Psychiatry Research 178 (2010) 419–424

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Social anhedonia associated with poor evaluative processing but not with poor cognitive control

Elizabeth A. Martin, John G. Kerns *

Department of Psychological Sciences, University of Missouri, United States

ARTICLE INFO

Article history:
Received 5 January 2009
Received in revised form 27 June 2009
Accepted 27 August 2009

Keywords:
Emotion
Schizotypy
Affective priming
Stroop
Semantic priming

ABSTRACT

Emotion researchers have distinguished between automatic vs. controlled processing of evaluative information. There is suggestive evidence that social anhedonia might be associated with problems in controlled evaluative processing. The current study examined whether college students with elevated social anhedonia would exhibit an increased processing effect on tasks involving either evaluative processing or cognitive control. On an evaluative processing task, affective primes and targets could be either congruent or incongruent and participants judged the valence of targets. On a cognitive control task, participants completed the color-naming Stroop task. Compared to control participants ($n=47$), people with elevated social anhedonia ($n=27$) exhibited an increased evaluative processing effect as they were slower and made more errors for incongruent than for congruent trials on the evaluative processing task. In contrast, there were no group differences on the Stroop task or on a semantic priming task. Overall, these results suggest that people with elevated social anhedonia might have problems with some aspects of evaluative processing.

1. Introduction

Negative symptoms of schizophrenia are associated with poor outcomes (e.g., Mueser et al., 1991) including poor interpersonal and occupational functioning (e.g., Bellack et al., 1990; Ho et al., 1998). One negative symptom is anhedonia, or diminished experience of positive emotion for social and/or physical stimuli (Horan et al., 2006; Wolf, 2006). Anhedonia is evident in the prodrome of schizophrenia (Hafner and an der Heiden, 2003), and social anhedonia has been found to predict the onset of schizophrenia-spectrum disorders (Kwapil, 1998; Gooding et al., 2005). At the same time, anhedonia is not well treated by existing interventions (Horan et al., 2006). Therefore, understanding social anhedonia could provide evidence about the susceptibility for developing schizophrenia (Lenzenweger, 1999) and could also help in the development of new interventions for a treatment-refractory aspect of the disorder.

Given that anhedonia involves decreased self-reported positive emotion, many psychopathologists have hypothesized that anhedonia might involve an emotional deficit (e.g., Berenbaum et al., 1987; Blanchard et al., 1994; Germans and Kring, 2000; Gooding et al., 2002). However, the exact nature of any emotional deficit in anhedonia is still unclear (Horan et al., 2006). Importantly, emotional functioning involves many different mechanisms, such as perception of emotional information, emotion elicitation, and identification of emotions (Feldman Barrett et al., 2007; Kring and Moran, 2008). At the same time, previous research on emotion in people with schizophrenia and in people at-risk for the disorder suggests that only some aspects of emotion might be impaired (Kring et al., 1999; Gard et al., 2007). Hence, it is possible that anhedonia is associated with problems only in certain aspects of emotional functioning.

Among different mechanisms involved in emotion, researchers have suggested a possible distinction between more automatic activation of evaluative information vs. more controlled processing of evaluative information (Ochsner and Gross, 2005; Barrett et al., 2007; Cunningham and Zelazo, 2007; Johnstone et al., 2007). Automatic evaluative processing refers to an implicit attitude system which is “rapid, unconscious and robust across situations” (Cunningham and Zelazo, 2007, p. 97). In contrast, controlled (or reflective) evaluative processes refer to an explicit attitude system which is “slower, conscious and more likely to generate evaluations that vary as a function of current contexts and processing goals” (Cunningham and Zelazo, 2007, p. 97). For example, automatic evaluative processing might be involved in the initial affective reaction to a stimulus. However, controlled evaluative processing might be involved in regulating or modifying automatically elicited affect, such as decreasing negative affect (Ochsner et al., 2004) or increasing positive affect (Larsen et al., 1996). At the same time, controlled evaluative processing might be involved in explicitly identifying emotions (Barrett et al., 2007), especially in the face of ambivalent feelings about an object (Cunningham et al., 2004; Cunningham et al., 2008). Previous research on automatic vs. controlled evaluative processing has found that they appear to involve activity in different brain regions (e.g., amygdala vs. medial prefrontal; Cunningham et al., 2004; Johnstone et al., 2007),

* Corresponding author. 210 McAlester Hall, Columbia, MO, 65211-2500, United States. Tel.: +1 573 882 6860; fax: +1 573 882 7710.
E-mail address: kernsj@missouri.edu (J.G. Kerns).

0165-1781/$ – see front matter
doi:10.1016/j.psychres.2009.08.018

exhibit different time courses (i.e., early vs. late; Cunningham et al., 2005), and are involved in different types of evaluative processing tasks (e.g., unconscious or implicit processing vs. explicit processing, Morris et al., 1998; Cunningham et al., 2004).

One task that involves both automatic and controlled evaluative processing is the primed evaluation task. Similar to the Stroop color-naming task, the primed evaluation task involves both congruent non-interference trials and incongruent high interference trials. On this task (Fazio et al., 1986; Fazio, 2001), participants read a valenced prime word (e.g., 'friendly') and then make an evaluative judgment on a target word (e.g., 'birthday'). When making evaluative judgments, valenced prime words are thought to automatically activate a possible response (e.g., "positive" vs. "negative"). This can produce response facilitation (i.e., faster reaction times (RTs)) if the prime and target are congruent and have the same valence. It can also produce interference (i.e., slower RTs) if the prime and target are incongruent and have different valences. Decreased automatic activation should result in a decreased influence of the prime word on the evaluation of the target (i.e., less difference between congruent and incongruent trials).

