

Testing Damasio's Somatic Marker Hypothesis With Psychopathic Individuals: Risk Takers or Risk Averse?

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Damasio and colleagues (A. R. Damasio, 1994; A. R. Damasio, D. Tranel, & H. Damasio, 1990) have theorized about a possible relationship between somatic markers and the behavior of psychopathic individuals (Ps), but, to date, there are no published data regarding the proposed relationship. The authors assessed 86 Caucasian and 71 African American male offenders using R. D. Hare's (1991) Psychopathy Checklist—Revised and used a modified version of Bechara and colleagues' (A. Bechara, A. R. Damasio, H. Damasio, & S. W. Anderson, 1994; A. Bechara, H. Damasio, D. Tranel, & A. R. Damasio, 1997) gambling task to test the hypothesis that Ps would, consistent with the somatic marker hypothesis, fail to become risk averse. Results indicated that level of anxiety, but not psychopathy, was predictive of response choices. Several limitations and implications of the study are noted.

Psychopathic individuals (Ps) have been described as “predators” (Hare, 1993) in part because of their callous and remorseless use of others and their antisocial behavior. Some researchers have attributed these personality characteristics and behaviors to low fear and inadequate motivation (e.g., Lykken, 1957, 1995) or to a reduced sensitivity to punishment cues (Fowles, 1980). Others have linked psychopathy to deficits in affective processing (Hare, Williamson, & Harpur, 1988; Patrick, 1994) or information processing more generally (Newman, 1998; Patterson & Newman, 1993).

The *somatic marker* hypothesis (Damasio, 1994; Damasio, Tranel, & Damasio, 1991; see also Gorenstein, 1991) is a compelling neuropsychological model of behavior that, when applied to psychopathic behavior, provides a potential integration of motivational, affective, and information-processing factors. Instead of focusing solely on sensitivity to punishment cues (i.e., motivational factors), the somatic marker hypothesis postulates a more general interaction between affective states and information processing in the initiation and regulation of behavior. More specifically, Damasio (1994) proposed that choosing the best or most adaptive behavior can be an informed decision whereby somatic or emotional states “mark” cognitions and, in turn, guide behavior. Difficulty in selecting appropriate behaviors occurs when response options (cognitions) are not marked by somatic states (emotions).

In defining somatic markers, Damasio (1994) stated, “When the bad outcome connected with a given response option comes into mind, however fleetingly, you experience an unpleasant gut feeling. Because the feeling is about the body, I gave the phenomenon the technical term *somatic* state (‘soma’ is Greek for body); and because it ‘marks’ an image, I called it a *marker*” (p. 173). Somatic markers are created during the process of education and socialization through the connection between certain types of stimuli and certain types of affective states. Once formed, the somatic marker guides behavior by focusing attention on the negative or positive outcomes of a given action and then serving “as an automated alarm signal which says: Beware of danger ahead” (p. 173) or “Go for it!” (p. 180) in the case of negative and positive affective states, respectively.

Damasio's neuropsychological model of behavior is based on the consequences of ventromedial frontal (VMF) lesions in humans. In brief, the model specifies that “response selections required for appropriate decision making in social cognition and equivalent realms, necessitates the holding on-line . . . highly heterogeneous sets of cognitive components that must be attended effectively, if a choice is to be made” (Damasio et al., 1991, pp. 219–220). Damasio proposed that VMF patients fail to make the most advantageous decisions because they are unable to choose from multiple response options. According to Damasio and colleagues, this response selection deficit is the result of a defect in the utilization of somatic markers. For the VMF patient, somatic markers do not tag or mark “the ultimate consequences of the response option with a negative or positive somatic state” (Damasio et al., 1991, p. 220), and this deficiency may lead to problems in living such as inappropriate social behavior, indecisiveness, irresponsibility, and failure to plan ahead, or, in other words, “acquired sociopathy” (Damasio, 1994; Saver & Damasio, 1991).

