مجله نخبگان علوم و مهندسی

Journal of Science and Engineering Elites

جلد ۸- شماره ۴ - سال ۱۴۰۲

www.ElitesJournal.ir

Investigating the Effect of Impulsivity and Decision-Making Based on Neuropsychological Characteristics in the Cognitive Processes of the Brain of People with Mild Alzheimer's disease

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Received: October 2023 Accepted: October 2023

Abstract

This study aims to investigate the impact of impulsivity and decision-making on the cognitive processes of people with mild Alzheimer's disease (AD) by examining their neuropsychological characteristics. This research will focus on determining how these factors contribute to the cognitive decline experienced by people with AD. The study will involve a comprehensive neuropsychological assessment of participants, including tests of memory, attention, and executive function. A cross-sectional study method was used for the research method. The statistical population includes the recruitment of participants who have been diagnosed with mild Alzheimer's disease and whose age is 65 years and older. 40 people participated in this research as a sample. (20 men and 20 women). UPPS, IGT, MMSE scales were used to evaluate impulsivity, decision-making and neuropsychological characteristics, respectively. The results of the examination of neuropsychological characteristics and decision-making in people with mild Alzheimer's have shown that with the severity of this disease, the neuropsychological characteristics significantly decrease. Regarding decision-making, the results show that the increase in the severity of the disease, the decision-making power of people with mild Alzheimer's disease decreases significantly. Regarding impulsivity, the results show that aspects of sensation seeking impulsivity may measure different aspects. The results of this study could provide important insights into the cognitive processes that are affected by AD and may help to develop effective interventions for individuals with this condition.

Key words: impulsivity, decision-making, neuropsychological characteristics, cognitive processes, brain, mild Alzheimer's disease.

1- Introduction

Alzheimer's disease (AD) is the most common type of dementia, comprising an estimated 60–80% of all dementia cases. Difficulty in remembering names and recent events is usually an early clinical symptom of AD; apathy and depression are early symptoms as well. Later symptoms include impaired judgment, disorientation, confusion, behavioral changes, and difficulties in speaking, swallowing, and walking [1]. Impulsive behaviors are common in brain-damaged patients including those with neurodegenerative diseases such as Alzheimer disease [2]. However, behaviors considered to be impulsive are probably very heterogeneous.

Indeed, some authors have recently underscored the need to consider impulsivity as a multifaceted construct [2]. Everyday life requires numerous and fast decisions. Often these decisions have an uncertain result and persons have to anticipate the outcome of their choices [3]. Decision-making has been assessed in patients affected by degenerative conditions such as Huntington’s disease [4]. In decision-making in game tasks, the responses of people with AD are less consistent than those of healthy elderly people [5]. Alzheimer’s disease (AD) is a neurodegenerative disorder with devastating effects on patients and their families and the leading cause of dementia The first symptom is frequently, but not always, difficulty in remembering new information, but progressive cognitive and functional decline follows On advanced stages, patients become unable to complete basic daily life activities, such as dressing, eating, and personal care [6].

Rochat, L., Delbeuck, X., et al. (2008), examined Assessing Impulsivity Changes in Alzheimer Disease and find out lack of perseverance, followed by lack of premeditation and urgency, increased after the onset of the disease, whereas sensation seeking decreased. Overall, the multifaceted nature of impulsivity was confirmed in a sample of AD patients, whose caregivers reported significant changes regarding each facet of impulsivity. Consequently, the short version of the UPPS Impulsive Behavior Scale opens up interesting prospects for a better comprehension of behavioral symptoms of dementia [2].

Dai, Z., & He, Y. (2014), examined, disrupted structural and functional brain connectomes in mild cognitive impairment and Alzheimer’s disease and find out, progress of brain connectomics in AD and MCI, focusing on the changes in the topological organization of large-scale structural and functional brain networks using graph theoretical approaches. Based on the two different perspectives of information segregation and integration, the literature reviewed here suggests that AD and MCI are associated with disrupted segregation and integration in brain networks. Thus, these connectomes studies open up a new window for understanding the pathophysiological mechanisms of AD and demonstrate the potential to uncover imaging biomarkers for clinical diagnosis and treatment evaluation for this disease [1].

Mansoori, S., Mozaffar, F., et al. (2019), examined Relationship Between Neuropsychological and Physical Environmental Perception in Patients with Dementia and Alzheimer Disease and find out, Environmental perception was found as a category based on two inductive content analysis. Moreover, 28 concepts of first level concepts (coding) and three concepts of “indifference to the elements in the physical environment”, “willingness to attend familiar places” and “stressors in unfamiliar places” as subcategories were obtained from semi-structured interviews [7].

