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Personality and Individual Differences 28 (2000) 659–672

PERSONALITY AND
INDIVIDUAL DIFFERENCES

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Hedonic deficit in anhedonia: support for the role of approach motivation

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Received 12 October 1998; received in revised form 4 April 1999; accepted 11 May 1999

Abstract

Anhedonia is defined as the diminished capacity to experience pleasure. However, previous research comparing the response of high and low scorers on the Scale for Physical Anhedonia (Chapman, L. J., Chapman, J.P., & Raulin, M.L. (1976). Scales for physical and social anhedonia. *Journal of Abnormal Psychology*, 85 (4), 374–382) to positive emotion-eliciting stimuli has not produced consistent support for hedonic deficit in anhedonia. Basing hypotheses on a neurobehavioral model of positive affect, the present study examined both hedonic experience and the proposed motivational substrates of hedonic experience in anhedonia. Specifically, to examine the linkage between anhedonia, approach motivation, and positive affect, 339 participants completed measures designed to assess these constructs. A subset of these participants, who were either high or low scorers on the Scale for Physical Anhedonia, also rated their affective response to positive, negative, and neutral sensory stimuli. Although anhedonia was associated with diminished general positive affect, diminished intensity of emotional experience, and diminished self-report of approach motivation, it was unrelated to participants' self-report of emotional experience to sensory stimuli. However, a measure of approach motivation was significantly related to self-report of positive emotional experience to sensory cues and stimuli, suggesting that approach motivation may be a better index of hedonic deficit than a commonly used anhedonia measure. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: Anhedonia; Pleasure; Appetitive; Consummatory; Motivation; Emotion

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1. Introduction

Hedonic capacity, or the ability to experience pleasure, is considered a personality characteristic which is normally distributed in the nonclinical population (Meehl, 1975; Myerson, 1923), with anhedonia falling at the lower extreme of this continuum. Anhedonia is a prominent feature of psychiatric disorders such as depression and schizophrenia (Andreasen, 1982; Bleuler, 1950; Kraepelin, 1971/1919; Myerson, 1923) and has been proposed as a risk factor for psychosis in the nondisordered population (Chapman, Edell & Chapman, 1980; Meehl, 1962, 1974, 1975; Rado, Buchenholz, Dunton, Karlen & Senescu, 1956), although there has not been strong empirical support for the link between anhedonia and the development of psychosis (Chapman, Chapman, Kwapil, Eckblad & Zinser, 1994). A number of previous empirical studies have found that high and low scorers on a commonly used measure of anhedonia, the Scale for Physical Anhedonia (SPA; Chapman, Chapman & Raulin, 1976), differ in their reported experience of positive emotion during both emotion-eliciting slides (Ferguson & Katkin, 1996; Putnam & Neale, 1996) and imagery of positive emotional scripts (Fiorito & Simons, 1994). Additional studies have indicated that anhedonic participants manifest impaired processing of positive stimuli, as reflected either by abnormal affective startle eyeblink modulation (Allen, Trinder, Rae & Brennan, 1995; Roedema & Simons, 1994) or by attenuated electrocortical activity in anticipation of a positive stimulus (Pierson, Ragot, Ripoche & Lesevre, 1987; Simons, MacMillan & Ireland, 1982). However, other studies have found no difference between anhedonic and control groups in reported experience of positive emotion (Allen, et al., 1995; Berenbaum, Snowwhite & Oltmanns, 1987) or in affective startle eyeblink modulation in response to positive emotion-eliciting stimuli (Putnam, 1996, personal communication; Roedema & Simons, 1994; Simons, Fitzgibbons & Fiorito, 1993, in: Roedema & Simons, 1994).

These apparently inconsistent findings may be integrated by considering hedonic experience as a function of the engagement of an approach motivational system. Several neurobehavioral models of hedonic experience, explicating the relation between reward and approach motivation, have been proposed to date (e.g. Depue & Iacono, 1989; Gray, 1987; Klein, 1984). Both Gray (1987), Corr, Pickering and Gray (1995) and Depue and Iacono (1989) have proposed that the expectation of reward engenders approach motivation and facilitates goal-directed behavior towards a rewarding stimulus. According to these models, ensuing goal-directed behavior results in engagement with the primary rewarding stimulus (via eating, drinking, sexual, social, or achievement-related behaviors). The activation of the approach motivational system is thought to be linked to individual sensitivity to cues of forthcoming reward. Notably, both Gray and Depue have related approach motivation to dimensions of personality. Gray (1987) has proposed that differences in activation of the behavioral approach system (BAS) may underlie individual differences on personality traits such as impulsivity, while Depue (Depue et al., 1994) has postulated a link between sensitivity to signals of incentive reward and trait positive emotionality.