The principal evidence for deficient use of somatic markers in VMF patients involves a gambling task (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, Tranel, & Damasio, 1997; Damasio, 1994). In this task, participants are presented with four decks of cards (A, B, C, and D) and told to choose one card at a time. Participants are told that all cards will

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yield some financial reward, but some will also yield a financial cost. Participants are instructed to maximize their winnings and continue selecting cards until instructed to stop. Cards from Decks A and B yield large rewards but also unpredictable, large punishments, whereas cards from Decks C and D produce smaller rewards and more predictable and limited punishments. In the end, Decks A and B yield smaller overall payoffs because the cost-to-benefit ratio is larger than that of Decks C and D.

Damasio and colleagues (Bechara et al., 1994, 1997; Damasio, 1994) found that normal (non-VMF-lesioned) participants, after initially sampling from all four decks, are drawn to the more risky decks because of the larger payoffs before ultimately shifting to the conservative decks because of the large costs associated with the risky decks (i.e., they become risk averse). VMF patients demonstrate the same initial sampling of all decks but then select primarily from the risky decks despite the large costs (i.e., they fail to become risk averse).

Most of the evidence discussed by Damasio and colleagues focuses on the behavior of VMF patients, but the somatic marker hypothesis has also been applied to the behavior of Ps (Damasio, 1994; Damasio, Tranel, & Damasio, 1990). Indeed, the somatic marker hypothesis could provide a powerful explanation for many symptoms of psychopathy, including impulsivity, irresponsibility, and failure to follow any life plan, as well as others.

The purpose of this experiment was to test Damasio's somatic marker hypothesis with Ps using a computerized replication of Bechara et al.'s (1994, 1997) gambling task. On the basis of Damasio's proposal concerning the similarity between the behavior of Ps and VMF patients (Damasio, 1994; Damasio et al., 1990), we predicted that psychopathy would be inversely related to risk aversion.

Moreover, as recommended by Newman and Brinkley (1997; see also Newman, Schmitt, & Voss, 1997), statistical analyses examined the effects of Welsh Anxiety Scale (WAS; Welsh, 1956) scores on task performance. Although there are numerous reasons to include this measure when evaluating the effects of psychopathy on task performance, the fact that psychopathy and the type of anxiety/negative affectivity assessed by the WAS are both associated with sensitivity to punishment cues and behavioral inhibition is especially relevant to this investigation. According to Gray (1987), individuals with this type of anxiety are hypersensitive to punishment cues and display better passive avoidance (i.e., inhibition of punished responses) than controls (see also Avila, Molto, Segarra, & Torrubia, 1995; Hagopian & Ollendick, 1994). Ps, on the other hand, are regarded as hyporeactive to punishment cues (e.g., Fowles, 1980) and are deficient in passive avoidance (Lykken, 1957; Newman & Schmitt, 1998; Thornquist & Zuckerman, 1995). Despite their common, albeit opposite, relationship to the processing of punishment cues, the dimensions of anxiety and psychopathy have been found to be statistically independent (Hare, 1991; Schmitt & Newman, 1999). In light of their statistical independence, it is possible for these dimensions to exert separate or interactive effects on laboratory measures involving sensitivity to punishment stimuli. On the basis of the apparent relation between sensitivity to punishment cues and performance on Bechara et al.'s (1994, 1997) task, it seemed essential to assess whether risk aversion on this task was most related to psychopathy, anxiety, or their interaction.

To date, Damasio and colleagues have not reported race differences (i.e., Caucasian and African American groups) in task per-

formance. However, we believe that examining race differences in task performance is important because of increasing evidence that group differences observed between Caucasian Ps and controls show only modest generalization to African American offenders (e.g., Kosson, Smith, & Newman, 1990; Newman & Schmitt, 1998; Newman et al., 1997; Thornquist & Zuckerman, 1995). In fact, we are not aware of any evidence demonstrating that significant associations between laboratory performance and psychopathy found in Caucasian offenders have been replicated in African American offenders. Thus, our lab has adopted an a priori strategy of testing hypotheses in Caucasian samples and assessing the generalizability of the finding to African American samples. In this report, we conducted analyses of variance (ANOVAs) separately for Caucasian and African American samples to remain consistent in our analytic strategy and to provide the fairest test of the somatic marker hypothesis.¹

