Effect of Age on Strategic Problem Solving Abilities Using an Open Ended Version of the Twenty Questions Task

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Citation

Abstract: The study explores the age-related trends for an open ended version of the Twenty Questions task, which requires an individual to freely choose questions pertaining to a category in order to organize concepts and solve problems, further making it sensitive in assessing frontal lobe functions. The study comprised of 63 adult participants with 21 participants each, in the young, middle and old age group, to whom an open-ended Twenty Questions task was administered. The accuracy of response, number and type of questions asked and impulsivity were measured. Statistically significant differences in performance were observed between old vs. young (p<0.05) and old vs. middle aged (p=0.002) adults. Older adults obtained lower accuracy scores (Median=0.333) and highest number of hypothesis scanning questions (Median=6.1667) and impulsivity (Median=3.333). The study highlights a reflection of frontal lobe functioning on the age-related differences in concept formulation with problem solving abilities, on a Twenty Questions task.

Key Words: Aging, Problem solving, Twenty questions task, Frontal lobe

Introduction: Executive function includes a spectrum of processes like concept formation, verbal fluency, problem solving, reasoning and judgment. They have been assessed through several cognitive communication test batteries in various ways (1). One such task which has gained relatively lesser attention in the executive assessment practice is the ‘Twenty Questions task’ which originated in the United States during Nineteenth century. It gained its popularity during the late 1940s. Twenty Questions is an extension of the old parlor game which requires the participants to guess the semantic entity from a category that the examiner has in mind within a limit of 20 polar questions, which elicits the answer in the form of yes or no. This task taps the way people organize their knowledge about the world and it requires them to modify their answers based on the examiner’s feedback for their previous answers (2). The participants’ concept formation skills are directly reflected in his/her approach towards identifying the entity. There are two versions of the Twenty Questions task: one is closed, in which the participant selects a response from a limited array of objects and the other is open, in which the participant is free to choose from the entire category and is not presented with an array of items (3). The close-ended version of the task has been used in past for studying frontal lobe dysfunctions and age-related changes (4). However, studies with open-ended version have been limited to frontal lobe dysfunction. (3, 5)

The frontal regions of the brain have been reported to be sensitive in planning, evaluating the feedback and in adopting an appropriate strategy to complete a task like Twenty Questions (6). Various clinical conditions which involve the frontal regions in the cortex, like Autism spectrum disorders (7); Chronic alcoholism (8), and Traumatic brain injury (9-10), have shown deviant performances on the Twenty Questions task.

Within the frontal regions, the orbitofrontal regions are reported to be responsible for the reduction in the impulse control (11-13). The dorsolateral regions are suggested to be
responsible for executing the efficient strategies for problem solving (14-15). Frontal lobe is proven to be vulnerable to age related changes. According to frontal aging hypothesis, the skills that largely depend on frontal regions would decline with aging, while skills that are independent of frontal lobes would be considerably spared. The hypothesis further predicts that age-related brain changes would selectively impact frontal regions (16). Knowing the dependence of Twenty Questions task on the frontal lobe integrity, and the differential aging patterns of frontal lobe, it is logical to hypothesize that aging may pose distinct effects on the performance of Twenty Questions task.

There have been attempts to explore the age-related differences on the strategies used while solving a Twenty Questions task. Authors have provided evidence that efficiency on this task is age sensitive (4, 17-18). Older adults use single target questions or less efficient types of constraint questions while arriving at the accurate answer. Also, the existing studies have focused on evaluating these changes on accuracy and the nature of strategy used from a close set version of the Twenty Questions task through visual modality. Thus, the aim of the present study was to explore the trends across different adult age groups, for an open ended version of the Twenty Questions task. Parameters like number of questions for correct identification; accuracy of the answer; measure of impulsivity; and the type of questions asked to arrive at the target entity were considered for the study. It further attempted to understand the age related changes on the Twenty Question task with respect to the frontal lobe function.

