PSYCHOPHYSIOLOGY
Vol. 28, No. 3

Printed in U.S.A.

Abnormal Processing of Affective Words by Psychopaths

SHERRIE WILLIAMSON, TIMOTHY J. HARPUR, AND ROBERT D. HARE
Department of Psychology, University of British Columbia, Vancouver, Canada

ABSTRACT

We tested the hypothesis that psychopathy is associated with abnormal processing of affective verbal material. Criminal psychopaths and nonpsychopaths, defined by the Psychopathy Checklist, performed a lexical decision task ("Is it a word or not?") while we recorded reaction time and event-related potentials in response to letter-strings consisting of affective and neutral words and pronounceable nonwords. On the assumption that they do not make efficient use of affective information, our primary prediction was that psychopaths would show less behavioral and event-related potential differentiation between affective and neutral words than would nonpsychopaths. The results were in accordance with this prediction. The lexical decisions of nonpsychopaths were significantly faster, and relevant event-related potential components were significantly larger, to affective words than to neutral words. In sharp contrast, psychopaths failed to show reaction time facilitation or larger amplitude event-related potentials to affective words. We suggest that psychopaths extract less information from affective words than do other individuals. Possible implications of these and related findings for understanding the behavior of psychopaths are discussed.

DESCRIPTORS: Psychopathy, Event-related potentials, Lexical decisions, Semantic processing, Affective words, Information processing.

Clinicians have often speculated that psychopathy involves an inability to experience or appreciate the emotional significance of everyday life events. Cleckley (1976), for example, suggested that psychopaths suffer from a central and deep-seated semantic disorder in which meaning-related associative and elaborative processes are missing. These deficits are then "masked" by well-functioning expressive and receptive processes. He proposed that this disorder, if not specifically language based, is at least reflected strongly in language processes. The psychopath, he argued, "cannot be taught awareness of significance which he fails to feel. He can learn to use the ordinary words and, if he is very clever, even extraordinarily vivid and eloquent words that signify these matters to other people. He will also learn to reproduce appropriately all the pantomime of feeling: but as Sherrington said of the decerebrated animal, the feeling itself does not come to pass" (Cleckley, 1976, p. 374). Others have commented on the psychopath in a similar vein: ". . . ideas of mutuality of sharing and of identification are beyond his understanding in an emotional sense; he knows only the book meaning of words" (Grant, 1977, p. 50). Johns and Quay (1962, p. 217) put it most succinctly when they commented that psychopaths "know the words but not the music." The implication here is that psychopaths have little difficulty with referential content, but that they are unable to effectively analyze, appreciate, or use the affective components of language. The purpose of the present study was to examine this proposition by studying their responses to single words varying in affective tone.

Words with affective connotations[1] have been dissociated experimentally from non-emotional (or

This research was supported by Grant MT-4511 from the Medical Research Council of Canada.

The cooperation of the staff and inmates of the Lower Mainland Regional Correctional Centre, and the assistance of Rodney Day, Adelle Forth, Mike Satterfield, and Gary Birch are gratefully acknowledged.

Sherrie Williamson and Tim Harpur are now at the University of Illinois. Requests for reprints should be sent to either Sherrie Williamson, Department of Psychology, University of Illinois, 603 East Daniel Street, Champaign, Illinois 61820, or to Robert D. Hare, Department of Psychology, University of British Columbia, Vancouver, B.C., Canada V6T 1Y7.

[1]In the present article we use the terms "emotional" and "affective" interchangeably to refer to words rated as extremely pleasant or unpleasant. This dimension corresponds closely to Osgood's Evaluative dimension (Osgood & Suci, 1969). It was used in preference to evaluation ratings themselves because it provided us with a larger pool of standardized ratings from which to select our stimuli.

neutral) words in a number of ways. Graves, Landis, and Goodglass (1981) reported that lexical decisions (whether or not a letter-string is a word) were more accurate when the words involved were affective (negatively toned) than when they were neutral. Strauss (1983) replicated this finding, and also found that reaction times for lexical decisions were faster to affective than to neutral words, even though the two sets of words had been matched for frequency and imageability. We have recently extended these results in a lexical decision study in which the stimuli were pleasant, unpleasant, and neutral words (matched for frequency, concreteness, and imagery), and an equal number of pronounceable nonwords (Harpur, Williamson, & Hare, 1989). Reaction times were significantly faster to positive and negative words than to neutral words.

Event-related brain potentials (ERPs) have also proved useful in investigations of word meaning (Brown, Marsh, & Smith, 1979) and affect (Begleiter, Gross, & Kissin, 1967; Begleiter, Porjesz, Chou, & Aunon, 1983; Johnston, Miller, & Burleson, 1986). Begleiter and Platz (1969) showed that taboo words could be differentiated from neutral words on the basis of the ERPs they elicited. Kostandov and Arzumanov (1977) reported substantial latency and amplitude differences between P300s recorded to neutral words and those recorded to words of particular emotional significance to the subjects (who were reported as being in a state of emotional stress caused by jealousy).

Chapman and his colleagues have provided the most systematic demonstration of a relation between ERPs and the affective component of word meaning (Chapman, 1979; Chapman, McCrary, Chapman, & Bragdon, 1978; Chapman, McCrary, Chapman, & Martin, 1980). They recorded ERPs to six classes of words representing the extreme ends of Osgood's dimensions of Evaluation, Potency, and Activity (Osgood, Suci, & Tannebaum, 1957). Using component scores derived from principal components analysis, they were able to discriminate the ERPs to the six word classes at well above chance levels. Furthermore, they successfully cross-validated their classification function on a new set of ERPs derived from a different list of words. The most significant result for the present paper was that ERPs to words rated extremely good or bad were distinguishable from the remaining four word classes, all of which contained words rated near the mean on evaluation.

It is unclear from these studies which ERP components provide the greatest differentiation between affective and neutral words. Begleiter and Platz (1969) and Kostandov and Arzumanov (1977) examined components with peak latencies in the range of 100–400 ms. Chapman et al. (1978) reported that components with peak latencies of 295, 410, and 495 ms contributed most to the differentiation of word classes. However, none of these studies examined components occurring later than 500 ms. In particular, none measured the late positive component (LPC) elicited by words. The LPC typically peaks between 400 and 800 ms and is maximal at parietal sites. Its amplitude is inversely related to the probability of the eliciting stimulus, and its latency is sensitive to the time taken to evaluate a stimulus independent of factors affecting response selection (Duncan-Johnson & Kopell, 1981; Polich & Donchin, 1988; Polich, McCarthy, Wang, & Donchin, 1983; Rugg, 1983). It appears, therefore, to correspond to the traditional P300 found in many nonlanguage tasks (e.g., Duncan-Johnson & Donchin, 1977; Kutas, McCarthy, & Donchin, 1977; McCarthy & Donchin, 1981). Because affective words carry information of motivational or emotional significance, we would expect them to elicit larger LPC responses than would neutral words (see Begleiter et al., 1983).

In the present study we used a lexical decision task to investigate the processing of lexical affect in criminal psychopaths and nonpsychopaths defined by the Psychopathy Checklist (Hare, 1980). The task allowed us to obtain both behavioral (reaction time) and electrocortical (ERP) data in response to letter-strings consisting of affective and neutral words and pronounceable nonwords. On the assumption that psychopaths do not make efficient use of affective linguistic information, our primary prediction was that they would show less behavioral and electrocortical differentiation between affective and neutral words than would nonpsychopaths.

We used a divided visual field procedure in which the letter-strings appeared in either the right or the left visual field. This allowed us to determine whether we could replicate previous reports of weak functional asymmetries in psychopaths during performance of language-based information processing tasks (Hare & Jutai, 1988; Hare & McPherson, 1984; Jutai, Hare, & Connolly, 1987). Reliable laterality effects have been reported for ERPs recorded both during performance of divided visual field tasks (e.g., Hillyard & Munte, 1984; Kok, van de Vijver, & Rooyakkers, 1985) and during language processing (e.g., Kutas & Hillyard, 1982; Neville, Kutas, & Schmidt, 1982a). Therefore we recorded ERPs bilaterally from temporo-parietal sites approximately over Wernicke's area, as well as from midline electrodes. Although no predictions about specific ERP asymmetries were made in the present study, we did expect that any language-related laterality effects would be less evident in psychopaths than in nonpsychopaths.

