NEUROPSYCHOLOGICAL DIFFERENTIATION OF PSYCHOPATHIC AND NONPSYCHOPATHIC CRIMINAL OFFENDERS

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Summary—A battery of neuropsychological measures was administered to 69 right-handed incarcerated male offenders to test the hypothesis that psychopaths would perform more poorly than nonpsychopaths on measures related to left hemisphere (verbal) functioning, frontal lobe (executive) functioning, or both. Psychopathy was assessed with the Psychopathy Checklist and subjects were further subdivided into low-and high-anxious groups. Robust group differences were found on two of six measures (Block Design and Trail Making Test, Part B) predicted to differentiate the groups. Consistent with other studies that subdivided subjects into low- and high-anxious groups, group differences were specific to the low-anxious subjects. The results provided no support for the hypothesis that psychopaths are characterized by verbal or left hemisphere dysfunction. Although the results were not inconsistent with the hypothesis of deficient frontal lobe functioning in psychopaths, the evidence supporting the hypothesis was specific to tasks involving the integration of cognitive-perceptual and motor processes.

Several theories of psychopathy have postulated a cortical basis for the disorder. For example, Quay (1965) posited that psychopaths are characterized by general cortical and autonomic underarousal whereas Hare and McPherson (1984) have argued that psychopaths may manifest asymmetric hemispheric arousal. Other models of psychopathy have implicated septal-hippocampal and frontal dysfunction (e.g. Fowles, 1980; Gorenstein & Newman, 1980; Yeudall, Fedora & Fromm, 1987). Most of these theories attempt to relate prominent features of psychopathy (e.g. impulsivity, insensitivity to punishment, shallow affect, etc.) to individual differences in brain functioning rather than overt brain damage.

During the last 25 years, a small amount of literature on the neuropsychology of psychopathy has been accumulated. This research includes studies testing the theory that psychopathy reflects lateralized brain dysfunction (e.g. Fedora & Fedora, 1983; Yeudall, 1977), studies focussing on frontal lobe functioning in psychopaths (e.g. Gorenstein, 1982; Hare, 1984) and less focussed studies in which psychopaths were tested with one or more neuropsychological measures (e.g. Hart, Forth & Hare, 1990; Schalling & Rosen, 1968). Hart *et al.* (1990) pointed out that the lack of methodological rigor in many of these studies has led to equivocal results concerning the neuropsychological basis of psychopathy. In this regard, Hart *et al.* (1990) noted that inadequate diagnosis of psychopathy, failure to control for potentially confounding variables (e.g. substance abuse), and small sample sizes coupled with large test batteries are typical of this area of research.

Two methodologically rigorous neuropsychological studies of psychopathy were recently conducted by Hare and his colleagues (Hare, 1984; Hart *et al.*, 1990). Consistent with other similar studies (e.g. Sutker & Allain, 1987), no group differences were found in either study. Taken together, these studies provided no evidence that psychopaths manifest brain damage or dysfunction as measured by clinical neuropsychological measures. However, Newman and his colleagues have shown that "anxiety" appears to mediate deficient delay of gratification and poor passive avoidance in psychopaths (Newman, Kosson & Patterson, in press; Newman, Patterson, Howland & Nichols, 1990; see also Lykken, 1957; Schmauk, 1970). In these studies, psychopaths and controls were divided into low- and high-anxious subgroups on the basis of the Welsh Anxiety Scale (Welsh, 1956), a measure of neurotic maladjustment. In both studies, poor task performance

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was specific to the low-anxious psychopaths only. These results suggest that anxiety could interact with psychopathy to obscure group differences on other performance measures including neuropsychological measures.

Hart et al. (1990) examined the influence of anxiety on neuropsychological performance by covarying self-reported anxiety in analyses of covariance. No performance differences between psychopaths and controls were found. Only one other study has examined performance differences on neuropsychological measures for low- and high-anxious psychopaths. Based on the work by Howard (1984), Devonshire, Howard and Sellars (1988) predicted that secondary (high-anxious) psychopaths would manifest poorer performance compared to primary (low-anxious) psychopaths on the Wisconsin Card Sorting Test (WCST). This prediction was supported although it should be noted that the psychopathic subgroups were identified on the basis of legal classification (according to British Law) and elevations on MMPI scales. In addition, each psychopathic subgroup consisted of fewer than 10 Ss and only WCST performance was tested. Given these shortcomings, no firm conclusions can be drawn from this study.