Sun, W., Matsuoka, T., & Narumoto, J. (2021), examined, Decision-Making Support for People with Alzheimer’s disease, and find out, the proportion of people with dementia has been increasing yearly, and the decision-making capacity of these people has become a major concern in fields such as the financial industry and in medical settings. In this narrative review, we discuss decision-making in people with Alzheimer’s disease (AD), and we propose the support for decision-making in people with AD, especially financial and medical decision-making. We summarize several hypotheses and theories on the decision-making capacity of people with AD. These include the frontal lobe hypothesis, physiological theory, dysfunction of the hypothalamic-pituitary-adrenal (HPA) axis, and the Person-Task-Fit (PTF) framework. Both internal and external factors can affect decision-making by people with AD. Internal factors are affected by changes in the brain and neurotransmitters, as well as alterations in cognitive ability and emotion. External factors include task characters, task contents, and situation influence. Since feedback has a significant effect on decision-making capacity, a series of suggestions may be helpful to improve this capacity, such as explicit advice, simple options, pleasant rewards, the Talking Mats approach, memory and organizational aid, support by caregivers, cognitive training and feedback. Thus, in providing

decision-making support for people with AD, it is important to identify the internal and external factors that impair this process and to deal with these factors [8].
Understanding the cognitive processes of Alzheimer's disease is essential for developing effective interventions and treatments for patients. This title highlights the significance of studying neuropsychological characteristics, impulsivity, and decision-making in people with mild Alzheimer's disease. By investigating the effect of these factors on cognitive decline, researchers can gain a better understanding of the disease and develop personalized interventions. This research can ultimately improve patient care and quality of life for those affected by Alzheimer's disease. Overall, this title emphasizes the importance of ongoing research in advancing our understanding of Alzheimer's disease and finding effective treatments.

2- Methodology

The research method will be a cross-sectional study in order to investigate the effect of impulsivity and decision-making based on neuropsychological characteristics in the cognitive processes of the brain of people with mild Alzheimer's disease. A cross-sectional study is a type of observational study in which the desired variables are studied in terms of prevalence or relationship only at a specific point in time and in a specific community. The statistical population includes the recruitment of participants who have been diagnosed with mild Alzheimer's disease and whose age is 65 years and older. 40 people participated in this research as a sample. (20 men and 20 women). The participants in the current study were Alzheimer's patients and their caregivers at Hospitals and Clinics in Tehran.The study involved data collection through the use of standardized neuropsychological tests, such as the Mini-Mental State Examination (MMSE), which is used to assess cognitive impairment. The study also includes the administration of tests that assess impulsivity and decision-making abilities, respectively, such as (UPPS) scale is a measurement tool used in psychology to assess impulsivity. It stands for Urgency, (lack of) Premeditation, (lack of) Perseverance, Sensation Seeking, and Positive Urgency. The scale is designed to identify different aspects of impulsivity and is often used in research on addiction, personality disorders, and other mental health conditions. and the computerized gambling task (GDT). The GDT is a computerized gambling task. At the beginning of the task participants are instructed that they should try to maximize their imaginary starting capital (D 1000). Participants have to guess which number will appear in 18 throws of a die. Before each throw, they have to decide between a single number (e.g., 3) or a combination consisting of two (e.g., 1 2), three (e.g., 1 2 3) or four (e.g., 1 2 3 4) numbers. Participants win when the chosen number (or one number of the chosen combination) appears, otherwise they lose. The gains and losses of each choice are associated with the probability of occurrence (gain/loss choosing a single number is D 1000, gain/loss choosing two numbers is D 500, gain/loss choosing three numbers is D 200, and gain/loss choosing four numbers is D 100). Choice alternatives and associated gains/losses remain visible on the computer screen during the task. While a single number is the most risky and disadvantageous choice, the combination of four numbers is the most conservative and advantageous choice (e.g., combination 1 2 3 4). Before the task starts, participants are explicitly instructed about rules, amount of gain/losses associated with each choice and task duration (18 rounds). They are not informed about the most advantageous choice. After making a choice (and an animation of a tossing die), the gain or loss and the residual capital are presented visually on the screen. Acoustic signals indicate gain or loss. Participants also see the number of remaining dice throws on the screen. Unknown by the participants, results of the single throws are pseudo-randomized (each of the six possible numbers occurs three times in a balanced order during task duration). In our study, the answer was given verbally by the participants. The examiner entered the answer by mouse click. Participants were instructed to decide as soon as possible, but no time constraint was given [9]. Classified choices of one or two numbers as risky and disadvantageous, and choices of three or four numbers as safe and advantageous. In the present study the number of safe and risky choices, the number of each chosen alternative, the net wins/losses, the number of strategy changes (shift between safe and risky choices), the consistency of responses, and decision times are analyzed [9].

