



Assessment of emotion and language processing in psychopathic offenders: results from a dichotic listening task

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Abstract

Previous research has demonstrated that psychopaths exhibit abnormal language lateralization, and it has been proposed that psychopaths may be characterized by abnormal processing asymmetries in other domains as well [Hare, (1998). *Psychopathy, affect, and behavior*. In D. J. Cooke, A. E. Forth, & R. D. Hare (Eds.). *Psychopathy: theory, research and implications for society* (pp. 105–137). Netherlands: Kluwer Academic Publishers.]. The present study employed Bryden and MacRae's [Bryden, M. P., & MacRae, L. (1988). Dichotic laterality effects obtained with emotional words. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, 1, 171–176] dichotic listening task to investigate language and emotion lateralization among criminal psychopaths. Contrary to expectations, psychopaths demonstrated a normal right-ear advantage for word targets. However, psychopaths did show a reduced left-ear advantage for emotion targets, which was driven by high right-ear accuracy. We propose that psychopaths' abnormal processing asymmetries are evident primarily on complex tasks and may be related to poor interhemispheric integration. © 2002 Elsevier Science Ltd. All rights reserved.

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1. Introduction

Abnormal linguistic and emotional processing have consistently been associated with the syndrome of psychopathy. Cleckley (1976) postulated that psychopaths fail to appreciate the full array of meanings and implications inherent in language, and also characterized psychopaths' emotional experiences as deficient in both range and depth. Empirical studies have repeatedly

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demonstrated that psychopaths are less responsive than nonpsychopaths to a variety of emotional cues (e.g. Blair, Jones, Clark, & Smith, 1997; Christiansen, Forth, Hare, Strachan, Lidberg, & Thorell, 1996; Lykken, 1957, 1995; Patrick, 1994; Patrick, Bradley, & Lang, 1993; Williamson, Harpur, & Hare, 1991), and a growing body of literature documents unusual use and processing of language by psychopaths (e.g. Brinkley, Bernstein, & Newman, 1999; Brinkley, Newman, Harpur, & Johnson, 1999; Hare & Jutai, 1988; Hare & McPherson, 1984; Kiehl, Hare, McDonald, & Brink, 1999; Raine, O'Brien, Smiley, Scerbo, & Chan, 1990; Williamson, 1991).

Several studies suggest that psychopaths' abnormal language processing may be related to abnormal cerebral lateralization. For most right-handed individuals, language is processed more efficiently in the left than the right cerebral hemisphere (e.g. Fiez, Raichle, Balota, Tallal, & Petersen, 1996; Kimura, 1961; Posner & Raichle, 1994). This left-hemisphere specialization is reflected in superior processing of linguistic stimuli unilaterally presented to the left as opposed to the right hemisphere. Psychopaths, however, often fail to show left-hemisphere superiority for language processing. Hare and Jutai (1988) found a markedly reduced right visual field (RVF) advantage in psychopaths when assigning tachistoscopic, laterally presented nouns to abstract categories, although psychopaths demonstrated a normal RVF advantage for simple word recognition. Raine et al. (1990) found that adolescent psychopaths had smaller performance asymmetries than controls on a consonant-vowel dichotic listening task. Similarly, Hare and McPherson (1984) found a significantly smaller right-ear advantage (REA) among psychopaths for the recall of dichotically presented words. Taken together, these studies suggest a relatively consistent pattern of reduced left-hemisphere specialization for language processing among psychopaths.

While language processing is generally superior in the left hemisphere, emotion processing, particularly for negative emotions, is generally superior in the right hemisphere (e.g. Borod, 1992; Bulman-Fleming, & Bryden, 1994; Liotti & Tucker, 1995). Although the lateralization of psychopaths' emotional processing has rarely been investigated, Day and Wong (1996) found that psychopaths failed to display a left visual field (LVF) superiority for localizing bilaterally presented emotional words. Whereas controls identified LVF emotional targets more quickly and accurately than RVF targets, psychopaths showed no significant laterality and in fact tended to be faster and more accurate in the RVF than the LVF. These findings suggest that psychopaths' well-documented emotion-processing deficits may be related to unusual lateralization for the processing of emotion, just as their language deficits appear to be related to unusual language lateralization (see also Hare, 1998).

The present study employs a dichotic listening task in an attempt to replicate findings of unusual language lateralization in psychopaths while simultaneously investigating the lateralization of psychopaths' emotion processing. Dichotic listening is a well-established method of examining hemispheric asymmetries, and is based on the principle that auditory input to either ear is most strongly represented in the contralateral hemisphere, due to the greater strength and preponderance of contralateral auditory projections (Kimura, 1967). Asymmetrical performance indicates greater processing efficiency by the hemisphere contralateral to the more accurate ear (Sidtis, 1988; Sparks & Geschwind, 1968). Numerous studies have demonstrated a right-ear/left hemisphere advantage for language processing (e.g. Bulman-Fleming & Bryden, 1994; Ley & Bryden, 1982) and a left-ear/right hemisphere advantage for emotion processing in normal subjects (e.g. Bryden & MacRae, 1988; Erhan, Borod, Tenke, & Bruder, 1998).

The consistency with which dichotic listening tasks reveal hemispheric processing asymmetries makes them ideal for probing emotion and language lateralization in psychopaths. The present

study employs the dichotic listening paradigm developed by Bryden and MacRae (1988). The advantage of this particular design is that the same dichotic stimuli are used for both the language and the emotion tasks, and participants are merely required to indicate whether or not a target is present on each dichotic trial. The laterality results are therefore uncontaminated by either memory load (i.e. having to remember words for later report) or by any effects of mere exposure to the stimuli. What differs across the emotion and word trials is simply the target that the participant is trying to detect. Based on their abnormal linguistic and emotional functioning, it is expected that psychopaths will demonstrate less hemispheric specialization than nonpsychopaths for the recognition of both words and emotional tones.

