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Altering a Dominant Response: Performance of Psychopaths and Low-Socialization College Students on a Cued Reaction Time Task

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The passive avoidance learning deficits of disinhibited Ss have been attributed to their difficulty inhibiting dominant responses. To date, evidence for this hypothesis has been derived from complex tasks. In two experiments, a cued reaction time task requiring no learning or memory was used to evaluate the degree to which groups of disinhibited Ss inhibit simple dominant responses. Disinhibited groups were incarcerated psychopaths identified with Hare's (1985) Psychopathy Checklist and undergraduate males who scored low on the Socialization Scale. Both disinhibited groups committed more errors than controls on trials containing misleading cues, but in both samples, findings were limited to trials in which Ss expected to make right-hand responses. Although alternative interpretations are possible, these data are consistent with the proposal that disinhibited individuals are less likely to inhibit well-established dominant responses.

Passive avoidance—the act of withholding a response to avoid punishment—plays an important role in theories of socialization and psychopathy (e.g., Trasler, 1978). Indeed, several studies have demonstrated poor passive avoidance learning in psychopaths (Lykken, 1957; Schmauk, 1970; Siegel, 1978) and other less socialized subject groups (e.g., Moses, Ratliff, & Ratliff, 1979; Newman, Widom, & Nathan, 1985). The most common explanation for these findings involves poor fear conditioning (Hare, 1970; Lykken, 1957). However, Gorenstein and Newman (1980) proposed an alternative explanation: Passive avoidance deficits reflect the inability of poorly socialized individuals to modulate dominant responses. For the purposes of this article, dominant responses are operationalized as highly probable responses. The mechanisms by which these responses become dominant have not yet been established but may include both the direction of attentional focus and the preparation of anticipated responses.

Newman et al. investigated poorly socialized subjects' performance on several passive avoidance tasks. Psychopaths and other disinhibited subjects performed more poorly on a passive avoidance task than nondisinhibited subjects when both reward and punishment contingencies were tied to the same approach response (Newman & Kosson, 1986; Newman et al. 1985). However, no group differences were observed when both correct-approach responses and correct abstentions were equally rewarded or when both incorrect-approach responses and incorrect abstentions were equally punished. These conditions, which do not require inhibition of a dominant response, suggest that the poor performance of disinhibited subjects is not general but may be specific to tasks in which adequate performance requires the inhibition of dominant-approach responses. This specificity is difficult to explain using fear conditioning and consequently makes a dominant-response theory more attractive. However, even if these data are compatible with a dominant-response theory, they do not rule out explanations based on learning, because adequate performance depends on subjects learning correct responses.

Further support for this hypothesis comes from experiments assessing time to extinguish a maladaptive response during a card-playing task. In these tasks, subjects were given the opportunity to play as many cards as they wished from one or more prearranged decks of cards. In each deck, some cards were winners, which were accompanied by monetary reward, and other cards were losers, which were accompanied by monetary punishment. Siegel (1978) and Newman, Patterson, and Kosson (1987) started subjects with a high rate of reward and found that, under some conditions, psychopaths played more cards in spite of unfavorable odds and consequently won less money than nonpsychopaths. These findings are consistent with the prediction that psychopaths perseverate dominant-approach responses.

Thus, a variety of evidence appears consistent with the hypothesis that psychopaths and other disinhibited groups are relatively unable to modulate dominant responses. However, the behavioral studies mentioned thus far involved complex tasks in which subjects had to learn multiple contingencies (e.g., Newman & Kosson, 1986; Newman et al., 1985) or integrate information about changing contingencies across trials (New-

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man et al., 1987; Siegel, 1978). The complexity of these tasks makes it difficult to conclude that observed performance deficits reflect a specific difficulty in modulating a dominant response.

Fortunately, complex learning tasks are not required to establish dominant responses or to test hypotheses regarding modulation of dominant responses. Simple button presses can become dominant in cued reaction time tasks (e.g., LaBerge, 1973; Posner & Cohen, 1984). In one common form of this task, an initial *cuing stimulus* imperfectly predicts the location of a second imperative stimulus on each trial. The *imperative stimulus* signals subjects to initiate a specific, rapid button press that is specified by the actual location of this stimulus. Because each cuing stimulus creates an expectation that a particular imperative stimulus will follow, the cued response becomes a dominant (i.e., highly probable) response. That is, subjects are likely to pay increased attention to the cued location or to prepare the cued motor response or both. Thus, as in other paradigms used to study psychopaths' ability to modulate dominant responses, this paradigm presents stimuli that elicit particular expectations and response preparation as a result of instructions and practice. Although prior studies have indirectly signaled subjects to alter their expectations and responses using reinforcement contingencies, the cued reaction time paradigm provides subjects with an explicit signal that they must alter their expectation and response preparation to emit an alternative response on specific (i.e., invalidly cued) trials. In addition to providing a more direct assessment of subjects' ability to alter dominant responses, the present paradigm permits this assessment on multiple trials, whereas studies such as the card playing tasks described previously that use reinforcement contingencies severely limit the number of assessments that are possible.

A subject's ability to alter the dominant response created by cuing stimuli is measured by including a small percentage of trials in which the cuing stimulus incorrectly specifies the location of the imperative stimulus. Slower response latencies after invalid cues are thought to reflect the time required to overcome the preparation generated by the invalid cue (Posner & Cohen, 1984). Furthermore, subjects do not always successfully inhibit the dominant response and may press the incorrect button. These errors provide a second index of their modulation of dominant responses. Additional information about the degree to which subjects used the cuing stimuli can be obtained by examining the change in response latency produced by valid and invalid cues.

