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Emotion in the Criminal Psychopath: Startle Reflex Modulation

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Startle-elicited blinks were measured during presentation of affective slides to test hypotheses concerning emotional responding in psychopaths. Subjects were 54 incarcerated sexual offenders divided into nonpsychopathic, psychopathic, and mixed groups based on file and interview data. Consistent with findings for normal college students, nonpsychopaths and mixed subjects showed a significant linear relationship between slide valence and startle magnitude, with startle responses largest during unpleasant slides and smallest during pleasant slides. This effect was absent in psychopaths. Group differences in startle modulation were related to affective features of psychopathy, but not to antisocial behavior per se. Psychopathy had no effect on autonomic or self-report responses to slides. These results suggest an abnormality in the processing of emotional stimuli by psychopaths that manifests itself independently of affective report.

Abnormal or deficient emotional responding is considered to be a hallmark of psychopathy. Cleckley's (1955) classic diagnostic criteria for psychopathy include absence of nervousness, lack of remorse or shame, egocentricity and incapacity for love, and general poverty in major affective reactions. He believed that a discordance between linguistic and experiential components of emotion, a condition he termed *semantic dementia,* defined the essence of psychopathy. From this standpoint, the psychopath knows the "words" of emotion, but not the "music" (cf. Johns & Quay, 1962).

Lykken (1957) provided empirical evidence that psychopaths defined by Cleckley's criteria are deficient in their capacity to develop anxiety responses. Subsequent empirical studies of emotion in psychopaths have focused largely on the responses of these individuals in punishing or threatening situations. The most consistent findings have been that psychopaths show reduced electrodermal response during anticipation of a noxious event and poor passive avoidance learning, that is, a failure to learn to inhibit punished responses (see reviews by Hare, 1978a, and Siddle & Trasler, 1981; see also Newman, Widom, & Nathan, 1985). These data have led to speculation that psychopathy is related to a specific deficit in neurophysiological systems modulating fear behavior (Fowles, 1980; Gray, 1971).

One problem in this research area has been the absence of a consensus regarding diagnostic criteria for psychopathy. Many studies have used psychometric data (e.g., Minnesota Multiphasic Personality Inventory scores) to classify subjects, whereas others have equated psychopathy with criminality. In fact, a criticism of the *Diagnostic and Statistical Manual of Mental Disorders* (rev. 3rd ed.; American Psychiatric Association, 1987) criteria for antisocial personality disorder (a category that was intended to capture the essential features of psychopathy) has been that criminal behaviors are overemphasized to the exclusion of affective and interpersonal features believed to be pathognomonic of psychopathy (Hare, 1985; Harpur, Hare, & Hakstian, 1989).

A second difficulty of interpretation in psychophysiological studies of aversive responding in psychopaths arises from their near exclusive reliance on electrodermal and cardiovascular measures. Recent research suggests that neither measure indexes fear reliably. Electrodermal activity tends to increase as emotional arousal increases, whether the eliciting stimulus is pleasant or aversive (Greenwald, Cook, & Lang, 1989). Heart rate, on the other hand, appears to be sensitive to the task demands of an experimental situation; the heart rate response to an aversive stimulus, for example, may be either acceleratory or deceleratory, depending on the method used to evoke emotion (e.g., visual stimulus vs. imaginal; Lang, Bradley, & Cuthbert, 1990; Vrana & Lang, 1990).

Psychophysiological studies have generally found reduced skin conductance responses in psychopaths during anticipation of punishment. With regard to heart rate, some experiments have not found differences between psychopathic and nonpsychopathic subjects in threatening situations (e.g., Hare & Quinn, 1971; Tharp, Maltzman, Syndulko, & Ziskind, 1980), but others have reported increased heart rate acceleration along with decreased electrodermal activity (Hare & Craigen, 1974;

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Hare, Frazelle, & Cox, 1978; Ogloff & Wong, 1990). Hare (1978a) attempted to explain this discordant pattern of electrodermal and cardiovascular responding by postulating that psychopaths adopt an active coping stance in the face of threat that reduces anxiety (see also Fowles, 1980). Siddle and Trasler (1981) cited several problems with this interpretation and questioned whether the impact of an impending aversive stimulus is attenuated by psychopaths in this fashion. What is needed to resolve this issue is a response measure that indexes aversive emotional activation independently of arousal and experimental task demands.

Emotional Valence and the Startle Response

Lang (1985) outlined a dimensional theory of affect in which emotional response is conceptualized fundamentally as an action disposition. Emotional responses to stimuli or situations are defined in terms of two orthogonal dimensions: affective valence and arousal. Valence refers to the directionality of the elicited action disposition, varying from avoidance to approach: arousal refers to the intensity of activation of the response. The emotion of fear, for example, may be conceptualized as a state of low valence (involving preparation for avoidance or withdrawal) and high arousal or activation.

As noted earlier, electrodermal response provides a reliable measure of emotional arousal, but not of valence. Changes in facial activity appear to index valence (Greenwald et al., 1989) but can be problematic because they are subject to voluntary distortion (Craig, Hyde, & Patrick, 1991). Recent research indicates that the probe–startle response may provide an alternative measure of emotional valence with unique advantages (Lang et al., 1990; Vrana, Spence, & Lang, 1988). Studies with normal subjects have repeatedly shown that reflex eyeblink responses to a sudden, intense acoustic probe are larger during viewing of unpleasant slides than during presentation of pleasant slides (Bradley, Cuthbert, & Lang, 1990a, 1990b, 1991; Bradley, Lang, & Cuthbert, 1990; Cuthbert, Bradley, & Lang, 1990; Vrana et al., 1988). In each of these studies, the basic phenomenon (termed the *affect–startle effect* by Lang et al., 1990) has been demonstrated by a significant linear trend relationship—within subjects—between startle reflex magnitude and slide valence (i.e., rated pleasantness).

This startle modulation effect has also been demonstrated during imagery of scenes varying in rated pleasantness (Cook, Hawk, Davis, & Stevenson, 1991; Vrana & Lang, 1990). Thus, unlike heart rate, the startle reaction varies with affective valence independently of the task demands of the situation. Furthermore, unlike facial expression, it is a reflexive response to an unwarned probe that occurs in less than 50 ms, and thus it is little influenced by voluntary control.