Owing to theoretical and empirical concerns regarding potential interactions between anxiety and psychopathy, the a priori hypotheses of our laboratory are always directed specifically to low-anxious psychopaths and controls (see Newman & Brinkley, 1997; Schmitt & Newman, 1999). For the present report, however, we are choosing to examine psychopathy effects both with and without restriction of the analyses to low-anxious groups. We have chosen to collapse across anxiety, as well as perform planned comparisons between low-anxious groups, because we wish to compare the present results with those of previously published investigations of psychopaths' processing asymmetries, none of which specifically examined low-anxious groups. We will therefore report main effects of psychopathy but, in accord with our theoretical perspective, will also report planned comparisons for the low-anxious groups. Throughout, use of the term "psychopath" without qualification will be meant to refer to psychopaths regardless of anxiety, whereas statements specific to low-anxious groups will be specified as such.

2. Methods

2.1. Participants

Participants were 57 Caucasian male inmates with Psychopathy Checklist-Revised (PCL-R; Hare, 1991) scores in either the psychopathic (30 or higher; $n=22$) or nonpsychopathic (20 or lower; $n=35$) range. File screens were used to exclude individuals who were age 40 or older, were prescribed psychotropic medication, or scored below the fourth-grade reading level on prison-administered achievement tests. Participants were also excluded if they were left-handed according to their score (greater than 21) on the Hand Usage Questionnaire (Chapman & Chapman, 1987) or had borderline or lower intelligence as assessed by the Shipley Institute of Living Scale (Zachary, 1986). Median splits on the Welsh Anxiety Scale (WAS; Welsh, 1956) were used to divide participants into high- (scores greater than 10) and low-anxious (scores of 10 or lower) groups for planned comparisons. All participants gave informed consent and received modest financial compensation for their participation.

2.2. Materials

The dichotic listening stimuli were provided by L. MacRae, and consisted of the words "power," "bower," "dower," and "tower," each spoken by a male speaker in happy, sad, angry and neutral tones. As reported by Bryden and MacRae (1988), the 16 word/emotion combinations

were digitized on a modified PDP 11/40 computer, edited to a common length of 500 ms, and equalized in loudness. Each word/emotion combination was paired with each of the nine other combinations that differed by both word and tone. These dichotic pairs were presented with a 3-s intertrial interval and a 10-s rest period after every 18 trials. There were a total of 144 different stimulus pairings with any one word appearing on one-half of the trials and any given emotional tone appearing on one-half of the trials. The stimuli were recorded on an audiocassette and presented over stereophonic headphones.

2.3. Procedure

Each participant completed two blocks of the 144 trials, one with a word target and one with an emotion target. The word targets were either 'dower' or 'tower,' and the emotion targets were either sad or angry. Possible targets were limited to this set of two words and two tones to allow for adequate counterbalancing within relatively small participant groups. The negatively valenced tones were chosen as the emotion targets because negative emotions have produced a stronger and more consistent right-hemisphere advantage in previous studies (e.g. Ahern & Schwartz, 1979; Bryden & MacRae, 1988). The word targets were chosen for the relatively high accuracy with which they were identified on the Bryden and MacRae (1988) task.

Participants were tested individually in a quiet room. For each block of trials, participants were instructed to listen for a specific word or emotion. After each stimulus presentation, participants circled "yes" or "no" on a response sheet to indicate whether the target was present or not present, respectively.

An attempt was made to counterbalance task (word- or emotion-target) order, but technical complications resulted in an overwhelming majority receiving the word task first and the emotion task second. All 57 participants included in this report completed the word task before the emotion task.

2.4. Dependent variables

Responses were scored as the number of targets that were correctly identified for each ear. In addition, a false alarm measure was obtained by summing "yes" responses for trials on which the

Table 1
Demographic characteristics^a

Measure	Psychopaths			Controls		
	Low-anxious (<i>n</i> = 10)	High-anxious (<i>n</i> = 11)	Total (<i>n</i> = 21)	Low-anxious (<i>n</i> = 19)	High-anxious (<i>n</i> = 15)	Total (<i>n</i> = 34)
	<i>M</i> (S.D.)	<i>M</i> (S.D.)	<i>M</i> (S.D.)	<i>M</i> (S.D.)	<i>M</i> (S.D.)	<i>M</i> (S.D.)
Age	29.60 (6.11)	28.80 (4.32)	29.20 (5.17)	28.89 (6.24)	28.27 (5.30)	28.62 (5.77)
Education	10.70 (1.49)	9.80 (2.20)	10.25 (1.89)	11.53 (1.50)	10.80 (1.52)	11.21 (1.53)
SILS- estimated IQ	99.38 (11.21)	94.28 (13.35)	96.83 (12.28)	98.47 (11.42)	97.60 (10.62)	98.08 (10.92)
PCL-R	30.90 (0.99)	32.40 (1.58)	31.65 (1.50)	15.42 (4.57)	16.00 (3.18)	15.68 (3.98)
WAS	5.40 (2.59)	26.00 (7.29)	15.70 (11.83)	4.63 (3.53)	19.80 (6.61)	11.32 (9.15)

^a PCL-R, Psychopathy Checklist-Revised; WAS, Welsh Anxiety Scale; SILS, Shipley Institute of Living Scale.

target was not presented. Note that false alarms do not affect laterality measures, as they cannot be attributed to one ear or the other.

