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Decision-Making in People Who Relapsed to Driving Under the Influence of Alcohol

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Background: Alcohol use has been previously associated with neurocognitive impairments, especially in decision-making cognition. However, some studies have shown little to no decision-making deficits in relation to different characteristics of people with drinking problems. Relapsing to driving under the influence (DUI) of alcohol is an important issue with legal and psychosocial aspects. We evaluated decision-making performance in second-time DUI offenders by using the Iowa Gambling Task (IGT).

Method: Thirty-four male second-time DUI offenders who had been selected for an official psychoeducational rehabilitation program and 31 healthy controls that were matched for age, education, and alcohol use were included. Along with psychiatric assessment, we applied conventional neuropsychological testing comprising cognitive set-shifting, response inhibition, attention, and visuospatial abilities. Also, we used the Temperament and Character Inventory (TCI) to assess personality patterns. A computerized version of IGT was used.

Results: No significant differences were found between the groups in regard to sociodemographics and conventional neuropsychological testing. DUI participants had significantly higher scores only in "self-transcendence" subdomain of TCI. On the fifth block of the IGT, DUI participants had significantly lower net scores than controls (U = 380.0, p < 0.05). Also, DUI participants chose significantly more risky decks compared to controls.

Conclusions: Our results suggest that there may be subtle decision-making deficits in DUI participants, which goes undetected on conventional neuropsychological testing and which is not correlated with TCI subdomains related with impulsivity patterns.

Key Words: Decision-Making, Gambling Task, Alcohol, Driving, Neuropsychology, Impulsivity.

THE ASSOCIATION BETWEEN alcohol use and cognitive impairment has been previously reported in the literature (e.g., Evert and Oscar-Berman, 1995; George et al., 2005), particularly in regard to deficits in executive functioning (Giancola, 2007). However, some studies have found little to no cognitive deficits (Bates and Tracy, 1990; Fein et al., 2006) in groups of individuals who consume alcohol at a range from "social drinking" through to "problem drinking" and thence to florid alcohol dependence, but who seek no medical help. In fact, some studies have shown a positive effect of alcohol usage on cognitive functioning (Stampfer et al., 2005). The contradictory nature of these results may stem from the different testing methods employed in each study and it may be strongly influenced by the interfering effects of extraneous variables, such as temperament and personality, which have been previously shown to be associated with distinct drinking patterns (Bon et al., 2004).

Some authors have suggested that a subgroup of alcohol or substance-dependent individuals may be suffering from a distinct and generalized form of neurocognitive deficit including impaired decision-making cognition that might be associated with poor decision-making in real-life situations, such as uncontrollable alcohol or drug usage (Bechara and Damasio, 2002). The behavioral pattern of this subset of patients in terms of their risk taking, sensitivity to reward, and planning of future consequences was similar to the behavioral impairment exhibited by patients with ventromedial prefrontal lesions (Bechara et al., 2002). These deficits were detected using the Iowa Gambling Task (IGT), a widely used computerized task that mimics real-life affective decision-making (Bechara et al., 1994). Impaired performance on the IGT has been only reported in alcoholic patients with a history of antisocial behavior (Finn et al., 2002; Mazas et al., 2000; Petry, 2001). Yet, treatment-naive alcoholics who did not report real-life problems other than their drinking habits had a within-normal performance on the IGT (Fein et al., 2006).

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One of the major problems associated with excessive drinking behavior is driving under the influence of alcohol (DUI), which has major negative consequences for public health measures (Centers for Disease Control and Prevention, 2002). DUI is regarded as one of the foremost hazards regarding alcohol use, as it accounts for nearly 40% of fatal motor crashes in North America (Mayhew et al., 2002). Also, it has been shown that 33% of DUI individuals were recidivists (Fell, 1995), which reveals the importance of paying attention to the underlying mechanism of repeated DUI. In this sense, previous studies have examined neurocognitive characteristics of DUI recidivists and found deficits in conventional tests of executive functioning (Glass et al., 2000; Ouimet et al., 2007).

