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Comparing the cognitive Flexibility and Response Inhibition Abilities in Individuals with Mild Cognitive Impairment and Older Healthy Individuals

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Abstract

Cognitive flexibility refers to the ability to switch rapidly between different responses sets. It is further sub divided into set shifting and cognitive shifting. While set shifting is considered to be automatic, cognitive shifting is considered to be conscious and strategic. Cognitive shifting can be assessed through a variety of linguistic and non-linguistic tasks. The non-linguistic tasks include stroop task, non-zero task etc. The alternating fluency task is a linguistic task, built in the same lines of generative naming. The only difference is that the participant has to rapidly alternate between two lexical categories in other words has to name a lexical item from first lexical category and then name a lexical item from the other lexical category. Response inhibition is the other executive function required for performing the alternating fluency task, as it would require the participants to inhibit the response belonging to the other lexical category. The current study was taken up with the aim of comparing cognitive shifting abilities in individuals with MCI and older individuals by employing alternating fluency task. Four lexical category combinations (animals-vehicles; birds-common objects; fruits-vegetables, colours and body parts) were considered and the task of participant was to name a lexical category from each combination (at once) within a period of 2 minutes. Each correct response was given a score of 1 when the participant could produce responses from both lexical categories given.

0 was given for partial and incorrect responses. Older participants performed better compared to participants with MCI. Individuals with MCI performed poorly as the cognitive flexibility and response inhibition are found to be compromised in these individuals.

Keywords

category fluency, lexical category combinations, interference

1. Introduction

Executive Function (EF) is one of the key processes of cognition. It refers to a variety of skills which help in making socially responsible, self-serving, independent and purposive behaviour possible (Lezak, 1995). Miyake and his colleagues (2000) postulated that the executive function may not refer to a single entity rather it refers to a variety of domains such as problem solving, cognitive flexibility, mental flexibility, attentional control, inhibitory control, and response inhibition.

Cognitive flexibility is considered to be one of the major executive functions. It refers to the ability to switch rapidly between different response sets (Anderson, 2002) and is found to be compromised in individuals with aging. It is assumed to operate on both the lines of automatic processing and volitional processing as it involve the conscious or un conscious shift of attention from one fixation to another. Cognitive flexibility is divided into two sub categories: task switching and cognitive shifting. Task switching involves unconscious shifting of attention from one task to another. While cognitive shifting is assumed to operate at conscious level. Cognitive shifting is often of relevance to daily life as it reflects the brains ability to adapt to changes or unexpected events which may take place in the routine. Mental shifting is a relative term which in turn may be responsible to adapt to the change. Hence it can be assumed that mental shifting would regulate cognitive shifting. Cognitive shifting plays an instrumental role in the process of learning and problem solving. It enables an individual to device strategies in coping up with the new challenge imposed or the new change.

Cognitive shifting is viewed as a higher cognitive function while few other researchers view it as a executive function. Some proponents in the field of cognitive neuro psychology also view cognitive shifting as a term related to fluid intelligence as it helps in problem solving. Cognitive shifting is a term which has fascinated social psychologists as reflects adaption. Cognitive shifting alike to the motor and language skills requires the use of developmental processes and cerebral maturation. The development is ongoing and would take place till the age of 20 and the abilities would plateau till the age of 40-50 years and would detiorate with aging. The extent of detioration is individual specific. The lack of cognitive flexibility is viewed as cognitive rigidity. It is a condition where the individual feels that he/she is struck and is not able to transit from one state to another.

Cognitive shifting as stated earlier allows an individual to adapt to new situation, the rate at which an individual adapts and the extent to which the individual adapts could reflect the amount of cognitive shifting. If the rate is fast and the extent of adaptation is more, cognitive shifting is assumed to be better. Cognitive shifting on clinical grounds is measured as the smooth transition from one activity to another

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activity. The transition which is quick and error free reflects good cognitive shifting abilities again. There are a series of nonverbal tasks which can be used in the assessment of cognitive flexibility. Local-global task is one such task, where a global larger figure composed of local smaller figures would be presented. The task of the participant would be to draw the global or local figure based on instructions provided, the participant has to inhibit the other stimulus while doing so.