The purpose of the present study was to use a cued reaction time task to test the hypothesis that disinhibited individuals would be less likely to modulate simple dominant responses. Relative to their nondisinhibited counterparts, disinhibited subjects were expected to respond more slowly or to make more errors on trials demanding alteration of a dominant response. This prediction assumes that a strong dominant response has been established.

To test this hypothesis, we chose two groups that differ in many respects but are hypothesized to share a disinhibited response style: less socialized college students and incarcerated psychopaths. By performing the same study with both groups, the generality of effects can be assessed despite differences in socioeconomic status, education, intelligence, and incarceration.

Experiment 1

Method

Subjects

The Socialization (So) Scale (Gough, 1960) was used to select subjects because of extensive evidence indicating that it identifies individuals differing in their level of socialization. Among college students, low-So subjects report participating in more acts of vandalism and theft and using more controlled substances than high-So students (Kosson, Steuerwald, Newman, & Widom, 1992). Low-So students also display passive avoidance deficits in some laboratory situations (Nathan, 1980), and there is evidence that low-So students have difficulty inhibiting well-established verbal responses (Waid & Orne, 1982). Moreover, in several different countries, delinquents have been shown to score lower on this scale than nondelinquents, and even among delinquents low scores are associated with greater recidivism and offense frequencies (Megargee, 1972). Finally, significant correlations ranging from .27 to .43 have been reported between the So Scale and psychopathy (for a review, see Hare, 1990).

The So Scale was administered to approximately 800 male undergraduates enrolled in introductory psychology courses. Right-handed students from the highest third (scoring above 38) and the lowest third (scoring below 32) of this pool were randomly chosen for inclusion in the study. Twenty-nine low-So students and 23 high-So students were successfully scheduled in the study.

Experimental Task

The cued reaction time task was adapted from the cued attention task used by Posner and Cohen (1984, Arrow Experiment; see also LaBerge, 1973; Posner, Walker, Friedrich, & Rafal, 1984). Posner and Cohen's paradigm was modified in several ways to simplify the task and to maximize the probability that cued responses would create a dominant response. First, only trials in which the imperative stimuli directly followed the cuing stimuli were included. Second, the interval between cuing stimuli and imperative stimuli was always 1 s. Third, the cuing stimuli were placed peripherally near the edges of the display, as described in Posner and Cohen's Basic Paradigm section rather than in the center of the display. Fourth, subjects were asked to respond with the index finger of both hands, each using a single button, and, finally, were required to make a button press on every trial. The first two changes simplified the experiment, and the last two changes allowed errors to be recorded in addition to response latencies. Presentation and pacing of trials were controlled by an Apple II+ computer, which also recorded subjects' responses.

Each trial consisted of a cuing stimulus that was replaced after 1 s by an imperative stimulus. A 1-s delay was chosen to ensure that subjects had time to process the cuing stimulus fully and to prepare a response. The arrival of the imperative stimulus signaled subjects to make a speeded button press using the left or right button (and hand) corresponding to the location of the imperative stimulus. Monetary rewards were given on the basis of the speed and accuracy of each response. After a correct response, subjects received at least a 1¢ reward. Rewards of 2¢ were given for response latencies less than 210 ms, and rewards of 3¢ were given for response latencies less than 170 ms. If subjects pushed the wrong button or made no response within 3 s, they received no monetary reward and an error was recorded.

The cuing stimulus consisted of the word "READY" displayed in letters 0.8° high on the video monitor (standard Apple Pascal graphics characters).[1] This word was centered vertically on the screen. Its hori-

[1] Because subjects were not provided with a headrest, calculations of visual angle are, of necessity, approximate.

zontal position was located in one of three positions: near the left edge, center, or right edge of the video monitor. The word was 3.2° wide, and the distance between the right and left placements was 13.9°. The cuing stimulus remained visible until the onset of the imperative stimulus.

The imperative stimulus was a rectangle 3.6° high × 6.7° wide (drawn in 40-column text mode with the * character) with a smaller solid rectangle (the cursor; 0.8° high × 0.6° wide) in its center. This stimulus appeared either at the right or left edge of the video monitor; that is, it never appeared in the center. When the imperative and cuing stimuli appeared on the same side, they were centered at the same position. Each imperative stimulus remained on the screen until the subject responded or until 3 s elapsed.

After each trial, subjects received feedback in the upper left corner of the screen. Correct responses were indicated with the words "YOU WIN *X* CENTS," indicating subjects' reward for that trial. Incorrect responses were followed by the word "WRONG." In addition, after every sixth trial, subjects received cumulative feedback stating, "YOU HAVE NOW WON *XXX* CENTS." These feedback messages remained on the screen until the next cuing stimulus appeared, a random interval between 0.5 and 3.0 s.

An experimental session consisted of 180 trials. Twelve trials began with *neutral cues*, which were presented in the center of the video monitor. Of these trials, 6 were followed by imperative stimuli on the right-hand side of the screen and 6 were followed by imperative stimuli on the left-hand side of the screen. Of the 168 remaining trials, 144, or 86%, contained *valid cues*, in which the cuing stimulus and the imperative stimulus were presented on the same side. There were also 24 (14%) trials with invalid cues, consisting of a cuing stimulus presented on one side of the monitor and an imperative stimulus presented on the opposite side. Valid and invalid cues were evenly divided between left- and right-side presentation of the cuing stimuli. Trials were presented in a pseudorandom order that was constant for all subjects.

Procedure

Subjects were seated at a table 56 cm in front of a 32.5-cm (13-in.) video monitor. They were shown a small box (158 × 95 × 53 mm) on which four buttons were mounted in a row. Subjects were then instructed on the nature of the task. Subjects were explicitly informed that

> the position of the word "READY" is your best guide to where the target will be displayed. Most of the time that the word "READY" appears on the left, the target square will also appear on the left. Most of the time the word "READY" appears on the right, the target square will also appear on the right. When the word "READY" appears in the center, you cannot predict where the square will appear.

