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ORIGINAL PAPER

Thomas Suslow · Cornelia Roestel · Volker Arolt

Affective priming in schizophrenia with and without affective negative symptoms

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Abstract In the present study automatic perceptual sensitivity to facial affect information was examined in chronic schizophrenic patients. An affective priming task including subliminal and supraliminal presentations of sad and happy facial affect was administered to schizophrenia patients with a flat affect expression (n = 30), schizophrenia patients suffering from anhedonia (n = 30), schizophrenia patients not suffering from anhedonia or flat affect (n = 28), and a group of healthy controls (n = 30). Subjects had to judge valence of neutral Chinese ideographs. Anhedonic and flat affect patients but not patients without affect symptoms were found to be sensitive to negative facial affect on an automatic processing level. None of the schizophrenic patient groups but healthy controls showed a subliminal valence-congruent priming effect based on positive facial affect. Anhedonia as assessed by standardised psychiatric rating was related to a subliminal sensitivity to negative facial expression and a valence-inverted perception of positive facial expression. This pattern of results is largely consistent with predictions derived from Meehl's model of anhedonia. The aversive automatic perception of positive facial expression primarily found in anhedonic patients but also in schizophrenic control patients could lie in structural disturbances concerning the regulation of intimacy and distance.

Key words schizophrenia · priming · facial affect · anhedonia · affective flattening

T. Suslow (✉) · C. Roestel · V. Arolt
Department of Psychiatry
School of Medicine
University of Münster
Albert-Schweitzer-Str. 11
48149 Münster, Germany
Tel.: +49-251/83-56615
Fax: +49-251/83-56612
E-Mail: Suslow@uni-muenster.de

EAPCN 443

Introduction

Among the most prominent affective deficits especially in chronic schizophrenia are flat affect, a diminished expression of emotion, and anhedonia, a lowered ability to experience pleasure (e. g., Andreasen 1987). Even though flat affect and anhedonia have been conceptualised both as negative symptoms (Andreasen 1982) results from factor analytic studies based on psychiatric rating instruments suggest that they are part of different symptom dimensions (Mueser et al. 1994, Sayers et al. 1996).

Meehl (1962), expanding on the views of Rado (1956), thought that a diminished capacity to experience pleasure was a "quasi-pathognomonic sign" of schizophrenia. According to Meehl's model anhedonia was the expression of a genetic defect in the limbic brain system involved with reward. In the original (1962) and revised (1990) theory of Meehl, anhedonia represents an important contributor to or, in some cases, the result of an "aversive drift" in schizophrenia, i. e., the tendency for activities, and people to take on a burdensome, threatening, negative affective charge. The aversive drift was interpreted as the consequence of an enduring imbalance between appetitive and aversive brain centers.

Research on the impairments of schizophrenia patients to process affective information has focused primarily on conscious or controlled processes. However, according to recent theories of emotion, automatic evaluation of stimulus intrinsic pleasantness lies at the heart of affective processing and determines the fundamental reaction of the organism: pleasurable feelings, generally encouraging approach, versus aversion, leading to withdrawal (Scherer 2001). According to the affective primacy hypothesis (Zajonc 1980, 1994), the affective system concerned with stimulus evaluation is separate and partially independent from the cognitive system concerned with stimulus meaning. This assumption is compatible with recent neurophysiological evidence suggesting that the thalamo-amygdaloid pathways evaluate

stimuli quickly and allow an immediate response without involvement of more complex information processing systems (e. g., LeDoux 1993, Damasio 1994).

To our knowledge, only a few studies exist hitherto that have examined automatic processing of valence or affect information in schizophrenia. Schlenker et al. (1995) examined the affective modulation of the startle reflex in chronic schizophrenia. Patients with flattened affect expression showed modulation effects very similar to those of normal controls. Schizophrenic patients who appeared normal with regard to affective flattening were not influenced by the aversive valence of unpleasant pictures but they exhibited no perceptual abnormalities with regard to pleasant pictures. In the patient sample, affective flattening was positively correlated with the reflex potentiation due to unpleasant stimuli. Furthermore, a negative near-significant relationship was found between self-reported anhedonia and startle-reflex inhibition during exposure to pleasant slides indicating that high anhedonia tended to be associated with a low responsivity to positive valence (Schlenker et al. 1995). In a second study using the affect startle paradigm (Curtis et al. 1999) chronic schizophrenic patients had a pattern of affective modulation of the startle reflex that was comparable to the normal control group which was not consistent with the findings of Schlenker et al. (1995). However, in Curtis et al.'s study no schizophrenia subgroups were examined and no formal symptom rating scales were used.

