Alexithymia may modulate decision making in patients with de novo Parkinson's disease

Michele Poletti, PsyD[a,b]
Daniela Frosini, MD[b]
Cristina Pagni, PsyD[a,b]
Claudio Lucetti, MD[a]
Paolo Del Dotto, MD[a]
Gloria Tognoni, MD[b]
Roberto Ceravolo, MD[b]
Ubaldo Bonuccelli, MD[a,b]

[a] Neurology Unit, Hospital of Viareggio, Italy
[b] Department of Neuroscience, University of Pisa, Italy

Corresponding author: Ubaldo Bonuccelli
Department of Neuroscience, University of Pisa, Italy
E-mail: u.bonuccelli@med.unipi.it

Summary

The aim of this study was to investigate whether and how alexithymia may influence decision making under conditions of uncertainty, assessed using the Iowa Gambling Task, in patients with newly diagnosed, untreated (de novo) Parkinson's disease, as previously reported for healthy subjects.
Twenty-four patients with de novo Parkinson's disease underwent a neuropsychological and neuropsychiatric assessment, including the Toronto Alexithymia Scale, the Geriatric Depression Scale Short Form, and the Iowa Gambling Task (IGT).
The assessment showed that 12 patients were alexithymic and 12 were non-alexithymic; seven patients were found to be mildly depressed and 17 non-depressed. Alexithymic and non-alexithymic patients did not differ in the IGT total score; however, significant differences emerged across the third block of the IGT, in which the alexithymic patients outperformed the non-alexithymic patients. Depression did not influence IGT performance.
Alexithymia may modulate decision making, as assessed with the IGT; alexithymia could be associated with faster learning to avoid risky choices and negative feedback, as previously reported in some studies conducted in anxious or depressed patients.

KEY WORDS: alexithymia, anxiety, decision making, de novo Parkinson's disease, depression, Iowa Gambling Task

Introduction

In recent years several studies have investigated how neuropsychiatric features may influence decision making under conditions of uncertainty, as assessed using the Iowa Gambling Task (IGT) (1). High levels of impulsivity are associated with a poorer ability to alter choice behavior in response to changing reward contingencies (2-4).

With regard to depression, some studies reported poorer performances in depressed patients compared with healthy subjects (5,6), while another study reported better performances in depressed patients, suggesting that depression may be associated with faster learning to avoid risky choices (7); finally, one study reported that the IGT performances of remitted depressed patients were similar to those of healthy subjects, suggesting that alterations of decision-making behavior may be state-dependent (8). As regards anxiety, some studies reported an association between high trait anxiety and poor decision making (9,10), while others reported opposite findings (11,12). Summarizing, although no clear pattern emerges from these studies, they nevertheless show that affective features, at least, influence decision making, as assessed using the IGT.
Among affective disorders, depression and anxiety are strongly associated with alexithymia (13-16), a phenomenon related to an alteration in affect regulation (17): its characteristics include inability to identify and describe feelings, difficulty distinguishing feelings from bodily sensations of emotional arousal, impaired symbolization, and an externally oriented cognitive style. Only one study investigated the potential influence of alexithymia on decision making (18): Ferguson and colleagues reported that, on the IGT, alexithymic subjects exhibited a response pattern characterized by standard exploration and learning over the first blocks of the trial, followed by a shift to a relatively higher proportion of disadvantageous choices over subsequent blocks, and finally a return to the advantageous choices in the last blocks. This pattern was not observed in the low alexithymia participants, who showed the standard learning curve for the IGT. This effect was especially evident when subjects were under conditions of reduced cognitive information, that is, in the absence of cumulative feedback. To summarize, higher levels of alexithymia were found to be associated with a slowed learning rate on the IGT, and with increased risk taking toward the end of the task; this was consistent with the finding of an attenuation of emotional learning in tasks requiring the use of previous emotional information to guide future performance (19).
To confirm the potential influence of alexithymia on decision making, we used findings derived from our previous studies that assessed i) the relationship between alexithymia and depression (20) and ii) decision making under conditions of uncertainty (21) in patients with newly diagnosed untreated (de novo) Parkinson's disease (PD). The reason we decided to assess alexithymia in this specific clinical population is that alexithymia is strictly related to depression and anxiety (13-16) and these affective disorders may precede the clinical motor onset of PD (22,23); our decision to assess decision making was prompted by the consideration that medicated patients may present decision making difficulties from the early stages of PD (24-26). In these studies (20,21) we showed that untreated patients in the early

