Research Report

LEFT-HEMISPHERE ACTIVATION AND DEFICIENT RESPONSE MODULATION IN PSYCHOPATHS

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Abstract—*Psychopathic offenders have difficulty processing contextual or secondary cues once they have initiated goal-directed behavior or allocated attention to a primary task. To test the hypothesis that this deficit in* response modulation *is specific to conditions in which psychopaths' left-hemisphere resources are engaged, we administered a serial recall task to 21 incarcerated psychopaths and 21 control subjects. Subjects were instructed to memorize eight words that were presented one at a time, each in one of the four corners of the visual display. Subjects' primary task was to recall the words in serial order. Then, without forewarning, they were asked to recall the words' locations. As predicted, psychopaths performed as well as control subjects in recalling words from the left and right spatial fields, but recalled significantly fewer locations from the right spatial field. Thus, psychopaths' deficient response modulation was specific to conditions in which their left-hemisphere resources were actively engaged.*

Psychopaths have been characterized as grandiose, manipulative, and coldhearted. Their affective responses are shallow and labile, and they are relatively lacking in empathy, anxiety, and genuine remorse. Behaviorally, psychopaths' chronic criminality, substance abuse, and failure to fulfill social obligations demonstrate their propensity to violate social norms (Cleckley, 1976; Hare, 1996).

On the basis of a selective review of the clinical and experimental literatures on psychopathy, we (Newman & Wallace, 1993; see also Newman, 1998) proposed that an information processing deficiency may underlie psychopaths' behavioral and affective symptoms. More specifically, we proposed that psychopaths are deficient in response modulation. Response modulation involves a brief and relatively automatic shift of attention from the effortful organization and implementation of goal-directed behavior to its evaluation (i.e., processing peripheral cues). According to this model, psychopaths are relatively deficient in processing and utilizing contextual cues that are peripheral to their dominant response set and, consequently, in using contextual information to regulate ongoing behavior (Newman, Schmitt, & Voss, 1997; Patterson & Newman, 1993; Wallace, Vitale, & Newman, 1999).

Other investigators have related psychopaths' dysfunctional information processing to aberrant cerebral organization (Day & Wong, 1996; Hare & McPherson, 1984; Hare & Jutai, 1988; Jutai, Hare, & Connolly, 1987) and specifically to cognitive deficits given left-hemisphere activation (e.g., Kosson, 1996, 1998). For instance, expanding upon an earlier proposal by Hare, Williamson, and Harpur (1988), Kosson and Harpur (1997) wrote that "limitations in their use of left hemisphere processing resources provide a plausible mechanism underlying psychopaths' apparent dual-task deficits and some of their difficulties shifting attention" (p. 398). Such proposals are based on evidence that psychopaths' anomalous task performance has been observed in language-related tasks, under task conditions involving right- as opposed to left-handed responses, and for stimuli appearing in the right spatial field (RSF) as opposed to the left spatial field (LSF). At present, however, it is unclear whether such proposals predict that the performance of psychopaths will be deficient on any task that utilizes left-hemisphere resources primarily or, more specifically, whether the ongoing commitment of left-hemisphere resources to a primary task interferes with psychopaths' ability to process secondary cues.

The purpose of this study was to examine whether deficient response modulation, like other attention anomalies shown by psychopaths, is related to left-hemisphere activation and, if so, whether deficient response modulation relates to left-hemisphere activation per se or to the ongoing commitment of left-hemisphere resources in particular.[1] Toward this end, we needed a research paradigm that included (a) primary and secondary task components to assess response modulation, (b) a primary task that would engage the left hemisphere predominantly, and (c) experimental conditions that would provide separate assessments of response modulation in the RSF and LSF. With regard to the last criterion, Kinsbourne (1970) noted that individuals commonly display lateral asymmetries in attention, so that predominant engagement of one hemisphere biases attention to the contralateral side of space. For example, while right-handed individuals are engaged in verbal activity, their attention is biased to the RSF. Consequently, given a verbal task, subjects' left-hemisphere-mediated primary-task resources should be more readily engaged when stimuli are presented in their RSF as opposed to their LSF. Furthermore, Levy and Kueck (1986) demonstrated that lateralized hemispheric activation results in lateralized biases of attention even within a free-vision, spatial-field context (i.e., even without tachistoscopic presentation of stimuli).

