Failure to utilize feedback during explicit decision-making task in alcohol-dependent patients

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ABSTRACT

Background: Patients who are diagnosed with alcohol-dependent syndrome (ADS) are shown to have neuropsychological deficits, especially executive function (EF) deficits. Among the EFs, decision-making is one such function which has consistently been shown to be impaired in people who are dependent on alcohol, compared to controls. Decision-making in this population is usually assessed with gambling-type tasks. However, some of these tasks are ambiguous, work on chance factors, rarely match with real-life gambling situations, and/or involve nonconscious mechanisms. Materials and Methods: The current study compared 26 male patients with ADS (P-ADS) with equal number of their nonalcohol-dependent male siblings on sensation seeking and explicit gambling task (EGT). EGT is similar to the Iowa gambling task in administration, but varies from it as it involves a single outcome and provides unambiguous, explicit, and continuous feedback for the participants. Results and Conclusion: The results did not show any significant relationship between decision-making variables and sensation seeking. However, despite unambiguous, explicit, and continuous feedback, patients showed significantly poor decision-making as compared to the siblings of the P-ADS group. This study throws light on why people who are addicted to alcohol have difficulties in decision-making, despite knowing the adverse effects.

Keywords: Alcohol-dependent syndrome, explicit gambling task, gambling paradigm, siblings of alcohol dependents

Patients who are diagnosed with alcohol-dependent syndrome (P-ADS) are shown to have brain functional deficits, especially executive function (EF) deficits. Among the EFs, decision-making is one such function which has been consistently shown to be impaired in people who are dependent on alcohol, cocaine and marijuana, and substance. Deficits in decision-making are also observed in alcoholic individuals who are abstinent for a long time. In the laboratory setting and for research, decision-making is usually assessed with gambling-type tasks. One such task that has been widely used to study decision-making in alcoholics is the Iowa gambling task (IGT). Studies using IGT has shown that individuals with alcohol abuse generally show disadvantageous decision-making, which favors immediate larger rewards, at the risk of long-term negative consequences. This indicates greater insensitivity to future negative consequences and reflects a general predisposition to disinhibitory psychopathology. These patients are generally considered as disordered gamblers, who are unable to anticipate the negative consequences, which are usually associated with the risky choices that they make during a gambling task, thereby leading to poor performance.
Decision-making demands that one is able to predict possible outcomes, evaluate alternatives, select an action, and learn from the feedback. Based on the degree of information, a participant has at her/his disposal, decision-making conditions can be classified into, decisions that are made under conditions of risk and decisions that are made under conditions of ambiguity. In risky situations, the decision is made between different options, without clear explicit knowledge of possible results as well as the probability of reward and punishment. In addition to these, performance on a gambling task such as IGT also requires adequate working memory capacity for advantageous decision-making. In this regard, to unravel the different components of the complex decision-making processes in the IGT, other decision-making tasks, including different modifications of the IGT, have been designed and tested on individuals. However, some of these tasks work only on chance factor, rarely match with real-life gambling, require the person to remember the gain or loss of a particular choice, and/or involve nonconscious mechanisms. The current study is an attempt to overcome such limitations.

The explicit gambling task (EGT) developed for the study is similar to the IGT in terms of administration. However, conceptually, the components that it assess differ and very closely match real-life gambling tasks. In the IGT, the individual is presented with four un-named decks (A, B, C, and D) of cards on the computer monitor. The individual has to choose cards one by one from each deck. After each selection, the individuals will be provided with feedback on how much they won and how much they lost. Some decks are good decks (high amount of gain and small amount of loss) and some are bad decks (low amount of gain and high amount of loss). The individuals will not be informed about which are the good decks and which are the bad decks. In addition, after the individual chooses a card from any deck, it disappears. This implicit nature of the task forms its limitation where it does not reflect the real-life gambling situations. In real-life gambling, the individuals who gamble have access to or can record which decks yielded more gains and which yielded more losses. Further, in IGT, each pick of a card yields “a win” and “a loss” at the same time, although the amount varies. This again can be considered another limitation of IGT. In real-life gambling, majority of the times, a gambling person either wins or loses, but not both.

Given the above limitations, the aim of the current study is to explore the performance of alcohol-dependent patients on a gambling task that resembles real life and to compare the performance with their siblings who are not alcohol dependent.

**METHODS**

**Sample**

Twenty-six male patients, who can read and write English, between the age group of 18- and 45 years, and who are diagnosed as alcohol dependent based on the International Classification of Diseases, Tenth Edition criteria by a consultant psychiatrist at the Center for Addiction Medicine, National Institute of Mental Health and Neurosciences (NIMHANS), were taken up for the study. The patients were admitted to the inpatient setting and the current study was carried out for 2 weeks after detoxification. Patients were excluded from the study if they had any other comorbid psychiatric, major medical disorder, neurological disorder, neurosurgical disorder, and significant vision problems. However, patients with nicotine dependence were not excluded from the study.