In this study, we aimed to investigate the decision-making profile of a group of individuals who had relapsed to DUI of alcohol and we hypothesized that DUI recidivists would perform worse than controls in the IGT. We also sought to determine whether there was a relationship between decision-making and temperament, as measured by Cloninger's Trait and Character Inventory (TCI) (Cloninger et al., 1993). A number of specific temperament traits, such as reward dependence and novelty seeking, might be related to impulsivity and acting against the laws. Previously, a few studies had shown an association between decision-making and antisocial personality in alcohol-dependent individuals (Cantrell et al., 2008; Mazas et al., 2000). Our sample of DUI recidivists did not include alcohol-dependent patients, and as previously suggested (Bon et al., 2004), we preferred to use TCI rather than a diagnosis of antisocial personality disorder to investigate possible traits associated with DUI recidivism. For this reason, we further hypothesized that DUI recidivists may have decision-making deficits that could also be associated with alterations in specific TCI subdomains, such as elevated scores for reward dependence and novelty seeking. To exclude any effects of severity of alcohol use, we did not include people who had no history of alcohol consumption whatsoever in the control group and we matched DUI recidivists and controls in our sample in terms of frequency, duration, and amount of alcohol use.

METHODS

Participants

Driving under the influence (DUI) participants were recruited from the official traffic psychoeducational program conducted at the local psychosocial department of the Ministry of Health in Istanbul, Turkey. According to Turkish Traffic Code, people who drive under the influence of alcohol (legal limit is 50 mg/l) are banned from traffic for a period of 6 months. People who offend the rule on a second occasion are banned from driving for 2 years and directed to a psychoeducational program composed of psychiatric evaluation and psychoeducation seminars focused on preventing risky driving behaviors. This psychoeducational program is mandatory, and the recidivists are obliged to attend the entire course and pass certain examinations, otherwise they cannot get the certificate to get back their driving licenses. Ethical approval for this study was provided by the Ethics Committee at the Bakirkoy Research and Training Hospital for Psychiatry, Neurology and Neurosurgery, and all testing procedures were conducted according to the Declaration of Helsinki. We interviewed and informed the participants about the study at the time of their first application to the program. Participants who gave written consent were included in this study. Control participants were recruited through local advertisement in our hospital and matched by sociodemographic profile with DUI participants. Applicants in the control group who had never consumed alcohol were not included in this study. Exclusion criteria for both groups were as follows: psychotic disorder, mood disorder, head trauma, alcohol dependence, psychoactive drug abuse or dependence, anxiety disorder, and neurological disorders, all of which were assessed during the initial interview by an experienced psychiatrist. We enrolled 34 adult male DUI participants and 31 male controls. Although initially recruited, we excluded the data of 3 female DUI participants because of the small sample and likelihood of showing different neurocognitive performance (Lapham et al., 2000). All participants were measured on a breathalyzer before neuropsychological testing, and none of the participants had a positive result.

Measures

Sociodemographics and Alcohol-Related Measures. Sociodemographic data were collected by means of a structured form, including information about age, education, smoking history, driving license (years), medical history, psychiatric history, and alcohol use characteristics (amount/frequency/total time/standard drink at one time). For DUI participants, CAGE (a screening test to determine risk of alcohol dependence; Mayfield et al., 1974) scores and time to second violation (months) were also obtained.