Recently, Höschel and Irle (2001) examined automatic affective priming effects in partially remitted chronic schizophrenic inpatients who still suffered considerably from positive symptoms. In this experiment negative and positive facial expressions were presented subliminally as primes, followed by a pattern mask and then a face with a neutral expression which was shown for 50 ms as target. Subjects had to judge whether they had seen a pleasant or unpleasant face expression. Schizophrenia patients exhibited a stronger negative judgement shift due to negative primes than normal controls. These results suggest that schizophrenic patients are particularly sensitive for negative facial affect on an automatic processing level – at least in a clinical state characterised primarily by positive symptoms.

The purpose of the present study was to examine automatic perceptual sensitivity to affective information in chronic schizophrenic patients suffering from different affective symptoms. For this aim, an affective priming task was administered to three groups of schizophrenia patients, patients with a flattened affect expression, patients suffering from anhedonia, and schizophrenic control patients not suffering from anhedonia or flat affect, as well as to a group of healthy controls. On the basis of the findings of Schlenker et al. (1995) and Meehl's model of anhedonia (1962, 1990), it was hypothesised that patients with a diminished affect expression should show automatic priming effects due to positive and negative affect stimuli, whereas anhedonic schizophrenia patients should exhibit an automatic priming effect due to negative stimuli but impaired automatic processing of positive affect stimuli (i. e., less or no priming due to positive valence). Finally, schizophrenic patients who appear (nearly) normal with regard to subjective experience of pleasure and affective expression should manifest an automatic priming effect due to positive stimuli but no automatic priming due to negative stimuli. It was predicted that measures of affective flattening and anhedonia are positively associated with automatic priming effects based on negative stimuli. In contrast, measures of anhedonia were expected to be inversely correlated with automatic priming based on positive stimuli. For affective flattening, a positive correlation with automatic priming based on positive stimuli was hypothesised.

Methods

Subjects

Four groups of subjects participated in the study: 30 schizophrenic patients with blunted affect, 30 schizophrenic patients suffering from anhedonia, 28 schizophrenic control patients not suffering from blunted affect and anhedonia, and 30 healthy control subjects (Table 1). All patients fulfilled the criteria for a DSM-IV diagnosis of schizophrenia (American Psychiatric Association 1994). The German version of the Structured Clinical Interview for DSM-IV (SCID-I, Wittchen et al. 1997) was administered to assess psychiatric diagnoses. Subjects with additional Axis I disorders or with severe head trauma, stroke, neurological disease, marked positive symptoms, subnormal intelligence or electroconvulsive therapy (ECT) treatment were excluded. All subjects were between 18 and 57 years, did not suffer from dyslexia, attested to being native speakers of German, and had normal or corrected-to-normal vision. Of the included patients, 29 received medical services at the Department of Psychiatry of the University of Münster, the other 59 patients came from nine other psychiatric clinics or institutions in Münster and its surroundings. All subjects were informed of the nature of the investigation and the procedures involved, and informed consent was obtained. Approval to conduct the study was obtained from the ethics committee at the University of Münster. Patients and healthy controls were paid a fee for their participation. All schizophrenic patients were on neuroleptic treatment at the time of testing and were in a stable period of illness.

Clinical study participants were determined on the basis of a semi-structured screening interview using a psychiatric rating instrument, the Scale for the Assessment of Negative Symptoms (Andreasen 1989). In this scale, the major negative symptoms in schizophrenia are broken down into observable behavioural phenomena and rated on a six-point scale (0–5). Decision on group assignment or exclusion of a subject was based on scores of the SANS subscales "affective flattening" and "anhedonia". The SANS scale "affective flattening" comprises six symptoms: unchanging facial expression, decreased spontaneous movements, paucity of expressive gestures, poor eye contact, affective non-responsivity, and lack of vocal inflections, whereas the SANS scale "anhedonia" includes (four) symptom ratings regarding recreational interests and activities, sexual interest and activity, ability to feel intimacy and closeness, and relationships with friends and peers. A patient was assigned to the flat affect group when he/she had a minimum sum score of 21 on the "affective flattening" scale and a maximum sum score of 8 on the "anhedonia" scale. A patient was included in the anhedonia group when he/she had a minimum sum score of 14 on the "anhedonia" scale and a maximum sum score of 12 on the "affective flattening" scale. That is, the mean item rating was ≥ 3.5 on one scale (i. e., the lowest mean rating of anhedonia or affective flattening was equivalent to a symptom manifestation between "moderate" and "marked" according to the SANS terminology), whereas it was ≤ 2 on the other scale (here the highest mean rat-