Lang et al. (1990) explained the valence effect on startle in terms of synergistic response matching. The startle probe (e.g., a sudden noise) is an inherently aversive stimulus that elicits a defensive withdrawal response, one component of which is the reflex eyeblink. Unpleasant slides or images prompt a state of defensive readiness that is synchronous with the response to the startle probe, producing a larger blink reflex; pleasant stimuli elicit an opposing appetitive disposition, producing a smaller startle reaction. From this viewpoint, the startle response provides a direct index of the valence disposition of the organism (appetitive or defensive) in relation to putatively emotional stimuli.

There is independent evidence linking larger startle responses to fear states. Studies of classical conditioning in animals and humans have demonstrated augmented acoustic startle during presentation of a conditioned stimulus previously paired with shock (Brown, Kalish, & Farber, 1951; Greenwald, Hamm, Bradley, & Lang, 1988). In related research with animals, Davis (1979, 1986) demonstrated that this effect can be blocked by administration of antianxiety drugs and that activity in the region of the amygdala probably plays a mediating role. The startle response thus provides a potential solution to the problem of fear measurement in psychophysiological research.

Research Questions

Affective Modulation of Startle in a Criminal Population

To date, all investigations of the affect–startle phenomenon have been conducted with normal college student subjects. The present study examined emotional responses to pleasant, neutral, and unpleasant visual stimuli in a sample of convicted criminal offenders. Measures included physiological responses (startle, corrugator electromyographic [EMG] activity, heart rate, and skin conductance), affective reports (pleasantness, arousal, and interest), and behavior (stimulus-viewing time). We were interested in how patterns of responses in this sample of criminal offenders would compare with the responses of normal subjects. To permit a direct comparison, stimulus materials and experimental procedures in the present study paralleled those used in earlier research with college students (Bradley et al., 1990b, 1991).

Psychopathy and Startle Reflex Modulation

A second objective was to investigate hypotheses concerning emotional deficits in a subset of criminal offenders—those meeting criteria for psychopathy. The basis for diagnostic classification was Hare's (1991) Revised Psychopathy Checklist (PCL-R), which consists of 20 items based on Cleckley's (1955) criteria. As noted earlier, normal subjects show a linear relationship between startle magnitude and affective valence, with startle responses being larger during unpleasant as compared with pleasant slides. On the basis of existing evidence for an aversive response deficit in psychopaths, it was predicted that psychopaths (unlike other criminal subjects and normals) would fail to show this expected linear trend effect. A dramatically different, nonlinear startle pattern would provide the strongest evidence for affective abnormality in psychopaths; one possibility was that psychopaths would show a quadratic pattern (i.e., reduced startle responses for both pleasant and unpleasant stimuli as compared with neutral stimuli), reflecting appetitive (Lang et al., 1990) or attentional (Hackley & Graham, 1984) modulation of the startle reflex.

A further prediction for psychopathic subjects was that they would show weaker differentiation between pleasant and unpleasant slides in corrugator EMG ("frown") response, which is specifically sensitive to aversive stimuli in normal subjects (Greenwald et al., 1989). Patterns of response in skin conductance and heart rate, which are known to be strongly affected by arousal and experimental task demands (Lang et al., 1990), were not expected to be as discriminating. Cleckley's (1955) description of the disorder also predicts desynchrony between psychopaths' reports of their affective experience and their physiological responses, a hypothesis that has received some recent experimental support (e.g., Williamson, Harpur, & Hare, 1991). The availability of both types of data permitted this hypothesis to be assessed in the present study.

Emotional Detachment and Antisocial Behavior Dimensions of Psychopathy

Factor-analytic studies of Hare's PCL-R (Harpur, Hakstian, & Hare, 1988; Harpur et al., 1989) have identified two major dimensions: the first comprises affective and interpersonal items such as superficial charm, grandiosity, lying and manipulativeness, affective shallowness, absence of remorse, and lack of empathy; the second comprises items describing an impulsive, antisocial lifestyle including early behavior problems, juvenile delinquency, aggressive behavior, proneness to boredom, absence of planning, and irresponsibility as an adult.

A descriptive label for Factor 1, which captures the "loveless," "guiltless" nature of the classic psychopath (cf. McCord & McCord, 1964), might be *emotional detachment.* Consistent with this, Williamson et al. (1991) detected abnormalities in processing of emotional words among psychopaths high in PCL-R Factor 1, and Harpur et al. (1989) reported that Factor 1 scores correlated negatively with self-report anxiety scales and positively with measures of narcissism, a personality dimension characterized by selfishness and affective shallowness. In contrast, correlates of PCL-R Factor 2 include frequent criminal and antisocial behavior, low socialization, and high sensation seeking (Harpur et al., 1989). Smith and Newman (1990) recently reported that substance abuse was significantly related to Factor 2 but not to Factor 1. Thus, Factor 2 deals more with impulsivity and behavioral disinhibition than affective responsiveness and might be called the *antisocial behavior* dimension.

On the basis of the above-mentioned information, it was predicted that deviant patterns of response to affective slides would be most evident among subjects high on PCL-R Factor 1 (emotional detachment). In particular, it was expected that the normal linear affect-startle function would be most notably absent in this subgroup of individuals (i.e., startle reactions during pleasant and unpleasant slides would be similar).

Method

Subjects

Subjects were 54 male residents of a forensic treatment facility for sexual offenders located near Gainesville, Florida, selected from a larger group of volunteers ($N = 60$) assessed for purposes of the study. All subjects were convicted felons who had been transferred to the sexual offender facility from state prisons and who were still under sentence at the time of the study. Before psychophysiological testing, each subject participated in a structured diagnostic interview. Information collected during the interview was used in combination with institutional file data—case histories, criminal records, police and court reports, medical and psychiatric data, and daily summaries of institutional behavior—to assign scores on the PCL-R (Hare, 1991). Christopher J. Patrick completed assessments on all 60 interviewees; trained, independent raters provided reliability checks on a random sample ($n = 32$, or 53%) of these cases. The product-moment correlation between total PCL-R scores for the two assessments was very high, $r = .96$, consistent with reliability figures from other studies in which original and revised versions of the PCL have been used (e.g., Hart & Hare, 1989; Patrick & Iacono, 1989). Separate reliability coefficients were also computed for PCL-R factor scores (cf. Hare, 1991; Hare et al., 1990). For Factor 1 (emotional detachment), the correlation was .85; for Factor 2 (antisocial behavior), it was .92.

On the basis of their PCL-R total scores, subjects were selected to form three equal groups ($n = 18$ per group) using cutoffs recommended by Hare (1991): one nonpsychopathic group (PCL-R ≤ 20), one mixed group with some psychopathic features (PCL-R between 20 and 30), and one clearly psychopathic group (PCL-R ≥ 30). The mean PCL-R total scores (maximum possible = 40) for the three groups were 13.4, 25.8, and 33.3, respectively. Their mean ages were 31.7, 28.2, and 32.8 years, respectively, with the differences being nonsignificant, $F(2, 51) = 1.27$.