Method

Participants

One hundred fifty-seven incarcerated men from a minimum security prison meeting the inclusion criteria for the study completed our modified version of Bechara et al.'s (1994, 1997) gambling task. File information was used to exclude men who were 40 years or older, who were currently psychotic or taking psychotropic medication, or whose reading or math scores were below the fourth-grade level. Following a consent procedure that included a description of the study and an emphasis on the study's voluntary and confidential nature, participants were interviewed for approximately 1 hr (see Kosson et al., 1990, for further description). After reviewing the file information, interviewers evaluated participants using the Psychopathy Checklist—Revised (PCL-R; Hare, 1991). The PCL-R has been found to be a reliable and valid measure of psychopathy (Hare, 1991). Interrater reliability (i.e., intraclass correlation [ICC]) was calculated on a subset of 80 offenders and was .77 across African American and Caucasian samples. Although adequate, this ICC is somewhat lower than the interrater reliabilities reported by our lab (e.g., Kosson et al., 1990; Newman et al., 1997) and others (see Hare, 1991) in past reports. Examination of the data indicated a small number of large disagreements. For example, eliminating 1 inmate for whom there was a 16-point discrepancy increased the ICC to .82.

Participants receiving a score of 20 and below were classified as controls, participants scoring between 20 and 30 were classified as middles, and participants with scores of 30 and above were classified as Ps. For Caucasian offenders, this procedure resulted in 29 controls, 38 middles, and 19 Ps. For African American offenders, this procedure resulted in 22 controls, 30 middles, and 19 Ps. To examine the influence

¹ The intent of this report was to examine explicitly the somatic marker hypothesis in Ps using the Bechara et al. (1994, 1997) gambling task. Although there are superficial similarities between Bechara et al.'s task and other card-playing tasks used to assess risk appraisal or response modulation (RM; Patterson & Newman, 1993) in Ps (e.g., Newman, Patterson, & Kosson, 1987; Siegel, 1978), there are important differences between the tasks and Damasio's and Newman's models of information processing as they pertain to Ps (see Newman, 1998). Given our lab's emphasis on exploring RM deficits in Ps, we recognize the potential for confusion concerning whether our version of the Bechara et al. task tested the RM hypothesis. We believe that there are sufficient differences between (a) the tasks used to test the RM and somatic marker hypotheses and (b) the hypotheses themselves to consider this study independent of our RM work (see Newman, 1998). Thus, the findings of this study have no implications, positive or negative, for the RM hypothesis.

of anxiety on task performance, we subdivided participants into low- and high-anxious groups using the median WAS score (9.0) for the entire sample. This procedure resulted in groups consisting of 49 low- and 37 high-anxious Caucasians and 27 low- and 44 high-anxious African Americans.

Procedure

Participants were tested individually by a male experimenter. They were seated in front of a computer monitor and response box containing four buttons (labeled 1, 2, 3, and 4) mounted on the top side. Presentation of the stimuli and recording of responses were controlled by PC-based, Micro-Experimental Laboratory software (Schneider, 1988).

The gambling task described by Bechara et al. (1994, 1997) was modified from an actual card task to a computerized version to standardize task administration and facilitate data collection. The card stimuli were somewhat similar in appearance to real cards, and the schedule of rewards and punishments was identical to Bechara et al.'s experiments. In the original Bechara et al. study, participants started the experiment with \$2,000 in play money and won amounts as much as \$100 and lost amounts as much as \$1,250. Because our study used real money, the initial amount of money and the rewards and punishments were adjusted downward but preserved the proportion of wins to losses used by Bechara et al.

The computer display contained four decks and instructions to select a card from one of the decks. After a participant pressed one of the four buttons indicating which deck he was selecting from, a display appeared for 2,000 ms indicating the amount of money won as well as the amount lost (if applicable) along with a running total of the participant's earnings. Each deck contained 40 cards. If a participant selected all 40 cards from one deck and attempted to select another card from the same deck, feedback on the computer screen indicated that he should select from another deck. The task ended after the participant had selected 100 cards.

