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EXPLORING THE ASSOCIATION BETWEEN THE IOWA GAMBLING TASK AND COMMUNITY FUNCTIONING IN PEOPLE WITH SCHIZOPHRENIA

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SUMMARY

Background: *Decision making (DM) consists of a number of complex processes involving higher-order cognitive functions involved in outcome evaluation. Problems in DM may have significant negative repercussions on community functioning. We hypothesise in individuals with schizophrenia difficulties in community functioning will be associated with DM problems.*

Subjects and methods: *DM performance was assessed using the Iowa Gambling Task (IGT) in 30 individuals with schizophrenia and 32 healthy controls. Participants' choices on the IGT were grouped as: Ambiguous Decisions, where the outcome is uncertain and cannot be predicted (i.e. IGT initial phase), and Risky Decisions, where the outcome can be predicted with an error margin (i.e. IGT final phase). People with schizophrenia were also assessed with measures of community functioning and symptoms.*

Results: *Controls outperformed individuals with schizophrenia in risky decisions. In patients, levels of community functioning positively correlated with DM performance. Symptomatology was not associated with DM proficiency or functioning.*

Conclusions: *DM impairment may represent an important contributor to poor functional outcomes in people with schizophrenia. Interventions targeting decision making and higher order cognitive problems in people with schizophrenia may have a greater impact on functional difficulties.*

Key words: *decision making – schizophrenia - Iowa Gambling Task - community functioning*

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INTRODUCTION

Decision making (DM) involves the consideration of outcomes associated with a set of possible actions. It consists of a number of complex processes involving higher-order cognitive functions with which people regulate actions to achieve optimal outcomes (Paulus 2007). Despite its apparent complexity, individuals make countless decisions in their everyday life without noticeable mental effort. This consideration has also led to the speculation that automatic and less conscious processes may be responsible and guide, to some extent, DM (Damasio 1996).

Previous research showed that individuals faced with a choice may recruit different resources if they have to make a decision under ambiguous situations (ambiguous decisions, i.e. when the possibility to forecast the outcome is unclear) compared to a decisions in situations where the probability of a particular outcome can be estimated (i.e. risky decisions) (Brand et al. 2007, Fond et al. 2013).

Both these types of decisions are essential in everyday life and, to a large extent, will influence the functional and social outcomes of an individual in the community. When faced with a new situation requiring a decision a range of cognitive processes are needed to conduct a cost-benefit analyses, forecast possible outcomes and relate the situation to similar past experiences. In this situation the cognitive system monitors and evaluates incoming information in relation to the ultimate goal (Gazzaniga et al. 2002). The condition in which an outcome probability prediction could be reliably estimated (i.e. risky condition) is more frequent in everyday life. However, the outcome of choices under ambiguity is necessary to compute the risk of future decisions based on probability knowledge rather than uncertainty.

A large number of studies have investigated decision making in individuals with schizophrenia highlighting a number of impaired processes including reward and punishment insensitivity, inflexibility, overconfidence and jump to conclusion just to name some of the most researched (Gold et al. 2008, Moritz et al. 2009, Langdon et al. 2010). Some of these mechanisms have been linked to symptoms of schizophrenia. Reward sensitivity problems have been associated with cognitive difficulties (Strauss et al. 2013) while the jump to conclusion bias has been associated to delusions (Peters et al. 2008).

The Iowa Gambling Task (IGT) is a well-known experimental paradigm that was developed with the specific intent to assess complex DM associated with real life functional impairment (Bechara et al. 1994, Bechara et al. 2005).

Studies using the IGT in individuals with schizophrenia, to date, have shown inconclusive results. The

majority of the studies found a DM impairment while a minority reported comparable performance between to healthy controls and individuals with schizophrenia (for a review see Sevy et al. 2007, Adida et al. 2011). Multiple factors might account for these findings including limited sample size, large variance in the IGT indexes, irregular performance among controls, heterogeneous clinical samples, lack of appropriate matching for factors such as level of education, antipsychotic dosage and substance use.

