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Emotional processing in a non-clinical psychosis-prone sample

Mascha van 't Wout[a,b], André Aleman[a,b,*], Roy P.C. Kessels[b], Frank Larøi[c], René S. Kahn[a]

[a] *Rudolf Magnus Institute of Neuroscience, Department of Psychiatry, A01.126, University Medical Center, Heidelberglaan 100, 3584 CX Utrecht, The Netherlands*
[b] *Helmholtz Research Instituut, Psychological Laboratory, Utrecht University, The Netherlands*
[c] *Cognitive Psychopathology Unit, University of Liège, Belgium*

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Abstract

Symptoms of psychosis have been proposed to form part of a continuous distribution of experiences in the general population rather than being an all-or-nothing phenomenon. Indeed, schizotypal signs have been reported in subjects from non-clinical samples. Emotional processing has been documented to be deficient in schizophrenia. In the present study, we tested the hypothesis whether putatively psychosis-prone subjects would show abnormalities in emotion processing. Based on the extremes of Launay–Slade Hallucination Scale (LSHS) ratings of 200 undergraduate students, two groups of subjects (total $N=40$) were selected. All 40 participants filled in the Schizotypal Personality Questionnaire (SPQ). We compared both groups on an alexithymia questionnaire and on four behavioral emotional information processing tasks. Hallucination-proneness was associated with an increased subjective emotional arousal and fantasy-proneness. Although no differences between the high and low group were observed on three behavioral emotion processing tasks, on the affective word-priming task presentation of emotional stimuli was associated with longer reactions times to neutral words in high schizotypal subjects. Also, SPQ scores correlated with several emotion processing tasks. We conclude that these findings lend partial support to the hypothesis of continuity between symptoms characteristic of schizophrenia and psychosis-related phenomena in the normal population.

Keywords: Psychosis-prone; Hallucination; Schizophrenia

1. Introduction

A growing number of studies consider psychosis as a continuum with normal functioning at one end and abnormal functioning (psychosis) at the other end (Verdoux and van Os, 2002; Johns and van Os, 2001; Claridge, 1997). In accordance with this view, Johns and van Os (2001) have reviewed evidence indicating that psychotic signs, often called schizotypal signs or schizotypal traits, are present in healthy people to a certain extent. Schizotypy refers to the personality trait of experiencing 'psychotic' symptoms (Claridge, 1997) and schizotypy may be conceptualized as a predisposition to schizophrenia at the level of the organization of the personality (Meehl, 1989; Vollema and van den Bosch, 1995). Such schizotypal traits, e.g., referential thinking and odd or eccentric behavior have

* Corresponding author. Department of Psychiatry A01.126, University Medical Center Heidelberglaan 100, 3584 CX Utrecht, The Netherlands. Tel.: +31-30-2508459; fax: +31-30-2505443.
E-mail address: a.aleman@azu.nl (A. Aleman).

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been hypothesized to be normally distributed in the non-clinical population (Chapman et al., 1976).

One of the cardinal dysfunctions associated with schizophrenia concerns processing of emotional information (McKenna, 1994), including disturbances in the expression, experience and perception of emotions. Indeed, Kreapelin (1907) regarded emotional disturbances, such as flattened and inappropriate affect, to be characteristic of schizophrenia. Although schizophrenic patients inadequately *express* emotions (Berenbaum and Oltmanns, 1992; Knight and Valner, 1993; Kring et al., 1994; Kring and Neale, 1996), Kohler et al. (2000) and Myin-Germeys et al. (2000) suggested that the subjective *experience* of emotion is much less disturbed in schizophrenia.

Sifneos (1973) introduced the term 'alexithymia' to describe abnormalities in affect regulation. More specifically, alexithymia refers to difficulties in recognizing, identifying and describing one's own emotions. Thus, alexithymic individuals have impaired affect regulation (Bagby and Taylor, 1997) and may also show specific inabilities to communicate emotions while the experience of emotion might be intact (Kihlstrom et al., 2000). Cedro et al. (2001) demonstrated that schizophrenic patients have higher scores on an alexithymia questionnaire than healthy controls, i.e., they have more problems in identifying and verbalizing their emotions.