Neuropsychological Testing. Neuropsychological assessment focused mainly on executive functioning, including planning, set-shifting, response inhibition, cognitive flexibility, but also covered a wide range of neurocognitive functions, such as attention, language, and visuospatial abilities. All participants were screened for depression with the Turkish version of the Beck Depression Inventory for validity of tests (Hisli, 1988), and none of the participants scored above 12 points, which is accepted as a cut-off point for neuropsychological testing (Karakaş, 2004). TCI forms were completed on the same day. The battery for this study included:

1. Digit span test: Subtest from the WAIS-III (Wechsler, 1997). Both the forward and backward digit span tests were used. The former primarily assesses attention, while the latter requires a stronger working memory component, thus evaluating executive functions.
2. Reaction Time: A computerized reaction time set was used to assess attention and sensory-motor integration abilities. We used 2 sets for visual and auditory reaction timing.
3. Verbal fluency test: The original version of the test included 3 letters (F, A, S). Validation in Turkish was carried out by Tumac (1997) with K, A, S. In this test, participants are asked to generate as many different words as they can during one minute. Verbal fluency test is a measure of mental processing, and repetition of the same words is recorded as perseverations (Lezak, 1995).
4. Clock Drawing Test: This is a valid instrument to assess planning and visuospatial abilities. Participants are asked to write numbers of the clock in a circle with a diameter of 8 cm; correct order of numbers, rotation, and proper position of clock hands are assessed (Friedman, 1991).
5. Rey Complex Figures Test: The Rey Complex Figure Test (RCFT) was used to measure visuospatial constructional ability and visual memory (Meyers and Meyers, 1995). Participants were presented a complex figure composed of 18 elements and were required to copy it. We only used the copy accuracy subtest in our study.
6. Symbol Digit Test: Based on a key that pairs 9 different figures with the numbers 1 through 9, participants are instructed to substitute a geometric figure in place of a number (Wechsler, 1981). Optimal performance in this test requires domains, such as motor persistence, sustained attention, response speed, and hand–eye coordination play (Schear and Sato, 1989).

7. Stroop Color-Word Interference Test: The Stroop color-word task (Stroop, 1935) is a measure of response inhibition, selective attention, and cognitive flexibility (Spreen and Strauss, 1998). In order, participants are asked to read aloud sets of words written in black or colored ink. The Stroop effect is measured when the subject is asked to verbalize the actual color of the word instead of its written content. We assessed time for color-word reading, time for interference, number of errors, and correction.
8. Wisconsin Card Sorting Test (WCST): The WCST (Heaton, 1981) is a task designed to assess executive functions, primarily set-shifting abilities. Participants are asked to match a card to 1 of 4 key cards. All of the cards have colored pictures of geometric figures, and each card has a different number of figures, type of figure, and color of the figure(s). Following ten consecutive correct matches, the "matching" rule changes (1 completed category). The test continues until reaching 6 categories or running out of cards (maximum total is 128 cards). We used measures for number of categories completed, number of total errors, number of perseverative errors, and number of nonperseverative errors. The validity of the WCST in the Turkish population is included in the BİLNOT battery (Karakaş, 2004)
9. Iowa Gambling Task (IGT): We used the modified computerized version of the IGT for which normative data are available in healthy Turkish populations (Icellioglu and Gurvit, 2008). The task involves continuous card selection from 4 separate decks (A, B, C, and D) using a mouse and is completed after 100 selections. For each card, the participant wins certain amount of money, which can be, occasionally, followed by a loss of money. Decks A and B yield large immediate wins (e.g., 100 to 150 TL) but occasionally heavy losses (e.g., 350 to 1250 TL), which leads to a net loss upon subsequent selections. For this reason, these decks are classified as "high risk" decks. Decks C and D generate smaller wins (25 to 60 TL) but also smaller penalties, hence yielding an overall net profit. These decks are classified "low risk" or "advantageous" decks. Net score is calculated by subtracting the number of choices from the risky decks (A + B) from the number of choices from the safe decks (C + D). For the purpose of analysis, the task is divided into 5 blocks, each comprising 20 consecutive card choices, to quantify the change in decision-making across the course of the task (Bechara et al., 1994).
10. Cloninger's Trait and Character Inventory (TCI): For evaluation of temperament and character traits, the TCI by Cloninger et al. (1993) was used in the Turkish version, a 240-item, forced-choice, self-report scale (Kose et al., 2004). Dimensions of temperament were (i) harm avoidance (HA); (ii) novelty seeking (NS); (iii) reward dependence (RD); and (iv) persistence (P). Dimensions of character were (i) self-directedness (SD); (ii) cooperativeness (C); and (iii) self-transcendence (ST).