The widespread cognitive impairment often observed in individuals with schizophrenia was found to be associated with severe deficit in various areas of everyday community functioning (Green et al. 2000, Bowie & Harvey 2006, Fett et al. 2011). Despite the numerous studies showing an association between cognitive problems and functional deficit, limited research has attempted to specify the contribution of cognitive processes. In order to put forward testable hypotheses it is important for research to advance cognitive domains and mechanisms responsible for the observed deficit. In this respect the domain of DM may constitute a good candidate to explain functional problems associated with the diagnosis of schizophrenia because it encompasses elements such as feedback sensitivity and learning that are likely to be represented in everyday life.

Difficulties in cognitive domains may impact functioning by reducing the proficiency of the DM process. Despite the relevance of DM to everyday functioning and the claim that the IGT can capture real life DM, no study used this paradigm to assess whether DM deficit in individuals with schizophrenia is associated with functional impairment. This paradigm, in contrast to most laboratory tasks, possesses highly recognized ecological validity, and may be more suitable to explore the relationship between decision making and community functioning outcomes in individuals with schizophrenia.

The primary aim of this study is to investigate the association between DM and community functioning in individuals with schizophrenia. The IGT was selected because it is widely used to study phenomena such as reward-based decision making and choice risk computation. We hypothesise that a task such as IGT can capture some ecological features of DM and these will be associated with daily life functioning problems.

The secondary aims are to compare the DM performance with a well-matched control group and investigate the relationship that symptom severity may have with DM and functioning.

SUBJECTS AND METHODS

Subjects

Thirty (18 men, 60%) community dwelling individuals with schizophrenia (Sz), were recruited to from the community mental health service of Giulianova (Italy).

Inclusion criteria were: age range 18-65; DSM-IV diagnosis of schizophrenia assessed with a clinical interview by a senior psychiatrist. Exclusion criteria were: history of learning disability/developmental disorder, history of organic brain disorder/head trauma, a diagnosis of substance dependence.

The control group (Ctrl) consisted of 32 individuals (16 men) recruited from the general population in the same geographical area matched for age, gender and educational level. In addition to the patient exclusion criteria, controls were also screened for any psychiatric condition.

The study was reviewed by the local Institutional Review Board and all participants signed an informed consent.

Procedure

Decision making assessment

All participants completed a computerised version of Iowa Gambling Task (IGT) (Struglia et al. 2011, Tomassini, et al. 2012). implemented using the Bechara et al. (Bechara et al. 1994, Bechara et al. 2000) instructions. The IGT is a card game in which participants, starting with a loan of 2000 Euro of virtual money, have to make card selections. The goal of the game is to win as much money as possible by selecting one card at a time from any of four decks (i.e. A, B, C, and D) over the course of 100 trials. The participants are instructed that each card selection results in a gain (‘reward’) or a loss (‘punishment’). After each selection the monetary outcome associated with the choice is displayed on the screen and added or subtracted to the total. The four decks differ in the magnitude and ratio of ‘reward to penalty’ provided. Two of the decks (i.e. A and B) are termed “disadvantageous”, produce larger amounts of immediate gains but, as the game progresses, they also deliver high magnitude losses in such a way to result in long-term losses. The other two decks (i.e. C and D) are termed “advantageous” in that they involve small immediate gains and occasional small penalties. The more conservative strategy of selecting from these decks results in a long term gain. IGT outputs include the net score, defined as the number of choices from advantageous minus disadvantageous decks, for each of the 5 blocks of 20 choices, and the amount of money earned (Dymond et al. 2010). High net score indicates a profitable DM strategy.

Given the difference in the processes recruited for DM at different stages of the IGT the task can be divided in two stages: ambiguous decisions and risky decisions. This division is based on Brand et al. (Brand et al. 2006, Brand et al. 2007). These authors suggest to group the IGT trials into two phases: a first phase (the first 40 trials) where participants learn to make choices without any explicit knowledge of the task contingencies; a latter phase (the last 60 trials), where participants acquire some conceptual knowledge of the

contingencies, and decisions become more influenced by explicit knowledge about risks.

Clinical assessment

Symptoms were evaluated using the Positive and Negative Syndrome Scale (PANSS) (Kay 1991, Daneluzzo et al. 2002). The total PANSS score (score range 30-210), scores for positive (range 7-49), negative (range 7-49) and general psychopathology (range 16-112) were considered. Higher scores are indicative of more severe symptoms.