Table 1 Demographic and clinical characteristics of study participants

	Anhedonic Schizophrenic Patients		Flat affect Schizophrenic Patients		Schizophrenic Control Patients		Healthy Controls	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	37.1	(9.8)	32.9	(8.4)	35.7	(9.4)	35.5	(8.6)
Education (years)	12.9	(3.2)	14.3	(2.6)	12.9	(2.2)	16.1	(2.6)
Gender (male/female)	20/10		15/15		14/14		15/15	
Months since first hospitalisation	135.5	(114.9)	118.3	(94.9)	128.1	(96.3)		
Lifetime psychiatric hospitalisation (months)	21.5	(34.1)	14.4	(17.6)	14.3	(21.0)		
Neuroleptic dosage (CPZ equivalent)	581.9	(335.2)	587.3	(438.7)	556.1	(327.4)		
Anticholinergic dosage (BZT equivalent)	0.42	(0.51)	0.63	(0.79)	0.28	(0.49)		
Extrapyramidal symptoms (ESE)	3.4	(2.9)	4.7	(3.6)	2.7	(2.9)		
Affective flattening (SANS)[1]	9.2	(2.2)	22.5	(1.3)	3.5	(1.6)		
Anhedonia (SANS)	16.2	(1.5)	5.9	(1.5)	2.9	(1.1)		
SANS sum score	40.0	(6.3)	41.9	(5.4)	14.0	(5.0)		
SAPS sum score	5.5	(6.1)	4.1	(6.2)	2.6	(3.8)		
Neuroleptic medication:								
Typical	5		6		9			
Atypical	21		20		14			
Both	4		4		5			
Employment status:								
University student	1		5		2		12	
Unemployed/retired	28		22		22		8	
Employed	1		3		4		10	

SD standard deviation; *CPZ* Chlorpromazine equivalents; *BZT* Benztropine equivalents; *ESE* Extrapyramidal Symptoms Rating Scale of Simpson and Angus; *SANS* Scale for the Assessment of Negative Symptoms; *SAPS* Scale for the Assessment of Positive Symptoms; *SCID* Structured Clinical Interview for DSM-IV.
[1] SANS scores reflect the mean of the two raters

ing was equivalent to a "mild" symptom manifestation). In this way, two patient groups were formed that suffered predominantly from affective flattening or anhedonia. Finally, the third group consisted of patients with no or minimal symptoms of blunted affectivity and anhedonia according to the SANS. That is, a patient was included in the group without affective negative symptoms when he/she had maximum sum scores of 4 on the "anhedonia" scale and 6 on the "affective flattening" scale (here the highest mean rating was equivalent to "questionable evidence" of anhedonia or affective flattening).

The screening interview was conducted with 149 patients who according to the treating clinicians appeared likely to fit into one of the study groups. Screening sessions lasted about 1 hour and were focused on difficulties in experiencing interest and a lack of involvement in social relationships, on the one hand, and impoverishment of affect expression and reactivity, on the other hand. At the end of the interview patients were rated independently on the SANS scales by an experienced psychiatrist (C. R.) and an experienced clinical research psychologist (T. S.). A patient was included in one of the study groups if the means of the two independent ratings corresponded with one of the above mentioned symptom profiles. Intraclass correlation coefficient interrater reliabilities were > 0.90 for the SANS subscale ratings of anhedonia and affective flattening.

One-way analyses of variance (ANOVAs) revealed that clinical groups did not differ significantly on duration of illness, $F(2,85) = 0.21$, $p = 0.81$, or lifetime duration of psychiatric hospitalisation, $F(2,84) = 0.77$, $p = 0.47$. Clinical groups did not differ regarding chlorpromazine equivalent dose (Laux et al. 2000) of neuroleptic medication, $F(2,85) = 0.06$, $p = 0.95$, or type of neuroleptic medication, $\chi^2(4) = 3.0$, $p = 0.56$. There were marginally significant differences between clinical groups regarding benztropine equivalent dose (de Leon et al. 1994) of anticholinergic medication, $F(2,85) = 2.42$, $p = 0.10$, and on the Extrapyramidal Symptoms Rating Scale of Simpson and Angus (1970), $F(2,75) = 2.78$, $p = 0.07$. According to Tukey HSD post hoc tests flat affect schizophrenia patients tended to exhibit more extrapyramidal symptoms and tended to take a higher dose of anticholinergic medication than schizophrenia patients without affective negative symptoms ($p < 0.10$). Clinical groups differed on the SANS sum score, $F(2,85) = 219.9$, $p \leq 0.001$. Anhedonic and flat affect patients had more negative symptoms compared to patients without affective negative symptoms. Clinical groups did not differ significantly on the SAPS composite or sum score, $F(2,85) = 1.93$, $p = 0.15$.

Control subjects were healthy volunteers responding to advertisements in local newspapers (n = 26) and hospital employees (n = 4). In addition to the general inclusion criteria they met the criterion of no previous psychiatric (or psychotherapeutic) hospitalisations. Control subjects had no personal history of schizophrenic or bipolar disorders, no severe depressive episodes and no first-degree relatives' history of schizophrenic disorders.