Statistical Analyses. Student's t tests were performed for group comparisons on demographic and neuropsychological variables. When equal variances could not be assumed, U Mann–Whitney comparisons were performed. For categorical variables (e.g., hand dominance), Chi-square tests were conducted to compare proportions. The paired sample t test was used for intragroup comparisons of experimental variables. Spearman's coefficients were used in calculating correlations between the variables.

RESULTS

Sociodemographics

As shown in Table 1, no significant differences were found between the groups for age ($t_{63} = -0.116, p = 0.91$), years of education ($t_{63} = 0.81$, $p = 0.42$), hand dominance ($\chi^2 = 1.87$, df $= 2$, $p = 0.38$), ocular dominance ($\chi^2 = 1.46$, df $= 2$, $p = 0.48$), or foot dominance ($\chi^2 = 1.64$, df $= 2$, $p = 0.44$). While there were no significant differences between the groups on smoking history, as measured by the numbers of years as smoker ($t_{57} = -1.57$, $p = 0.12$), a significant difference was observed on the number of average cigarette packages smoked per day ($t_{57} = -2.46, p = 0.017$). A significant difference was found between the groups on the number of years they have possessed a driving license ($t_{56} = -2.45, p = 0.017$). Surprisingly though, DUI participants had had a driving license for longer than controls. Importantly, no significant differences were found between the groups neither for the numbers of years drinking alcohol ($t_{57} = 0.33$, $p = 0.73$) nor for the average frequency of use of alcohol per month ($t_{57} = -0.15, p = 0.88$), nor for the mean standard drink at one time ($t_{57} = -0.77$, $p = 0.44$).

Table 1. Sociodemographic Variables for Driving Under the Influence (DUI) Participants and Controls. Values Are Shown as Mean (SD) Unless Otherwise Specified

	DUI	Control	p
N	34	31	–
Age	35.4 (8.4)	35.1 (9.5)	0.91
Education (years)	9.74 (3.6)	10.5 (3.9)	0.42
Gender (% male)	100	100	–
Hand dominance (L:R:A)	2:30:1	3:23:3	0.38
Eye dominance (L:R:A)	5:27:0	6:22:1	0.48
Foot dominance (L:R:A)	3:26:3	6:20:3	0.44
Alcohol use (years)	12.7 (7.6)	12.1 (5.6)	0.73
Alcohol use (times/month)	4.70 (5.1)	4.92 (5.6)	0.88
Standard drink at one time	5.41 (2.4)	4.78 (3.8)	0.44
Smoking (years)	14.5 (8.5)	10.7 (9.8)	0.12
Smoking (packs/day)	1.00 (0.5)	0.66 (0.5)	**0.017**
Driving license (years)	13.7 (5.0)	10.5 (5.0)	**0.017**

Bold indicates significance at $p < 0.05$.

Neuropsychological Performance

No significant differences were found between the groups on any of the variables included in the comprehensive neuropsychological battery used in this study (Table 2).

Decision-Making

While no significant differences were found between the groups on block 1 ($U = 460.5$, $p = 0.38$), block 2 ($U = 437.0$, $p = 0.23$), block 3 ($U = 482.0$, $p = 0.55$), and block 4 ($U = 418.5$, $p = 0.52$), a significant difference was observed on block 5 ($U = 380.0$, $p = 0.04$), with controls outperforming DUI participants (Fig. 1). As shown in Fig. 2, a significant difference was found between the groups on the total number of risky (A + B) and safe (C + D) cards chosen ($U = 367.5$, $p = 0.048$ for both variables). When comparing risky versus safe choices within each group independently, controls chose a similar number of cards from each type of deck (*paired* $t_{30} = -0.082$, $p = 0.93$), but DUI participants chose significantly more risky than safe cards (*paired* $t_{33} = 1.98, p = 0.049$).