Laterality Quotients (LQs), designed to adjust raw ear scores for the level of overall accuracy, were computed according to the recommendations of Harshman and Lundy (1988). For the word targets, the LQ was computed as the number of correct right-ear responses minus the number of correct left-ear responses, divided by the total number of correct responses ($R - L/R + L$). For the emotion targets, the LQ was computed as the number of correct left-ear responses minus the number of correct right-ear responses, divided by the total number of correct responses ($L - R/R + L$). Positive LQs thus represent a right-ear advantage (REA) for the word targets and a left-ear advantage (LEA) for the emotion targets.

3. Results

Two participants (one high-anxious control, one high-anxious psychopath) were omitted from analyses due to neglect of one ear throughout the experiment (i.e. fewer than five correct responses for one ear, collapsed across target type).

Group differences in age, education, and IQ were assessed by conducting 2 (Psychopathic or Nonpsychopathic) \times 2 (High- or Low-Anxious) ANOVAs with age, education, and estimated IQ as the dependent variables. These analyses revealed no significant main effects or interactions. Overall, mean (S.D.) age of participants was 28.83 (5.51) years, mean education was 10.85 (1.72) years, and mean estimated IQ was 97.62 (11.34). Participant characteristics are presented in Table 1.

Accuracy, false-alarm, and laterality scores for each participant group are presented in Tables 2 (word targets) and 3 (emotion targets).

Table 2
Dichotic listening performance, word targets

	Psychopaths			Controls		
	Low-anxious (<i>n</i> = 10)	High-anxious (<i>n</i> = 11)	Total (<i>n</i> = 21)	Low-anxious (<i>n</i> = 19)	High-anxious (<i>n</i> = 15)	Total (<i>n</i> = 34)
	<i>M</i> (S.D.)	<i>M</i> (S.D.)	<i>M</i> (S.D.)	<i>M</i> (S.D.)	<i>M</i> (S.D.)	<i>M</i> (S.D.)
Correct detections	49.80 (9.52)	48.55 (16.80)	49.14 (13.50)	47.74 (14.18)	52.13 (14.87)	49.68 (14.44)
Left Ear	21.10 (8.12)	22.64 (7.88)	21.90 (7.83)	21.63 (6.82)	22.33 (9.58)	21.94 (8.03)
Right Ear	28.70 (7.67)	25.91 (10.08)	27.24 (8.91)	26.11 (9.09)	29.80 (7.34)	27.74 (8.45)
False alarms	17.00 (14.16)	16.55 (10.48)	16.76 (12.05)	14.11 (13.01)	14.40 (10.25)	14.24 (11.70)
Laterality quotient (WLQ)	0.157 (.265)	0.058 (0.169)	0.105 (0.220)	0.089 (0.211)	0.169 (0.211)	0.124 (0.212)
WLQ > 0,% of participants	80.0%	81.8%	81.0%	78.9%	80.0%	79.4%

3.1. Word targets

3.1.1. Accuracy

Laterality effects for the detection of word targets were first examined by conducting a 2 (Psychopathic or Control) \times 2 (High or Low Anxious) \times 2 (Left or Right Ear) mixed-model ANOVA with ear as the within-subjects variable and raw accuracy as the dependent variable. This analysis revealed a main effect of Ear [$F(1, 51) = 21.96, P < 0.001$], indicating the expected right ear advantage for word targets ($M = 27.63$ vs. $M = 21.93$ for the right and left ears, respectively). No other main effects or interactions approached significance. The raw accuracy scores thus indicate that all participant groups demonstrated a right-ear advantage for word targets.

3.1.2. False alarms

A 2 (Psychopathic or Control) \times 2 (High- or Low-Anxiety) ANOVA revealed no group differences in the number of false alarms (all $F_s < 1.0$, n.s.).

3.1.3. Laterality quotient

Group differences in the Word Laterality Quotient (WLQ) were assessed by means of a 2 (Psychopathic or Control) \times 2 (High- or Low-Anxiety) ANOVA with WLQ as the dependent variable. This analysis revealed a highly significant right-ear advantage across subjects [$F(1, 51) = 15.61, P < 0.001$] and no other significant main effects or interactions. The mean word LQ was 0.118, indicating a difference of 11.8% between right- and left-ear performance.

3.1.4. Planned comparisons

The planned comparisons between low-anxious psychopaths and controls revealed no significant laterality differences for either the raw ear scores [$t(27) < 1.00$, n.s.] or the WLQ [$t(27) < 1.00$, n.s.].

Table 3
Dichotic listening performance, emotion targets

	Psychopaths			Controls		
	Low-anxious ($n = 10$)	High-anxious ($n = 11$)	Total ($n = 21$)	Low-anxious ($n = 19$)	High-anxious ($n = 15$)	Total ($n = 34$)
	M (S.D.)	M (S.D.)	M (S.D.)	M (S.D.)	M (S.D.)	M (S.D.)
Correct detections	53.10 (17.10)	54.09 (17.11)	53.62 (16.68)	43.16 (15.00)	52.07 (11.21)	47.09 (13.98)
Left Ear	27.70 (9.20)	28.92 (9.08)	28.83 (8.93)	24.68 (9.11)	30.00 (5.53)	27.03 (8.09)
Right Ear	25.40 (8.90)	25.18 (8.34)	25.29 (8.39)	18.47 (8.11)	22.07 (6.82)	20.06 (7.67)
False alarms	13.00 (11.25)	12.45 (17.00)	12.71 (14.20)	10.32 (13.78)	7.80 (12.31)	9.21 (13.02)
Laterality quotient (ELQ)	0.045 (0.123)	0.068 (0.081)	0.057 (0.101)	0.134 (0.239)	0.163 (0.113)	0.147 (0.192)
ELQ > 0.0% of Participants	70.0%	90.9%	81.0%	73.7%	93.3%	82.3%

