PERGAMON

PERSONALITY AND INDIVIDUAL DIFFERENCES

Personality and Individual Differences 35 (2003) 1061–1072

www.elsevier.com/locate/paid

Cost–benefit reasoning in students with multiple secondary school suspensions

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Received 18 March 2002; received in revised form 9 September 2002; accepted 16 October 2002

Abstract

Twenty-seven high-school students whose careers had been characterized by multiple school suspensions were compared to a control group on a cost–benefit reasoning task developed by Bechara, Damasio, Damasio, and Anderson (1994) as a laboratory probe for the study of the problems in behavioral regulation. Like some clinical populations that have been studied with this task, the adolescents with multiple school suspensions failed to maximize their earnings in the task because they were not deterred from options with high penalties. This group displayed less optimal behavior in the cost–benefit reasoning task despite having measured intelligence that was equal to that of the controls. The results are consistent with the notion that these students lack adequate somatic markers in an automatic goal orientation system.

Keywords: Cost–benefit reasoning; School suspensions; Rationality

Bechara, Damasio, Damasio, and Anderson (1994) have developed an important laboratory probe to detect and measure impairments in behavioral regulation that characterize several clinical populations including individuals with certain types of disruption in frontal lobe functioning (Bechara, Damasio, Tranel, & Damasio, 1997; Damasio, 1994, 1996), heroin addicts (Petry, Bickel, & Arnett, 1998), and individuals with psychopathic tendencies (Blair, Colledge, & Mitchell, 2001). Their task was designed to simulate the uncertainties of real-life decision making as well as its properties of intermittent rewards and punishments. In their task, the participant sat facing four decks of cards, labeled A, B, C, and D and was given $2000 of play money. The

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0191-8869/03/$ - see front matter
doi:10.1016/S0191-8869(02)00318-5

participant was told that he/she must begin turning over cards from the decks in whatever order they preferred. The task was stopped after 100 draws, but the participant was not told this in advance. The participant received a reward on each card turn but was not told in advance what the reward would be. The reward was $100 for each card in decks A and B and $50 for each card in decks C and D. However, on a few cards there were penalties indicated. When those cards were turned, the participant received the reward ($100 or $50) but then paid a penalty as well. In the Bechara et al. (1994) study, the high reward decks (A and B) were accompanied by enough high penalties that the expected values of the decks were negative, whereas the low reward decks (C and D) were accompanied by low penalties and had positive expected values.

Using this gambling/decision-making task, Bechara et al. (1994) studied a particular type of patient with damage in the ventromedial prefrontal cortex. These individuals have severe difficulties in real-life decision making but do not display the impairments in sustained attention and executive control that are characteristic of individuals with damage in the dorsolateral frontal regions (e.g., Duncan, Emslie, Williams, Johnson, & Freer, 1996; McCarthy & Warrington, 1990; Pennington & Ozonoff, 1996). Bechara et al. (1994) found that control participants begin by sampling all of the decks with perhaps a slight bias toward the high reward decks A and B—but by the final 50 trials have migrated away from the low expected values decks A and B and end up making most of their final choices from decks C and D (the high expected value decks). Patients with ventromedial prefrontal damage also began by sampling all the decks, but their preference for the high reward A and B decks did not diminish throughout the testing period. They continued to pick from these low expected value decks throughout the 100 trials—apparently unshaped by the fact that the frequency and magnitude of the penalties outweighed the larger rewards for these decks. As a result, over the course of the 100 draws the ventromedial prefrontal participants chose significantly more cards from decks A and B and significantly fewer from decks C and D than either normal controls or control subjects with brain damage outside the ventromedial prefrontal area.

Thus, the performance of these patients on this task mirrored their problems in real-life. They consistently repeated acts that were inefficacious and they failed to carry out behaviors that would have ensured unproblematic outcomes. Damasio (1994) explains the behavior of these patients by his somatic marker hypothesis. These individuals seem to lack emotional systems that mark positive and negative outcomes with evaluative valence. These nonconscious somatic markers are thus unavailable to help guide responses the next time similar choices are encountered (see Bechara et al., 1997, for physiological evidence on this possibility). Petry et al. (1998) found that heroin addicts also displayed more disadvantageous choices in the Bechara et al. (1994) gambling/decision-making task than controls of equal intelligence, although the effect was not as large as that displayed by the patients studied by Bechara et al. (1994).