Method

Subjects

The subjects were 16 male inmates from a Canadian provincial prison near Vancouver, British Columbia. Volunteers were selected to participate if they were between 18 and 41 years of age, had learned English as their first language, had normal, or corrected-to-normal vision, were free of known neurological impairment, and were strongly right-handed (Annett, 1970). Each subject was paid $10 for his participation, and an additional $25 was offered to the inmate who responded most quickly and accurately.

Institutional files and a semi-structured interview were used to complete the 22-item Psychopathy Checklist (PCL). The PCL, described in detail elsewhere (Hare, 1980; Hare & Frazelle, 1980), is a reliable and valid instrument for the assessment of psychopathy in criminal populations (Hare, 1983, 1985; Harpur, Hakstian, & Hare, 1988; Harpur, Hare, & Hakstian, 1989; Hart & Hare, 1989; Newman & Kosson, 1986; Schroeder, Schroeder, & Hare, 1983; Wong, 1984; see also reviews by Widiger & Frances, 1987, and Green, 1988). Each item is scored on a 3-point scale (0–2) according to the extent to which it applies to the inmate. Alpha coefficients and interrater correlations for total scores (which can range from 0–44) typically are above .85. The mean and standard deviation of the PCL in this sample (N=134) were 27.0 and 7.5 respectively. The intraclass correlation (two independent ratings; Shrout & Fleiss, 1979) for a subsample of 76 inmates rated by two raters was .86.

Inmates with a mean PCL score above 33 (n=8) were defined as Psychopaths, and those with a mean PCL score below 25 (n=8) were defined as Nonpsychopaths. The mean PCL score was 36.6 (SD=1.8) for the Psychopaths, and 18.6 (SD=4.1) for the Nonpsychopaths. Mean age, years of formal education, and occupational class (Hollingshead & Redlich, 1958) were 25 and 23 years, 10.7 and 8.4 years, and 6.12 and 5.75 for Psychopaths and Nonpsychopaths respectively. The two groups did not differ significantly in age, education, socioeconomic status, or reported level of drug and alcohol use. Fifteen subjects were white and one (a nonpsychopath) was North American Indian. IQ measures were not available for subjects in this sample. However, there is considerable evidence that psychopaths defined by the PCL do not differ in IQ from nonpsychopaths (Hare, Frazelle, Bus, & Jutai, 1980; Harpur, Hare, & Hakstian, 1989; Newman & Kosson, 1986).

Stimuli

Stimulus words were affectively positive, negative, and neutral (13 of each type), and were selected from the 7-point pleasant/unpleasant ratings given in Toglia and Battig (1978). Words rated as more than 1.3 SDs above or below the mean pleasantness rating were defined as positive (e.g., milk) and negative (e.g., scar) respectively; neutral words (e.g., gate) were those that fell less than .5 SDs from the mean[2]. Words of each type were individually matched for length (3–5 letters), number of syllables (1–3), imagery and concreteness (Toglia & Battig, 1978), and frequency (Kucera & Francis, 1967; see Table 1). The resulting three word groups did not differ on any of these dimensions. Thirty-nine pronounceable nonwords were created by altering a single letter (a vowel in all but two cases), other than the first, for each of the selected words.

Physiological Recording

Brain electrical activity was recorded from Beckman Ag/AgCl electrodes attached with collodion over F_Z, C_Z, P_Z, PT_3, and PT_4 (midway from P_Z to the external auditory meatus), and referenced to linked earlobes. Electrical impedances were kept below 5 Kohms throughout the experiment. Impedance differences for the left and the right earlobes were always less than 5 Kohms. Blinks were monitored by a bipolar supraorbital-to-external canthal montage and trials containing eye-movement artifact (greater than $50\mu V$) were excluded. Signals were filtered (.16–30 Hz bandpass), digitized on-line at 512 Hz for 2250 ms beginning 250 ms prestimulus, and stored on microcomputer hard-disk. Trials on which subjects responded correctly were averaged off-line separately for each word type, visual field, electrode lead, and group.

Procedure

After the attachment of electrodes, the subject was given a randomised list of the 78 words and nonwords

[2]The word list is available upon request from the first author.

Table 1
Characteristics of the three word types: Mean frequency and ratings for imagery, concreteness, and pleasantness

Word Type	Mean Values (SDs in parentheses)			
	Frequency (per million)[a]	Imagery[b]	Concreteness[b]	Pleasantness[b]
Positive	86.6 (123)	5.82 (.53)	5.27 (1.16)	5.81 (.31)
Negative	85.7 (126)	5.50 (.66)	5.16 (.99)	2.32 (.27)
Neutral	90.9 (113)	5.62 (.39)	5.70 (.47)	3.95 (.24)

[a]from Kucera and Francis (1967).
[b]7-point scale; from Toglia and Battig (1978).

to be used in the experiment and was asked to circle the real words. This ensured that he knew the words and reduced the effect of priming due to repetition (Scarborough, Cortese, & Scarborough, 1977).

The subject sat approximately 40 cm from a graphics monitor on which stimuli appeared for 176 ms. The letters were uppercase, white on a black background, and vertically oriented approximately 3° to the right or left of a central fixation point. The stimuli subtended a vertical angle of 2.3°–4.3°. Intertrial interval varied randomly from 3–5 s to prevent the development of an anticipatory slow negative wave. Recording was carried out in an empty tier of the prison which could not be shielded from occasional extraneous sounds. For this reason subjects heard 65dB SPL white noise through headphones while doing the task.

The subject was asked to watch the central fixation point and to press a button with the right hand as rapidly and accurately as possible whenever a letter-string formed an English word. Words and nonwords appeared in the same random order for all subjects. The subject performed two practice blocks of 18 stimuli each using a different set of words and nonwords, all of which were neutral. Then 26 blocks of 18 trials each were presented, with a word and its corresponding nonword never appearing in the same block. A short break (15–30 s) was given between each block with a longer pause (5–10 min) at the midpoint of the experiment. Each word and nonword appeared three times in each visual field, for a total of 468 trials. At the end of the experiment the subject completed a 7-point rating scale (bad to good) for each word seen during the experiment. Word rating data was unavailable for one nonpsychopathic subject.

Data Analysis

Reaction time and ERP data were analysed only on trials on which the subject responded correctly. Responses delayed by more than 2.5 SDs from his mean reaction time were counted as errors. These errors were equally distributed among word types, and occurred on 1.2% and 1.6% of the trials for Nonpsychopaths and Psychopaths respectively.

Separate 2(Group) × 3(Word Type) × 2(Visual Field) analyses of variance (ANOVAs) were performed on the accuracy and reaction data. Similar ANOVAs were performed on ERP amplitudes, one for the midline sites and one for the lateral sites. These latter analyses included an additional factor of Site (F_Z, C_Z, and P_Z for the midline analyses; PT_3 and PT_4 for the lateral analyses). We treated each Word Type (positive, negative, neutral) as an independent source of variance in the initial ANOVA, but collapsed across positive and negative words for the planned comparisons. This allowed us to observe possible differences between positive and negative words. However, we planned to compare only emotional words, regardless of valence, with nonemotional words. For each ANOVA we were primarily interested in the Group × Word Type interaction. Following a significant interaction, specific hypotheses were tested by two planned comparisons. These hypotheses were that (1) responses to emotional words (the average of positive and negative) would differ significantly from responses to neutral words for nonpsychopaths, and (2) the emotional-neutral difference would be significantly smaller in psychopaths than in nonpsychopaths. Type I error rate was maintained below .05 across the two comparisons by means of the Dunn-Bonferroni correction, resulting in a critical value of the t statistic for these planned comparisons of 2.37 (Glass & Hopkins, 1984, p. 381). Other significant effects were reported where appropriate and were followed by simple main effects analyses, or Tukey (type A) multiple comparisons.

In each ANOVA we treated subjects as a random effect and words as a fixed effect. Therefore a significant effect of word type can be expected to generalize to a new sample of similarly chosen subjects, but not necessarily to a new set of similarly chosen words (see Clark, 1973). Such an approach was appropriate because our primary interest was in psychopathy, not emotional words per se. Where we discuss differences between emotional and neutral words, we intend to refer only to the specific words used in our study.

The assumption of sphericity was not violated for any of the significant Word Type × Group interactions. In one case the Huynh-Feldt estimate of epsilon equalled .88; in all other cases it was unity. Therefore, we are confident that the significance levels associated with these interactions, and the planned comparisons that followed them, are accurate (see Vasey & Thayer, 1987).

