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Semantic Priming and Reaction Time Measures in 5-6 Year Old Normal Subjects

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Abstract

Priming demonstrates participant's enhancement or change in outcome during a cognitive task (e.g. lexical naming task) because of exposure to a stimulus or prior experience McNamara & Holbrook, 2003. It has long been confirmed by the researchers that reaction times are lessened to words preceded by semantically related words ("cat"-"dog") in comparison with words preceded by semantically unrelated words ("bus"-"dog"). This is called as the semantic priming effect. Twenty primary school going typically developing children (10 boys and 10 girls) in the age range of 5 to 6 years participated in this study. 25-line drawing pictures were used for the current study. The children were instructed to name the pictures offered on a laptop monitor who was programmed with the help of DMDX software under prime and no prime conditions. For both the conditions (with prime and without prime) the speech reaction time for naming the pictures was measured. Reaction time was measured in millisecond. The outcome of the analysis revealed that there was significant difference in the retrieval time for target words in two priming conditions i.e. with prime and without prime conditions. Retrieval time improvement in this study can be useful in knowing semantic and lexical processing in children.

Introduction

Priming state subject's change or enhancement in outcome during a cognitive task (e.g. lexical naming task) because of experience to a stimulus (McNamara & Holbrook, 2003). Priming may also reflect a meaning integration process that occurs after access of the target and affects the decision stage of the task. Semantic priming is major area of investigation in the cognitive sciences from past three decade and semantic priming is frequently used tool for research in various aspect of cognition and perception i.e. knowledge representations, word recognition and language comprehension. Researcher have confirmed that reaction times are reduced to words preceded by semantically connected words ("cat"-"dog") in comparison with words preceded by semantically unconnected words ("bus"-"dog"). This is recognized as the semantic priming effect. Since then semantic effect has been extensively used especially for associatively related pairs. Later it was demonstrated between spoken words using the lexical decision task [1] and single word shadowing Slowiaczek, 1994 and was exposed to happen across various sensory modalities, one among those is between a visual target and auditory prime Swinney, 1979. Semantic priming encompasses the belief that a ''target'' stimulus (e.g. picture or word) is processed and answered to more rapidly and/or precisely when it is preceded by a semantically linked ''prime'' (e.g. word). It has been revealed to be valuable in the empirical research of hypotheses concerning to linguistic planning and processing for speech-language production. Such paradigm allows a researcher to ''increase a high level of experimental control over many aspects of word production,'' such as the lexicalization process (Brooks & MacWhinney, 2000). Semantic priming denotes to the simplification (e.g. faster reaction time during a lexical decision task) in the processing of a word (e.g. dog) which has been preceded by a connected word (e.g. cat) compared to unconnected word (Table 1). Even though numerous probable mechanisms may trigger this phenomenon two of the more frequently considered processes are automatic spread of activation through interconnected conceptual nodes and the generation of attentionally mediated expectancies (Neely, 1991). Even though numerous investigational approaches might be used to measure the effect of conceptual and perceptual properties of objects on speed and competence of lexical retrieval, a semantic priming paradigm (e.g. McNamara & Holbrook, 2003) [2] appears advantageous. Such paradigm permits for experimental operation of the time course or speed of covert linguistic arrangement processes that lead to subjects'

overt speech language production. The method allows the researchers to couple auditory lexical representation with visual lexical representation of the target stimulus (picture) rather than just trusting on the written form of the target word (Nation & Snowling, 1999). Such priming approaches have been used effectively to assess extensive aspects of semantic and lexical processing in healthy adults as well as typically developing children [2,3]. Priming paradigms are a perfect technique of assessing children's acquaintance of semantic relations without needing the child to knowingly articulate that information. Two priming studies have addressed the development of children's taxonomic and thematic concepts. McCauley, Weil and Sperber (1976) studied semantic priming in 6 and 8 years old. These children participated in a picture naming task in which prime-target pairs were

Table 1: Speech reaction for prime and without prime conditions.