3.2. Emotion targets

3.2.1. Accuracy

Emotion laterality was first examined using raw accuracy scores as the dependent variable in a 2 (Psychopathic or Control) \times 2 (High or Low Anxious) \times 2 (Left or Right Ear) mixed-model ANOVA with ear as the within-subjects variable and raw accuracy as the dependent variable. This analysis revealed a main effect of Ear [$F(1, 51) = 31.05, P < 0.001$], indicating the expected left-ear advantage for emotion targets ($M = 27.82$ vs. $M = 22.78$ for the left and right ears, respectively). In addition, this analysis revealed an Ear \times Psychopathy interaction [$F(1, 51) = 5.03, P < 0.05$], indicating a smaller laterality effect for psychopaths ($M = 28.83$ vs. $M = 25.29$ for the left and right ears, respectively) than controls ($M = 27.03$ vs. $M = 20.06$ for the left and right ears, respectively). This group difference in laterality reflects the fact that psychopaths were more accurate than controls on right-ear targets [$t(56) = 2.35, P < 0.05$] but performed similarly on left-ear targets [$t(56) < 1.00, n.s.$].

3.2.2. False alarms

A 2 (Psychopathic or Control) \times 2 (High- or Low-Anxiety) ANOVA revealed no group differences in the number of false alarms (all $F_s < 1.0, n.s.$).

3.2.3. Laterality quotient

Group differences in the Emotion Laterality Quotient (ELQ) were assessed by means of a 2 (Psychopathic or Control) \times 2 (High- or Low-Anxiety) ANOVA with ELQ as the dependent variable. This analysis revealed a highly significant left-ear advantage across subjects [$F(1, 51) = 19.51, P < 0.001$] as well as a main effect of Psychopathy [$F(1, 51) = 3.97, P = 0.05$]. The mean emotion LQ was 0.102, indicating a difference of 10.2% between left- and right-ear performance. The main effect of psychopathy reflects a smaller LEA among psychopaths than controls (0.057 vs. 0.147, respectively). This main effect is consistent with the significant Ear \times Psychopathy interaction reported above.

3.2.4. Planned comparisons

The planned comparisons between low-anxious psychopaths and controls revealed no significant laterality differences for either the raw ear scores [$t(27) = 1.54, n.s.$] or the ELQ [$t(27) = 1.38, n.s.$].

4. Discussion

Contrary to expectations, psychopathic individuals, irrespective of anxiety, displayed a normal right-ear advantage for word targets. Similarly, our planned comparisons revealed no evidence of reduced laterality for word targets among low-anxious psychopaths relative to low-anxious controls. The present results therefore fail to support our prediction that psychopaths would show reduced language lateralization.

In contrast, psychopaths did demonstrate a smaller left-ear advantage than controls for the detection of emotion targets. Remarkably, psychopaths' reduced laterality on the emotion task

reflects normal left-ear performance but superior right-ear performance as compared to controls. Despite their reduced asymmetry, psychopaths did appear to process emotion more efficiently in the right than in the left hemisphere, and were just as likely as controls to show a left-ear advantage (81% of psychopaths vs. 82% of controls; see Table 3). Thus, psychopaths appear to have normal efficiency for the processing of left-ear emotion targets but greater than normal efficiency for right-ear emotion targets. A similar pattern of results emerged among low-anxious psychopaths and controls (Table 3), although the planned comparisons between low-anxious groups failed to reach statistical significance.

Our ability to interpret psychopaths' better right-ear accuracy and reduced asymmetry on the emotion task is limited by the fact that the emotion task was preceded by the word task for all participants. We are unable to rule out the possibility that prior experience with the word task differentially biased psychopaths' and controls' performance on the emotion task. Nevertheless, psychopaths' high accuracy on the emotion task argues against the existence of a generalized emotion deficit. Our results indicate that psychopaths are able to recognize emotion as readily as controls, at least when discriminating among discrete emotional intonations.

Psychopaths' good performance on the emotion task may seem surprising given their widely recognized deficits in emotion processing (e.g. Christiansen et al., 1996; Kiehl, Hare, McDonald, & Brink, 1999b; Williamson et al., 1991). However, their high accuracy is consistent with a substantial literature demonstrating that psychopaths do not differ from controls when asked to appraise emotional content (e.g. Levenston, Patrick, Bradley, & Lang, 2000; Patrick et al., 1993; Williamson et al., 1991). Indeed, the disjunction between psychopaths' ability to recognize versus utilize emotional information was documented by Cleckley (1976) in his classic description of the disorder (see also Lorenz & Newman, submitted for publication). Further, a distinction between the processes of appraisal and utilization is supported by many theories of emotion processing (e.g. Clore et al., 1994; Salovey & Mayer, 1990; Schwarz & Clore, 1983). Psychopaths' normal ability to detect emotion targets is therefore consistent with clinical observation, theoretical models, and previous empirical findings.