With regard to behavioral measures of emotional processing in schizophrenia, deficits in emotion recognition have been found (Edwards et al., 2002). In addition, schizophrenic patients appear to inadequately process facial affect (Addington and Addington, 1998; Streit et al., 2001) and demonstrate a reduced left-perceptual bias in the processing of emotional chimeric faces (Gooding et al., 2001). There might also be a bias towards material with a negative emotional valence, as observed in a study in which hallucinating patients were more sensitive to negative words compared to controls (Johns et al., 2002). Moreover, a recent study (Hoschel and Irle, 2001) reported that negative emotional expressions yield stronger priming effects in schizophrenia patients compared to control subjects (hyperpriming).

The present study is important for several reasons. First, research on psychosis-prone or schizotypal individuals may help to develop preventive interventions for schizophrenia. Cannon et al. (2002) and McGorry et al. (2002) already showed that early interventions in prodromal schizophrenic patients reduces the risk of early transition to psychosis in young people and possibly reduces the incidence of schizophrenia. Second, the study of non-clinical subjects with schizotypal traits enables researchers to study schizotypal phenomena without the confounding contribution of factors such as medication, duration of illness and severe psychopathology or institutionalization. Third, previous research has concentrated on cognitive dysfunctions that may be associated with psychotic traits in non-clinical samples (Aleman et al. 2000; Suhr, 1997). To our knowledge, the present study is the first to examine emotional processing in such a sample.

The aim of this study was to investigate whether healthy individuals with high positive schizotypy differ from individuals with low positive schizotypy (as screened by the Launey–Slade Hallucination Scale (LSHS)) on measures of subjective and objective emotional information processing tasks. Following the schizophrenia literature positive schizotypal signs could, like positive symptoms in schizophrenia, be associated with an attentional bias for negative-valenced material, including threat, anger and sadness (Phillips et al., 1999; Mandal et al., 1999). In contrast, negative symptoms of schizophrenia reflect a more generalized and severe emotion-recognition deficit (Mandal et al., 1999; Schneider et al., 1995).

On subjective emotion processing (as measured with an alexithymia questionnaire), we predicted that individuals with positive schizotypal signs would report lower levels of identifying and verbalizing their own emotions compared to individuals without positive schizotypal signs. On the other hand, higher levels of emotionalizing might be expected, as an increase in arousal and anxiety has been associated with occurrence of positive symptoms in schizophrenia (Delespaul et al., 2002). With regard to behavioral emotional information processing, we concentrated on verbal and facial affect recognition. On verbal affect recognition tasks, we hypothesized that persons with positive schizotypal signs would show an increased sensitivity to emotional material, specifically an attentional bias for material with a negative valence. Thus, greater priming especially for negative-valenced words and a reduced Stroop effect in an emotional counting Stroop paradigm for the positive

schizotypal persons compared to persons with less schizotypal signs. On facial affect recognition tasks, we predicted that persons with positive schizotypal signs would show a reduced left perceptual bias in a chimeric faces task (David and Cutting, 1990) and more errors in recognizing degraded facial affect (Mandal et al., 1998).

Finally, in a more exploratory analysis, we also included the Schizotypal Personality Questionnaire (SPQ). First, to explore relations between positive schizotypy and the other two dimensions, disorganization and negative schizotypy in a non-clinical sample. Second, to explore the relation between the SPQ subscales and the emotional measures. Given the exploratory nature of this analysis, we only hypothesized that subjects selected for positive schizotypy would also show negative schizotypal signs and emotional processing characteristics associated with negative symptoms. We based this prediction on the fact that positive and negative symptoms generally occur together in patients with schizophrenia (McKenna, 1994). For example, whereas positive symptoms such as hallucinations and delusions occurred in about 70% of a sample of 306 concordant patients with schizophrenia in the International Pilot Study on Schizophrenia (World Health Organization, 1973), flatness of affect was also found in 66% of the sample (Murray, 1997).

2. Methods

2.1. Participants

Two hundred undergraduate students from Utrecht University (79 male and 120 female (one student did not specify 'gender'); mean age 20.9 ± S.D. = 4.5) completed the revised Launey–Slade Hallucination Scale (LSHS; Launay and Slade, 1981; Bentall and Slade, 1985; Larøi et al., (in press)). Their scores ranged from 0 to 58, mean score: 16.12 ± S.D. = 10.1).

