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Full Length Research Paper

Cognitive estimation in patients with Alzheimer's disease and schizophrenia

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The purpose of this research was to examine the role of cognitive estimation in patients with schizophrenia and Alzheimer disease (AD), and also to investigate the role of gender and levels of education in the cognitive estimation. Participants were 43 patients with AD, schizophrenia and controls that were selected through matching sampling method in Iran. A demographic questionnaire and cognitive estimation test (CET) were used in this study. Resulting data demonstrated that patients with schizophrenia and AD had significantly higher size and quality underestimation than normal individuals and the control group had significantly higher size and time overestimation than patients with schizophrenia and AD. However, there weren't any significant group differences in weight under estimation and overestimation. Findings indicated that gender didn't have a significant effect in cognitive estimation and its dimensions. Nevertheless, the levels of education play significant roles in size underestimation, size overestimation, quality underestimation and time overestimation.

Key words: Cognitive estimation test (CET), schizophrenia, Alzheimer disease, gender, level of education.

INTRODUCTION

Cognitive estimation is an ability domain first proposed by Shallice and Evans (1978). This construct is typically assessed by posing questions for which the answers are not generally acquired through formal education and then to compare responses to estimations made by a normative sample. Cognitive estimation is an important task that people have to apply in their daily lives. For this task, person people often rely on several diverse mechanisms. For instance, numerical estimates can be directly retrieved from reconstructed memory (Friedman, 1993, 2004). In this manuscript, we will focus on the quantitative estimation: estimation from probabilistic information. To estimate a quantity of interest people usually rely on multiple information which is probabili-stically related to their required criterion in ongoing and working tasks. Overestimation is quite distance and higher from a real estimation while under estimation is somewhat close or smaller from a real object. For example, time as a dimension of cognitive estimation is a systematic tendency, an organization of mental representations and the way by which people give the order to their experiences (Michon and Jackson, 1985). The majority of the experimental work in the area of time perception has dealt with time estimation (Fraise, 1984), and the concept of time perspective (Decortis and Cacciabue, 1988; Marmaras et al., 1995; Zakay, 1990). However, people might show considerable differences in their efficiency with time. These differences and problems might result from their differences in a basic ability to perceive and estimate time (Wickens, 1992). Additionally, several factors such as gender, culture, and mental health have a direct influence on the participants' ability to estimate time (Block et al., 2000; Zakay, 1990). Likewise when people try to estimate a camel size or weight they could rely on information from many sources. Here, research indicated that size estimation is influenced by a few biological, educational and psychological intervention factors (Altabe and Thompson, 1990; Farrell et al., 2006; Rosen et al.,

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1995; Rosen et al., 1989). However, there are a variety of cognitive models that have been tendered to describe the cognitive processes caught up in quantitative estimations. These theories try to elucidate which information people rely on and how they use and integrate multiple pieces of information.

According to social judgment theory, human estimation comprising the cognitive one follows a linear additive strategy that can be apprehended by a regression model (Doherty and Brehmer, 1997). The linear additive approach infers that first; each cue is weighted according to its importance. Then, an estimate is procured by adding up the weighted cue values (Cooksey, 1996). Thus, optimal cue weights are building analytically by minimizing the squared deviation between the estimated quantity and the estimation (Cohen et al., 2003).

Exemplar models have been flourishing initially in modeling the cognitive process underlying categorizations (Nosofsky and Johansson, 2000). Due to this success, they recently have been pondered as models of estimations (Juslin, et al., 2003; Juslin et al., 2008). Exemplar models suppose that encountered objects are kept in memory and retrieved if a new object is evaluated. The estimation is grounded on a judgment of similarity between the object under evaluation and the exemplars put aside in memory. Consequently, the more similarity between an exemplar and the object under evaluation, there is the stronger the impact on the estimation of the requested task. The final estimate is given by the average of the criterion values of all stored exemplars, weighted by their similarities to the object under evaluation. Similarity is conceptualized as the cue or feature based and objects are described by their values on a list of features. Two objects are considered similar if their values on the features match. The features can differ in their importance for the similarity evaluation. For instance, when two objects are matching on all but one feature, they can still be considered as different if this cue is of central importance. Thus, the overall evaluation of similarity is reached by integrating all features based on the context model (Medin and Schaffer, 1978).

