Performance of Depressive and Healthy Participants on an Affective Priming Task Using Word Pronunciation

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Abstract

Objective: The present study attempted to shed further light on processing biases for emotional material in depression using the affective priming procedure.
Methods: Affective priming and affective semantic priming was investigated in 23 healthy and 22 depressed participants using a word pronunciation task.
Results: Significant affective priming emerged, which, however, did not interact with group membership. Affective priming for congruent pairs was equally strong for pairs with and without shared semantic meaning. However, reaction times were shorter for incongruent pairs that were semantically related than for incongruent pairs without semantic overlap. Older age was associated with enhanced affective priming.
Conclusions: It is assumed that affective priming effects in the word pronunciation task are mediated by two routes of spreading activation: a semantic and an affective route. We believe the failure to find differences between our subject groups is mainly attributed to affective interference effects. It seems likely that patients with depression ruminate on the affective properties of the target and doing so may counteract a heightened accessibility of mood-congruent material. We speculate that the robustness of word pronunciation in the present affective priming task (22 ms) is partly attributable to context factors, which have likely increased the emotional salience of the affective material (German J Psychiatry 2006; 9: 1-9).

Keywords: depression, semantic network, priming, affective priming

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Introduction

Affective priming denotes the phenomenon that the response to a valenced target such as *enemy* is facilitated when preceded by a similarly valenced prime such as *poor* in comparison to a word pair in which the affective connotation between prime and target is different (e.g., *love – misery).* Typically, research on the priming of valenced materials has employed pairs of emotionally charged stimuli with no shared semantic properties. Since the initial demonstration of the effect by Fazio and coworkers (Fazio et al. 1986), a large body of studies has replicated the basic effect under various conditions (for reviews see Fazio 2001; Klauer and Musch 2003; Wentura and Rothermund 2003). Affective priming studies have provided valuable insights into the processing of emotional materials by healthy participants and the affective priming paradigm clearly bears the potential to advance our understanding of affective disturbances, most notably depression. However, to our knowledge no study has investigated affective priming in depression so far, and our major objective for the present investigation was to fill this gap.

Affective priming is an independent phenomenon that cannot be equated with semantic priming. Unlike semantic priming effects, spreading of activation within a conventional semantic network is not sufficient to produce affective priming effects as the semantic distance between congruent but semantically unrelated word pairs would soon exhaust the rather short-lived spreading of activation process. From a network perspective, one way to explain the emergence of affective priming is by the assumption of an emotion node (see Bower 1981) that creates a *short-cut* connection among items with the same affective connotation (see for example Rolls and Stringer 2001). According to this line of thinking, affective priming in the example above would result from a spreading of activation from *enemy* via a negative emotion node to other negatively valenced nodes, so that a congruent word such as *poor* becomes pre-activated.

When applying emotional network models (Bower 1981; Ingram 1984; Siegle 1999) to the study of depression, various malfunctions at different sites of the network could produce a processing advantage for negative-valenced materials when a person is in a dysphoric mood state. Such network failures or alterations would also predict differences in affective priming between normal and depressed participants. Of special interest for the present study is the symmetry of affective priming for positive and negative target words in depression, that is, if affective priming is different whether the target is a negatively or a positively valenced word. In depression, the associations of negative-valenced nodes to and from a negative emotion node may be strengthened, thereby predicting that affective priming is especially strong for negative-negative word pairs (e.g., *coffin – unemployed*). The feeling of sadness that is the hallmark of depression may also result from a decrement in the processing of positive information when primed by similarly valenced materials. These two possible accounts of affective priming in depression are not mutually exclusive and may alone or in concert account for mood-congruent memory effects (e.g., Rinck et al. 1992; Williams et al. 1997) as well as for attention biases in depression (e.g., Williams et al. 1996).