Community functioning assessment

Functional performance was assessed with the Specific Level of Function Scale (SLOF) (Schneider & Struening 1983) translated in Italian by P.S and A.R. This scale is a 43-item report of the patient's behaviour and functioning assessed with an interview (score range 43-215). It assesses six domains including: physical functioning (e.g., vision, hearing: 5 items; range 5-25), personal care skills (e.g., eating, grooming: 7 items; range 7–35), interpersonal skills (e.g., initiating, accepting, and maintaining social contacts; 7 items; range 7–35), social acceptability (e.g., verbally or physically abusing others, performing repetitive behaviours: 7 items; range 7–35), community activities (e.g., shopping, , paying bills, leisure time, use of public transportation: 11 items; range 11–55), and work skills (e.g., employable skills, level of supervision, punctuality: 6 items; range 6–30). Higher scores indicate higher level of functioning.

In order to increase the confidence in the SLOF the rating scores were corroborated by an informant report gathered from a care-giver, a relative or a or a health care professional. The rating focussed on the patient's level of every day performance over the preceding week.

Clinical evaluations (i.e. PANSS and SLOF) were performed by expert and certified psychiatrists (GDE and AR). Administration training includes session recording and inter-rater reliability with the assessor trainer.

Statistical analysis

Sample size was calculated to detect a statistically significance at p=0.05 criterion, providing 80% power. As our hypothesis was unidirectional (i.e. whether IGT performance was poorer in Sz compared to controls) the test was one tailed. According to these criteria it was estimated that a sample size of 30 participants per group would be sufficient (Cohen 1977).

Given the relatively limited samples size and scarce gaussianity of the IGT variables, non-parametric statistics were chosen (Robson 1994). Mann-Whitney Test and Chi Square were used for comparison between the groups. Spearman's rho was used to assess correlations. Independent T-test was used for between group comparisons of continuous variables (i.e. age and educational level). All tests were two-tailed and analyses yielding a $p<0.05$ were considered significant.

RESULTS

The two groups were comparable for age and level of education: Sz, age 37.5 (10.2 SD), education 13.3 (3.9 SD) years; Ctrl age 39.6 (10.4 SD), education 12.8 (3.0 SD) years. All patients were taking a stable dose of antipsychotic medication, 19 atypical and 11 typical. Benzodiazepines prescribed as sleep inducers were recorded for 9 patients.

Decision making performance

When considering overall decision making performance the two groups differed significantly in IGT total net score. Total monetary outcome showed a trend towards a significant difference (Sz 2075.00+572.92 vs. Ctrl 2382.81+536.51; z=1.78, p=0.07). When examining performance (net score) by blocks significant differences between groups were evident only for block 4 and 5 net scores (Table 1 and Figure 1). A comparison of decision making stages showed that the two groups differed only in the risky decisions (the last 60 choices).

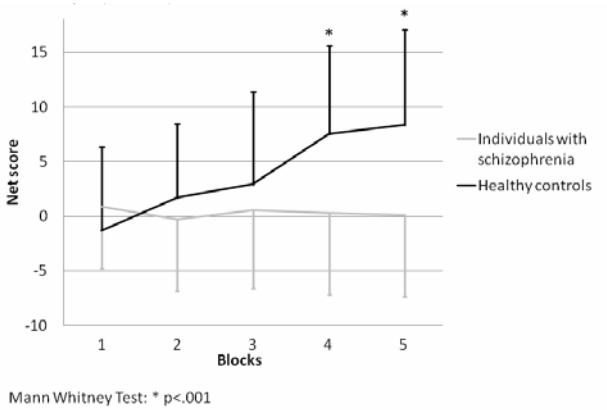

Figure 1. Iowa Gambling Task Net Scores, defined as the number of chioces from advantageous minus disadvantageous decks. for each of the 5 blocks of 20 choices. in the schizophrenic and control samples (mean±SD)

Clinical assessments

The SLOF and PANSS mean (SD) and item scores are reported in the Table 2.

Correlates of decision making performance in individuals with schizophrenia

None of the PANSS scales (i.e. positive, negative symptoms and general psychopathology) correlated significantly with the IGT or the SLOF scores. Table 3 shows the correlations between the SLOF scores and the IGT. The score domains related to social interactions (i.e. interpersonal relationships and community activities) and work skills significantly correlated with both IGT total and under risk net scores. Under risk net score was also positively correlated with the SLOF total score.

