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ORIGINAL PAPER

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Masked facial affect priming is associated with therapy response in clinical depression

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Abstract In the present study, automatic processing of facial affect in clinical depression was investigated in the course of an inpatient treatment program. Patients suffering from clinical depression (n = 20) and healthy controls (n = 21) completed the facial affective priming task developed by Murphy and Zajonc (1993) twice, about 7 weeks apart. Subjects were instructed to evaluate neutral Chinese ideographs primed by masked displays of sad, happy, and neutral facial affect, including a no-prime condition. In the course of treatment, patients recovered significantly. In acutely depressed patients, no priming based on emotional faces could be found compared to neutral faces at time 1. However, compared to the no-prime condition, negative evaluation shifts elicited by neutral and sad faces were found which were significantly correlated with symptom severity. Patients with persisting high levels of depression after therapy judged ideographs more negatively in all three facial prime conditions at time 1. We conclude that clinically depressed patients are characterized by automatic processing biases for facial affect. An enhanced sensitivity for sad facial expressions and a negatively biased automatic processing of neutral and happy facial affect appears to be associated with depression persistence.

Key words affective priming · emotion · facial expression · amygdala · processing bias

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Introduction

Facial expressions are believed to be a crucial component of social interactions and emotional experience (Blair 2003), making them particularly important for guiding social and motivational activities, and regulating other's behavior. Several authors suggested at least two distinct neural circuits responsible for the processing of facial affect: a subcortical, colliculo-pulvinar pathway to the amygdala that allows for a rapid and unconscious assessment of affect valence, working in parallel with a cortical circuit necessary for conscious emotion processing (e. g., Morris et al. 1999; Adolphs 2002, 2004). Using brief (< 30 ms) and visually masked (sometimes also referred to as "subliminal") displays of facial expressions is a proposed tool for studying quick and unconscious processing of facial affect specifically, whereas tasks involving overt presentations of facial expressions assess controlled processes (Esteves and Öhman 1993). In functional neuroimaging studies using the backward-masking technique, the amygdala has been identified to be a key structure in the automatic, unconscious processing of facial expressions (Whalen et al. 1998; Morris et al. 1999; Nomura et al. 2004; Phillips et al. 2004), while several cortical and subcortical structures were found to be activated during conscious perception of facial affect (Gur et al. 2002; Haxby et al. 2002).

Interestingly, neurobiological models of depression suggest aberrant activation patterns of neural structures that are also responsible for the processing of facial emotions (Phillips et al. 2003b). Amygdala hyperactivity might be the substrate of a biased emotional processing (Whalen et al. 2002), which is a frequent observation in depressed patients (e. g., Gotlib et al. 2004). Sheline et al. (2001) presented happy, neutral, and fearful facial expressions backward-masked by neutral faces to clinically depressed subjects before and after treatment. Within the depressed sample, *all three* masked face conditions produced higher amygdala activity at the intake session that resolved after therapy. Recently, Nomura

et al. (2004) reported that high amygdala activity is associated with a negative evaluation shift for target faces primed by masked displays of negative facial affect.

Beside a range of neuropsychological deficits (e. g., Biringer et al. 2005), several studies found depressed patients to be impaired in encoding of facial expressions of emotions (e. g., Gaebel and Wölwer 2004) as well as in identification and discrimination tasks of facial affect (e. g., Rubinow and Post 1992; Persad and Polivy 1993), which was furthermore reported to be associated with depression severity (Gur et al. 1992). Other researchers using rather short presentation times found a negative processing bias for facial expressions in depressed patients (Surguladze et al. 2004; Leppänen et al. 2004). It has been suggested that a negative bias in facial identification tasks could be a predictor for therapy outcome (Geerts and Bouhuys 1998), relapse (Bouhuys et al. 1999), or symptom persistence (Hale 1998).