In an unpublished pilot study (Moritz et al. 2001) we have utilized a paradigm in which valenced pairs were semantically related (e.g., *hell-heaven*). We gathered preliminary support for the assumption that the *semantic* associations between negatively valenced items are strengthened in depression. Patients with major depression, as opposed to matched healthy control subjects, showed greater priming effects for negative targets when these were preceded by semantically related negative primes (for a similar finding see Scott et al. 2001). Moreover, the flow of information processing in depressive patients relative to healthy controls was facilitated from semantically related positive to negative stimuli (e.g., heaven-hell) but not vice versa. This led us to suspect that the *semantic* network of depressive patients is biased to negative information (emotional *black hole*) regardless of whether the input is positive or negative in valence (see also Beck 1970, p. 285). The pilot experiment, however, was flawed in two ways. First, no appropriate experimental control condition was utilized. Secondly, group differences on priming could not fully be disentangled from differences in the baseline conditions. Therefore, another aim of the present study was to strengthen our preliminary findings by means of an experiment with more rigorous controls.

The present study involved the parallel assessment of affective priming and affective semantic priming to discern whether negative stimuli are more accessible in depression per se or if such a bias is confined to adjacent (i.e., semantically related) concepts. We were also interested in learning whether affective semantic priming would yield surplus-activation due to an additional source of overlap between congruent primes and targets, that is, due to the semantic connection among words.

In the present study we utilized an affective priming task with word pronunciation that was sensitive to automatic information processing (i.e. stimulus onset asynchrony (SOA) = 400 ms). According to Beck (1970) and other researchers (Ingram et al. 1987) automatic processing is of special relevance to the pathogenesis of depression. However, it needs to be acknowledged that studies on mood-congruent effects have yielded conflicting results whether or not depressed patients exhibit problems with automatic or more controlled processing. Whereas mood-congruent memory effects have been more consistently obtained with explicit memory tasks (Denny and Hunt 1992; Watkins et al. 1992; Williams et al. 1997) which are sensitive to controlled processes, a number of studies has also found dysfunctions in the preconscious processing of mood-congruent information (Bradley et al. 1995; Bradley et al. 1996; Scott et al. 2001). Therefore, caution is warranted when making predictions about the performance of depressed patients on an automatic task such as affective priming. Notwithstanding this, based on our initial findings and suggestions from both neurocognitive (e.g., Joormann 2004; Moritz et al. 2005) and neuroimaging studies (e.g., Siegle et al. 2001) that depressed patients are biased towards emotionally charged information relative to neutral information, particularly toward negatively valenced stimuli, we predicted greater facilitation effects for affectively and semantically primed negatively valenced targets in depression.

Although the word pronunciation procedure unlike the evaluation task has produced conflicting findings in affective priming research (Hermans et al. 1994; Bargh et al. 1996; Giner-Sorolla et al. 1999; however see Klauer and Musch 2001), we chose it for two major reasons over the evaluation task. First, word pronunciation allows a rather pure measurement of automatic processes (Neely 1991). Secondly, the adoption of the word pronunciation procedure enabled us to test affective priming and affective semantic priming in a single experimental run, because the word pronunciation procedure, unlike the evaluation procedure, has been validated for the measurement of both affective priming (e.g., Giner-Sorolla et al. 1999) and semantic priming (e.g., Neely 1991).

Method

Participants

The participants were 26 Geman-speaking inpatients who fulfilled diagnostic criteria for major depression or dysthymia. Patients were recruited from the University of Hamburg Hospital for Psychiatry and Psychotherapy. All diagnoses were based on the neuropsychiatric interview (MINI, Sheehan et al. 1998), which relies on DSM-IV criteria. All patients were further assessed with the Hamilton depression scale (Hamilton, 1960). A detailed chart examination revealed a concurrent diagnosis of schizophrenia for two of the patients and a severe brain dysfunction for one patient. These individuals were removed from the sample. Another patient for whom German was a second language was also removed from the sample. The final sample comprising 22 patients (10 males, 12 females) averaged 41.64 (SD = 12.44)

Table 1. Definitions, examples and mean reaction times in ms for pair types. Standard deviations are given in brackets