A third model (Klein, 1984), similar to those of Depue and Iacono (1989) and Gray (1987) holds that the expectation of reward, elicited by a cue or signal of forthcoming reward, itself produces a positive feeling state, or *appetitive* pleasure. This positive emotional feeling state engenders the motivation to approach and pursue the rewarding stimulus. According to Klein, subsequent engagement with the stimulus is thought to produce a second, drive reducing

positive feeling state, or *consummatory* pleasure. In a practical example, the positive emotional experience in anticipation of a delicious dinner (appetitive pleasure) would impel one, workload permitting, to hurry home at the end of the day (approach motivation), enjoy the meal (consummatory pleasure) and feel sated.

Based on these models, several patterns of hedonic deficit may be evident in anhedonia. First, it is possible that anhedonia reflects a deficit in anticipatory or ‘appetitive’ pleasure, resulting in a failure of approach motivation and behavior directed toward obtaining reward. Alternatively, it is possible that anhedonia reflects diminished pleasure from the engagement with a putatively rewarding stimulus (i.e. consummatory pleasure). Lastly, it is possible that both appetitive and consummatory pleasure are deficient in anhedonia.

A re-examination of previous findings in light of these hypotheses provides support for an appetitive pleasure deficit in anhedonia. In Klein’s (1984) model, appetitive pleasure ensues from the pleasurable expectancies and images generated by presentation of a reward cue. Several studies have indicated that anhedonic participants report diminished experience of positive emotion during imagery of positive events or scenes (Fiorito & Simons, 1994; Roedema & Simons, 1994), suggesting that purportedly pleasurable images do not engender the same hedonic experience for anhedonic individuals as for controls. Given the link between pleasurable images and appetitive pleasure, these findings suggest that anhedonic individuals should experience diminished appetitive pleasure as compared to controls. Additional studies suggest that anhedonic individuals differ from controls in their physiological response to reward cues. Several studies comparing cortical activity in anhedonic and control groups indicate that anhedonic participants show a different pattern of electrocortical activity than controls when presented with a cue of a forthcoming rewarding stimulus (Pierson et al., 1987; Simons et al., 1982). Taken together, these empirical findings suggest that anhedonic individuals manifest a deficit in appetitive pleasure. Moreover, previous empirical findings suggest that consummatory pleasure is intact in anhedonia. Most studies examining emotional experience or processing during the presentation (as opposed to imagery or anticipation) of positive emotion-eliciting stimuli have failed to find group differences between anhedonics and controls (Allen et al., 1995; Berenbaum et al., 1987; Putnam & Neale, 1996; Roedema & Simons, 1994; Simons et al., 1993, in: Roedema & Simons, 1994; but see Ferguson & Katkin, 1996). In sum, prior research suggests that anhedonic individuals manifest hedonic deficit when required to imagine or anticipate positive emotional stimuli, but not when they are directly presented with these stimuli.

In the Klein (1984), Gray (1987) and Depue and Iacono (1989) models, approach motivation plays an important role in hedonic experience. Accordingly, anhedonia should be associated with diminished approach motivation, regardless of the particular pattern of appetitive and consummatory pleasure deficit. Research examining animal models of anhedonia provides support for the linkage between anhedonia and diminished approach motivation. For example, Blackburn, Phillips and Fibiger (1987) found that the administration of pimozide (a D1/D2 dopamine receptor antagonist) decreased rats’ entries into a feeding niche to obtain food, but did not affect feeding behavior once the food was presented to the animal. This finding suggests that approach motivation is deficient in the ‘anhedonic’ animals, but consummatory (feeding) behavior remains intact. Similarly, Pfaus and Phillips (1991) found that delivery of any one of several dopamine antagonists (including pimozide and halperidol, a D2 dopamine receptor antagonist) decreased preparatory sexual behaviors in rats but did not affect the

initiation of copulation. These studies support the hypothesis that anhedonia is linked to diminished approach motivation.