The failure to find a reduced REA among psychopaths for the detection of word targets appears to contradict the results of prior dichotic-listening studies (Hare & McPherson, 1984; Raine et al., 1990). Raine et al. (1990) found a reduced right-ear advantage among psychopathic (assessed by multiple, non-PCL, methods) as compared to nonpsychopathic adolescents for the identification of dichotic consonant-vowel stimuli. In a study with adult psychopaths, Hare and McPherson (1984) presented single-syllable words dichotically and, after each presentation of three word pairs, asked participants to report aloud all the words they had detected. Psychopaths' REA was significantly smaller than that of nonpsychopaths, laterality was significantly correlated with PCL scores, and a smaller percentage of psychopaths than nonpsychopaths demonstrated a REA.

Despite these discrepancies with previous reports of psychopaths' dichotic listening performance, the present failure to find a reduced right-ear advantage among psychopaths for word identification is in fact consistent with much of the literature on psychopathy and laterality. Hare (1979) presented psychopaths with a tachistoscopic word-recognition task in which words were presented to either the left or the right visual field and found that psychopaths, like controls, had a pronounced RVF advantage for word identification. Hare and Jutai (1988) used a similar paradigm and demonstrated a normal RVF advantage among psychopaths for the simple identification of tachistoscopic, laterally-presented words [replicating Hare (1979)] as well as for the

assignment of words to concrete categories (e.g. bird, vehicle, weapon, or four-footed animal). However, psychopaths' RVF advantage on the recognition and simple-categorization tasks reversed to a LVF advantage when they were required to assign laterally presented words to an abstract category (e.g. living thing or not) whereas nonpsychopaths continued to show a RVF advantage. These results are in accord with Hare's (1986; Hare & Jutai, 1988) suggestion that psychopaths' abnormal language lateralization may not be evident unless the task involves considerable semantic or memory demands. This perspective suggests that simple word identification should not elicit abnormal processing asymmetries in psychopaths, and also raises the possibility that Hare and McPherson's (1984) finding of a reduced REA among psychopaths for the recall of dichotic words may have been driven by the memory demands of their task. In retrospect, therefore, we might have expected psychopaths to show a normal REA on dichotic language tasks that, like the one we employed, require only simple word detection.

Further evidence for the dependence of psychopaths' unusual processing asymmetries upon task demands comes from Jutai, Hare, and Connolly (1987), who recorded event-related brain potentials to oddball speech phonemes and found that psychopaths' N100 and P300 responses to the oddball targets were comparable to those of controls when their task was simply to respond to the target. When a second concurrent task was introduced, however, psychopaths' P300 responses were marked by significantly greater slow-wave amplitude than controls,' particularly in the left hemisphere, although they continued to demonstrate normal levels of performance. These data lend support to the idea that psychopaths' processing abnormalities are dependent upon task demands and, specifically, are evident only when the task is relatively complex (but see Kiehl, Hare, Liddle, & McDonald (1999) for evidence of abnormal asymmetries on a simple visual oddball task).

A recent study by Bernstein, Newman, Wallace, and Luh (2000) underscores the importance of task demands in eliciting psychopaths' processing asymmetries. They instructed participants to memorize, for subsequent recall, words that were presented on a computer monitor. The words appeared one at a time, each positioned at one of the four corners of the computer monitor. After the words had been presented, participants were asked to recall the words and were then unexpectedly asked to recall the spatial location of each word (i.e. in which corner of the display it had appeared). Both psychopaths and controls demonstrated a RVF advantage for word recall (i.e. they were better at recalling words that had been presented on the right side of the monitor). However, only the controls demonstrated a RVF advantage for the incidental recall of the word positions. Psychopaths recalled as many locations as controls, but their recall was evenly distributed across the left and right spatial fields whereas controls recalled fewer LVF locations and more RVF locations. It is interesting that psychopaths' abnormal asymmetry did not appear for the aspect of the stimuli to which they were effortfully attending. This suggests that while task complexity or difficulty may be needed to elicit psychopaths' abnormal processing asymmetries, other factors, such as attention, may influence where the asymmetries appear.

Despite limited inconsistencies (Kiehl, Hare, Liddle, & McDonald, 1999a; Raine et al., 1990), previous studies suggest a pattern in which psychopaths demonstrate abnormal asymmetries for word categorization, word detection, oddball phoneme detection, and memory for spatial locations, but only when the task involves a particular degree of complexity (i.e. assigning words to abstract categories; detecting but also remembering dichotically presented words; identifying rare targets when engaged in a concurrent distractor task; incidentally remembering spatial locations

while focusing upon word memorization). It has been proposed (Hare, 1986; Hare & Jutai, 1988) that psychopaths' abnormal asymmetries may be revealed only in the presence of concurrent verbal memory or semantic demands. The findings of Jutai et al. (1987), however, indicate that abnormal processing asymmetries for simple detection can be elicited by concurrent perceptual-motor tasks, and Bernstein et al. (2000) demonstrated normal visual field asymmetries on a verbal memory task along with abnormal asymmetries on an incidental spatial memory task. Together, these studies suggest that psychopaths' abnormal processing asymmetries are not limited to tasks involving verbal memory or semantic processing. Rather, it appears that abnormal asymmetries among psychopaths may be elicited more generally by tasks that involve the integration of multiple task components.

Thus, task complexity appears to be an important determinant of psychopaths' abnormal performance asymmetries. While we can only speculate as to how psychopaths' performance asymmetries may be related to brain function, it is worth noting that task complexity has been shown to promote interhemispheric processing (Banich & Belger, 1990; Weissman & Banich, 2000). That is, the advantage of across-hemisphere, bilateral processing over within-hemisphere, unilateral processing generally increases with task complexity. It is important to note that increased interhemispheric processing does not necessarily imply reduced performance asymmetries (Banich, 1995). However, the evidence that interhemispheric processing increases with greater task complexity, along with the evidence that psychopaths' abnormal asymmetries depend upon task complexity, suggests that psychopaths' processing asymmetries may be related to the efficiency with which they can perform interhemispheric processing [see also Hare, 1998; Mills, 1995 (as cited in Hare, 1998)].