In addition, subjects were informed about the dependence of monetary reward on speed as well as accuracy and were encouraged to press the correct button as quickly as possible. Subjects were instructed to use both index fingers for button pressing and to rest each index finger on the two outside buttons of the four-button box between trials. The two middle buttons were not used.

Results

Data Reduction

The design of the study yielded two dependent measures for each trial: response latency and accuracy (correct vs. incorrect). Analyses for both measures were performed after data were grouped according to whether the cuing stimulus was valid, invalid, or neutral and according to the side on which the imperative stimulus was presented.

Median response latencies for each group of trials were calculated for each subject. Unless explicitly stated, response latencies are reported only for correct responses. Two subjects (one from each group) made no correct responses on trials with invalid cuing stimuli and left-side imperative stimuli and were therefore excluded from analyses of response latency and from response latency values in Table 1.

Preliminary Analyses

A subject's success in inhibiting incorrect responses depended, in part, on the importance he attached to avoiding errors. Although subjects were instructed to maximize their winnings, some subjects may have placed greater emphasis on making rapid responses than others, consequently producing more errors (see Dickman & Meyer, 1988). To determine whether subjects differed in their response styles, we examined our data for speed–accuracy trade-offs. The Spearman correlation between response latency on validly cued trials and number of errors on invalidly cued trials indicated that such a trade-off occurred. Using all subjects, this correlation was significant for both right ($r_s = -.51$, $p < .001$) and left ($r_s = -.55$, $p < .001$) sides. Similar correlations calculated for high and low-So subject groups revealed no significant group differences in the magnitude of this trade-off. Nevertheless, this finding suggested that correcting error rates for speed of responding would provide the clearest estimate of subjects' ability to inhibit prepared responses.

Response Latencies

Response latencies were analyzed in a 2 (socialization) × 2 (side) × 3 (trial type) analysis of variance (ANOVA).

Main effects and Side × Trial Type interaction. There was no main effect for socialization, $F(1, 48) = 0.257$, *ns*, $MS_e = 14,727.5$, suggesting that, over all types of trials, neither subject

Table 1
Study 1: Performance as a Function of Socialization (So) and Side of Imperative Stimuli

	Left-side imperative stimuli		Right-side imperative stimuli	
Measure	Low So	High So	Low So	High So
Mean response latency (ms)				
Valid cues	247	243	241	239
Neutral cues	261	260	277	280
Invalid cues	348	316	311	306
Errors as percentage of trials				
Valid cues	1.29	1.45	0.62	0.84
Neutral cues	1.15	5.07	2.30	2.30
Invalid cues	36.78	27.17	27.85	25.00
Adjusted mean rank errors				
Valid cues	27.2	25.6	24.4	29.2
Neutral cues	24.1_a	29.5_b	24.7	28.7
Invalid cues	29.6_a	22.5_b	28.3	24.2

Note. Within rows, means with different subscripts differed significantly at $p < .05$.

group responded more quickly than the other. A main effect for trial type, $F(2, 96) = 60.76$, $p < .001$, $MS_e = 2,526.8$, suggested that longer response latencies were associated with attention to invalid cuing stimuli and shorter response latencies followed attention to valid cuing stimuli. Such effects are commonly described as reflecting the costs and benefits of attending to partially valid cuing stimuli. However, a Side × Trial Type interaction, $F(2, 96) = 13.77$, $p < .001$, $MS_e = 765.5$, qualified this effect, indicating that these costs and benefits also depended on the location of the cuing stimuli.

Costs and benefits. These effects can be explicated with contrasts comparing response latencies after neutral and valid stimuli (i.e., benefits) or after neutral and invalid stimuli (i.e., costs). This methodology has, however, been criticized by Jonides and Mack (1984) on the basis that neutral trials are less frequent than validly cued trials and may consequently change subjects' level of arousal. We have nevertheless maintained this presentation because it remains the most common method of assessing costs and benefits. An alternative approach yielded similar results.[2]

The Side × Trial Type interaction was explored with single degree of freedom contrasts for the interactions between side and costs and side and benefits. These analyses revealed that for all subjects costs were greater for invalidly cued trials requiring left-hand responses, $F(1, 48) = 16.68$, $p > .001$, $MS_e = 5,020.9$. The interaction between side and benefits was also significant, $F(1, 48) = 10.91$, $p = .002$, $MS_e = 2,502.8$, with the benefits stronger for the right-hand than for the left-hand responses. In both of these findings, the trials following right-sided cuing stimuli produced greater effects than did those following left-sided cuing stimuli.

A planned comparison of invalid and neutral trial response latencies was used to test the hypothesis that low-So subjects would have more difficulty (costs) with the invalidly cued trials than high-So subjects. It revealed a trend for low-So subjects to display greater costs associated with the left-hand responses (i.e., responses following right-side cues and left-side imperative stimuli relative to responses following neutral cues with left-sided imperative stimuli), $F(1, 48) = 2.97$, $p = .09$, $MS_e = 3,674.2$. There was no difference, however, in costs associated with the right-hand responses (i.e., responses following left-side cues and right-side imperative stimuli relative to responses following neutral cues with right-sided imperative stimuli), $F(1, 48) = 0.19$, *ns*, $MS_e = 4,640.8$. Subject groups did not differ in the benefits elicited by valid stimuli for either the right-hand responses (i.e., responses following right-side cues and right-side imperative stimuli relative to responses following neutral cues with right-sided imperative stimuli), $F(1, 48) = 0.10$, *ns*, $MS_e = 3,000.6$, or left-hand responses (i.e., responses following left-side cues and left-side imperative stimuli relative to responses following neutral cues with left-sided imperative stimuli), $F(1, 48) = 0.04$, *ns*, $MS_e = 1,616.0$. (See Table 1.)