In addition to automatic evaluative processing, the primed evaluation task also involves controlled evaluative processing. On this task, the prime (e.g., 'friendly') can interfere and can conflict with the response to the target ('virus'). Hence, just as for incongruent Stroop color-naming trials (e.g., Kerns et al., 2004), the primed evaluation task involves the occurrence of response conflict (Wentura, 2000; De Houwer et al., 2002). Critically, people appear able to engage in relatively controlled evaluative processing in order to counteract interference from the prime, for example, by activating the response that is opposite from the one indicated by the prime. There is evidence that the influence of controlled evaluative processing can occur even at a relatively brief stimulus onset asynchrony (SOA). For example, the response facilitation effect on this task is only clearly evident with a short SOA of 100 ms but not at a slightly longer SOA of 200 ms (Klauer et al., 1997). At even longer SOAs, counteracting the prime results in reverse evaluative processing effects, as participants are actually (i.e., slower when the prime and target are congruent and have the same valence, Klauer et al., 1997; Wentura, 2000; Kerns, 2005). Hence, as in some interference tasks (Machado et al., 2007), on the primed evaluation task with more time between the prime and the target, participants appear to engage in controlled processing to counteract the influence of the prime.

The current study examined the performance of people with elevated social anhedonia on the primed evaluation task to further test whether social anhedonia is associated with diminished automatic or with diminished controlled evaluative processing. The current research focused on people with elevated social anhedonia because previous research has found that they are at increased risk for schizophrenia-spectrum disorders (Kwapil, 1998; Gooding et al., 2005). If people with elevated social anhedonia have diminished automatic evaluative processing, then they should be less influenced by the prime and should exhibit a decreased evaluative processing effect (i.e., performance should be less influenced by whether the prime and target have the same or different valence). In contrast, if people with elevated social anhedonia have impaired controlled evaluative processing, then they should be less likely to attempt to counteract the influence of the prime and should exhibit an increased evaluative processing effect (i.e., increased effect when the prime is incongruent with the target).

If people with elevated social anhedonia exhibit poor controlled evaluative processing on the primed evaluation task, one possibility is that this might be due to poor cognitive control in general. However, previous research has suggested that cognitive and emotional control might be somewhat distinct. For example, they appear to involve distinct regions of the prefrontal cortex (Bush et al., 2000; Ochsner et al., 2004; Zelazo and Cunningham, 2006). Furthermore, there is some evidence that social anhedonia is not associated with poor cognitive control (Kerns, 2006). To examine whether social anhedonia was specifically associated with poor controlled evaluative processing or was generally associated with poor controlled processing, participants in the current study also performed a cognitive control task, the Stroop color-naming task (Stroop, 1935).

In addition to examining evaluative vs. cognitive control, the current research also examined whether performance on the primed evaluation task in social anhedonia might be attributable to semantic processing impairments. On the primed evaluation task, it is possible that a greater influence of the prime on the target could be due to increased semantic spreading activation. Although an effect of semantic priming on the primed evaluation task has not been supported (De Houwer et al., 2002), perhaps such an influence could occur in people with elevated social anhedonia, as some previous research has reported semantic impairments in people at-risk for schizophrenia (e.g., Kerns and Berenbaum, 2000). To examine whether performance by people with elevated social anhedonia could be due to increase semantic priming, participants also completed a semantic priming task (McRae and Boisvert, 1998).

2. Methods

2.1. Participants

Participants were college students attending a large Midwestern public university who received credit for an Introduction to Psychology course for their participation. There were 27 people in the elevated social anhedonia group (14 females, mean age = 18.8, S.D. = 1.2; 26 Caucasian, one African-American) who, following previous research (e.g., Eckblad et al., 1982; Eckblad and Chapman, 1983; L. J. Chapman et al., 1994), scored at least 1.96 S.D. above the same-sex mean on the Social Anhedonia Scale. There were 47 people in the comparison group (30 females, mean age = 18.8, S.D. = 1.1; 43 Caucasian, two African-American, two Asian-American) who scored less than 0.5 S.D. above the mean on Magical Ideation, Perceptual Aberration, and Social Anhedonia Scales. Cut-offs for the Social Anhedonia Scale was obtained from a previous large Midwestern college student sample ($n = 532$, Kerns and Berenbaum, 2000). The two groups did not differ in proportion of female participants, $P > 0.10$. However, given the numerical difference in sex distribution between the two groups, all analyses were conducted using scores that were first standardized within sex.

2.2. Materials

2.2.1. Social Anhedonia Scale

Participants completed the Revised Social Anhedonia Scale (Eckblad et al., 1982), a 40-item true–false questionnaire. Scores on this scale have been found to be strongly associated with other measures of negative schizotypy (Kerns, 2006). In addition, people with elevated social anhedonia have been found to be at increased risk for schizophrenia-spectrum disorders (Kwapil, 1998; Gooding et al., 2005). Participants also completed the Chapman Infrequency Scale (Chapman and Chapman, 1983), which measures careless or invalid responses (e.g., "I cannot remember a time when I talked with someone who wore eyeglasses"). Following previous research (e.g., Chmielewski et al., 1995), participants who endorsed three or more Infrequency Scale items were excluded. No participants were excluded from the Social Anhedonia or comparison groups due to careless/invalid responses on the Chapman Infrequency Scale.