stages of PD, at the onset of clinical motor symptoms, present similar levels of alexithymia and depression and preserved decision making, compared with healthy controls. These findings are consistent with those of studies showing that both alexithymia and decision making under conditions of uncertainty are related to the orbital portions of the prefrontal cortex (27-30), a cortical area that is not affected by the neuropathology of PD in the early clinical stages (31).

On the basis of our previous studies, we hypothesized that, as observed in healthy subjects, alexithymia may modulate decision making in patients with de novo PD; in particular we predicted that alexithymic patients may display a different pattern of choices, during the IGT, compared with non-alexithymic patients, but that these differences would not necessarily correspond to a different IGT total score between the groups. Moreover, we expected that the relationship between alexithymia and decision making, if found, would probably not be influenced by the concomitant PD neuropathology, which, in the early clinical stages, does not involve cerebral areas related to alexithymia and decision making under uncertainty.

Materials and methods

Twenty-four de novo PD patients were enrolled from two Italian tertiary movement disorders clinics (Versilia Hospital, Viareggio; Neurological Clinic, University of Pisa) in the period from January to December 2008. All patients fulfilled research diagnostic criteria for idiopathic PD (32) and gave their informed consent to participate in the study. Patients who had clinical features suggestive of primary atypical parkinsonism, such as multiple system atrophy, progressive supranuclear palsy and corticobasal degeneration, and those with a diagnosis of dementia according to DSM-IV criteria (33), were not included in the study. Magnetic resonance imaging showed no signs of atypical parkinsonism, normal pressure hydrocephalus, moderate-to-severe vascular abnormalities, or tumors. In all the PD patients, gender, age and years of education were recorded.

The patients performed a computerized standard version of the IGT, and completed the twenty-item Toronto Alexithymia Scale (TAS-20) (34), the Geriatric Depression Scale Short Form (GDS-15) (35), and the Mini-Mental State Examination (MMSE) (36).

The Frontal Assessment Battery (FAB) (37) was also administered to assess the presence of an executive dysfunction. In addition, we also interviewed patients to detect positive family histories of PD or of affective disorders.

The IGT (1) requires subjects to repeatedly select cards (100 in total) from four decks of cards, which are identical in appearance; they start with a 2000$ loan of play money and are instructed to maximize their profit. The aim of the game is to win as much money as possible, or, as far as possible, to avoid losing money; to achieve this, subjects must discover which are the most advantageous decks and prevalently pick up cards from those decks. Each time they turn over a card, they win some money; sometimes, however, on turning over a card they also have to pay a penalty, according to a pre-programmed schedule of reward and punishment. Gains and losses are different for each card selected from the four decks. However, decks A and B are “disadvantageous” because whilst they pay 100$ (and are therefore high-paying decks), the penalties are also higher, so they cost more in the long run; decks C and D, on the other hand, are “advantageous” because whilst they pay only 50$ (and are therefore low-paying decks), the penalties are also lower, resulting in an overall gain in the long run. In summary, decks A and B are equivalent in terms of overall net loss over the trials, as are decks C and D; the difference is that in decks A and C, punishments are more frequent, but of a smaller magnitude, while in decks B and D punishments are less frequent but of a greater magnitude. Thus, successful task performance relies on sampling more from decks C and D than from decks A and B; indeed, there is no advantage to be gained, for participants, by selecting more cards from the frequent punishment (A and C) as opposed to the infrequent punishment (B and D) decks, and vice versa. The quantitative parameters in the IGT are the net number of advantageous choices (selections from decks C and D minus selections from decks A and B) computed both for the whole 100 cards (total score) and for five successive blocks of 20 cards each (1-20, 21-40 and so on); this latter parameter is used in order to quantify the progressive change in selection pattern across the IGT. Therefore, successful performances are indicated by a positive score (>0; higher scores mean better performances) while lower scores indicate more risky choices (1).