For comparison, siblings (siblings of ADS [S-ADS]) of the above group (P-ADS) were considered. One male sibling who is not alcohol dependent and who is close to age for each P-ADS was taken, totaling 26 samples in the S-ADS group, that is, each patient had one of his/her siblings as his/her control. Siblings were considered for the comparison, to control for heredity as well as family upbringing. Inclusion criteria of age between 18 and 45 years and the ability to read and write English were also followed in recruiting this group. Those with a history of psychiatric, neurological, and/or neurosurgical condition based on the spontaneous report as well as significant vision problems were excluded from the study. In addition, this group was administered Kessler-10 scale and only those who scored below cutoff were considered for the study.

The current research was approved by the NIMHANS Ethics Committee, and written informed consent was obtained from both the patients as well as their siblings prior to the commencement of the study.

**Assessment tools and procedure**

The Severity of Alcohol Dependence Questionnaire (SADQ) was administered to P-ADS group to determine the severity of alcohol dependence. Siblings were administered Kessler-10 scale.

Both the groups were administered Sensation-Seeking Scale (SSS) and EGT (developed by the first author). SSS is popularly used to assess sensation seeking. It has forty items in which the individual has to choose between two alternatives for each item. Particular choice of the answer will decide whether the individual will get a score of “1” or “0.” Higher scores reflect higher sensation seeking.
EGT (Roopesh) has four decks (un-marked A, B, C, and D) of cards. Each deck has 45 cards which are placed one below the other. Individuals have to pick one card at a time and turn to see the value behind it. Behind each card, there will be a mention of either a “positive value: gain,” a “negative value: loss,” or a “blank: neither gain nor loss.” Deck A yields smaller wins and smaller losses compared to deck B over time, deck B yields smaller wins and smaller losses compared to deck C over time, and deck C yields smaller wins and smaller losses compared to deck D over time. On the whole, decks A and B are more advantageous as compared to decks C and D in the long run. After seeing the outcome, i.e., the “amount of gain” or the “amount of loss” or “nil outcome,” individuals have to place the card (under the same deck) showing the outcome/value up [Figure 1]. Similarly, after every choice, cards are placed one below the other so that the individual can see the values (or nil outcome) of all the cards under all the decks. In addition, after each choice, individual will be given immediate behavioral feedback of gain or loss, with the help of play currency. That is if the individual wins 2000, play currency of the said denomination (can be in multiples of 100, 500, or 1000) is given to the individual. If the individual loses 1000, that particular amount is taken back. A chart showing the currency value obtained by the individual (either gained or lost) is continuously displayed to the individual at all times and constantly updated after each choice. On the whole, the individual has to choose 45 cards from any of the decks. As the main scores (a) the final value the individual achieves (can be either positive or negative value), and (b) the number of choices made for each decks, are considered. More positive values indicate that the individual has more gain. In addition, more number of picks from deck A indicates that the individual has realized that deck A is beneficial over time.

Statistical analysis

Statistical analysis was carried out with the help of statistical software SPSS version 15.0 (SPSS Inc, USA). Statistics such as mean and standard deviation were used for descriptive analysis. Data were normally distributed, and hence to compare the two groups, Student’s t-test was used to analyze the group differences for both sociodemographic variables, such as age and education, and test variables such as SSS scores and EGT scores (final value obtained, number of choices for deck A, number of choices for deck B, number of choices for deck C, and number of choices for deck D). Further, Pearson’s product moment correlation was used to determine the association among sociodemographic and clinical variables.

RESULTS

Both the groups did not differ in sociodemographic variables of age and education [Table 1], and hence both the groups can be compared. However, there was a tendency toward significant difference with respect to number of years of education, where individuals of S-ADS group were older compared to that of P-ADS group.

Table 2 shows that both the groups did not show any significant differences in sensation seeking. Similarly, both the groups did not significantly differ in the number of choices made in each of the four decks. However, both the groups significantly differed in the net value of the final amount obtained from the whole task, whereas P-ADS group had a significantly lower final amount/value compared to their siblings.

With respect to association among sociodemographic and clinical variables in P-ADS group (n = 26), Table 3 shows significant positive correlation between age and SADQ, as well as age and EGT final amount. When the whole group was considered together (n = 52), only age showed significant negative correlation with education.