From the 200 students, 40 participants were selected for participation in the study. Twenty participants were from the highest and 20 participants were from the lowest quartile (range LSHS scores: 27–49 and 0–8, respectively). For the high LSHS group, mean age was 21.65 ± S.D. = 2.43) with a male/female ratio of 1:4. The low LSHS group had a mean age of 22,75 ± S.D. = 3.73) with a male: female ratio of 1:1.5. There were no significant group differences for mean age and gender, $F(1,38) = 1.222$, $p = 0.276$ and $F(1,38) = 1.9$, $p = 0.176$, respectively. Handedness was measured with the Edinburgh Handedness Inventory (− 24 = exclusively left handed, 0 = no preference, 24 = exclusively right handed; Oldfield, 1971). All participants were right handed except one (mean 19.5, S.D. = 6.9).

2.2. Schizotypy questionnaires

Subjects were selected on the basis of either high or low ratings on a measure of positive schizotypy, the LSHS (Vollema and van den Bosch, 1995). The Schizotypal Personality Questionnaire (SPQ), a more comprehensive syndrome-based measure, was used to further characterize the two groups on other schizotypal traits.

The revised LSHS questionnaire consists of 16 questions, including items on sleep-related hallucinatory experiences and visual hallucinations (Larøi et al., (in press)). Answers are scored on a 5-point scale (0 = certainly does not apply to me, up to 4 = certainly applies to me) and a high score on the LSHS indicates proneness towards hallucinations.

The Schizotypal Personality Questionnaire (SPQ: Raine, 1991) is a 74-item questionnaire with a dichotomous response format (yes or no) and is seen as an indicator of the genetic vulnerability to schizophrenia (Vollema et al., 2002). The items of the schizotypal traits are reduced to three dimensions. Positive schizotypy includes magical ideation, unusual perceptual experiences, delusional atmosphere, referential thinking and suspiciousness. The dimension of negative schizotypy includes the subscales social anxiety, referential thinking, no close friends, constricted affect and suspiciousness. Finally, the disorganization dimension includes the subscales odd speech and odd or eccentric behavior (Vollema et al., 2002). We followed Vollema et al. (2002) in the allocation of the items to the dimensions (see also Table 1).

2.3. Subjective and objective emotion measures

2.3.1. Alexithymia questionnaire

The Bermond–Vorst Alexithymia Questionnaire measures personality traits associated with experienc-

Table 1
Means, SDs and ANOVA results of the three-dimensional SPQ model according to Vollema et al. (2002) for both high and low LSHS group

SPQ-scores	High LSHS	Low LSHS	$F(1,38)$	P
Positive schizotypy	14.4 (6.83)	6 (4.94)	19.85	<0.0001*
Magical ideation	3.45 (2.52)	1.05 (1.32)	14.22	0.001*
Unusual perceptual experiences	4.25 (2.86)	0.7 (2.09)	20.47	<0.0001*
Delusional atmosphere	1.8 (1.11)	0.9 (0.97)	4.51	0.009*
Referential thinking	3.1 (1.41)	2 (1.75)	4.80	0.035*
Suspiciousness	1.8 (1.88)	1.35 (1.63)	0.65	0.424
Disorganization	8.25 (4.0)	3.6 (3.5)	15.31	<0.0001*
Odd speech	6.20 (3.11)	3.05 (2.98)	10.71	0.002*
Odd or eccentric behavior	2.05 (1.57)	0.55 (1.05)	12.59	0.001*
Negative schizotypy	9.7 (4.3)	7.6 (5.9)	1.65	0.207
Social anxiety	2.55 (1.93)	1.9 (1.83)	1.19	0.282
Referential thinking	3.1 (1.41)	2 (1.75)	4.80	0.035*
No close friends	1.40 (1.23)	1.35 (1.73)	0.01	0.917
Constricted affect	0.85 (0.99)	1 (1.17)	0.19	0.664
Suspiciousness	1.8 (1.88)	1.35 (1.63)	0.65	0.424

* Significant at a $p < 0.05$ levels.

ing, verbalizing, fantasizing, identifying and thinking about one's own emotions (BVAQ: Bermond et al., 1994; Vorst and Bermond, 2001). These traits have been proposed to be essential for affect regulation (Bagby and Taylor, 1997). The BVAQ consists of five subscales: *Emotionalizing*: the degree to which someone is emotionally aroused by emotion inducing events. *Fantasizing*: the degree to which someone is inclined to fantasize, imagine, daydream, etc. *Identifying*: the degree to which one is able to define one's arousal states. *Analyzing*: the degree to which one seeks out explanations of one's own emotional reactions. *Verbalizing*: the degree to which one is able or inclined to describe or communicate about one's own emotional reactions (cf. Vorst and Bermond, 2001).