The present study sought to clarify the relations between anhedonia, approach motivation and appetitive and consummatory pleasure using self-report measures, as well as a laboratory task designed to assess appetitive and consummatory pleasure. Participants completed questionnaire measures of anhedonia, approach and avoidance motivation, and emotional experience and expressivity. On the basis of their Scale for Physical Anhedonia (SPA) scores, a subgroup of participants were selected to complete a laboratory task in which they rated their emotional experience in response to cues of, and interaction with, positive, negative, and neutral stimuli. This approach to the study of anhedonia is unique in several ways. First, instead of assuming that anhedonia reflects a singular hedonic deficit, both appetitive and consummatory pleasure were examined among anhedonic individuals. Second, the present study examined the relations between sensitivity of an approach motivational system and hedonic experience in anhedonia. Third, responses to positive, negative, and neutral stimuli in several sensory modalities were examined, providing an opportunity to assess possible modality-specific deficits in hedonic experience for anhedonic participants.

Based on findings from previous human and animal studies of anhedonia, it was expected that greater hedonic deficit, as reported on the Scale for Physical Anhedonia, would be linked to diminished approach motivation, but not to avoidance motivation. SPA scores were also expected to be related to the general experience of positive affect, but not to the general experience of negative affect. As predicted from the models of positive affect discussed above, it was expected that diminished approach motivation would be linked to diminished self-report of pleasure to the presentation of both positive cues and stimuli.

Support for a hypothesized appetitive pleasure deficit in anhedonia would be obtained if high scorers on the SPA reported decreased pleasure in response to positive cues (appetitive pleasure) but not to positive stimuli (consummatory pleasure) relative to low SPA scorers. An alternative hypothesis of a deficit in both appetitive and consummatory pleasure would be supported if anhedonic and control groups differed in their responses to both positive cues and stimuli. Support for the hypothesized appetitive pleasure deficit might further elucidate the seemingly contradictory findings of prior examinations of hedonic deficit in anhedonia. That is, if the anhedonic deficit is indeed appetitive and a methodological distinction is not made between appetitive and consummatory pleasure, some studies which in effect tap anticipatory hedonic experience would find differences between anhedonic and control groups, while other studies which tapped consummatory pleasure would not find such differences. A finding of appetitive hedonic deficit in anhedonia might therefore explain why, given that prior studies have not made the appetitive/consummatory distinction, previous findings regarding hedonic deficit in anhedonia have been equivocal.

2. Method

2.1. Participants

A total of 339 undergraduate students were screened using the revised version of the Scale

for Physical Anhedonia (SPA; Chapman et al., 1976). The scale comprises 61 true/false items tapping a wide range of purportedly pleasurable experience involving eating, touching, feeling, sex, movement, smell, and sound, with higher scores indicating greater anhedonia. The SPA has been demonstrated to have adequate construct validity (Peterson & Knudson, 1983) and good internal consistency (Chapman et al., 1976). The SPA was chosen as the measure of anhedonia in the present study for several reasons. First, Chapman et al. (1976) regarded the Scale for Physical Anhedonia (in contrast to the Scale for Social Anhedonia) as more likely reflecting a biological deficit such as that proposed by early anhedonia theorists (e.g. Meehl, 1962, 1974, 1975). Second, Chapman et al. viewed the SPA as less vulnerable than the Scale for Social Anhedonia to response distortion secondary to social desirability. Finally, almost all previous research examining anhedonia in nonclinical populations has utilized the SPA to select anhedonic and nonanhedonic groups. Thus, in order to maximize comparability between the present study and previous work, the SPA was chosen as the measure for participant selection.