Our three criteria are satisfied by the serial recall task used by Hockey and Hamilton (1970) to assess the effects of arousal on the processing of primary- and secondary-task stimuli. In this paradigm, the primary task involves memorizing a series of eight words. Subjects are asked to recall the word list in serial order. Each of the words appears unpredictably in one of the four corners of a visual display, and the secondary task involves recalling each word's location. The secondary task is not described to subjects until after they have been shown and asked to recall the list of words. Thus, the serial recall task meets the specified criteria because (a) subjects must modulate their attention between the primary and secondary tasks to perform well on both tasks, (b) the primary task is verbal and thus activates the left hemisphere predominantly, and (c) half of the words are presented to the LSF and half to the RSF, allowing assessment of whether psy-

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1. In this article, we use the term *engaged* to indicate that a cerebral hemisphere is occupied with processing information. *Activated* is used to refer to the consequences of priming or arousing a cerebral hemisphere.

Table 1. *Means (and standard deviations) for correctly recalled words and locations*

Group and list	*n*	Words		Locations	
		LSF	RSF	LSF	RSF
Psychopaths					
List 1	7	1.29 (0.49)	1.57 (0.98)	1.00 (0.58)	1.14 (1.07)
List 2	8	1.88 (0.99)	2.13 (1.46)	1.88 (0.99)	2.00 (1.31)
List 3	6	1.33 (0.82)	3.17 (0.75)	1.50 (0.55)	2.33 (0.52)
Nonpsychopaths					
List 1	9	1.44 (0.53)	1.33 (0.87)	1.11 (0.33)	1.56 (1.01)
List 2	6	2.00 (0.63)	2.33 (1.03)	1.50 (1.05)	2.33 (0.52)
List 3	6	0.50 (0.55)	2.33 (1.03)	0.83 (0.75)	2.50 (0.84)

Note. n = number of participants per cell; LSF = left spatial field; RSF = right spatial field.

chopaths' deficient response modulation is specific to conditions in which left-hemisphere resources are actively engaged in primary task processing.

We hypothesized that if the serial recall task engages the left hemisphere predominantly and elicits a bias of attention to the RSF as expected, then subjects (both psychopathic and nonpsychopathic) should display superior performance in recalling words (i.e., primary stimuli) from the RSF relative to the LSF. In addition, psychopaths should recall fewer secondary (i.e., location) cues from the RSF than the control subjects but perform as well as control subjects in recalling secondary cues from the LSF. Support for this hypothesis would be consistent with our more specific interpretation regarding the importance of actively engaging left-hemisphere resources to observe deficient response modulation in psychopaths. No group differences in primary-task performance were expected.

METHOD

To test these hypotheses, we recruited 42 Caucasian male inmates from a minimum-security prison in Wisconsin. Only inmates with Psychopathy Checklist-Revised (PCL-R; Hare, 1985) scores in the psychopathic range (30 or higher) or nonpsychopathic range (20 or lower) were included. All subjects completed the Shipley Institute of Living Scale (Zachary, 1986), a short but reliable measure of intelligence. We excluded subjects who were 40 or more years old, had borderline or lower intelligence, were prescribed psychotropic medication, scored below the fourth-grade level on prison-administered achievement tests, or were left-handed according to their score (greater than 21) on the Hand Usage Questionnaire (Chapman & Chapman, 1987). In addition, African-American inmates were not included in this study because there was no documentation that the PCL-R provided valid diagnoses of psychopathy in African-American offenders when these data were collected (i.e., 1989). These procedures resulted in the inclusion of 21 psychopaths and 21 control subjects in this study. All subjects were presented with the elements of informed consent both orally and in written form. Subjects received $3.00 for participating and an additional payment contingent upon their task performance.