The TAS-20 (34) is an extensively validated self-report questionnaire, comprised of three subscales that investigate the following factors: F1, Difficulty identifying feelings; F2, Difficulty describing feelings; F3, Difficulty focusing on inner affective experience. The total score on the questionnaire allows subjects to be categorized as non-alexithymic (scores ranging from 20 to 51), borderline alexithymic (scores ranging from 52 to 60), or alexithymic (scores ≥61). In order to compare our findings with those of Ferguson and colleagues (18), we adopted their cut-off point, classifying patients as low alexithymic (TAS-20 score ≤51) or high alexithymic (TAS-20 score >51). The GDS-15 is a validated self-report questionnaire for the evaluation of depressive symptoms; we adopted a cut-off point of 5 (presence of depression if the score is >5), as previously suggested for PD patients (38).

A chi-square test was used to compare the qualitative characteristics of patient subgroups (alexithymic vs non-alexithymic patients; depressed vs non-depressed); for the comparison of the quantitative variables, the Wilcoxon-Mann-Whitney test for independent data was used. The relation between quantitative variables was evaluated by means of a linear correlation, with a Bonferroni correction for multiple comparisons.

Results

All patients were cognitively preserved (mean adjusted MMSE score 28.60±2.14; mean adjusted FAB score 16.46±1.70). The demographic and clinical characteristics of the patients are reported in Table 1. As regards IGT performance, 10 patients obtained a negative score (≤0) and 14 a positive (>0) score. Applying the TAS-20

cut-off point of 51, 12 patients were found to be alexithymic and 12 non-alexithymic. Applying the GDS-15 cut-off point of five, 17 patients were categorized as non-depressed and seven as mildly depressed. Three patients had a positive family history of PD and four patients had a positive history of affective disorders (2 major depression, 1 dysthymia and 1 generalized anxiety disorder). No demographic (age, gender, education) or cognitive (MMSE, FAB) differences emerged between the alexithymic and the non-alexithymic patients or between the depressed and the non-depressed patients.

De novo PD patients gave the following IGT scores: (block 1-20: -1.83±3.27; block 21-40: -1.42±3.25; block 41-60: 0.42±4.60; block 61-80: 3.75±6.78; block 81-100: 3.58±7.29; total score: 4.50±16.15); in the previous study (21) in which we compared IGT performances of de novo PD patients and healthy controls, although the healthy controls outperformed the de novo PD patients, the difference did not reach statistical significance.

In the present study, the alexithymic patients outperformed the non-alexithymic patients in the third IGT block (41-60) (p=0.04); in the other IGT blocks and in the IGT total score no differences emerged between the alexithymic and the non-alexithymic patients (Fig. 1). No differences emerged (p=0.45) between the IGT performances of depressed and non-depressed patients, either in the total score (2.44±12.40 and 2.63±17.37 respectively) or in the five blocks of 20 choices.