Based on their results with patients with ventromedial prefrontal damage Bechara et al. (1994) argued that the task they developed "offers, for the first time, the possibility of detecting these patients' elusive impairment in the laboratory, measuring it, and investigating its possible causes" (p. 13). It is common in cognitive science for theorists to extrapolate the dissociations observed in brain-damaged individuals to explanations of developmental difficulties. For example, the results of studies of individuals with acquired reading disability due to brain damage have been theoretically extrapolated to cases of developmental dyslexia (Castles & Coltheart, 1993; although of course such extrapolation is not uncontroversial, see Snowling, Bryant, & Hulme, 1996).

Here, we attempt a similar extrapolation by examining the performance on the Bechara et al. (1994) gambling/decision-making task in a nonclinical sample of adolescents who were experiencing problems of behavioral adjustment. The focal participants of the present study were students who had experienced multiple suspensions from school—thus exhibiting the consistent inability to adjust behavior to environmental standards that was characteristic (in vastly more extreme form) of Damasio's (1994) patients with ventromedial prefrontal damage. They had been sanctioned for behavior but had persisted in actions that carried penalties. Like Damasio's (1994) patients, our participants did not differ from their controls in general intelligence. Because prefrontal damage has been associated with anti-social behavior (e.g., Blair & Cipolotti, 2000; Blair et al., 2001; Damasio, 1994; Davidson & Irwin, 1999; Grafman, Schwab, Warden, Pridgen, & Brown, 1996; Lapierre, Braun, & Hodgins, 1994; Pennington & Ozonoff, 1996), we predicted that if the Bechara gambling/decision-making task was indeed a measure of prefrontal functioning then we might find detectable differences in the performance of these students as well.

1. Method

1.1. Participants

The participants were a convenience sample of ninety male students attending a regular secondary school in a large metropolitan area. Their mean age was 16.2 years (SD = 1.7). The secondary school had a total population of 950 students and served a diverse community, with the most prominent cultural backgrounds being Portuguese, Spanish, and Italian. Only native-born students who came from homes in which English was a primary language were included.

Consent to participate was obtained by the second author. Of those who agreed to participate, 45 had experienced no school suspensions in the first semester of the school year and 45 had experienced at least one school suspension during the same period. The latter group was obtained by requesting the participation of the entire sample of 49 male students who had received a suspension during the first semester. Of these 49, 45 agreed to participate. Verification of school records revealed that of the suspended students, 18 had experienced one suspension, 16 had experienced two suspensions, and 11 had experienced more than two suspensions. The suspensions were for a variety of reasons including destroying property (e.g. graffiti, vandalism), fighting, stealing, cutting class/skipping school, threatening others, using a prohibited substance (e.g. alcohol, drugs), smoking, use of foul language, excessive lates, opposition to authority, and "other". The most common categories of suspension were fighting (17), smoking (17), skipping school (15), and destroying property (10). For purposes of the initial analysis present below three groups were formed: those students who had not received a suspension ($n = 45$), those who had received one suspension ($n = 18$), and those who had experienced more than one suspension ($n = 27$).

1.2. Tasks

1.2.1. General cognitive ability

As a measure of general cognitive ability, participants completed four subtests from the Canadian Cognitive Abilities Test (CCAT), Multilevel Edition, Level F, Form 7 (Thorndike & Hagen, 1989). The four subtests were the figure classification, figure analogies, figure analysis, and sentence completion subtests. The first three comprised the entire nonverbal battery for this test. The latter was one of three subtests that comprised the verbal battery. To obtain a measure of general cognitive ability the raw scores on each of the four tests were standardized and summed. This score will be termed the Cognitive Ability Composite score.