Identification and discrimination tasks assess primarily controlled, effortful processing. Little attention has been paid to investigating *automatic*, unconscious emotion processing in depression hitherto. In the present study, we administered the facial affective priming paradigm developed by Murphy and Zajonc (1993) to clinically depressed patients in a longitudinal design in order to investigate the unconscious processing of emotional stimuli indirectly, via their influence on evaluative responses to subsequent neutral stimuli. To date, only one study measured affective priming elicited by subliminally presented facial primes in clinical depression (Koschack et al. 2003). In acutely depressed subjects, Koschack and colleagues reported a reduced sensitivity for subliminally presented positive and negative facial expressions compared to a *neutral-face* baseline. They suggested that the amygdala might have a filter function for subliminally evoked affect. This assumption seems to conflict with recent opinions of the amygdala function (Davis and Whalen 2001), in which the amygdala rather plays a role in the production of (probably negative) "raw" affective states (Phillips et al. 2003a) and attention allocation processes (Whalen et al. 2002). Given recent findings that depression is characterized by a negative response bias for neutral faces (Leppänen et al. 2004) and amygdala hyperactivation in response to masked displays of sad, happy, and neutral expressions (Sheline et al. 2001), which could indicate a negative evaluation shift for all three emotion qualities in a subliminal priming task (Nomura et al. 2004), it may well be that the findings presented by Koschack et al. (2003) do not reflect an *impaired* processing of facial affect, but rather a *biased* processing of the neutral-face baseline. If depressed patients perceive subliminally presented neutral – or even happy – facial primes like negative faces on an automatic level of processing, these neutral faces should also evoke negative evaluation shifts, which in turn would distort any priming effects. To investigate the effect of neutral faces, we added a no-prime condition to the design (cf. Murphy and Zajonc 1993).

A biased processing of facial expressions has been proposed as being a key factor for interpersonal difficulties frequently observed in depressed patients (Gotlib et al. 2004; Suslow and Dannlowski 2005). A major symptom of depression is social withdrawal. Depression seems to be associated with impairments in various aspects of interpersonal functioning, such as social competence or interpersonal problem-solving (Segrin 2000). Between two test sessions, patients underwent an inpatient treatment program, including a high-frequency group psychotherapy for about 7 weeks. If a biased automatic processing of facial affect is indeed associated with social dysfunction, then patients who demonstrate a strong bias at the intake session should benefit less from a therapy approach that involves a high degree of social interaction.

We hypothesize that, in acute depression, patients do not show affective priming compared to a neutral-face baseline. However, we predict that acutely depressed patients show a negative evaluation shift based on negative and neutral (and maybe even happy) faces: patients judge ideographs primed by sad and neutral faces more negatively than unprimed ideographs. Negative evaluation shifts based on facial primes of any emotion quality are hypothesized to be associated with symptom severity. Dysfunctional priming patterns should resolve with symptom improvement.

Healthy controls should demonstrate affective priming based on positive and negative facial primes. We predict that the evaluative ratings in the two baseline conditions (neutral face and no face) do not differ in this group.

Method

Subjects

Our sample comprised 22 depressed patients, ranging in age from 20 to 46 years, admitted to the Department of Psychiatry of the University of Münster. Patients met the criteria for a DSM-IV diagnosis of major depression (APA 1994) assessed by the German version of the Structured Clinical Interview for DSM-IV (SCID-I) (Wittchen et al. 1997). Eleven of the depressed patients were also suffering from a comorbid anxiety disorder (panic disorder, agoraphobia, social phobia, generalized anxiety disorder, or an anxiety disorder not otherwise specified). Subjects with a history of neurological disease, substance abuse, bipolar or psychotic disorder, organic impairments, subnormal intelligence, or electroconvulsive therapy (ECT) were excluded. None of the patients received tricyclic antidepressants or benzodiazepines. At time 1, six patients were unmedicated (three were drug-naïve and three had a wash-out phase). The others were taking mirtazapine 15–45 mg (n = 7), citalopram 20–40 mg (n = 4), venlafaxine 150–225 mg (n = 3), sertraline 50 mg (n = 1) and reboxetine 8 mg (n = 1). At time 2, three patients were still drug-naïve. The others were taking mirtazapine 15–60 mg (n = 8), citalopram 20–60 mg (n = 4), venlafaxine 150–300 mg (n = 4), nefadazone 500 mg (n = 1), reboxetine 8 mg (n = 1) and venlafaxine 300 mg combined with mirtazapine 30 mg (n = 1). Patients were tested at intake and on average after 7 weeks of psychoanalytic-interactional group therapy (M: 50 days; SD: 13). Inpatient psychoanalytic-interactional group therapy is a widespread therapeutic approach in Germany. In contrast to other efficient therapy approaches, e. g., interpersonal therapy (de Mello et al. 2005), psychoanalytic-interactional group therapy was developed specifically for the treatment of structural disorders and involves a

high frequent inpatient group setting. Its efficacy has been documented for depressed patients (Heigl-Evers and Ott 1996; Staats and Rüger 2000). Our setting included four 90-min group therapy sessions per week led by an experienced psychiatrist plus an additional complementary therapy program.