DISCUSSION

Studies have shown alcohol dependence to have detrimental effects on EFs by influencing prefrontal cortex (PFC) activity, such as the dorsolateral PFC and the anterior cingulate cortex.[25-28]

Table 1: The sociodemographic variables of age and education between the patients with alcohol-dependent syndrome and siblings of alcohol-dependent syndrome

| Groups          | ADS (n=26) | S-ADS (n=26) | t   | Significant |
|-----------------|------------|--------------|-----|-------------|
| Age*            | 33.88      | 32.69        | 0.59| 0.56        |
| Education*      | 9.61       | 11.92        | -1.88| 0.07       |

*Number of years. SD – Standard deviation; S-ADS – Siblings of alcohol-dependent syndrome
IGT was developed to assess decision-making in patients with damage to the ventromedial PFC.\textsuperscript{[7]} Imaging studies have shown reduced gray matter volume in the PFC of people who abuse drugs,\textsuperscript{[29]} particularly in the orbitofrontal cortex (OFC).\textsuperscript{[30]} Similarly, animal studies show changes in functional activity in the OFC, including reductions in glucose metabolism, which correspond to increased drug exposure.\textsuperscript{[31]} Further, studies using tasks such as IGT have demonstrated decision-making deficits, such as preferring immediate larger rewards, at the risk of long-term negative consequences in individuals who abuse alcohol.\textsuperscript{[4,7,8,9]} indicating poor sensitivity to future negative consequences and disinhibitory behavior.\textsuperscript{[7,10]}

However, these findings were based on decision-making tasks such as IGT which, due to its complexity, involves multiple neuropsychological processes,\textsuperscript{[32‑34]} such as working memory, response inhibition, and cognitive flexibility. Due to these difficulties, modified versions of the IGT have been developed to separate the subprocesses.\textsuperscript{[19,35‑38]} Therefore, the current research is an attempt to study decision-making in individuals who are alcohol dependent where the task has explicit and continuously available feedback, which closely resembles real-life gambling situations.

With respect to the severity of the symptoms, the mean SADQ of the P-ADS indicates that the group on the whole is “severely dependent” on alcohol. In terms of sociodemographic variables, the current study showed that there are no significant group differences with respect to age and education. However, a tendency toward significant difference was observed in education, where S-ADS group had more number of years of education compared to the P-ADS group. It can be observed from Table 1 that the mean age of the individuals of S-ADS group is about 1 year less than that of the P-ADS group. Despite this, the individuals of S-ADS group have more number of years of education (about 2 years) compared to the siblings who are dependent on alcohol. This is in accordance with the existing literature where individuals with lower education show higher dependence on alcohol as compared to people with higher education.\textsuperscript{[39,40]}

Surprisingly, both the groups did not significantly differ in sensation seeking [Table 2], and sensation seeking did not show any significant relationship with age, education, SADQ, or any of the gambling paradigm variables either in P-ADS group [Table 3] or when both the groups were combined. Literature is replete with studies showing high correlation between high sensation seeking and higher quantity as well as frequency of alcohol consumption.\textsuperscript{[41,42]}

Given this, the result of the current study contradicts the findings of other studies. The reason for the lack of a significant relationship between sensation-seeking score and SADQ scores might be because the SSS\textsuperscript{[24]} used in the current study is not standardized on Indian population. The items of the scale such as “parachute jumping” and “camping out” might not be culturally relevant to the study participants. On the other hand, the reason for nil significant difference between P-ADS and S-ADS group on sensation seeking might be because participants in both the groups are siblings who have shared both heredity as well as family upbringing. However, further studies are needed in this regard to arrive at a conclusion.

Significant positive correlation has been observed in P-ADS group, between age and SADQ scores [Table 3]. This implies that, with increasing age, the severity of alcohol consumption also increases. Similarly, significant positive correlation has been observed between age and “EGT-final amount obtained” in P-ADS group [Table 3]. This indicates that, as age increases, advantageous decisions

Table 2: The values for the clinical variables between the patients with alcohol-dependent syndrome and siblings of alcohol-dependent syndrome

| Groups   | P-ADS (n=26) | S-ADS (n=26) | t    | Significant |
|----------|--------------|--------------|------|-------------|
|          | Mean | SD  | Mean | SD  |       |      |
| SADQ     | 31.73 | 10.66 | -    | -    | -     | -     |
| SSS      | 12.11 | 3.91 | 11.03 | 4.92 | 0.87  | 0.56  |
| EGT      |        |      |      |      |       |       |
| Choice in A | 12.19 | 2.49 | 13.46 | 6.13 | -0.97 | 0.33  |
| Choice in B | 11.73 | 2.49 | 11.38 | 2.61 | 0.49  | 0.63  |
| Choice in C | 10.31 | 2.49 | 11.00 | 3.57 | -0.81 | 0.42  |
| Choice in D | 10.81 | 3.49 | 9.19  | 5.01 | 1.35  | 0.18  |
| Final amount | 1015 | 1163 | 1296 | 1363 | -2.50* | 0.016 |