Errors

Preliminary examination of error data revealed a floor effect: After left-side imperative stimuli, 17.3% of the subjects committed no errors, and after right-side imperative stimuli, 13.5% committed no errors. Transformations are not applicable for a distribution of this type because the modal response will always be at the lower extreme of the distribution. Although parametric statistics are insensitive given such distributions, analyses based on ranks are appropriate (Marascuilo & McSweeney, 1977).

For invalidly cued trials, it was predicted that low-So subjects would make more errors on invalidly cued trials than high-So subjects. As noted previously, the correlation between errors and response latency indicates that those subjects making fast responses were also likely to make more errors. To control for this potentially confounding factor, we used response latencies following valid instances of the same cuing stimuli as covariates. A procedure that allows analysis of covariance (ANCOVA) with rank data has been developed by Harwell and Serlin (1985). In this procedure, ranks are computed for both the covariate and the dependent measure. These ranks are then submitted to a standard ANCOVA program. The significance tests are calculated from the sums of squares and the degrees of freedom provided by the ANCOVA program. Harwell and Serlin (1988) also demonstrated that their Puri-Sen-Harwell-Serlin (PSHS) analysis is appropriate for analyzing group differences on data with exponential distributions (i.e., with floor effects). The PSHS test statistic in this analysis is distributed as a chi-square variable with 1 degree of freedom. If alpha is set to .05, the critical value for this statistic is 3.84 for a sample size of 52.

To test the hypothesis that low-So subjects would make more errors on invalidly cued trials, a two-group (socialization level) PSHS analysis was performed on the number of errors committed during trials with invalid cues for the right- and left-hand imperative stimuli. In each case, the corresponding median response latency for correct validly cued trials with the same cuing stimulus was used as a covariate. Results for the comparison of errors following invalid left-side imperative stimuli were 4.11 ($p < .05$) and for those following invalid right-side imperative stimuli, 1.44 (*ns*). These results indicate that, independent of their speed of responding, low-So subjects made more errors on invalidly cued trials with left-side imperative stimuli than high-So subjects. Although a similar pattern is apparent in trials with right-side imperative stimuli, the effect was smaller and not statistically reliable. Table 1 presents the adjusted mean ranks for both sides and the actual number of errors (expressed as a percentage of trials) committed by each group.

Supplemental Analyses

Neutral trials. Although subjects were not expected to make errors on neutral trials, 7 subjects made one or more errors on trials with neutral cues followed by right-side imperative stim-

[2] It is possible to avoid this problem by sacrificing the ability to differentiate costs from benefits. This analysis uses the contrast between response latency on trial with valid and invalid cuing stimuli, omitting entirely the trials with neutral cuing stimuli. This analysis replicates the reported findings with no group differences to right-side imperative stimuli, $F(1, 48) = 0.01$, *ns*, $MS_E = 3,447.48$, and a nonsignificant trend for low-So subjects to show a larger difference in left-hand response latencies between trials with valid and invalid cuing stimuli than high-So subjects, $F(1, 48) = 2.80$, $p = 0.10$, $MS_E = 3,851.54$. In Experiment 2, similar analyses revealed no interaction with group for either left-side, $F(1, 47) = 1.06$, *ns*, $MS_E = 3,804.55$, or right-side, $F(1, 47) = 1.08$, *ns*, $MS_E = 3,384.87$, imperative stimuli.

uli and 8 made errors on trials with neutral cues and left-side imperative stimuli. These errors were analyzed with the same rank covariance procedure used for the invalidly cued trials. In this analysis, the median response latency for correct responses following neutral cuing stimuli and the same imperative stimuli were used as covariates. This analysis yielded a PSHS statistic of 2.70 (*ns*) for trials with the imperative stimulus presented on the right side and 4.39 ($p < .05$) for those on the left side. Table 1 reveals that, on neutral trials with left-side imperative stimuli, low-So subjects' errors yielded lower mean ranks (i.e., fewer errors) than those of the high-So group. Thus, in contrast to their poorer performance on the invalidly cued trials, low-So subjects were significantly more accurate than high-So subjects on trials with neutral cues and left-side imperative stimuli. To further understand these neutral trial errors, the latencies of incorrect responses were examined. The mean latency for incorrect responses was 190 ms for neutral trials with left-side imperative stimuli compared with a response latency of 261 ms for correct trials with the same cuing and imperative stimuli. Because these incorrect responses were much faster than correct responses, it appears likely that subjects responded on these trials before they had adequately processed the stimuli.

Validly cued trials. Errors on trials with valid cues were analyzed using median latencies of correct responses as covariates. Subject groups did not differ on the number of errors made following either valid right-side (PSHS = 0.18, *ns*) or left-side (PSHS = 1.88, *ns*) imperative stimuli.

Winnings. An ANOVA comparing the earnings of low- and high-So subjects revealed that low-So subjects earned an average of $2.43, whereas High-So subjects earned $2.44, $F(1, 50) = 0.024$, *ns*, $MS_e = 2.595$.

Discussion

Low-So college students committed more errors than high-So students in responding to invalidly cued left-side imperative stimuli but not to invalidly cued right-side imperative stimuli, suggesting that they were less likely to inhibit prepared right-hand responses. The finding that group differences disappeared or reversed for neutral trials—in which no dominant response was established—suggests that low-So students' difficulties were not general but were specifically related to prepared or dominant responses. These findings are further supported by the trend ($p = .09$) for low-So subjects to respond more slowly than high-So subjects on left-hand responses following invalid right-side cuing stimuli. That is, low-So subjects not only committed more errors following invalid right-side cuing stimuli but also tended to respond more slowly than high-So subjects even when they responded correctly.