Table 2. Neuropsychological Performance of Driving Under the Influence (DUI) Participants and Controls

			DUI participants		Controls			
			Mean	SD	Mean	SD	*t* or *U*	*p*
Digit Span	Forward		6.13	1.2	5.79	1.0	*t* = −1.2	0.23
	Backward		4.69	1.2	4.69	1.3	*t* = 0.01	0.99
Fluency	Semantic	Items	21.41	6.0	23.45	4.3	*t* = 1.53	0.13
		Repetitions	0.32	.6	0.21	0.7	*t* = −0.7	0.48
	Phonological	Items	12.47	4.3	13.38	4.3	*t* = 0.83	0.41
		Repetitions	1.18	1.1	0.86	0.8	*t* = −1.3	0.20
Rey figure copy			34.23	3.5	34.84	1.3	*U* = 407.5	0.51
Clock drawing			6.84	0.4	6.85	0.5	*t* = 0.07	0.95
Cube drawing			.879	0.3	0.833	0.2	*t* = −0.67	0.51
Symbol digit (number)			59.45	18.0	55.81	16.2	*t* = −0.79	0.43
Stroop	Colored word reading		9.24	2.9	9.50	2.6	*t* = 0.37	0.71
	Interference		24.88	10.8	24.97	7.4	*U* = 416.5	0.38
	Error		0.55	1.4	0.55	1.0	*t* = 0.02	0.98
	Correction		0.82	1.0	0.55	0.8	*t* = −1.20	0.24
Reaction time	Visual (seconds)		0.3512	0.1	0.3218	0.1	*t* = −1.26	0.21
	Auditory (seconds)		0.2530	0.1	0.2621	0.1	*t* = 0.52	0.61
Wisconsin card sorting test	Number of trials		119.7	15.4	114.83	21.3	*U* = 458.5	0.39
	Number correct		68.79	13.8	66.33	15.2	*t* = −0.70	0.50
	Total errors		50.97	22.4	48.50	26.1	*t* = −0.41	0.69
	Perseverative responses		34.74	23.6	33.33	24.3	*t* = −0.23	0.82
	Nonperseverative errors		21.15	10.0	19.90	11.7	*t* = −0.46	0.65
	Perseverative errors		29.82	17.9	28.60	19.0	*t* = −0.27	0.79
	Categories		3.00	2.2	3.33	2.3	*t* = 0.60	0.55
	Percent perseverative errors		24.23	13.4	23.36	13.9	*t* = −0.25	0.80
	Trials to complete 1st category		28.69	24.9	22.31	16.1	*U* = 341.5	0.55
	% Conceptual level responses		41.11	19.8	46.23	25.2	*t* = 0.85	0.40
	Failures to maintain set		1.56	1.5	0.90	1.1	*U* = 385.5	0.08
	Learning to learn score		−7.56	7.9	−2.15	7.3	*U* = 102.0	0.06

Trait and Character

As shown in Fig. 3, controls and DUI participants score similarly on all of the subdomains of the TCI inventory, except for the self-transcendence items, for which a significant difference was found ($t_{63} = -3.31, p < 0.01$).