All probability levels are reported using epsilon-adjusted degrees of freedom. Because the degree of non-sphericity was in general small, estimates of epsilon derived by Huynh and Feldt (1970) were used (see Boik, 1981). When used, the nominal degrees of freedom and the value of epsilon are both reported. We note that although epsilon protects the F-tests from violations of sphericity assumptions, it does not protect post hoc comparisons. In light of this, caution is recommended when interpreting the results of post hoc Tukey comparisons in cases where epsilon deviates more than trivially from unity (Boik, 1981; Vasey & Thayer, 1987).

Results

Behavioral Measures

Reaction time. Mean reaction times (RTs) were calculated for correct responses to each word type in each visual field. The predicted Group × Word Type interaction was the only significant effect ($F(2/28)=3.72$, $\epsilon=1$, $p<.04$).[3] Mean reaction times for

[3]We also determined whether or not each inmate met the criteria for antisocial personality disorder (APD) described in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III; American Psychiatric Association, 1980). Diagnoses of APD are related to, but not interchangeable with, the PCL (Psychopathy Checklist) criteria

Table 2
Accuracy and reaction time for Psychopaths (P) and Nonpsychopaths (NP) for each word type

	% Correct		Reaction Time (ms)	
Word Type	**NP**	**P**	**NP**	**P**
Positive	82	79	812	884
Negative	85	79	817	905
Neutral	76	70	863	867

each PCL group and condition are shown in Table 2. Planned comparisons indicated that Nonpsychopaths responded faster to the emotional words than to the neutral words ($t(28)=2.37$), and that this RT facilitation differed from that found for Psychopaths ($t(28)=2.62$). In fact, inspection of Table 2 reveals that Psychopaths responded slower to emotional than to neutral words. Because this finding was not predicted, it was inappropriate to test this difference statistically. However, future research should consider whether psychopaths show a reliable interference effect when processing emotional material.

for psychopathy (Hare, 1985; Harpur, Hare, & Hakstian, 1989; Hart & Hare, 1989). Reanalysis of reaction time, with subjects grouped according to the presence/absence of APD, failed to produce a significant Group (APD, nonAPD) × Word Type interaction ($F(1/14)=0.23$).

Accuracy. There was a main effect of word type ($F(2/28)=12.79$, $\epsilon=1$, $p<.001$), but no group differences for accuracy. The percentage of correct responses for each group is presented in Table 2. Post hoc comparisons indicated that responses to positive and negative words (no difference between them) were more accurate than those to neutral words.

Event-Related Potentials

Separate averages were calculated for each word type and visual field, excluding trials on which subjects responded incorrectly or that were contaminated by EOG artifact. The grand averages for each group are shown in Figure 1. There were no group differences in the number of trials averaged in any condition.

We performed preliminary principal components analyses followed by varimax rotations separately for the two groups. We followed this pro-

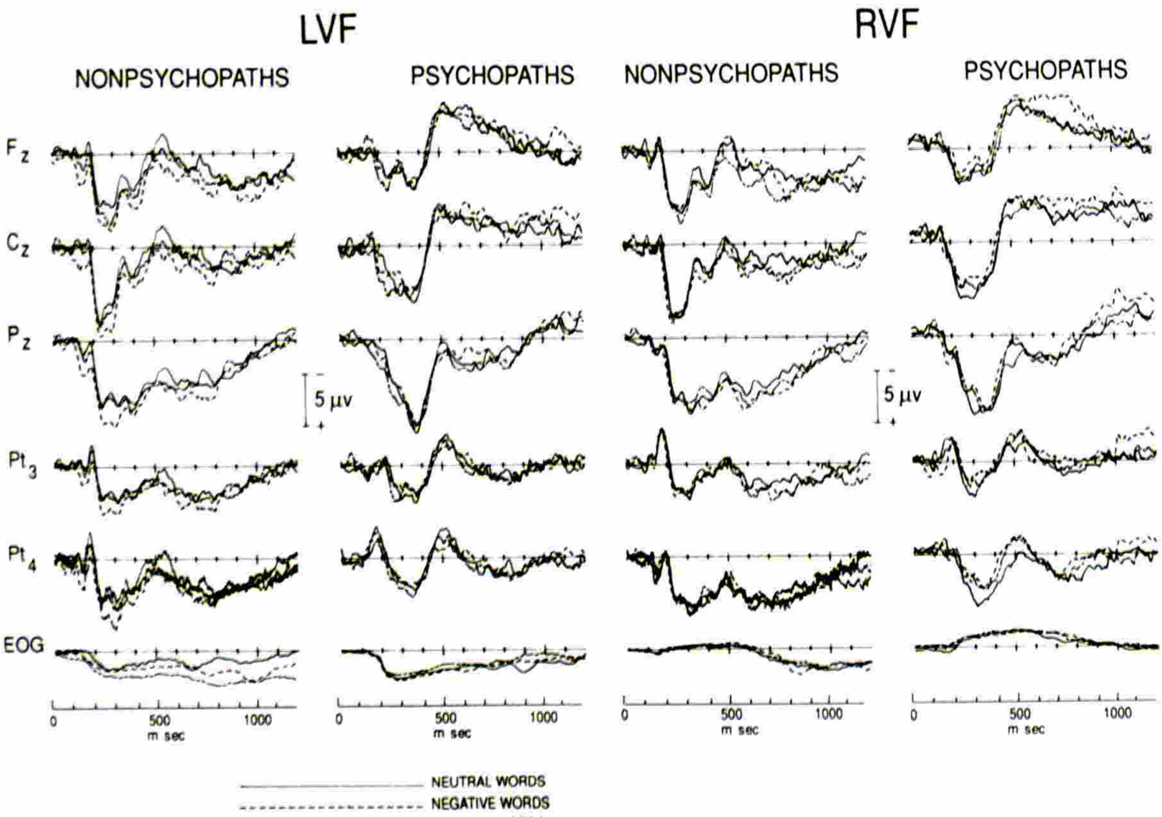

Figure 1. Grand average ERPs for psychopaths and nonpsychopaths to positive, negative, and neutral words presented in the right and left visual fields (RVF and LVF respectively).

cedure in order to avoid identifying spurious components as a result of the apparent differences in the latency and morphology of the waveforms of the two groups. We were also interested in identifying components related to word affectivity, which we expected to be present for the Nonpsychopaths but not necessarily for the Psychopaths. The identification of similar components for the two groups, based on the latency of the component and the sensitivity of the component score to experimental manipulations, was possible in only two cases: A slow wave, spanning 600–1000 ms, and an early component (220–320 ms). The latter showed the greatest sensitivity to emotional valence of any component for the Nonpsychopaths (factor scores greatest for negative then positive and smallest for neutral words). For the Psychopaths, the similar component showed some sensitivity to affective valence, but in the opposite direction to that for Nonpsychopaths. An earlier component, spanning 160–200 ms, also differentiated emotional and nonemotional words for the Nonpsychopaths. For the Nonpsychopaths there were no components that distinguished between the two types of emotional words.

Visual inspection of raw and subtraction (positive-neutral and negative-neutral) waveforms also identified several components that appeared to differentiate affective from neutral words. These components corresponded to an early positive-negative complex (P150-N180), the first major positive deflection (P240), and, as predicted, a late positive component (LPC) peaking at about 613 ms and maximal at P_Z (see Figure 1). Consistent with the results of the principal components analysis, there were no areas of the waveforms that appeared to distinguish between positive and negative words.

Components were quantified by calculating the mean amplitude (relative to the prestimulus baseline) over the following latency windows: P150-N180, 130–200 ms; P240, 225–300 ms; LPC, 650–800 ms. In addition, an unexpected frontal negativity, peaking at about 500 ms, was clearly apparent, particularly in Psychopaths' waveforms. We quantified this as the mean amplitude over the latency window 475–525 ms.

We chose to use mean amplitudes rather than peak measurements as our primary method of analysis for the following reasons. First, we were primarily interested in ERP differences related to the emotional content of the words, at least in Nonpsychopaths' waveforms. These differences tended to overlap several component peaks in the raw waveforms. Second, there was considerable variability in subjects' individual averages which, in some conditions, led us to doubt the validity of identifying a specific peak. This difficulty was compounded by the differences in morphology of ERPs for the two groups (see Figure 3). Measurement of the P150, N180, and P240 peaks was generally easier in the ERPs of Nonpsychopaths than in those of Psychopaths. For similar reasons, use of a principal components analysis incorporating data from both groups was considered likely to result in the identification of spurious components.