Pair Type	Example	Healthy (*n* = 23)	Depressed (*n* = 22)
Semantically Related Pairs			
negative – negative	defect - error	717 (225)	709 (182)
positive – positive	hero - courage	715 (232)	717 (183)
negative – positive	ugly - beautiful	686 (179)	677 (163)
positive – negative	good - bad	714 (289)	685 (171)
neutral - neutral	hand - finger	710 (208)	687 (164)
Semantically Unrelated Pairs			
negative – negative	doubt - cage	725 (225)	717 (181)
positive – positive	smart - optimist	718 (232)	714 (188)
negative – positive	threat - perfect	731 (237)	730 (187)
positive – negative	fresh - bankruptcy	752 (265)	752 (220)
Baseline Pairs			
letter-string - negative	xxx - fear	753 (269)	774 (233)
letter-string - positive	xxx - peace	734 (233)	754 (224)
letter-string - neutral	xxx - telephone	745 (237)	769 (214)
Filler Pairs			
negative - neutral	panic - blanket	744 (250)	731 (170)
positive - neutral	holidays - word	708 (201)	700 (189)

years of age, 11.41 (SD = 1.84) years of education, and a Hamilton depression score of 16.95 (SD = 8.22).

By means of advertisement and word-of-mouth, we recruited a group of 24 healthy controls from the general population. One of these subjects was removed because of a history of concussions, leaving a final sample of 23 individuals (6 males, 17 females), with an average of 36.96 (SD = 10.06) years of age and 11.9 (SD = 1.86) years of education. By means of the neuropsychiatric interview, all controls were screened for and found free of psychopathological disturbances or substance abuse. They were also assessed with the Hamilton depression scale and obtained an average a score of 1.48 (SD = 2.89).

Statistical analysis showed that the patient and control samples were not significantly different on age, years of education or gender composition (all $p > 0.15$). All participants gave written informed consent at the start of the experiment. Experiments were carried out in the neuropsychological unit of the Department of Psychiatry at the University Hospital of Hamburg (Germany).

Material

We created 14 items for each of the 14 conditions listed in Table 1, with each item consisting of a prime (the first presented stimulus) and a target (the second presented stimulus). For the three sets of items that were used in the baseline conditions, the prime was always a string consisting of lowercase x's. For all other conditions, the primes and targets were medium frequency German words (average frequency = 22.68 per million), with a maximum of 9 letters (average length = 5.75 letters, SD = 1.38). Conditions did not differ on word frequency or word length ($p > 0.1$).

We used an iterative procedure for selecting prime and target words that were appropriately related and valenced for each experimental condition. First, the first author created a large corpus of pairs, some consisting of two words that were semantically related (e.g., good-bad) while others consisted of unrelated words (e.g., doubt-cage), with primes and targets that were assumed to be affectively neutral, positively valenced or negatively valenced. To validate the pairs, they were randomly arranged in a printed list and presented to an independent group of 11 adult volunteers, mainly students and hospital employees. Each volunteer was asked to read each pair carefully, to rate the paired words for their semantic relatedness, as well as to rate each individual word for its affective valence.

The subjects used different rating scales for each of these tasks. The end-points of the semantic relatedness scale were marked *not at all related* (1) and *strongly related* (7), while the end-points of the affective valence scale were marked *very negative* (-7) and *very positive* (7), a value of 0 designated that a subject considered the item to be emotionally neutral. On the valence scale, words with ratings higher than 1.5 were defined as positive, those with ratings lower than minus 1.5 were defined as negative, and those with ratings between these cut-offs values were considered affectively neutral. We replaced any word or pair if the subjects' ratings were not unanimous (i.e. if the range of ratings placed it in more than one of the preceding categories). This selection procedure was repeated until we had 14 items that met the requirements of each condition.

Our materials preparation procedure yielded a set of positively valenced prime and target word that averaged 4.37 (SD = 1.11) on the rating scale, a set of negatively valenced words with an average rating of -4.41 (SD = 1.10), and a set of neutral words with an average rating of 0.25 (SD = 0.38). Statistical analyses showed no differences between the positively valenced prime and target words, between the negatively valenced prime and target words, or between the neutral prime and target words (all p's were $> .05$). On the semantic relatedness scale, the related pairs achieved an average rating of 5.67 on our 7-point scale, and statistical analyses revealed no difference in relatedness among the 4 types of related pairs listed in Table 1 (all p's > .05). By contrast to the related pairs, the unrelated word pairs received an average rating of 0.2 on our 7-point relatedness scale. Finally, all of the conditions listed in Table 1 had about the same number of words beginning with a plosive letter (e.g., b, p). Conditions did not differ on word frequency or word length (p > 0.1). None of these words was a compound word (e.g., heartbreak).