Given the simplicity of the present dichotic listening task, lack of task complexity provides a straightforward explanation for psychopaths' normal right-ear advantage for the detection of word targets. However, psychopaths' reduced left-ear advantage for the detection of emotion targets appears inconsistent with this proposal, given that the demands of the word-target and emotion-target tasks are nearly identical. While interpretation of the emotion findings must be tentative due to the lack of counterbalancing, the present framework suggests some possible explanations for psychopaths' reduced emotion asymmetry. One possibility is that the detection of emotional prosody is more complex, or relies more heavily on interhemispheric processing, than the detection of word targets. This is certainly plausible, especially given that the products of right-hemisphere emotion processing would, at the very least, need to be transferred to the left hemisphere to enable the right-handed motor response. However, further consideration of psychopaths' performance on the emotion task suggests an alternative explanation. In particular, the fact that psychopaths' reduced left-ear advantage was driven by unusually strong right-ear performance suggests that emotion processing may be less lateralized in psychopaths than in controls.

Reduced lateralization of function may, like psychopaths' sensitivity to task complexity, be a consequence of poor interhemispheric integration. It has been proposed that the benefits of hemispheric specialization depend upon efficient interhemispheric communication, as the products of specialized processing systems must be rapidly integrated to produce organized behavior (Gazzaniga, 2000; Sperry, 1984). Poor interhemispheric communication may therefore increase reliance on within-hemisphere processing and promote development of the capacity to perform simple operations in either hemisphere, thereby reducing functional lateralization. Thus, poor interhemispheric integration may give rise to unusual asymmetries on complex tasks by disrupting

the coordination of bilateral processing, and may also give rise to reduced asymmetries on simple tasks by promoting duplication of basic processing abilities.

The present evidence that psychopaths have a reduced right-hemisphere advantage for emotion suggests that psychopaths may have greater distribution of functions that, like emotion processing, are normally lateralized to the right hemisphere. At the same time, psychopaths appear to have normal left-hemisphere lateralization for language processing. One possible interpretation of these findings is that psychopaths are particularly poor at transferring right-hemisphere information to the left hemisphere. Inefficient transfer of right-hemisphere information may increase reliance on left-hemisphere processing and promote duplication of some right-hemisphere functions within the left hemisphere, resulting in reduced asymmetries on tasks normally performed by the right-hemisphere. To the extent that transfer of information from the left hemisphere to the right hemisphere is not impaired, normal lateralization of left-hemisphere functions would be expected.

Another possible interpretation of our findings is that psychopaths have difficulty integrating information regardless of the direction of interhemispheric transfer, but that reductions in functional lateralization are limited by the intrinsic capabilities of each hemisphere. Whereas psychopaths' reduced emotion asymmetry indicates that the left hemisphere is able to adopt strategies for identifying emotional prosody, psychopaths' normal language asymmetry may reflect a relative inability of the right hemisphere to adopt strategies for identifying target words. Although highly speculative, the proposed interpretations of our findings suggest important avenues for future research.

Psychopaths' processing asymmetries are often observed in the presence of normal overall performance (e.g. Bernstein et al., 2000; Hare & Jutai, 1988; Jutai et al., 1987). However, psychopaths are well-known for performance abnormalities, such as difficulty inhibiting behavior in response to punishment cues (Lykken, 1957; Newman & Kosson, 1986), and it is these behavioral deficits that seem most immediately relevant to the clinical features of psychopathy. Interestingly, there is evidence that psychopaths' overall performance may be most affected by tasks that demand the integration of multiple stimulus or task components (e.g. Kosson, 1998; Lorenz & Newman, submitted; Newman et al., 1997). Thus, task complexity appears to be an important determinant of both psychopaths' processing asymmetries and their behavioral performance, suggesting that both may be related to the quality of psychopaths' interhemispheric processing.

A final comment should be made with regard to the potential moderating effects of anxiety. As mentioned in the introduction, and further elaborated elsewhere (e.g. Newman & Brinkley, 1997; Newman & Schmitt, 1998; Schmitt & Newman, 1999; Schmitt, Brinkley, & Newman, 1999), we consider it crucial to separate the influences of psychopathy and anxiety when evaluating psychopaths' task performance. We therefore restrict our a priori hypotheses to low-anxious psychopaths and controls. Although anxiety had little impact on performance within the present study (see also Brinkley et al., 1999b), many experimental investigations have demonstrated that collapsing across anxiety can obscure important differences between psychopaths and controls on both behavioral and psychophysiological measures (e.g. Arnett, Smith, & Newman, 1997; Newman, Schmitt, & Voss, 1997; Newman, Patterson, Howland, & Nichols, 1990). The degree to which anxiety affects task performance will generally be a function of the task requirements. That is, we might expect anxiety to be particularly important on tasks with a motivational or stressful component. Accordingly, we believe that despite its minimal influence on performance in the

present study, anxiety should continue to be examined as a potential moderator of psychopathy effects.