In the whole patient sample, correlation analyses revealed that the MMSE and FAB were negatively correlated with age (respectively r=-.443; p=0.03 and r=-.565; p=0.004); the TAS-20 and the GDS-15 were significantly correlated (r=.451; p=0.027). Considering the TAS-20 subscales, the GDS-15 significantly correlated with the F1 subscale (Difficulty identifying feelings) (r=.561; p=0.012) and the F2 subscale (Difficulty describing feelings) (r=.929; p<.001). The TAS-20 was correlated negatively with education (r=-.520; p=<0.001). The TAS-20 total score and the TAS-20 subscales F2 and F3 did not correlate with any IGT parameter, while the TAS-20 F1 subscale correlated positively with the IGT 21-40 score (r=.0559; p=0.013) and negatively with the IGT 61-80 (r=-.488; p=0.034) and the IGT 81-100 (r=-.666; p=0.02) scores.

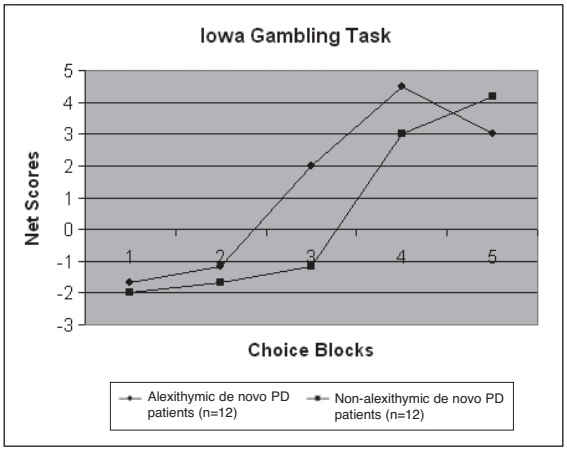

Figure 1. IGT performances of alexithymic and non-alexithymic de novo PD patients.

Table 1 - Characteristics of de novo Parkinson's disease patients

	PD patients (total sample) n = 24 Mean (SD)	Non-alexithymic PD patients n = 12 Mean (SD)	Alexithymic PD patients n = 12 Mean (SD)	p value
Age	65.04 (6.23)	66.17 (5.20)	63.92 (7.17)	0.47
Gender m/f	17/7	7/5	10/2	/
Education	8.92 (4.03)	10.58 (4.37)	7.25 (2.95)	0.60
MMSE	28.60 (2.14)	28.72 (2.41)	28.49 (1.94)	0.71
FAB	16.46 (1.70)	16.27 (1.89)	16.64 (1.55)	0.79
GDS-15	4.83 (3.49)	3.33 (2.34)	6.33 (3.89)	0.14
TAS-20	51.46 (13.47)	40.67 (8.35)	62.25 (7.44)	< 0.01*
TAS-20 F1	17.11 (5.71)	12.86 (4.18)	19.58 (5.07)	0.013*
TAS-20 F2	15.21 (5.32)	10.00 (3.91)	18.25 (3.27)	< 0.01*
TAS-20 F3	21.16 (5.39)	15.86 (4.70)	24.25 (2.70)	< 0.01*
IGT Total score	4.50 (16.15)	2.33 (18.04)	6.67 (14.48)	0.29
IGT 1-20	-1.83 (3.27)	-2.00 (3.19)	-1.67 (3.49)	0.75
IGT 21-40	-1.42 (3.25)	-1.67 (3.17)	-1.17 (3.46)	0.75
IGT 41-60	0.42 (4.60)	-1.17 (3.99)	2.00 (5.90)	0.04*
IGT 61-80	3.75 (6.78)	3.00 (7.97)	4.50 (5.60)	0.17
IGT 81-100	3.58 (7.29)	4.17 (8.37)	3.00 (6.35)	0.97

Abbreviations and symbols: *=statistically different; FAB=Frontal Assessment Battery; GDS-15: Geriatric Depression Scale Short Form; IGT=Iowa Gambling Task; MMSE=Mini-Mental State Examination; SD=standard deviation; TAS-20= twenty-item Toronto Alexithymia Scale; TAS-20 F1=Difficulty identifying feelings; TAS-20 F2=Difficulty describing feelings; TAS-20 F3=Difficulty focusing on inner affective experience.