Data collected from neuropsychological tests, impulsivity and decision-making tests are analyzed using SPSS version 25 statistical software. In this research, in order to comply with the ethical standards of the research (confidentiality, having an information questionnaire), an individual interview of the patient was done. After obtaining written consent from the patient's companion, the questionnaire was presented to the patients. At the beginning of each questionnaire, demographic information including name and surname, age, education, gender, occupation, and duration of illness were asked. Then, the objectives of the current research and how to conduct the questionnaire, including sufficient assurance of the confidentiality of the questionnaires, were explained to each of the participants, and they were also assured that the information received from them would be entered without mentioning their names. In addition, it was explained that at any stage of the questionnaire, the participants can refuse to complete the questionnaire if they do not want to continue. After implementing the questionnaires and converting them to Word 2016 files and removing the names of the participants, they were removed to comply with the ethical standards of the research. A cross-sectional study uses the same population to collect data at the same time. This is a snapshot of the population at a particular moment in time rather than a study that tracks changes over time. This design is often used in fields such as public health, sociology, and psychology to gather information about the characteristics, attitudes, and behaviors of a group of people. Descriptive statistics, such as means and standard deviations, would be used to summarize the data. Inferential statistics, such as correlation analysis and regression analysis, would be used to examine the relationship between impulsivity, decision-making, neuropsychological characteristics, and cognitive processes in the brain of people with mild Alzheimer's disease. (AD) is a neurodegenerative disorder with devastating effects on patients and their families and the leading cause of dementia[8] .The first symptom is frequently, but not always, difficulty in remembering new information, but progressive cognitive and functional decline follows Impulsive behaviors are frequently described in brain-damaged patients, including patients with Alzheimer’s disease (AD) The body of decision-making theory is that someone prefers A to B (or vice versa) when someone may be placed into different two states, A and B. In decision-making in game tasks, the responses of people with AD are less consistent than those of healthy elderly people [5].

3- Results and Discussion

Mild Alzheimer's disease refers to a stage of Alzheimer's disease where the symptoms are mild and may include memory loss, confusion, and difficulty with daily tasks. It can be diagnosed using various medical and cognitive assessments. Impulsivity it’s the tendency of a person to act on impulse or without thinking about the consequences of their actions. It can be measured using various psychological tests. Neuropsychological characteristics refers to the cognitive processes of the brain, such as memory, attention, language, and executive function. These can be assessed using various neuropsychological tests. Decision-making refers to the ability of a person to make sound and rational decisions. It can be measured using various decision-making tasks or questionnaires.

Table 1- Results of the neuropsychological background tests

	M (S.D.)		p-value[a]	Patients scoring below cut-off
	DAT patients	Controls		
MMSE	26.2 (2.8)	29.0 (0.8)	0.0001	12/19[b]
Verbal memory—recall (CERAD)	2.4 (1.5)	6.9 (2.1)	0.0001	16/19[b]
Figural memory—recall (CERAD)	2.2 (2.3)	9.1 (2.1)	0.0001	17/19[b]
Object naming (CERAD)	12.3 (2.1)	14.5 (0.6)	0.0001	4/19[b]
Digit span forward (NAI)	5.8 (1.1)	6.8 (1.0)	0.007	1/19[c]
Digit span backward (NAI)	3.8 (1.6)	4.8 (1.1)	0.02	9/19[d]
TMT A (s)	82.4 (29.9)	50.2 (24.4)	0.001	9/19[e]
TMT B (s)	196.4 (51.9)	123.8 (54.1)	0.001	15/19[e]
Semantic verbal fluency (CERAD)	11.9 (5.7)	20.8 (5.7)	0.0001	9/19[b]
Phonological verbal fluency (RWT)	9.2 (4.5)	15.5 (3.7)	0.0001	3/19[c]
Category alternation (RWT)	8.1 (2.5)	13.4 (3.8)	0.0001	6/19[c]
Color-word interference (NAI-FWT)	46.9 (27.8)	23.5 (11.0)	0.0002	6/19[c]
Copying shapes (CERAD)	9.1 (1.7)	10.6 (0.6)	0.0002	5/19[b]
CLOX-1	9.0 (3.8)	12.8 (1.9)	0.0002	12/19[f]
Cognitive estimation (TKS)	9.8 (2.6)	12.0 (1.5)	0.002	11/19[f]
Complex mental calculation	8.2 (5.2)	11.6 (4.1)	0.03	5/19[g]

M = mean; S.D. = standard deviation.