1.2.2. Cost-benefit reasoning task

The task was an adaptation of the card game devised by Bechara et al. (1994) and described in the introduction. Each student was tested individually. The materials consisted of white index cards measuring 3 × 5 inches. On one side of each card the deck label (A, B, C, or D) was printed. There were 50 cards in each deck, for a total of 200. On the other side of each card both the monetary rewards and monetary penalties (if any) associated with that card were clearly labeled (e.g. Reward \$1.00; Reward \$0.50; Reward \$1.00 & Penalty \$2.00). Each card in decks A and B had a \$1.00 reward on it and each card in decks C and D had a \$0.50 reward on it. The penalties on the cards (values given later) were intermittent and occurred at the locations in the decks indicated in Fig. 1.

As is clear from Fig. 1, the logic of the reward and penalty arrangement in our study was analogous to that used in Bechara et al. (1994). Despite the larger rewards for the cards in decks A and B, these decks were disadvantageous. The expected value of each deck was negative—the participant would lose \$2.50 for each 10 cards drawn from decks A and B. In contrast, despite the smaller rewards for the cards in decks C and D, these decks were advantageous. The expected value of decks C and D was positive—the participant would win \$2.50 for each 10 cards drawn from decks C and D.

Decks A and B were equivalent in terms of overall net loss over trials. The difference between the decks was that in deck A, the penalty was more frequent, but of smaller magnitude (e.g. \$1.50, \$2.00, \$2.50, \$3.00, \$3.50). In deck B, the penalty was less frequent, but of higher magnitude (\$12.50). Decks C and D were equivalent in terms of overall net gain over trials. The difference in these two decks was that in deck C, the penalty was more frequent and of smaller magnitude (e.g. \$0.25, \$0.50, \$0.75), while in deck D, the penalty was less frequent, but of higher magnitude (\$2.50).

The experimenter sat beside each participant at a table in an empty and quiet room to assure privacy. This seating arrangement minimized the possibility of card selections based on any physical or facial cues inadvertently communicated by the experimenter. The four decks of cards were presented horizontally on the table in sequential order with their labels (A,B,C,D) on top and facing the participant. Each participant was given a \$20.00 loan of real money (i.e., 10 \$1.00 coins and 40 \$0.25 coins totaling \$20.00) and instructed on how to play the game. Each participant was told:

1. that the game required a series of 100 card selections (one card at a time) from the four decks
2. that the goal of the task was to maximize profit on the loan of money
3. that cards had rewards and possible penalties
4. that they were free to switch from any deck to another, at any time, and as often as they wished.

Response Option	Deck A (+ $1.00)	Deck B (+ $1.00)	Deck C (+ $ .50)	Deck D (+ $ .50)
1				
2				
3	- $1.50		- $ .25	
4				
5	- $3.00		- $ .75	
6				
7	- $2.00		- $ .25	
8				
9	- $2.50	- $12.50	- $ .75	
10	- $3.50		- $ .50	- $2.50
11				
12	- $3.50		- $ .25	
13			- $ .75	
14	- $2.50	- $12.50		
15	- $2.00			- $2.50
16				
17	- $3.00		- $ .25	
18	- $1.50		- $ .75	
19				
20			- $ .50	
21		- $12.50		- $2.50
22	- $3.00			
23				
24	- $3.50		- $ .50	
25			- $ .25	
26	- $2.00		- $ .50	
27	- $2.50			
28	- $1.50			
29			- $ .75	
30			- $ .50	
31	- $3.50			
32	- $2.00	- $12.50		- $2.50
33	- $2.50			
34			- $ .25	
35			- $ .25	
36				
37	- $1.50		- $ .75	
38	- $3.00			
39			- $ .50	
40			- $ .75	
41		- $12.50		- $2.50
42	- $3.00			
43				
44	- $3.50		- $ .50	
45			- $ .25	
46	- $2.00		- $ .50	
47	- $2.50			
48	- $1.50			
49			- $ .75	
50			- $ .50	

Fig. 1. The schedule of rewards and penalties in the four decks. Each card chosen from decks A and B was accompanied by a reward of $1.00 and each card chosen from decks C and D was accompanied by a reward of $0.50. The penalties in each deck were as indicated.

Only no. 1 is different from Bechara et al. (1994). They did not inform their participants about how many selections there would be, whereas we did.