Correlations

Correlations were analyzed between block 5 on the IGT and both sociodemographic variables and TCI subdomain scores. No significant correlations were found between these variables neither for controls nor for DUI participants. Within the DUI participants, significant correlations were found between net score on block 5 of the IGT and performance on the Symbol Digit test ($r = 0.44$, $p = 0.017$) and the auditory block on the Reaction Time test ($r = -0.33$, $p = 0.05$). Within the control group, however, net score on block 5 of the IGT correlated significantly with the total number of errors ($r = -0.42$, $p = 0.022$), perseverative responses ($r = -0.41$, $p = 0.025$), number of categories

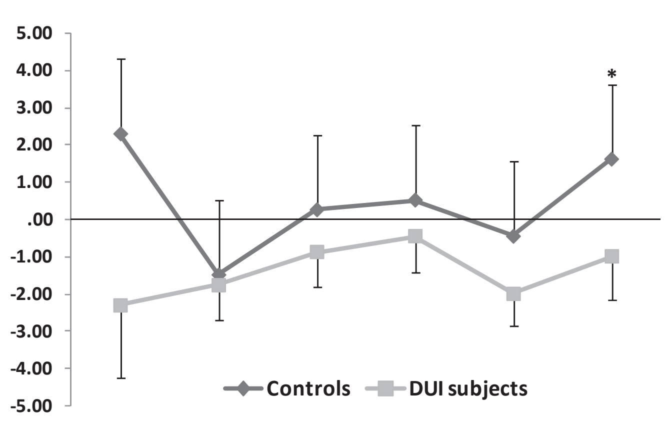

Fig. 1. Iowa Gambling Task performance for controls and driving under the influence participants. A significant difference was observed between the groups on block 5. Error bars represent SEM. *p < 0.05.

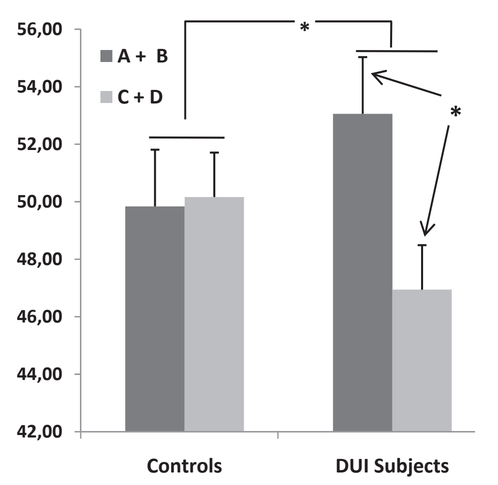

Fig. 2. Total number of cards chosen from the risky (A + B) and safe (C + D) decks. Error bars represent SEM. *p < 0.05.

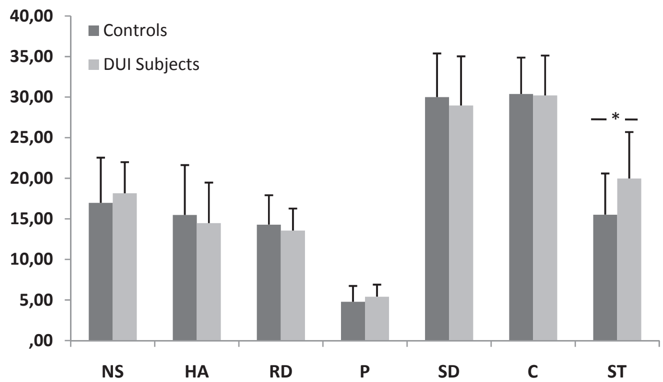

Fig. 3. Temperament and Character Inventory subdomain scores for driving under the influence participants and controls. A significant difference (*$p < 0.01$) was found on the self-transcendence domain.

abstracted ($r = -0.43$, $p = 0.017$), and percent conceptual level response ($r = -0.38$, $p = 0.041$) on the WCST. No other significant correlations were observed. No significant correlations were found between measures of alcohol use (years, times/month, standard drink at one time) or smoking (years, packs/day) and any of the neuropsychological variables.

DISCUSSION

In this study, we evaluated neurocognitive functioning along with decision-making and temperament characteristics of second-time DUI offenders. Our sample of DUI participants and controls was accurately matched in comparison with age, education, smoking history, frequency, and amount of alcohol use. A significant difference was found on the average years of driving license possession, but it was the DUI participants who had had a driving license for longer period of time. We found that DUI participants performed significantly worse than controls on the fifth block of IGT, although none of the classical neuropsychological test measures included in this study differed significantly between the groups. Our results suggest that there is a poorer decision-making profile in DUI participants relative to controls, which may go undetected on standard tests of executive functions. These findings confirmed our main hypothesis, concerning IGT performance by DUI recidivists.