Table 1. Comparison of Iowa Gambling Task (IGT) between individuals with schizophrenia (n=30) and healthy controls (n=32)

IGT	Schizophrenics n=30	Controls n=32	Mann-Whitney test	p
Total Net score	1.40+27.48	19.13+28.03	2.14	0.030
Final budget	2075.00+572.92	2382.81+536.51	1.78	0.070
Block 1 net score	0.87+5.65	-1.31+7.63	1.61	NS
Block 2 net score	-0.27+6.62	1.69+6.82	0.17	NS
Block 3 net score	0.53+7.16	2.94+8.45	1.24	NS
Block 4 net score	0.27+7.48	7.53+8.07	3.42	0.001
Block 5 net score	0.10+7.47	8.37+8.75	3.36	0.001
Net score under ambiguity	0.60+10.75	0.37+11.76	1.16	NS
Net score under risk	0.90+18.37	18.84+2.36	3.07	0.002

Table 2. Means (SD) and item scores for Specific Level of Function Scale (SLOF) and Positive and Negative Syndrome Scale (PANSS) evaluations

	Mean score	Mean item score
SLOF		
Physical functioning	24.4 (1.0)	4.8 (0.1)
Personal care skills	31.6 (3.1)	4.5 (0.4)
Interpersonal relationships	21.3 (5.1)	3.0 (0.7)
Social acceptability	31.5 (3.4)	4.4 (0.4)
Community activities	46.5 (5.5)	4.2 (0.5)
Work skills	16.7 (6.9)	2.7 (1.1)
Total score	172.4 (13.6)	4.0 (0.3)
PANSS		
Positive symptom score	16.7 (7.8)	2.3 (1.1)
Negative symptom score	21.3 (7.0)	3.0 (0.9)
General psychopathology score	37.9 (11.7)	2.3 (0.7)
Total score	75.3 (21.1)	2.5 (0.7)

Table 3. Spearman rho correlations of Iowa Gambling Task (IGT) and Specific Level of Function Scale (SLOF) scores in participants with schizophrenia

	SLOF total score	Interpersonal relationships	Community activities	Work
Total Net score	0.52**	0.41*	0.39*	0.38*
Risky decisions net score	0.55**	0.44**	0.40*	0.37*

*p<0.05; **p<0.01

DISCUSSION

Decisions permeate people's everyday life and to a large extent direct people's success in life. Proficiency on a decision making task may provide an index of how people may approach decisions in their everyday life. In this study we investigated the relationship between the IGT and daily community functioning in individuals with schizophrenia. The results show a considerable and significant association between risky decisions, as evaluated by the IGT, and social and vocational functioning as measured by the SLOF. To the best of our knowledge, this is the first report showing an association between the DM performance and functioning in this group. We found only another study exploring this issue, however this was performed in individuals with a substance abuse diagnosis (Cunha et al. 2010).

The measure of functioning employed in this study is a hybrid scale, whose scores derive both from high contact clinicians and from patient observation and information (Harvey 2013). It has been found to be sensitive to milestone social and functional achievements and to correlate with neuropsychological measures suggesting this as a comprehensive measure of functional status (Sabbag et al. 2011).

We found significant correlations between the IGT and functioning scores but not with symptoms scores. The literature on the relationship between DM scores and symptomatology is rather inconsistent.. Some studies reported a positive association between IGT impairment and negative symptoms (Shurman et al. 2005); one study instead found association with positive symptomatology (Struglia et al. 2011). Other studies however did not found correlations with symptoms

(Evans et al. 2005, Hutton et al. 2002, Ritter et al. 2004, Cella et al. 2012).

Our results show no association between the PANSS and the SLOF scores suggesting a relative independence between symptoms and functioning assessments (Cella, et al. 2013). This result is consistent with previous studies (Heinssen et al. 2000, Bellack et al. 2004) and it is also compatible with the different perspectives of the psychopathological and social functioning evaluations with only partial overlap among these constructs, although with some exceptions (Harvey et al.1996).