No significant differences were found between study groups with respect to age, $F(3,114) = 1.08$, $p = 0.36$, and gender, $\chi^2(3) = 2.5$, $p = 0.48$. However, with regard to educational level the groups differed significantly, $F(3,114) = 9.58$, $p < 0.001$. Results of post hoc tests (Tukey HSD) indicate that healthy subjects had more years of education compared to anhedonic patients and patients without affective negative symptoms ($p < 0.05$) and tended to have more education than flat affect patients ($p < 0.10$). Finally, study groups differed with respect to employment status, $\chi^2(6) = 35.0$, $p < 0.001$), with more unemployed individuals and fewer students in the clinical groups than in the healthy control group.

Affective priming task

The affective priming task consisted of two blocks (block 1 and 2) with subliminally presented (not con-

sciously perceivable) primes and a third block of supraliminally presented (consciously perceivable) primes (block 3). The experimental procedures used here were similar to the experiments 1 and 2 conducted by Murphy and Zajonc (1993).

Stimuli and apparatus

Five happy, five sad, and five neutral faces were selected as affective primes (in each condition, 3 women and 2 men). All faces were monochrome pictures of actors and actresses posing happy, sad, and neutral facial expressions (cf. Erwin et al. 1992). They were photographed against a black backdrop to eliminate all clothing and background distractors. Target masks were 20 Chinese or Chinese-like ideographs, selected as being affectively bland, and ambiguous. Twelve of the ideographs were taken from Zajonc (1968, p.16). Faces and ideographs on the screen had a height of approx. 15 centimetres. Ideographs were drawn in black on a lightish grey background.

Chinese ideographs had been evaluated from an independent sample of non-patients (n = 40) for affective valence on a 7-point scale (from –3 to +3). Ideographs were randomly subdivided in four sets (with five elements) which did not differ in affective valence, $F(3,16) = 0.66$, NS; M_{SetA}: –0.12; M_{SetB}: 0.52; M_{SetC}: 0.20; M_{SetD}: 0.15. The prime faces were representative for their affect expression category as the evaluation ratings of a non-patient sample (n = 24) suggested (cf. Schneider et al. 1994). Facial expressions were rated for happiness and sadness on a 5-point unipolar intensity scale (0–4). For faces with a sad facial expression, mean sadness rating was 2.1, whereas mean joy rating was 0.12. For faces with a happy expression, mean joy rating was 3.1, whereas the mean sadness rating was 0.17. Finally, with neutral faces, mean affect ratings were low (joy: 0.29; sadness: 0.33). Happy faces were judged as significantly happier than neutral faces and sad faces were evaluated as significantly sadder than neutral faces (two-tailed t test; $ps < 0.001$).

Procedure

Subjects were told that the experiment dealt with snap judgements of novel stimuli and that they would be presented with an assortment of Chinese characters. They were to rate on a 6-point scale whether they felt each ideograph represented a good or pleasant object by pressing one of the three positive response buttons (marked with +, ++ and +++) or an unpleasant or bad object by responding with one of the three negative buttons (marked with –, –– and –––) on the keyboard. It was stressed that each ideograph represented an actual object, the implication being that there was a correct answer. Subjects had 3 practice trials at the beginning of the task and before the third block.

The evaluation task consisted of three blocks of 20 ideographs. In the first two blocks facial primes were presented to subjects using a backward-pattern-masking technique, where the facial prime was presented for 16.7 ms, followed immediately by the subsequent presentation of the target (an ideograph) that also served as backward mask (degraded or subliminal exposure condition). To ensure that subjects attended to the screen during the brief subliminal exposure, a fixation cross was projected for 500 ms at the centre of the screen immediately prior to the prime, signalling the start of each trial. On all trials, the Chinese ideographs appeared for 2000 ms.

From block 1 to block 2 assignment of primes to ideograph sets varied systematically: ideographs which were combined with positive primes in block 1 were presented with negative primes in block 2 and vice versa.

In the supraliminal viewing condition (third block), facial primes were shown to the subjects for a 1000 ms duration prior to the onset of the target ideographs which were shown for a period of 2000 ms. Since subjects in this condition could clearly see the primes, they were told before the last block there would be two slides presented on each trial, a face followed by an ideograph. The experimenter stressed that the task remained the same, subjects were to rate quickly only the second slide or ideograph and should not pay attention to the face.

Each prime and target was shown once in a block. Within each block each of the four sets of ideographs were combined with a different prime condition (happy prime, sad prime, neutral prime, or no prime) across subjects. Within each presentation condition facial primes were randomly assigned to target ideographs for each participant. The presentation order of primes and targets was randomised for each test block and participant. A new trial was started with the response to a target. The inter-trial interval was 8 s. Subjects took a 30 s break after each block. The blocks with subliminal presentations always preceded the block with the supraliminal presentation. Ideographs and primes were presented in the centre of an all-black background. The evaluation task had a duration of about 18–20 minutes.