Average TCI scores were also comparable between the 2 groups except for the self-transcendence subscale. We suggest that this difference might be related to the scores in self-forgetfulness subdomain. Interestingly, TCI measures of NS and RD did not differ significantly between the groups that did not confirm our hypothesis about personality traits and their relation to DUI recidivism. Furthermore, we did not find any significant correlations between TCI subdomains and performance on IGT or neuropsychological testing.

At least 2 studies investigated neurocognitive characteristics of DUI recidivists. Glass and colleagues (2000) demonstrated that majority of second-time DUI offenders showed signs of cognitive dysfunction, most of them having a poor performance on the Porteus maze task, which is indicative of impairments in planning, foresight, and impulse control. They also reported deficits in the word fluency and digit symbol tests. Another study by Ouimet and colleagues (2007) showed that recidivists in their sample had impaired performance in 4 subscales of RCFT, verbal fluency, total inhibition errors on the Stroop, Total Accuracy on the 2 & 7 test, and Part B of Trail Making Test. These 2 studies shared similar findings in several cognitive domains, but while Glass and colleagues (2000) suggested that recidivists in their sample suffered from a lack of impulse control, Ouimet and colleagues (2007) did not identify any deficits on the mean first move time of the Tower Test, which is an indicator of functional impulse control. Yet, it must be noted that both of these studies used normative data for comparison purposes, but neither used properly matched control groups. This, of course, may raise questions in terms of whether the neurocognitive impairments reported by the authors are indeed specific to recidivists. This is a crucial issue because the results of the present study seem to be inconsistent within the context of these 2 studies. However, the present analysis included a control group that was matched for basic sociodemographic variables, but also for more specific variables, such as alcohol consumption and smoking. Naturally, there are some limitations to this study, mainly in terms of our relatively small sample size. Also, we did not include female recidivists, so the results of the present study may not reflect the whole population of DUI recidivists in the Turkish population. In terms of neuropsychological assessment, we used a comprehensive battery, which tackled several cognitive domains employing tasks that are used globally; however, we did not include all variables of tasks, such as the RCFT and the Tower test, which may have added extra valuable information about cognitive performance differences between the groups.

Impaired performance of alcohol use disorder (AUD) participants on test measures related with executive functioning has been previously reported (Lyvers, 2000). However, deficits in neuropsychological testing may not necessarily reflect daily living problems associated with alcohol abuse, as some of the abusers could perform fairly well in conventional neuropsychological testing (Pihl et al., 1990). In fact, AUD participants with comparable neurocognitive test results might differ by means of daily living problems (Bechara et al., 2002).

It can be suggested that executive functioning in real life involves abilities other than planning, set-shifting or motor inhibition, such as sensitivity to reward, predicting future consequences, interpreting risky situations, which may be collectively grouped under the umbrella term "decision-making." The Iowa Gambling Task is regarded as a laboratory simulation of real-life decision-making situations (Bechara et al., 1994). Recent studies (Manes et al., 2002) confirm the association of the IGT with ventral prefrontal cortex (PFC) integrity, but also highlight the importance of other prefrontal regions for this task, such as the dorsolateral PFC. For instance, the IGT may detect impairment on the basis of its extra load in working memory and associative learning, in addition to its capacity for measuring decision-making. IGT assesses the subject's ability to calibrate between rewards and risks by means of their future consequences. Decision-making among risky and safe choices and strategical planning while experiencing gains and losses of play money are crucial for normal test performance. These cognitive abilities are closely related with ambiguous situations and daily contingencies, which mostly require estimation and critical choices. In our study, we observed correlations between last block of IGT performance and several measures of WCST performance only in control group, which might suggest that DUI recidivists have failed to shift from implicit to explicit knowledge for contingencies in the course of IGT.