Discussion

On the basis of previous empirical findings we hypothesized that alexithymia may influence decision making under conditions of uncertainty. To test this hypothesis we adopted findings from our previous studies investigating i) the relationship between alexithymia and depression (20) and ii) decision making under uncertainty (21) in patients with newly diagnosed untreated PD. In these studies we found similar levels of alexithymia and preserved decision making in PD patients in comparison with healthy controls, probably because alexithymia and decision making under uncertainty are both related to the orbital portions of the prefrontal cortex (27-30), a cortical area that is not affected by the PD neuropathology in the early clinical stages (31). These findings suggested that the relationship between alexithymia and decision making, if found, would probably not be influenced by the concomitant PD neuropathology, which in the early clinical stages does not involve cerebral areas related to alexithymia and decision making under uncertainty. On the basis of reports of modulating effects of affective features on decision making under uncertainty (5-12), we predicted that alexithymia would have a modulating effect on decision making under uncertainty also in de novo PD patients.

Three empirical findings emerged from the present study. First, the alexithymic and non-alexithymic patients performed similarly on the IGT; in fact, although the alexithymic patients outperformed the non-alexithymic patients, the difference did not reach statistical significance. This finding is in line with the findings of Ferguson and colleagues (18), who reported similar IGT total scores in alexithymic and non-alexithymic healthy young subjects.

Second, it emerged that alexithymia may modulate learning across the IGT. The alexithymic patients significantly outperformed non-alexithymic patients in the central phase of the IGT (block 41-60), suggesting that alexithymia could be associated with faster learning to avoid risky choices and the negative feedback with which these choices are more frequently associated. This pattern of choices is similar to patterns described in some studies in depressed patients (7) and anxious patients (11), which showed that depression and anxiety are associated with faster learning to avoid risky choices. The modulating effect of some alexithymic features on decision making is also suggested by the different direction of the correlations between the TAS-20 F1 subscale (Difficulty identifying feelings) and IGT partial scores: positive in the second block (choices 21-40) and negative in the last two blocks (choices 61-100). In the early phases of the IGT the reward-punishment schedule of the task is opaque and learning is taking place at a non-declarative, implicit level (39); in these phases, in which subjects do not have a clear understanding of what is going on – this is the pre-hunch phase of the task (39) –, difficulty identifying feelings related to the reward-punishment schedule may induce them to adopt a conservative strategy, which enhances the IGT performance. However, while this strategy of choice enhances performances in the early IGT phases, it impairs them in the final IGT phases, as suggested by the negative correlations in the last two IGT blocks, and as also previously reported; as a matter of fact Ferguson and colleagues (18) reported that alexithymic subjects were characterized by a relatively higher proportion of choices from disadvantageous decks in the last IGT phases (choices 71-90). Our finding confirms that alexithymic subjects may present attenuated emotional learning along the task; this attenuated emotional learning is probably due to problems consolidating previous emotional experience (19) and probably hampers the hunch phase (hypotheses generated on which were the "good" and "bad" decks) and the conceptual phase (clear idea of what is going on) in the IGT performance. Considering that i) a substantial minority of healthy subjects does not reach the conceptual phase despite performing normally on the task (18), and ii) a minority of healthy subjects fails the task, obtaining a negative total score (40-42), it would be interesting to verify in further studies whether these subgroups have higher levels of alexithymia, which may interfere with their emotional learning.

Third, contrary to what has been reported in samples of patients with major depression (5,6), in our study depression did not influence the IGT performance. However, the patients in our sample did not show major depression, with the exception of one who had a score of 14 on the GDS-15. The presence of patients with only mild depressive symptoms may probably explain why our study found a different relationship between depression and decision making compared to studies on patients with major depression.

In conclusion, this study confirmed that alexithymia may modulate decision making under uncertainty, as assessed by the IGT, suggesting that alexithymic features in patients should be taken into account when assessing decision making.