Procedure

Each participant was tested individually. After obtaining informed consent and psychopathological information, they completed a single session that lasted about 20 minutes. The presentation of all materials was controlled by Superlab®, running on a Macintosh PowerMacintosh computer, equipped with a voice-activated microphone for collecting responses. To familiarize subjects with the procedure and to provide feedback on performance, they completed a set of 14 practice trials prior to the critical trials. Subsequently, we displayed a list of 196 prime-target pairs, 14 pairs from each of the 14 conditions, with items from the different conditions presented in random order. For each trial, a fixation point was displayed for 300 ms in the centre of the screen, followed by a prime word (experimental conditions) or a letter string (baseline conditions) for 250 ms, and finally by a target word that appeared exactly after an inter-stimulus interval of 150 ms. The target remained on the screen until the subject read it aloud, thereby triggering the voice key and blanking the screen. The experimenter then entered a code corresponding to whether the subject's response was correct or incorrect, thereby initiating the next trial.

Subjects were instructed to attend carefully to the prime words, and to read aloud each target word as fast and accurately as possible. They were informed that both performance speed and accuracy were important and would be recorded.

Data Analysis

We used only subjects' correct responses for the statistical analyses reported in this section. All priming effects are expressed as positive values. For computing affective priming scores, we treated the congruent word pairs that were semantically unrelated as the experimental conditions and the incongruent word pairs that were semantically unrelated as the control conditions. For computing affective semantic priming, the four conditions with the valenced prime-target pairs that were semantically related served as the experimental conditions. In turn, we compared performance in these conditions to two kinds of control conditions: to pairs with a similar valence but no semantic relationship (i.e., the four unrelated affective priming conditions), and to items with letter-string primes and valenced targets (i.e. baseline condition items).

We computed semantic priming effect as the difference between related non-valenced conditions from the neutral baseline condition. The two conditions with valenced prime words and non-valenced targets (no semantic relationship) served as filler conditions.