Stroop colour task is the simplest of the measures used, where the name of the colour is printed either in the same colour (congruent trails) or different colour (in congruent trails). Stroop task employs primary colours basically and may not be used in those participants who do not know the colours. Non-Zero task is considered as an alternate to this task. In this task the participant is required to present a desired key to indicate the numerals which are accompanied by Zero (0) and press any other key for those numerals which are not accompanied by Zero. The Wisconsin card sorting test on the other hand is a test for set shifting than cognitive shifting. In this test/ task, a number of stimuli cards are given to the participants. The task of the participants is to match the cards. The number of matches and the strategies employed in sorting cards is considered for determining the performance Cognitive shifting can also be assessed through tasks such as Navon's letter identification. In Navon's letter identification the person has to concentrate on the letter shape and its constituents. If the shape and constituents are the same, the trail is considered to be congruent and if the letter shape and its constituent are different the trails are called as incongruent trails. The task of the participant is to indicate the congruent and incongruent trails by press different keys on the key board.

The cognitive shifting can be studied from an SLP's perspective by employing alternating fluency task (Kirsner, 2012). Alternating fluency is a commonly used linguistic task, used to assess the cognitive flexibility, the task of the participant would be rapidly switch between two response classes. Usually, the participant would be asked to switch between the two lexical categories. The assumption here is that the participant has to focus on retrieving lexical items related to one lexical category at a time while doing so the participant also has to inhibit the lexical items belonging to the second lexical category, which may intrude while listing the lexical items in the first lexical category. Cognitive flexibility along with the other domains of executive functions is often assumed to deplete with age. Older individuals often find it difficult to focus their attention on a specific target by inhibiting the competitor stimulus simultaneously. There are few studies on cognitive flexibility in older individuals (Ex Vijay Kumar & Prema, 2007). The study used congruent stimulus and incongruent stimulus. Congruent stimulus referred to four words belonging to the same lexical category while the incongruent stimulus consisted of four items belonging to various lexical categories. The task of the participants was to press different buttons on the key board to indicate congruent and incongruent trails, older adults performed poorly compared to younger adults, the limitation of the study is that the task is vulnerable to fast positive response as the participant may speculate and press the button. Alternating fluency task can be considered as an alternate. Studies on cognitive flexibility can be extended on individuals with Mild cognitive impairment, to observe if the performance would differ in this population compared to

neuro typical participants. In a nutshell, Executive functions is generally affected in individuals with aging. The present study is an attempt in comparing the cognitive flexibility in individuals with normal aging and individuals with MCI, to investigate if the task would differ in them. The study employed alternating fluency task, a verbal task which counteract the false positive responses which may be seen on button press task. The study aimed to investigate cognitive flexibility in individuals with normal aging and individuals with MCI.

2. Method

Participants: The participants enrolled in the study were divided into two groups. The first group comprised of 30 healthy older individuals without any cognitive impairment in the age range of 55- 70 years. MoCA-Montreal Cognitive Assessment Scale was administered on these participants and the score on MOCA was within the cut off of 26 as per the normative of the test. The second group comprised of 20 individuals medically diagnosed to have MCI. In addition MOCA was administered on these participants as well and participants within this group obtained scores ranging from 21-23 indicating MCI.

Stimulus and Procedure: Alternating fluency task was administered on the participants where the participants were asked to name lexical items from two lexical categories alternatively. Four different lexical category combinations were used. The combinations included animals-birds, common objects-vegetables, fruits-vehicles, body parts and colours. The task of the participant was to name lexical items from each of these combinations alternatively for duration of 2 minutes. A correct of 1 was given when the participant was able to produce the correct responses from both the lexical categories. The total scores for each of the lexical category combination were computed separately.