Significant differences were also found in the magnitude of costs and benefits for the different sides. Across groups, the costs associated with invalid cues and the benefits associated with valid cues were larger for trials beginning with right-side cuing stimuli than for those beginning with left-side cuing stimuli. These findings suggest that the responses following right-side cues were prepared more strongly than the responses following left-side cues.

Finally, these data provide no evidence that the poor performance of less socialized individuals following invalid cues was balanced by superior performance following valid cues. They did not respond significantly faster or more accurately than high-So subjects on validly cued trials.

Experiment 2

The results for college students provide partial support for the hypothesis that disinhibited individuals have more difficulty altering a dominant response than nondisinhibited individuals. To extend this finding, we examined the same hypothesis in psychopathic and nonpsychopathic subjects incarcerated in a minimum-security prison. Psychopathy is often considered the prototypical syndrome of disinhibition (Gorenstein & Newman, 1980; Shapiro, 1965). Psychopaths commit more varied crimes than nonpsychopaths (Williamson, Hare, & Wong, 1987), tend to fail conditional release programs (Hart, Kropp, & Hare, 1988), and demonstrate poor passive avoidance learning (for a review, see Hare, 1990; Kosson, Smith, & Newman, 1990; Schmauk, 1970).

Method

Subjects

Forty-nine incarcerated White men were included in this study. As part of an ongoing research program, subjects were randomly selected for the project by choosing every fifth name from the institution roster. File information was used to exclude men who were 40 years of age or older, who were currently psychotic or taking psychotropic medication, or whose reading level was below that of the fourth grade. The remaining subjects were invited to participate. After a description of the project, consenting subjects were interviewed for approximately 1 to 1.5 h. Interviewers then classified prisoners with the 20-item Psychopathy Checklist (Hare, 1985). Hare and his colleagues have provided substantial evidence that this checklist is a valid measure of psychopathy (Hare, 1990; Harpur, Hare, & Hakstian, 1989). For our project interrater agreement (.85) and internal consistency estimates of .80 to .84 (as reported in Kosson et al., 1990) are similar to those reported by Schroeder, Schroeder, and Hare (1983). Subjects receiving a score of 30 or higher were classified as psychopaths, and subjects scoring 20 or below were classified as nonpsychopaths (Kosson et al., 1990). Thirty psychopaths and 19 nonpsychopaths participated. Five psychopaths and no nonpsychopaths were left-handed. In addition, the Welsh Anxiety Scale (Welsh, 1956) was administered to all subjects to assess the role of anxiety in mediating the performance of psychopaths and nonpsychopaths.

Procedure

The experimental task was administered on a separate day after the interview. The task followed a passive avoidance task reported by Newman, Patterson, Howland, and Nichols (1990). The experimental task was identical to the one used in Experiment 1, including the same instructions, the same number of trials, and the same response latency criteria for 1¢, 2¢, and 3¢ rewards.

Results

Data Reduction

Data were grouped by imperative stimuli (right and left) and cuing stimuli (valid, neutral, and invalid) as in Experiment 1.[3]

[3] The treatment of left-handed subjects, under conditions in which hand effects are predicted, is problematic. Examination of the data

Preliminary Analyses

Speed–accuracy trade-offs within this experiment (as indicated by Spearman correlations between errors and response latencies from trials with valid cues) were similar to those in Experiment 1 (right hand, $r_s = -.70$, $p < .001$; left hand, $r_s = -.66$, $p < .001$), and, as in the previous study, there were no differences between subject groups. Anxiety did not interact with psychopathy in any of the principal analyses and is not included in further analyses.

Response Latencies

Response latencies were analyzed with the equivalent mixed-model ANOVA—2 (Psychopathy) × 2 (Side) × 3 (Trial Type)—used in Experiment 1.

Main effects and Side × Trial Type interaction. As in Experiment 1, the main effect for subject group (here, psychopathy), $F(1, 47) = 0.03$, *ns*, $MS_e = 23{,}690.3$, and side, $F(1, 47) = 1.95$, *ns*, $MS_e = 1{,}048.4$, was not significant, whereas the main effect for trial type, $F(1, 47) = 52.43$, $p < .001$, $MS_e = 2{,}004.9$, and the Side × Trial Type interaction, $F(2, 94) = 12.78$, $p = .001$, $MS_e = 1{,}260.1$, were significant. Neither the main effects nor the Side × Trial Type interaction revealed significant interactions with psychopathy.

Costs and benefits. Unlike the data for the right side, data for trials with left-side imperative stimuli revealed a surprisingly small difference between neutral and validly cued trials (i.e., no appreciable benefits). It may be speculated that the infrequent neutral cuing stimuli produced greater alerting than the more common peripheral cuing stimuli (Jonides & Mack, 1984). However, because the cuing stimuli for all neutral trials are identical, this explanation does not explain the difference between the right- and left-side data.

As in Experiment 1, unplanned comparisons testing both costs, $F(1, 47) = 14.87$, $p < .001$, $MS_e = 8{,}126.4$, and benefits, $F(1, 47) = 22.92$, $p < .001$, $MS_e = 2{,}745.7$, revealed significant interactions with side at the Dunn adjusted probability level of .025. That is, right-side cuing stimuli produced both greater costs and greater benefits, indicating stronger cuing.

