



Effect of Stimulus abstractness on problem solving abilities in healthy young adults

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ABSTRACT

Problem solving is a mental process that requires the modulation and control of more routine or fundamental skills. There is limited knowledge at present about the construction of problem solving stimuli in various cognitive communicative test batteries. Whether abstractness of the stimulus content would change the performance of the subjects on the task is also ambiguous. Thus the present study is an attempt to resolve this ambiguity. Twenty eight young adults between the age range of 18-27 years were included in the study. The task included a total of 56 problem solving questions which were divided into two sets. This preliminary data indicates that the effect of abstractness of the stimulus varies with respect to the nature of the problem, the complexity of the problem and the working memory load involved in the problem.

KEYWORDS : abstractness, problem solving, cognition, young adults

INTRODUCTION

Problem solving is a mental process that involves discovering, analyzing and solving problems. In everyday life, we face different problems both in the work place and personal situations and these problems can range from simple to complex levels. The stages in problem solving involve identification of the problem, representing the problem mentally, developing a solution strategy and deciding a solution for the problem (Bransford and Stien, 1993). In a study done by Murray and Byrne (2005), they reported that individuals who are good in solving insight problems have good attention, working memory storage and processing capacity which suggest that problems solving need combinations of executive function to solve the problems accurately. Reasoning is a key step in problem solving. Carlson and Baily, 1997 reported that reasoning can be of two type. First one is "computerized thinking" which is a kind of thinking that is used by an individual by analyzing, comparing and relating the facts and making computations which is taught to solve the problems. On the other hand "free flowing" thinking can occur when individuals do not know the variables used in the problem.

Problem solving cannot be studied as an isolated act of pure cognition (Labouvie-vief et al, 1989). Problem solving tasks require a meaningful context (Lawton, 1982). Individual's problem solving abilities not only depend on the innate capabilities of the problem solver but also it varies based on the novelty, complexity and structure of the task (Chi, 1985). Cohen & Faulkner in 1989 found that routinized and repetitive everyday problems can easily be recalled and implemented at the appropriate time. As the complexity of the tasks increases the efficacy to execute the problem decreases (Meyer & Willis, 1993). Abstractness in problem solving task refers to the novelty, and relatedness and unfamiliarity of the stimulus. It may be with respect to the agents, objects or locations mentioned in the stimulus items.

Goel et al. (2000) conducted a study to measure task related neural activity using event related fMRI on 11 right handed normal subjects. They studied differences in problem solving between logical arguments containing familiar content (i.e. propositions that they would have beliefs about) and logically identical arguments lacking any meaningful content (i.e. subjects can have no beliefs about the truth or falsity of these propositions). These studies indicate that fa-

miliar and unfamiliar material is associated with two distinct systems. The left lateralized frontal-temporal conceptual/language system has been thought to be associated with familiar, conceptually coherent material, whereas a bilateral parietal visuospatial system have been reported to be associated to unfamiliar, non-conceptual material.

There is limited knowledge at present about the construction of problem solving stimuli in various cognitive communicative test batteries. Whether abstractness of the stimulus content would change the performance of the subjects on the task is also ambiguous. Thus the present study is an attempt to resolve this ambiguity. The aim of the study was to evaluate the effect of abstractness of the stimulus on linguistic problem solving abilities of young healthy adults. The objectives of the study were to study the differences for accuracy and reaction time of problem solving across several complexity and nature of the problems

METHOD

Participants - A total of 28 young adults, 14 males and 14 females between the age range of 18-27 years (mean age-21.5 years and SD-3.98) were included in the present cross sectional study. The selected participants were native Kannada, Malayalam and Hindi speakers and they were well versed with English. They did not possess any neurological and psychological problems that impair the vision and cognitive processing. They were needed to have a mental state lexicon and should have known the semantics of the terms used in the questions to solve the given tasks. No exclusion criteria were used regarding ethnic or social background.

Material and Stimuli -The task in this study included a total of 56 problem solving questions which were divided into two sets with 28 questions each. The task was performed in closed set format with four multiple choices per question. The first set included questions with familiar and related names of objects, agents and locations whereas the second set had questions with abstract names. Both the sets had problem solving questions based on different 7 conditions i.e. temperature, time, relationship, date and year, above and below, highest & lowest and height & weight respectively. The rationale for the nature of linguistic problems was adopted from Bajaj et al. 2014. The questions were arranged in a hierarchy of increasing complexity ranging

from two step questions to five step questions.

The questions were presented through a paradigm experiment version 2.1.0.95 (86). Paradigm allows to create sophisticated experiments that collect responses from wide array of devices. It helps in presenting images texts, sounds; collecting open/closed end responses; collecting accurate reaction time. According to the stimulus designed, all 7 sets of questions in each situation with each category consisting of 4 questions each of four complexities.