References

1. Bechara A, Damasio AR, Damasio H, Anderson SW. Insensitivity to future consequences following damage to human prefrontal cortex. Cognition 1994;50:7-15
2. Franken IH, Van Strien JW, Nijs I, Muris P. Impulsivity is associated with behavioural decision-making deficits. Psychiatry Res 2008;158:155-163
3. Sweitzer MM, Allen PA, Kaut KP. Relation of individual differences in impulsivity to nonclinical emotional decision making. J Int Neuropsychol Soc 2008;14:878-882
4. Zermatten A, Van der Linden M, d'Acremont M, Jermann F, Bechara A. Impulsivity and decision making. J Nerv Ment Dis 2005;193:647-650
5. Cella M, Dymond S, Cooper A. Impaired flexible decision-making in Major Depressive Disorder. J Affect Disord 2010;124:207-210
6. Must A, Szabó Z, Bodi N, Szasz A, Janka A, Keri S. Sensitivity to reward and punishment and the prefrontal cortex in major depression. J Affect Disord 2006;90:209-215
7. Smoski MJ, Lynch TR, Rosenthal MZ, Cheavens JS, Chapman AL, Krishnan RR. Decision making and risk aversion among depressive adults. J Behav Ther Exp Psychiatry 2008;39:567-576
8. Westheide J, Wagner M, Quednow BB et al. Neuropsychological performance in partly remitted unipolar depressive patients: focus on executive functioning. Eur Arch Psychiatry Clin Neurosci 2007;257:389-395
9. de Visser L, van der Knaap LJ, van de Loo AJ, van der Weerd CM, Ohl F, van den Bos R. Trait anxiety affects decision making differently in healthy men and women: to-