To determine membership in the anhedonic and control groups, scores for male and female participants were analyzed separately since previous research suggests that different cutoffs for the dichotomization of anhedonic and nonanhedonic participants may be appropriate for the different sexes (Chapman et al., 1976). Within each group, participants who scored two standard deviations or more above the mean of the same-sex group were considered anhedonic. Participants who scored within 0.25 standard deviations either above or below the mean of the same-sex group were considered nonanhedonic. These cut points are consistent with those adopted in previous studies of anhedonia in the nonclinical population (e.g. Berenbaum et al., 1987; Ferguson & Katkin, 1996). Moreover, they allow for the comparison of individuals of abnormally low hedonic capacity with those with average reported hedonic experience. Utilizing a lower cut point for the control group would select participants with greater than average hedonic capacity, who might in and of themselves constitute another unique subgroup (e.g. hyperhedonics). The mean score on the Scale for Physical Anhedonia was 30.44 (S.D.=3.09) for male anhedonics and 35.63 (S.D.=13.27) for female anhedonics. The mean score on the Scale for Physical Anhedonia was 13.38 (S.D.=1.6) for male nonanhedonics and 9.57 (S.D.=1.81) for female nonanhedonics. Both anhedonic and nonanhedonic control groups were 47% female. Anhedonic ($n = 15$) and nonanhedonic ($n = 15$) groups did not differ in age ($t(28)=1.97$, ns; anhedonic group mean=19.1 (1.1), range=18–21; nonanhedonic group mean=19.9 (1.2), range=19–22). Participants comprising the anhedonic and nonanhedonic groups completed the Scale for Physical Anhedonia for a second time when they returned to complete the laboratory task.

2.2. Questionnaires

All participants completed a series of questionnaires designed to measure approach motivation and trait positive affect, as well as emotional expressivity and the intensity of emotional experience. Measures included the BIS/BAS Scale (Carver & White, 1994), a scale designed to assess the reported sensitivity of approach and avoidance motivational systems. The BAS subscale is thought to index sensitivity to signals of reward, as well as general tendency toward approach motivation. The Positive and Negative Affect Schedule-Extended

Form, General Version (PANAS-X, GEN; Watson & Clark, 1991) was employed as a measure of the degree to which positive and negative emotion are generally experienced. The Emotional Intensity Scale (EIS; Bachorowski & Braaten, 1994) is an index of the intensity with which positive emotion and negative emotion are experienced. Lastly, the Berkeley Expressivity Questionnaire (BEQ; Gross & John, 1995) is designed to measure individual differences in the degree to which positive and negative emotions are expressed.

2.3. Cues and stimuli

Participants in the anhedonic and nonanhedonic subgroups were presented with cues, or written descriptions, of positive, negative, and neutral tactile, gustatory, and visual stimuli. Cues were intended to elicit a positive, negative, or neutral feeling state in anticipation of a sensory experience. An example of a positive gustatory cue was the phrase “a golden-brown, freshly baked, chocolate chip cookie” typed on a laminated index card (a full list of cues and stimuli obtainable from the author). Participants were requested to rate the pleasure/displeasure and the degree of arousal they experienced at the presentation of each cue using a Likert scale (−5 to +5). Participants were then presented with the actual positive, negative, and neutral tactile, gustatory, and visual stimuli. Visual stimuli were 30 (ten each of positive, negative, and neutral) slides from the International Affective Picture System (Lang, Ohman & Vaitl, 1988), presented for a 6 s duration¹. Area of projection of the largest slide was 75 × 48.5 cm, which is comparable to the dimensions of slides used in previous studies (Lang, Greenwald, Bradley & Hamm, 1993). Participants were asked to rate the pleasure/displeasure and degree of arousal they experienced following the presentation of each stimulus.

2.4. Procedure

After receiving both written and oral explanations of the experiment, participants in the anhedonic and nonanhedonic groups ($n = 30$) gave consent by signing a consent form which stated that the purpose of the experiment was to examine the manner in which different people report their likes and dislikes. Participants then completed a questionnaire screening them for allergies or any other physical conditions (e.g. hypertension) which might preclude their participation in one or more parts of the study. Participants completed the Scale for Physical Anhedonia (for the second time) and began the first section of the study. Within each of the three (Tactile, Gustatory, Visual) sections of the study, cues were presented first, followed by stimuli. Participants received both oral and written instructions for rating the cues and stimuli:

In this section of the study you will be presented with descriptions (on index cards) of various materials (cookies/visual images). Please take a moment to read each description, beginning with the one marked (1) on the back. After you have read the first description and thought about it for a moment, please use the rating form provided to rate how much

¹ IAPS slide numbers; positive: 175, 207, 215, 253, 254, 468, 733, 735, 820, 851; neutral: 615, 700, 701, 705, 706, 708, 709, 710, 717, 770; negative: 112, 127, 128, 130, 131, 139, 193, 619, 848, 930.

pleasure you think you would get from feeling the material (tasting the cookie/seeing the image) described to you.