Planned comparisons revealed no evidence of group differences related to either costs—right side, $F(1, 47) = 0.00$, *ns*, $MS_e = 4{,}126.6$, left side, $F(1, 47) = 1.10$, *ns*, $MS_e = 4{,}345.45$—or benefits—right side, $F(1, 47) = 1.56$, *ns*, $MS_e = 2{,}057.2$, left side $F(1, 47) = 2.20$, *ns*, $MS_e = 2{,}710.6$. (See Footnote 2.)

Errors

Preliminary examination of error data again revealed an exponential distribution: On trials with invalid cues and left-side imperative stimuli, 38.8% of the subjects committed no errors, and the same number committed no errors on trials with invalid cues and right-side imperative stimuli. On the basis of the floor effect and exponential distribution of error data, it was again decided to analyze error data with a two-group PSHS analysis using response latencies from validly cued trials with the same cuing stimuli as a covariate. Because psychopaths response latencies from invalidly cued left-side trials were nonsignificantly faster than those of control subjects, the use of this covariate has the effect of reducing psychopaths errors relative to those of nonpsychopaths.

Regarding invalidly cued trials, the PSHS ANCOVA demonstrated that, consistent with our hypothesis, psychopaths made more errors than nonpsychopaths on invalidly cued trials with left-side imperative stimuli (PSHS = 4.09, $p < .05$). There was, however, almost no effect for invalidly cued trials with right-side imperative stimuli (PSHS = 0.25, *ns*). These findings are consistent with the results of the previous study including the differentiation of right- and left-hand responses (Table 2) and provide partial support for the hypothesis that psychopaths are less likely to inhibit anticipated responses.

Supplemental Analyses

Neutral trials. In contrast to invalidly cued trials, the results for trials with neutral cues differ from those of Experiment 1. Whereas low-So college students made fewer covariate adjusted errors on left-side neutral trials than controls, psychopaths made significantly more errors on right-side neutral trials (imperative stimulus, right) than controls (PSHS = 4.80, $p < .05$). Although unexpected, this effect is quite strong: Of 11 subjects making incorrect responses on right-side neutral trials, 10 were psychopathic. This finding was absent, however, for left-side trials (PSHS = 0.45, *ns*).

Examination of the latency of these errors revealed that, although some of these responses were rapid, 36% were either longer than the median correct response latency or resulted from subjects making no response at all. Thus, whereas most errors may be caused by rapid responding, others appear to reflect a disruption of task performance by the relatively rare neutral cuing stimuli.

Validly cued trials. As in Experiment 1, the groups did not differ on the number of errors made on validly cued trials with either the right-side (PSHS = 0.24, *ns*) or left-side (PSHS = 0.45, *ns*) imperative stimuli.

Winnings. As in Experiment 1, analysis of the total earnings by psychopaths (M = \$2.05) and nonpsychopathic (M = \$1.99) subjects revealed no significant group differences, $F(1, 47) = 0.001$, *ns*, $MS_e = 1.8$.

General Discussion

The error data from trials with invalid cues and left-hand imperative stimuli are consistent with the hypothesis that disinhibited subjects are less likely to inhibit dominant responses.

revealed that the pattern of response latencies in left-handed subjects was similar to that of right-handed subjects. Like right-handed subjects, our left-handed subjects made slightly faster responses to the right-side imperative stimuli with valid cues relative to left, faster responses to left-side imperative stimuli following neutral cuing stimuli relative to right, and faster responses to right-side imperative stimuli with invalid cues than similar left-side imperative stimuli. In addition, both left- and right-handed subjects made more errors on right-side imperative stimuli with invalid cues than on similar left-side imperative stimuli. Consequently, data were grouped by side of the imperative stimuli regardless of subjects' hand preference. Nevertheless, we conducted analyses to examine the effects of omitting left-handed subjects from the study. When the 5 left-handed subjects were omitted from the analysis of errors on invalidly cued trials, the PSHS statistic for invalidly cued trials with left-side imperative stimuli dropped slightly to 3.07 ($p = .08$).

Table 2
Study 2: Performance as a Function of Psychopathy and Side of Imperative Stimuli

Measure	Left-side imperative stimuli: Psychopaths	Left-side imperative stimuli: Controls	Right-side imperative stimuli: Psychopaths	Right-side imperative stimuli: Controls
Mean response latency (ms)				
Valid cues	294	307	293	304
Neutral cues	291	306	336	330
Invalid cues	374	370	360	352
Errors as percentage of trials				
Valid cues	0.60	0.66	0.65	0.44
Neutral cues	1.60	0.88	5.55	0.88
Invalid cues	18.21	13.60	15.83	11.84
Adjusted mean rank errors				
Valid cues	26.5	24.0	25.6	24.0
Neutral cues	25.3	24.5	27.7_a	20.7_b
Invalid cues	27.4_a	21.2_b	25.6	24.1

Note. Within rows, means with different subscripts differ significantly at $p < .05$.

Replication of this finding in two dissimilar groups of disinhibited subjects strengthens our confidence in this finding. Moreover, the fact that disinhibited subjects made more errors following invalid imperative stimuli, even after adjusting for their response latencies, suggests that these errors were not entirely a consequence of rapid responding.

These data expand our knowledge concerning the types of dominant responses that disinhibited subjects are unlikely to inhibit. Prior research demonstrates that disinhibited subjects have difficulty modifying dominant responses in complex learning tasks (e.g., Lykken, 1957; Newman et al., 1987) and inhibiting prepared verbal responses (Waid & Orne, 1982). The data presented here indicate that some disinhibited subjects are also relatively poor at inhibiting very simple responses when those responses are highly prepared.