Heuristic models have been suggested as alternative models for explaining human estimation processes recently. In more complex decision situations, the simple heuristics were better suited to describe the behaviour than more complicated models based on optimization procedures (Bröder, 2000; Bröder and Schiffer, 2003; Rieskamp, 2006; Rieskamp and Otto, 2006). Hereby in many real-life situations, simple heuristics can predict human behaviour very well. For example, Hertwig et al., (1999) brought up a heuristic for estimation, which called the quick estimation. That is a non-compensatory model that does not merge information but bases its estimation on only one cue by sequentially searching through all available cues. Once a cue fulfils a previously set criterion, search is stopped and then an estimation is performed. However, there is no evidence that it can model human estimation processes successfully (Hausmann et al., 2007).

Brown and Siegler (1993) advocated a cognitive model of the quantitative estimation. They suggested two types of knowledge are necessary to make estimation. First, knowledge about the “mapping” properties of the objects is required. This knowledge reflects the ordinal relation among objects, that is, how high an object ranks on the criterion of interest, compared to the other objects. Secondly, knowledge about the “metric” properties of the criterion is necessary, such as the distribution, the mean, or the range. The mapping model describes how knowledge about the mapping properties of an object is linked to the metric properties of the criterion in the estimation process. During the first step, the mapping models use the cue information to capture the mapping properties of an object. Objects are grouped together according to their cue sums, inferring the ordinal relations of the objects from the number of positive cue values. Secondly, to represent the metric properties of the criterion, a typical criterion value is derived for each category by considering the criterion values of the objects falling into the same category.

Finally, based on a neuropsychological perspective, cognitive estimation is amongst the frontal lobe-associated functions and the neurological structures (Brand et al., 2003). Shallice and Evans (1978) have noted that patients with anterior brain lesions tend to make higher inaccurate and sometimes bizarre estimations. Coherent with the traditional view of executive dysfunction, Spencer and Johnson-Greene (2009) recognized that the assumption underlying the cognitive estimation tests are that there is a potential disconnection between an individual’s fund of knowledge and their responses. They revealed that even if the causality of cerebral damage was not examined, it does not negate the finding that the CET was not differentially sensitive to executive dysfunction. However, estimations were found to be disturbed in patients with specific disorders or diseases that might be due to a deficiency in emotional processing or their deteriorated basic processes underlying all kinds of cognitive estimation tasks. Many investigations in this field suggest that time; size, quantity and weight estimations can play possible roles in patients with neurological and psychotic disorders. For example, the Alzheimer's disease (AD) patients showed significant deficits in cognitive estimation in all tested dimensions (Brand et al., 2002). It was documented that patients with AD perform worse on cognitive estimation than healthy controls (Brand et al., 2003a, b). Nevertheless, investigation of subjects with Parkinson’s disease (Appollonio et al., 2003), frontote-mporal dementia (Mendez et al., 1998), and focal lesions (Taylor and O’Carroll, 1995) questioned the assumption that the cognitive estimation measures only evaluate frontal dysfunction. Alternatively, the study of time estimation in schizophrenia might reveal important information on the core cognitive disturbances of this disorder (Andreasen, 1999). This importance might arise from the involvement of key structures like the prefrontal cortex, thalamus, striatum and possibly the cerebellum (Gibbon et al., 1997).

Therefore, in spite of the aforementioned literature the complete and conclusive psychology of cognitive estimation in all dimensions has not been achieved properly. In sum, cognitive estimation is a type of problem solving ability and can be defined as a process of answer generation in which an exact answer is not readily available. Both semantic information and comparative strategies are used to generate an appropriate answer (Brand et al., 2002). According to aforesaid theories and literature cognitive estimation data could aid in differential diagnoses of patients with AD and schizophrenia from normal individuals but there is a lack of evidence for this area in Iran. This study proposed to investigate the influence of the estimates of size, weight, quantity and time in terms of the average error (accuracy) and the constant error (over and underestimation of the size, weight, quantity and time) in patients with AD, schizophrenia and in the control group; and then explore the differences between genders and the effects of levels of education concerning the size, weight, quality and time estimations. These would contribute to the further understanding of factors and variables involved in size, weight, quantity and time estimations, and thus help unravel this complex psychological puzzle. The first hypothesis of this study is that cognitive estimations (size, weight, quality and time) are differing among patients with AD, schizophrenia and the control group. The second hypothesis of this study is that gender and level of education play significant roles in cognitive estimations (size, weight, quality and time) among this sample.