Similar instructions were provided for rating stimuli. Tactile cues and stimuli were always presented first. Tactile stimuli were housed in black boxes to prevent participants from identifying the material they were touching. Gustatory cues and stimuli were presented next. For gustatory stimuli, participants were requested to eat about one third of the cookie presented. Between gustatory stimuli, participants were asked to take a drink of water to cleanse their palate. Visual cues and stimuli were presented last. Each slide stimulus was presented for a 6 s duration, after which the slide carousel advanced to a dark screen and participants made their ratings.

3. Results

3.1. Scale for physical anhedonia

Test–retest reliability for the Scale for Physical Anhedonia was computed by correlating the scores obtained at the initial screening with the scores obtained at the laboratory session. Initial analyses indicated that the correlation coefficient was lower than would be expected ($r = 0.32$, $p = 0.046$). Further inspection of the change in individual participants' scores revealed that the scores of two participants who were classified as anhedonic decreased dramatically from screening to retest (mean change = 47 points). Upon removal of these two participants from the analysis, test–retest reliability of the scale increased ($r = 0.83$,

Table 1
Correlations: anhedonia and measures of motivation, experience and expression of emotion^a

Measure	Scale for Physical Anhedonia
Positive Affect (PANAS-X, GEN)	−0.33**
Negative Affect (PANAS-X, GEN)	0.11
BAS (total)	−0.40**
Reward Responsiveness	−0.31**
Fun Seeking	−0.33**
Drive	−0.20**
BIS	−0.04
BEQ	
positive	−0.33**
negative	−0.22**
EIS	
positive	−0.42**
negative	−0.19**

^a ** $p < 0.001$; Correlations are Spearman Rank-Order; BAS = Behavioral Activation Scale; BIS = Behavioral Inhibition Scale; BEQ = Berkeley Expressivity Questionnaire; EIS = Emotional Intensity Scale.

Table 2

Mean ratings on positive, negative and neutral tactile, gustatory and visual cues and stimuli

Group	Cues			Stimuli		
	positive	neutral	negative	positive	neutral	negative
<i>Tactile</i>						
Anhedonic	8.7 (1.2)	5.9 (0.43)	4.1 (1.0)	8.5 (1.2)	6.1 (0.43)	4.5 (1.8)
Control	9.0 (0.74)	6.0 (0.61)	3.9 (1.2)	8.8 (0.88)	6.4 (0.70)	4.0 (1.2)
<i>Gustatory</i>						
Anhedonic	9.7 (1.2)	4.2 (2.3)	2.0 (1.0)	9.5 (1.1)	6.2 (2.2)	2.2 (2.1)
Control	9.1 (1.5)	4.4 (1.3)	2.3 (0.85)	9.7 (0.99)	6.8 (1.6)	1.8 (0.70)
<i>Visual</i>						
Anhedonic	8.2 (1.0)	5.7 (0.62)	3.5 (1.3)	8.2 (1.1)	5.7 (0.73)	3.4 (1.1)
Control	8.5 (0.77)	5.8 (0.27)	3.6 (1.4)	8.4 (0.70)	5.9 (0.34)	3.9 (1.5)

$p < 0.001$). These two participants were removed from subsequent group comparisons, as they could not be considered anhedonic.

3.2. Questionnaires

Correlations were computed between the Scale for Physical Anhedonia and other questionnaire measures for the entire sample and are presented in Table 1. Nonparametric (Spearman–Rank order) correlations were performed, as the distribution of the anhedonia measure was significantly skewed ($z = 15.9$, $p < 0.01$)². One-tailed tests of significance were employed for analyses concerning a priori hypotheses and two-tailed tests were used for all other analyses.

The Scale for Physical Anhedonia was significantly negatively related to PANAS-X (GEN) positive affect, indicating that anhedonia is associated with diminished general experience of positive emotion. However, the SPA was not significantly associated with general experience of negative emotion from the PANAS. The SPA was negatively related to the Behavioral Activation System (BAS) Scale total score, as well as to the Reward Responsiveness (RR), Drive (D) and Fun Seeking (FS) subscales. This suggests that, as predicted, greater hedonic deficit is associated with diminished responsivity to reward and decreased approach motivation. However, the SPA was unrelated to an index of avoidance motivation, the Behavioral Inhibition System (BIS) subscale. The SPA was negatively correlated with self-report of both positive and negative emotional expressivity as measured by the BEQ and with self-report of intensity of positive and negative emotional experience, as measured by the EIS, suggesting that anhedonia is associated with a general dampening of emotional expressivity and intensity of emotional experience.