After the second block (after subjects had rated 40 targets) they were questioned as to whether they had noticed anything out of the ordinary and whether they had seen anything just before the Chinese ideograph on the screen.

A Pentium II microcomputer with a super-VGA colour monitor (Belinea, 17") (with a refresh rate of 60 Hz) was used for stimulus presentation. The priming experiment was realised by means of the software package Experimental RunTime System (ERTS; Beringer 1999). An intelligent pre-load algorithm is built into the runtime system managing the image switching process and allowing to realise each onset within one video refresh.

Self-report measures

The Physical Anhedonia Scale and the Social Anhedonia Scale (PAS and SAS; Chapman et al. 1976) were used in their adaptations of Burgdörfer and Hautzinger (1987) to assess a lack of pleasure with respect to physical activities and stimulation or to social interactions. The Beck Depression Inventory (BDI; Beck and Steer 1987) was administered to measure severity of depression at time of testing. The reliability and validity of the German version have been reported by Hautzinger et al. (1995). The State-Trait-Anxiety Inventory (STAI; Spielberger et al. 1970), a measure of anxious emotional and cognitive reactions, was administered in its trait form (German adaptation of Laux et al. 1981).

Procedure

After the screening session clinical subjects participated in a standardised interview in which the SCID-I and self-descriptive instruments were administered. Finally, clinical subjects took part in the experimental testing sessions which were always conducted at the Department of Psychiatry of the University of Münster. Screening, interview, and testing sessions took place on separate days. Non-clinical subjects were only screened and then took part in a single testing session in which they were first given the experimental test battery and then the questionnaires.

Testing sessions were always conducted in a quiet room free from auditory and visual distractions. Room lighting was held constant at 40 lx (measured one meter in front of the monitor). The experimenter was located to the side and somewhat behind the participant. The computer monitor was placed directly in front of the participant with participant's eyes about 90 cm from the screen.

The affective priming task was part of a larger test battery; tests were administered in six counterbalanced orders of presentation; overall duration of testing was about 90 min. Results of the other experimental tasks were not central to the present topic and are reported elsewhere. Between tests subjects had the possibility to take a break.

Statistical analyses

Because evaluation of ideographs was done on a rating scale for which equal distances between any two numbers cannot be assumed analysis of affective priming data was based on nonparametric methods. The Wilcoxon signed-ranks test was used for all groups to assess whether affective priming occurred. The Wilcoxon test utilises not only information about the direction of the differences within pairs but also about the magnitude of the differences. For block 1 and 3, ratings of ideographs primed with neutral faces were compared with ratings of ideographs primed with happy or sad faces. Furthermore, evaluative judgement shifts from block 1 to block 2 due to change of valence of primes were analyzed. A measure of the strength of affective priming was calculated on the basis of the number of positive and negative differences ignoring ties. This measure could vary from –5 (in this case all differences in a block were negative (e. g., judgement (positive prime) < judgement (neutral prime))) to +5 (in this case all differences were positive (e. g., judgement (positive prime) > judgement (neutral prime))). Priming scores with a positive sign indicated a valence-congruent evaluative judgement manipulation. Spearman rank correlation coefficients were calculated to evaluate the relationship between affective priming and self-report and psychopathological measures (two-tailed p if not specified otherwise).

Results

The affective priming task was completed by all subjects. The frequency distribution of judgements (percent) in the affective priming task under the different prime conditions is presented in Table 2. One healthy control with a knowledge of Chinese was excluded. One schizophrenic patient without affective negative symptoms and one anhedonic schizophrenic patient reported seeing something before the ideographs. These clinical subjects were also excluded from the analysis.

Self-report measures

One-way ANOVAs (and Tukey HSD post hoc tests) were conducted to compare variables of affectivity between study groups (Table 3). Anhedonic schizophrenic patients had higher scores of physical anhedonia and social anhedonia than the other study groups. Analysis of the BDI scores indicated that anhedonic schizophrenic patients were more depressed than any of the other study groups. In addition, healthy controls were less depressed than flat affect schizophrenic patients and those without affective negative symptoms. Trait anxiety was higher in anhedonic and flat affect schizophrenic patients than in healthy subjects. Interestingly, flat affect schizophrenic patients and schizophrenic patients without affective negative symptoms did not differ with respect to trait anxiety, physical and social anhedonia, and depressive mood.