Each of the subscales consists of eight items. Answers are scored on a 5-point scale (1 = certainly does not apply to me, up to 5 = certainly applies to me). High scores are an indication for problems in affect regulation.

2.3.2. Objective measures of emotional information processing

2.3.2.1. Affective priming task. All words were selected from Hermans and de Houwer (1994, appendix A). The 15 words with the highest mean evaluation on affectivity served as positive targets and primes. The 15 words with the lowest mean evaluation served as negative targets and primes. Forty-five non-words only served as targets and were letter strings that were pronounceable legally. The Stimulus Onset Asynchrony (SOA) was 250 ms. Priming will rely on more automatic processing when short SOAs are used rather than longer SOAs, which have been associated with more controlled processing (Rossel et al., 2001). Participants had to decide as quickly as possible if a word presented on a computer screen was a real word or a non-word (i.e., lexical decision). Subjects responded by pressing 'N' for a non-word and 'M' for a real word on a keyboard.

2.3.2.2. Emotional counting Stroop task. This task was adapted from Whalen et al. (1998), and is intended to measure attentional biases (as indexed by increased reaction times) for emotional words. Participants had to decide by button press how many words were presented on a screen. The number of words varied from 1 to 4 and the presentation of these numbers of words was balanced over the conditions. When more than one word was presented, the other words were repetitions of the first word. There were five categories of words: neutral, fearful, negative, positive and obsessive–compulsive disorder-related words (Whalen et al., 1998). Word groups did not differ significantly on word length ($F(1,4) = 0.414$, $p = 0.798$) and word frequency ($F(1,3) = 0.138$, $p = 0.937$). Each condition consisted of 15 trials, resulting in a total of 75 trials. Participants were instructed to decide as quickly as possible, and to

try to make no mistakes. Subjects pressed 'N' in the case of 1 or 3 words (odd) and 'M' when 2 or 4 words (even) had been presented on the screen.

2.3.2.3. Emotional chimeric faces task. In this task, participants viewed 48 happy–sad chimeric face drawings (David, 1989). These schematic face drawings had a happy expression on the left half and a sad expression on the right half. There were 12 original drawings and 12 mirror images of the original drawings, and both were shown twice. Participants had to tell immediately when they saw the picture whether the face looked sad or happy. Afterwards, they were asked how they felt on a scale ranging from 0 (very sad) to 100 (very happy) and these subjective scores are so-called mood ratings. This task has been shown to reflect the use of the right hemisphere for visuospatial processing and for emotion processing. Healthy subjects show a left perceptual bias when they have to make a judgment of emotion. David and Cutting (1990) reported that schizophrenic patients display a reduction of this bias.

2.3.2.4. Degraded facial affect recognition task. This task is a measure of facial affect recognition of degraded faces. Photographs of four different actors, two males and two females, were used. Sixty-four trials were presented, consisting of 16 face presentations in each of four conditions: angry, happy, fearful and neutral. The photographs of the faces were passed through a filter that reduced visual contrast by 30%. This procedure was adopted in order to increase the difficulty of the task and to enhance the contribution of perceptual expectancies and interpretation. Subjects were asked to indicate the expression of each face with button press (F1 to F4) and were asked to respond as accurately as possible.

3. Results

Statistical analyses were performed using Statistical Package for the Social Sciences 10.01 (2000). The SPQ and the emotion processing measures for the high and low LSHS groups were compared by analysis of variance (ANOVA). Furthermore, correlations were computed between SPQ scores and objective emotional processing tasks. Alpha was set at 0.05. On request, the authors can provide tables with means and SDs for all parameters of each measure.

3.1. Group comparisons

3.1.1. Schizotypal personality questionnaire

High and low LSHS groups differed significantly on the positive schizotypy dimension as well as the disorganization dimension (both $p < 0.001$). When subscales were compared separately, significant differences were observed on, unusual perceptual experiences, magical ideation, delusional atmosphere, referential thinking, odd speech and odd or eccentric behavior. In which the high LSHS group had higher scores than the low LSHS group (Table 1).

3.1.2. Alexithymia questionnaire

There was a significant difference between the two groups on the dimensions of 'fantasizing' and 'emotionalizing' of the Alexithymia Questionnaire. The high LSHS group had lower ratings on these dimensions than the low LSHS group ($p < 0.05$), which is indicative of higher levels of fantasizing and emotionalizing (Table 2).

