

Sensation Seeking and Reward Sensitivity are related to Poor Performance Monitoring (ERN) and Decision-making (IGT)

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Introduction

Background: Sensation seeking (SS) and sensitivity to reward (SR) have been theoretically linked to poor decision-making, disinhibition, and approach motivation. For example, disinhibited and substance abuse subjects make risky choices on the Iowa gambling task (IGT), which may reflect inefficient activity of the orbitofrontal and dorsolateral prefrontal cortices¹. No studies have examined SS and SR in relation to performance monitoring, necessary for evaluating and altering on-going behaviors. Performance monitoring has been measured using the error-related negativity (ERN), an ERP component thought to reflect activity of the anterior cingulate cortex^{1,2,3}. The ERN has been conceptualized as indexing error detection or response conflict but a number of recent studies have reported affective and motivational influences on the ERN, suggesting the ERN may be sensitive to goal states and affective responses to errors. For example, enhanced ERNs have been found in obsessive-compulsive⁴ subjects while reduced ERNs were related to low-socialization⁵.

Purpose: To examine SS and SR in relation to IGT performance and the ERN.

Method

Participants:

- 50 unselected, 17- to 20-year-old males
- Right-handed, free of head injury

Self-report measures:

- Sensation Seeking Scale Form V⁶: a 40-item scale assessing thrill and adventure seeking, experience seeking, disinhibition and boredom susceptibility
- Sensitivity to Punishment and Sensitivity to Reward Questionnaire⁷: a 48-item scale assessing worry about threats of punishment or failure and the extent to which individuals do things to obtain rewards

Iowa Gambling Task (IGT)⁸:

- Participant selected card-by-card from 4 decks to maximize payoff for a total of 100 trials (decks A & B were disadvantageous, C & D were advantageous)
- Performance was evaluated by calculating a net score for card selections (e.g., decks C + D minus decks A + B)

ERP Flanker task:

- 4 computer generated visual displays of 5 letters, displayed 250 ms each with SOA of 1250 ms
- Target letter (S or H) flanked on each side by either congruent (SSSSS, HHHHH) or incongruent (SSHSS, HHSHH) letters, target letter required key press

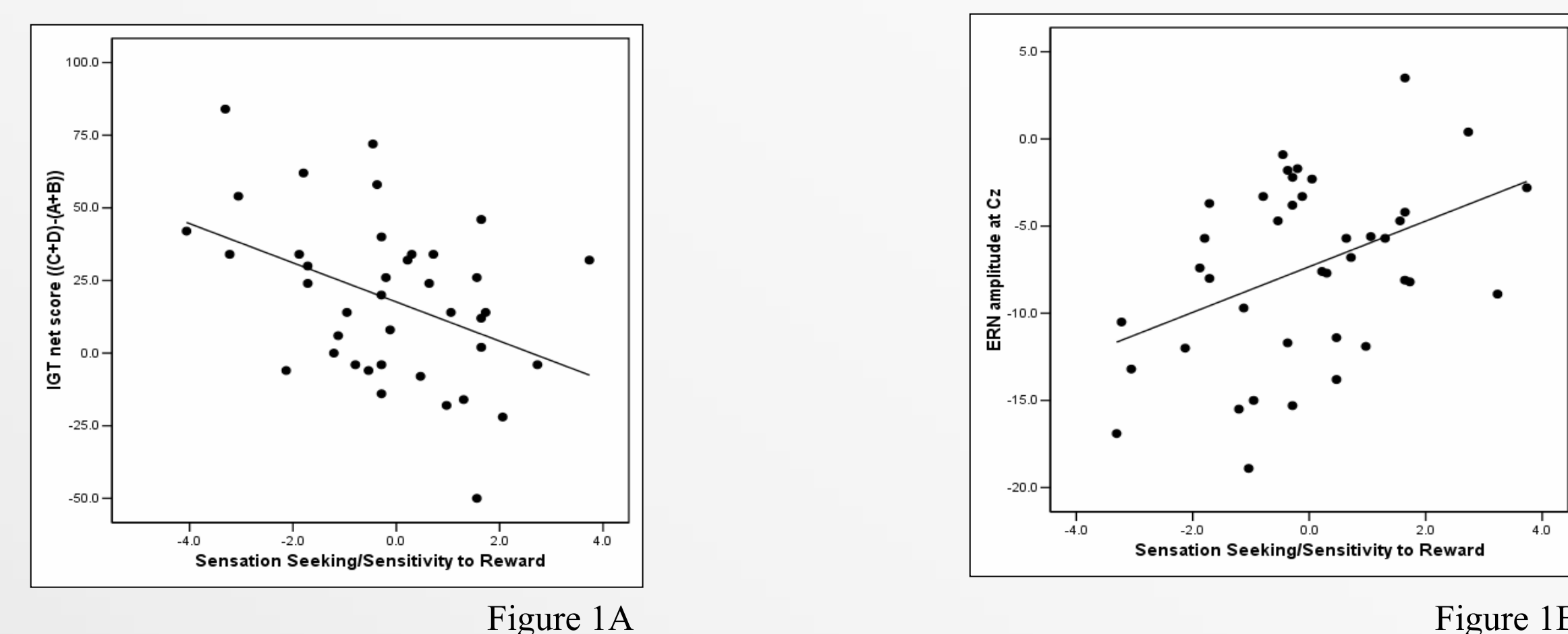
Electrophysiological measurements:

- 4 midline scalp sites scored: Fz, FCz, Cz, Pz
- ERPs were averaged time-locked to error responses starting 600 ms prior and continuing 800 ms post response

Results

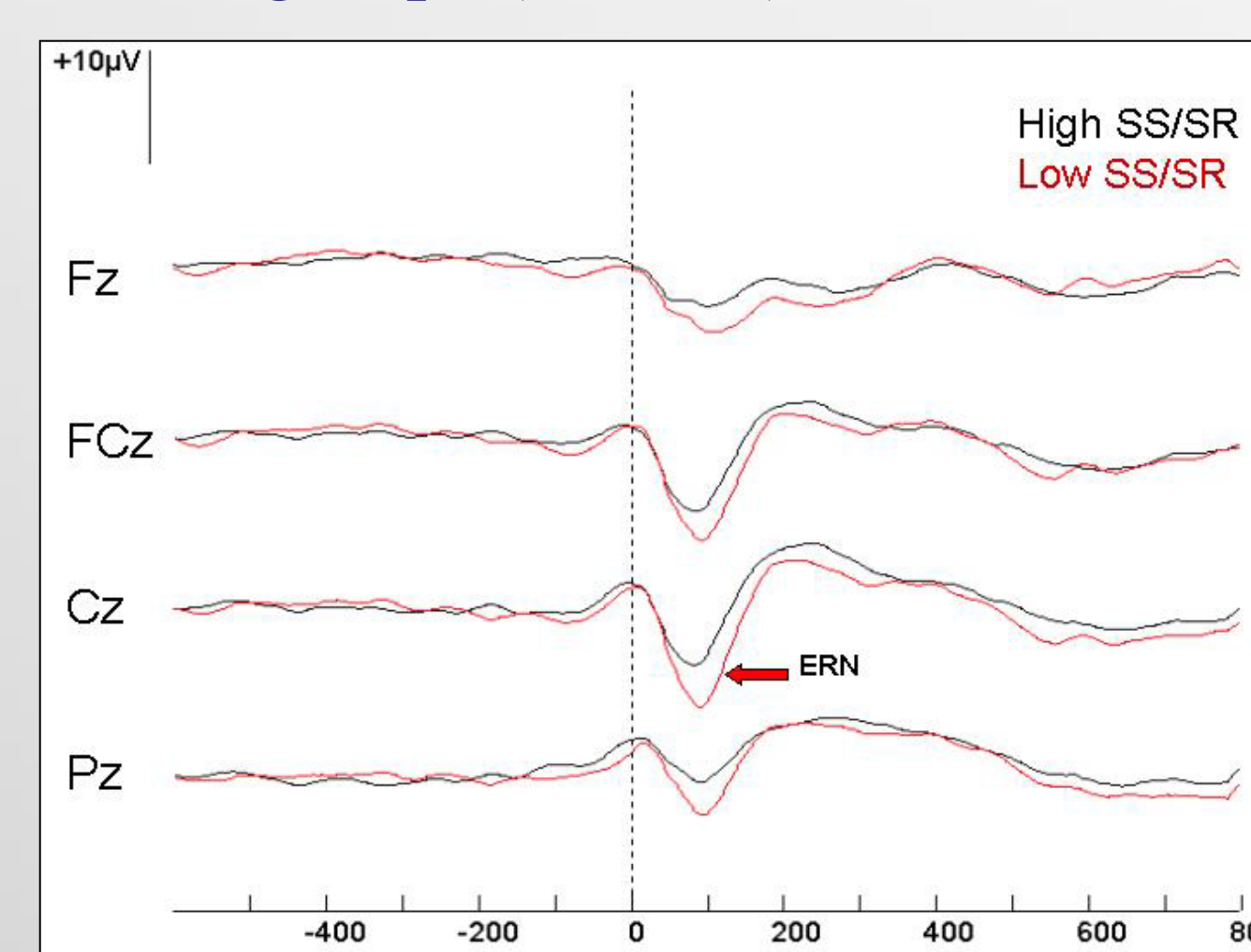
- SS and SR were highly related ($r = .45, p = .003$) and a composite (SS/SR) was constructed from the sum of the two
- SS/SR was related to the ERN at Cz ($r = .49, p = .001$; see Figure 1A)
- SS/SR was significantly related to net scores on the IGT ($r = -.33, p = .02$; see Figure 1B)

Figure 1 – Scatterplots of SS/SR and ERN amplitude at Cz and net scores on the IGT.