In conclusion, psychopaths' normal right-ear advantage for the detection of dichotically presented word targets appears at first to contradict previous findings, but in fact fits nicely within an emerging pattern of evidence suggesting that psychopaths' processing asymmetries are highly dependent upon task demands. In particular, it appears that psychopaths are most likely to show abnormal processing asymmetries when required to integrate multiple dimensions or aspects of a task. The relationship between psychopaths' abnormal asymmetries and task complexity suggests that their performance asymmetries may reflect poor interhemispheric integration. Psychopaths' reduced left-ear advantage for emotion targets suggests that psychopaths may have greater distribution of functions that are normally lateralized to the right hemisphere, which may also be a consequence of poor interhemispheric integration.

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References

- Ahern, G. L., & Schwartz, G. E. (1979). Differential lateralization for positive versus negative emotion. *Neuropsychologia*, *17*, 693–698.
- Annett, P. A., Smith, S. S., & Newman, J. P. (1997). Approach and avoidance motivation in incarcerated psychopaths during passive avoidance. *Journal of Personality and Social Psychology*, *72*, 1413–1428.
- Banich, M. T. (1995). Interhemispheric processing: Theoretical considerations and empirical approaches. In R. J. Davidson, & K. Hugdahl (Eds.), *Brain asymmetry* (pp. 427–450). Cambridge, MA, US: The MIT Press.
- Banich, M. T., & Belger, A. (1990). Interhemispheric interaction: how do the hemispheres divide and conquer a task? *Cortex*, *26*, 77–94.
- Bernstein, A., Newman, J. P., Wallace, J. F., & Luh, K. E. (2000). Left-hemisphere activation and deficient response modulation in psychopaths. *Psychological Science*, *11*, 414–418.
- Blair, R. J., Jones, L., Clark, F., & Smith, M. (1997). The psychopathic individual: a lack of responsiveness to distress cues? *Psychophysiology*, *34*, 192–198.
- Borod, J. C. (1992). Interhemispheric and intrahemispheric control of emotion: a focus on unilateral brain damage. *Journal of Consulting and Clinical Psychology*, *60*, 339–348.
- Brinkley, C. A., Bernstein, A., & Newman, J. P. (1999a). Coherence in the narratives of psychopathic and non-psychopathic criminal offenders. *Personality and Individual Differences*, *27*, 519–530.
- Brinkley, C. A., Newman, J. P., Harpur, T. J., & Johnson, M. M. (1999b). Cohesion in texts produced by psychopathic and nonpsychopathic criminal inmates. *Personality and Individual Differences*, *26*, 873–885.
- Bryden, M. P., & MacRae, L. (1988). Dichotic laterality effects obtained with emotional words. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *1*, 171–176.

- Bulman-Fleming, M. B., & Bryden, M. P. (1994). Simultaneous verbal and affective laterality effects. *Neuropsychologia*, *32*, 787–797.
- Chapman, L. J., & Chapman, J. P. (1987). The measurement of handedness. *Brain and Cognition*, *6*, 175–183.
- Christiansen, S. A., Forth, A. E., Hare, R. D., Strachan, C., Lidberg, L., & Thorell, L. H. (1996). Remembering details of emotional events: a comparison between psychopathic and nonpsychopathic offenders. *Personality and Individual Differences*, *20*, 437–446.
- Cleckley, H. (1976). *The mask of sanity* (5th ed.). St. Louis, MO: Mosby.
- Clore, G. L., Ellsworth, P. C., Frijda, N. H., Izard, C. E., Lazarus, R., LeDoux, J. E., Panksepp, J., Scherer, K. R., Eckman, P., & Davidson, R. J. (1994). What are the minimal cognitive prerequisites for emotion? In P. Eckman, & R. J. Davidson (Eds.), *The nature of emotion: fundamental questions. Series in affective science* (pp. 179–234). New York: Oxford University Press.
- Day, R., & Wong, S. (1996). Anomalous perceptual asymmetries for negative emotional stimuli in the psychopath. *Journal of Abnormal Psychology*, *105*, 648–652.
- Erhan, H., Borod, J. C., Tenke, C. E., & Bruder, G. E. (1998). Identification of emotion in a dichotic listening task: event-related brain potential and behavioral findings. *Brain and Cognition*, *37*, 287–307.
- Fiez, J. A., Raichle, M. E., Balota, D. A., Tallal, P., & Petersen, S. E. (1996). PET activation of posterior temporal regions during auditory word presentation and verb generation. *Cerebral Cortex*, *6*, 1–10.
- Gazzaniga, M. S. (2000). Cerebral specialization and interhemispheric communication: does the corpus callosum enable the human condition? *Brain*, *123*, 1293–1326.
- Hare, R. D. (1979). Psychopathy and laterality of cerebral function. *Journal of Abnormal Psychology*, *88*, 605–610.
- Hare, R. D. (1986). Twenty years of experience with the Cleckley psychopath. In W. H. Reid, D. Dorr, J. I. Walker, & J. W. Bonner III. (Eds.), *Unmasking the psychopath: antisocial personality and related syndromes* (pp. 3–27).
- Hare, R. D. (1991). *The Hare psychopathy checklist—revised*. Toronto: Multi-Health Systems.
- Hare, R. D. (1998). Psychopathy, affect, and behavior. In D. J. Cooke, A. E. Forth, & R. D. Hare (Eds.), *Psychopathy: theory, research and implications for society* (pp. 105–137). Netherlands: Kluwer Academic Publishers.
- 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.
- Harshman, R. A., & Lundy, M. E. (1988). Can dichotic listening measure “degree of lateralization”? In K. Hugdahl (Ed.), *Handbook of dichotic listening: theory, methods and research* (pp. 215–282). New York: John Wiley.
- 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.
- Kiehl, K. A., Hare, R. D., Liddle, P. F., & McDonald, J. J. (1999). Reduced P300 responses in criminal psychopaths during a visual oddball task. *Biological Psychiatry*, *45*, 1498–1507.
- Kiehl, K. A., Hare, R. D., McDonald, J. J., & Brink, J. (1999). Semantic and affective processing in psychopaths: an event-related potential (ERP) study. *Psychophysiology*, *36*, 765–774.
- Kimura, D. (1961). Cerebral dominance and the perception of verbal stimuli. *Canadian Journal of Psychology*, *15*, 166–171.
- Kimura, D. (1967). Functional asymmetry of the brain in dichotic listening. *Cortex*, *3*, 163–166.
- Kosson, D. S. (1998). Divided visual attention in psychopathic and nonpsychopathic offenders. *Personality and Individual Differences*, *24*, 373–391.
- Levenston, G. K., Patrick, C. J., Bradley, M. M., & Lang, P. J. (2000). The psychopath as observer: emotion and attention in picture processing. *Journal of Abnormal Psychology*, *109*, 373–385.
- Ley, R. G., & Bryden, M. P. (1982). A dissociation of right and left hemispheric effects for recognizing emotional tone and verbal content. *Brain and Cognition*, *1*, 3–9.
- Liotti, M., & Tucker, D. M. (1995). Emotion in asymmetrical corticolimbic networks. In R. J. Davidson, & K. Hugdahl (Eds.), *Brain asymmetry* (pp. 389–423). Cambridge, MA: The MIT Press.
- Lorenz, A. R., & Newman, J. P. (submitted for publication). Deficient response modulation and emotion processing: results from a lexical decision task.
- Lykken, D. T. (1957). A study of anxiety in the sociopathic personality. *Journal of Abnormal and Social Psychology*, *55*, 6–10.
- Lykken, D. T. (1995). *The antisocial personalities*. Hillsdale, NJ: Erlbaum.