MATERIALS AND METHODS

Participants

Participants included 43 patients with AD (N=12, F=5, M=7), schizophrenia (N=16, F=7, M=8) and control group (N=15, F=7, M=8) that were selected from Shiraz, Fars province, Iran. The control group screened for both Alzheimer's and schizophrenia diagnostic criteria by two professional specialists and after their approval, they recruited in this study. These samples were demographically comparable because all they matched with respect on their age and the level of education. The educational level of participants was assessed by asking them about their formal education in the national educational systems per years and their attained formal degrees. All patients recruited from outpatient departments. After informed consent was obtained, participants completed a demographic questionnaire with four inventories. For Alzheimer dementia patients, consent was acquired from a family member according to stately policies.

The demographic questionnaire contained age, gender and level of education. Then a cognitive estimation test (CET) was used for data collection on this issue. The CET is a 20-item test that was created by the authors in this study and measure four aspects of cognitive estimations with five estimation questions in each of these categories: Size, weight, quantity and time. This scale was founded on aforementioned theories and conceptualization models that involve dimensions of cognitive estimation across different situations in everyday life. All participants' replied to all items using three alternatives -1 (underestimation), 0 (accurate estimation) and +1 (overestimation). The CET reliability by Cronbach's alpha for all domains ranged from .63 to .86 in this study. According to the test-retest correlations provided by the authors the CET has a .86 correlation after one month interval. However, the construct validity of all domains was affirmed again by a few faculty staffs in psychology. When the CET concurrent validity was measured by the Biber cognitive estimation test (BCET; Bullard, Fein, Gleeson, Tischer, Mapou et al., 2004) its concurrent correlations were .72.

RESULTS AND DISCUSSION

To examine possible group differences in the first hypothesis one way analysis of variance (ANOVA) was conducted among the three groups with the group situation as between-subjects variables and all dimensions of CET as dependent variables. There are significant group differences in size underestimation ($F2, 40=7.49$, $p=.002$), size overestimation ($F2, 40=19.72$, $p=.0001$), quality underestimation ($F2, 40=4.67$, $p=.01$), and time overestimation ($F2, 40=9.89$, $p=.0001$). Posteriori following test for group differences by Duncan test indicated that patients with schizophrenia and AD had significantly higher size and quality underestimation than normal individuals. The control group had significantly higher size and time overestimation than patients with schizophrenia and AD. However, there aren't any significant group differences in weight under estimation and overestimation (Table 1). To examine the second hypothesis of this research study, a t-test for independent groups was conducted to evaluate the effects of gender and several ANOVAs were calculated for level of education differences in the cognitive estimations. Analysis rejected the effect of gender in the cognitive estimation. Findings indicated that levels of education play significant roles in size underestimation ($F2, 39=4.15$, $p=.01$), size overestimation ($F2, 39=13.77$, $p=.0001$), quality underestimation ($F2, 39=3.57$, $p=.02$) and time overestimation ($F2, 39=2.89$, $p=.05$). Posteriori following test for group differences by Duncan test indicated that individuals with elementary education had a significant lower size under estimation than those with secondary, high school and higher education but individuals with high school and higher education had significant size overestimation than other groups. Moreover, individuals with a higher education had significantly lower quality underestimation and higher time over-estimation than other groups. Additionally, to examine possible group, gender and levels of education differences and their interactions, a multivariate analysis of variance (MANOVA) conducted by

Table 1. The effects of cognitive estimation in different groups.