In the current study, the diagnosis of psychopathy was accomplished by means of a wellvalidated and reliable instrument, the Psychopathy Checklist (Hare, Harpur, Hakstian, Forth, Hart & Newman, 1990). Furthermore, the Welsh Anxiety Scale (WAS; Welsh, 1956) was used to subdivide psychopathic and nonpsychopathic Ss into low- and high-anxious subgroups. The WAS is a measure of trait anxiety and maladjustment and has been used often in psychopathy research (e.g. Newman *et al.*, 1990; Widom, 1976) to identify low- and high-anxious psychopaths and controls. Consistent with the analytic strategy employed by Newman *et al.* (1990), the predicted performance differential (nonpsychopaths performing better than psychopaths) was examined *within* levels of anxiety.

Based on the theoretical work of Yeudall (Yeudall et al., 1987) and others (e.g. Flor-Henry, 1976; Gorenstein, 1982), we predicted that psychopaths would manifest poorer performance on cognitively demanding tests primarily associated with verbal-left hemisphere functioning and frontal lobe (executive) fuctioning. Consequently, psychopaths were predicted to perform more poorly than nonpsychopaths on 6 neuropsychological measures: (a) the Block Design subtest from the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981); (b) the Controlled Oral Word Association Test (Benton, 1968); (c) the Digits Backward portion of the WAIS/R Digit Span subtest; (d) the Stroop Color-Word test, Part II time and errors (Dodrill, 1978); and (e) the Trail Making Test, Part B from the Halstead-Reitan Neuropsychological Battery (HRNB; Reitan & Wolfson, 1985).

A set of six control measures was also administered to all Ss. These measures included the Category Test (Wetzel & Boll, 1987), WAIS-R Digit Span Digits Forward, the Finger Tapping Test from the HRNB, Paired Associate Learning (Wechsler, 1945), Stroop Part I time, and Part A of the Trail Making Test. Although no group differences were predicted for these control measures, they were used to form an index to control for nonspecific performance factors. Thus, the index was intended to be used as a covariate in supplementary analyses of primary measures for which group differences were predicted. Other variables that could potentially affect neuropsychological performance (e.g. substrate abuse) were also evaluated in the supplementary analyses of covariance.

METHOD

Subjects

Ss were 69 right-handed White males recruited from the inmate population at a minimum security prison in southern Wisconsin. Recruitment was limited to inmates 18 to 40 years of age who were identified by selecting every fifth name on the institution roster. Inmates were excluded from recruitment for any of the following reasons: (1) taking psychotropic medication, (2) borderline or lower intelligence, (3) significant medical conditions (e.g. serious head injury), and (4) performance below the fifth grade level on standard achievement tests.

Inmates who agreed to participate in the research completed a semi-structured, clinicalbehavioral interview designed to elicit information to be used in making psychopathy ratings on the 20-item Revised Psychopathy Checklist (PCL-R; Hare *et al.*, 1990). Ss with PCL-R scores of 20 or below were labeled controls; Ss scoring 30 or above were labeled psychopaths (Hare, 1985). Ss scoring between 20 and 30 on the PCL-R ("middle" group Ss) were tested in the current study but were excluded from the analyses for several reasons. First, middle group Ss constitute a heterogeneous group (that may include controls and psychopaths) with the result that the middle group offers little as a comparison group. Second, Hare (1984) has reported that middle group Ss appeared to be more psychologically maladjusted (with significant elevations on MMPI scales of depression, schizophrenia, and psychasthenia). Consequently, their performance on many outcome measures may be related to aspects of psychological functioning unrelated to psychopathy. Finally, it was observed in the current study that, as a group, middle Ss were significantly more variable on the neuropsychological measures, perhaps reflecting group heterogeneity and/or psychological maladjustment.

Ss were also asked questions from the alcohol and drug sections of the Diagnostic Interview Schedule (DIS; Robins, Helzer, Croughan & Ratcliff, 1981). Computer scoring of Ss' responses to DIS questions provided the number of lifetime alcohol symptoms and the number of lifetime drug symptoms. Ss also completed the WAS (Welsh, 1956), the Hand Usage Questionnaire (Chapman & Chapman, 1987), and the Shipley Institute of Living Scale (SILS; Zachary, 1986). The WAS (median = 9) was used to divide controls and psychopaths into low- and high-anxious subgroups. Ss identified as left-handed on the Hard Usage Questionnaire were omitted from the analyses. The SILS provided age-corrected estimates of WAIS-R Full Scale IQ. Table 1 provides means and standard deviations for S variables for all four groups.