To increase the realism of the task, participants were also told that they would be staked for \$20.00. At the end of the game, participants were told that they would return the original \$20.00 loan. However, if participants had a net gain, they could keep any amount of money over the original \$20.00 loan. Participants were also assured that they would not be held accountable for any net losses experienced by the end of the game. Participants were not told the number of cards in each deck (several blank cards were added to the bottom of each deck so that participants would not be concerned that a deck would be exhausted). Participants were not told that decks A and B always yielded a reward of \$1.00 and that decks C and D always yielded a reward of \$0.50. This information had to be induced during the initial selections. They were also told nothing about the penalty schedules indicated in Fig. 1.

After turning each card, participants were either given money and instructed to proceed with the next selection or were given money and asked to pay a penalty before proceeding with the next selection. Participants placed selected cards on the table in a single pile and right side up so that they had a visual reminder of the consequences (reward/penalty) from their last card selection but had no memory aid from earlier selections.

1.3. Procedure

Participation took place on three different days. On the first day participants filled out a series of questionnaires that were not part of the present study. However, the demographics sheet was filled out at this session. On the second day the cost–benefit reasoning task was completed in a vacant seminar room in the students' school. The task took approximately 30–40 min to complete. On the third day the four subtests of the Canadian Cognitive Abilities Test were administered in a groups of 3–6 by the experimenter. Each section was time limited and the administration of all the subtests took approximately 60 min.

2. Results

Table 1 displays the performance differences between three groups of participants: the students with no suspensions, the students with one suspension, and the students with more than one suspension. The three groups did not differ in age or general cognitive ability. Although the group without a suspension slightly outperformed both of the other groups on three of the four subtests of the Canadian Cognitive Abilities Test, none of the differences approached significance. Finally, on the composite measure of cognitive ability, which combined all four tests, the three groups did not differ. That the three groups did not differ in general intelligence is a true finding in the sense that no matching procedure had been used to guarantee that outcome.

The next comparisons in Table 1 concern performance on the cost–benefit reasoning task. The mean number of cards drawn from decks A, B, C, and D over the entire 100 draws is presented for all three groups. Although none of the individual comparisons was statistically significant, there was a tendency for the two groups with fewer suspensions to choose fewer cards from the disadvantageous decks (A and B) and more cards from the advantageous decks (C and D). This is

Table 1
Mean scores of the students with no suspensions ($N=45$), students with one suspension ($N=18$), and students with more than one suspension ($N=27$) on the cognitive ability measures and measures from the cost–benefit reasoning task (standard deviations in parentheses)

	No suspensions ($n=45$)	One suspension ($n=18$)	>1 suspension ($n=27$)	F ratio
Age	16.2 (1.7)	15.4 (1.7)	16.5 (1.6)	2.32
Cognitive ability				
Sentence comp (raw)	17.1 (4.0)	16.8 (4.4)	16.4 (3.8)	0.26
Figure class (raw)	13.7 (3.8)	14.1 (4.1)	12.7 (3.6)	0.81
Figure analogies (raw)	15.9 (4.0)	13.8 (4.2)	14.8 (5.1)	1.65
Figure analysis (raw)	8.7 (3.6)	7.0 (4.1)	8.5 (3.6)	1.35
Cognitive ability comp	0.102 (0.75)	−0.130 (0.91)	−0.084 (0.82)	0.75
Cost–benefit reasoning				
Deck A (100 sel)	20.4 (5.9)	18.8 (6.1)	21.1 (8.3)	0.63
Deck B (100 sel)	26.2 (8.4)	25.2 (7.5)	29.1 (10.8)	1.26
Deck C (100 sel)	24.9 (7.0)	24.4 (7.9)	23.7 (6.4)	0.28
Deck D (100 sel)	28.4 (7.7)	31.5 (10.3)	26.1 (7.9)	2.30
Deck A+B (100 sel)	46.6 (10.0)	44.1 (10.3)	50.3 (10.1)	2.16
Deck C+D (100 sel)	53.4 (10.0)	55.9 (10.3)	49.7 (10.1)	2.16
Deck A (last 50 sel)	9.5 (4.4)	7.4 (4.0)	9.9 (6.3)	1.52
Deck B (last 50 sel)	13.1 (6.1)	12.9 (5.8)	16.1 (8.1)	2.03
Deck C (last 50 sel)	13.3 (5.5)	12.8 (5.8)	11.9 (4.9)	0.60
Deck D (last 50 sel)	14.1 (5.5)	16.9a (7.7)	12.1b (5.1)	3.63*
Deck A+B (last 50 sel)	22.6a (7.2)	20.3a (7.1)	26.0b (7.0)	3.77*
Deck C+D (last 50 sel)	27.4a (7.2)	29.7a (7.1)	24.0b (7.0)	3.77*
Monetary outcome	−$3.44 (7.49)	−$0.65a (6.99)	−$6.16b (6.82)	3.21*