3.1.3. Affective priming task

Repeated-measures ANOVA did not reveal significant differences between the groups for affective priming, when the reaction times for the conditions with a positive prime and a positive target were compared to conditions with a neutral prime and a neutral target, $F(1, 38) = 0.32$, $p = 0.58$, nor when conditions with a negative prime and a negative target were compared to conditions with a neutral prime and a neutral target, $F(1, 38) = 3.12$, $p = 0.09$. However, when the conditions with a positive prime and a neutral target were compared to conditions with a

Table 2
Bermond–Vorst Alexithymia total score and sub-scores for the high and low LSHS group and statistics

Alexithymia	High LSHS	Low LSHS	$F(1,38)$	P
Verbalizing	19.35/8.52	20.45/5.96	0.224	0.639
Fantasizing	14.1/5.45	23.9/8.69	18.251	< 0.0001*
Identifying	19/5.18	15.7/5.55	3.782	0.059
Emotionalizing	17.05/5.05	20.55/5.13	4.722	0.036*
Analyzing	14.95/5.70	16.35/5.67	0.607	0.441

* Significant at a $p < 0.05$ levels.

neutral prime and a neutral target, a significant Group × Task interaction was observed, $F(1, 38) = 6.60$, $p = 0.01$. The same difference was observed for the negative–neutral versus neutral–neutral comparison, $F(1, 38) = 5.67$, $p = 0.02$. Mean reaction time on the neutral–neutral condition was 757 ms ± S.D. = 110) for the high LSHS group and 782 ms ± S.D. = 232) for the low LSHS group. On average there was a 99 ms reduction in the low LSHS group due to emotional primes, whereas in the high LSHS groups an increase of 23 ms was found. This indicates that there was no priming in the high LSHS group.

3.1.4. Emotional counting Stroop task

Analysis revealed no significant differences between high and low LSHS groups on Stroop reaction time for the different word groups.

3.1.5. Chimeric faces task

Due to practical reasons, we included 15 subjects in the high LSHS group and 20 subjects in the low LSHS group. Both groups showed the typical left-field bias that has been reported for subjects from the normal population, $F(1, 13) = 7.75$, $p = 0.02$, and $F(1, 18) = 4.91$, $p = 0.04$, for the high and low LSHS groups, respectively. There were no significant differences in bias between the high and the low LSHS groups. The results remained not significant after compensating for mood ratings, $F(1, 32) = 2.31$, $p = 0.14$. The effect of mood on hemifield bias was significant, $F(1, 32) = 7.13$, $p = 0.01$.

3.1.6. Degraded facial affect recognition task

ANOVA showed no significant differences the number of mistakes made for the two groups.

3.2. Correlations between SPQ and emotion measures

3.2.1. Alexithymia questionnaire

Non-parametric Spearman correlation coefficients were computed between the SPQ and BVAQ across the whole sample ($N = 40$). Higher ratings on the positive schizotypy and disorganization dimension correlated with fewer problems on fantasizing ($r = -0.41$, $p = 0.009$ and $r = -0.337$, $p = 0.033$, respectively). Additionally, higher ratings on all SPQ dimensions correlated with more problems in identifying emotions, $r = 0.46$, $p = 0.003$ for the positive dimension; $r = 0.339$, $p = 0.032$ for the disorganization dimension; $r = 0.404$, $p = 0.01$ for the negative dimension.

Regarding the different SPQ subscale, higher ratings on magical ideation, unusual perceptual experiences and odd or eccentric behavior correlated with fewer problems in fantasizing ($r = -0.35$, $r = -0.49$, and $r = -0.38$, respectively, all $p < 0.05$). Magical ideation also correlated with fewer problems in emotionalizing, $r = -0.38$, $p = 0.02$. On the other hand, unusual perceptual experiences correlated with more problems in identifying emotions ($r = 0.48$, $p = 0.002$), which was also true for the dimensions delusional atmosphere ($r = 0.34$, $p = 0.03$), odd or eccentric behavior ($r = 0.40$, $p = 0.01$) and no close friends ($r = 0.41$, $p = 0.009$). In addition, the subscale-constricted affect correlated with more problems on verbalizing ($r = 0.66$, $p = 0.001$), emotionalizing ($r = 0.35$, $p = 0.03$) and analyzing ($r = 0.37$, $p = 0.02$)).