Neuropsychological measures

The selection of particular neuropsychological measures for purposes of assessing postulated functional differences between psychopaths and controls was guided by examination of the literature on the neuropsychology of psychopathy (e.g. Fedora & Fedora, 1983; Hart *et al.*, 1990; Schalling & Rosen, 1968) as well as review of available tests for assessing neuropsychological functioning of interest. A test that discriminated psychopaths and controls previously (Trail Making Test, Part B; Fedora & Fedora, 1983) and reliable measures with demonstrated sensitivity to frontal and/or verbal functioning (WAIS-R Block Design, Controlled Oral Word Association Test, Digit Span Digits Backward, and Stroop Interference Time and Errors) were selected for use in the study. Although the WCST (Grant & Berg, 1948) is commonly employed as a measure of frontal functioning, previous experience with the WCST in our laboratory indicated that it does not discriminate psychopaths from controls unless monetary rewards and punishment are used (Howland & Newman, 1987). Thus, the WCST was not used in the current study because no rewards or punishments were administered during the testing. The six measures that we predicted would discriminate psychopaths and controls were selected on an *a priori* basis as documented in a dissertation proposal by the first author.

The decision to classify the Category Test, Digit Span Digits Forward, the Finger Tapping Test, Paired Associate Learning, noninterference part of the Stroop, and Part A of the Trail Making Test as control measures was also made on an *a priori* basis. The Category Test (administered in the current study as the Short Category Test, Booklet Format; Wetzel & Boll, 1987) is often described as a frontal measure. The Category Test has been found to be a sensitive indicator of brain impairment (King & Snow, 1981; Pendleton & Heaton, 1982), albeit *diffuse* impairment without localizing or lateralization significance (Bornstein, 1986; Cullum, Steinman & Bigler, 1984; Reitan, 1986). In this regard, Bornstein (1986) noted that "the HCT [Category Test] has not been demonstrated to be specifically sensitive to frontal lobe dysfunction" (p. 21). Thus, the Category Test was used as a control measure in the current study.

Block Design. The Block Design subtest of the WAIS-R is a nonverbal measure of perceptual and visual-spatial reasoning (Wechsler, 1981). This test requires the integration of visual-spatial ability, abstract reasoning, and visual-motor coordination in order to solve a constructional, concept formation problem. Standard scores were computed according to the WAIS-R manual (Wechsler, 1981). Although Block Design is less often described as a frontal measure, Stuss and Benson (1986) pointed to the important role of the frontal lobes in Block Design due to the planning, sequencing, and abstract aspects of the task. However, Lezak (1983) and others (e.g. Warrington, James & Maciejewski, 1986) emphasize that Block Design primarily depends on intact right parietal functioning.

Controlled Oral Word Association Test (COWAT). This test is a measure of verbal associative fluency in which the S is asked to generate orally as many words as possible that begin with a specific letter of the alphabet. The version of the COWAT used in the current study was developed by Benton (1968) and utilized the letters F, A, and S. Scoring consisted of the total number of valid words (corrected for education; Lezak, 1983) generated for the three letters. The COWAT requires the S to organize verbal output according to a set of rules or conditions (words must begin with a particular letter and cannot be names, places, etc.). Deficits in verbal fluency have been found to be associated with left or bilateral frontal lobe pathology (Benton, 1968; Borkowski, Benton & Spreen, 1967; Crockett, Bilsker, Hurwitz & Kozak, 1986; Perret, 1974).

Digit Span. Digit Span is a verbal subtest of the WAIS-R that involves auditory attention and immediate auditory memory. There are two parts to Digit Span (Digits Forward and Digits Backward) that require the S to remember and repeat sequences of numbers. For purposes of neuropsychological assessment, Lezak (1983), Banken (1985), and others recommend consideration of Digits Forward and Digits Backward separately. Although Digits Forward is typically thought of as a measure of memory, Lezak (1983) described the test as a measure of efficiency of attention that involves passively holding information. In contrast, Digits Backward has been described as a measure of active memory that requires effort and concentration in order to store and manipulate information (Banken, 1985; Lezak, 1983). Lezak considers Digits Backward to be more of a memory test than Digits Forward because it requires two simultaneous cognitive operations: memory and reversal of number sequences. Scoring for each part consisted of the raw score total (Wechsler, 1981).

Finger Tapping Test. The Finger Tapping Test (FTT) is a measure of finger-tapping (motor) speed, manual dexterity and lateralization derived from the HRNB (Reitan & Wolfson, 1985). Scoring consisted of the mean number of taps across the three highest trials (out of a minimum of five 10-sec trials) that were within five taps of each other. Means were computed separately for each hand. In the current study, the FTT was administered as the first task in the neuropsychological battery and a second time as the last task in the battery to allow examination of stability of performance over the testing session although no group differences were predicted.

Paired Associate Learning. The Paired Associate Learning test (PAL) is a subtest from the Wechsler Memory Scale (Wechsler, 1945) that provides a measure of verbal learning and recall (Larrabee, Kane & Schuck, 1983). In the PAL, the S must remember a list of word pairs consisting of six easy associates (e.g. north-south) and four hard associates (e.g. school-grocery). Two scores were computed based on the total number of words recalled across three trials for the easy associates only and the hard associates only.