3. Results

The responses produced by group 1 and group 2 participants were analysed. A response was designated as correct response only when the participant was able to the correct response in the same slot. The response was considered as incorrect when the response was partially correct also. When the participant was able to produce the correct response for one of the lexical category but failed to produce a correct response for the other lexical category, the response was considered as partially correct. Quantitative and Qualitative analysis was carried out. Group 1 participants secured scores of 8,9, 8 and 7 for the four lexical category combinations while group 2 participants secured scores of 3, 6,5 and 4 for the four lexical category combinations respectively (see Figure 1).
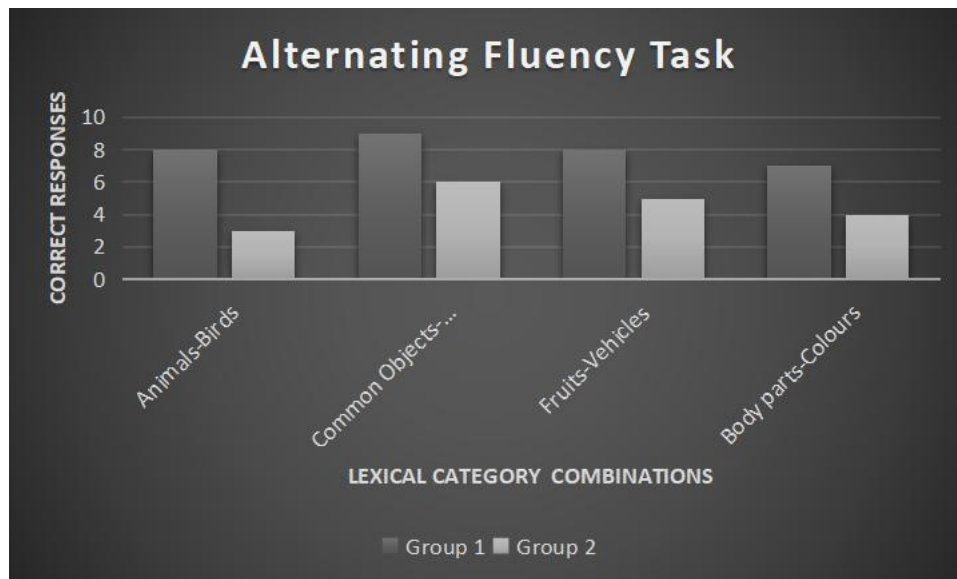
Figure 1. Mean Scores for Group 1 and Group 2 Participants on the Four Lexical Category Combinations

Group 1 participants outperformed the group 2 participants. Group 2 participants found it difficult to produce the correct responses in both the slots. The participants produced ore of partially correct responses. Partially correct responses were also given a score of 0 in the present study. Owing to this, the overall scores were less for this group. Group 1 participants secured the same scores all most for the four lexical category combinations. While group 1 participants faced ore difficulty in naming Animals-Birds probably because the two lexical category combinations share common conceptual features.

The data thus obtained was subjected to test of normality by employing Shapiro Wilks test and the results showed non normal distribution. Hence Kruskal-Wallis test was administered and the X^2 value obtained on comparison was 3.88 and corresponding p value showed significant difference, thus Mann Whitney U test was used further. The Z scores for the four combinations was 3.88, 4,12, 2.74 and 4.02 respectively and corresponding p values showed significant difference for all the four lexical category combinations.

5. Discussion

Individuals with normal aging secured less scores compared to younger participants as per the findings of a previous study carried out on younger individuals (Gowda & Hanji, 2017). Individuals with MCI secured even poorer scores. Qualitative analysis revealed that participants from both the groups were not able to inhibit the responses from the other lexical category while producing responses. Participants exhibited category interferences from the first lexical category i.e. they produced responses from the same lexical category instead of alternating the lexical category and producing the responses.

Of the four different lexical category combinations, group 1 participants' secured higher scores for the

second combinations, interestingly even the second group of participants secured higher scores for the same combination. The second lexical category combination was that of common objects and vegetables, the differences between the lexical items is marked enough so that the interference offer by the lexical items belonging to the other category would be minimal. The first combination was that of animals and birds, where the errors was maximum. Since the conceptual features shared by the lexical items belonging to these categories would be close enough, the participants would have found it difficult to inhibit the responses from the other lexical category.

Individuals with MCI faced problems in performing the task, the participants faced ore difficulty in inhibiting the responses belong to the other lexical category. This inhibition was more difficult when the two lexical category combinations shared conceptual features. The response switching abilities were poor in the individuals with MCI owing to which, the performance would have been affected.

6. Conclusion

The present study was carried out with the aim of investigating cognitive flexibility abilities in individuals with MCI and normal aging. Alternating fluency task was employed to tap cognitive flexibility. The participants were prescribed a pair of lexical categories, where they were asked to list lexical items belonging to both these lexical categories alternatively. Four different lexical category combinations were used. A score of 1 was given when the participant was able to produce the appropriate lexical item from both the lexical categories correctly. Older healthy individuals performed relatively better compared to individuals with MCI on the four lexical category combinations. Kruskal Wallis test followed by Mann Whitney U test was carried out in order to verify if there was any significant difference between older healthy individuals and MCI individuals the statistic showed significant difference. In addition, qualitative analysis was carried out and the analysis revealed more category interferences in MCI individuals and deficits in inhibiting responses belonging to the other lexical categories

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