sel = selections.
Means with different letters (a,b) are significantly different (Fisher).
* $P<0.05$.

even more apparent in the next two comparisons in the table, which combine the number of selections from the two disadvantageous decks (A and B) and the two advantageous decks (C and D). Since these two means are complements, the F ratio for both comparisons is the same. As indicated in Table 1, across all of the 100 trials, the group with more than one suspension drew almost four more disadvantageous cards than did the group with no suspensions and drew approximately six more disadvantageous cards than the group with just one suspension. However, as indicated in the table, none of these differences reached statistical significance.

Because participants need several draws from each of the decks in order to register the properties of the four decks, examining the number of draws across all of the 100 trials may obscure differences between the groups that become apparent only after the properties of the decks have been registered. That is, it is possible that any differences between the groups would more strongly manifest themselves in the latter half of the draws from the decks. The next four lines in Table 1—where the mean number of draws from the decks over the final 50 trials are compared—indicate that this probably was the case. Here, not only was there a tendency for the >1 suspension group to choose more cards from the disadvantageous decks (A and B) and fewer cards from the advantageous decks (C and D), but over the last 50 draws the difference for deck D was statistically significant.

The next two comparisons in Table 1 combine the number of selections from the two disadvantageous decks (A and B) and the two advantageous decks (C and D). The >1 suspension group chose over three more cards from the disadvantageous decks than did the no suspension group and almost six more disadvantageous cards than did the one suspension group, and these differences were statistically significant. That the mean difference in the number drawn from the advantageous decks was almost the same over the last 50 cards as it was for the full set of 100 draws indicates that the performance difference arises almost entirely from the last 50 cards—after the different properties of the decks have been registered.

These different patterns of card selections of course had implications for the monetary outcomes experienced by the two groups of students. As is apparent in the last line of Table 1, the >1 suspension group lost more ($6.16) than did the no suspension group ($3.44), and significantly more than the one suspension group ($0.65). All three groups experienced mean losses largely because, as indicated in Fig. 1, after the first block of 10 cards, the large $12.50 and $2.50 losses in decks B and D occur early in each block of 10. Winning was possible, however. Fully 25 of the participants had net gains, 12 had gains over $5.00, and three earned over $10.00 above their stake. But, mirroring the results in terms of number of card category choices, the students with more than one suspension were much less likely to finish with net gains. Whereas 42.2% of the no suspension and one suspension groups combined finished with net gains, only 13.3% of the >1 suspension group finished with a net gain.

The significant differences that were obtained in the analyses depicted in Table 1 were most often between the >1 suspension students and the other two groups. The two low suspension groups never differed significantly from each other, and in fact there was a slight tendency for the one suspension group to make more advantageous deck choices than the group receiving no suspension. Table 2 presents data depicted in order to explore the consequences of collapsing the two low suspension groups into a single group of low suspension students (LSS) and comparing their performance with that of the >1 group (termed, in contrast, high suspension students—HSS). As expected from the previous three-group analysis, the two groups did not differ in general cognitive ability. Although the LSS group slightly outperformed the HSS group on three of the four subtests of the Canadian Cognitive Abilities Test, none of the differences approached significance. Furthermore, on one of the four subtests (figure analysis) the direction of the difference reversed. Finally, on the composite measure of cognitive ability, which combined all four tests, the two groups did not differ. Cognitive ability did not correlate significantly with any of the measures of performance on the cost-benefit reasoning task, a finding that replicates the outcome of the Blair et al. (2001) study which examined individuals with psychopathic tendencies.