Cards from Decks A and B (risky decks) yielded \$0.10 with higher and less frequent penalties (from \$0.15 to \$1.25), whereas cards from Decks C and D (conservative decks) yielded \$0.05 with lower and more frequent penalties (from \$0.03 to \$0.25). Overall, selections from Decks A and B are disadvantageous because the summated penalties are greater than the summated rewards, whereas selections from Decks C and D are advantageous because the summated rewards are greater than the summated penalties.

On the basis of the description from Bechara et al.'s (1994, 1997) reports, participants were told that the game required a long series of selections from the four decks and that, in selecting cards, they could choose from any of the decks and alternate between the decks. The participants were told that the object of the task was to win as much money as possible. They were not told that the task consisted of 100 trials.

Results

On the basis of previous reports (Bechara et al., 1994, 1997; Damasio, 1994), we predicted that controls would sample randomly from the decks before developing an aversion to the risky decks. By contrast, Ps were expected to sample at random initially and then select primarily from the risky decks. Thus, we predicted a Group \times Block interaction indicating a negative relationship between psychopathy and risk aversion.²

For Caucasian offenders, a 3 (control vs. middle vs. P) \times 2 (high vs. low anxiety) \times 5 (blocks of 20 trials) mixed-model ANOVA yielded main effects for block, $F(4, 320) = 2.93, p = .02, \eta^2 = .035$, with participants becoming increasingly risk averse over trials; anxiety, $F(1, 80) = 5.25, p = .02, \eta^2 = .062$, with high-anxious participants selecting fewer risky cards than low-anxious participants; and a significant Anxiety \times Block interaction, $F(4, 320) = 3.34, p = .01, \eta^2 = .040$, which qualifies both

significant main effects and indicates that high-anxious participants became more risk averse over time compared with low-anxious participants. Contrary to prediction, the Psychopathy \times Block interaction was not significant, $F(8, 320) = 1.19, \eta^2 = .029$. No other main effects or interactions approached significance (see Figure 1). For African American offenders, a 3 (control vs. middle vs. P) \times 2 (high vs. low anxiety) \times 5 (blocks of 20 trials) mixed-model ANOVA yielded no significant main effects or interactions. Here, too, the Psychopathy \times Block interaction did not approach significance, $F(8, 260) < 1.0, \eta^2 = .019$ (see Figure 2).

Following reviewers' recommendations, we conducted post hoc hierarchical regressions to examine the consequences of treating the PCL-R and WAS variables continuously. Because of the difficulty of conducting regression using repeated measures, we selected one dependent measure. According to Bechara et al. (1994, 1997), normal participants demonstrate random or "pre-hunch" behavior for approximately the first half of the task followed by the emergence of clear preferences (i.e., "hunch" and "conceptualization" behavior) during the last half of the task. For the purpose of the present regression analyses, therefore, we used number of risky selections during the last half of the task (Trials 51-100) as the dependent variable.

We entered psychopathy (using the entire range of PCL-R scores), anxiety (using the entire range of WAS scores), and their interaction. For Caucasian offenders, psychopathy accounted for 0.1% of the variance (*ns*), anxiety accounted for 5.7% of the variance ($p < .03$), and the Psychopathy \times Anxiety interaction accounted for 5.2% of the variance ($p = .03$). The significant interaction indicated that anxiety was inversely related to risk taking only at low levels of psychopathy. For African American offenders, psychopathy accounted for 0.1% of the variance (*ns*), anxiety accounted for 5.4% of the variance ($p = .05$), and the Psychopathy \times Anxiety interaction accounted for 0.0% of the variance (*ns*). Surprisingly, the significant relation between risk taking and anxiety was opposite in direction to the association obtained in Caucasian offenders.³

Following reviewers' recommendations, we also examined the contributions of the two PCL-R factors (see Harpur, Hare, & Hakstain, 1989) in predicting task performance with hierarchical regression. For both Caucasian and African American groups,