*P<0.05, SADQ – Severity of Alcohol Dependence Questionnaire; SSS – Sensation-seeking scale; EGT – Explicit gambling task; P-ADS – Patients with alcohol-dependent syndrome; S-ADS – Siblings of alcohol-dependent syndrome; SD – Standard deviation

Table 3: Correlation Severity of Alcohol Dependence Questionnaire with all other variables in patients with alcohol-dependent syndrome (n=26)

|            | Education | SADQ | SSS | Choice in A | Choice in B | Choice in C | Choice in D | EGT final amount |
|------------|-----------|------|-----|-------------|-------------|-------------|-------------|-----------------|
| Age        | -0.384    | 0.410* | -0.160 | -0.277     | -0.180     | 0.356       | 0.060       | 0.443*          |
| Education  | -         | -0.019 | -0.029 | 0.074      | 0.270      | 0.078       | -0.284      | -0.110          |
| SADQ       | -         | -     | 0.037 | -0.151     | -0.169     | 0.252       | 0.031       | 0.110           |
| SSS        | -         | -     | -    | -0.162     | 0.139      | -0.061      | 0.060       | -0.366          |

*P<0.05, SADQ – Severity of Alcohol Dependence Questionnaire; SSS – Sensation-Seeking Scale; EGT – Explicit gambling task
Table 4: Correlation among all variables (except Severity of Alcohol Dependence Questionnaire) of both groups combined (n=52)

|            | Education | SSS    | Choice in A | Choice in B | Choice in C | Choice in D | EGT final amount |
|------------|-----------|--------|-------------|-------------|-------------|--------------|-----------------|
| Age        | -0.368**  | -0.182 | -0.243      | -0.115      | 0.225       | 0.056        | 0.228           |
| Education  | -         | 0.074  | 0.188       | 0.109       | -0.016      | -0.214       | 0.390           |
| SSS        | -         | -      | -0.072      | 0.114       | -0.151      | 0.111        | -0.210          |

**P<0.01. SSS – Sensation-Seeking Scale; EGT – Explicit gambling task

Performance on the EGT did not show significant differences between P-ADS and S-ADS groups in the number of choices made in any of the decks, whether advantageous or disadvantageous [Table 2]. Although the means indicated that the S-ADS group had more choices in advantageous decks (e.g., deck A) and less choices in disadvantageous decks (e.g., deck D), compared to P-ADS group, the differences did not reach statistical significance. However, in terms of the final gain, S-ADS group significantly had higher amounts at the end of the task compared to the P-ADS group. The above findings appear to contradict each other, where, with respect to the number of choices in any of the decks (advantageous and/or disadvantageous decks), the groups did not differ, but the outcome shows significant differences, especially when the number of choices decided the final amount. However, the results are not contradictory, due to the variation in the mean scores, which indicates the differences between the groups. For example, in deck A (advantageous deck), P-ADS group on an average chose 12.19 times, which is less compared to 13.46 times chosen by S-ADS group. Similarly, in deck D (disadvantageous deck), P-ADS group on an average chose 10.81 times, which is more compared to 9.19 times by S-ADS group. This difference in the decision-making has led up to the differences observed in the final gain, which is significantly higher in S-ADS group compared to P-ADS group.

Given this, the study further reveals that patients with alcohol dependence perform significantly poorly on decision-making tasks even when explicit feedback is provided continuously. This deficit is present even when the results are compared to their own siblings with whom they share heredity and family atmosphere. Further, the results indicate that, despite the explicit continuous feedback available, the patients might not have fully analyzed the outcome of their decisions and might have reacted impulsively. This further implies that they prefer immediate larger rewards over smaller and delayed rewards and are not averse to taking risky decisions. Although there are no similar studies to compare the results of the current study, studies using IGT have revealed reduced ability to learn from negative consequences and/or a reduced sensitivity to rewards in patients with substance abuse.\[12,35,36]\]

The study involves few limitations, such as relatively small sample size and it is conducted only on males. Sensation-seeking measure used in this study is not standardized to the Indian population. The study should have used other decision-making tasks to throw more light on the results. Another group of normal controls might have produced additional information. Further, the money used in the task was play currency. Future research should try to overcome the limitations of this study in terms of replicating the findings, with larger samples, having both genders and corroborating the findings with other decision-making tasks, imaging studies, and real currency.

CONCLUSION

The results show that patients who are alcohol dependent show impaired decision-making despite providing unambiguous constant explicit feedback. This implies that they prefer larger immediate rewards over smaller and longer rewards and are not averse to taking risky decisions. The study sheds light as to why it is difficult for people with ADS to learn from mistakes.

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Conflicts of interest
There are no conflicts of interest.

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