In the current study, the PAL was given as the second task in the neuropsychological assessment (following the FTT). In addition, after approx. 45 min, Ss were retested for free recall of the words, followed by cued recall for the first set of word pairs. The retesting (PAL-Delay) occurred second to last in the test battery. For the delayed portion, the total number of easy words recalled and the total number of hard words recalled for both the free recall and cued recall were tallied. Retesting on PAL was intended to allow examination of long-term memory but no group differences were expected.

Short Category Test, Booklet Format. The Short Category Test, Booklet Format (SCT-BF; Wetzel & Boll, 1987) is an abbreviated version of the Halstead Category Test (HCT; Halstead, 1947; Reitan & Wolfson, 1985). The HCT is included in the HRNB and provides a measure of abstract reasoning and concept formation. The S's task in all forms of the Category test is to discover organizing principles in consecutive sets of designs. Successful performance on the Category Test requires the ability to deduce principles or rules through hypothesis testing in the context of positive and negative reinforcement as well as the ability to shift sets or principles (Pendleton & Heaton, 1982; Reitan & Wolfson, 1985). The SCT-BF takes approx. 15–20 min and scoring consists of the total number of errors across the subtests.

Stroop Color-Word Test. The Stroop Color-Word Test (Stroop) is a cognitive-perceptual task that involves verbal skills (reading), attention-concentration, and the ability to shift and maintain cognitive sets (Dodrill, 1978; Golden, 1976; Jensen & Rohwer, 1966; Lezak, 1983; Perret, 1974).

In this version of the test (Dodrill, 1978), there are two parts that use the same stimulus sheet on which 178 color-word names are printed in incongruous colors (e.g. RED printed in blue ink). In Part I, the S reads the color-words as printed ignoring the colors in which the words are printed. In Part II, the S names the colors in which the words are printed ignoring the words themselves. Scoring for the Stroop consisted of two scores, total time on Part I and total time on Part II. Also, the number of errors committed on each part was recorded.

The Stroop phenomenon (Jensen & Rohwer, 1966; Stroop, 1935) on which the test is based consists of the widely replicated finding that naming the color of incongruous color-words (e.g. saying "blue" for the word RED printed in blue ink) requires more time than reading the word itself (e.g. saying "red" for the word RED printed in blue ink). Part II of the Stroop requires initiation and maintenance of a cognitive set, suppression of competing responses, and perceptual-cognitive flexibility. These executive functions are typically compromised in frontal brain damage but damage to other areas of the brain may also affect performance (Lezak, 1983). Good evidence for left frontal involvement in poor color-word naming performance was reported by Perret (1974) and Golden (1976).

Trail Making Test. The Trail Making Test (TMT) is a two-part test related to motor speed and attention that involves visual conceptual tracking (Lezak, 1983; Reitan, 1958; Reitan & Wolfson, 1985). In Part A (TMT-A), the S draws lines between consecutively numbered circles on a sheet of paper. In Part B (TMT-B), the S sees circles with letters and circles with number interspersed on a page. The S is instructed to connect the circles by going from "1" to "A" to "2" to "B" to "3" to "C", etc. Scoring consisted of the amount of time (in sec) for each part.

Successful performance on the TMT requires counting ability, visual-spatial and motor skills, and the ability to form and maintain a cognitive set requiring planning, flexibility, and attention (Golden, 1979; Lezak, 1983). Although the TMT is often used as a screening test for brain impairment (Lezak, 1983), TMT-B has been characterized by some authors (e.g. Stuss & Benson, 1986) as dependent on frontal lobe functioning. In addition, Fedora and Fedora (1983) reported poorer performance by psychopaths on TMT-B (but not on TMT-A). Thus, psychopaths were predicted to perform more poorly than nonpsychopaths only on TMT-B.

Procedure

Ss eligible for participation were contacted individually and provided with a description of the research project. Two graduate research assistants (the first and second authors) served as interviewers and experimenters. [The project director (Newman) served as an interviewer for seven Ss in the current study but did not serve as an experimenter in the current study.] Ss who were interviewed by one research assistant were tested by the other research assistant in follow-up studies to ensure that the experimenters would be blind to Ss' psychopathy assessment. Experimenters were also blind to Ss' anxiety scores. In the current study, each S was assessed or tested individually on three separate days as follows:

Day 1. Each inmate who consented to participate in the research was assessed by interview, file review, and questionnaire (Hand Usage Questionnaire, and two other self-report measures not used in the current study). Ss were paid \$3.00 for completing the interview and questionnaire.

Day 2. Ss were contacted by the experimenter approx. 2 to 4 weeks following the interview day for participation in a separate psychophysiological study (Arnett, Smith & Newman, 1991). For purposes of the current study, only a self-report questionnaire measure (the WAS) was used from the experimental session.