Subliminal prime effects (block 1)

According to two-tailed Wilcoxon tests calculated for each group separately, the anhedonic schizophrenic patients evaluated ideographs primed with a masked sad face more negatively than ideographs primed with a

Table 2 Frequency distribution of judgements (percent) in the affective priming task under different prime conditions

Groups	Category	Subliminal conditions					Supraliminal condition		
		1st Block			2nd Block				
		Negative Prime	Neutral Prime	Positive Prime	Negative Prime	Positive Prime	Negative Prime	Neutral Prime	Positive Prime
I. Anhedonia	3	11.0	19.3	13.1	8.3	6.9	5.5	6.9	13.8
	2	21.4	24.1	15.9	22.8	21.4	15.2	11.7	21.4
	1	23.4	21.4	26.2	21.4	21.4	26.2	31.7	26.2
	–1	20.7	17.2	28.3	24.8	24.1	26.9	28.3	18.6
	–2	17.2	11.7	11.0	16.6	20.7	18.6	15.9	13.8
	–3	6.2	6.2	5.5	6.2	5.5	7.6	5.5	6.2
II. Flat Affect	3	16.0	12.0	14.7	12.0	12.7	6.0	7.3	17.3
	2	20.0	24.7	26.0	23.3	20.0	17.3	26.7	26.0
	1	22.0	24.7	24.0	22.0	23.3	21.3	26.7	20.7
	–1	20.7	17.3	13.3	12.0	18.0	26.0	14.7	18.0
	–2	14.0	11.3	16.0	18.7	14.0	20.0	18.0	11.3
	–3	7.3	10.0	6.0	12.0	12.0	9.3	6.7	6.7
III. Control Patients	3	20.0	19.3	24.4	20.0	14.1	11.9	14.8	23.0
	2	23.7	25.9	19.3	22.2	19.3	20.0	18.5	28.1
	1	20.0	20.0	19.3	23.0	23.7	19.3	21.5	19.3
	–1	12.6	14.1	13.3	17.0	15.6	15.6	23.7	12.6
	–2	11.1	10.4	14.8	12.6	13.3	19.3	15.6	10.4
	–3	12.6	10.4	8.9	5.2	14.1	14.1	5.9	6.7
IV. Healthy Controls	3	13.1	8.3	11.0	9.7	9.0	2.1	8.3	9.7
	2	18.6	29.7	29.0	17.2	25.5	18.6	14.5	21.4
	1	24.8	19.3	24.1	25.5	22.1	23.4	31.0	21.4
	–1	18.6	22.8	17.9	26.9	20.7	29.0	22.8	30.3
	–2	17.9	9.7	11.7	17.2	13.1	20.0	20.7	13.8
	–3	6.9	10.3	6.2	3.4	9.7	6.9	2.8	3.4

Table 3 Affectivity of study participants according to self-report measures

	Anhedonic Schizophrenic Patients (1) Mean (SD)	Flat affect Schizophrenic Patients (2) Mean (SD)	Schizophrenic Control Patients (3) Mean (SD)	Healthy Controls (4) Mean (SD)	ANOVA		Significant differences between groups ($p < 0.05$)
					F	*p*	
SAS	10.1 (4.0)	7.1 (4.0)	6.7 (3.6)	5.7 (4.2)	6.8	< 0.001	1 > 2, 3, 4
PAS	6.2 (3.2)	3.8 (2.1)	4.0 (2.1)	2.9 (2.1)	9.7	< 0.001	1 > 2, 3, 4
BDI	16.0 (8.9)	10.9 (6.9)	10.4 (6.1)	5.0 (3.8)	8.0	< 0.001	1 > 2, 3, 4; 2, 3 > 4
STAI Trait	48.7 (10.1)	44.5 (10.3)	42.6 (9.2)	36.6 (8.6)	8.0	< 0.001	1, 2 > 4

SD standard deviation; *SAS* Social Anhedonia Scale; *PAS* Physical Anhedonia Scale; *BDI* Beck Depression Inventory; *STAI Trait* State-Trait-Anxiety Inventory trait form

neutral face, $Z = -3.13$, $p = 0.002$. The other study groups showed no significant priming effects due to subliminally presented sad facial expression. For healthy subjects a significant priming effect due to masked happy faces was found: as inspection of the number of positive and negative differences revealed, in this study group ideographs primed with a happy face were judged as more positive than ideographs primed with a neutral face, $Z = -2.36$, $p = 0.018$. Anhedonic schizophrenic patients exhibited an unexpected effect: ideographs primed with a happy face were judged as more negative than ideographs primed with a neutral face, $Z = -2.81$, $p = 0.005$. For flat affect patients and control patients, no significant priming effect based on positive facial expression was found. A Kruskal-Wallis test indicated that groups did not differ significantly in the evaluative ratings of ideographs primed with neutral facial expression (baseline condition in block 1), χ^2 (3) = 4.65, $p = 0.20$.