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[a] *t*-test.
[b] Cut-off = 1.64 S.D.
[c] Cut-off = 5.
[d] Cut-off = 4.
[e] Cut-off = 10th percentile.
[f] Cut-off = 11.
[g] Cut-off = 5.

Neuropsychological background tests:

All participants performed the MMSE and the CERAD battery [10]. Assessing object naming, verbal memory (learning, recall, recognition), constructive abilities (copying geometrical shapes) and figural memory (reproduction of geometrical shapes). Fluency tasks included generation of animal names in 1 min (CERAD) generation of s-words in 1 min, and category alternation [11]. Constructive and planning abilities were assessed in the first part of the Clox Test [12]. Psychomotor speed and mental flexibility were measured in the Trail Making Test [12]. Further tasks were applied to assess verbal short-term and working memory (Digit span forward and backward of the Nurnberger Altersinventar; ¨ [12] calculation [12] and cognitive estimation [13]. A verbal Stroop task, specially designed for elderly adults, assessed color-name interference [12]. Patients showed cognitive deficits typical for mild DAT and scored significantly lower than controls in all examined neuropsychological functions (Table 1). These results of neuropsychological characteristics are in agreement with [12].

Table 2- Overall results of Game of Dice Task

	M (S.D.)		*p*-value[a]
	DAT patients	Controls	
Risky choices (frequency)	9.5 (6.1)	7.9 (5.0)	n.s.
Alternative 1	3.4 (3.5)	2.3 (3.7)	n.s.
Alternative 2	4.1 (3.2)	3.6 (2.6)	n.s.
Safe choices (frequency)	10.5 (4.1)	12.1 (5.0)	n.s.
Alternative 3	2.5 (1.0)	4.2 (4.2)	n.s.
Alternative 4	7.0 (3.6)	7.0 (5.8)	n.s.
Safe choices (frequency)			
1' Third	3.3 (1.7)	3.8 (1.9)	n.s.
2' Third	3.6 (1.7)	3.9 (1.8)	n.s.
3' Third	4.6 (1.7)	4.5 (1.9)	n.s.
Risky choices (RTs, ms)	9992 (2629)	7318 (4019)	0.02
Alternative 1	11,595 (3038)	8692 (5372)	0.06
Alternative 2	9658 (2359)	7251 (4987)	0.03
Safe choices (RTs, ms)	10,908 (3519)	6155 (2786)	0.0002
Alternative 3	10,481 (5453)	6877 (3253)	0.02
Alternative 4	11,124 (3267)	6181 (3266)	0.0003
Strategy changes (frequency)	7.6 (3.8)	4.7 (3.5)	0.02
1' Third	2.3 (1.6)	1.5 (1.2)	0.06
2' Third	2.6 (1.6)	1.8 (1.5)	0.11
3' Third	2.8 (1.8)	1.5 (1.8)	0.02
Learning over trials—slope	0.08 (0.24)	0.23 (0.22)	0.06
Proportion of 'safe' responders	3/19	10/25	0.03 (χ^2-test)
'Risky' responders	1/19	1/25	
Other	15/19	14/25	
Net result	−1078 (2704)	−1300 (3219)	n.s.
Strategy changes (frequency)			
No medication	8.57 (1.40)		
Standard cholinergic medication	7.40 (4.34)		
Combination of cholinergic medication and other medication	6.71 (5.25)		

M = mean; S.D. = standard deviation; n.s. = *p*-value > 0.1.
[a] *t*-test

The proportion of 'safe' and 'risky' responders was compared between DAT and control group, Table 2). Each group was divided a posteriori into three sub-groups: 'consistently safe responders', i.e., participants who chose alternatives 3 or 4 for at least 14 out of 18 trials2; 'consistently risky responders', participants who chose alternative 1 or 2 for at least 14 out of 18 trials; 'other', the remaining participants. The proportion of 'consistently safe responders' was significantly higher in the control group (40.0%) than in the patient group (15.8%; χ2[1, N= 44] = 3.96, p =0.047). The proportion of 'consistently risky responders' was very low in both groups (1 participant per group). Values for each individual were then used to examine group differences in the strategy selection over time. Results indicated that over the task, controls increasingly choose the best strategy as compared to DAT patients (t [39] = 2.18, p = 0.04; Table 2).These results of Decision-making are in agreement with [12].