2.2.2. Evaluative processing: Primed evaluation task

This task consisted of positively or negatively valenced prime and target words that appeared in succession on a computer screen. Each prime and target word appeared only once (Klauer et al., 1997). Prime and target words (e.g., positive words: angel, kitten, clothes; negative words: headache, funeral, lice) were selected from previous published norms of affectively valenced words (Anderson, 1968; Silverstein and Dienstbier, 1968; Brown and Ure, 1969; Rubin, 1980; Bellazza et al., 1986; John, 1988; Bargh et al., 1992; Bradley and Lang, 1999). Words in congruent word pairs (i.e., prime and target with the same valence) were matched to words in incongruent word pairs (i.e., prime and target with different valences) on length and frequency. The proportion of prime and target pairs that had the same valence was 0.50. Participants were told to read the first word silently to themselves and then to rate the second word for whether it was a "good" (or "positive") word or a "bad" (or "negative") word. Participants responded with a keyboard press, '1' for good and '2' for bad. After completing 12 practice trials, participants completed 8 blocks of 30 trials each. The 1st, 3rd, 6th, and 8th blocks had a short SOA and the other blocks had a long SOA. Each trial began with a fixation cross for 500 ms, followed by a prime word for either 150 ms (short SOA) or 450 ms (long SOA). Then the target word appeared until a participant made a response. Then the screen was blank for 2000 ms until the next trial. Participants were instructed to respond as quickly and accurately as possible. To insure that participants did not evaluate words in an idiosyncratic manner, participants were given visual feedback when they responded incorrectly. Since very fast or very slow responses are likely spurious (Ratcliff, 1993), trials with RTs less than 200 or greater than 3500 ms were eliminated. Because we used the standard version of the primed evaluation task, which includes only positively and negatively valenced words but does not include neutral prime words (e.g., Bargh et al., 1992; Fazio et al., 1986; Klauer et al., 1997), we could not discriminate between interference vs. facilitation effects. Following previous research (Klauer et al., 1997; Kerns, 2005), the *evaluative processing effect* was measured as the difference in RTs and error rates between congruent trials (i.e., where prime and target have same valence) vs. incongruent trials (i.e., where prime and target have different valences). A single evaluative processing effect variable was created by averaging standardized *z*-scores for RTs and error rates, with higher scores reflecting poorer performance for incongruent trials. Based on previous research (Klauer et al., 1997), if social anhedonia was associated with poor controlled evaluative processing, then it was expected that an increased evaluative processing effect in social anhedonia would be most clearly evident at the 150 ms SOA. This is because with a 150 ms SOA control participants should already have begun to counteract the influence of the prime word (e.g., Klauer et al. reported absence of effects at 200 ms). However, at the 450 ms SOA, the social anhedonia group might then have enough time to be able to counteract the influence of the prime in evaluating the target and therefore no longer differ from control participants in their evaluative processing effect. RTs for each condition by SOA are reported in Table 1. Collapsing across conditions, there were no differences between the groups in baseline RT for either the 150 ms SOA or 450 ms SOA, P's > 0.33.

2.2.3. Cognitive control: Stroop color-naming task

On this task (Stroop, 1935), on each trial participants saw a color word in a printed color (e.g., the word 'RED' in green ink) and needed to respond to the color of the stimulus (e.g., respond green) and ignore the word (e.g., ignore the word 'RED'). Four colors and color words were used as stimuli (red, green, blue, and yellow). Participants responded with a keyboard press (1 for red, 2 for green, 9 for blue, and 0 for yellow) using the second and third fingers of each hand. After practicing color naming (i.e., stimulus was 'XXXX') for 64 trials, participants completed 4 blocks of 32 trials each, with half of all trials being incongruent (i.e., color and word different). The intertrial interval was 400 ms. Stimuli appeared on the screen until participants responded. Participants also received visual feedback when they made an error. Trials with very short (RT < 200 ms) or very long (RT > 3500 ms) RTs and trials on which errors were made were eliminated. The *Stroop effect* was measured as the difference in RTs and error rates between incongruent vs. congruent trials. A single Stroop effect variable was created by averaging standardized *z*-scores for RTs and error rates. Previous functional brain imaging, experimental, and neuropsychological research with this task suggests that it involves cognitive control (Carter et al., 2000; Wentura, 2000; Kane and Engle, 2003; Kerns et al., 2004; Kerns et al., 2008b). As can be seen in Table 1, collapsing across conditions, the two groups did not differ in baseline RT, P's = 0.30.

2.2.4. Semantic priming task

Following the design of McRae and Boisvert (1998), participants decided whether a target word was concrete or abstract (e.g., 'chicken' concrete; 'belief' abstract). Target words were preceded by concrete or abstract prime words. Concrete and abstract words were taken from previous semantic priming studies (McRae et al., 1997; McRae and Boisvert, 1998; Cree and McRae, 2003). After 12 practice trials, participants saw 4 blocks of 30 trials each. The prime-target SOA was 150 ms, with a 2000 ms intertrial interval. One-third of prime-target pairs were semantically related. The *semantic priming effect* was measured as the difference in RTs and error rates between semantically related and unrelated trials. A single semantic priming effect variable was created by averaging standardized *z*-scores for RTs and error rates. Across all participants, there was a significant amount of semantic priming for RTs, t (73) = 2.87, P < 0.01.

Table 1
Means and standard deviations for reaction times on the primed evaluation and Stroop tasks.

	Social anhedonia	Comparison
Primed evaluation task		
150 ms SOA		
P–P	852.1 (181.4)	905.1 (242.2)
N–N	855.3 (166.2)	927.8 (257.2)
P–N	875.5 (163.3)	914.6 (219.6)
N–P	873.9 (159.5)	912.6 (231.7)
450 ms SOA		
P–P	836.5 (168.5)	886.6 (192.9)
N–N	815.8 (136.4)	889.4 (202.9)
P–N	815.7 (140.4)	875.9 (204.9)
N–P	821.5 (143.8)	877.8 (195.1)
Stroop task		
Congruent	745.1 (111.4)	779.1 (139.1)
Incongruent	912.1 (145.2)	953.8 (194.7)
Semantic priming task		
Related	759.1 (141.6)	776.7 (127.7)
Unrelated	785.3 (147.4)	812.5 (172.4)

Note: P–P = positive prime, positive target, N–N = negative prime, negative target, P–N = positive prime, negative target, N–P = negative prime, positive target.