Twenty-two subjects, responding to a public notice about our study, participated as normal controls. Control subjects received a fixed sum for their participation. In addition to the general inclusion criteria, they met the criteria of no previous psychiatric hospitalizations and no personal history of depressive episodes. Patients and controls were matched for gender, age, and time between the two test sessions. All participating subjects had normal or corrected-to-normal vision. Approval to conduct the study was obtained from the ethics committee at the University of Münster. Written informed consent was obtained from all subjects prior to the commencement of the study.

Self-report measures

The Mehrfachwahl-Wortschatz-Intelligenztest (MWT-B) (Lehrl 1995) was administered as an estimate of intelligence by assessing the size of an individual's vocabulary. The Beck Depression Inventory (BDI) (Beck and Steer 1987) was administered to measure severity of depression. The reliability and validity of the German version have been reported by Hautzinger et al. (1995). The State-Trait Anxiety Inventory (STAI), a measure of anxious emotional and cognitive reactions, was administered in its trait form (Laux et al. 1981).

Masked affective priming task

A detailed description of task design, selection of stimuli, and data analysis has been published elsewhere (Suslow et al. 2003). The subliminal affective priming task closely follows the seminal experiments of Murphy and Zajonc (1993, study 1 and 2).

Stimuli and apparatus

Five happy, five sad, and five neutral faces were selected as affective prime stimuli. Target masks were 20 Chinese ideographs, selected as being affectively bland and ambiguous. Faces and ideographs on the screen had a height of approximately 15 cm. 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. The prime faces were representative for their affect expression category as the evaluation ratings of a non-patient sample (n = 24) suggested. Happy faces were judged as significantly happier than neutral faces and sad faces were evaluated as significantly sadder than neutral faces (two-tailed t-tests, $Ps < 0.001$).

A Pentium II microcomputer with a super-VGA color monitor (Belinea, 17″) (with a refresh rate of 60 Hz) was used for stimulus presentation. Presentation and data collection was realized by means of the software package Experimental Run Time System (ERTS) (Beringer 1999).

Procedure

Subjects were told that the experiment dealt with snap judgments of novel stimuli and that they would be presented with an assortment of Chinese characters. They were instructed to rate on a 6-point scale whether they felt each ideograph represented a good or pleasant object by pressing one of three positive response buttons (marked with +, ++ and +++) or an unpleasant or bad object by responding with one of 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 practice trials before the task. 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. In the no-prime condition, only the target ideograph was presented. To ensure that subjects attended to the screen during the brief exposure, a fixation cross was projected for 500 ms at the center of the screen immediately prior to the prime, signalling the start of each trial. On all trials, the Chinese ideographs appeared for 2000 ms.

For each subject, each of the four sets of ideographs was combined with a random prime condition (happy prime, sad prime, neutral prime, or no prime). This combination was used for both testing times. Within each presentation condition, facial primes were randomly assigned to target ideographs for each participant and testing time. The presentation order of primes and targets was randomized for each test session. A new trial was started with response to a target. Ideographs and primes were presented in the centre of an all-black background. The priming task had a duration of about 6 min.

After the task, participants 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.

Procedure

Clinical subjects participated in a standardized interview in which the SCID-I and self-descriptive instruments were administered. Finally, clinical subjects took part in the experimental testing sessions. Interview and testing sessions took place on separate days. Non-clinical subjects were only screened and then took part in the first 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 the participant's eyes about 90 cm from the screen.

The affective priming task was part of a larger test battery, administered in a fixed order of presentation. Overall duration of testing was about 90 min. Between the tests, subjects had the possibility to take a break.

Data preparation and statistical analyses

Analysis of affective priming data was based on nonparametric methods, because the evaluation of the ideographs was done on a rating scale for which equal distances between any two numbers cannot be assumed. Two-tailed Wilcoxon signed-ranks tests were used for each group to assess whether affective priming occurred. Ratings of ideographs primed with neutral faces and ratings of those in the no-prime condition were compared with ratings of ideographs primed with happy and sad faces. Furthermore, ratings of ideographs primed with neutral faces were compared with ratings of ideographs in the no-prime condition.