Day 3. Approx. 1 week after the psychophysiological study, Ss were contacted about participation in the current study. Each S was provided with a brief overview of the various measures that would be administered and informed consent was obtained. Two semi-counterbalanced orders of measures were utilized. Both orders began with the FTT followed by PAL. Also, both orders ended with PAL-Delay followed by the FTT. The counterbalancing scheme applied only to the measures falling between PAL and PAL-Delay. The first counterbalanced order sequenced the middle measures as follows: (a) Stroop; (b) Digit Span; (c) Block Design; (d) TMT; (e) COWAT; and (f) SCT-BF. The second counterbalanced order simply reversed the sequence of the middle measures. After finishing the neuropsychological measures, the S completed the Shipley Institute

Table 1. Means and standard deviations for S variables by psychopathy and anxiety group

Variable	Low-Anxious		High-Anxious	
	Controls	Psychopaths	Controls	Psychopaths
Age	26.9 (4.2)	26.5 (4.3)	24.9 (4.6)	25.3 (4.1)
Education ^a	11.5 (0.9)	11.9 (0.6)	11.4 (1.0)	11.7 (1.0)
Estimated WAIS-R IQ ^b	98.6 (9.3)	97.5 (9.8)	95.9 (8.1)	96.0 (12.3)
Handedness	14.9 (2.6)	15.0 (3.0)	15.2 (3.1)	16.3 (2.8)
Alcohol Symptoms ^d	2.7 (3.8)	5.9 (4.1)	6.4 (4.9)	7.1 (4.4)
Drug Symptoms ^c	1.4 (1.8)	2.9 (2.0)	2.1 (2.0)	2.5 (1.9)
PCL-R	13.22 (5.1)	32.4 (2.2)	15.0 (2.9)	33.9 (2.4)
WAS	4.3 (2.5)	3.9 (2.5)	19.6 (9.1)	15.7 (5.9)
<u>N</u>	18	18	14	19

Standard deviations are in parentheses.

⁴Years of education corrected for completion of General Educational Development Test (GED). ^bEstimated WAIS-R based on SILS (Zachary, 1986). ^cHandedness scores ranged from 13 to 24 with lower scores (13 to 17) indicative of right hand preference. ^dTotal alcohol abuse/dependence symptoms from the DIS. ^cTotal drug abuse/dependence symptoms from DIS.

of Living Scale. The entire experimental session took 65 to 75 min to complete and Ss were paid \$5.00 for participating.

Analytic considerations

The design of the study was based on two factors, psychopathy (controls vs psychopaths) and anxiety (low vs high). Analyses proceeded in three steps. First, the six measures on which nonpsychopaths were predicted to perform better than psychopaths (Block Design, COWAT, Digits Backward, Stroop Part II time, Stroop Part II errors, and TMT-B) were tested via planned comparisons *within* each level of anxiety. For each measure, family-wise Type I error was controlled via a Bonferroni correction by setting alpha at 0.025 (reflecting the fact that two planned comparisons were computed for each measure). It could be argued that the Bonferroni-corrected alpha should be set at 0.004 reflecting 12 tests (6 dependent measures \times 2 planned comparisons each). However, given that most neuropsychological studies of psychopathy have reported no group differences or weak and inconsistent results, we felt that setting alpha at 0.025 provided a balance between Type I error and Type II error. In addition, two-tailed tests. were used for all comparison although one-tailed tests would be justified on the basis of the prediction that psychopaths would perform worse than controls; this decision served to further control Type I error rate.

Second, scores from the six control measures (Digits Forward, FTT, PAL, SCT-BF, Stroop Part I, and TMT-A) were z-transformed and the resulting z-scores were averaged to yield a single measure (the "control task index"). This index was used as a covariate in supplementary tests of the primary measure in order to control for nonspecific performance factors. In addition, estimated WAIS-R IQ and substance abuse variables (number of alcohol symptoms and number of drug symptoms) were also used as covariates in these supplementary analyses in order to control their potential influence on performance. Separate analyses of covariance (ANCOVAs) were computed for each covariate. The purpose of the supplementary covariate analyses was to test the robustness of any significant planned comparisons by covarying out variables that may account for group differences on the neuropsychological measures.

Finally, the interaction between psychopathy and anxiety was examined for the six primary measures in two-factor analyses of variance (ANOVAs).

RESULTS

Two-factor (Psychopathy × Anxiety) ANOVAs were computed for age, education, estimated WAIS-R IQ, handedness, number of alcohol symptoms, and number of drug symptoms. No significant main effects or interaction effects were found for age, IQ, education, or handedness. A significant anxiety group effect, F(1,65) = 5.62, P < 0.05, was found for number of alcohol symptoms, reflecting more abuse of alcohol among high-anxious Ss. In addition, a significant psychopathy group effect, F(1,65) = 10.43, P < 0.01, was found for number of drug symptoms, reflecting psychopaths' greater drug abuse (Smith & Newman, 1990).