We considered the use of mean amplitude, a measure that is far from uncommon in comparable circumstances (e.g., Neville, Kutas, Chesney, & Schmidt, 1986; Neville et al., 1982a; Neville, Kutas, & Schmidt, 1982b; Rugg, 1985, 1987; Rugg, Furda, & Lorist, 1988; Rugg & Nagy, 1987), to be the most appropriate method of testing our stated hypotheses. However, because mean amplitude measures encompassed both positive and negative deflections, especially in the case of the P150-N180 complex, we also recorded peak measurements for the early components (P150, N180, and P240). The P150 was recorded as the largest positivity occurring between 100 and 180 ms; the N180 as the largest negativity occurring before 220 ms following the P150; and the P240 as the maximal positivity prior to 260 ms following the N180. For the later N500 and late positive component, both appearing as slow waves, peak measurements were not made.

Data relevant to the hypotheses under study can be seen more clearly by collapsing the averages shown in Figure 1 across visual field and emotional valence (positive and negative). These grand averages are shown in Figure 2.

As will be described below, none of the analyses revealed significant Group × Visual Field effects. In addition, our primary hypothesis did not distinguish between positive and negative words: The comparisons carried out following a significant interaction were planned to compare the average of positive and negative words with neutral words. The averages in Figure 2, therefore, represent the data most directly relevant to the primary hypothesis of this study, namely that the Psychopaths would show less ERP and reaction time differentiation between emotional and neutral words than would the Nonpsychopaths. Average amplitudes at midline sites for relevant latency windows are presented in Table 3.

Inspection of Figure 2 revealed that the Nonpsychopaths' ERPs to the emotional words were different from those to the neutral words. This difference was characterized by a sustained positivity present in the ERPs to emotional words, widely distributed over the scalp and beginning as early as 100 ms after stimulus presentation. This positivity was present for words of both valence, although the

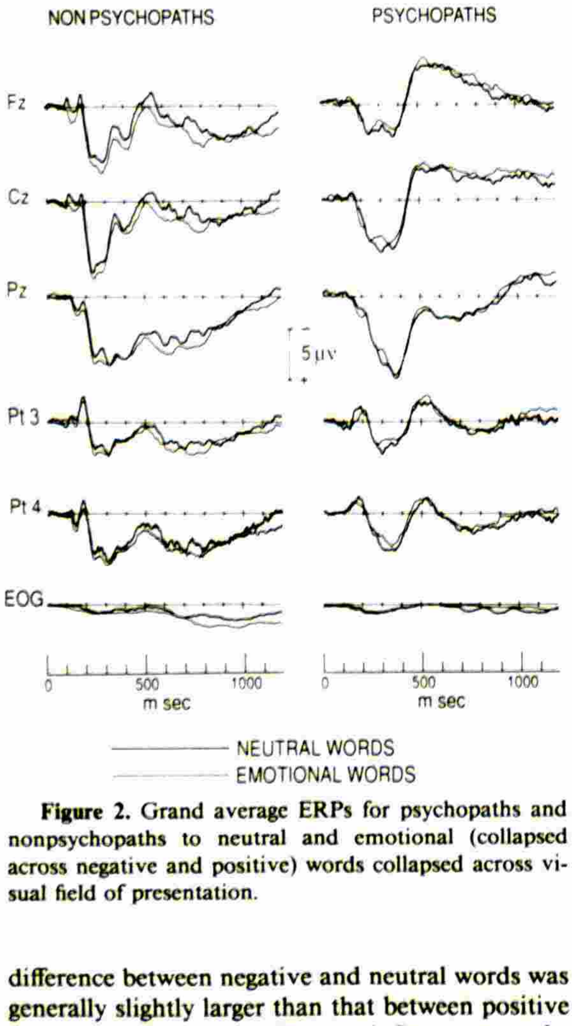

Figure 2. Grand average ERPs for psychopaths and nonpsychopaths to neutral and emotional (collapsed across negative and positive) words collapsed across visual field of presentation.

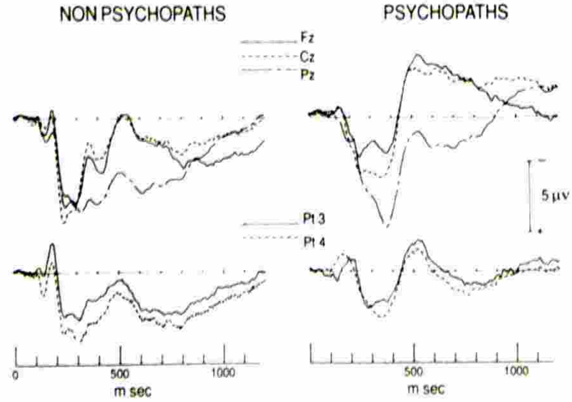

Figure 3. Grand average ERPs for psychopaths and nonpsychopaths collapsed across word type and visual field.

difference between negative and neutral words was generally slightly larger than that between positive and neutral words (see Figure 1). In contrast, the Psychopaths' ERPs to the emotional words were not very different from those to the neutral words. Indeed, any differences were generally opposite in direction to those obtained with the Nonpsychopaths.

Equally striking were group differences in the morphology of the waveforms. These differences are most apparent in Figure 3, in which the ERPs have been averaged across word types and visual fields. The ERPs of the Psychopaths lacked a clearly defined P240 at posterior sites and contained a very small late positive component. In addition, there was a large frontal negative wave that peaked at about 500 ms (N500). Although the Nonpsychopaths also showed evidence of frontal negativity around 500 ms, it involved primarily a return to baseline.

P150-N180 area analysis. No significant effects were obtained from analyses of data from midline sites.

Data from the lateral sites produced a significant Visual Field × Site interaction ($F(1/14)=12.76$, $p<.005$). Mean amplitudes (in μV) for the four combinations of visual field (right, left) and site were: left-PT_3, 0.24; left-PT_4, -0.68; right-PT_3, -1.35; right-Pt_4, 0.16. Although negativity was generally greater contralateral to the visual field of stimulation, post hoc comparisons indicated that

Table 3
Average ERP amplitudes for Psychopaths (P) and Nonpsychopaths (NP) for each word type at midline electrodes

ERP Component	Group	Neutral F_z	Neutral C_z	Neutral P_z	Negative F_z	Negative C_z	Negative P_z	Positive F_z	Positive C_z	Positive P_z
P150–N180	NP	−0.13	−0.11	0.80	1.10	1.24	1.83	0.62	0.36	1.12
(130–200 ms)	P	−0.13	−0.14	0.51	−0.51	0.12	1.01	0.02	0.37	1.00
P240	NP	5.05	6.33	5.39	6.02	7.65	6.81	5.94	6.83	5.81
(225–300 ms)	P	2.57	4.14	4.39	1.86	3.13	4.08	2.70	4.19	4.58
N500	NP	−0.40	−0.38	3.63	0.24	0.51	4.10	0.78	0.55	4.25
(475–525 ms)	P	−3.41	−3.01	1.71	−3.77	−3.19	1.31	−3.95	−3.65	1.12
LPC	NP	1.66	1.18	3.24	3.02	3.15	5.23	3.28	2.63	4.72
(650–800 ms)	P	−2.67	−2.37	1.80	−3.71	−3.17	1.50	−2.26	−2.33	2.21

Average ERP Amplitudes (μV)

the responses recorded over PT_3 and PT_4 were significantly different when the words were presented in the right visual field but not when they were presented in the left visual field.

There was also a Group × Site interaction for responses recorded over lateral sites ($F(1/14)=10.37$, $p<.01$). Nonpsychopaths' responses were more negative in the left hemisphere than in the right hemisphere, whereas the opposite was true for the Psychopaths. Mean amplitudes (in μV) for Nonpsychopaths were −0.94 at PT_3 and 0.49 at PT_4. Mean amplitudes for Psychopaths were −0.17 at PT_3 and −1.01 at PT_4. Post hoc comparisons indicated that only the group difference at PT_4 was significant.

P150 peak analysis. The results of the analysis of peak amplitude measurements at midline sites revealed a significant Group × Visual Field × Word Type interaction ($F(2/28)=3.46$, $\epsilon=1$, $p<.04$). However, analyses of simple main effects for Psychopaths and Nonpsychopaths revealed no significant effects of word type or visual field for either group. None of the peak latency results was significant.