The next comparisons in Table 2 concern performance on the entire set of 100 trials in the cost–benefit reasoning task. Although none of the individual comparisons was statistically significant, there was a tendency for the LSS group to choose fewer cards from the disadvantageous decks (A and B) and more cards from the advantageous decks (C and D). The next two comparisons in the Table combine the number of selections from the two disadvantageous decks (A and B) and the two advantageous decks (C and D). As indicated in Table 2, across all of the 100 trials the LSS group chose over four more cards from the advantageous decks and four fewer cards from the

Table 2
Mean scores of the low suspension students ($N = 63$) and high suspension students ($N = 27$) on the cognitive ability measures and measures from the cost-benefit reasoning task (standard deviations in parentheses)

Variable	LSS	HSS	$t(88)$
Cognitive ability			
Sentence completion (max = 25)	17.0 (4.1)	16.4 (3.8)	0.66
Figure classification (max = 25)	13.8 (3.9)	12.7 (3.6)	1.24
Figure analogies (max = 25)	15.3 (4.1)	14.8 (5.1)	0.51
Figure analysis (max = 15)	8.2 (3.8)	8.5 (3.6)	−0.34
Cognitive ability composite	0.036 (0.80)	−0.084 (0.82)	0.65
Cost–benefit reasoning			
Deck A (100 selections)	20.0 (6.0)	21.1 (8.3)	−0.74
Deck B (100 selections)	25.9 (8.1)	29.1 (10.8)	−1.55
Deck C (100 selections)	24.8 (7.2)	23.7 (6.4)	0.70
Deck D (100 selections)	29.3 (8.6)	26.1 (7.9)	1.69
Deck A + B (100 selections)	45.9 (10.1)	50.3 (10.1)	−1.88
Deck C + D (100 selections)	54.1 (10.1)	49.7 (10.1)	1.88
Deck A (last 50 selections)	8.9 (4.4)	9.9 (6.3)	−0.85
Deck B (last 50 selections)	13.0 (6.0)	16.1 (8.1)	−2.03*
Deck C (last 50 selections)	13.2 (5.6)	11.9 (4.9)	1.04
Deck D (last 50 selections)	14.9 (6.2)	12.1 (5.1)	2.06*
Deck A + B (last 50 selections)	21.9 (7.2)	26.0 (7.0)	−2.50**
Deck C + D (last 50 selections)	28.1 (7.2)	24.0 (7.0)	2.50**
Monetary outcome	−\$2.65 (7.40)	−\$6.16 (6.82)	2.11*

LSS = low school suspension group; HSS = high school suspension group.
* $P < 0.05$.
** $P < 0.025$, all two-tailed.

disadvantageous decks, a difference that approached significance even on a two-tailed test, $t(88) = 1.88$, $0.05 < P < 0.10$, and was significant on a one-tailed test. The difference translated into an effect size of 0.437, which Rosenthal and Rosnow (1991, p. 446) classify as "moderate."

The next four lines in Table 2—where the mean number of draws from the decks over the final 50 trials are compared—indicate that not only was there a tendency for the LSS group to choose fewer cards from the disadvantageous decks (A and B) and more cards from the advantageous decks (C and D), but over the last 50 draws the difference for both decks B and D was statistically significant. As the next two lines in Table 2 indicate, the LSS group chose over four more cards from the advantageous decks and four fewer cards from the disadvantageous decks, a difference that was statistically significant even on a two-tailed test, $t(88) = 2.50$, $P < 0.025$. The difference translated into an effect size of 0.582, which Rosenthal and Rosnow (1991, p. 446) classify as slightly greater than "moderate". That the mean difference in the number drawn from the advantageous decks (slightly over four cards) was the same over the last 50 cards as it was for the full set of 100 draws indicates that the performance difference arises almost entirely from the last 50 cards—after the different properties of the decks have been registered. The mean number of cards drawn across the four decks during the first 50 draws was very similar (deck A: 11.2 vs.