Results

Overall analysis

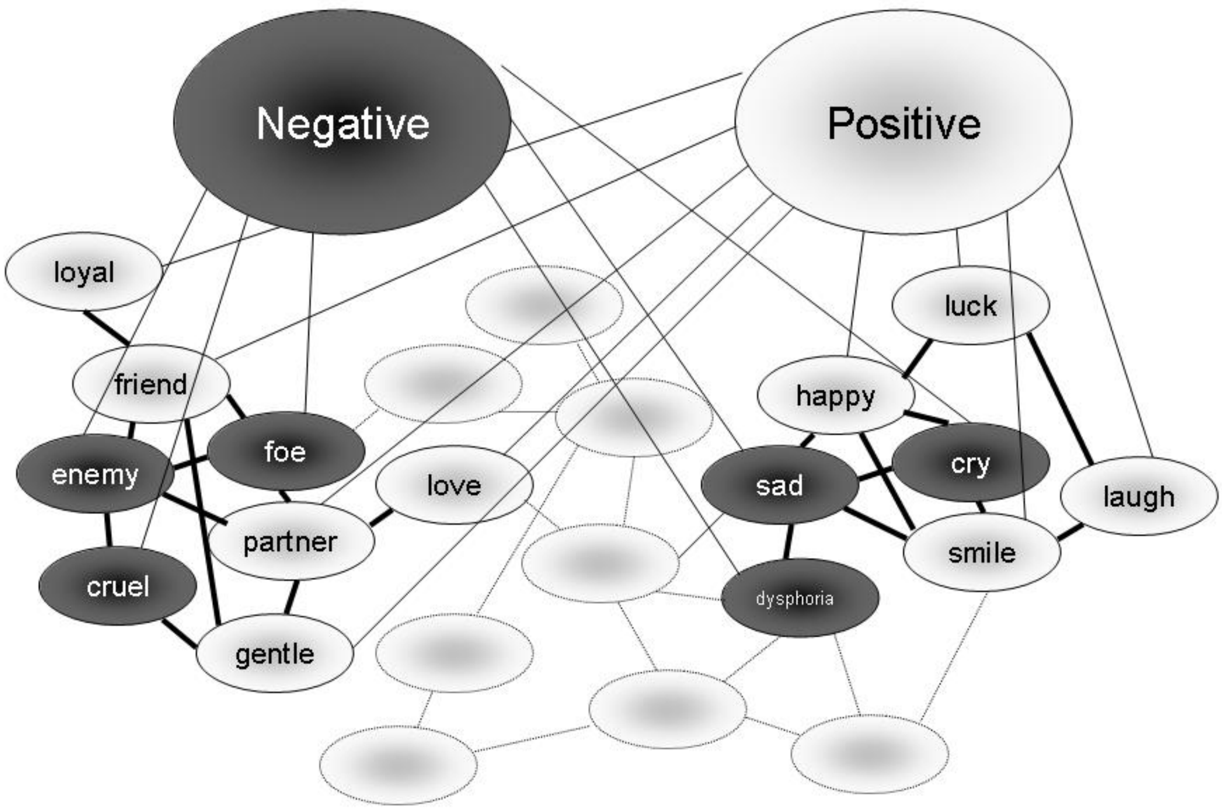
Healthy subjects made significantly fewer errors than depressed patients (3.5% vs. 7.82%; t (43) = 2.40, p = 0.02). In each subject group, errors were evenly distributed across conditions (all comparisons p > 0.1). Prior to carrying out more fine-grained analyses on the reaction time data summarized in Table 1, we performed a 2x2x2x2 ANOVA with Prime Valence (positive, negative), Target Valence (positive, negative) and Relatedness (semantically related, semantically unrelated) as within-subject factors and Group (healthy, depression) as a between-subjects factor. The effect for Relatedness achieved significance, F (1,43) = 24.71, p <0.001, indicating that a semantic priming effect occurred, that is, that subjects were faster in responding to semantically related pairs than to unrelated pairs (703 ms vs. 730 ms). This effect was further qualified by a significant interaction effect between Prime Valence x Target Valence x Relatedness, F (1,43) = 29.47, p <0.001. The three-way interaction is primarily attributable to strong semantic priming effects for incongruent pairs and the absence of semantic priming for congruent pairs (congruent: 4 ms priming; incongruent: 50 ms priming). No other main or interaction effects achieved significance.

Affective priming

To obtain estimates for affective priming we re-ran the above analysis on only the data obtained from the unrelated pairs (i.e. with the Relatedness factor removed). The results of the analysis showed the expected affective priming effect; it revealed a significant interaction effect between Prime Valence x Target Valence, F (1,43) = 16.84, p <0.001. Subjects were faster to respond to targets presented as part of a congruent pair than an incongruent pair (719 vs. 741 ms). The analysis showed no difference in affective priming for positive and negative targets or between subject groups. Although the expected interaction effect did not achieve significance, the results revealed that patients tended to show a greater amount of affective priming for negative targets (depressed: 34 ms priming; healthy subjects: 27 ms priming) relative to positive targets (depressed: 12 ms priming; healthy subjects: 16 ms priming) in comparison to healthy controls. In the analysis, the Target Valence factor achieved significance, F (1,43) = 5.07, p = 0.03, reflecting the overall longer reaction times observed with negative than positive prime words (737 ms vs. 726 ms).

To explore whether affective priming stems from the facilitated processing of congruent words or the slowed processing of incongruent pairs, we computed difference scores for

Figure 1. Emotional network model. Nodes carrying semantic information are interconnected according to semantic distance (i.e., adjacent nodes are semantically related such as in *partner – enemy*). Emotionally laden words are linked together via large emotion nodes (denoted as *positive* and *negative*) which spread activation to equally valenced nodes.



the congruent and incongruent conditions against their baselines (i.e., trials with letter-strings-word items). Post-hoc t-tests showed that the difference between congruent pairs and baseline (35 ms) produced a significant facilitation effect, $t\,(44) = 3.82$, $p = 0.001$, whereas the difference between the incongruent pairs and baseline failed to reach significance (12 ms).