A measure of the strength of affective priming was calculated on the basis of the number of positive and negative differences ignoring ties (cf. Suslow et al. 2003). This measure could vary from –5 [in this case all differences in a block were negative, e. g., judgment (positive prime) < judgment (neutral prime)] to +5 [in this case all differences were positive, e. g., judgment (positive prime) > judgment (neutral prime)]. Priming scores with a positive sign indicated a valence-congruent evaluative judgment manipulation. In case of the comparison between the neutral-face primes and the no-prime condition, a positive priming score indicated that subjects evaluated ideographs in the no-prime condition more positively than ideographs primed by neutral faces. Spearman rank correlation coefficients were calculated to evaluate the relationship between affective priming and self-report and psychopathological measures (two-tailed).

Results

One patient reported having seen something before the ideographs at time 1 and another patient reported having seen something before the ideographs at time 2. These clinical subjects were excluded from the analysis. Furthermore, one healthy subject was excluded for having some knowledge of Chinese.

To examine the time course of affective characteristics in depressed patients compared to healthy controls, 2 x 2 ANOVAs with group as a between-subjects factor (patients vs. control) and time as a within-subjects factor (time 1 vs. time 2) were calculated for BDI and STAI separately. For both scales, significant main effects of group [Fs(1,39) >49.1, Ps <0.001, and time, Fs(1,39) >18.2, Ps <0.001] were found. In addition, the interactions of group and time were highly significant [Fs(1,39) >12.7, Ps <0.001]. Depression level and trait anxiety were more pronounced in the patient group at both testing sessions, but declined substantially from test 1 to test 2 (see Table 1 for group statistics).

Priming time 1

Healthy control subjects demonstrated priming based on positive primes: control subjects rated ideographs more positively if they were primed by positive faces compared to ideographs primed by neutral faces ($Z=-1.96$, $P=0.050$). Surprisingly, a valence inverted effect of negative primes was observed: ideographs primed by sad faces were judged more positively than ideographs primed by neutral faces ($Z=-3.01$, $P=0.003$). Evaluative ratings in the neutral face condition did not differ significantly from evaluative ratings in the no-face condition ($P>0.1$).

In the patient group, no priming was found for emotional faces compared to the neutral-face condition. However, according to our hypothesis, patients judged ideographs primed by neutral faces significantly more negatively than unprimed ideographs ($Z=-2.18$, $P=0.030$). Ideographs primed by sad facial affect were judged marginally more negatively than unprimed ideographs ($Z=-1.75$, $P=0.080$).

In our sample, most patients had few remaining depressive symptoms at the end of the treatment program, indicated by a BDI-score of 12 or less (n = 14). However, the other six patients reported still high levels of symptoms at the end of the treatment program (BDI-score of 20 or more). Examination of these six patients showed that this subgroup evaluated ideographs consistently more negatively if they were primed by any facial expression, no matter if sad ($Z=-2.75$, $P=0.006$), neutral ($Z=-3.49$, $P<0.001$), or even happy ($Z=-2.69$, $P=0.007$) in comparison to the no-prime condition at time 1 (see Table 2 for frequency distribution of evaluations).

Priming time 2

In healthy controls, no priming based on positive or negative facial affect could be found at time 2, all Ps >0.20. Again, evaluative ratings in the neutral-face condition did not differ significantly from evaluative ratings in the no-face condition.

Depressed patients demonstrated valence-inverted priming based on negative primes, similar to the findings in healthy controls at time 1: patients evaluated ideographs primed by sad faces more positively than ideographs primed by neutral faces ($Z=-3.04$, $P=0.002$). The reversed priming effect based on sad faces was found in the not-remitted subgroup of patients

Table 1 Demographic, clinical, and affective characteristics of depressed patients and control subjects

	Healthy controls (n = 21)	Depressed patients (n = 20)		P-value[b]
Age	32.2 ± 9.7	32.3 ± 8.0		0.98
Education	14.7 ± 1.9	14.1 ± 2.2		0.34
Intelligence (MWT-B)	117.2 ± 11.6	111.6 ± 12.6		0.15
Time between test 1 and 2	49.3 ± 13.1	50.4 ± 13.4		0.81
Sex ratio	14/7	13/7		0.91
Duration of index episode (weeks)		66.4 ± 131.3		
Duration of illness (months)		96.2 ± 96.5		
Duration of lifetime hospitalization (weeks)		13.6 ± 26.5		
		Affective Characteristics		
	Time 1	Time 2	Time 1	Time 2
BDI[a]	3.3 ± 3.0	2.4 ± 2.7	27.1 ± 12.1	14.9 ± 14.1
STAI-T	32.7 ± 6.9	32.2 ± 6.2	59.5 ± 11.1	50.4 ± 11.9