² For the sake of completeness, we conducted an omnibus ANOVA using all participants and entered race as a variable. The 2 (Caucasian vs. African American) \times 3 (control vs. middle vs. P) \times 2 (high vs. low anxiety) \times 5 (blocks of 20 trials) mixed-model ANOVA yielded main effects for block, $F(4, 580) = 3.10, p < .02, \eta^2 = .021$, indicating that participants became increasingly risk averse over trials; race, $F(1, 145) = 4.83, p = .03, \eta^2 = .032$, indicating that African American participants selected fewer risky cards than did Caucasian participants; and a significant Anxiety \times Race interaction, $F(1, 145) = 6.68, p = .01, \eta^2 = .044$, which qualifies the significant race main effect and indicates that anxiety was positively related to risk aversion for Caucasian participants and negatively related to risk aversion for African American participants. No other main effects or interactions approached significance.

³ Because the findings from the regression analyses were somewhat different from the a priori ANOVAs, we conducted post hoc regressions using PCL-R and WAS discontinuously and continuously to examine whether this difference was most related to our use of a different dependent variable, using continuous measures of psychopathy and anxiety, or using

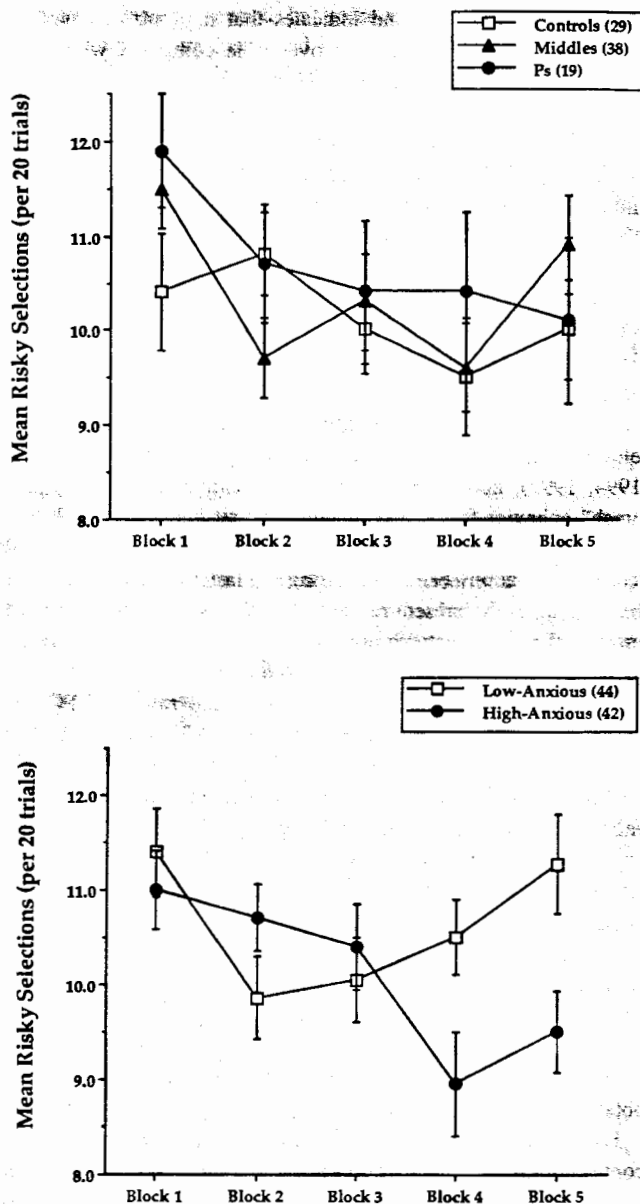


Figure 1. Caucasian offenders' mean number of selections from the risky decks across five blocks of 20 trials. The top graph contrasts controls, middles, and psychopathic individuals (Ps), whereas the bottom graph contrasts low- and high-anxious participants. Although psychopathy did not significantly predict task performance, anxiety was positively associated with the development of risk aversion over blocks. Points represent the mean number of selections from the risky decks per 20 selections; vertical lines depict standard errors of the means.

some combination of these factors. First, when we used PCL-R and WAS trichotomously and dichotomously, respectively, the results were consistent with the ANOVAs. Second, when we used PCL-R trichotomously with WAS continuously, the results closely approximated the supplemental regressions. Last, when we used WAS dichotomously with PCL-R continuously, the results replicated the a priori ANOVAs. Thus, these findings indicate that incorporating the continuous variability in the WAS but not in the PCL-R provided a more powerful analysis.

however, neither factor nor their interaction accounted for a significant proportion of the variance in task performance.