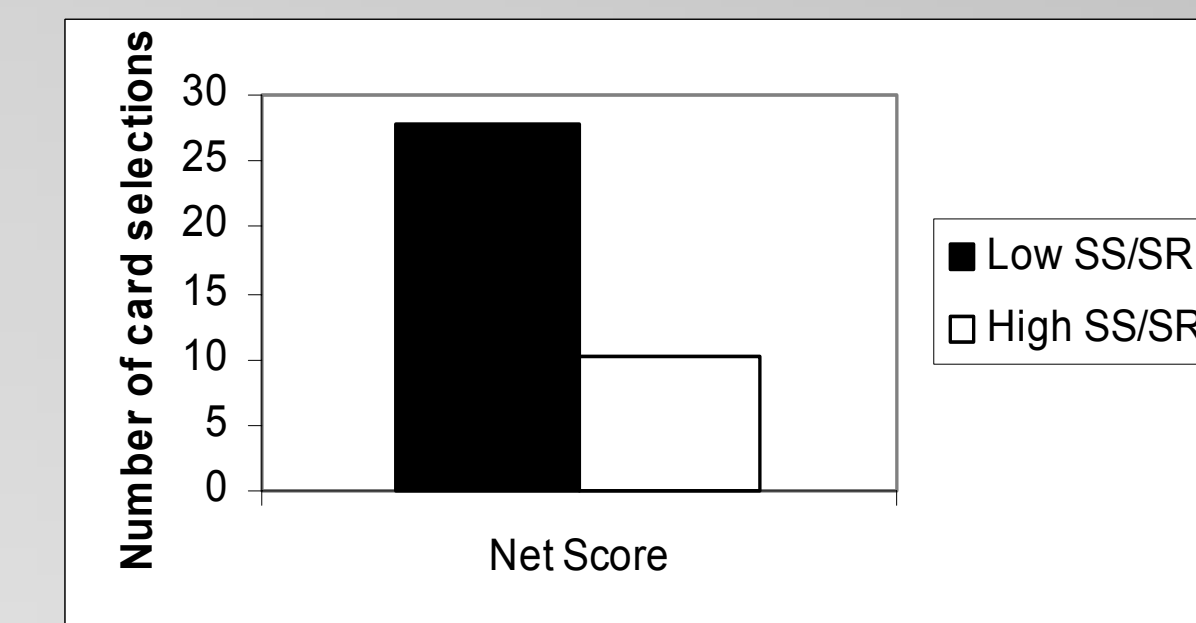
- Independent t-tests showed that those high on SS/SR had a significantly smaller ERN at Cz, $t(37) = 2.5, p = .018$ (see Figure 2)

Figure 2 – Average response-locked ERP waveforms for error trials for high (black line) and low SS/SR groups (red line).



- Independent t-tests showed that those high on SS/SR made disadvantageous choices, $t(36) = 2.0, p = .05$ (see Figure 3)

Figure 3 – Performance on the IGT by high and low SS/SR groups



- A multiple regression showed that the ERN and IGT performances were unrelated ($r = -.07, p = .34$) and each accounted for significant unique variance in SS/SR (see Table 1)

Table 1 – Results from a multiple regression predicting SS/SR from ERN amplitude at Cz and IGT performance

Variable	B	SE B	sr ²
ERN amplitude	.16**	.05	.22
IGT performance	-.02*	.01	.09

Note. R² = .33 (p < .01). ** p < .01, * p < .05.

Conclusions

- 1) SS and SR are sensitive to or affect functions of the ACC and PFC (OFC + DLPFC).
- 2) Results add to findings that personality factors have implications for performance monitoring as reflected in the ERN.
- 3) Poor decision-making and/or weak performance monitoring in combination with high sensation seeking and reward sensitivity may lead to risk-taking activities.

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Acknowledgements: This research was supported partially by grants from NSERC Canada awarded to SJS and from Health Canada's Centre of Excellence for Youth Engagement. Please address all correspondences to Dr. Sidney J. Segalowitz. E-mail: sid.segalowitz@brocku.ca

Presented at the 45th Annual Meeting for the Society for Psychophysiological Research, Lisbon, Portugal, Sept 21-24, 2005.