2.3. Procedure

Participants completed the study in the following order: primed evaluation task, Revised Social Anhedonia Scale and Chapman Infrequency Scale, Stroop task, and the semantic priming task.

3. Results

3.1. Evaluative processing effect

As can be seen in Table 2 and in Figs. 1 and 2, the social anhedonia group exhibited a larger evaluative processing effect at a short SOA than comparison participants for both RTs and for error rates, t (72) = 2.39, P < 0.05. This suggests that people with elevated social anhedonia might have poor controlled evaluative processing as they may have been less likely to counteract the influence of the prime than comparison participants.

As can be seen in Figs. 1 and 2, the two groups did not differ in the evaluative processing effect at the long SOA. In addition, as can be seen in Fig. 1, consistent with previous research (Klauer et al., 1997; Kerns, 2005), the comparison participants exhibited a significant reverse priming effect for RTs at the long SOA, t (46) = 2.15, P < 0.05, as they were significantly slower for primes and targets that had the same valence than for primes and targets that had different valences. Hence, as in previous research, there was evidence in this study that participants were attempting to counteract the influence of the prime word.

3.2. Stroop effect

In the previous analysis, there was evidence that social anhedonia exhibited poorer controlled evaluative processing. Next, we examined whether social anhedonia was also associated with poorer cognitive control on the Stroop task. As can be seen in Table 2, the groups did not differ significantly in the size of the Stroop effect, for either RTs or error rates, t (72) = 0.61, P = 0.55. Hence, it does not appear that poor emotional control in social anhedonia can be easily accounted for by poor cognitive control.

3.3. Semantic priming effect

Next, we examined whether social anhedonia, in addition to being associated with an increased evaluative processing effect, was also associated with increased semantic priming. As can be seen in Table 2, the groups did not differ significantly in the amount of semantic priming for either RTs or error rates, t (72) = 0.27, P = 0.79. Thus, it does not appear that the increased evaluative processing effect in social anhedonia can be easily accounted for by increased semantic priming.

Table 2
Overall task performance descriptive statistics for social anhedonia and comparison groups.

Measure	Social anhedonia	Comparison
Evaluative processing short SOA effect		
Reaction time	42.1 (92.1)*	−5.6 (104.5)
Error rates	0.06 (0.08)*	0.01 (0.07)
Stroop cognitive control effect		
Reaction time	167.0 (83.8)	174.7 (103.4)
Error rates	0.10 (0.10)	0.08 (0.07)
Semantic priming effect		
Reaction time	17.6 (67.5)	27.2 (73.3)
Error rates	0.013 (0.058)	0.002 (0.048)

Note: * p < 0.05.

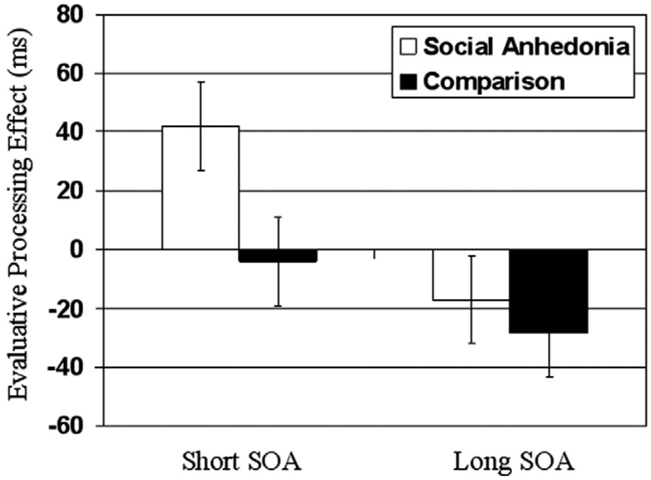

Fig. 1. Reaction time for the evaluative processing effect in milliseconds (ms) at short and long stimulus onset asynchronies (SOA) for people with elevated social anhedonia and comparison participants.

4. Discussion

The current results suggest that people with elevated social anhedonia might exhibit poor controlled evaluative processing. In this study, social anhedonia was associated with an increased evaluative processing effect on the primed evaluation task. In contrast, social anhedonia was not associated with an increased Stroop effect. This suggests that social anhedonia is associated with poor evaluative processing but not with poor cognitive control in general. At the same time, social anhedonia was not associated with increased semantic priming. This suggests that the association between social anhedonia and performance on the primed evaluation task is not likely due to increased semantic priming.

Overall, we think that the most likely interpretation of the association between social anhedonia and an increased evaluative processing effect on the primed evaluation task is that people with elevated social anhedonia have poor controlled evaluative processing. With a 150 ms SOA, comparison participants appeared to already be counteracting the influence of the prime as they did not exhibit a significant evaluative processing effect. This is consistent with research by Klauer et al. (1997) who reported a significant emotional interference effect at an SOA of 100 ms but not at 200 ms. Further evidence in the current study that comparison participants were actively attempting to counteract the influence of the prime is that comparison participants exhibited a significant reverse evaluative processing effect at the 450 ms SOA. In contrast, people with social anhedonia exhibited a significantly larger evaluative processing effect than control participants at the 150 ms SOA. This suggests that people with social anhedonia were less able to rapidly counteract the influence of the emotional prime, consistent with poor controlled evaluative processing. With a 450 ms SOA, people with social anhedonia did not differ from comparison participants on the primed evaluation task, suggesting that with time people with social anhedonia were able to start counteracting the influence of the prime. At the same time, the current results suggest intact automatic evaluative processing in social anhedonia because decreased automatic evaluative processing would have predicted a smaller influence of the prime on the target, which was not found in the social anhedonia group. Thus, consistent with poor controlled evaluative processing, it appears that people with social anhedonia were less able to rapidly counteract the influence of the emotional prime word resulting in increased evaluative processing effect.