**Method**

**Participants**

Sixty three adult participants were recruited from the community and divided into 3 groups; 21 young adults (mean age=21.25 years SD-5.3 years, Male=11, Female=10), 21 middle aged adults (mean age=47.5 years, SD = 6.8 years, Male=11, Female=10) and 21 old aged adults (mean age= 72 years, SD = 6.4 years, Male=11, Female=10). The participants across the age groups were matched for gender and minimum education. All the participants belonged to the middle socio-economic status on the basis of the National SES scale for Urban Population (19). Based on the National Institute on Alcohol Abuse and Alcoholism (NIAAA) scale (20) and the classification of smoking (21), only participants who were non/very light drinkers and non-smokers respectively were included in the study. Mini Mental State Examination (22) was administered to the participants for ruling out presence of occult cognitive impairment.

**Measures**

The present study involved the open ended version of the Twenty Questions task (3), where the participants had to find out the name of the entity that the examiners had in their mind for three semantic categories; Animal (Crocodile), Fruit (Grapes) and a famous Indian Person (Mahatma Gandhi).

**Procedure**

All procedures performed in the study were in accordance with the ethical standards of the Institutional Ethics Committee and written consent was obtained from all the participants included in the study.

The participants were instructed to identify the entity, from each semantic category, by generating not more than 20 polar questions. The semantic category was revealed to the participants before assessing each of the three entities. Each question generated by the participant was followed by yes/ no feedback from the examiner. The questions asked by the participants were audio recorded, transcribed and subjected to further analysis.

The responses obtained for all the three categories were averaged and the analysis involved the computation of:

a) The number of questions asked to arrive at the target entity

b) The accuracy of the response (which is determined if the participant could identify the entity accurately without exhausting the 20 questions) across the three categories.

c) The impulsivity measure which was extracted on the basis of the number of questions generated before the first direct guess in each trial

d) The number of constraint, pseudoconstraint and hypothesis scanning questions, across the three categories. Constraint questions are classified as being the most effective questions asked, to narrow down the semantic search by discarding a series of different possibilities of an entity (e.g. “Does it live in forest?” or “Is it a carnivore?” while identifying an entity from animal category). Pseudoconstraint questions are regarded as less effective type of questions asked during the search, as these questions only apply to one particular entity (e.g. “Does that animal bark?” while identifying an entity from animal category). Hypothesis scanning question involves a direct guess of the entity without eliminating the other possibilities, based on the feedback obtained from the previous questions (e.g. “Is it a dog?” or “Is it a cat?” while identifying an entity from animal category).

**Statistical Analysis**

The computed data was subjected to descriptive statistics, Kruskal Wallis test for assessing between group differences and Mann-Whitney test for pairwise comparison, using SPSS 16.0 version with 95% confidence interval and 5% significance level.

**Results**

**Age and accuracy on Twenty Questions task**

Across the three groups a statistically significant difference (H(2)= 21.284 , p= 0.000) in the accuracy scores were observed, with a mean rank of 42.86 for young adults, 34.43 for middle aged adults and 18.71 for old aged adults. Old aged adults obtained the lowest accuracy scores (Median= 0.333) than middle aged adults (Median= 0.6667), U= 103, p= 0.002 and young adults (Median= 1), U= 58,500, p= 0.000 as depicted in figure 1.

![Figure 1: Average accuracy scores on Twenty Questions task across the three adult age groups](image)

Note: A vAcc=A;verage accuracy scores; YA=Young adults; MA=Middle aged adults and OA=Old aged adults
Based on the descriptive statistics as shown in figure 2, the number of questions asked was slightly higher by the old aged adults than the other two groups. However, no statistically significant age effects were observed (p> 0.05).

**Age and type of the questions generated on Twenty Questions task.**

The median values for each of the question types asked by the participants of the three groups, has been depicted in the box plots as shown in figure 3, 4 and 5. As seen in figure 3 and 4, the middle aged adults generated significantly higher number of constraint and pseudoconstraint questions than the young and old aged adults, respectively. However, there were no statistically significant group effects (p>0.05). There was a statistically significant difference (H(2)= 13.239, p= 0.001) in the number of hypothesis scanning questions, as evident in figure 5 across the three groups with a mean rank of 24.69 for young adults, 27.57 for middle aged adults and 43.74 for old aged adults. Old aged adults asked more number of hypothesis scanning questions (Median= 6.1667) than middle aged adults (Median= 3), U= 105, p= 0.004 and young adults (Median= 3.6667), U= 89.5, p= 0.001.