Two individuals on whom assessments were performed did not participate in the testing phase of the study. Four others (one nonpsychopath, one mixed subject, and two psychopaths) were excluded from the study because of equipment failure or procedural problems (including unscoreable startle responses, $n = 2$) that rendered their data unusable.

Stimulus Materials and Design

Each subject viewed a series of 27 color slides depicting 9 pleasant, 9 neutral, and 9 unpleasant objects or scenes, drawn from a larger pool of slides (Lang, Öhman, & Vaitl, 1988) previously rated on dimensions of valence and arousal by normal subjects (Bradley et al., 1990b; Lang & Greenwald, 1988). Pleasant slides included depictions of opposite-sex nudes, food, sports scenes, and children; unpleasant stimuli included mutilations, aimed guns, and snakes; nonaffective stimuli included household objects and neutral faces. The pleasant and unpleasant slide sets were matched in terms of rated arousal, and both were rated as more arousing than slides in the neutral set.[1]

Slide viewing took place in a private studio located apart from the living quarters of the institution. Subjects sat in a reclining chair situated approximately 2.5 m from a slide screen. Slides were presented using a Kodak Ektagraphic IIIBR slide projector stationed in an adjoining equipment room, with presentation and timing of stimuli controlled by a Terak 8510a microcomputer.

Slide presentation order was balanced across subjects within diagnostic group. For each subject, slides were presented in blocks of nine, with three unpleasant, three neutral, and three pleasant slides ordered randomly within each block. Three orders of slide presentation were devised such that, across subjects within a particular diagnostic group, each slide was seen equally often in the first, second, or third block.

On six of the trials for each slide type, an acoustic startle probe consisting of a 50-ms burst of 95 dB (A) white noise with instantaneous rise time was presented at an unpredictable point during the 6-s slide-viewing period (i.e., either 3.5, 4.5, or 5.5 s after slide onset). Startle probes were presented binaurally through Telephonics stereo head-

[1] Slides were selected from the International Affective Picture System (IAPS; Lang, Ohman, & Vaitl 1988). The IAPS slide numbers were as follows: pleasant—160, 225, 465, 720, 803, 808, 418, 421, 425; neutral—220, 550, 700, 702, 705, 708, 710, 716, 718; unpleasant—109, 212, 300, 310, 313, 315, 620, 623, 904.

phones; the white noise was prerecorded on cassette tape and gated by a computer-controlled relay interfaced between the tape player and an audio amplifier. Three counterbalancing conditions were formed within each diagnostic group to ensure that, across subjects within groups, each slide was probed equally often with a startle stimulus. In addition, the timing of startle probes during slide viewing (early, middle, or late) was balanced across valence categories and over trials within subjects and also across specific slides for subjects within each diagnostic group. Finally, six startle probes were presented during intervals between slide presentations to minimize the predictability of the startle stimulus.

Physiological Measures

Physiological signals were recorded using a Beckman Type RM Dynograph connected to the Terak microcomputer, which controlled sampling, digitizing, and storage of output voltages from the polygraph. Blink responses to the startle probes were measured from Beckman miniature Ag-AgCl electrodes positioned at the orbicularis oculi muscle beneath the left eye. Following preamplification, EMG activity was full-wave rectified and integrated using a Beckman Type 9852A Direct-Average EMG Integrator with a 100-ms time constant. Digital sampling commenced 3 s before slide onset at a rate of 20 Hz and then increased to 1000 Hz at a point 50 ms before startle probe onset, continuing at this rate for 250 ms after probe onset. Sampling then resumed at 20 Hz and continued until 2 s after slide offset. The startle response data were reduced off-line using a program developed by Balaban, Losito, Simons, and Graham (1986), which scores startle-elicited blinks for magnitude in arbitrary analog-digital (A-D) units and onset latency in milliseconds.

An additional measure of EMG activity was recorded from the region of the corrugator muscle above the left eye, using a second Beckman 9852A EMG coupler. Beckman miniature electrodes filled with electrolyte paste were positioned in accordance with published guidelines (Fridlund & Cacioppo, 1986), and EMG activity was sampled at 20 Hz throughout each slide-viewing period and for 3 s before slide onset. For purposes of data analysis, corrugator EMG activity was expressed as the mean change during the first 3.5 s following slide onset (i.e., before the earliest startle probe) from the 1-s baseline immediately preceding slide onset.

Heart rate (HR) activity was recorded from 1-cm Beckman Ag-AgCl electrodes placed on the right and left inner forearms. The signal was filtered using a Beckman Type 9806A coupler, and a Schmitt trigger interrupted the computer each time it detected the *R* component of the cardiac waveform. Interbeat intervals were recorded in milliseconds and reduced off-line to HR in beats per minute for each half-second of the slide interval and the preslide baseline. For data analysis purposes, HR activity was defined as mean change during the 6-s slide-viewing period from the 1-s baseline immediately preceding slide onset.

Skin conductance activity was recorded from adjacent sites on the hypothenar eminence of the nondominant hand using 1-cm Beckman Ag-AgCl electrodes filled with Johnson & Johnson K-Y lubricating jelly. The electrodes were in turn connected to a Sensor Medics 9844 Skin Conductance Coupler, which imposed .5 V across the electrodes. Before each recording session, the skin conductance coupler was calibrated to map activity from 0 to approximately 40 μS over the available range of the A-D converter. Digitized values (in A-D units) were later converted back to conductance values (in microsiemens) using the appropriate calibration parameters. Skin conductance response (SCR) was defined as the largest increase occurring between .9 and 4 s after slide onset.

Procedure

The data in this article were collected as part of the second session of a larger experiment. Written consent was obtained from each participant before the diagnostic assessment and then again before experimental testing. During the first testing session, each subject completed a series of questionnaires and then participated in a brief normative recording procedure involving measurement of autonomic responses during exposure to simple tone and noise stimuli. In the second session, the subject participated in an independent experimental paradigm in which his physiological responses (HR, skin conductance, and corrugator EMG) were monitored during imagery of fearful and neutral scenes (see Patrick, Cuthbert, & Lang, 1990). As a filler activity between the imagery procedure and the slide series, the subject completed an additional questionnaire (Form V of the Sensation Seeking Scale; Zuckerman, 1979).