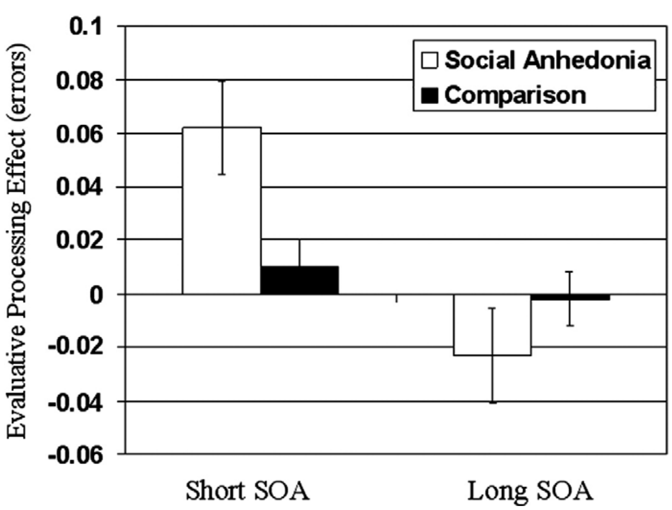

Fig. 2. Error rates for the evaluative processing effect at short and long stimulus onset asynchronies (SOA) for people with elevated social anhedonia and comparison participants.

The current evidence of poor controlled evaluative processing in social anhedonia seems generally consistent with previous research. Previous research involving questionnaires as well as analysis of verbal behavior has suggested that social anhedonia is associated with decreased attention to emotions (e.g., Kerns et al., 2008a), consistent with poor controlled evaluative processing. This is also consistent with research on self-reported emotional experience in schizophrenia in general (not specific to anhedonia), which has not found strong evidence of decreased self-reported emotional experience (e.g., Kring et al., 1999; Cohen and Minor, 2008). Hence, the current results seem generally consistent with previous research on anhedonia suggesting intact automatic but poor controlled evaluative processing.

Although we think that the most likely interpretation of increased evaluative processing effect in social anhedonia is poor controlled evaluative processing, another possible interpretation of the current results is that it reflects increased automatic evaluative processing in social anhedonia. From this view, people with social anhedonia have an intact controlled ability to counteract the influence of the prime word but they exhibit increased evaluative processing effect because they exhibit greater automatic evaluative processing than controls. Hence, they have a stronger initial affective response to the prime compared to controls, resulting in a larger evaluative processing effect at a 150 ms SOA. Although possible, this result seems somewhat improbable given other research on anhedonia. For example, it appears that if anything that emotional experience tends to be diminished in anhedonia and not increased (e.g., Fitzgibbons and Simons, 1992; Kerns et al., 2008a). This makes it less likely that increased evaluative processing on the primed evaluation task in social anhedonia is due to increased automatic evaluative processing.

The current research has found increased evaluative processing at a short SOA on the primed evaluation task in people with elevated social anhedonia which we think is likely due to poor controlled evaluative processing in anhedonia. Regardless of whether our interpretation is ultimately correct, the current results suggest that future research on the primed evaluation task might be helpful in further understanding how social anhedonia might be associated with deficits in specific aspects of emotion functioning (Kring et al., 1999). One issue for future research is to further examine whether associations between social anhedonia and primed evaluation task performance are due to increased automatic evaluative processing or to poor controlled evaluative processing. For example, research could examine even shorter SOAs than those in the current study (i.e., ≤100 ms, Klauer et al., 1997). If social anhedonia is associated with increased automatic evaluative processing, then social anhedonia should be associated with an increased evaluative processing at the shortest SOAs. If social anhedonia is associated with poor controlled evaluative processing, then social anhedonia should only differ from control participants in the evaluative processing effect after the control participants have had some time to begin to counteract the influence of the prime. In addition, future research could also examine whether social anhedonia is associated with poor performance on other controlled evaluative processing tasks to obtain possible converging evidence (Cunningham and Zelazo, 2007), such as the reversal learning modification of the Iowa Gambling task, which involves overcoming previously learned evaluative associations (Turnbull et al., 2006).

Another way to examine automatic and controlled evaluative processing it to specifically assess facilitation vs. interference effects on the primed evaluation task. In the current study, we could not separate facilitation vs. interference effects because we used the standard version of the primed evaluation task which includes only positively and negatively valenced words but does not include neutral words (e.g., Fazio et al., 1986; Bargh et al., 1992; Klauer et al., 1997). Future research could aim to discriminate between interference vs. facilitation effects by modifying the primed evaluation task to include neutral prime words. An interference effect could then be calculated comparing incongruent to neutral prime trials, and a facilitation effect could be calculated comparing congruent to neutral prime trials (e.g., Kane and Engle, 2003). However, based on previous research (Klauer et al., 1997), one potential problem with the inclusion of neutral prime trials is that it might alter the nature of controlled processing on the primed evaluation task. This is because varying the proportion of congruent and incongruent trials has been found to affect evaluative processing effects, with decreasing proportion of incongruent trials presumably decreasing the influence of controlled processing (Klauer et al., 1997). At the same time, future research could intentionally vary the proportion of congruent and incongruent trials to examine whether people with social anhedonia and comparison participants are affected by the proportion of incongruent trials in the same way.

Another way to examine automatic and controlled evaluative processing is to use functional brain imaging. For example, poor controlled evaluative processing might be associated with decreased activity in medial frontal and rostral anterior cingulate regions previously associated with controlled evaluative processing (Cunningham et al., 2004; Johnstone et al., 2007; Cunningham et al., 2008). Future studies could also examine whether decreased controlled evaluative processing is secondary to a deficit in anticipatory pleasure (Gard et al., 2007), which potentially could result in chronic inattentiveness to positive emotional experience.