For lateral sites the amplitude analysis produced a significant Visual Field × Site interaction ($F(1/14)=5.41$, $p<.04$). Post hoc tests revealed the same pattern of results as that found for the area analysis. The Visual Field × Site interaction ($F(1/14)=17.12$, $p<.001$) was the only significant effect for the latency analysis. The results of the post hoc tests revealed latencies to be about 10 ms faster, when recorded over PT_4 to stimuli that had been presented in the left visual field, than latencies obtained from the other combinations of Site and Visual Field.

N180 peak analysis. At midline sites there were no significant effects for amplitude or latency. For amplitude at lateral sites there was a significant Visual Field × Site interaction ($F(1/14)=4.67$, $p<.05$). Post hoc tests indicated a pattern of results similar to that found for P150 amplitude and peak measures. There were no differences in the latency of the N180 at lateral sites.

P240 area analysis. The Group × Word Type interaction was significant for both midline sites ($F(2/28)=5.23$, $\epsilon=1$, $p<.02$) and lateral sites ($F(2/28)=3.58$, $\epsilon=.88$, $p<.05$). Planned comparisons for the midline sites indicated that P240 responses were larger to emotional than to neutral words for Nonpsychopaths ($t(28)=2.43$), but this effect did not quite reach significance in distinguishing the two groups ($t(28)=2.25$). Planned comparisons for the lateral sites failed to reach significance ($t(28)$ = 1.76 and 1.84).

Two additional effects were significant for the P240 component. For midline sites there was a Group × Word Type × Visual Field × Site interaction ($F(4/56)=2.68$, $\epsilon=.87$, $p<.05$). We made no attempt to interpret this interaction. For lateral sites there was a main effect of site ($F(1/14)=4.72$, $p<.05$). The P240 was larger at PT_4 (3.03 μV) than at PT_3 (2.40 μV).

P240 peak analysis. The Group × Word Type interaction at midline sites was the only significant amplitude effect ($F(2/28)=4.43$, $\epsilon=1$, $p<.03$). Planned comparisons indicated that P240 peak responses were larger to emotional than to neutral words for Nonpsychopaths ($t(28)=3.06$), and that this effect was greater for Nonpsychopaths than Psychopaths ($t(28)=2.71$). Mean peak amplitudes (in μV) for emotional and neutral words were 8.20 and 7.00 for Nonpsychopaths, and 5.01 and 5.13 for Psychopaths respectively.

The only significant latency effect was for site at the lateral electrodes ($F(1/14)=7.94$, $p<.01$); the P240 occurred earlier at PT_3 (240 ms) than at PT_4 (248 ms).

Late positive component. The Group × Word Type interaction was significant at midline sites ($F(2/28)=5.16$, $\epsilon=1$, $p<.02$) but not at the lateral sites. Both planned comparisons for the midline sites were significant, indicating that Nonpsychopaths responded with a larger late positive component to emotional words than to neutral words ($t(28)=3.49$), and that the difference between word types was greater for Nonpsychopaths than for Psychopaths ($t(28)=2.89$).

There were several additional significant effects. At midline sites the LPC was of smaller amplitude in Psychopaths than in Nonpsychopaths ($F(1/14)=9.53$, $p<.01$). There were also significant effects of site ($F(2/28)=22.94$, $\epsilon=.91$, $p<.001$), and Group × Site ($F(2/28)=4.06$, $\epsilon=.91$, $p<.04$) and Word Type × Site ($F(4/56)=3.06$, $\epsilon=.82$, $p<.04$) interactions. Post hoc tests indicated that the late positive component was larger at P_Z than at C_Z or F_Z and that the latter two did not differ. This main effect of site was moderated by the Group × Site interaction. F_Z and C_Z differed from P_Z for Psychopaths, but the differences for Nonpsychopaths did not reach significance. Inspection of the amplitude values in Table 3 suggests that this interaction could be attributed to the sustained negativity still present at this latency at fronto-central sites for Psychopaths. We did not analyze further the unpredicted Word Type × Site interaction.

The late positive component was also significantly smaller for Psychopaths than for Nonpsychopaths at the lateral sites ($F(1/14)=6.17$, $p<.03$). There was a main effect of site ($F(1/14)=7.45$, $p<$

.02) and a Site × Visual Field interaction ($F(1/14)=8.02$, $p<.02$). This component was larger over the right hemisphere than the left, but this asymmetry was significant only for stimuli in the right visual field. Mean amplitudes (in μV) for visual field and site were: left-PT_3, 2.01; left-PT_4, 1.99; right-PT_3, 1.41; right-PT_4, 2.78.

N500. Psychopaths produced a consistently larger N500 than did Nonpsychopaths at midline sites ($F(1/14)=10.03$, $p<.01$) and at lateral sites ($F(1/14)=6.45$, $p<.03$). For the midline sites there was also a main effect of site ($F(2/28)=26.16$, $\epsilon=0.67$, $p<.0001$), indicating greater negativity at F_Z and C_Z (which did not differ) than at P_Z. Significant Visual Field × Site and Visual Field × Word Type × Site interactions for the lateral sites were not investigated further.

Nonwords. Our primary interest in this study was in the ERPs elicited by words. However, we also examined the ERPs to nonwords. Differences in the response requirements for the two types of stimuli ruled out the possibility of making direct comparisons of word and nonword ERPs, but we were able to examine whether group differences in the N500 and late positive component occurred for both words and nonwords. Because subjects were required to inhibit responding to nonwords, this allowed us to rule out the possibility that these differences resulted from the specific motor responses required to words.

Grand average ERPs to nonwords for each group are presented in Figure 4. "Emotional" and "Neutral" nonwords had been constructed by changing one letter of the corresponding words. For both subject groups the waveforms for nonwords were generally similar to their waveforms for words. The primary differences occurred with the Nonpsychopaths' late positive component (LPC). Their LPC amplitude was smaller for nonwords than for words, and the emotional-neutral difference observed with words did not occur with the corresponding nonwords. Because the physical features of the nonwords differed only slightly from those of the words, this supports our contention that the Nonpsychopaths' differentiation between emotional and neutral words is attributable to differences in word meaning rather than to differences in the physical attributes of the stimuli.

Statistical analyses of the midline sites confirmed that, like words, nonwords elicited a larger N500 ($F(1/14)=10.84$, $p<.01$) and a smaller late positive component ($F(1/14)=7.11$, $p<.02$) in Psychopaths than in Nonpsychopaths. However, here there were no main effects of word type or Word Type × Group interactions for either the P240 or the late positive component.

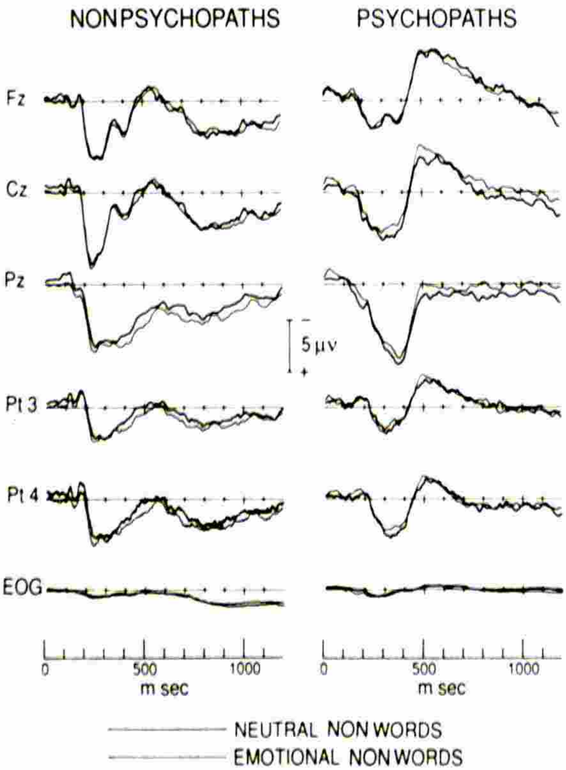

Figure 4. Grand average ERPs for psychopaths and nonpsychopaths for "neutral" and "emotional" (collapsed across negative and positive) nonwords. Nonwords were designated neutral or emotional depending on the word from which they were derived.

Word Ratings

Both groups rated positive, negative, and neutral words significantly differently on the Good-Bad scale. Average ratings for Psychopaths were 2.0, 4.4, and 3.3 respectively; for Nonpsychopaths they were 1.9, 5.3, and 3.1 respectively. Although the Psychopaths rated the negative words less bad than did the Nonpsychopaths, this difference was largely attributable to a single subject who rated all the words as good. None of the group differences in the ratings of these words was reliable whether or not this subject was included in the analyses (all t's<1.40).