Prior to beginning the task, subjects were given a sheet of paper with eight blank lines. To the left of each blank line, from top to bottom, was written "1st word," "2nd word," and so on through "8th word." The task was then presented on an Apple II+ computer and 13-in. monitor. First, subjects received instructions informing them that they were about to perform a memory task in which they would have to recall the eight words presented on the computer monitor and write them down on a sheet of paper in order. They were also informed that "how much you win depends on how many words you're able to recall." Words were displayed for 2 s each, with no programmed interstimulus interval. No two words appeared successively in the same location. Each participant was randomly assigned to recall words from one of three word lists.

Following word presentation, subjects were given 60 s to recall and write each word in its serial order. Next, the experimenter reminded subjects that each word had been presented in a corner of the computer monitor. The experimenter instructed them to draw a square next to each of the eight lines and then place an *X* in the corner in which the word in that serial position had appeared (regardless of whether they recalled what the word was). Subjects were then given 60 s to recall the word locations. Finally, the experimenter determined the number of words and word locations recalled correctly and provided subjects with feedback about their earnings.

RESULTS

Results were analyzed using a 2 × 3 × 2 × 2 mixed-model analysis of covariance (ANCOVA) with psychopathy (high, low) and word list (1, 2, 3) as between-subjects factors, and spatial field (RSF, LSF) and task (word, location) as within-subjects factors. Intelligence scores were used as a covariate.[2]

This analysis yielded a significant main effect and two significant interactions. There was a significant main effect for word list, $F(2, 35) = 4.47$, $p = .02$, $\eta^2 = .20$, which was qualified by a significant Spatial Field × Word List interaction, $F(1, 35) = 10.17$, $p < .001$, $\eta^2 = .37$. As shown in Table 1, subjects receiving List 3 showed the greatest RSF advantage, whereas those receiving List 1 showed the smallest advantage. In addition, there was a significant Psychopathy × Task × Spatial Field interaction, $F(2, 35) = 4.36$, $p = .04$, $\eta^2 = .11$. Whereas control subjects correctly recalled both more words and more locations from the RSF than from the LSF, psychopaths' RSF advantage

2. Because 2 subjects were missing IQ data, we assigned them the mean score of their subgroup so that their data could be included in the analyses. Including or excluding these subjects had relatively little effect on the findings.

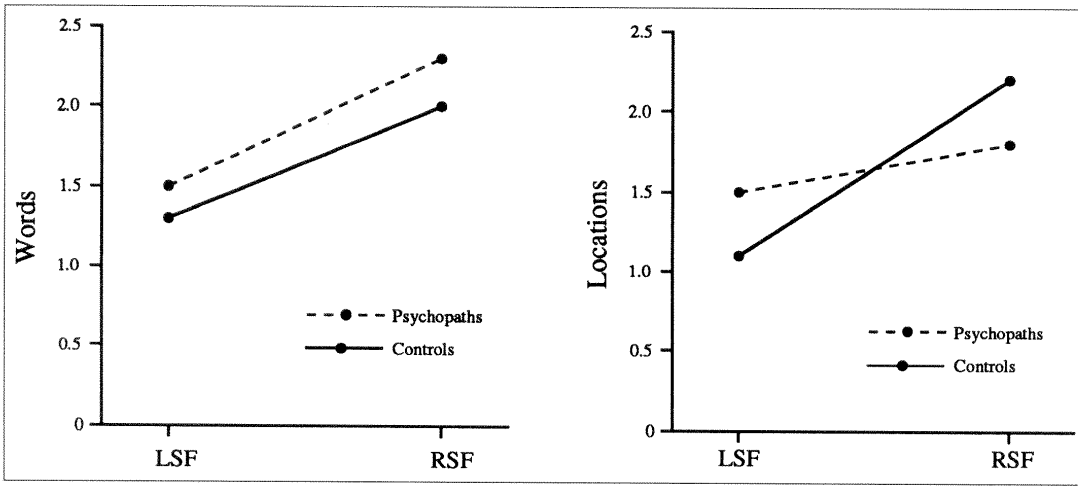

Fig. 1. Mean number of words (left panel) and locations (right panel) accurately recalled by psychopaths and control subjects on the serial recall task. LSF = left spatial field; RSF = right spatial field.