3.2.2. Affective priming task

There were no associations between affective priming parameters and schizotypy subscales.

3.2.3. Emotional counting Stroop task

The SPQ subscale suspiciousness correlated negatively with reaction times for negative words ($r = -0.40$, $p = 0.011$), fearful words ($r = -0.33$, $p = 0.039$) and obsessive–compulsive disorder-related words ($r = -0.41$, $p = 0.009$). The subscale no close friends correlated positively with reaction times for positive words, $r = 0.34$, $p = 0.03$.

3.2.4. Chimeric faces task

The SPQ subscale delusional atmosphere correlated significantly with a left perceptual bias, $r = 0.39$, $p = 0.02$. The correlation for the dimension of positive schizotypy with left perceptual bias approached significance, $r = 0.32$, $p = 0.06$. Furthermore, there was a significant negative correlation between the SPQ subscale social anxiety and mood rating, $r = -0.48$, $p = 0.003$.

3.2.5. Degraded facial affect recognition task

The positive schizotypy subscale correlated significantly with errors in classifying angry faces as happy, $r = 0.53$, $p = 0.0005$. Of the subscales, unusual percep-

tual experiences correlated significantly with erroneously classifying happy faces as angry ($r = 0.66$, $p = 0.0005$), and with erroneously classifying happy faces as fearful ($r = 0.37$, $p = 0.018$). All other correlations were not significant.

4. Discussion

This study examined the relationship between psychosis-proneness and subjective and objective emotional information processing measures in a non-clinical sample. We observed significantly lower ratings on the 'emotionalizing' and 'fantasizing' subscales of the alexithymia questionnaire in psychosis-prone subjects. This is indicative of an increased sensitivity for emotional arousal in positive schizotypy. An increase in subjective emotional arousal in relation to hallucinations and delusions is compatible with reports by Freeman et al. (2001) and Delespaul et al. (2002), who found associations between distress and anxiety levels and hallucinations. Indeed, Delespaul et al. (2002) reported that subjective anxiety levels rose before the onset of actual hallucinations and are the strongest predictor of hallucination intensity. Moreover, using direct measures of autonomic arousal, higher skin-conductance responsivity to emotional stimuli in schizophrenia patients has been reported (Kring and Neale, 1996). Our findings of both increased sensitivity for emotional affect and increased levels of fantasizing in hallucination-prone subjects are comparable to findings from Larøi et al. submitted for publication where both neuroticism and openness to experience were found to be associated with hallucinations in non-clinical subjects. We did not observe lower levels of identifying and verbalizing one's own emotions in the psychosis-prone group. Although these deficits have been associated with schizophrenia, apparently they are not related to hallucination-proneness per se. Such emotional deficits might possibly be more related to other positive or negative symptoms (Schneider et al., 1995; Cedro et al., 2001). Thus, an important finding of the present study is that emotional processing abnormalities associated with positive and negative symptoms are not correlated in psychosis-prone subjects from the general population, although they tend to occur together in schizophrenia.

Regarding behavioral emotion processing tasks, no differences between the high and low LSHS groups were observed, with the exception of the affective word-priming task. Although priming with congruent prime-target pairs (e.g. negative–negative as compared to neutral–neutral) was identical in the two groups, the high LSHS group was negatively primed by emotional words when a neutral target followed either a positive or a negative prime. Therefore, positive schizotypy seems to be associated with difficulties in the activation of an unrelated semantic network after activation of emotional nodes, possibly due to a preoccupation with emotional material. Using a similar lexical decision paradigm, Rossel et al. (2000) demonstrated an inhibition of priming for negatively valenced words in schizophrenic, deluded patients. They suggested that a preoccupation with negative emotional material could be associated with the inhibition of normal semantic associations.

However, our finding was not in line with our initial hypothesis that expected an attentional bias for negative valenced material, i.e., only priming in the congruent or incongruent negative prime conditions. This might be due to the difference in content of the hallucinations experienced by hallucination-prone people and schizophrenic patients. The content of hallucinations experienced by schizophrenic patients is often hostile (Nayani and David, 1996) and might result in a preoccupation with negative-valenced information. On the other hand, hallucinations experienced by persons from the normal population are rarely experienced as negative or hostile (Barrett and Caylor, 1998). Mikhailova et al. (1996) found that people with schizotypal personality disorder show poorer recognition of both sad and happy expressions. Moreover, Green et al. (2001) suggested that delusion-prone individuals are delayed when processing angry faces in an affective decision task as a result of a threat-related bias, which captures the attention of delusion-prone subjects and result in longer reaction times.