Semantic priming

We conducted a mixed-factors ANOVA with the five related pair conditions (i.e. the semantically related pairs conditions minus the corresponding baseline conditions) as a within-subjects variable and Group as a between-subject variable. Reaction time served as the dependent variable. Except for a marginally significant effect for Group ($p = 0.06$) which reflects overall enhanced semantic priming for depressed patients (70 vs. 35 ms), the analysis showed no significant effects.

Filler trials

Responses were made more slowly to neutral targets preceded by negative primes rather than positive primes, $F\,(1,44) = 3.03$, $p = 0.002$.

Relationship of priming effects with psychopathology and background variables

To control for the increased chance of false-positive relationships between priming effects with psychopathological and background variables, the level of significance was a priori set at $p < 0.01$. Gender, age and years of schooling (total sample) showed no relationship to any of the priming effects (affective priming, total and split for positively and negatively valenced targets, semantic priming). In depressive patients, affective semantic priming for negative-negative words (semantically related condition vs. baseline) was significantly correlated with the HDRS total score ($r = .57$, $p = 0.01$). No other correlations achieved significance.

A previous study (Maier et al. 2003) has reported an inverse relationship between anxiety levels and affective priming. We looked for a similar kind of relationship between affective priming and individuals' scores on the HDRS anxiety subscale (see Pancheri et al. 2002), but it was not significant ($r = .21$, $p > 0.3$).

Discussion

The present study confirms prior research findings (Hermans et al. 1994; Bargh et al. 1996; Giner-Sorolla et al. 1999) that affective priming can be reliably obtained using the word pronunciation procedure. Special attention was devoted to equate corresponding conditions on valence and semantic relationship. Therefore, the obtained affective priming effects are unlikely due to differences of the materials we used in constructing congruent and incongruent pairs (e.g., due to a residual semantic association between prime and target in the congruent conditions), particularly as strong affective priming was obtained for either valence type (i.e., positive and negative targets). The main goal of the present study, to detect differences between depressed and healthy participants on the processing of primed emotional information, was not accomplished. The present discussion, which is divided into three sections, will first attempt to explain the failure to find the expected group differences. Secondly, we deal with possible moderators for the occurrence of affective priming in the word pronunciation task and their impact on the present findings. Finally, we turn to the relationship between affective priming and affective semantic priming. A network model is proposed to account for the present findings.

Group differences on affective priming

Unexpected on the basis of our hypotheses was the result that depressive patients and healthy subjects did not differ on most of the priming effects. At trend level, semantic priming was elevated in depression. While we did not replicate the enhanced priming for negative-negative related words in depression, we found a significant association of this effect with severity of depression. However, these findings were statistically weak precluding any further meaningful interpretation. While problems with power and temporary mood elation in the depressed group (at times patients report that participation in experiments represents a welcome distraction, see also Beblo et al. 2005) cannot entirely be ruled out, we would like to offer a more parsimonious explanation. An article by Siegle et al. (2002a) which came to our attention after planning the current study suggests that dysphoric participants ruminate on the affective content of emotionally charged stimuli. This is thought to divert attention from non-emotional task demands (e.g., lexical decision, word pronunciation). Therefore, while some depressed subjects may have displayed the expected speeded reaction to negative stimuli in response to negative or even positive primes, other depressive subjects may have displayed the reversed pattern due to rumination effects elicited by the display of a valenced target. Hence, both effects may have cancelled each other.

A better methodology for future research might be to present patients with emotional Stroop-targets (i.e., colored words which require the participant to respond according to color; the semantic content of the word is the distractor). The evaluation paradigm may also be applicable. This provides the advantage that both heightened accessibility of negative valenced stimuli as well as rumination on such words predict slowing (Rothermund and Wentura 1998). A step in this direction, however, without manipulating semantic relatedness has already been undertaken. Depressed patients showed slower reaction times for self-descriptive negative Stroop words when these were primed by self- descriptive negative words (Segal et al. 1995).

As outlined in the Introduction, the literature on automatic processing deficits on negatively valenced material is contradictory. Therefore, it cannot be excluded that response biases will only be found with tasks allowing for controlled processing. From this perspective, no differences between depressed affective priming paradigm would be expected for an automatic phenomenon such as affective priming.