was relatively specific to word recall. No other main effects or interactions approached statistical significance, indicating that psychopaths' overall performance was at least as good as nonpsychopaths'.

A planned comparison, used to test the hypothesis that subjects would correctly recall more words from the RSF than the LSF, was significant, $t(35) = 5.85$, $p < .05$. This finding supports our assumption that the serial recall task elicited a lateralized allocation of attention to the RSF and demonstrates that the left hemisphere was activated predominantly for psychopaths as well as for control subjects (see the left panel of Fig. 1).

An interaction comparison was used to test the hypothesis that psychopaths would correctly recall fewer locations (i.e., secondary cues) than control subjects from the RSF while performing as well as control subjects in recalling locations from the LSF.[3] This interaction was significant, $t(35) = 2.75$, $p < .05$ (see the right panel of Fig. 1). As predicted, psychopaths correctly recalled significantly fewer locations than control subjects from the RSF, $t(35) = 2.38$, $p < .05$; although they recalled more locations from the LSF than control subjects, this difference was nonsignificant, $t(35) = -1.51$.

To ensure that our primary analyses were not unduly influenced by group differences in *response bias* or willingness to guess when uncertain,[4] we analyzed (a) the number of words and locations recalled (correct and incorrect responses summed) and (b) the number of incorrect words and locations recalled. The former, recall, analysis yielded no significant group differences or trends. In the latter analysis, of errors, the Psychopathy × Task × Spatial Field interaction approached significance, $F(2, 35) = 3.42$, $p = .07$. Whereas psychopaths made more errors than control subjects in recalling locations from the RSF, they made more errors than control subjects in recalling words from the LSF. The main effect for psychopathy did not approach significance, $F(1, 35) = 1.29$, $p > .25$. These results provide no evidence that group differences in response bias distorted the results of our primary analyses.

DISCUSSION

According to the response-modulation hypothesis, psychopaths are relatively deficient in processing peripheral cues once they have allocated attention to a primary task. In this study, we tested the hypothesis that psychopaths' deficient response modulation is specific to conditions in which their left-hemisphere resources are actively engaged. First, however, it was necessary to verify our assumption that the experimental conditions activated the left hemisphere predominantly and thus resulted in a bias of attention to the RSF. The fact that psychopaths and nonpsychopaths alike recalled significantly more words from the RSF than the LSF provides strong support for this assumption. Thus, we were able to investigate the consequences of actively engaging left-hemisphere processing resources for observing deficient response modulation in psychopaths. As predicted, psychopaths' deficient response modulation (i.e., processing of secondary cues) was specific to the RSF.

3. In past research, individual differences in trait anxiety and negative affect as measured by the Welsh Anxiety Scale (Welsh, 1956) have been found to moderate the effects of psychopathy (see Newman & Brinkley, 1997, for a discussion of this issue). However, anxiety was not found to moderate psychopathy in this study. Although we would have preferred to report and discuss the effects of anxiety, as in earlier publications, word limits for this report precluded this strategy.

4. We considered using a signal detection analysis to examine response bias, but decided against it for several reasons: First, signal detection analyses are most appropriate for use with recognition rather than recall tasks. Second, the analysis would not have satisfied common assumptions regarding the number or types of trials employed (e.g., there were no noise-only trials). Third, our primary analyses are consistent with previous uses of the task and are adequate to address questions related to spatial-field biases, especially in light of the fact that the groups did not differ in the overall number of words or locations that they attempted to recall.