For the slide-viewing procedure, the subject was advised that a series of slides would be presented and that he should view each slide for the entire time it appeared on the screen. He was also told that from time to time he would hear a brief noise over the headphones, which he could just ignore. Each of the 27 slides was presented for 6 s, with a variable interslide interval (during which no stimulus appeared on the screen) ranging from 10 to 20 s.

Following the aforementioned procedure, the same slides were presented to the subject a second time. During this series, the subject was instructed to view the slides for as long as he desired (up to 60 s) and to press a button to terminate the slide. Viewing times (in milliseconds) were recorded to provide a behavioral measure of interest. In addition, following slide offset, the subject rated his subjective experience of valence (pleasantness) and arousal using a computerized version of Lang's (1980) Self-Assessment Manikin (SAM). The subject also rated the interest value of each slide (from *not at all* to *very interesting*) using a computer-controlled line rating.

Data Analysis

For all physiological response measures, the distributions of mean raw scores across subjects were assessed for normality using formulae presented in Glass and Hopkins (1984, pp. 70–72). A mean was computed for each subject by averaging responses over all slide trials for a particular measure, and the distribution of these subject means was assessed for normality. Distributions for three measures (startle blink magnitude, corrugator EMG change, and SCR) showed significant positive skewness that was due to a minority of subjects with very large responses. To correct for the disproportionate influence of outliers, these data were standardized across slide trials within subjects using a *z*-score transformation (i.e., raw scores for each subject were deviated from the individual's mean score and divided by his standard deviation); a linear transform was then applied to the resultant scores, producing for each subject a score distribution with a mean of 50 and a standard deviation of 10. Response patterns for individual subjects (i.e., relative magnitudes of response to pleasant, neutral, and unpleasant slides) were not changed by this procedure; the transformation simply established a common metric for all individuals, ensuring that each subject contributed equally to the group pattern. For these measures (blink magnitude, corrugator EMG change, and SCR), separate analyses of both transformed values and the original raw scores are reported.[2]

General hypotheses involving the startle reflex were tested using multivariate analysis of variance (SYSTAT), with diagnostic group as a between-subjects factor and slide valence category (pleasant, neutral, unpleasant) as a repeated measures factor. Following prior research with this paradigm (Bradley et al., 1990a, 1990b, 1991; Bradley, Lang, &

[2] Results were the same when a range correction procedure (i.e., expressing scores as a proportion of each subject's maximum) was used instead of standardization.

Cuthbert, 1990; Cuthbert et al., 1990; Vrana et al., 1988), the predicted linear relationship between slide valence and the blink response (i.e., unpleasant greater than pleasant) was tested using a univariate analysis of trend for all subjects, and on the basis of a priori hypotheses was tested separately for each diagnostic group.

Relationships among valence and the other physiological and self-report measures were also examined with multivariate analysis. Again, slide category and diagnostic group were included as within- and between-subjects factors, respectively. Of particular interest in each of these analyses was the significance of the linear and quadratic trends (cf. Bradley et al., 1990b) and their interaction with diagnostic group. Quadratic trends (i.e., both pleasant and unpleasant greater than neutral) were predicted for those measures that have been shown to covary with arousal (i.e., SCR, viewing time, ratings of interest and arousal; cf. Lang et al., 1990). Unless otherwise specified, all effects were tested at a significance level of .05.

Results

Emotional Valence and the Startle Response

Groups did not differ in raw startle magnitude, $F(2, 51) = .10$. There was a significant slide valence effect, with blink magnitude differing significantly across the three affective categories (*M*s = 562, 681, and 696 for pleasant, neutral, and unpleasant slides, respectively), multivariate $F(2, 50) = 5.53$. Raw startle blink magnitude was largest during presentation of unpleasant slides and smallest during presentation of pleasant slides, producing a significant linear trend effect, $F(1, 51) = 7.93$; the overall quadratic trend effect was not significant, $F(1, 51) = 2.27$ (see Table 1). The significant linear trend effect for the sample as a whole replicated the pattern that has been observed in several previous studies with normal subjects (Lang et al., 1990). The overall Group × Slide Valence interaction was not significant, $F(4, 102) = .92$, nor were the interactions of the linear and quadratic trends, *F*s(2, 51) < 1. Table 2 shows raw blink magnitude and latency means for each slide category by diagnostic group.[3]

Analysis of the standardized blink magnitude scores produced generally similar results, with the following exceptions. The linear Group × Valence Trend *F* was higher, though again nonsignificant, $F(2, 51) = 2.01$, $p = .14$, quadratic trend $p = .80$. As expected, however, when the a priori trend tests were performed for each group, only the nonpsychopathic and mixed groups showed a significant linear valence relationship, $F(1, 17) = 5.19$ and 17.83, respectively (quadratic trend *F*s < 1), that is, startle responses were largest during unpleasant, intermediate during neutral, and smallest during pleasant slides (see Figure 1). On the other hand, for the clearly psychopathic subjects, probe responses to pleasant and unpleasant slides did not differ, linear Valence Trend, $F(1, 17) = 1.20$, *ns*. Furthermore, probe responses during neutral slides were significantly larger than responses during affective slides at either end of the valence dimension, quadratic Valence Trend, $F(1, 17) = 5.46$.

Blink latency scores presented in Table 2 were also analyzed using a Group × Slide Valence repeated measures analysis. The main effect of Group was not significant, $F(2, 51) = .09$, nor was the overall Slide Valence factor, $F(2, 50) = 2.24$, $p = .11$. As expected, however, the linear Valence Trend was significant, $F(1, 51) = 4.33$, with blink latencies generally shortest for unpleasant slides and longest for pleasant slides.

Group × Valence Trend effects were not significant, linear $F(2, 51) = 1.86$, $p = .17$; quadratic $F(2, 51) = .13$. The separate a priori analyses for each group were, however, generally consistent with prediction and with the observed pattern of latencies over slide valence (see Table 2). Thus, the linear trend was significant for nonpsychopaths, $F(1, 17) = 6.76$, and nearly so for the mixed group, $F(1, 17) = 3.43$, $p < .09$, tending to confirm the apparent slower blink response during pleasant than during unpleasant slides. Psychopaths, on the other hand, showed a flat latency curve over slide categories, with no evidence of this linear valence effect, $F(1, 17) = .08$. The quadratic trend was nonsignificant for all groups, *F*s(1, 17) < 1.