Moderators of affective priming

The affective priming effect in the present study was comparatively strong in magnitude (22 ms) relative to prior affective priming studies. Prior research using word pronunciation has yielded a rather mixed pattern of results in normals ranging from significant (Hermans et al. 1994; Bargh et al. 1996; Giner-Sorolla et al. 1999) to zero (e.g., Klauer and Musch 2001) to even inversed affective priming (e.g., Glaser and Banaji 1999). Other studies have found affective priming only in a subsample of participants (Maier et al. 2003) or under certain experimental constraints (De Houwer et al. 2001; De Houwer and Randell 2002; Spruyt et al. 2002). To date, the circumstances under which affective priming in the word pronunciation method occurs are yet not fully uncovered (Klauer and Musch 2003).

We think that emotional salience has contributed to the strong affective priming in our study. We suspect that the surrounding experimental context has raised the salience of the affective component of the stimuli as healthy and depressive subjects were interviewed regarding depressive symptoms and overall psychopathology *prior* to administering the affective priming experiment. Although this assessment was performed simply for the purpose of obtaining estimates of psychopathology, such procedures are often introduced to induce emotional salience (see Siemer and Reisenzein 1998). Moreover, all test sessions were carried out in a psychiatric hospital, which could have further raised the emotional salience of the material. In contrast, previous studies have investigated participants in a more neutral environment (mostly cognitive psychology departments) and have to our knowledge not assessed mood in healthy participants prior to the experiment (e.g., Maier et al. 2003). In such contexts the affective attributes of the stimuli may thus have been less accessible.[1] Emotional salience is known to exert a major impact in certain experimental situations, which may also extend to affective priming. For example, Siemer and Reisenzein (1998) have demonstrated that mood effects on emotional evaluation were only evident under conditions with high emotional salience. Our arguments are compatible with DeHouwer and colleagues who found that under instructions that encouraged deep (semantic) encoding of the prime the affective priming was present, while under instructions that either discouraged deep processing or asked subjects to ignore the prime, null effects occurred (De Houwer et al. 2001; De Houwer and Randell 2002). It is reasonable to assume that such instructions have influenced the accessibility of the prime's affective component.

The results of a recent study (Maier et al. 2003) imply that (subjective) trait anxiety may constitute a possible moderator of affective priming. In Experiment 1 of that study, healthy participants low on anxiety displayed affective priming, whereas high anxiety subjects showed reversed affective priming. In the present study we did not find an association between anxiety (as measured by the HDRS anxiety subscale) and affective priming. However, the anxiety scale employed in our experiment differed from that used by Maier et al. on several respects. First, unlike Maier and coworkers who used a self-report instrument we utilized an expert-rating scale. Secondly, the HDRS scale taps state rather than trait anxiety. In addition, we did not manipulate the extremity of prime words. Maier et al. (2003) found an association only for extreme primes. However, absolute valence of the emotional primes and targets in our study was at least -4 from a minimum of -7 points (extremely negative) and 4 from a maximum of 7 points (extremely positive) which rather corresponds to the extremely valenced condition in the Maier et al. experiment (mean: 1.4 out of 3). At this moment, we can only speculate that procedural differences have contributed to the divergent findings.

Another finding we would like to report is that negative target words led to slower reaction times in the affective priming conditions relative to positive and neutral words. Moreover, negative primes followed by neutral words were accompanied by slower responses relative to positive prime words. According to Pratto and John (1991) this finding can be understood by an attention-grabbing effect of negative valenced words which divert cognitive resources from the primary task (word naming) thereby producing greater slowing (see Moritz et al. 2004, for compatible results).

[1]The dependency of emotion recognition on contextual factors has been noted for example by Bower Bower GH. Commentary on mood and memory. Beh Res Ther 1987;25:443-455. To illustrate, readers of the present sentence, for example, may read the word anxiety without actually feeling fear, while in other contexts (exam; dark street) this word may well evoke negative feelings (see Bower, 1987, p. 444-445).