Psychosis-prone persons as measured with the LSHS differed significantly from non-hallucination-prone subjects on the SPQ dimension 'positive schizotypy' and 'disorganization', but not on 'negative schizotypy'. More specifically, hallucination-prone subjects also differed on all other subscales of the positive dimension of the SPQ, with the exception of

suspiciousness. This suggests that hallucination-prone subjects from the normal population may also show other psychotic-like phenomena related to schizophrenia, such as magical ideation, delusions and referential thinking. Thus, our results are an extension of Levine et al. (in press) who demonstrated an association between hallucination-proneness and a general vulnerability for psychosis on the Chapman scales Magical Ideation and Perceptual Aberration.

With regard to subjective emotional processing, our results indicate that all schizotypy dimensions correlated positively with 'identifying' one's own feelings. This suggests that a higher degree of schizotypal signs might result in more problems in the identification of one's own emotions, which is in line with Cedro et al. (2001). In addition, associations between the SPQ and behavioral emotion processing measures were observed in the emotional counting Stroop task, chimeric faces task and degraded facial affect recognition task. In the Stroop task, the subscale suspiciousness correlated negatively with negative valenced words. It might be that persons with a higher score on suspiciousness interpreted negatively valenced words in a more personal manner and had to reconsider whether these words had meant something especially to them.

Furthermore, correlations between positive subscales of the SPQ and the chimeric faces task suggested an increased left perceptual bias in subjects with high ratings for positive schizotypy. Although this is contrary to the finding in patients with schizophrenia, who show a reduced left perceptual bias (David and Cutting, 1990), our finding is in accordance with Luh and Gooding (1999) who reported an increased left perceptual bias in non-clinical subjects selected for positive schizotypy, whereas a reduced left perceptual bias was observed in subjects selected for negative schizotypy.

A limitation of our study is the use of healthy university students. On average, students function at a high level (Chapman et al, 1994) that may account for the absence in differences on the emotion processing tasks between the two groups, since the tasks used in the present study partially depend on general level of cognitive functioning. Additionally, we suggest that schizotypal individuals with high intellectual capacity might cope better with the problems associated with schizotypy. Romme et al. (1992) reported that hallucinating subjects who could cope with their voices were less often in psychiatric care.

In addition, emotional abnormalities could contribute highly to the severity gradient along the continuum of psychotic experiences from the normal population to patients with schizophrenia and are therefore not expected to be found in non-clinical populations. For example, Honig et al. (1998) reported differences between nonpatient voice-hearers and schizophrenic patients in content, emotional quality and locus of control of the voices. Patients experienced more negative voices were more afraid of the voices and patients had less control over their voices.

In conclusion, psychosis-proneness is associated with increased self-reported tendency for emotional arousal and increased fantasy-proneness. However, non-clinical hallucination-prone subjects do not show the same pattern of emotional processing deficits as patients with schizophrenia. This conclusion extends findings reported by Cadenhead and Kumar 1996, who failed to find deficits that were identical or similar to information processing abnormalities characteristic of schizophrenia, e.g., concerning prepulse inhibition, in hallucination-prone subjects from the normal population. On the other hand, we observed some interesting associations between schizotypal traits as measured by the SPQ and alexithymia traits on one hand, and between SPQ subscales and emotional processing biases on the other hand.

Consequently, our findings lend only partial support to the hypothesis of continuity between symptoms characteristic of schizophrenia and psychosis-related phenomena in the normal population. An alternative model concerns the hypothesis of a continuum-threshold, as described by Johns and van Os (2001). They suggested that people develop a full-blown psychosis only when above a certain threshold. As Johns and van Os (2001) illustrated, schizotypal signs might behave like blood pressure in which normal variation exists and is not symptomatic. However, above a certain threshold, blood pressure becomes dangerous for other organs. Thus, above critical value, schizotypal traits themselves or accumulating independent risk factors might lead to a need for care. According to the diathesis-stress models of schizophrenia, stress is such a mediating factor (Walker and Diforio, 1997). Future research should focus on emotional processing in non-clinical samples

that are more closely related to the schizophrenia genotype, e.g., relatives of schizophrenia patients, which will shed more light on the genetic liability for emotional processing impairments associated with schizophrenia.

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