Facial Electromyographic Activity

Corrugator EMG change, like the startle response, varied in a linear fashion across slide valence categories within the sample as a whole (similar to normal subjects; Bradley et al., 1990b; Greenwald et al., 1989), with unpleasant slides provoking larger reactions than pleasant slides (see Table 1): The overall slide valence effect was significant for raw EMG change scores, multivariate $F(2, 50) = 15.40$, as was the linear trend component, $F(1, 51) = 19.61$. The Group × Valence linear trend interaction was also significant, $F(2, 51) = 4.07$: Nonpsychopathic and mixed subjects showed a significant difference in corrugator EMG responses to unpleasant as compared with pleasant slides, linear trend $F(1, 17) = 7.04$ and 13.87, respectively, whereas psychopaths did not, $F(1, 17) = .32$ (see Table 3). A significant overall quadratic trend effect was also obtained, $F(1, 51) = 8.38$, signifying larger EMG responses to unpleasant slides than to either neutral or unpleasant slides (see Table 1). The Group × Quadratic Trend interaction was not significant, $F(2, 51) = 0.73$. Separate trend analyses for groups indicated quadratic patterns for nonpsychopathic and mixed subjects, $F(1, 17) = 2.97$ and 9.30, respectively, *p*s = .10 and .007. This difference in response to unpleasant slides versus the other two slide categories did not even approach significance for psychopaths, $F(1, 17) = .48$ (see Table 3).[4]

[3] Analyses of group differences in raw startle patterns were problematic because of the presence of very large responders who disproportionately influenced group patterns. The majority of subjects in the sample (44 of 54) had mean blink magnitudes below 925 A-D units. Three nonpsychopaths, 5 mixed subjects, and 2 psychopaths had mean responses in excess of 1125 A-D units. Because of these outliers, the raw magnitude differences between slide categories reported in Table 2 do not accurately represent the startle modulation patterns for the three groups. It was for precisely this reason that further analyses were conducted on standardized magnitude data, that is, to ensure that each subject contributed equally to the group startle patterns.

[4] To assess the relationship between corrugator EMG response and the magnitude of the startle reaction in the present study, correlations were computed between corrugator EMG change and raw blink magnitude scores across trials for each subject. The mean within-subjects correlation for the sample as a whole was −.03, with results similar across diagnostic groups (mean $r = -.11, -.01$, and .04 for nonpsychopathic, mixed, and psychopathic groups, respectively). These data suggest that startle modulation effects were relatively independent of changes in corrugator EMG, even though both measures showed a linear trend across slide valence categories in the sample as a whole. It is also possible that the linear relationship between slide valence and

Table 1
Overall Sample Means for Physiological and Self-Report Measures

Response measure	Slide category			Trend test (p)	
	Pleasant	Neutral	Unpleasant	Linear	Quadratic
Startle reflex					
Magnitude	562	681	696	.01	
Latency	46.7	46.5	45.0	.05	
Facial electromyographic activity					
Base orbicularis	131	102	126		.01
Corrugator change	−.08	.00	1.23	.005	.01
Visceral response					
Heart rate change	−.04	−.93	−1.66	.005	
Conductance change	.37	.08	.18	.005	.005
Slide evaluation					
Valence rating	22.0	14.7	5.9	.005	
Arousal rating	15.0	2.5	11.0	.005	.005
Interest rating	21.7	6.1	10.9	.005	.005
Viewing time	14.8	5.7	10.7	.005	.005

Note. $N = 54$ for all means. Units of measurement are as follows: startle magnitude, A-D units; startle latency, ms; base orbicularis, A-D units; corrugator change, μvolts; heart rate change, beats/min; conductance change, μsiemens; all ratings, 0–29; viewing time, s.

Standardized corrugator EMG scores also showed a clear linear trend effect for Slide Valence, $F(1, 51) = 61.95$. The Group × Linear Trend interaction, however, only approached significance, $F(2, 51) = 2.51$, $p = .09$. Separate group analyses again yielded highly significant linear effects for the nonpsychopathic and mixed groups, $F(1, 17) = 17.76$ and 20.06, respectively; the effect was weaker for psychopaths, but significant, $F(1, 17) = 7.73$. Neither the overall quadratic trend effect nor the individual group trends were significant.

Visceral Response

The main effect of Group was not significant for either raw SCR scores or 6-s HR change scores, $F(2, 51) = .96$ and .81, respectively, but the overall slide valence effect was significant for each variable, multivariate $F(2, 50) = 8.26$ and 14.88, respectively (see Table 1). Heart rate change showed a clear linear trend across slide valence categories: Greater deceleration was observed for unpleasant slides than pleasant slides, with neutral slides falling in between, linear $F(1, 51) = 34.38$. The quadratic trend effect was not significant for heart rate, $F(1, 51) = .11$. On the other hand, SCRs were larger for both pleasant and unpleasant slides than for neutral slides, producing a significant quadratic trend effect, $F(1, 51) = 9.82$. This finding suggests that affectively laden slides, whether pleasant or unpleasant, were more arousing for subjects than were neutral slides (cf. Greenwald et al., 1989; Lang et al., 1990). Also, pleasant slides evoked consistently larger SCRs than unpleasant slides, producing a significant linear trend effect, $F(1, 51) = 16.84$. Group × Trend interactions for the linear and quadratic components were not significant for either measure.

Analysis of standardized SCR scores yielded results identical to those for raw scores: Significant overall linear and quadratic trend effects were obtained, but the Group × Trend interactions were not significant. Separate analyses for nonpsychopaths, mixed subjects, and psychopaths confirmed that this pattern was consistent across groups.

Affective Report and Interest Measures

Table 1 shows overall sample means ($N = 54$) by slide affect category for the valence, arousal, and interest ratings, together

the blink reflex might be mediated by baseline tension in the orbicularis oculi muscle. To examine this issue, baseline orbicularis scores (i.e., activity during the 20 ms following startle probe onset but preceding the startle response) were computed for each startle probe trial, and trend effects were tested across slide valence categories. The quadratic trend effect was significant, $F(1, 51) = 10.03$, but the linear trend effect was not, $F(1, 51) = .10$ (see Table 1). Also, the quadratic relationship between valence and base orbicularis was similar across groups, $F(2, 51) = .34$ for Group × Quadratic Trend interaction. This same pattern (i.e., higher baseline orbicularis for both pleasant and unpleasant slides relative to neutral slides) was reported by Bradley, Cuthbert, and Lang, (1990b) for normal subjects and indicates that blink magnitude is not solely mediated by differences in baseline muscle tension.