The limitation of the findings to left-side imperative stimuli may result from several factors. One possibility is that the dominant responses may have been established primarily in subjects' right hands. Indeed in both experiments, the Side of Imperative Stimulus × Trial Type interaction reveals that for all subjects the dominant response was more strongly prepared following right-side cuing stimuli than following left-side cuing stimuli.

An alternative to the dominant-response hypothesis is that the visual field of the cuing or the imperative stimuli is the critical factor. Several reports have suggested that psychopaths and nonpsychopaths differ in left-hemisphere processing (Flor-Henry, 1983; Hare & Jutai, 1988). In the current study, the invalidly cued left-side trials are of primary interest. In these trials, the cuing stimuli were likely to be initially presented to the right visual field and left hemisphere. During the 1-s presentation of the cuing stimuli, however, these stimuli were likely to have become foveal. The imperative stimuli were then presented to the left visual field and, therefore, the right hemisphere. The other trials that share a left-hemisphere presentation of the cuing stimuli are the validly cued trials with right-side imperative stimuli. It follows, then, that if the left-hemisphere presentation of the cuing stimuli were critical, these trials should share a common deficit. However, in neither experiment did disinhibited subjects show a distinctive response to these trials. Consequently, it is unlikely that a global deficit in left-hemisphere processing is responsible for the observed performance deficit. Rather, the differences may reflect a more complicated interaction of left- and right-hemisphere activation or the switching of attention between hemispheres (Kosson, 1989).

Although not addressing the observed Side × Trial Type interactions, it is also possible that disinhibited subjects either used the cuing stimuli more extensively than the control subjects or voluntarily chose some strategy (such as focusing on reward) that was prone to errors. This argument is weakened by the lack of evidence that the observed performance deficits following invalid cues were balanced by faster responses or fewer errors on trials following valid cuing stimuli. Moreover, the similarity of response latencies following valid cuing stimuli in the disinhibited and control groups and the similarity of the speed–accuracy correlations in the two groups also suggest that the disinhibited subjects did not adopt a higher risk response style (i.e., focusing on rapid responses at the expense of errors). Finally, differences in response style are not supported by the equivalence of earnings between disinhibited and control subjects. Subjects may, of course, have adopted a strategy based on some other unmeasured characteristics of the stimulus (e.g., salience of 3¢ rewards) or adopted a strategy that did not effectively increase their earnings.

Group differences in response latency were in the predicted direction only for Experiment 1, and this trend only approached statistical significance. One explanation for the insensitivity of response latency measures in these studies is suggested by comparing our response latency data with those reported by Posner and Cohen (1984). Posner and Cohen reported response latencies approximately 40 to 50 ms slower than those observed in our Experiment 1. The monetary incentives used in our studies may have increased the likelihood that subjects would respond before they had finished processing the stimuli, which, in turn, may have reduced meaningful variance in response latencies while increasing variance in error scores (Logan & Cowan, 1984). Direct comparison of error rates with those in Posner and Cohen's study was not possible because their procedure did not allow errors to be recorded.

Although cued reaction time tasks are simpler than the complex tasks usually associated with passive avoidance learning, each response nevertheless requires a number of cognitive operations. These operations can be characterized as either response selection and production operations or as attentional/perceptual operations. In the current experiments, the interval between the cuing and imperative stimuli allowed cuing of both attentional and motor responses. Moreover, paradigms that manipulate spatial expectancy are reported to produce not only less strict response criteria but also heightened perceptual sensitivity at cued locations (Downing, 1988). Consequently, the dominant responses in this experiment may have been produced by a combination of dominant motor set (i.e., preparation of a motor response) and dominant attentional set (i.e., focus on a stimulus location). An alternative hypothesis is that disinhibited subjects' difficulty altering dominant responses may not reflect the strength of their dominant-response set but may reflect a problem registering or accommodating unexpected stimuli while they are engaged in organizing and implementing nonautomatic (i.e., attention demanding) motor responses (see Newman & Wallace, in press; Smith, Arnett, & Newman, 1992). On the basis of this study alone, it is difficult to determine which factors or combination of factors were responsible for the deficits displayed by disinhibited subjects.

The purpose of this study was to examine the hypothesis that disinhibited subjects are less likely to alter established dominant responses. This finding of decreased inhibition on a task with minimal requirements for learning or memory complements earlier findings using more complex paradigms (e.g., Lykken, 1957; Newman et al., 1987). These positive findings are consistent with the dominant-response hypothesis and extends its relevance to a broader range of performance deficits. Establishing the role played by alternative hypotheses, such as those based on hemispheric asymmetries, or the relative contribution of the components of a dominant response such as the direction of attention and the preparation of a motor response will require additional data.

References

Dickman, S. J., & Meyer, D. E. (1988). Impulsivity and speed-accuracy tradeoffs in information processing. *Journal of Personality and Social Psychology, 54,* 274–290.

Downing, C. J. (1988). Expectancy and visual-spatial attention. *Journal of Experimental Psychology: Human Perception and Performance, 14,* 188–202.

Flor-Henry, P. (1983). *Cerebral basis of psychopathology.* Boston: John Wright.

Gorenstein, E. E., & Newman, J. P. (1980). Disinhibitory psychopathology: A new perspective and a model for research. *Psychological Review, 87,* 301–315.

Gough, H. G. (1960). Theory and measurement of socialization. *Journal of Consulting and Clinical Psychology, 24,* 23–30.

Hare, R. D. (1970). *Psychopathy: Theory and research.* New York: Wiley.

Hare, R. D. (1985). *The Psychopathy Checklist.* Unpublished manuscript, University of British Columbia, Vancouver, Canada.

Hare, R. D. (1990). *Manual for the Revised Psychopathy Checklist.* Unpublished manuscript, Department of Psychology, University of British Columbia, Vancouver, Canada.

