantic total number of words: VF-P = Verbal Fluency Phonemic total number of words; coefficients in bold are from partial correlations controlling for HADS-Total scores.

Figure Legends

Figure 1. Self-disgust scores (and standard error) as a function of Sample (Greek and Arabic) and Group (Schizophrenia and Controls).

Figure 2. Shame and Guilt scores (and standard error) as a function of Group (Schizophrenia and Controls) in the Greek sample.

Figure 1

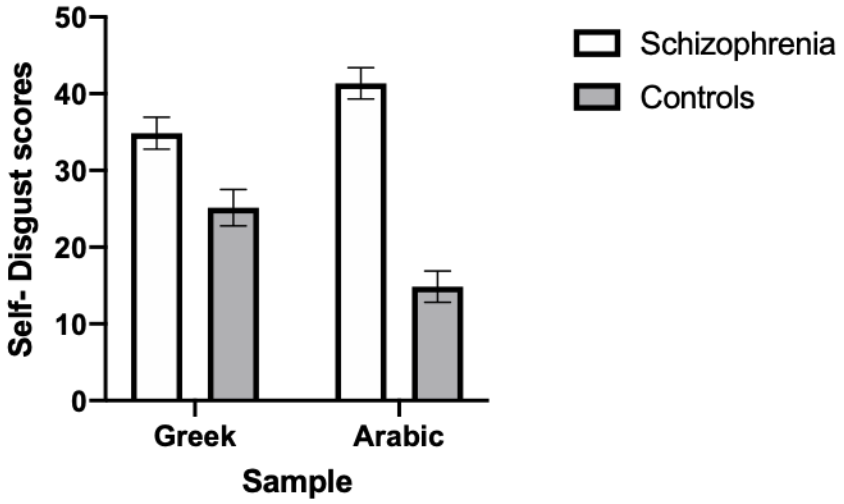

Figure 2