Participations	Age Range	Condition	Speech Reaction Time
Children	5-6 years	With prime	890.93
	5-6 years	Without prime	1048.86

A. High thematic (associative) 1-high taxonomic (categorical; e.g. cat-dog).

B. High thematic-low taxonomic (e.g. bone-dog).

C. Low thematic-high taxonomic (e.g. lion-dog).

D. Low thematic-low taxonomic (e.g. airplane-dog).

Thematic priming was showed in both groups, whereas taxonomic priming was showed only by the children of 8-year. In both cases, the prime assisted to ease the speed of picture naming. Nation and Snowling (1999) also showed the effect of developmental ability on priming behaviour when they asked 10-year-old normal readers and 10 years old poor readers to make auditory lexical decisions. Both groups answered more rapidly to thematic primes (e.g. beach-sand; hospital-doctor) than to an unrelated baseline. The picture naming task [4] is frequently used in semantic priming researches and typically involves the subject to verbally name a target picture presented on a computer screen. The associated computer assesses the subject's speech reaction time, defined as the time from start of the target picture to onset of the participant's verbal reply. This measure is thought to permit the researchers to estimate the time duration of the subject's lexical access or encoding or other cognitive processes [5]. This commonly includes the researcher presenting a prime such as an auditory presented word connected to the target picture, immediately before, during, or after the onset of the target. Rideau, Monique, Canadian Used an auditory lexical decision paradigm to determine occurrence of semantic priming between spoken words and to examine the organization of the mental lexicon in preliterate typically developing children. 30 undergraduates and 24 1st-grade children (aged 6 years 2 months to 7 years) were tested on a lexical decision task. In both groups, significant facilitation was observed for semantically connected words compared with unconnected ones [6]. The review done above suggests that semantic priming paradigm in children is a well accepted method. Lexical access studies using such a paradigm provide vital clues in the language acquisition domain. The present study is also an attempt in this direction.

Need for the study

As semantic priming has been established as a method to measure lexical retrieval the methodology is accessible. Such data provides controlled measures of reaction time [7]. Measuring such reaction time can be valuable in assessing the lexical retrieval task. In Indian context the efforts in this direction are not reported. Such measures may bring in an experimental outlook at lexical retrieval tasks which are primary in any therapeutic process.

Objective of the study

A. To prepare reaction time measurement paradigm using DMDX software for measuring lexical retrieval.

B. To obtain and compare reaction time measurement with and without priming.

C. To compare the retrieval of target words in children and previously available data in adults.

Methodology

Subjects: Twenty children (age range 5-6 years) and participated in this study. Those who had no complaint of speech, language, cognition or visual impairment were selected. All subjects attended an English medium primary school.

Experimental paradigm

To collect data on speech reaction time during two picture naming conditions (with and without semantic prime) a computer assisted Picture-naming experiment was developed using DMDX software [8]. Two picture naming situations were employed in a counter balanced order across participants.

A. No-prime condition, in which no auditory stimulus were offered before picture presentation;

B. Related-prime condition, in which a word semantically connected to the target picture, was offered auditory 700ms before picture presentation.

A 700ms stimulus onset asynchrony (i.e. time period from the onset of the auditory prime to the onset of the target picture) was used to confirm that none of the auditory offered primes would temporally overlap the visual onset of the target picture [9]. Subjects were comfortably seated and observed a computer screen and were told to name the picture on the screen ''as fast as you can and as soon as you see it. The utterances were recorded on the laptop computer and the naming latency (speech reaction time; in milliseconds) measured.

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Data collection

No-prime condition

10 subjects were shown the set of 25 target pictures single at a time, with the onset of successive pictures dictated by the subject's replies through activation of a gating switch on a microphone connected to the desktop computer. The computer documented the subject's speech reaction time and offered the subsequent picture 1,500ms after each of the subject's spoken replies. Figure 1 shows the details.

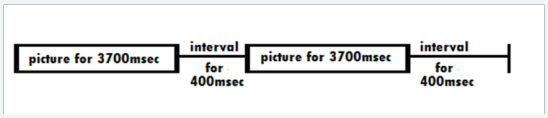

Figure 1: Pictorial representation of no prime condition.

Related-prime condition

Remaining 10 participants were involved. The related-prime condition was alike to the no-prime condition, with one exception: 700ms before picture presentation, subjects were well-informed with a related auditory stimulus, free-field, from a pair of standard computer speakers (e.g. related auditory prime=boat, target picture=car). As with the no prime condition the computer recorded the subject's speech reaction time and offered the next prime and picture 1,500ms after each of the subject's verbal responses [10]. Figure 2 shows pictorial representation of prime condition. Instrumentation DMDX software Version. 3.2.6.4, developed by the University of Arizona which can assess the priming was used. This was installed in Compaq computer, running on Microsoft Windows vista ultimate. Creative Computer Associates Microphone of the model no. 1124 was used to record the subjects' verbal responses. Details about DMDX software is given in appendix 1.