Discussion

Since the publication of *Descartes' Error* (Damasio, 1994), there has been a great deal of interest regarding the implications of somatic markers for the understanding of human information processing and decision making. To date, however, there are few published studies testing Damasio's somatic marker hypothesis. Moreover, all of these reports appear to focus on patients with VMF lesions (Bechara et al., 1994, 1997; Damasio, 1994). To our knowledge, the present report represents the first attempt to test the somatic marker hypothesis as applied to Ps.

Damasio has theorized that Ps, like VMF-lesioned patients, are impaired in using somatic markers to guide behavior. Thus, we predicted an inverse relation between psychopathy and risk aversion. Contrary to our a priori prediction, however, the Psychopathy \times Block interaction did not approach significance, suggesting that Ps may not differ from controls with regard to using somatic markers, at least as measured by this version of Bechara et al.'s (1994, 1997) task.

There are several factors that may have contributed to our inability to detect the predicted psychopathy effects. First, the incarcerated controls used in this study may have displayed less risk aversion than those of Bechara et al. (1994, 1997) because they differ in potentially important ways from nonincarcerated controls (Arnett, Smith, & Newman, 1997; Raine, 1993). Along this line, it is clearly important to gather data from a random sample of nonincarcerated participants to determine whether a noncriminal control group would display stronger risk aversion. Second, participants in this study were paid actual money for their involvement, whereas Bechara et al.'s participants were not. Third, because real money was used, we modified the monetary rewards and punishments to be realistic about how much money participants won and lost (e.g., whereas Bechara et al. were paying out over \$2,000 in pretend money, we paid out less than \$5 in real money). Last, our computerized version of the gambling task (vs. using actual cards) may have been too artificial to engage the participants compared with the card game administration used by Bechara et al. Related to this point is the possibility that our task instructions may have differed in important ways from Bechara et al.'s. Indeed, the most recent version of the gambling task used by Bechara and colleagues contains instructions that inform participants that some decks involve more loss than others and that participants can win more money overall if they avoid the costly decks (D. Tranel, personal communication, July 2, 1998). By contrast, our instructions made no mention of win-loss differences between decks. Perhaps strong risk aversion develops more readily with instructions that highlight important differences between the decks.

Despite these limitations, the computerized gambling task used in this study was sufficiently sensitive to differentiate between low- and high-anxious offenders. The positive association between anxiety and risk aversion for Caucasians is consistent with theories of anxiety such as Gray's (1987) as well as with evidence regarding the excessive risk aversion/passive avoidance of high-anxious individuals (Avila et al., 1995; Hagopian & Ollendick, 1994). Conversely, the negative association between anxiety and risk aversion for African Americans is not consistent with the above-