[a] *BDI* Beck Depression Inventory; *STAI-T* State-Trait Anxiety Inventory, trait-version; [b] *T-tests* (df = 39), except sex ratio (Chi^2-test, df = 1)

Table 2 Frequency distribution of judgments (percent) in the affective priming task

		Prime conditions time 1				Prime conditions time 2			
Group	Category	Sad	Neutral	Happy	No prime	Sad	Neutral	Happy	No prime
Patients	3	11.0	7.0	12.0	15.0	19.0	15.0	12.0	3.0
	2	22.0	20.0	20.0	24.0	23.0	16.0	18.0	29.0
	1	14.0	23.0	25.0	16.0	19.0	21.0	25.0	26.0
	–1	24.0	15.0	13.0	18.0	16.0	16.0	17.0	16.0
	–2	18.0	24.0	13.0	16.0	15.0	21.0	15.0	12.0
	–3	11.0	11.0	17.0	11.0	8.0	11.0	13.0	14.0
Controls	3	14.3	11.4	18.1	11.4	15.2	11.4	13.3	8.6
	2	28.6	25.7	23.8	21.0	17.1	26.7	24.8	25.7
	1	22.9	16.2	19.0	27.6	21.9	20.0	21.9	26.7
	–1	16.2	18.1	17.1	21.0	16.2	17.1	17.1	14.3
	–2	14.3	19.0	16.2	13.3	21.9	18.1	16.2	16.2
	–3	3.8	9.5	5.7	5.7	7.6	6.7	6.7	8.6

($Z = -2.70$, $P = 0.007$), as well as in the remitted subgroup ($Z = -2.12$, $P = 0.034$).

Correlation analyses

A Spearman rank correlation analysis conducted on the whole sample yielded no significant correlations between priming indices and sociodemographic characteristics (age, MWT-B-IQ, and years of education). Within the patient sample, no correlations were found between priming indices and total hospitalization time, duration of index episode, and duration of illness.

For the depressed group, correlations were calculated between priming indices and self-report measures (Table 3). Associations were found between priming based on sad facial affect compared to the neutral-face baseline and the severity of symptoms: less affective priming was associated with higher scores in the affect scales. This finding parallels results reported by Koschack et al. (2003), who concluded that acute depression reduces the ability to preactivate emotional concepts. However, according to our hypothesis, examination of priming effects in relation to the no-prime condition yielded a different picture: priming based on sad facial affect at time 1 was positively associated with depression severity and marginally associated with trait anxiety at time 2. Priming based on neutral facial expressions was consistently associated with symptom severity at both testing times: patients who evaluated ideographs primed by neutral faces more negatively than ideographs in the no-prime condition at the initial testing reported significantly more severe symptoms at time 1 and time 2. Negative evaluation shifts elicited by happy faces were also positively associated with symptom severity, though the correlations did not reach significance.

Table 3 Spearman rank correlations between priming indices at time 1 and self-report measures in depressed patients (n = 20)

	S-N	S-U	H-N	H-U	N-U
S-N[a]					
S-U	0.15				
H-N	–0.08	0.23			
H-U	0.18	–0.42(*)	0.64**		
N-U	–0.38(*)	0.76***	0.24	–0.50*	
BDI 1[b]	–0.58**	0.26	–0.03	–0.36	0.53*
BDI 2	–0.23	0.52*	0.14	–0.34	0.52*
STAI-T 1	–0.75***	0.13	–0.01	–0.31	0.52*
STAI-T 2	–0.41(*)	0.41(*)	0.19	–0.28	0.55*

(*) $P < 0.1$; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

[a] *S-N* priming index sad prime (S) compared to neutral prime (N); *S-U* priming index sad prime (S) compared to no prime (U); *H* happy prime

[b] *BDI 1* Beck Depression Inventory at testing time 1; *STAI-T 1* State-Trait Anxiety Inventory, trait-version at testing time 1

To assess the role of antidepressant medication, all medications were coded in terms of treatment duration and dose into medication levels from 1 to 4 for each testing session separately, following the suggestions of Sackheim (2001). Patients with no antidepressant medication were coded as level 0. Spearman rank correlation indices were calculated for priming indices and medication level at both testing times. No significant correlations were found (all $Ps > 0.1$).

We further addressed the role of gender and comorbid anxiety disorder on affective ratings. Mann-Whitney-U-tests were carried out on judgments in the happy, sad, neutral, and no-prime condition. No significant differences between male and female participants and no significant differences between depressed patients with and without comorbid anxiety disorder could be found (all $Ps > 0.05$).