Notably, the observed pattern of group difference is not consistent with a number of relatively common, though nonspecific, interpretations concerning psychopaths' information processing deficits. First, because psychopaths recalled as many words and locations as nonpsychopaths overall, the results are inconsistent with interpretations positing deficient motivation or general memory or performance deficits. Furthermore, the results are not readily explained by a general perceptual asymmetry, a general deficiency in left-hemisphere processing resources, or the existence of less lateralized language functions in psychopaths. If psychopaths' deficient processing of secondary cues derived from any of these factors, then they would have displayed less lateralized performance than control subjects on both the primary and the secondary tasks, but they did not. Finally, it appears that activation of the left hemisphere alone is not sufficient to engender deficient response modulation in psychopaths because, despite performing a task that activated their left hemisphere predominantly, they processed secondary cues from the LSF nonsignificantly better than control subjects did.

In light of their specificity, the current findings provide valuable information concerning the nature of psychopaths' response-modulation deficit. It appears that control subjects' secondary processing automatically followed their dominant response, as their performance in both the primary and the secondary tasks reflected a strong RSF attentional bias. By contrast, the secondary-task performance of psychopaths was roughly comparable across spatial fields, suggesting that this coordination of processing resources shown by control subjects was relatively absent in psychopaths. Whereas control subjects displayed superior processing of secondary (i.e., contextual) cues that were associated with their attentional bias (i.e., dominant response set), psychopaths did not.

Early investigations of deficient response modulation in psychopaths were concerned with the motivational and attentional conditions necessary for establishing a dominant response set that would interfere with their processing and use of secondary cues (e.g., Patterson & Newman, 1993). This research indicated that psychopaths have difficulty suspending dominant response sets for reward, though it is unlikely that hypersensitivity to reward per se is responsible for their deficient response modulation (Newman, 1998; Newman, Patterson, Howland, & Nichols, 1990). If psychopaths are not hypersensitive to reward, then why does reward seeking hamper processing of secondary cues? One explanation suggested by the present findings is that a dominant response set for reward might actively engage left-hemisphere resources. According to Sutton and Davidson (1997), the "left prefrontal cortex is a biological substrate of approach behavior and 'pre-goal attainment positive affect' because it facilitates representation of desired goal states in the absence of explicit sensory cues, thus guiding behavior toward the acquisition of these goals" (p. 209). To the extent that activity in this approach system is sufficient to engender left-hemisphere activation and bias attention toward goal-relevant stimuli, then psychopaths might experience difficulty processing secondary cues, and therefore regulating behavior, whenever goal-related cues (i.e., those related to their dominant response set) are present. If correct, this analysis would not only elucidate the property of a dominant response set that is necessary and possibly sufficient to disrupt psychopaths' processing of secondary cues (response modulation), but also help to explain how such a subtle deficit could have large clinical significance (i.e., owing to its importance for regulating inappropriate goal-directed behavior).

A potential problem with our conclusions is that the primary and secondary components of the serial recall task may draw upon different regions of the left hemisphere. Without a secondary-task-only condition, we cannot rule out the possibility that psychopaths are characterized by reduced lateralization of spatial processing. Moreover, because we did not use procedures to establish an attention bias to the LSF as well as the RSF, it is possible that psychopaths' deficient response modulation may not be specific to left-hemisphere-mediated processing per se. That is, had we employed experimental conditions that engaged subjects' right-hemisphere resources predominantly, psychopaths may also have displayed poorer response modulation than control subjects in the LSF.

The psychopathic deficit is, at once, subtle and consequential. The challenge facing researchers is to specify the processing deficiency in sufficient detail so that the means by which this subtle processing anomaly gives rise to a tragic failure of self-regulation and social adjustment may be understood. The present study supports speculation by Kosson and Harpur (1997) and Hare et al. (1988) regarding the importance of left-hemisphere engagement in this phenomenon. Furthermore, our findings suggest that it is psychopaths' peripheral or secondary-task processing, as opposed to information processing in general, that is adversely affected by engaging their left-hemisphere processing resources. Finally, our results suggest that it is the active engagement of left-hemisphere resources in primary-task processing that interferes with psychopaths' ability to process and utilize information that is peripheral to their dominant response set.