Dimension	Type of estimation	Groups						F	p
		Schizophrenia		Alzheimer disease		Normal			
		M	SD	M	SD	M	SD		
Size	Under	-20.25	10.06	-10.83	0.93	-0.93	0.88	70.36	0.002
	Over	0.68	10.07	10.50	10.31	30.13	0.91	190.72	0.0001
Weight	Under	-10.87	10.14	-20.58	10.62	-20.13	10.06	10.07	0.351
	Over	10.25	10.18	10.50	10.16	20.06	10.09	20.02	0.146
Quality	Under	-20.68	0.79	-30.58	0.99	-30.46	0.83	40.67	0.015
	Over	0.87	0.88	0.66	0.77	10.20	0.77	10.47	0.242
Time	Under	-0.87	0.80	-10.41	0.79	-0.86	0.51	20.52	0.093
	Over	20.00	0.81	20.25	0.62	30.40	10.18	90.89	0.0001

by group situation, gender, levels of education and their interactions as independents and the cognitive estimation and its four dimensions as dependent variables. An overall multivariate effect rejected the effects of gender, *Wilks' k* = .72; *F* (8, 24) = 1.14; *p*= .37, group status, *Wilks' k* = .41; *F* (16, 48) = 1.66; *p*= .08, levels of education, *Wilks' k* = .35; *F* (24, 70) = 1.24; *p*= .23, and their interactions in the cognitive estimation and its dimensions.

The results from this research in the first hypothesis demonstrated that patients with schizophrenia and AD had a significantly higher size and quality under-estimation than the normal individuals and control group had a significantly higher size and time overestimation than patients with schizophrenia and AD. However, there aren't any significant group differences in weight under estimation and overestimation. In line with previous literature, it seems that size estimation could be affected by three biological, educational and the psychological factors that including both psychological and neurological impairments (Altabe and Thompson, 1990; Farrell et al., 2006; Rosenet al., 1995; Rosen et al., 1989). This finding highlights the role of social judgment theory in cognitive estimation (Doherty and Brehmer, 1997).

It is possible both patients with schizophrenia and AD pursue underestimation strategy when they encounter different dimensions of estimation and this may result in cue's retrieval problems in their cognitive functioning in general. Therefore, there may be some correlation between memory difficulties and cognitive estimation in schizophrenia and AD, and this speculation is relatively supported by the exemplar models ((Nosofsky and Johansson, 2000; Juslin et al., 2003; Juslin et al., 2008). In contrast, heuristic models can simply predict the estimation strategy among healthy people (Bröder, 2000; Bröder and Schiffer, 2003; Rieskamp, 2006; Rieskamp and Otto, 2006). In addition, in concurrence with cognitive models it seems there is a different cognitive mapping and working mechanisms for knowledge attainment in normal individuals and patients with schizophrenia and AD (Brown and Siegler; 1993). The real explanation of these distinctions might needs to understand their neuropsychological underpinnings in schizophrenia and AD (Brand, Fujiwara, Kalbe, Steingass, Kessler et al, 2003; Shallice and Evans, 1978). Altogether cognitive estimation represents the personal knowledge procedures about the possible functionality of imaginative and non-compensatory problem solving skills that eventually will prevent the occurrence of executive dysfunction in normal individuals (Hausmann et al., 2007; Spencer and Johnson-Greene, 2009).

The results from this study in second hypothesis indicated that gender doesn't show a significant effect in cognitive estimation and its dimensions. However, the levels of education play a significant role in size under-estimation, size overestimation, quality underestimation and time overestimation. These are in contradiction with earlier literature, which supported the role of some cultural factor like gender in cognitive estimation (Block et al., 2000; Zakay, 1990).

Conclusion

In conclusion, the current research adds to the psychology literature because it explored the role of cognitive estimation in schizophrenia and AD as two deteriorating disorders with some shared neuropsychological impairment in the frontal lobe. Furthermore, this study rejected and confirmed the roles of gender and literacy in cognitive estimation respectively. Additionally, the results of the current study implicitly confirmed the roles of neuropsychological dysfunctions in cognitive estimation. However, this study limited because only was relied on data from the CET test in a clinical sample and control group. Further research may apply experimental and longitudinal designs for this purpose, and to examine this construct across different clinical samples with both psychological and neuropsychological instruments.

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