In the current research, the evidence suggesting poor controlled evaluative processing in elevated social anhedonia is not likely explained by the instructions participants were given on the primed evaluation task. They were told explicitly to decide between "good (positive)" vs. "bad (negative)" judgments. In previous research on the primed evaluation task, researchers have used both good/bad or positive/negative judgments. For example, in the earliest primed evaluation task research, researchers used good/bad judgments (Fazio et al., 1986; Bargh et al., 1992). In some later primed evaluation task research, researchers have used positive/negative judgments (Klauer et al., 1997). Overall, effects have been found on this task using either set of instructions without any evidence of differences between the two types of instructions. In the current research, we used both sets of instructions, telling participants to decide between "good (positive)" vs. "bad (negative)" judgments. Hence, to the extent that good/bad judgments might differ from positive/negative judgments, this might be minimized in our study, but future research should examine whether instructional differences in this task affect results.

Another issue for future research is to examine whether social anhedonia is specifically associated with poor controlled evaluative processing or whether other aspects of schizotypy are also associated with controlled evaluative processing. In another recent study, we have found evidence that only social anhedonia but not positive schizotypy (i.e., odd beliefs and perceptions) is associated with an increased evaluative processing effect on the primed evaluation task (Martin and Kerns, manuscript in preparation). In addition, future work could examine whether anhedonia in people with schizophrenia is also associated with an increased evaluative processing effect. Consistent with this possibility, in other research involving questionnaires and analysis of verbal behavior, we have found evidence of poor controlled evaluative processing in people with schizophrenia (Becker et al., 2007).

A specific deficit in controlled evaluative processing in social anhedonia could have implications for how people with social anhedonia process emotional information in their daily lives. For example, it is possible that decreased controlled evaluative processing in some instances could result in diminished positive affect. For example, it has been found that people with increased affect intensity are more likely to focus on and amplify their feelings (Larsen et al., 1996). Hence, decreased controlled evaluative processing might result in decreased attention to and diminished experience of positive affect in people with anhedonia. At the same time, given evidence that controlled evaluative processing is involved in processing emotionally ambivalent stimuli (Cunningham et al., 2008), poor controlled evaluative processing could help account for increased ambivalence in schizophrenia, which has long been thought to be a central feature of schizophrenia (Bleuler, 1911/1950; Raulin and Brenner, 1993). In addition, as can be seen in Table 1, overall it does not clearly appear that the results for social anhedonia can be interpreted as due to an effect just for pleasant words. For example, for people with social anhedonia, the difference between affectively congruent stimuli vs. affectively incongruent stimuli appears to be virtually identical for both congruent pleasant stimuli and congruent unpleasant stimuli. Potentially, this suggests that social anhedonia may be associated with poor controlled evaluative processing for both positive and negative stimuli, which could affect the regulation of both positive and negative mood states. Hence, future research could examine whether poor controlled evaluative processing in anhedonia is associated with (a) dampened response to positive stimuli, (b) increased ambivalence, and (c) poor regulation of both positive and negative emotions.

In addition to finding evidence suggesting poor controlled evaluative processing in elevated social anhedonia, the current research found evidence that this was not due to poor cognitive control or to increased semantic priming. In the current study, social anhedonia was associated with an increased evaluative processing but not with an increased Stroop effect. These results are consistent with other research finding that social anhedonia is not associated with performance of cognitive inhibition tasks such as the Stroop (Kerns, 2006). Given evidence that regions involved in emotional and cognitive control might be at least somewhat distinct (Cunningham and Zelazo, 2007), this suggests that social anhedonia might be associated specifically with dysfunction in regions involved in evaluative processing. However, although social anhedonia may not be associated with poor cognitive inhibition, other research has found that social anhedonia might be associated with other aspects of complex cognitive abilities, such as poorer working memory (Gooding et al., 2002). The current research also found evidence suggesting that increased evaluative processing in social anhedonia is not likely due to increased semantic priming as social anhedonia was not associated with increased semantic priming. This is consistent with research on schizophrenia which has found that semantic priming is unassociated with negative symptoms (Minzenberg et al., 2003).

References

Anderson, N.H., 1968. Likeableness ratings of 555 personality-trait words. Journal of Personality and Social Psychology 9, 272–279.

Bargh, J.A., Chaiken, S., Govender, R., Pratto, F., 1992. The generality of the automatic attitude activation effect. Journal of Personality and Social Psychology 62, 893–912.

Barrett, L.F., Mesquita, B., Ochsner, K.N., Gross, J.J., 2007. The experience of emotion. Annual Review of Psychology 58, 373–403.

Becker, T.M., Cicero, D.C., Kerns, J.G., 2007. Disorganized Speech, Cognitive Control Components, and Emotion in Schizophrenia. Poster Presented at the Society for Research in Psychopathology, Iowa City, IA.

Bellack, A.S., Morrison, R.L., Wixted, J.T., Mueser, K.T., 1990. An analysis of social competence in schizophrenia. British Journal of Pychiatry 156, 809–818.

Bellazza, F.S., Greenwald, A.G., Banaji, M.R., 1986. Words high and low in pleasantness as rated by male and female college students. Behavior Research Methods, Instruments, & Computers 18, 299–303.