Table 2
Group Means for Raw Startle Magnitude and Latency, by Slide Valence Category

Measure and group	Slide category		
	Pleasant	Neutral	Unpleasant
Startle magnitude			
Nonpsychopaths	648	699	716
Mixed group	468	594	683
Psychopaths	570	751	688
Startle latency			
Nonpsychopaths	47.0	46.3	43.7
Mixed group	47.9	46.7	45.5
Psychopaths	45.3	46.4	45.7

Note. $N = 18$ per group. Units of measurement are as follows: startle magnitude, A-D units; startle latency, ms.

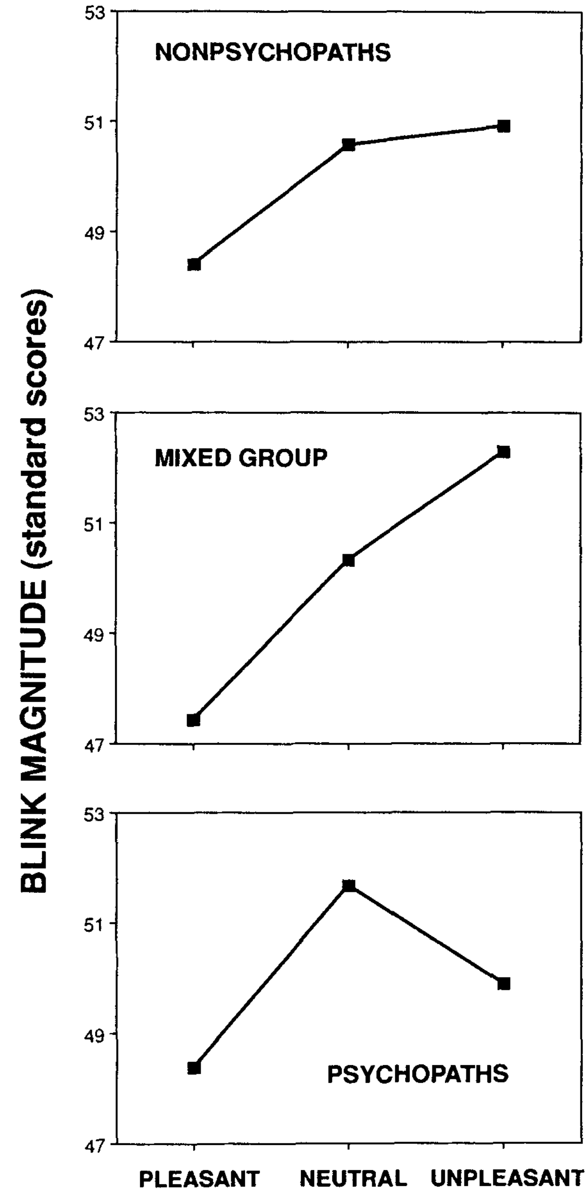

Figure 1. Mean blink response magnitudes for startles presented during viewing of pleasant, neutral, and unpleasant slides, by diagnostic group (top panel = nonpsychopaths; middle = mixed group; bottom = psychopaths; $n = 18$ per group). (Startle magnitude is expressed in standard score units [$M = 50$; $SD = 10$] obtained by standardizing raw blink magnitude scores within subjects.)

with the viewing time measure. As with the physiological measures, each rating variable was subjected to a two-way (Group × Slide Valence) repeated measures analysis. The overall slide valence effect was significant for all measures, multivariate $F(2, 50) = 339.75$, 207.80, 270.78, and 45.90 for valence, arousal, interest, and viewing time, respectively.

For valence ratings, there was a significant linear trend effect for slide category, with pleasant slides rated highest and unpleasant slides rated lowest in valence, $F(1, 51) = 656.79$, and this effect did not interact with Group, $F(2, 51) = 1.36$; the overall quadratic trend component was not significant, $F(1, 51) = 3.00$ (i.e., neutral slides fell midway between pleasant and unpleasant). Arousal, interest, and viewing time scores were higher for both pleasant and unpleasant slides than for neutral slides, producing significant quadratic trend effects, $F(1, 51) = 292.79$, 154.55, and 64.06, respectively. Together with the SCR results, these data suggest greater interest and arousal for affective slides (whether pleasant or unpleasant) than for neutral slides. In addition, arousal, interest, and viewing time scores (like SCR) were higher for pleasant slides than for unpleasant slides, linear trend $F(1, 51) = 19.04$, 120.51, and 25.25, respectively. None of these effects interacted significantly with Group (i.e., similar patterns over affective contents were obtained for nonpsychopaths, mixed subjects, and psychopaths).

Psychopathy Factors and Startle

Consistent with prediction, nonpsychopaths showed the expected linear pattern of startle modulation (i.e., unpleasant greater than pleasant) whereas psychopaths did not, instead showing a quadratic pattern. Somewhat surprisingly, mixed subjects (who by definition possessed moderate features of psychopathy) did not show an intermediate pattern, but instead showed a strong linear trend effect. In fact, when only the mixed and psychopathic subjects were included in the analysis, the Group × Linear Trend interaction for startle magnitude approached significance, standard score $F(1, 34) = 3.52$, $p = .07$. Thus, it appeared that the phenomenon of startle inhibition for aversive as well as pleasant slides might be a simple function of degree or severity of psychopathy. However, subsequent analyses of these same subjects, reassigned on the basis of PCL-R factor scores (Harpur et al., 1988, 1989), suggested a different interpretation.

It was hypothesized at the outset that abnormalities in startle modulation would be related specifically to psychopaths' emotional and interpersonal deficits, that is, rather than to their antisocial behavior. To examine this hypothesis, all subjects with high scores on the antisociality factor (including most mixed and psychopathic subjects) were grouped and analyzed. PCL-R factor scores were obtained by summing together ratings for items comprising Factor 1 (emotional detachment) and Factor 2 (antisocial behavior). Subjects with high antisocial behavior scores (i.e., those above the scale midpoint on PCL-R Factor 2) were divided into two subgroups based on their Factor 1 scores (*ns* = 18 and 17, respectively; see Figure 2). Means tests

Table 3
Group Means for Raw Corrugator Electromyographic Activity Change, by Slide Valence Category

	Slide category		
Group	Pleasant	Neutral	Unpleasant
Nonpsychopaths	−.20	.01	1.39
Mixed group	−.21	.01	1.97
Psychopaths	.17	−.02	.34

Note. $N = 18$ per group. Units of measurement are μvolts.