Discussion

The reaction time and ERP data supported the prediction that psychopaths would show less behavioral and electrocortical differentiation between affective and neutral words than would nonpsychopaths. The nonpsychopaths responded faster to the emotional than to the neutral words, whereas the psychopaths did not. Moreover, the P240 and LPC components of the ERPs differentiated between the emotional and neutral words in nonpsychopaths. In psychopaths this differentiation was greatly reduced. These results support our hypothesis that psychopaths do not make appropriate use of the affective components of language.

It is important to note here that the waveforms of the nonpsychopaths resembled those of noncriminal individuals tested in similar paradigms (e.g., Bentin, McCarthy, & Wood, 1985; Neville et al., 1986; Neville et al., 1982a; Polich & Donchin, 1988; Rugg, 1983, 1985, 1987). This occurred despite the fact that the nonpsychopathic control group employed in this study probably differed from the usual "normal" (i.e., university undergraduate) subjects in ERP studies in many important ways (age, education, IQ, institutionalisation, etc.), and recording was carried out in less than ideal conditions.

One apparent difference from the noncriminals was the relatively small midline ERP amplitudes obtained from the nonpsychopaths in this study. Several things could account for this difference. Most studies have used either central presentation of stimuli and recordings from midline electrode sites (e.g., Bentin et al., 1985; Polich & Donchin, 1988; Rugg, 1983, 1985, 1987), or lateral presentation of stimuli and recordings predominantly from lateral sites (e.g., Neville et al., 1982a). Our use of lateral presentations may have resulted in smaller midline ERPs than would have been obtained with central presentation (Kok et al., 1985; Kutas & Hillyard, 1982). We also recorded many more trials than is usual in similar designs, which may have produced smaller ERPs than would otherwise have been the case (Kutas & Hillyard, 1982).

Besides their failure to differentiate between affective and neutral words in a way consistent with that found in nonpsychopaths, the psychopaths also differed from the nonpsychopaths in the overall amplitude of the fronto-central negative component (N500) and the late positive component. An N500 of smaller magnitude was also visible in the nonpsychopaths' ERPs, which returned to baseline at frontal and central sites.

The functional significance of this component cannot be unambiguously determined from the present study, but two possible explanations present themselves. The N500 may be similar to the N4 described by Kutas and Hillyard (1980, 1983, 1984), a negative component sensitive to the semantic expectancy set up by linguistic contexts during reading. Previous studies of lexical decision tasks have suggested that the N4 is elicited by each occurrence of an isolated word, but that words primed by an immediately preceding semantically related word elicit an attenuated N4 (Bentin et al., 1985; Rugg, 1985). Although the negativity observed here occurred at a longer latency than is usual, the same delay occurred for the late positive component and reaction time and thus may reflect the lower verbal skills of the criminals used in the present study. A more compelling reason for rejecting this interpretation is the distribution of the N500. N4 has been shown to be maximal at parietal sites and larger over the right than over the left hemisphere. The N500 observed here was frontally distributed and slightly, but not significantly, larger over the left hemisphere. Furthermore, stimuli in the present study were read by the subjects before beginning ERP recording and were presented six times, albeit not consecutively, which would further militate against the development of an N4.

We must note, however, that the literature on late negativities associated with word repetition and priming is somewhat inconsistent. Although Bentin et al. (1985) and Rugg (1985) reported parietally maximal negativities associated with priming in lexical decision tasks, Rugg (1987), in Experiment 1, has also reported a frontally and left hemisphere dominant negativity associated with semantic priming. In his study a qualitatively different component associated with word repetition (but not priming) was topographically more similar to the classical N4.

Despite the preceding arguments, the current literature supports the contention that isolated words elicit one or more late negative components which seem to index the "elaborative processes . . . which act to integrate various attributes of the item, such as its meaning, with its context" (Rugg et al., 1988, p. 62). Viewed from this perspective, the abnormal N500 may be a measure of the greater difficulty psychopaths have integrating word meanings either within larger linguistic structures or with other conceptual structures (Gillstrom & Hare, 1988).

An alternative account of the N500 might involve the use in the present study of a Go/No-Go procedure in which the subject either had to make (Go) or had to inhibit (No-Go) a response. Most other studies have required subjects to make a discriminative (Go/Go) response on each trial (e.g., Bentin et al., 1985; Rugg, 1983); fronto-central negativity at this latency is less evident in these latter studies. However, in three studies that have recorded ERPs during performance of Go/No-Go tasks, including word reading, a fronto-central negativity (prior to P300) can be seen quite prominently (Pfefferbaum & Ford, 1988; Pfefferbaum, Ford, Weller, & Kopell, 1985; Rugg et al., 1988). Procedural differences between these studies and our own, as well as the fact that the other investigators did not consider this negativity in relation to response inhibition, makes this explanation tenuous at present. However, behavioral studies have repeatedly demonstrated that psychopaths are, in certain circumstances, very poor at appropriately modulating their responses (Newman, 1987; Newman & Kosson, 1986; Newman, Patterson, & Kosson, 1987).

The reduced LPC amplitude in psychopaths is not consistent with previous reports of normal or enhanced P3s in this group (Forth & Hare, 1989; Raine & Venables, 1987, 1988). However, these studies employed nonlinguistic tasks, suggesting that the LPC difference observed here may reflect specifically linguistic aspects of information processing. Possibly the words (both emotional and neutral) used as stimuli had less significance for the psychopaths than they did for the nonpsychopaths. Whether such a deficit results from, or is related to, the hypothesis that psychopaths have trouble integrating word meanings into wider contexts, we cannot tell, but the two explanations are certainly compatible. Alternatively the reduced LPC amplitude may have partly resulted from a carry-over from the large N500, which overlapped the LPC in latency, although the fronto-central distribution of the latter argues against this explanation.

Psychopaths also failed to show the P240, LPC, and RT (reaction time) differentiation between neutral and emotional words found for nonpsychopaths. This suggests that affective words do not have the same emotional or motivational significance for psychopaths that they do for nonpsychopaths. Possibly psychopaths do not extract any more information from affective words than they do from neutral words. Alternatively, there may have been a complex interaction, which differed for the two groups, between the repetition of a word and its emotional valence. A difference in how the groups responded to repetitions of words in general could also underlie the observed overall difference in LPC amplitude. It is also possible that the use of a divided visual field paradigm may have caused the processing of affective words to be particularly difficult for the psychopaths. If emotional words have a significant right hemisphere representation (Graves et al., 1981), and psychopaths have difficulty integrating affective and linguistic information, a divided visual field task may have emphasized this deficit. The resolution of these questions will require further studies using word sets that are sufficiently large not to require repetition of individual words and the comparison of central and lateral presentation.

Both groups displayed several ERP laterality effects similar to those found in previous research with normal subjects (Kutas & Van Petten, 1988). The P240 and the LPC amplitudes were larger in the right than in the left hemisphere, and the LPC amplitude was also larger in the hemisphere ipsilateral to the field of stimulation. The P150-N180 complex was larger (more negative) contralateral to the visual field of stimulation, particularly to stimuli in the right visual field. Contralateral dominance for a negative component at about 200 ms is common in divided visual-field paradigms (Kok et al., 1985; Hillyard & Munte, 1984).

In addition, nonpsychopaths showed greater negativity over the left hemisphere for the P150-N180, a result reported for both frontal and parietal sites in nonincarcerated subjects during reading (Neville et al., 1982a). This hemisphere difference is absent in congenitally deaf subjects, who, like psychopaths (Hare & McPherson, 1984), show behavioral evidence for reduced lateralization of language processing (Neville et al., 1982b). Psychopaths showed a nonsignificant trend toward greater negativity over the right hemisphere at this latency (see Figure 2). This finding provides further evidence that psychopaths display abnormal lateralization for language processing even though they demonstrated normal lateralization of other ERP components in the same paradigm.