Judgement shifts between block 1 and block 2

For healthy controls and flat affect patients valence-congruent judgement shifts due to negative primes were observed: ideographs primed with sad facial expression (in block 2) were evaluated more negatively than they had been evaluated in block 1 when they were primed with happy facial expression, $Z = -3.99$, $p < 0.001$; $Z = -3.08$, $p = 0.002$. Anhedonic patients and control patients showed no shift effects due to negative primes but va-

lence-incongruent shift effects due to positive primes: ideographs primed with happy facial expression in block 2 were evaluated more negatively by these schizophrenic patients than when primed with sad facial expression in block 1, $Z = -2.0$, $p = 0.046$; $Z = -2.64$, $p = 0.008$. For healthy controls and flat affect patients no significant judgement shifts due to positive primes were observed.

Supraliminal prime effects (block 3)

All patient groups showed significant priming effects due to supraliminally presented happy facial expression: ideographs primed with a happy face were judged as more positive than ideographs primed with a neutral face ($ps < 0.05$). In addition, flat affect patients, control patients and healthy controls exhibited a significant or near-significant priming effect due to supraliminally presented negative primes, $Z = -4.54$, $p < 0.001$; $Z = -1.85$; $p = 0.065$; $Z = -3.15$; $p = 0.001$. They evaluated ideographs primed with a sad face as more negative than ideographs primed with a neutral face. Anhedonic schizophrenic patients showed no significant priming effects due to supraliminally presented sad facial expression. A Kruskal-Wallis test indicated that groups did not differ significantly in the evaluative ratings of ideographs primed supraliminally with neutral facial expression (baseline condition in block 3), $\chi^2\ (3) = 3.95$, $p = 0.27$.

Relationships between subliminal affective priming and demographic and clinical characteristics

A Spearman rank correlation analysis conducted on the whole sample yielded no significant correlations between affective priming indices and sociodemographic characteristics (age, gender, and education). In the patient sample affective priming indices did not correlate ($p < 0.05$) with medication (type (typical vs. atypical) and dosage of neuroleptic medication, anticholinergic dosage), extrapyramidal symptoms, duration of illness or lifetime duration of psychiatric hospitalisation or employment status.

Regardless of valence, strength of judgement shifts from block 1 to block 2 due to subliminal priming did not correlate with any of the above mentioned demographic or clinical variables.

Relationships between subliminal affective priming and psychopathological and self-report measures

As expected, the anhedonia subscale score of the SANS was positively correlated with affective priming due to negative faces, $r_s = 0.20$, $p_{1tailed} = 0.034$, and negatively correlated with affective priming due to positive faces, $r_s = -0.21$, $p_{1tailed} = 0.026$. That is, strong anhedonic symptoms were associated with enhanced priming based on sad faces and reduced priming effects based on happy faces. In contrast, the affective flattening subscale score of the SANS correlated neither with affective priming due to negative faces, $r_s = -0.06$, NS, nor with affective priming due to positive faces, $r_s = 0.06$, NS. Equally, no significant correlations were observed between the SANS sum score and the SAPS sum score, on the one hand, and the affective priming indices on the other hand. Affective priming indices did not correlate significantly with the STAI (Trait), the BDI, the SAS, or the PAS.

Strength of judgement shifts from block 1 to block 2 due to subliminal positive primes was found to correlate only with trait anxiety as assessed by the STAI, $r_s = -0.23$, $p = 0.014$. Thus, high trait anxiety was associated with low affective priming due to positive facial affect or, in other words, with an enhanced valence-incongruent shift. None of the other psychopathological or self-report measures was associated with judgement shift priming indices.

Discussion

In the current study the affective priming paradigm of Murphy and Zajonc (1993) was used to assess automatic perceptual sensitivity to affective information in different groups of chronic schizophrenia patients. Among all study groups, only anhedonic schizophrenia patients exhibited automatic priming effects in almost all subliminal presentation conditions suggesting a particular sensitivity to affectively laden material that possibly exceeds that of healthy controls. Anhedonic patients' evaluative judgements of neutral target stimuli were quite consistently a function of subliminal facial affect: sad compared to neutral prime faces produced decreases in evaluative ratings. Happy prime faces produced unexpectedly but consistently negative evaluative shifts. Thus, it appears that on an automatic processing level positive facial affect is perceived by anhedonic patients as aversive or unpleasant.

Schizophrenia patients with a flat affect expression were only found to be responsive to negative valence on an automatic processing level: sad prime faces led to a negative evaluative shift. Finally, schizophrenic patients who appeared (nearly) normal with regard to subjective experience of pleasure and affective expression showed as predicted no automatic priming due to negative stimuli. The only effect exhibited by the latter patients was a valence-incongruent evaluative shift due to subliminal happy facial affect. The present findings parallel in some aspects previous results based on the startle reflex paradigm (Schlenker et al. 1995) that indicate a hyposensitivity to negative valence in schizophrenic patients with a normal affect expression.