**Age and measure of impulsivity on Twenty Questions task**

There was a statistically significant difference (H(2)= 6.616, p= 0.037) for the impulsivity measure, between the three groups (as shown in figure 6), with a mean rank of 36.52 for young adults, 35.86 for middle aged adults and 23.62 for old aged adults. The least number of questions before the first direct guess were asked by the old aged adults (Median= 3.3333) than middle aged adults (Median= 5.1667), U= 139.5, p= 0.041 and young adults (Median= 4.6667), U= 125.5, p= 0.017.
Discussion
The aim of the present was to examine the differences in the performance on a Twenty Questions task between the young aged, middle aged and the old aged adults. The various measures evaluated were total number of questions, accuracy of the response, the impulsivity measure, and the type of questions. The findings of the present study indicate significantly lower accuracy scores for old aged adults in comparison to middle and young aged adults. The accuracy of semantic search, in tasks like Twenty Questions, seems to reflect the deductive problem-solving efficiency in an individual. It is difficult to achieve high level performance without using efficient strategies to identify the target item. Age-related differences in the use of such efficient strategies have been evidenced in literature. Elderly adults tend to use less efficient strategies than younger adults in problem solving (4). Moreover, strategies profoundly rely on the working memory capacity. In the Twenty Questions task, it is important that one efficiently monitors the prior responses and the feedback, in order to accurately solve the problem. There have been multiple instances in literature where significant decline of working memory among old aged adults has been emphasized. Old aged adults have difficulties in both gating out irrelevant information from working memory and deleting the previous information which are no longer useful (23). It is worth noting that the age related changes which are evident on the accuracy measures do not reflect similarly on the number of questions generated. All the three age groups generated equivalent number of questions while solving the problem. This finding further supports the working memory deficits among the old aged adults where they seem to ask more number of redundant questions (e.g. asking if the famous person is a male, having already asked if the person is a female), thus leading to a mismatch between number of questions generated and the problem solving accuracy. Similar mismatch was not present for the other two groups who asked equivalent number of questions and exhibited better accuracy. With respect to the type of questions, the present study found old aged adults using significantly higher number of hypothesis scanning questions as compared to young and middle aged adults. The differences between the number of constraint and pseudoconstraint questions across the three groups were insignificant. It should be recalled at this stage that hypothesis scanning type of questions are the least efficient and indicate a poor strategizing ability during problem solving. The key to success in Twenty Questions task is to understand how to split the problem space with effective questions. Older people fail to apply this strategy and immediately ask a hypothesis scanning question (e.g., ‘is it a dog?’) (24). The frontal lobe has been reported to play a critical role in exploration age related changes in frontal lobe regions. Among various parameters of the Twenty Questions task, which was administered across participants of the three age groups, the impulsivity measure and the number of hypothesis scanning questions seems to be sensitive to age effects. In the last two decades, Twenty Questions task had been widely used in assessment of individuals with frontal lobe dysfunction. Present evidences, though emerging from a smaller sample size, further widens the scope of the open-ended version of Twenty Question Task in cognitive-communication assessment battery among healthy and pathologically aging adults. Inclusion of twenty question task in clinical settings can offer a quick and economical option for assessment of strategic problem solving, to the clinicians catering to the cognitive communicative concerns of the ageing population.

Conclusion
The present study was conducted with an objective of exploring the utility of Twenty Questions task in providing an insight into age related changes in frontal lobe regions. Among various parameters of the Twenty Questions task, which was administered across participants of the three age groups, the impulsivity measure and the number of hypothesis scanning questions seems to be sensitive to age effects. In the last two decades, Twenty Questions task had been widely used in assessment of individuals with frontal lobe dysfunction. Present evidences, though emerging from a smaller sample size, further widens the scope of the open-ended version of Twenty Question Task in cognitive-communication assessment battery among healthy and pathologically aging adults. Inclusion of twenty question task in clinical settings can offer a quick and economical option for assessment of strategic problem solving, to the clinicians catering to the cognitive communicative concerns of the ageing population.

Funding
This study was funded by Technology Interventions for Disabled and Elderly, Department of Science & Technology (DST-TIDE), Government of India (Grant No. SEED/TIDE/005/2013-[C]).

References