A network model of affective priming and affective semantic priming

The present study investigated affective priming and affective semantic priming in one experimental run. This enabled us to explore whether semantic overlap between congruent emotional words would enhance the affective priming effect. Interestingly, the magnitude of the affective priming and affective *semantic* priming condition were comparable for *congruent* pairs in both groups. We interpret the present results in terms of a variant of Bower's network model (1981; see also Siegle 1999). It is suggested that valenced stimuli can be accessed via two routes: a semantic and an emotional route (see Figure 1). For congruent word pairs with shared semantic properties, a priming effect is elicited via both the semantic route and the emotional route (perhaps once emotional salience is achieved), whereas for pairs without additional semantic relationship, priming can only be established via the emotional route. Due to parallel activation, one accessible route is apparently sufficient to generate fast priming for congruent but otherwise unrelated pairs (as noted, the difference between semantically related and unrelated congruent word pairs was not significant, i.e. 7 ms). For incongruent pairs, however, a different prediction follows, which is accommodated by the model. Incongruently valenced words that are semantically related can elicit a priming effect via the semantic route. In contrast, for an incongruently valenced pair that is semantically unrelated, neither route is accessible, thus predicting no priming. In agreement with this argument, the difference between semantically related and unrelated incongruently valenced word pairs achieved significance (positive-negative and vice versa).

Comparison of the affective priming with the baseline conditions (xxx-word) revealed that affective priming was due to facilitation of congruent pairs rather than due to inhibition of incongruent pairs since incongruent pairs yielded comparable reaction times as the baseline conditions. This result is predicted from (semantic) network models as inhibitory effects are rather expected for longer SOAs, whereas we used an SOA that is sensitive to automatic information processing (i.e., 400 ms).

While the outlined model is largely built on the spreading of activation metaphor it is conceded that the spreading of activation model entertains several difficulties to integrate a number of findings in the affective priming literature (Klauer and Musch 2003; Wentura and Rothermund 2003). For example, it has been demonstrated that a high percentage of congruent pairs elevates affective priming effects in the evaluation task even at very short SOAs (Klauer and Musch 2001), where according to spreading activation models such strategic processes are unlikely to occur (Neely 1991). Another potential problem refers to the short-lived nature of priming which precludes semantic spreading of activation from a valenced node to any equally valenced node. This, however, can be modeled within an emotional network approach. As outlined, the activation of a positive or negative word cannot reach affectively congruent but unrelated material via the semantic route because the distance between nodes would rather result in inhibition according to the *Mexican hat* function of spreading of activation, whereby close nodes receive high spreading of activation, indirect nodes receive some and remote associations are inhibited (Spitzer 1999). However, assuming that all valenced words are linked together via an emotional node, a direct route between non-semantically related nodes can be imagined (see Figure 1). For anxiety, this emotional node may thereby correspond to the amygdala (LeDoux 2000), while depressive mood has been linked to cortical networks involving the subcallosal cingulate cortex and insula (Phan et al. 2002) as well as the amygdala (Siegle et al. 2002b). Interestingly, a recent study indicates that the amygdala is involved in the memory for both pleasant and unpleasant information (Hamann et al. 1999). Thus, the framework of semantic memory can be applied to the present data set when an additional emotional node is presumed that combines similarly valenced stimuli (for a related network model see Rolls and Stringer 2001).

Finally, we need to acknowledge that the spreading of activation account does not fare well as a meta-theory for affective priming. However, there is yet no theory that can fully integrate all results collected in affective priming research and – somewhat reminiscent of negative priming research (May et al. 1995) - it may well be possible that different procedures may tap different processes (Klauer and Musch 2003; Maier et al. 2003). For example, while affective matching and Stroop-like interference are persuasive to explain affective priming in the affective matching and evaluation task, both approaches have less explanatory power for predicting the occurrence of affective priming in the word pronunciation task. The most parsimonious explanation of affective priming in the latter task is the spreading of activation account (Maier et al. 2003; however see Wentura and Rothermund 2003).

If different affective priming procedures tap different functions it would be instructive to correlate task performance among different affective priming procedures to explore the amount of shared variance. In addition, if spreading of activation is the primary source of the affective priming effect in the word pronunciation task it is predicted that the consistency proportion effect which was found in the evaluation decision task (Klauer and Musch 2001) and which according to network models is unlikely to operate at short SOAs will not be observed in the word pronunciation task.

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