Berenbaum, H., Snowhite, R., Oltmanns, T.F., 1987. Anhedonia and emotional responses to affect evoking stimuli. Psychological Medicine 17, 677–684.
Blanchard, J.J., Bellack, A.S., Mueser, K.T., 1994. Affective and social–behavioral correlates of physical and social anhedonia in schizophrenia. Journal of Abnormal Psychology 103, 719–728.
Bleuler, E., 1911/1950. Dementia Praecox (J. Zinkin, Trans.). International Universities Press, New York.
Bradley, M.M., Lang, P.J., 1999. Affective norms for English words (ANEW): instruction manual and affective ratings. In: Florida, U. (Ed.), Technical Report C-1, The Center for Research in Psychophysiology.
Brown, W.P., Ure, D.M., 1969. Five rated characteristics of 650 word association stimuli. British Journal of Psychology 60, 233–249.
Bush, G., Luu, P., Posner, M.I., 2000. Cognitive and emotional influences in anterior cingulate cortex. Trends in Cognitive Sciences 4, 215–222.
Carter, C.S., Macdonald, A.M., Botvinick, M., Ross, L.L., Stenger, V.A., Noll, D., Cohen, J.D., 2000. Parsing executive processes: strategic vs. evaluative functions of the anterior cingulate cortex. Proceedings of the National Academy of Sciences of the United States of America 97, 1944–1948.
Chapman, J.P., Chapman, L.J., 1983. Reliability and the discrimination of normal and pathological groups. The Journal of Nervous and Mental Disease 171, 658–661.
Chapman, L.J., Chapman, J.P., Kwapil, T.R., Eckblad, M., Zinser, M.C., 1994. Putatively psychosis-prone subjects 10 years later. Journal of Abnormal Psychology 103, 171–183.
Chmielewski, P.M., Fernandes, L.O., Yee, C.M., Miller, G.A., 1995. Ethnicity and gender in scales of psychosis proneness and mood disorders. Journal of Abnormal Psychology 104, 464–470.
Cohen, A.S., Minor, K.S., 2008. Emotional experience in patients with schizophrenia revisited: meta-analysis of laboratory studies. Schizophrenia Bulletin. doi:10.1093/schbul/sbn061.
Cree, G.S., McRae, K., 2003. Analyzing the factors underlying the structure and computation of the meaning of chipmunk, cherry, chisel, cheese, and cello (and many other such concrete nouns). Journal of Experimental Psychology. General 132, 163–201.
Cunningham, W.A., Espinet, S.D., DeYoung, C.G., Zelazo, P.D., 2005. Attitudes to the right- and left: frontal ERP asymmetries associated with stimulus valence and processing goals. Neuroimage 28, 827–834.
Cunningham, W.A., Raye, C.L., Johnson, M.K., 2004. Implicit and explicit evaluation: FMRI correlates of valence, emotional intensity, and control in the processing of attitudes. Journal of Cognitive Neuroscience 16, 1717–1729.
Cunningham, W.A., Van Bavel, J.J., Johnsen, I.R., 2008. Affective flexibility: evaluative processing goals shape amygdala activity. Psychological Science 19, 152–160.
Cunningham, W.A., Zelazo, P.D., 2007. Attitudes and evaluations: a social cognitive neuroscience perspective. Trends in Cognitive Science 11, 97–104.
De Houwer, J., Hermans, D., Rothermund, K., Wentura, D., 2002. Affective priming of semantic categorization responses. Cognition and Emotion 16, 643–666.
Eckblad, M., Chapman, L.J., 1983. Magical ideation as an indicator of schizotypy. Journal of Consulting and Clinical Psychology 51, 215–225.
Eckblad, M., Chapman, L.J., Chapman, J.P., Mishlove, M., 1982. The Revised Social Anhedonia Scale.
Fazio, R.H., 2001. On the automatic activation of associated evaluations: an overview. Cognition and Emotion 15, 115–141.
Fazio, R.H., Sanbonmatsu, D.M., Powell, M.C., Kardes, F.R., 1986. On the automatic activation of attitudes. Journal of Personality and Social Psychology 50, 229–238.
Fitzgibbons, L., Simons, R.F., 1992. Affective response to color-slide stimuli in subjects with physical anhedonia: a three-systems analysis. Psychophysiology 29, 613–620.
Gard, D.E., Kring, A.M., Gard, M.G., Horan, W.P., Green, M.F., 2007. Anhedonia in schizophrenia: distinctions between anticipatory and consummatory pleasure. Schizophrenia Research 93, 253–260.
Germans, M.K., Kring, A.M., 2000. Hedonic deficit in anhedonia: support for the role of approach motivation. Personality and Individual Differences 28, 659–672.
Gooding, D.C., Davidson, R.J., Putnam, K.M., Tallent, K.A., 2002. Normative emotion-modulated startle response in individuals at risk for schizophrenia-spectrum disorders. Schizophrenia Research 57, 109–120.
Gooding, D.C., Tallent, K.A., Matts, C.W., 2005. Clinical status of at-risk individuals 5 years later: further validation of the psychometric high-risk strategy. Journal of Abnormal Psychology 114, 170–175.
Hafner, H., an der Heiden, W., 2003. Course and outcome of schizophrenia, In: Weinberger, D.R. (Ed.), Schizophrenia, 2nd ed. Blackwell, Malden, MA, pp. 101–141.
Ho, B.C., Nopoulos, P., Flaum, M., Arndt, S., Andreasen, N.C., 1998. Two-year outcome in first-episode schizophrenia: predictive value of symptoms for quality of life. American Journal of Psychiatry 155, 1196–1201.
Horan, W.P., Green, M.F., Kring, A.M., Nuechterlein, K.H., 2006. Does anhedonia in schizophrenia reflect faulty memory for subjectively experienced emotions? Journal of Abnormal Psychology 115, 496–508.
John, C.H., 1988. Emotionality ratings and free-association norms of 240 emotional and non-emotional words. Cognition and Emotion 2, 49–70.