Acknowledgments—Data collection and preparation of this manuscript were supported by a research grant from the National Institute of Mental Health. We thank Richard Davidson for his critical review and helpful suggestions on earlier versions of this manuscript.

REFERENCES

Chapman, L., & Chapman, J.P. (1987). The measurement of handedness. *Brain and Cognition, 6*, 175–183.

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

Day, R., & Wong, S. (1996). Anomalous perceptual asymmetries for negative emotional stimuli in the psychopath. *Journal of Abnormal Psychology, 105*, 648–652.

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

Hare, R.D. (1996). Psychopathy: A clinical construct whose time has come. *Criminal Justice and Behavior, 23*, 24–54.

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*, 140–149.

Hare, R.D., Williamson, S.E., & Harpur, T.J. (1988). Psychopathy and language. In T.E. Moffitt & S.A. Mednick (Eds.), *Biological contributions to crime causation* (pp. 68–92). Dordrecht, The Netherlands: Martinus Nijhoff.

Hockey, G.R.J., & Hamilton, P. (1970). Arousal and information selection in short-term memory. *Nature, 226*, 866–867.

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.

Kinsbourne, M. (1970). The cerebral basis of lateral symmetries in attention. *Acta Psychologica, Amsterdam, 33*, 93–201.

Kosson, D.S. (1996). Psychopathy and dual-task performance under focusing conditions. *Journal of Abnormal Psychology, 105*, 391–400.

Kosson, D.S. (1998). Divided visual attention in psychopathic and nonpsychopathic offenders. *Personality and Individual Differences, 24*, 373–391.

Kosson, D.S., & Harpur, T.J. (1997). Attentional functioning of psychopathic individuals: Current evidence and developmental implications. In J.A. Burack & J.T. Enns (Eds.), *Attention, development, and psychopathology* (pp. 379–402). New York: Guilford.

Levy, J., & Kueck, L. (1986). A right hemispatial field advantage on a verbal free-vision task. *Brain and Language, 27*, 24–37.

Newman, J.P. (1998). Psychopathic behavior: An information processing perspective. In D.J. Cooke, A.E. Forth, & R.D. Hare (Eds.), *Psychopathy theory: Research and implications for society* (pp. 81–104). Dordrecht, The Netherlands: Kluwer.

Newman, J.P., & Brinkley, C.A. (1997). Reconsidering the low-fear explanation for primary psychopathy. *Psychological Inquiry, 8*, 236–244.

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., & Voss, W. (1997). The impact of motivationally neutral cues on psychopathic individuals: Assessing the generality of the response modulation hypothesis. *Journal of Abnormal Psychology, 106*, 563–575.

Newman, J.P., & Wallace, J.F. (1993). Psychopathy and cognition. In P.C. Kendall & K.S. Dobson (Eds.), *Psychopathology and cognition* (pp. 293–349). New York: Academic Press.

Patterson, C.M., & Newman, J.P. (1993). Reflectivity and learning from aversive events: Toward a psychological mechanism for the syndromes of disinhibition. *Psychological Review, 100*, 716–736.

Sutton, S.K., & Davidson, R.J. (1997). Prefrontal brain asymmetry: A biological substrate of the behavioral approach and inhibition systems. *Psychological Science, 8*, 204–210.

Wallace, J.F., Vitale, J.E., & Newman, J.P. (1999). Response modulation deficits: Implications for the diagnosis and treatment of psychopathy. *Journal of Cognitive Psychotherapy, 13*, 55–70.

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.

Zachary, R.A. (1986). *Shipley Institute of Living Scale: Revised manual*. Los Angeles: Western Psychological Services.

(RECEIVED 7/29/99; REVISION ACCEPTED 1/8/00)