² There was no difference in the pattern or direction of correlation coefficients when Pearson product–moment correlations were computed for these analyses.

3.3. Responses to tactile, gustatory and visual cues and stimuli

Descriptive statistics for the ratings of cues and stimuli are presented in Table 2. To assess differences between the anhedonic and control groups in self-reported experience of emotion to positive, negative, and neutral cues and stimuli in the three sensory modalities, separate 2 (group: anhedonic and control) \times 3 (valence: positive, negative, and neutral) \times 2 (presentation: cue and stimulus) repeated measures MANOVAs were conducted for each sensory modality: touch, taste, and vision. Neither the group main effect nor any interactions with group were significant, indicating that anhedonics did not differ from controls in their overall self-report of emotional experience. The valence main effect was significant for all sensory modalities (tactile: $F(2, 60) = 190.43$, $p < 0.001$; visual: $F(2, 58) = 158.12$, $p < 0.001$; gustatory: $F(2, 58) = 323.10$, $p < 0.001$). Follow-up analyses indicated that all participants found positive cues and stimuli of all sensory modalities significantly more pleasurable than negative cues and stimuli (tactile: $t(31) = 14.98$, $p < 0.001$; visual: $t(30) = 14.29$, $p < 0.001$; gustatory: $t(30) = 25.48$, $p < 0.001$). Participants also found positive cues and stimuli significantly more pleasurable than neutral cues and stimuli in all sensory modalities (tactile: $t(31) = 15.63$, $p < 0.001$; visual: $t(30) = 12.45$, $p < 0.001$; gustatory: $t(30) = 14.47$, $p < 0.001$).

3.4. Relations between questionnaires and ratings of cues and stimuli

To further explore relations between anhedonia, approach motivation, and response to positive cues and stimuli, the BAS Scale, PANAS Positive Affect and the Emotional Intensity Scale (positive subscale) were correlated with participants' self-reported experience of pleasure to positive, negative, and neutral cues and stimuli (collapsed across group). As shown in Table 3, although the BAS Scale total score was related only to ratings for positive stimuli, the BAS Reward Responsivity subscale was significantly and positively related to pleasure ratings for both positive cues and positive stimuli. This suggests that decreased responsivity to reward is associated with diminished experience of both appetitive and consummatory pleasure. To assess whether the relations between the BAS RR subscale and appetitive and consummatory

Table 3

Correlations: pleasure ratings for cues and stimuli with measures of motivation, experience of emotion^a

	Positive cue	Positive stim.	Negative cue	Negative stim.	Neutral cue	Neutral stim.
BAS Scale (total)	0.19	0.32*	-0.28	-0.44**	-0.20	0.14
BAS Reward Responsiveness	0.45**	0.38*	-0.40*	-0.56**	-0.29	-0.02
BAS Fun Seeking	-0.02	0.11	-0.13	-0.13	-0.11	0.34
BAS Drive	-0.04	0.23	-0.08	-0.30	-0.02	0.03
Positive Affect (PANAS-X, GEN)	0.26	0.49**	-0.04	-0.25	-0.02	0.18
Positive Emotional Intensity (EIS)	0.52**	0.21	-0.49**	-0.58**	-0.45*	-0.27
Positive Emotional Expressivity (BEQ)	0.14	0.03	-0.07	-0.25	-0.09	0.02

^a * $p < 0.05$; ** $p < 0.01$.

pleasure ratings were independent of the effects of the SPA, partial correlations were computed between the BAS RR subscale and ratings for positive cues and stimuli, controlling for scores on the SPA. Removing the effects of the SPA did not weaken the relation between the BAS RR subscale and participants' ratings of cues (partial $r = 0.51$, $p = 0.007$). Rather, the magnitude of the correlation increased slightly, suggesting that a measure of approach motivation may more adequately capture an appetitive pleasure deficit than the measure of anhedonia employed here. Notably, removing the effects of the SPA did not alter the magnitude of the correlation between BAS RR and participants' ratings of stimuli (partial $r = 0.38$, $p = 0.048$), underscoring the strength of the relation between approach motivation and consummatory pleasure, independent of the effects of the Scale for Physical Anhedonia. Intensity of positive emotional experience (EIS) was positively related to response to positive cues, but not to stimuli, suggesting that the intensity with which positive emotion is typically experienced is linked to the degree to which appetitive pleasure is experienced. General experience of positive affect was significantly related to self-reported experience to positive stimuli, but not to positive cues. Thus, the degree to which participants report generally experiencing positive affect is linked to their experience of consummatory pleasure. Positive emotional expressivity was not related to responses to either positive cues or stimuli.