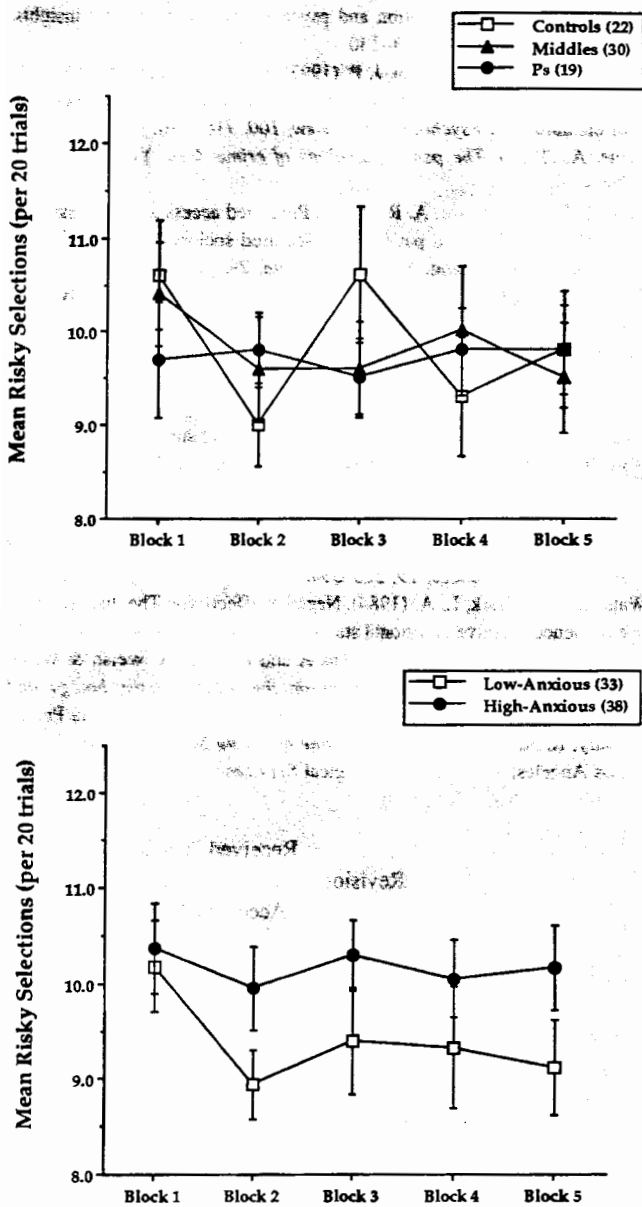


Figure 2. African American offenders' mean number of selections from the risky decks across five blocks of 20 trials. The top graph contrasts controls, middles, and psychopathic individuals (Ps), whereas the bottom graph contrasts low- and high-anxious participants. Although psychopathy did not significantly predict task performance, anxiety was inversely associated with risk aversion. Points represent the mean number of selections from the risky decks per 20 selections; vertical lines depict standard errors of the means.

noted theory or behavioral evidence. Though admittedly post hoc, this finding is consistent with descriptions of anxiety's disruptive effects on information processing (see Watson & Clark, 1984) as well as with reports of "paradoxical impulsivity" in high-anxious individuals (see Newman & Wallace, 1993). Though speculative, these findings may indicate that our measure of anxiety (i.e., WAS) reflects different processes or consequences in Caucasian and African American offenders.

In addition to the anxiety effects, the significant effect for block observed in the Caucasian sample was not replicated in the African

American sample. This difference, indicating that African American offenders failed to become risk averse over time, may have been due to differences in their level of task engagement, the fact that they selected more conservatively overall compared with Caucasians (see footnote 2), or other factors.⁴ The unexpected results involving overall task performance and anxiety in Caucasian and African American offenders require further study.

⁴ We assessed for potential race differences on age, highest level of attained education, estimated IQ (i.e., Shipley Institute of Living Scale; Zachary, 1986), and psychiatric cocondition (i.e., Symptom Checklist-90—Revised Global Severity Index; Derogatis, 1992). No race differences emerged for age, education, and psychiatric co-condition (all F s < 1.0). A significant race difference emerged for estimated IQ (Caucasian $M = 98.2$; African American $M = 86.4$), $F(1, 155) = 41.5, p < .001, \eta^2 = .209$. We thus conducted a 2 (Caucasian vs. African American) \times 3 (control vs. middle vs. P) \times 2 (high vs. low anxiety) \times 5 (blocks of 20 trials) mixed-model analysis of covariance with estimated IQ as the covariate. The Anxiety \times Race interaction remained significant, $F(1, 144) = 7.60, p < .01, \eta^2 = .050$, although the race main effect was no longer significant, $F(1, 144) = 2.44, p = .12, \eta^2 = .017$. Although we did not assess for socioeconomic status, we acknowledge that this variable, like estimated IQ, may have accounted at least in part for the detected race differences on task performance.

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