Procedure: The participants were seated comfortably in front of a laptop and were instructed to solve the questions as quickly as possible by keying the correct response number. In both the sets, questions were presented randomly. And for each questions they were instructed to choose the best suited answer out of the four options given in the paradigm. The participants were given more than one hour gap in between the two sets to reduce the mental load.

Analysis -The answer provided by the participants was scored as 0 and 1. The correct responses were scored as 1 and the incorrect responses were scored as 0. Responses were recorded in an excel sheet with the reaction time calculated on the basis of time lapsed between presentation of the stimulus and the response entered. The recorded responses were tabulated and subjected to statistical analysis using SPSS version 16.

RESULTS AND DISCUSSION

The results of the present study revealed that there was no significant effect of abstractness of stimulus on the accuracy of problem solving across all the seven categories of problem solving. However trends observed from descriptive statistics suggested that the accuracy was better for abstract problem solving condition in four out of seven problem categories (Greater and Lesser, Height and Weight, Year and Date and Relationship). Condition with familiar stimuli entities was found to be more accurate for rest of the three problem categories (temperature, time, above and below). The results obtained from the present study suggest that abstractness of the stimulus leads to a marginal difference in accurately solving the problem. Even though these differences in the present study did not reach statistically significant thresholds, their presence should not be overlooked. The present study supports the findings of previous researchers who have identified differential brain activation for stimulus varying in abstractness (Goel et al 2000). Dissociations between familiar and unfamiliar stimulus has been reported with respect to frontal temporal and parietal temporal systems respectively.

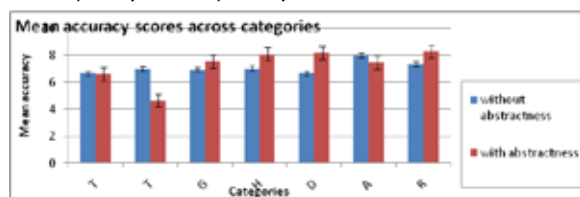


Figure 1: Mean accuracy scores across categories for problems with and without abstractness.

Reaction time differences between problems with abstractness and problems without abstractness

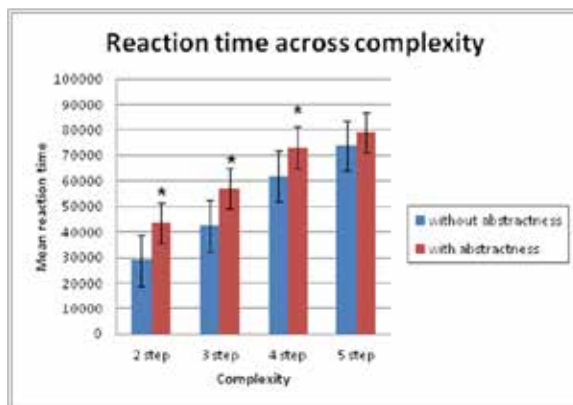


Figure 2: Mean reaction time across four complexities for problems with and without abstractness. The asterick signifies the presence of significant difference as revealed on the paired T test.

Paired t test was applied to the reaction time of the problems solved accurately for the two conditions. For this purpose, the responses of respective steps for all seven categories were pooled together. A statistically significant difference was observed between the problems with and without abstractness conditions for problems involving 2 to 4 steps (2 step problem solving: $t(27) = -5.841; p = 0.003$, 3 step problem solving: $t(27) = -2.706; p = 0.012$, 4 step problem solving: $t(27) = -3.123; p = 0.004$). Significant differences could not be observed in reaction time for the problems involving five steps. The results of descriptive statistics showed that the average reaction time of the participants for correctly solving the problems upto four steps was lesser for the condition without abstractness (Mean=51836.77 msec, SD=24610.11msec). However reversed trends were observed for problems with five steps. A study by Goel et al in 2004 found similar trends for problems involving abstract and familiar landmarks. They argue that abstractness of the stimulus leads to a slowed processing as subjects take time to form a belief about a fictional nature of the stimulus. This explains the differences observed in the present study for reaction time between the two conditions. A possible reason that the prolonged reaction time disappeared for problems involving five steps could be a release from excessive memory load which familiar stimulus may put. For instances, a person may find easier to solve a multi step problem when he does not have to remember the names involved in the problem.

Summary and Conclusion

The present study aimed at exploring the effectiveness of abstractness in problem solving in young healthy adults. Present study suggests that abstractness of the problems may not affect the accuracy of solution to a greater extent but it definitely is associated with speed of problem solving. This preliminary data indicates that the effect of abstractness of the stimulus varies with respect to the nature of the problem, the complexity of the problem and the working memory load involved in the problem. We hypothesize that the effect observed in the present study may vary in its magnitude and direction if studied on an older age group as their strategies of solving the problem vary.

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