Although neither group exhibited the right visual-field RT advantage that is often found for words, all of the lateralized ERP effects discussed (with the exception of the P150-N180 for psychopaths) were consistent with previously reported ERP evidence for lateralized cognitive processing during reading. The lack of RT evidence for lateralization may have resulted from the preponderance of emotional words among the stimuli: Bryden and Ley (1983) have shown that memorizing emotional material can reduce the left hemisphere advantage usually seen for language processing. They suggested that highly affective words prime the right hemisphere because of their affective content. There is increasing evidence that the right cerebral hemisphere is superior to the left for the expression and perception of affect (e.g., Silberman & Weingartner, 1986). This, coupled with findings that suggest that an attentional bias to the contralateral visual field, or the increased arousal of one hemisphere, can be produced by tasks that are differentially dependent on one hemisphere (cf. Levy, Heller, Banich, & Burton, 1983), may offer some explanation for the lack of a right-visual-field effect for reaction time. As previously mentioned, there is evidence to suggest that affective words have a significant right hemisphere representation (Graves et al., 1981). These types of effects may have been operating in our study because the majority of the words were affective and we presented a large number of trials.

We currently know little about the mechanisms underlying the response facilitation seen for emotional words. Unpublished data from our laboratory (Harpur, Williamson, & Hare, 1989) indicate that it is not simply the result of motor facilitation; the mere presence of an emotional word, in a situation where its processing is unavoidable, is insufficient to facilitate responding. The affective dimension used here to select stimuli appears to be cross-culturally universal (e.g., Osgood, May, & Miron, 1975; Russel, 1983), and it may be that lexical or conceptual organization in normal individuals reflects this universal dimension. If this is so, then the performance of the psychopaths in the present experiment would be indicative of a profound disorganization of their conceptual or lexical systems. Of course, psychopaths did provide evidence that they could distinguish emotional from neutral words in their postexperimental ratings, and in their accuracy. At present we can only speculate that these measures are sensitive to other factors in addition to lexical or conceptual organization. For instance, when confronted with a word and asked to judge its "goodness," psychopaths may be able to invoke alternative strategies, such as trying to guess how other people would judge the word, which could mask their inability to judge the word's affect for themselves. At present these are only speculations, but a mechanism of this sort may explain how psychopaths can "know the words but not the music."

It also remains to be determined what implications these and other linguistic processes might have for the etiology and dynamics of psychopathy. Internalized speech mechanisms and their affective components presumably play an important role in the development of "conscience" and in the self-control of behavior (Luria, 1973). In psychopaths these mechanisms may be inefficiently distributed across the cerebral hemispheres (Hare & McPherson, 1984), and relatively devoid of affective components; as a consequence, they may not be as effective in controlling behavior as they are in normal individuals.

REFERENCES

American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, DC: Author.

Annett, M. (1970). A classification of hand preference by association analysis. *British Journal of Psychology, 61*, 303–321.

Begleiter, H., Gross, M.M., & Kissin, B. (1967). Evoked cortical responses to affective visual stimuli. *Psychophysiology, 3*, 336–344.

Begleiter, H., & Platz, A. (1969). Cortical evoked potentials to semantic stimuli. *Psychophysiology, 6*, 91–100.

Begleiter, H., Porjesz, B., Chou, C.L., & Aunon, J.I. (1983). P3 and stimulus incentive value. *Psychophysiology, 20*, 95–101.

Bentin, S., McCarthy, G., & Wood, C.C. (1985). Event-related potentials, lexical decision and semantic priming. *Electroencephalography & Clinical Neurophysiology, 60*, 343–355.

Boik, R.J. (1981). A priori tests in repeated measures designs: Effects of non-sphericity. *Psychometrika, 46*, 241–255.

Brown, W.S., Marsh, J.T., & Smith, J.C. (1979). Principal component analysis of ERP differences related to the meaning of an ambiguous word. *Journal of Electroencephalography & Clinical Neurophysiology, 46*, 706–714.

Bryden, M.P., & Ley, R. G. (1983). Right hemisphere involvement in imagery and affect. In E. Perecman (Ed.), *Cognitive processing in the right hemisphere* (pp. 111–123). New York: Academic Press.

Chapman, R.M. (1979). Connotative meaning and averaged evoked potentials. In H. Begleiter (Ed.), *Evoked brain potentials and behavior* (pp. 171–196). Plenum Press: New York.

Chapman, R.M., McCrary, J.W., Chapman, J.A., & Bragdon, H.R. (1978). Brain responses related to semantic meaning. *Brain and Language, 5*, 195–205.

Chapman, R.M., McCrary, J.W., Chapman, J.A., & Martin, J.K. (1980). Behavioral and neural analyses of connotative meaning: Word classes and rating scales. *Brain and Language, 11*, 319–339.

Clark, H.H. (1973). The language-as-a-fixed-effect fallacy: A critique of language statistics in psychological research. *Journal of Verbal Learning and Verbal Behavior, 12*, 335–359.

Cleckley, H. (1976). *The mask of sanity* (5th ed.). St. Louis, MO: Mosby.

Duncan-Johnson, C.C., & Donchin, E. (1977). On quantifying surprise: The variation of event-related potentials with subjective probability. *Psychophysiology, 14*, 456–467.

Duncan-Johnson, C.C., & Kopell, B. (1981). The Stroop effect: Brain potentials localize the source of interference. *Science, 214*, 938–940.

Forth, A.E., & Hare, R.D. (1989). The contingent negative variation in psychopaths. *Psychophysiology, 26*, 676–682.

Gillstrom, B.J., & Hare, R.D. (1988). Language-related hand gestures in psychopaths. *Journal of Personality Disorders, 2*, 21–27.

Glass, G.V., & Hopkins, K.D. (1984). *Statistical methods in education and psychology*. Englewood Cliffs, NJ: Prentice-Hall.

Grant, V. (1977). *The menacing stranger*. New York: Dover.

Graves, R., Landis, T., & Goodglass, H. (1981). Laterality and sex differences for visual recognition of emotional and non-emotional words. *Neuropsychologia, 19*, 95–102.

Green, C.J. (1988). The Psychopathy Checklist. *Journal of Personality Disorders, 2*, 185–187.

Hare, R.D. (1980). A research scale for assessment of psychopathy in criminal populations. *Personality and Individual Differences, 1*, 111–119.

Hare, R.D. (1983). Diagnosis of antisocial personality disorder in two prison populations. *American Journal of Psychiatry, 140*, 887–890.

Hare. R.D. (1985). Comparison of the procedures for the assessment of psychopathy. *Journal of Consulting and Clinical Psychology, 53*, 7–16.

Hare, R.D., & Frazelle, J.L. (1980). *Some preliminary notes on the use of a research scale for the assessment of psychopathy in criminal populations.* Unpublished manuscript, Department of Psychology, University of British Columbia, Vancouver, Canada.

Hare, R.D., Frazelle, J., Bus, J., & Jutai, J. (1980). Psychopathy and structure of primary mental abilities. *Journal of Behavioral Assessment, 2*, 77–88.

Hare, R.D., & Jutai, J.W. (1988). Psychopathy and cerebral asymmetry in semantic processing. *Personality and Individual Differences, 9*, 329–337.

Hare, R.D., & McPherson, L.M. (1984). Psychopathy and perceptual asymmetry during verbal dichotic listening. *Journal of Abnormal Psychology, 93*, 141–149.

Harpur, T.J., Hakstian, A.R., & Hare, R.D. (1988). Factor structure of the Psychopathy Checklist. *Journal of Consulting and Clinical Psychology, 56*, 741–747.

Harpur, T.J., Hare, R.D., & Hakstian, A.R. (1989). Two-factor conceptualization of psychopathy: Construct validity and assessment implications. *Psychological Assessment: A Journal of Consulting and Clinical Psychology, 1*, 6–17.

Harpur, T.J., Williamson, S.E., & Hare, R.D. (1989). *Lexical decisions about affective words.* Manuscript in preparation.

Hart, S.D., & Hare, R.D. (1989). Discriminant validity of the Psychopathy Checklist in a forensic psychiatric population. *Psychological Assessment: A Journal of Consulting and Clinical Psychology, 1*, 211–218.

Hillyard, S.A., & Munte, T.F. (1984). Selective attention to color and location: An analysis with event-related brain potentials. *Perception & Psychophysics, 36*, 185–198.

Hollingshead, A.B., & Redlich, F.C. (1958). *Social class and mental illness.* New York: Wiley.

Huynh, H., & Feldt, L.S. (1970). Conditions under which mean square ratios repeated measurements designs have exact *F* distributions. *Journal of the American Statistical Association, 65*, 1582–1589.

Johns, J.H., & Quay, H.C. (1962). The effect of social reward on verbal conditioning in psychopathic and neurotic military offenders. *Journal of Consulting and Clinical Psychology, 26*, 217–220.