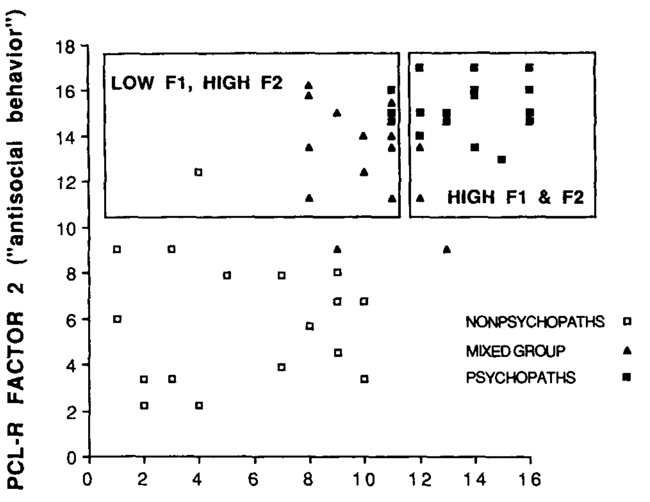

Figure 2. Scatterplot of Revised Psychopathy Checklist (PCL-R; Hare, 1991) factor scores for individual subjects, with initial diagnostic grouping (nonpsychopaths, mixed group, psychopaths) indicated. (F1 = Factor 1 [emotional detachment]; F2 = Factor 2 [antisocial behavior]. Noninteger values on Factor 2 occur in cases in which totals were prorated due to unscoreable items [see Hare, 1991]. Five subjects [1 nonpsychopath, 3 mixed subjects, and 1 psychopath] had F1 and F2 scores that matched another subject's; these points overlap in the figure. For the group high on Factor 2 and the group low on Factor 1, n = 18; for the group high on both factors, n = 17.)

confirmed that these groups differed significantly in emotional detachment, $t(33) = 6.84$, but not in antisocial behavior, $t(33) = 1.58$. Thus, startle patterns could be compared for subjects differing in emotional detachment, but matched on the antisocial behavior factor.

Using this categorization, a significant Factor Group × Linear Trend interaction was obtained for standardized blink magnitude scores, $F(1, 33) = 6.31$; Group × Quadratic Trend, $F(1, 33) = 1.80$, *ns.* The low Factor 1 subgroup showed a significant linear relationship, $F(1, 17) = 22.71$ (quadratic trend, $F < 1$) between slide valence and startle magnitude, with startles largest during unpleasant slides, moderate during neutral slides, and smallest during pleasant slides. For the group high in emotional detachment, startles during pleasant and unpleasant slides did not differ (linear trend, $F < 1$), but a significant quadratic trend effect (reflecting smaller startles during affective slides, whether pleasant or unpleasant, than during neutral slides) was found, $F(1, 16) = 4.65$. Thus, a more refined analysis of subjects differing purely on the emotional detachment dimension of the PCL-R revealed a striking group difference in patterns of startle modulation.

Discussion

Responses to Visual Affective Stimuli in a Criminal Population

Overall patterns of response to affective slides in this sample of convicted male sexual offenders were similar in all measures—physiological, subjective, and behavioral—to those of undergraduate students in the normal college population (Bradley et al., 1990b, 1991). The startle eyeblink reflex, hypothesized to measure affective valence, was larger for aversive materials, relative to pleasant materials, in both subject samples. Heart rate deceleration and corrugator EMG (frown) responses were associated almost exclusively with the affective valence of the materials: larger responses occurred during the viewing of unpleasant, relative to pleasant, slides. Not surprisingly, ratings of pleasantness for slides categorized a priori as pleasant were higher than for slides categorized as unpleasant. More interestingly, both the offender sample and the normal college students produced the same pattern of pleasantness ratings for these slide stimuli.

In both the criminal and college samples, electrodermal responses were related to the level of arousal of the slide stimulus: Pleasant and unpleasant slides produced larger SCRs than did neutral slides. Also, subjects in both samples rated the pleasant and unpleasant slides as more arousing and more interesting than neutral slides and chose to view these slides longer when allowed to control viewing time. These overall findings are important because they replicate, for the first time in an adult clinical population (i.e., convicted sexual offenders), phenomena until now observed only in college student subjects.

One of the few differences between the present sample and normal college students was that SCRs and arousal ratings for the offenders were comparatively larger for pleasant slides than for unpleasant slides. Considering that a few pictures of attractive nudes were included in the slide set and that the subjects were incarcerated sexual offenders with limited access to erotic materials, this effect is not surprising. In fact, with erotic slides removed from the pleasant category, only the expected quadratic relationship was found between slide valence and arousal ratings, $F(1, 51) = 209.62$; linear trend $F(1, 51) = 1.89$, *ns.* Similar results were obtained for SCR and viewing-time measures.

Psychopathy and Emotional Valence

Considering the total weight of evidence, the startle response pattern over slide categories appears abnormal for psychopaths. Although the statistical interactions between Group and Slide Valence were not significant, the expected pattern of results was obtained in the a priori hypothesis tests for the individual groups. Thus, nonpsychopaths and mixed subjects showed larger and faster blink reflexes during unpleasant than during pleasant slides. The linear valence tests were significant for mixed and nonpsychopathic subjects, exactly as has been shown in college subjects (Bradley et al., 1990b, 1991). Conversely, psychopaths did not show this effect in either startle magnitude or startle latency: Neither test of the difference between pleasant and unpleasant slides approached significance. Furthermore, for standardized blink magnitude, the responses of psychopaths during exposure to affective stimuli (comprising pleasant and unpleasant slides) were significantly smaller than during neutral slides.

Of the other physiological measures, the corrugator muscle response showed effects closest to those for the probe reflex. Thus, in analyses of the raw data, psychopaths differed from other offenders in slide valence pattern. This effect was not, however, reliable when standard scores were used to correct for the presence of outliers in the raw score distribution.[5]

Autonomic response measures (SCR and heart rate change) did not show different valence effects across groups. Previous researchers have reported differences between psychopaths and other prisoners on these measures (cf. Hare, 1978a; Siddle & Trasler, 1981), but group differences have been obtained most often in paradigms involving anticipation of aversive events, rather than the kind of direct exposure to unpleasant stimuli used here. In a related experiment with the present population (Patrick et al., 1990), differences in autonomic measures (i.e., reduced reactivity for psychopaths) were observed during imagery of unpleasant experiences. Visceral reactions to a direct perceptual stimulus may be more obligatory for all subjects than is the case in a less-constrained context (i.e., situations of stimulus uncertainty, anticipatory anxiety, or the recall of anxiety images).[6]

Differing patterns of startle reflex modulation for subjects with moderate and extreme scores on the PCL-R were examined in terms of the two psychopathy factors (Factor 1 = emotional detachment; Factor 2 = antisocial behavior) identified by Harpur et al. (1988). Among subjects similarly high in antisocial behavior (Factor 2), the low Factor 1 subgroup showed the same linear relationship between slide valence and startle magnitude seen in nonpsychopaths. On the other hand, for subjects high in emotional detachment, blink reflex magnitudes were equivalent during pleasant and unpleasant slides and, for these affective stimuli, were significantly smaller than during neutral slides. Thus, emotional detachment—defined by such scale features as interpersonal glibness, absence of remorse, callousness, and lack of affective depth, and not simple criminality—appears to be the factor most pertinent to psychopaths' unusual startle pattern.