Discussion

The present study investigated the *automatic* processing of facial emotions in clinical depression in the course of an inpatient treatment program. Our findings contradict suggestions that depression is characterized by an *impaired* processing of subliminally presented facial affect (Koschack et al. 2003). It appears that, on an automatic level, especially neutral and in some cases even

happy displays of facial expressions can elicit aversive evaluative responses in acutely depressed patients – something that was found to be especially strong in patients with persisting high levels of depressive symptoms after several weeks of inpatient group psychotherapy. A negative evaluative shift evoked by masked neutral expressions at time 1 was consistently associated with symptom severity at time 1 and time 2. Furthermore, also negative evaluation shifts based on sad facial expressions were positively associated with symptom severity at time 2. In accordance with our hypothesis, we conclude that the present data suggest a *biased* rather than an *impaired* automatic processing of facial affect, especially of neutral faces, supporting findings of Leppänen et al. (2004). It should be noted here that an automatically biased processing of neutral faces could explain null results in other experimental tasks using neutral faces as baseline, e. g., the dot-probe paradigm (Mogg et al. 2000).

Negative evaluative shifts in the facial prime conditions could no longer be found in the patient sample at time 2. Unexpectedly, patients at time 2 as well as controls at time 1 demonstrated *valence-inverted* priming based on sad facial primes instead. However, there are repeated findings in affective priming literature that priming based on subliminal displays of positive emotions is a more robust phenomenon than priming based on negative faces in healthy subjects (e. g., Suslow et al. 2003; Wong and Root 2003). Additionally, reports of reversed affective priming have accumulated in recent literature (Glaser 2003). Possible explanations include automatic overcorrection processes due to the biasing influence of the (negative) prime. In this case, our findings might reflect a "protective bias" in healthy subjects and recovering patients, away from being influenced by negative affective stimuli.

According to neurobiological models of depression, the observation of negative evaluation shifts based on neutral (and in the case of the "non-responders" even happy) faces in the present sample could be the result of a hyperactivated amygdala evoking rudimentary negative affects in response to facial expressions. It has been suggested that amygdala activity modulates emotion perception via projections to the temporal visual cortices (Adolphs 2004). In the case of depressed patients, the perception of other's facial emotions might be negatively colored via the same neural circuits at a very early stage of processing. Corresponding with our findings, subliminal presentations of happy facial affect were reported to evoke complementary facial reactions, as measured by facial electromyography (EMG) in healthy subjects (Rotteveel et al. 2001), whereas subclinically depressed subjects were reported to show a frowning facial expression in response to happy as well as unhappy faces (Sloan et al. 2002).

Our finding that especially "non-responders" show negative evaluation shifts based on facial expressions might be interpreted in terms of disturbed interpersonal functioning. Obviously, an abnormal decoding of facial emotion (e. g., the tendency to interpret neutral facial expressions as negative) may underlie interpersonal problems. Emotional expressions convey information about the sender's mental states, intentions and dispositions, which are critical to social interactions (Fridlund 1994). A biased automatic processing of facial emotions should disturb the course of social interactions and may function as a mediator of rejecting attitudes of others. Frequency of social interactions may decline as a consequence of this impairment to experience other persons' smiles as positive or pleasant. A bias toward a negative interpretation of facial expressions could then generate more stressful interpersonal events. Others may distance themselves from inadequately responsive individuals, who, in turn, could become even more depressed. This might explain why patients with strong negative evaluation shifts seem to benefit less from an interactional group therapy setting.

Certain limitations should be acknowledged. The longitudinal evaluation of the affective state of patients was performed exclusively as a self-assessment, not by a standardized psychiatric rating. Patients were heterogeneous with respect to their antidepressant medication. Coding of drugs into medication levels is only an approximation to assess the effect of medication on automatic processing of facial affect. The valence-inverted priming effect that was recorded in healthy controls at time 1 failed to reach significance in healthy controls at time 2, although the direction of priming was the same. This could have been a problem of statistical power due to our moderate sample size.

However, the masked affective priming task appears to be a promising approach to investigate automatic emotional processing in patient samples. The present findings are supported by data from an ongoing study that combines masked facial affective priming with fMRI in acutely depressed patients (Dannlowski et al. unpublished data). Significant associations have been found between amygdala activation in response to masked displays of positive and negative facial expressions and negative evaluation shifts elicited by the corresponding affect qualities, which, in turn, were associated with depression level and duration of illness.

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