Healthy controls' judgements of neutral stimuli were more positive when preceded by subliminal facial expression of joy relative to neutral expression and judge-

ment of these stimuli became more negative after the subliminal exposure of sad facial expression. These findings further support the affective primacy hypothesis, suggesting that evaluative reactions can be elicited with minimal stimulation and alter subsequent cognitions in healthy controls.

The present findings extend those of Höschel and Irle (2001) which show that partially remitted schizophrenic inpatients are sensitive to and even more sensitive to subliminal negative facial affect than normal controls by demonstrating that chronic schizophrenia patients suffering from anhedonia or flat affect are responsive to negative valence on an automatic processing level. The pattern of results found highlights differences in the automatic perceptual sensitivity to affective information between schizophrenia patients groups but also between patients and healthy controls.

First, schizophrenia patients suffering from affective negative symptoms such as anhedonia or flat affect but not schizophrenia patients without these affect symptoms were found to be sensitive to negative facial affect on an automatic processing level. Social withdrawal and avoidance and symptoms of flat affect expression in schizophrenia might develop at least in part as self-protective mechanisms to reduce or avoid aversive stimulation during social interactions or to cope with negative affect states. Among normals, inhibition of one's expressive behaviour is an effective technique for controlling one's feelings (Duclos and Laird 2001).

Second, in none of the schizophrenic patient groups was there evidence for a subliminal valence-congruent priming effect based on positive facial affect. Only healthy controls showed an automatic sensitivity to happy facial affect. These data might indicate a dysfunction of the approach or reward system. In all groups schizophrenia patients exhibited poor occupational or work functioning. Two basic brain systems or circuits have been proposed to mediate different forms of motivation and emotion (e. g., Gray 1994). The approach system facilitates appetitive behaviour and generates approach-related or pregoal attainment positive affect. This type of positive affect is usually generated in the context of moving toward a desired goal (Davidson 2000). It is assumed that the approach system's sensitivity to signals of reward plays a decisive role in the achievement of social and work-related goals (Depue and Collins 1999).

Even though we did not conduct an experimental awareness check for the subliminal priming condition, it appears very unlikely that study participants were aware of the presence of faces in the masked condition. When asked, all study participants negated to have seen anything just before the target stimulus. Esteves and Öhman (1993) examined the detectability of angry and happy facial expression with neutral facial expression masks. When the stimulus onset asynchrony (SOA) was less than 30 ms the masking stimulus tended to completely block recognition of the target stimulus. These results were stable irrespective of whether subjects were highly fearful or nonfearful. In the present study, the SOA was only 16.7 ms followed by a high energy mask (with a duration of 2000 ms) containing graphic information which should have disrupted the identification of the face stimulus. In addition, the different pattern of priming results found in the automatic and the controlled processing condition for positive facial affect suggests that study participants were unaware of the presence of the subliminally presented faces.

Contrary to expectation, flat affect was not observed to be associated with automatic priming effects. Instead, our correlational analysis revealed that anhedonia as assessed by psychiatric rating is related to a subliminal sensitivity to negative facial expression and a valence-inverted perception of positive facial expression. This pattern of results is largely consistent with the predictions derived from Meehl's model of anhedonia (1962, 1990). In his view, an enduring imbalance between impaired appetitive and normally functioning aversive brain centers in the limbic system may lead to an aversive drift in (anhedonic) schizophrenic patients. In this process, people and activities could acquire a general threatening, negative affective charge. Considering that automatic evaluation processes may be one of the first steps to affective experiences as assumed by appraisal models (e. g., Scherer 2001) high depressivity found in anhedonic patients compared to flat affect patients and patients without affective negative symptoms may be due to their automatic responsivity pattern.

An additional explanation for the aversive automatic perception of positive facial expression primarily in anhedonic patients but also in schizophrenic control patients could lie in structural or boundary disturbances concerning the regulation of intimacy and distance (Krause et al. 1989, Scheflen 1981). Other persons' expression of joy may trigger the potential danger of increasing interactive intimacy jeopardising the identity of the schizophrenia patients. There is evidence from a dyadic interaction study (Krause et al. 1992) that in healthy people other's laughter reduces the probability of attributing to him or her negative affects such as anger, contempt, or disgust, whereas it increases the probability in schizophrenia patients. The laughter of the partner had a negative meaning to schizophrenic patients. Thus, schizophrenia patients tend to subsume positive signals such as laughter and smiling under negative intentionality.

The affective priming paradigm appears to be a promising experimental approach that could help to elucidate further the psychological and biological substrate which underlies the affect disturbances in schizophrenia. Future studies administering for example masked verbal (i. e., abstract) information beside masked face expression have to further clarify whether schizophrenic patients exhibit a perceptual valence-inversion that is limited to highly interaction-relevant positive stimuli such as happy facial affect.

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