Table 2. Means and standard deviations for neuropsychological measures for which controls were predicted to perform better than psychopaths

Variable	Low-Anxious		High-Anxious	
	Controls	Psychopaths	Controls	Psychopaths
Block Design ^a	11.7 (2.3)	9.4 (2.4)	10.3 (2.4)	10.6 (2.1)
COWAT ^b	41.1 (8.1)	42.6 (7.5)	38.9 (8.5)	47.2 (16.6)
Digits Backward ^c	6.7 (2.3)	6.9 (1.8)	6.8 (1.8)	7.2 (2.5)
Stroop II time (sec)	195.9 (28.9)	217.1 (40.5)	224.8 (36.8)	216.9 (57.0)
Stroop II errors	10.6 (4.5)	9.8 (6.7)	11.2 (7.5)	10.7 (9.1)
TMT-B (sec)	47.0 (12.7)	57.3 (9.8)	67.7 (25.3)	56.4 (18.6)

Standard deviations are in parentheses. For cell sizes, see Table 1. For Stroop II time, cell sizes were 18, 18, 12, and 16. For Stroop II errors, cell sizes were 18, 16, 12, and 15.

were 18, 18, 12, and 16. For Stroop II errors, cell sizes were 18, 16, 12, and 15. ^aFrom the WAIS-R (Wechsler, 1981); in scaled scores. ^bUnit is total number of words generated for the three letters, F, A, and S. ^cFrom WAIS-R Digit Span; unit is raw total.

Experimenter and order effects were also initially examined for all the neuropsychological measures by means of three-factor ANOVAs with anxiety group, psychopathy group, and experimenter (or order) as between-Ss factors. Significant interactions were found for 5 of 18 dependent measures. However, there was a total of 108 interaction terms possible (3 interaction effects for each of 18 dependent measures tested $\times 2$ types of nuisance variables, experimenter and order). Thus, the 5 significant interactions represent chance level occurrence of significant interaction effects. Given the unsystematic nature of the significant effects, any variance possibly attributable to experimenter and/or order was left unaccounted for in subsequent analyses.

Table 1 also provides means and standard deviations for the PCL-R and the WAS. Focussed comparisons were computed to ensure that, within levels of anxiety, mean anxiety was comparable for psychopaths and controls. Similarly, focussed comparisons were computed to ensure that, within levels of psychopathy, mean psychopathy scores were comparable for low-anxious Ss and high-anxious Ss. None of these comparisons revealed any statistically significant differences at the 0.05 alpha level.

Planned comparisons

A set of two-factor (Psychopathy × Anxiety) ANOVAs were computed for the six primary measures to derive error terms for planned comparisons and to examine main and interaction effects. Two planned comparisons were computed for each of six dependent measures for which controls were predicted to perform better than psychopaths. (Group means and standard deviations for these six dependent measures are presented in Table 2.) As noted above, the performance of control Ss was contrasted with the performance of psychopathic Ss within levels of anxiety group. Significant comparisons involving the low-anxious Ss were found for two measures, Block Design, t (34) = 2.91, P < 0.007, and TMT-B, t (32) = -2.73, P < 0.02. Examination of experimenter and order effects for Block Design and TMT-B revealed no bias due to these variables. However, TMT-B exhibited significant heterogeneity of variance by both the Bartlett-Box test, F (3,7350) = 5.08, P < 0.003, and Cochran's test, C (16,4) = 0.51, P < 0.005. As a result, the planned comparisons for TMT-B were tested by computing Welch's (1947) approximate t solution (cf. Games & Howell, 1976; Klockars & Sax, 1986). None of the comparisons involving high-anxious control Ss versus high-anxious psychopaths were statistically significant.

Supplementary analyses of Block Design and TMT-B were computed using the control index, estimated WAIS-R IQ, number of alcohol symptoms, and number of drug symptoms as covariates in separate analyses of covariance (ANCOVA). The planned comparison involving Block Design remained significant (P < 0.025) after covarying out the variance in performance (in separate ANCOVAs) attributable to control task performance, IQ, and substance abuse. For TMT-B, none of the covariates adversely affected the statistical significance of the planned comparison with the exception of the control index which resulted in a marginally significant result, t (32) = -2.28, P < 0.03. In fact, inclusion of alcohol symptoms as a covariate resulted in a larger t statistic for the TMT-B comparison in low-anxious groups, t (32) = -3.56, P < 0.002. (The ANCOVA assumption of homogeneity of regression was satisfied for these analyses involving Block Design and TMT-B.) Similar supplementary analyses (covarying out the control index, estimated WAIS-R IQ, and substance abuse symptoms) on the remaining four dependent measures for which planned