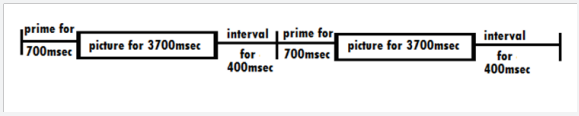

Figure 2: Pictorial representation of prime condition.

Response

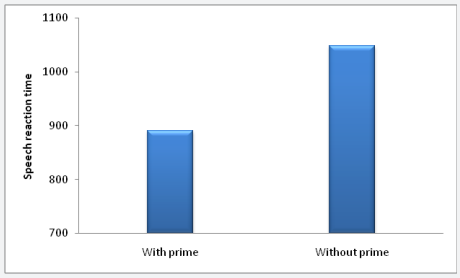

Figure 3: Speech reaction for prime and without prime conditions.

First utterance from the speaker was considered as appearance of target response. So, reaction time is the time duration between stimulus presentations to appearance of the first verbal output. Reaction time in millisecond was noted and saved in Microsoft excel by the software [11]. Further data was examined using SPSS 16 version software. RT data omitted error and lost trials. Errors were considered in those trials in which participants used words other than the target name of the pictures (e.g. retelling the priming word), repetition at the onset of the word or self-corrected on the previous response (Figure 3) [12]. In a similar way lost trials were the trials in which the subjects produced cough or mouth clicks, stopped performing the task (e.g. talking to the researcher). Lost trials included trials in which the voice key was not able to pick up the response (i.e. the voice was too soft).

Results and Discussion

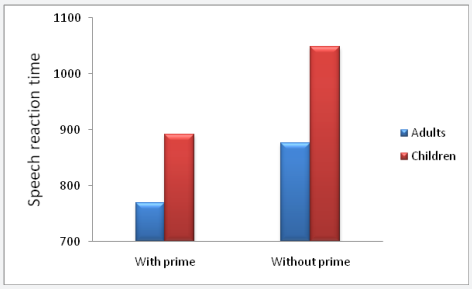

Figure 4: Speech reaction for prime and without prime conditions in children and adults.

The aim was the study was to prepare reaction time measurement paradigm using DMDX software for measuring lexical retrieval and to obtain and compare reaction time measurement with and without priming. To compare differences for retrieval of words in children and adults, the reaction times (RTs) of the picture naming task for the two age groups in the two different conditions (i.e.) were analyzed. The responses were measured using DMDX software. The Reaction time was recorded from the onset of picture presentation to the onset of the subject's voice and measured for all the target words in millisecond. Results were analysed using SPSS software. RT data excluded three stimuli pictures out of twenty five on which all subjects failed to name the pictures. They were pumpkin, knife, and ladder which are probably not familiar [13,14]. Results showed that there was significant difference in the retrieval time for target words in two priming conditions i.e. with prime and without prime conditions. It was observed that target words were retrieved faster in lexical priming conditions (890.93) rather than no prime conditions (1048.86msec). Similar study was done on adults by the present authors, which showed that the mean RT without prime was 875.88msec, and with prime it was 769.40. These data was compared with reaction time data on children. As can be observed in Figure 4, Adults show about 150 ms3c less RT than children. Maturation in adults may be factor for this effect. Results showed consistent with previous studies [2]. The finding that the naming of an object is executed faster when it is preceded by the semantic priming than when there

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is no prime condition expected from previous studies on this issue. Similar study was done on adults by the present authors, which showed that the mean RT without prime was 875.88msec, and with prime it was 769.40. These data was compared with reaction time data on children. As can be observed in Figure 2, adults show about 150ms 3c less RT than children. Maturation in adults may be factor for this effect. This study implies a quantitative method of measurement of lexical retrieval in children which may be useful in experimental outlook at lexical retrieval tasks which are primary in any therapeutic process and also in the language acquisition domain. Retrieval delay may involve impairment in any stage during child development. So retrieval time improvement in this study can be useful in knowing semantic and lexical processing in children.

Conclusion

Speech response time was measured for 20 normal children for 25 target pictures in two priming conditions i.e. with prime and without prime conditions. Results were recorded and analysed further. Results revealed that individuals showed significantly faster speech reaction time during semantic priming conditions than no priming conditions. Therefore, presentation of semantically related words before the picture-naming response appeared to ''speed-up'' lexical retrieval for the children. This study implies a quantitative method of measurement of lexical retrieval in children which may be useful in experimental outlook at lexical retrieval tasks which are primary in any therapeutic process and also in the language acquisition domain. The research needs to be conducted with improved sophistication of measurement. Number of participants and diversity needs to be increased.

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