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

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

Hart, S. D., Kropp, P. R., & Hare, R. D. (1988). Performance of male psychopaths following conditional release from prison. *Journal of Consulting and Clinical Psychology, 56,* 227–232.

Harwell, M. R., & Serlin, R. C. (1985, April). *A nonparametric test statistic for the general linear model.* Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Harwell, M. R., & Serlin, R. C. (1988). An empirical study of a proposed test of nonparametric analysis of covariance. *Psychological Bulletin, 104,* 268–281.

Jonides, J., & Mack, R. (1984). On the cost and benefit of cost and benefit. *Psychological Bulletin, 96,* 29–44.

Kosson, D. S. (1989). *Psychopathy and dual-task performance under focusing conditions.* Unpublished doctoral dissertation, University of Wisconsin—Madison.

Kosson, D. S., Smith, S. S., & Newman, J. P. (1990). Evaluating the construct validity of psychopathy in Black and White male inmates: Three preliminary studies. *Journal of Abnormal Psychology, 99,* 250–259.

Kosson, D. S., Steuerwald, B. L., Newman, J. P., & Widom, C. S. (1992). *The relation between socialization and antisocial behavior, substance use, and family conflict in college students.* Manuscript submitted for publication.

LaBerge, D. (1973). Identification of two components of the time to switch attention: A test of a serial and a parallel model of attention. In S. Kornblum (Ed.), *Attention and performance IV* (pp. 71–85). San Diego, CA: Academic Press.

Logan, G. D., & Cowan, W. B. (1984). On the ability to inhibit thought and action: A theory of an act of control. *Psychological Review, 91,* 295–327.

Lykken, D. T. (1957). A study of anxiety in the sociopathic personality. *Journal of Abnormal and Social Psychology, 55,* 6–10.

Marascuilo, L. A., & McSweeney, M. (1977). *Nonparametric and distribution free methods for the social sciences.* Monterey CA: Brooks/Cole.

Megargee, E. I. (1972). *The California Psychological Inventory handbook.* San Francisco: Jossey-Bass.

Moses, J. A., Ratliff, R. G., & Ratliff, A. R. (1979). Discrimination learning of delinquent boys as a function of reinforcement contingency and delinquent subtype. *Journal of Abnormal Child Psychology, 7,* 443–453.

Nathan, S. (1980). [Passive avoidance learning in college students with high and low Socialization scale scores]. Unpublished raw data, Indiana University.

Newman, J. P., & Kosson, D. S. (1986). Passive avoidance learning in psychopathic and nonpsychopathic offenders. *Journal of Abnormal Psychology, 95,* 257–263.

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., Patterson, C. M., & Kosson, D. S. (1987). Response perseveration in psychopaths. *Journal of Abnormal Psychology, 96,* 145–148.

Newman, J. P., & Wallace, J. F. (in press). Psychopathy and cognition. In P. C. Kendall & K. S. Dobson (Eds.), *Psychopathology and cognition.* San Diego, CA: Academic Press.

Newman, J. P., Widom, C. S., & Nathan, S. (1985). Passive-avoidance in syndromes of disinhibition: Psychopathy and extraversion. *Journal of Personality and Social Psychology, 48,* 1316–1327.

Posner, M. I., & Cohen, Y. (1984). Components of visual orienting. In

H. Brouma & D. Bowhuis (Eds.), *Attention and performance X* (pp. 531–556). Hillsdale, NJ: Erlbaum.

Posner, M. I., Walker, J. A., Friedrich, F. J., & Rafal, R. D. (1984). Effects of parietal injury on covert orienting of attention. *Journal of Neurosciences, 4,* 1863–1874.

Schmauk, F. A. (1970). Punishment, arousal, and avoidance learning in sociopaths. *Journal of Abnormal Psychology, 76,* 144–150.

Schroeder, M. L., Schroeder, K. G., & Hare, R. D. (1983). Generalizability of a checklist for assessment of psychopathy. *Journal of Consulting and Clinical Psychology, 51,* 511–516.

Shapiro, D. (1965). *Neurotic styles.* New York: Basic Books.

Siegel, R. A. (1978). Probability of punishment and suppression of behavior in psychopathic and nonpsychopathic offenders. *Journal of Abnormal Psychology, 87,* 514–522.

Smith, S. S., Arnett, P. A., & Newman, J. P. (1992). Neuropsychological differentiation of psychopathic and nonpsychopathic criminal offenders. *Personality and Individual Differences. 13,* 1233–1245.

Trasler, G. (1978). Relations between psychopathy and persistent criminality—Methodological and theoretical issues. In R. D. Hare & D. Schalling (Eds.), *Psychopathic behavior: Approach to research* (pp. 273–298). New York: Wiley.

Waid, W. T., & Orne, M. T. (1982). Reduced electrodermal response to conflict, failure to inhibit dominant behaviors, and delinquency proneness. *Journal of Personality and Social Psychology, 43,* 769–774.

Welsh, G. S. (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., Hare, R. D., & Wong, S. (1987). Violence: Criminal psychopaths and their victims. *Canadian Journal of Behavioral Science, 19,* 454–462.

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Call for Nominations

The Publications and Communications Board has opened nominations for the editorships of *Behavioral Neuroscience*, the *Journal of Experimental Psychology: General*, and the *Journal of Experimental Psychology: Learning, Memory, and Cognition* for the years 1996–2001. Larry R. Squire, PhD, Earl Hunt, PhD, and Keith Rayner, PhD, respectively, are the incumbent editors. Candidates must be members of APA and should be available to start receiving manuscripts in early 1995 to prepare for issues published in 1996. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. To nominate candidates, prepare a statement of one page or less in support of each candidate.

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