Table 3. Means and standard deviations for neuropsychological measures for which psychopathy-specific performance differences were not expected

	Low-Anxious		High-Anxious	
Variable	Controls	Psychopaths	Controls	Psychopaths
Digits Forward*	7.8 (1.5)	7.8 (1.6)	8.1 (1.4)	7.9 (2.5)
FTT1-Right ^b	56.9 (4.8)	52.5 (4.5)	53.3 (7.0)	51.2 (5.7)
FTT2-Right ^b	56.0 (5.6)	54.2 (3.1)	55.0 (6.7)	52.2 (5.7)
FTT1-Left ^b	49.1 (5.5)	46.6 (5.7)	48.8 (7.8)	47.4 (5.8)
FTT2-Left ^b	51.4 (5.1)	48.4 (6.4)	51.2 (6.9)	48.2 (5.5)
PAL-Easy ^c	5.6 (0.5)	5.6 (0.4)	5.5 (0.3)	5.6 (0.3
PAL-Hard ^c	2.4 (0.9)	2.9 (0.6)	2.2 (0.8)	2.5 (0.9)
PALD-Easy ^d	5.8 (0.5)	5.9 (0.2)	5.8 (0.6)	5.8 (0.4)
PALD-Hard ^d	2.8 (1.3)	3.3 (0.7)	2.1 (1.2)	3.2 (0.9)
SCT-BT (errors)	28.1 (13.6)	29.7 (12.8)	33.2 (12.8)	26.7 (10.2)
Stroop I time (sec)	82.6 (14.5)	89.7 (20.3)	89.7 (8.0)	95.8 (19.8)
TMT-A (sec)	20.8 (5.5)	22.1 (7.3)	25.4 (8.6)	22.4 (7.6)
Control Index	0.17 (0.43)	0.03 (0.43)	-0.14 (0.34)	-0.08 (0.58)

Note. Standard deviations are in parentheses. For cell sizes, see Table 1. For Stroop I time, cell sizes were 18, 18, 14, and 19. For FTT variables, cell sizes were 18, 18, 13, and 18.
^a From WAIS-R Digit Span; raw total. ^b 1 = first administration; 2 = second administration; right = right hand; left = left hand; unit is average number of taps in 10 sec. ^cEasy = easy words; Hard = hard words; unit is average number of words recalled across three trials. ^d PALD = PAL, delayed cued recall; Easy = easy words; Hard = hard words; unit is number of words recalled across three trials. ^d PALD = Sec. ^c Casy = control measures.

comparisons were computed failed to reveal any significant differences between controls and psychopaths regardless of anxiety level. (The ANCOVA assumption of homogeneity of regression was satisfied for these four dependent measures for all covariates with the exception of the control index used with Digits Backward. As reported above, no group differences were found via planned comparisons for this variable, and, as such, the failure of the assumption is irrelevant.)

Examination of main and interaction effects for Block Design revealed only a significant Psychopathy × Anxiety interaction, F(1,65) = 5.33, P < 0.03. As reflected in the planned comparison presented above for Block Design, the performance difference between low-anxious controls and low-anxious psychopaths (see Table 2) appears to account for this significant interaction. For TMT-B, a significant main effect of anxiety group was found F(1,65) = 5.76, P < 0.02, which was qualified by a significant psychopathy group by anxiety group interaction, F(1,65) = 6.80, P < 0.02. Although low- and high-anxious psychopaths perform similarly on TMT-B, low- and high-anxious controls appear to differ. However, a *post-hoc* comparison testing the difference between low- and high-anxious controls was statistically nonsignificant by Scheffe's test. No significant main effects or interactions were found for the COWAT, Digits Backward, Stroop Part II time, or Stroop Part II errors. (Means and standard deviations of the control measures and the control index are presented in Table 3.)

DISCUSSION

The results of the planned comparisons provided partial support for the hypothesis that psychopaths would be characterized by poorer performance (relative to control Ss) on tasks primarily dependent on frontal lobe (executive) functioning. There was no support for the hypothesis that psychopaths would perform more poorly than controls on measures primarily dependent upon verbal-left hemisphere functioning. More specifically, the planned comparisons for the six measures for which psychopaths were predicted to perform more poorly than control Ss revealed that *low-anxious* psychopaths performed more poorly than *low-anxious* control Ss on Block Design and TMT-B. No psychopathy-specific group differences were found for the remaining four measures involving planned comparisons (COWAT, Digits Backward, and Stroop Part II time and errors).