The BAS total score was negatively related to participants' reported experience of negative stimuli and the BAS RR subscale was significantly, negatively related to ratings for both negative cues and stimuli. This suggests that decreased approach motivation and responsivity to reward is linked to greater experience of 'displeasure' to noxious stimuli as well as to cues of impending unpleasant stimuli. Positive emotional intensity (EIS) was also negatively correlated with reported experience to negative cues and stimuli, suggesting that decreased intensity of positive emotional experience is linked with stronger feelings of displeasure for negative emotional stimuli. Ratings of positive emotional intensity were also negatively related to reported experience of neutral cues, suggesting that weaker intensity of positive emotional experience was linked to greater ratings of displeasure for neutral cues. Participants' ratings of negative and neutral cues and stimuli were unrelated to other measures of approach motivation and positive emotion.

4. Discussion

The present study was designed to investigate more closely the nature of hedonic deficit in anhedonia, grounding hypotheses in two neurobehavioral models of positive affect. Based on these models of hedonic experience, anhedonia was expected to be linked to diminished approach motivation and decreased general experience of positive affect. In addition, hedonic deficit in anhedonia was expected to manifest as an appetitive and/or consummatory pleasure deficit. Lastly, diminished approach motivation was predicted to be associated with diminished experience of both appetitive and consummatory pleasure, as reflected by ratings to positive cues and stimuli.

In support of the predicted association between anhedonia and approach motivation, anhedonia was linked to diminished responsivity to reward as well as diminished motivation to seek out and pursue putatively rewarding stimuli. Anhedonia was also associated with a

generally low level of positive affect. Diminished experience of PA is consistent with decreased or deficient approach motivation, according to the models of Klein (1984) and Depue and Iacono (1989). In sum, these findings suggest that anhedonia (as assessed by the SPA) is associated with comprised function of an approach motivational system.

Notably, however, results from the present study did not support either appetitive or consummatory pleasure deficit in anhedonia. Anhedonic and control subgroups did not differ in their reported experience of pleasure to either positive sensory cues or stimuli. This finding is difficult to reconcile with the other findings of relations between anhedonia and questionnaire measures of emotional experience. Furthermore, given that anhedonia is, by definition, a diminished capacity to experience pleasure, it is puzzling that no hedonic deficit was evident in the laboratory task. It is possible that the self-report measure of pleasure following cues and stimuli did not adequately tap hedonic deficit in anhedonia. However, previous studies have also failed to find group differences in reported experience of positive emotion in response to emotion-eliciting stimuli. Berenbaum et al. (1987) found no differences between anhedonic and control groups in their reported experience following the presentation of emotion-eliciting film clips. Additionally, Allen et al. (1995) found that anhedonic and control groups did not differ in their reported experience of positive emotion-eliciting slides. Given that these studies used varied emotion-eliciting stimuli as well as alternative self-report measures of emotional experience, it is likely that the stimuli and/or measures of experience may not be accountable for a failure to find group differences in the present study. It may be that self-report of emotional experience is not adequately sensitive to detect differences in emotional responding in anhedonic and control groups and that the addition of other measures, such as facial EMG and/or startle eyeblink modulation, would better elucidate the expected group differences. Alternatively, it may be that the measure of anhedonia used as the basis for grouping in these studies does not wholly represent the nature of hedonic deficit in anhedonia. Indeed, previous research examining the construct validity of anhedonia found that scores on the Scale for Physical Anhedonia were essentially uncorrelated with self- and peer-report of hedonic deficit (correlations of 0.10 and 0.07 respectively; Peterson & Knudson, 1983). This finding suggests that scores on the Scale for Physical Anhedonia may not tap the same domain as other self-report (and peer-report) measures of hedonic experience or deficits thereof.