Johnstone, T., van Reekum, C.M., Urry, H.L., Kalin, N.H., Davidson, R.J., 2007. Failure to regulate: counterproductive recruitment of top-down prefrontal–subcortical circuitry in major depression. The Journal of Neuroscience 27, 8877–8884.
Kane, M.J., Engle, R.W., 2003. Working-memory capacity and the control of attention: the contributions of goal neglect, response competition, and task set to Stroop interference. Journal of Experimental Psychology: General 132, 47–70.
Kerns, J.G., 2005. Positive schizotypy and emotion processing. Journal of Abnormal Psychology 114, 392–401.
Kerns, J.G., 2006. Schizotypy facets, cognitive control, and emotion. Journal of Abnormal Psychology 115, 418–427.
Kerns, J.G., Berenbaum, H., 2000. Aberrant semantic and affective processing in people at risk for psychosis. Journal of Abnormal Psychology 109, 728–732.
Kerns, J.G., Cohen, J.D., MacDonald III, A.W., Cho, R.Y., Stenger, V.A., Carter, C.S., 2004. Anterior cingulate conflict monitoring and adjustments in control. Science 303, 1023–1026.
Kerns, J.G., Docherty, A.R., Martin, E.A., 2008a. Social and physical anhedonia and valence and arousal aspects of emotional experience. Journal of Abnormal Psychology 117, 735–746.
Kerns, J.G., Nuechterlein, K.H., Braver, T.S., Barch, D.M., 2008b. Executive functioning component mechanisms and schizophrenia. Biological Psychiatry 64, 26–33.
Klauer, K. C., Rossnagel, C., Musch, J., 1997. List-context effects in evaluative priming. Journal of Experimental Psychology. Learning, Memory, and Cognition 23, 246–255.
Kring, A.M., Kerr, S.L., Earnst, K.S., 1999. Schizophrenic patients show facial reactions to emotional facial expressions. Psychophysiology 36, 186–192.
Kring, A.M., Moran, E.K., 2008. Emotional response deficits in schizophrenia: insights from affective science. Schizophrenia Bulletin 34, 819–834.
Kwapil, T.R., 1998. Social anhedonia as a predictor of the development of schizophrenia-spectrum disorders. Journal of Abnormal Psychology 107, 558–565.
Larsen, R.J., Billings, D.W., Cutler, S.E., 1996. Affect intensity and individual differences in informational style. Journal of Personality 64, 185–207.
Lenzenweger, M.F., 1999. Schizophrenia: refining the phenotype, resolving endophenotypes. Behaviour Research and Therapy 37, 281–295.
Machado, L., Wyatt, N., Devine, A., Knight, B., 2007. Action planning in the presence of distracting stimuli: an investigation into the time course of distractor effects. Journal of Experimental Psychology. Human Perception and Performance 33, 1045–1061.
McRae, K., Boisvert, S., 1998. Automatic semantic similarity priming. Journal of Experimental Psychology. Learning, Memory, and Cognition 24, 558–572.
McRae, K., de Sa, V. R., Seidenberg, M. S., 1997. On the nature and scope of featural representations of word meaning. Journal of Experimental Psychology. General. 126, 99–130.
Minzenberg, M.J., Poole, J.H., Vinogradov, S., Shenaut, G.K., Ober, B.A., 2003. Slowed lexical access is uniquely associated with positive and disorganised symptoms in schizophrenia. Cognitive Neuropsychiatry 8, 107–127.
Morris, J.S., Ohman, A., Dolan, R.J., 1998. Conscious and unconscious emotional learning in the human amygdala. Nature 393, 467–470.
Mueser, K.T., Douglas, M.S., Bellack, A.S., Morrison, R.L., 1991. Assessment of enduring deficit and negative symptom subtypes in schizophrenia. Schizophrenia Bulletin 17, 565–582.
Ochsner, K.N., Gross, J.J., 2005. The cognitive control of emotion. Trends in Cognitive Sciences 9, 242–249.
Ochsner, K.N., Ray, R.D., Cooper, J.C., Robertson, E.R., Chopra, S., Gabrieli, J.D., Gross, J.J., 2004. For better or for worse: neural systems supporting the cognitive down- and up-regulation of negative emotion. Neuroimage 23, 483–499.
Ratcliff, R., 1993. Methods for dealing with reaction time outliers. Psychology Bulletin 14, 510–532.
Raulin, M.L., Brenner, V., 1993. Ambivalence. In: Costello, C.G. (Ed.), Symptoms of Schizophrenia. Wiley, New York, pp. 201–226.
Rubin, D.C., 1980. 51 properties of 125 words: a unit analysis of verbal behavior. Journal of Verbal Learning and Verbal Behavior 19, 736–755.
Silverstein, A., Dienstbier, R.A., 1968. Rated pleasantness and association value of 101 English nouns. Journal of Verbal Learning and Verbal Behavior 7, 81–86.
Stroop, J.R., 1935. Studies of interference in serial verbal reactions. Journal of Experimental Psychology 18, 643–662.
Turnbull, O.H., Evans, C.E., Kemish, K., Park, S., Bowman, C.H., 2006. A novel set-shifting modification of the Iowa gambling task: flexible emotion-based learning in schizophrenia. Neuropsychology 20, 290–298.
Wentura, D., 2000. Dissociative affective and associative priming effects in the lexical decision task: yes versus no responses to word targets reveal evaluative judgment tendencies. Journal of Experimental Psychology. Learning, Memory, and Cognition 26, 456–469.
Wolf, D.H., 2006. Anhedonia in schizophrenia. Current Psychiatry Reports 8, 322–328.
Zelazo, P.D., Cunningham, W., 2006. Executive function: mechanisms underlying emotion regulation. In: Gross, J. (Ed.), Handbook of Emotion Regulation. New York, Guilford, pp. 135–158.