The psychopathy-specific group effects for Block Design and TMT-B appear to be robust in light of the results of the covariance analyses that separately partialled out the effects of level of performance, IQ, and substance abuse. In addition, low-anxious psychopaths did not appear to manifest global performance deficits as indicated (indirectly) by performance on several control tasks that was comparable to or somewhat better than control Ss' performance (see Table 3). Educational level, age, and estimated WAIS-R IQ were quite similar for both groups as well. Thus, the results for Block Design and TMT-B cannot be attributed to confounding variables or global performance deficits in psychopaths.

Both Block Design and TMT-B have been used in previous studies of the neuropsychology of psychopathy. Fedora and Fedora (1983) found that psychopaths performed more poorly than normal controls on TMT-B but no group differences were found for Block Design. More recently, Malloy, Noel, Longabaugh and Beattie (1990) reported that alcoholics displaying Antisocial Personality Disorder (ASP) performed more poorly on Block Design and TMT-B (and other measures) compared to nonASP alcoholics matched on age and sex. In contrast, Hart *et al.* (1990) failed to find significant group differences for Block Design or TMT-B. However, these authors reported a marginally significant result (P < 0.06) for TMT-B in one of two samples. Specifically, Hart *et al.* reported that psychopaths in sample 1 averaged 94.8 sec on TMT-B and controls averaged 75.5 sec; means for sample 2 were 72.0 and 70.4 for psychopaths and controls, respectively. Interestingly, the mean for psychopaths in sample 1 is fairly high and actually falls in the "mildly impaired range" of 86 to 120 sec reported by Reitan and Wolfson (1985). Thus, the Hart *et al.* study failed to provide a clear answer regarding TMT-B performance in psychopaths.

In light of the significant Psychopathy \times Anxiety interaction observed for Block Design and TMT-B, the difference between previous neuropsychological studies of psychopathy and the current study most likely relates to the decision to control for level of anxiety. Indeed, the significant Psychopathy \times Anxiety interaction for Block Design and TMT-B demonstrated that the effect of psychopathy on performance was mediated by anxiety level. Consistent with other studies that identified low-anxious and high-anxious psychopaths (e.g. Newman *et al.*, 1990), performance differences in the current study were associated with the low-anxious groups only. In fact, collapsing across low- and high-anxious subgroups of Ss would have resulted in no psychopathy-specific group differences. Thus, the failure to account for the mediating influence of anxiety in previous studies may explain the null results reported heretofore.

Although it is true that most of the measures employed in the current study involve some verbal processing, Block Design and TMT-B are typically described as nonverbal tasks that require integrated processing of visuo-spatial, motor, and executive functioning. Furthermore, there is evidence that Block Design is more dependent on the integrity of the right parietal lobe than other brain structures (Warrington *et al.*, 1986) although poor performance can also result from damage to the prefrontal cortex (Lezak, 1983; Stuss & Benson, 1986). There appears to be little evidence for any lateralization significance for TMT-B although Reitan and Wolfson (1985) noted that the visual scanning and spatial aspects of the TMT are more lateralized to the right hemisphere. Thus, contrary to the hypothesis that psychopaths would perform more poorly on tasks dependent upon verbal-left hemisphere functioning, the results of the current study suggest that low-anxious psychopaths may be less adept at cognitively demanding activities mediated primarily by the right hemisphere—at least while actively engaged in motor responding.

The lower performance on Block Design and TMT-B observed in low-anxious psychopaths may reflect deficient integration of cognitive-perceptual and motor functioning. Accordingly, poorer performance may be related to the functional integrity of the right hemisphere, or, alternatively, may reflect inefficient utilization of right hemisphere resources while engaged in effortful, goal-directed behavior. Similarly, Hare, Williamson and Harpur (1988) concluded that the language processing anomalies displayed by psychopaths may reflect a deficit in cortical integration perhaps related to impaired interhemispheric communication, inefficient distribution of processing resources, or "poor integration between affective and other components of cognition and behavior" (p. 88).

The overall pattern of results in the current study suggests that, contrary to the assertions of Flor-Henry (1976) and Yeudall (1977), psychopaths are not characterized simply by verbal or left hemisphere dysfunction. In fact, consistent with Hart *et al.* (1990), our results provide no support for brain-damage explanations of psychopathy. Nevertheless, low-anxious psychopaths appear to manifest poorer performance on cognitively demanding tasks that depend on integration of cognitive-perceptual and motor processes. Interestingly, the low-anxious psychopaths and controls performed similarly on the SCT-BF, a cognitive-perceptual measure of abstraction lacking significant motor involvement. Thus, the current findings suggest that future studies should include

neuropsychological measures that involve processing demands similar to Block Design and TMT-B as well as carefully matched control tasks. In addition, the role of anxiety (or neurotic maladjustment) in mediating group differences in test performance also should be addressed to better understand the possible neuropsychological basis of psychopathy.

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