Although anhedonia was not related to ratings of pleasure to either positive sensory cues or stimuli, a measure of responsivity to reward (BAS RR) was related to these ratings. These findings are consistent with the predicted relations between approach motivation and hedonic experience. Greater sensitivity of an approach motivational system is thought to be linked with propensity toward anticipatory pleasure and the experience of emotions such as elation and happiness (e.g. Depue & Iacono, 1989; Gray, 1990). Previous studies have found the BAS Reward Responsivity subscale to be related to the speed of acquisition of reward expectancies (Zinbarg & Mohlman, 1998) and changes in experienced happiness as a function of reward cues (Carver & White, 1994). In addition, scores on the BAS scale have previously been linked to electrocortical activity in the left prefrontal cortex, a brain region which has been associated with trait positive affect (Davidson, 1995; Sutton & Davidson, 1997; Tomarken, Davidson, Wheeler & Doss, 1992). The BAS scale, and particularly the Reward Responsivity subscale, may therefore better index hedonic deficit than a more widely used measure of anhedonia. Furthermore, use of the BAS scale in the empirical examination of hedonic deficit may serve to

elucidate the relations between anhedonia and activity of specific neurophysiological systems in human participants.

Interestingly, although anhedonia is defined as a deficit in *positive* emotional experience, the SPA was associated with decreased emotional expressivity and intensity of emotional experience for both positive and negative emotions. This finding is consistent with some previous studies. For example, Ferguson and Katkin (1996) found that anhedonic participants manifested fewer positive observable facial expressions in response to positive slides and fewer negative observable facial expressions in response to negative slides. Another study (Putnam & Neale, 1996) found that anhedonic participants manifested diminished affect-appropriate activity of the facial musculature, suggesting that anhedonic individuals are generally less expressive than controls and that this deficit is not constrained to observable expressive behavior. Ferguson and Katkin (1996) also found that anhedonic participants manifested diminished heart rate reactivity to slide stimuli compared to controls, regardless of slide valence, suggesting that anhedonics were less aroused by slide stimuli overall. In conjunction with results from the present study, these findings suggest that there may be some degree of general emotional dulling in anhedonic individuals. However, these findings are in contrast to those from other studies in which anhedonics manifested a deficit selectively for positive emotion-eliciting stimuli, with apparently intact responding to negative emotional stimuli (e.g. Fiorito & Simons, 1994; Fitzgibbons & Simons, 1992). Furthermore, in the present study there was a significant negative correlation between measures of approach motivation and responses to negative cues and stimuli. These findings suggest that decreased sensitivity of the motivational system underlying positive emotion is linked to *increased* experience of negative emotion. This is consistent with Meehl's (1975) theoretical account of anhedonia, in which he proposes that diminished hedonic capacity increases vulnerability to psychological distress. Taken together, the findings of the present study and of prior studies indicate the need for further investigation of anhedonics' responding to negative emotion-eliciting stimuli.

The present study is limited by the small sample size in the anhedonic and control groups and by a sample of participants restricted to the college undergraduate population. Another potential limitation of the present study is the possibly difficult distinction between visual cues and visual stimuli. Visual stimuli may be said to differ from tactile and gustatory stimuli in that participants did not 'consume' the stimulus in the same way. It may therefore be argued that visual stimuli are not truly 'consummatory,' and may even be closer to appetitive cues in that they are representations of other stimuli. However, it has also been argued that there is a distinct pleasure to be derived from solely viewing interesting or attractive visual stimuli (e.g. Funch, 1997; Molnar, 1992). Therefore, although visual stimuli may be 'consumed' differently, they can serve as hedonic stimuli in their own right and not simply as cues of other (e.g. tactile or gustatory) stimuli.

Self-report was the only measure used in the present study to tap the experience of pleasure in response to positive cues and stimuli. Future studies, therefore, might utilize additional measures of emotional responding such as facial EMG, observable facial expression and physiological measures such as skin conductance and heart rate to investigate appetitive and consummatory pleasure in anhedonia. To more closely examine relations between approach motivation and hedonic experience in anhedonia, additional studies might also employ measures such as affective modulation of the startle eyeblink, which is hypothesized to be

linked to the engagement of approach/avoidance motivational systems, during the presentation of valenced cues and stimuli. Subsequent empirical examinations of anhedonia in humans might utilize multiple measures of anhedonia, as well as the BAS scale, in order to evaluate the efficacy of each as an index of hedonic deficit. Lastly, additional research might examine more directly the putative link between appetitive and consummatory hedonic deficit, self-report of BAS strength, and regional electrocortical activity in order to further elucidate the neurophysiological underpinnings of hedonic deficit in humans.

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