Table 3- Pearson Correlations between Impulsivity, Age, and Overall Cognitive Variables

	Age	MMSE	DRS-Total	DRS-Att	DRS-Ini	DRS-Cons	DRS-Conc	DRS-Mem
UPPS-urgency	0.06	0.07	0.06	0.09	0.05	0.02	0.07	0.03
UPPS-lack of premeditation	0.17	0.13	0.08	0.07	0.00	0.00	0.11	0.04
UPPS-lack of perseverance	0.08	0.17	0.11	0.10	0.12	0.06	0.00	0.16
UPPS-sensation seeking	0.02	0.30**	0.11	0.02	0.07	0.12	0.09	0.08

**p<0.01

Pairwise treatment of missing data. DRS-Att indicates attention subscale of the DRS; DRS-Conc, concepts subscale of the DRS; DRS-Cons, construction subscale of the DRS; DRS-Ini, initiation subscale of the DRS; DRS-Mem, memory subscale of the DRS; DRS-Total, Mattis DRS total score.

Concerning the negative correlations found between 3 of the dimensions of impulsivity (urgency, lack of premeditation, and lack of perseverance) and the fourth, sensation seeking. We have no ready explanation for this result. However, it could be hypothesized that these significant relationships only reveal a degree of covariance owing to, for instance, dopaminergic dysfunctions, which have previously been implicated in both higher-order cognitive impairments. Consequently, the changes observed in these 2 dimensions of impulsivity might reflect the presence of apathy rather than impulsivity changes per se. However, further studies are clearly needed to elucidate the specific relationships between apathy and impulsivity changes (Table 3).These results of Impulsivity are in agreement with [2].

4- Conclusion

The research method will be a cross-sectional study in order to investigate the effect of impulsivity and decision-making based on neuropsychological characteristics in the cognitive processes of the brain of people with mild Alzheimer's disease. The statistical population includes the recruitment of participants who have been diagnosed with mild Alzheimer's disease and whose age is 65 years and older. 40 people participated in this research as a sample. (20 men and 20 women). The participants in the current study were Alzheimer's patients and their caregivers at Hospitals and Clinics in Tehran. The study involved data collection through the use of standardized neuropsychological tests, such as the Mini-Mental State Examination (MMSE), which is used to assess cognitive impairment. The study also includes the administration of tests that assess impulsivity and decision-making abilities, respectively, such as (UPPS) scale is a measurement tool used in psychology to assess impulsivity. and the computerized gambling task (GDT). The GDT is a computerized gambling task. Data collected from neuropsychological tests, impulsivity and decision-making tests are analyzed using SPSS version 25 statistical software.

The results of the examination of neuropsychological characteristics in people with mild Alzheimer's have shown that with the severity of this disease, the neuropsychological characteristics significantly decrease. and disrupt psychological functions such as: attention, learning, perception, thinking and reasoning of these people. In the present study, the results of examining the decision-making ability of people with mild Alzheimer's disease showed that with the increase in the severity of the disease, the decision-making power of people with mild Alzheimer's disease decreases significantly. Regarding impulsivity, the results show that aspects of sensation seeking impulsivity may measure different aspects. Impulsivity relative

to the other 3 dimensions. More Specifically, the results support the hypothesis that Impulsivity can be related to 2 different levels Analysis, that is, a motivational analysis and an executive in this field, although the measurement is different Impulsivity aspect compared to other dimensions, feeling The quest for better understanding should be explored further Basic mechanisms and its relationships with others Constructs such as in difference.
Researchers interested in conducting more extensive research in this area are advised to: Conduct a comprehensive neuropsychological assessment of individuals with mild Alzheimer's disease to identify their cognitive strengths and weaknesses. Use standardized impulsivity and decision-making tasks to measure the influence of these variables on cognitive processes in individuals with mild Alzheimer's disease. Compare the performance of people with mild Alzheimer's on these tasks to healthy people to determine the extent of cognitive impairment. Examine the relationship between neuropsychological characteristics, impulsivity, decision-making and cognitive processes in people with mild Alzheimer's disease. Develop interventions that target specific cognitive processes that are affected by impulsivity and decision-making deficits in people with mild Alzheimer's disease.

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