11.1; deck B: 12.9 vs. 13.0; deck C: 11.6 vs. 11.8; deck D: 14.4 vs. 14.0). An analysis of variance on the efficacious responses (C plus D) indicated that there was a significant interaction between group and the first versus the second block of 50 trials [$F(1, 88) = 6.03$, $P < 0.025$). The LSS group showed more change over the sequence of trials than the HSS group. In fact, the HSS group did not change their proportion of responses toward the efficacious decks at all from the first to second block of 50 trials, whereas there was a significant shift in this direction on the part of the LSS group. Finally, as is apparent in the last line of Table 2, the HSS group lost $3.51 more than the LSS group after the 100 selections, a difference that was statistically significant, $t(88) = 2.11$, $P < 0.05$.

3. Discussion

The students with multiple school suspensions in the present study displayed interesting parallels to the patients with damage in the ventromedial prefrontal cortex studied by Bechara et al. (1994, 1997). First, like the prefrontal patients studied by Bechara et al., they displayed no deficits in intelligence when compared with controls without a history of multiple school suspensions. Nevertheless, they displayed significantly suboptimal performance on the cost–benefit reasoning task. The effect observed in our study was smaller than that shown by the patients studied by Bechara et al. (1994) but it was equal in size to that displayed by the heroin addicts studied by Petry et al. (1998) and almost as large as that obtained by Blair et al. (2001) with children and adolescents with psychopathic tendencies. The pattern of the one suspension group being more similar to the no suspension group than to the >1 suspension group (in fact, they selected even more advantageous cards than the zero suspension group) is interesting given the logic of the cost–benefit reasoning task. Note that students in the >1 suspension group have repeated a penalty-causing behavior, whereas the one suspension group have not.

The parallel in the performance patterns between the students in our study and the patients studied by Bechara et al. (1994) suggests that inadequate somatic marking might underlie the behavioral problems experienced by the HSS students. Many cognitive scientists view somatic markers as processing interrupt signals supporting goal achievement (de Sousa, 1987; Johnson-Laird & Oatley, 1992; Oatley, 1992). The basic idea is that emotions serve to stop the combinatorial explosion of possibilities that would occur if an intelligent system tried to calculate the utility of all possible future outcomes. Somatic markers are thought to constrain the possibilities to a manageable number.

The function of somatic markers can become problematic in either of two ways. Incorrectly signalling somatic markers might need to be overridden by analytic cognition (Evans & Over, 1996; Norman & Shallice, 1986; Stanovich, 1999; Stanovich & West, 2000) or, alternatively, somatic markers might be absent or malfunction. Presumably, the Bechara et al. gambling/decision-making task implicates problems of the second type in our group of multiply suspended students. Importantly, there is empirical evidence for both types of problems. Dorsolateral prefrontal damage has been associated with executive functioning difficulties (and/or working memory difficulties) that can be interpreted as the failure to override the activity of automatic processes (Dempster, 1992; Dempster & Corkill, 1999; Duncan et al., 1996; Harnishfeger & Bjorklund, 1994; Kimberg, D'Esposito, & Farah, 1998; Norman & Shallice, 1986; Pennington & Ozonoff, 1996; Phillips & Della Sala, 1998; Shallice, 1988). In contrast, ventromedial damage to the prefrontal cortex has been associated with problems in behavioral regulation that are accompanied by affective disruption (Bechara et al., 1994, 1997; Damasio, 1994). Difficulties of the former but not the latter kind are associated with lowered intelligence (Damasio, 1994; Duncan et al., 1996)—consistent with the lack of intelligence differences between our LSS and HSS groups. Our evidence adds to that of Blair et al. (2001) and Petry et al. (1998) in indicating that the Bechara et al. gambling/decision-making task may be useful in operationalizing these different types of problems of behavioral regulation.

Acknowledgements

This research was supported by a grant from the Social Sciences and Humanities Research Council of Canada to Keith E. Stanovich. David Moshman is thanked for his comments on an earlier version of the manuscript

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