wards gender-specific endophenotypes of anxiety. Neuropsychologia 2010;48:1598-1606
10. Miu AC, Heilman RM, Houser D. Anxiety impairs decision-making; psychophysiological evidence from an Iowa Gambling Task. Biol Psychol 2008;77:353-358
11. Mueller EM, Nguyen J, Ray WJ, Borkovec TD. Future-oriented decision-making in generalized anxiety disorder is evident across different versions of the Iowa Gambling Task. J Behav Ther Exp Psychiatry 2010;41:165-171
12. Werner NS, Duschek S, Schandry R. Relationship between affective states and decision-making. Int J Psychophysiol 2009;74:259-265
13. Berthoz S, Consoli S, Perez-Diaz F, Jouvent R. Alexithymia and anxiety : compounded relationships? A psychometric study. Eur Psychiatry 1999;14:372-378
14. Hendryx MS, Haviland MG, Shaw D. Dimensions of alexithymia and their relationships to anxiety and depression. J Pers Assess 1991;56:227-237
15. Honkalampi K, Hintikka J, Tanskanen A, Lehtonen J, Viinamaki H. Depression is strongly associated with alexithymia in the general population. J Psychosom Res 2000;48:99-104
16. Honkalampi K, Saarinen P, Hintikka J, Virtanen V, Viinamaki H. Factors associated with alexithymia in patients suffering from depression. Psychother Psychosom 1999;68:270-275
17. Taylor GJ, Bagby RM, Parker JD. The alexithymia construct. A potential paradigm for psychosomatic medicine. Psychosomatics 1991;32:153-164
18. Ferguson E, Bibby PA, Rosamond S, et al. Alexithymia, cumulative feedback and differential response patterns on the Iowa Gambling Task. J Pers 2009;77:883-902
19. Aleman A. Feelings you can't imagine: towards a cognitive neuroscience of alexithymia. Trends Cogn Sci 2005;9: 553-555
20. Poletti M, Frosini D, Pagni C et al. Alexithymia is associated with depression in de novo Parkinson's disease. Psychother Psychosom 2011;80:251-253
21. Poletti M, Frosini D, Lucetti C, Del Dotto P, Ceravolo R, Bonuccelli U. Decision making in de novo Parkinson's Disease. Mov Disord 2010;25:1432-1436
22. Ishihara L, Brayne C. A systematic review of depression and mental illness preceding Parkinson's disease. Acta Neurol Scand 2006;113:211-220
23. Ishihara-Paul L, Wainwright NW, Khaw KT et al. Prospective association between emotional health and clinical evidence of Parkinson's disease. Eur J Neurol 2008;15: 1148-1154
24. Pagonabarraga J, García-Sánchez C, Llebaria G, Pascual-Sedano B, Gironell A, Kulisevsky J. Controlled study of decision-making and cognitive impairment in Parkinson's disease. Mov Disord 2007;22:1430-1435
25. Kobayakawa M, Koyama S, Mimura M, Kawamura M. Decision making in Parkinson's disease: Analysis of behavioral and physiological patterns in the Iowa gambling task. Mov Disord 2008;23:547-552
26. Euteneuer F, Schaefer F, Stuermer R et al. Dissociation of decision-making under ambiguity and decision-making under risk in patients with Parkinson's disease: a neuropsychological and psychophysiological study. Neuropsychologia 2009;47:2882-2890
27. Larsen JK, Brand N, Bermond B, Hijman R. Cognitive and emotional characteristics of alexithymia: a review of neurobiological studies. J Psychosom Res 2003;54:533-541
28. Bermond B, Vorst HC, Moormann PP. Cognitive neuropsychology of alexithymia: implications for personality typology. Cogn Neuropsychiatry 2006;11:332-360
29. Bechara A, Tranel D, Damasio H. Characterization of the decision-making deficit of patients with ventromedial prefrontal cortex lesions. Brain 2000;123:2189-2202
30. Li X, Lu ZL, D'Argembeau A, Ng M, Bechara A. The Iowa Gambling Task in fMRI images. Hum Brain Map 2010;31:410-423
31. Owen AM. Cognitive dysfunction in Parkinson's disease: the role of frontostriatal circuitry. Neuroscientist 2004;10:525-537
32. Hughes AJ, Daniel SE, Kilford L, Lees AJ. Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. J Neurol Neurosurg Psychiatry 1992;55:181-184
33. American Psychiatric Association. Diagnostic and Statistical Manual for Mental Disorders, IV Edition, text revision (DSM-IV-TR). Washington, DC; American Psychiatric Association 2000
34. Bagby RM, Parker JD, Taylor GJ. The twenty-item Toronto Alexithymia Scale. Item selection and cross-validation of the factor structure. J Psychosom Res 1994;38:23-32
35. Sheik JI, Yesavage JA. Geriatric Depression Scale (GDS): recent evidence and development of a shorter version. In: Brink TL ed Clinical Gerontology. A Guide to Assessment and Intervention. NY; The Haworth Press 1986:165-173
36. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state." A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-198
37. Dubois B, Slachesvsky A, Litvan I, Pillon B. The FAB: a Frontal Assessment Battery at bedside. Neurology 2000;55:1621-1626
38. Meara J, Mitchelmore E, Hobson P. Use of the GDS-15 geriatric depression scale as a screening instrument for depressive symptomatology in patients with Parkinson's disease and their carers in the community. Age Ageing 1999;28:35-38
39. Bechara A, Damasio H, Tranel D, Damasio AR. Deciding advantageously before knowing the advantageous strategy. Science 1997;275:1293-1295
40. Bechara A, Damasio H. Decision-making and addiction (part I): impaired activation of somatic states in substance dependent individuals when pondering decisions with negative future consequences. Neuropsychologia 2002;40:1675-1689
41. Dunn BD, Dalgleish T, Lawrence AD. The somatic marker hypothesis: a critical evaluation. Neurosci Biobehav Rev 2006;30:239-271
42. Buelow MT, Suhr JA. Construct validity of the Iowa Gambling Task. Neuropsychol Rev 2009;19:102-114