- Newman, J. P., & Brinkley, C. A. (1997). Reconsidering the low-fear explanation for primary psychopathy. *Psychological Inquiry*, 8, 236–244.
- Newman, J. P., & Kosson, D. (1986). Passive avoidance learning in psychopathic and nonpsychopathic offenders. *Journal of Abnormal Psychology*, 95, 252–256.
- Newman, J. P., Patterson, C. M., Howland, E. W., & Nichols, S. L. (1990). Passive avoidance in psychopaths: the effects of reward. *Personality and Individual Differences*, 11, 1101–1114.
- Newman, J. P., & Schmitt, W. A. (1998). Passive avoidance in psychopathic offenders: a replication and extension. *Journal of Abnormal Psychology*, 107, 527–532.
- Newman, J. P., Schmitt, W. A., & Voss, W. D. (1997). The impact of motivationally neutral cues on psychopaths: assessing the generality of the response modulation hypothesis. *Journal of Abnormal Psychology*, 106, 563–575.
- Patrick, C. J. (1994). Emotion and psychopathy: startling new insights. *Psychophysiology*, 31, 319–330.
- Patrick, C. J., Bradley, M. M., & Lang, P. J. (1993). Emotion in the criminal psychopath: Startle reflex modulation. *Journal of Abnormal Psychology*, 102, 82–92.
- Posner, M. I., & Raichle, M. E. (1994). *Images of mind*.
- Raine, A., O'Brien, M., Smiley, N., Scerbo, A., & Chan, C. J. (1990). Reduced lateralization in verbal dichotic listening in adolescent psychopaths. *Journal of Abnormal Psychology*, 99, 272–277.
- Salovey, P., & Mayer, J. D. (1990). Emotional Intelligence. *Imagination, Cognition and Personality*, 9, 185–211.
- Schmitt, W. A., Brinkley, C. A., & Newman, J. P. (1999). Testing Damasio's somatic marker hypothesis with psychopathic individuals: risk-takers or risk-averse? *Journal of Abnormal Psychology*, 108, 538–543.
- Schmitt, W. A., & Newman, J. P. (1999). Are all psychopathic individuals low-anxious? *Journal of Abnormal Psychology*, 108, 353–358.
- Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: informative and directive functions of affective states. *Journal of Personality and Social Psychology*, 45, 513–523.
- Sidtis, J. J. (1988). Dichotic listening after commissurotomy. In K. Hugdahl (Ed.), *Handbook of dichotic listening: theory, methods, and research* (pp. 161–184). Chichester, England, UK: John Wiley.
- Sparks, R., & Geschwind, N. (1968). Dichotic listening in man after section of neocortical commissures. *Cortex*, 4, 3–16.
- Sperry, R. W. (1984). Consciousness, personal identity, and the divided brain. *Neuropsychologia*, 22, 661–673.
- Weissman, D. H., & Banich, M. T. (2000). One of twenty questions for the twenty-first century: how do brain regions interact and integrate information? *Brain and Cognition*, 42, 29–32.
- Welsh, G. (1956). Factor dimensions A and R. In G. S. Welsh, & W. G. Dahlstrom (Eds.), *Basic readings on the MMPI in psychology and medicine* (pp. 264–281). Minneapolis: University of Minnesota Press.
- Williamson, S. E. (1991). *Cohesion and coherence in the speech of psychopathic criminals*. Unpublished doctoral dissertation, University of British Columbia.
- Williamson, S., Harpur, T. J., & Hare, R. D. (1991). Abnormal processing of affective words by psychopaths. *Psychophysiology*, 28, 260–273.
- Zachary, R. A. (1986). *Shipley institute of living scale: revised manual*. Los Angeles: Western Psychological Services.