Previous studies have reported impaired IGT performance for participants with alcohol dependency (Fein et al., 2004; Mazas et al., 2000). However, impairments were often reported to be associated with antisocial behavior patterns or daily living problems (Finn et al., 2002; Mazas et al., 2000). Fein and colleagues (2006) further suggested that normal IGT performance of treatment-naive alcohol-dependent individuals might be related with their relatively spared (not global) decision-making ability, while the participants in their sample did not show increased measures in deviance proneness or antisocial traits.

Our study further reveals that IGT performance was not correlated with measures of impulsivity even though impulsiveness is expected to be closely related with impaired decision-making. Bechara and colleagues (2000) also argued that impulsivity can be separated into "motor impulsiveness" and "cognitive impulsiveness," the former being associated with response inhibition and performance in WCST or delayed alternation task, and the latter being associated with decision-making and performance on IGT. However, it has long been recognized that impaired decision-making is dissociable from measures of impulsivity (Clark and Manes, 2004).

It can be suggested that the lack of significant correlations between IGT performance and TCI measures stems from the distinct variables of impulsive traits being tackled by each tool. That is, IGT is a measure of self-assessment and impulse control, which is related to future consequences and it also reflects an intact ability to associate past and future contingencies. In contrast, measures of impulsivity in TCI, such as novelty seeking and reward dependence, might reflect "motor impulsiveness" more closely, which is highly dependent on impulses in "here and now" situations. In this sense, it could be the case that our sample of second-time DUI offenders is primarily affected by "cognitive impulsiveness" as they have had problems in the assessment of previous punishments (6 months of ban from traffic) and associating negative experiences with possible negative consequences (2 years of ban from traffic in the case of second-time offense), which is related with a specific decision-making impairment. Compatible with this is a lack of significant difference on other tests of executive functioning, such as WCST, Stroop, and verbal fluency, when compared to controls.

It can be easily argued that second-time DUI offense is a broad and complex cognitive issue implicating several aspects of neurocognitive functioning, particularly risk assessment, planning for future consequences, and sensitivity to reward. Remarkably, we only found significant differences between DUI participants and controls on IGT performance, suggesting that IGT might be a useful neuropsychological tool for populations having poorer decision-making skills. A recent study has shown decreased IGT performance in penalized traffic offenders relative to nonoffenders, which supported applicability of the IGT to the study of risky behavior in otherwise healthy individuals (Lev et al., 2008). One possibility is that poorer performance on IGT by DUI recidivists is associated with an inability to generate a long-term beneficial strategy, rather than a genuine risk-appetitive behavior. This kind of "flattened" IGT performance is typical of psychiatric disorders (e.g., Bechara et al., 2001; Kester et al., 2006; Shurman et al., 2005; Starcke et al., 2010) and is worthy of further research.

In light of the findings from the present study, a good case can be made that psychoeducation programs for DUI offenders should ideally include routine neurocognitive testing using tasks such as the IGT. Assessment of individual impairments on decision-making and other cognitive domains would lead to more specific methods, which may help preventing DUI recidivism. Further studies comparing people who had first-time DUI offense versus recidivists should be conducted to evaluate the specific nature of decision-making in DUI recidivism, which may also affect policy implications on drinking and driving. Also, other ecological factors, such as alcohol availability, transportation options, and life style, should be taken into account for future studies. The ability to quantify the extent of decision-making impairment in these participants would greatly facilitate the design of appropriate rehabilitation strategies with the objective of improving the impact of these deficits in DUI participants' daily living. The ecological nature of the IGT is an essential aspect of the kind of cognitive assessment that must be carried out in several different psychiatric disorders. In particular, it could enhance the recognition of real-life impairments in situations involving affective decision-making.

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