Johnston, V.S., Miller, D.R., & Burleson, M.H. (1986). Multiple P3s to emotional stimuli and their theoretical significance. *Psychophysiology, 23*, 684–694.

Jutai, J.W., Hare, R.D., & Connolly, J.F. (1987). Psychopathy and event-related brain potentials (ERPs) associated with attention to speech stimuli. *Personality and Individual Differences, 8*, 175–184.

Kok, A., van de Vijver, R.F., & Rooyakkers, J.A.J. (1985). Effects of visual field, stimulus degradation, and level of practice on event-related potentials of the brain. *Psychophysiology, 22*, 707–717.

Kostandov, E., & Arzumanov, Y. (1977). Averaged cortical evoked potentials to recognized and non-recognized verbal stimuli. *Acta Neurobiologiae Experimentalis, 37*, 311–324.

Kucera, H., & Francis, W.N. (1967). *Computational analysis of present-day American English.* Providence, RI: Brown University Press.

Kutas, M., & Hillyard, S.A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science, 207*, 203–205.

Kutas, M., & Hillyard, S.A. (1982). The lateral distribution of event-related potentials during sentence processing. *Neuropsychologia, 20*, 579–590.

Kutas, M., & Hillyard, S.A. (1983). Event-related brain potentials to grammatical errors and semantic anomalies. *Memory and Cognition, 11*, 539–550.

Kutas, M., & Hillyard, S.A. (1984). Brain potentials during reading reflect word expectancy and semantic association. *Nature, 307*, 161–163.

Kutas, M., McCarthy, G., & Donchin, E. (1977). Augmenting mental chronometry: The P300 as a measure of stimulus evaluation time. *Science, 197*, 792–795.

Kutas, M., & Van Petten, C. (1988). Event-related brain potential studies of language. In P.K. Ackles, J.R. Jennings, & M.G.H. Coles (Eds.), *Advances in psychophysiology* (Vol. 3, pp. 139–187). Greenwich, CT: JAI Press.

Levy, J., Heller, W., Banich, M. T., & Burton, L. A. (1983). Are variations among right-handed individuals in perceptual asymmetries caused by characteristic arousal differences between hemispheres? *Journal of Experimental Psychology: Human Perception and Performance, 9*, 329–360.

Luria, A.R. (1973). *The working brain.* New York: Penguin.

McCarthy, G., & Donchin, E. (1981). A metric for thought: A comparison of P300 latency and reaction time. *Science, 211*, 77–80.

Neville, H.J., Kutas, M., Chesney, G., & Schmidt, A. (1986). Event-related brain potentials during initial encoding and recognition memory of congruous and incongruous words. *Journal of Memory and Language, 25*, 75–92.

Neville, H.J., Kutas, M., & Schmidt, A. (1982a). Event-related potential studies of cerebral specialization during reading. I. Studies of normal adults. *Brain and Language, 16*, 300–315.

Neville, H.J., Kutas, M., & Schmidt, A. (1982b). Event-related potential studies of cerebral specialization during reading. II. Studies of congenitally deaf adults. *Brain and Language, 16*, 316–337.

Newman, J.P. (1987). Reaction to punishment in extraverts and psychopaths: Implications for the impulsive

behavior of disinhibited individuals. *Journal of Research in Personality, 21*, 464–480.
Newman, J.P., & Kosson, D.S. (1986). Passive avoidance learning in psychopathic and nonpsychopathic offenders. *Journal of Abnormal Psychology, 95*, 252–256.
Newman, J.P., Patterson, C.M., & Kosson, D.S. (1987). Response perseveration in psychopaths. *Journal of Abnormal Psychology, 88*, 145–148.
Osgood, C.E., & Suci, G.J. (1969). Factor analysis of meaning. In J.G. Snider & C.E. Osgood (Eds.), *Semantic differential technique: A sourcebook* (pp. 42–55). Chicago: Aldine.
Osgood, C.E., Suci G.J., & Tannebaum, P.H. (1957). *The measurement of meaning.* Urbana: University of Illinois Press.
Osgood, C.E., May, W.H., & Miron, M.S. (1975). *Cross-cultural universals of affective meaning.* Chicago: University of Illinois Press.
Pfefferbaum, A., & Ford, J.M. (1988). ERPs to stimuli requiring response production and inhibition: Effects of age, probability and visual noise. *Electroencephalography & Clinical Neurophysiology, 71*, 55–63.
Pfefferbaum, A., Ford, J., Weller, B.J., & Kopell, B.S. (1985). ERPs to response production and inhibition. *Electroencephalography & Clinical Neurophysiology, 60*, 423–434.
Polich, J., & Donchin, E. (1988). P300 and word frequency effect. *Electroencephalography & Clinical Neurophysiology, 70*, 33–45.
Polich, J., McCarthy, G., Wang, W.S., & Donchin, E. (1983). When words collide: Orthographic and phonological interference during word processing. *Biological Psychology, 16*, 155–180.
Raine, A., & Venables, P.H. (1987). Contingent negative variation, P3 evoked potentials and antisocial behavior. *Psychophysiology, 24*, 191–199.
Raine, A., & Venables, P.H. (1988). Enhanced P3 evoked potentials and longer P3 recovery times in psychopaths. *Psychophysiology, 25*, 30–38.
Rugg, M.D. (1983). Further study of the electrophysiological correlates of lexical decision. *Brain and Language, 19*, 142–152.
Rugg, M.D. (1985). The effects of semantic priming and word repetition on event-related potentials. *Psychophysiology, 22*, 642–647.
Rugg, M.D. (1987). Dissociation of semantic priming, word and nonword repetition effects by event-related potentials. *Quarterly Journal of Experimental Psychology, 39A*, 123–148.
Rugg, M.D., Furda, J., & Lorist, M. (1988). The effects of task on the modulation of event-related potentials by word repetition. *Psychophysiology, 25*, 55–63.
Rugg, M.D., & Nagy, M.E. (1987). Lexical contribution to nonword-repetition effects: Evidence from event-related potentials. *Memory & Cognition, 15*, 473–481.
Russel, J.A. (1983). Pancultural aspects of the human conceptual organization of emotions. *Journal of Personality and Social Psychology, 45*, 1281–1288.
Scarborough, D., Cortese, C., & Scarborough, H. (1977). Frequency and repetition effects in lexical memory. *Journal of Experimental Psychology: Human Perception and Performance, 3*, 1–17.
Schroeder, M.L., Schroeder, K.G., & Hare, R.D. (1983). Generalizability of a checklist for the assessment of psychopathy. *Journal of Consulting and Clinical Psychology, 51*, 511–516.
Shrout, P.E., & Fleiss, J.L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin, 86*, 420–428.
Silberman, E.K., & Weingartner, H. (1986). Hemispheric lateralization of functions related to emotion. *Brain and Cognition, 5*, 322–353.
Strauss, E. (1983). Perception of emotional words. *Neuropsychologia, 21*, 99–103.
Toglia, M.P., & Battig, W.F. (1978). *Handbook of semantic word norms.* Hillsdale, NJ: Lawrence Erlbaum.
Vasey, M.W., & Thayer, J.F. (1987). The continuing problem of false positives in repeated measures ANOVA in psychophysiology: A multivariate solution. *Psychophysiology, 24*, 479–486.
Widiger, A., & Frances, T.A. (1987). Interviews and inventories for the measurement of personality disorders. *Clinical Psychology Review, 7*, 49–75.
Wong, S. (1984). Criminal and institutional behaviors of psychopaths. In *Programs Branch Users Report*, Ministry of the Solicitor General of Canada, Ottawa, Ontario.

(Manuscript received February 1, 1989; accepted for publication June 26, 1990)

Announcement

21st Annual Meeting
Society for Computers in Psychology

On November 21, 1991, the day before the annual meeting of the Psychonomic Society, the 21st Annual Meeting of the Society for Computers in Psychology will be held at the Hyatt Regency Hotel in San Francisco, California, USA. The meeting includes presentations, discussions, tutorials, and times for software and hardware demonstrations. The application of computer-based solutions to all areas of psychology are featured, including research, education, clinical practice, and industrial applications.

For further information, contact: William L. Palya, Department of Psychology, Jacksonville State University, Jacksonville, AL 36265 (BITNET address FWLP@JSUMUS). Phone 205/782-5641, Fax 205/782-5680.