A possible confounder of previous studies result may be medications. Drugs could affect mediators and moderators of symptoms and DM such as motivation, reward sensitivity, contextual processing and other dopaminergic related processes. The impact of medication on DM performance has been inconsistently reported in the literature with some studies suggesting no association (Ludewig et al. 2003, Ritter et al. 2004, Bark et al. 2005, Shurman et al. 2005) and only one study showing an association between atypical antipsychotics use and poor IGT performance (Beninger et al. 2003).

The motivational drive deficit could be a common explanation for both the cognitive and functional outcome impairments and influenced by reward processing dysfunction (Juckel et al. 2006, Foussias & Remington 2010). Unlike other negative symptoms motivational drive (i.e., avolition) is not clearly assessed in the PANSS hence we could not test its relevance to the processes investigated in this study (Ventura et al. 2009).

Although this is not the primary aim of the study, we report further evidence that individuals with schizophrenia show DM deficit. This finding is in line with previous research (Shurman et al. 2005, Sevy et al. 2007, Struglia et al. 2011). After the first IGT phase, where both patients and controls performed similarly, only controls showed a marked improvement in performance. A recent report by Kim et al. (2012) further support our results suggesting that individuals with schizophrenia are particularly impaired during the last IGT trials. Despite an initial DM strategy similarity in the two groups, control participants use initial experience to modify their DM behaviour. This may suggest that shifting behaviour may be problematic in individuals with schizophrenia and could imply that the second IGT phase could still be characterised by decisions under ambiguity in the patients group. Motivational difficulties are prevalent in individuals with psychosis and motivational issues might have further accentuate the differences in DM performance found in this study (Gold et al. 2015).

The study of risky decisions, in which options can be characterized by a known probability distribution over possible outcomes, has received significant attention from economists, psychologists and neuroscientist in the last few decades. These studies provided both cognitive accounts of preferences as well as an understanding of how neural processes mediating risk-taking behaviour relevant for real life choices (Trepel et al. 2005). Although our results do not provide enough information on the mechanisms underlying patients' impairment, based on the literature a number of possible explanations can be advanced. Inflexibility and perseveration are common difficulties observed in individuals with schizophrenia (Rossi et al. 2000, Goldberg & Green 2002) and these may have a detrimental effect on DM. The lack of sensitivity to large punishment (i.e. sensitivity to feedback) (Gold et al. 2008, Waltz et al. 2011) might also contribute to perseverative behaviour and lack of adaptation. The computation of accurate risk evaluation relies on working memory (i.e. memory encoding); extensive research has shown that this cognitive domain is impaired in individuals with schizophrenia (Cirillo & Seidman 2003, Lee & Park 2005, Ragland et al. 2009) and therefore may negatively impact DM.

Some limitations should be considered when interpreting the results of the study. The sample recruited is not large however adequate to explore the hypothesis under scrutiny. We do not have information from other decision making assessment task that could corroborate the information from the IGT such as the WCST (Cavallaro et al. 2003). A wider neuropsychological assessment would have provided further information on the possible correlations between real life functioning, decision making and specific cognitive domains. This information would have been interesting in assessing the relative contribution that different cognitive domains may have to functioning. The literature however suggests that the association between functional outcomes and cognition in psychosis are sparse and possibly mediated by other factors such as social cognition (Bowie & Harvey 2006).

Future research may explore the relationships between DM and prognostic factors, such as illness progression, duration of untreated psychosis, behavioural and/or financial problems, poor treatment adherence, addictive behaviours and interpersonal conflicts (Tandon et al. 2009).

CONCLUSIONS

Difficulties in adopting and maintain a successful decision making strategy may be responsible for poor functioning in individuals with schizophrenia. Complex feedback and adaptation requirements are common experience in novel situations, however people with schizophrenia may find it difficult to successfully master these processes and adapting their behaviour. Some recent work suggested that this pattern of insensitivity to reward is not permanent and can be modified with clinical interventions such as cognitive remediation therapy (Cella et al. 2014). In the context of broader psychosocial rehabilitation interventions targeting cognitive problems may also be beneficial to improve functioning (Penadés et al. 2012).

Taken together, these results, although preliminary and in need of replication, suggest that the assessment of DM, may be an important cognitive underpinning of functional outcomes.

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