Possible Mechanisms for Group Differences in Startle Modulation

Cleckley (1955) hypothesized that the clinically observed discordance between emotional language and emotional behavior in psychopaths is part of a broader affective deficit that he termed *semantic dementia.* His criteria for psychopathy included "general poverty" in emotional reactions, absence of "nervousness," and incapacity for guilt or shame. In the present study, psychopaths' affective reports paralleled those of the other offenders and normal subjects. In terms of physiological response patterns, however, significant differences emerged. The most singular finding (for psychopaths generally, and specifically for subjects high in emotional detachment, PCL-R Factor 1) was the absence of an augmented probe–startle response during exposure to unpleasant slides as compared to pleasant slides.

The absence of the expected startle pattern is of particular interest because prior research indicates that the startle response indexes the underlying action disposition of the organism. Following Konorski (1967), Lang et al. (1990) and Lang, Bradley, Cuthbert, and Patrick (in press), postulated the existence of reciprocal motivation systems in the brain—appetitive, positive affect and aversive, negative affect. The affect–startle effect occurs because probes and slides engage either the same or different systems: The startle response is larger when elicited during an aversive emotional state because the negative valence of the reflex probe matches the valence of the ongoing motivational disposition of the organism (defense or withdrawal); conversely, the startle response is diminished during pleasant states because of a mismatch between the defensive startle response and an ongoing positive, appetitive disposition. Responses such as corrugator EMG or heart rate do not have this theoretical significance. They are reactions to the primary emotional stimulus and their motivational relevance is inferred. The probe reflex, on the other hand, is a new behavior to an independent stimulus. Its potentiation necessarily implies that the primary stimulus (the slide) has prompted a motivational change in the organism, that is, because of the amplitude increase or decrease in the new behavior.

Many of the unpleasant slides used in the present study were described as fearful by normal subjects (Bradley et al., 1990b). There is a long research tradition demonstrating that startle responses to acoustic probes are augmented after fear conditioning in both animal (e.g., Brown et al., 1951) and human subjects (e.g., Greenwald et al., 1988). Furthermore, Vrana and Lang (1990) showed that startle responses increased in magnitude with increases in the reported fearfulness of aversive imagery, and Cook et al. (1991), also studying imagery, found larger probe responses generally in subjects preselected for prevalence of phobia. Finally, Davis (1979, 1986) demonstrated that fear-conditioned or fear-sensitized startle augmentation is blocked by administration of antianxiety drugs and that the amygdala plays a key mediating role in the fear–startle relationship. Thus, one interpretation of an absence of potentiated startle during exposure to unpleasant versus pleasant slides (as was observed in psychopaths) is that this reflects a deficit in aversive responding—perhaps specifically, in fear. This interpretation is consistent with theories of psychopathy proposed by Lykken (1957) and Gray (1971).

The startle modulation effects were not complemented by group differences (psychopaths vs. other offenders) in responses unrelated to affective valence. In fact, all measures re-

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[5] As noted earlier, startle modulation effects in the present study occurred independently of valence-related changes in corrugator EMG. These measures have also been found to be dissociated in other research. Bradley, Lang, and Cuthbert (1990) examined response habituation over repeated presentations of a six-slide set (two pleasant, two neutral, and two unpleasant) and found that the affect–startle effect (i.e., unpleasant greater than pleasant) persisted over the entire experiment whereas corrugator EMG differentiation dissipated relatively quickly. These results are consistent with the idea that corrugator muscle activity is a direct response to the affective stimulus (i.e., slide), which is relatively transient. In contrast, the startle reflex (a response to an unwarned probe) reflects the ongoing action disposition of the organism (cf. Lang, Bradley, & Cuthbert, 1990), which is elicited by the stimulus over repeated presentations.

[6] Some published studies have reported electrodermal hyporesponsivity in psychopaths in relation to unsignalled noxious stimulation (Hare, 1972, 1978b), but others have not (Hare, 1975; Hare, Frazelle, & Cox, 1978; Patrick & Iacono, 1991), and none of these studies examined phasic responses to aversive visual stimuli. Group differences in cardiovascular response have not typically been found in unsignalled stimulus paradigms (Hare, 1978a; Siddle & Trasler, 1981).

lated to simple arousal (arousal ratings, skin conductance, interest value, and viewing time) covaried closely (i.e., responses to pleasant and aversive slides were greater than to neutral slides) and were highly similar for all subjects. Thus, it cannot be said that psychopaths showed a deficit in all aspects of emotional responding. The element that may not be present is the capacity of an aversive affective state to prime aversion actions—in this case, to increase the vigor of a defensive reflex, but potentially more broadly, to avoid situations involving pain or punishment.

In conclusion, we must reiterate that the interpretations offered here are tentative, and their acceptance depends on future work with this paradigm. Although the results as a whole encourage the conclusion that the normal valence pattern is not present in psychopaths (suggesting a deficit in emotional responding), the full implications of this result are far from clear. For example, the tendency of psychopaths to show a quadratic effect over slide valence categories for startle magnitude—with smaller reflexes at both affective extremes—suggests that psychopaths may find both positive and aversive slides to be appetitive (despite their contrary subjective judgments). It may indicate that attention inhibits reflex reactions (e.g., Hackley & Graham, 1984) in emotionally detached subjects even when the foreground content is unpleasant (indeed, considerable evidence exists for attentional abnormalities in psychopaths, e.g., Harpur & Hare, 1990; Kosson & Newman, 1986). These interpretations are necessarily tentative: The present experiment focused not on specific group differences in slide affect categories, but on differential patterns of response for each group. From this latter perspective, however, it is compelling that the quadratic startle pattern seen in psychopaths was not observed for any other valence measures. Although this first use of the startle methodology leaves some important issues unresolved, the findings are provocative and represent a palpable advance in our understanding of emotion in criminal deviance. They strongly encourage its use in future research with psychopaths and with other populations for which affective deficits have been hypothesized.

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