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Negative Priming in Aging Population

Manjunath. N., M.Sc. (Speech and Hearing)

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Abstract

A total of 40 subjects participated in the study, divided into two groups. Group I consisted of elderly population (mean age 60.3 years) and Group II consisted of young adults (mean age 22.1years). Superimposed line drawing pictures were presented in semantically ignored and control negative priming conditions. Reaction time was measured for verbal responses in each condition by using DmDx software.

The results showed no significant negative priming effect in older individuals. Results are discussed with reference to 'spreading inhibition' in semantic memory networks, analogous to that of 'spreading activation' (Collins & Loftus, 1975). The reason behind the absence of negative priming in older adults may be attributed to the deficit in the spreading inhibition system and reduced information processing efficiency.

Key Words: Inhibition, Language Processing, Reaction time.

Introduction

Normal aging often refers to the most common or usually encountered functional state of the nervous system in a population of older individuals (Civil & Whitehouse, 1991). It is associated with special physical, emotional and social burdens imposed by mental decay in later life and a general wear and tear at anatomical and functional levels.

Normal aging is accompanied by changes in the ability to process, understand and use language. There is no global decline in linguistic functions. However, decline in certain cognitive functions like attention, memory and reaction time has been documented. These cognitive changes impinge on linguistic abilities leading to difficulties in word retrieval process (Kempler, 1992; Maxim, 1999) decline in complex discourse processes (Ulatowastia, 1985), slight diminution in language performance in terms of use of semantic information, structures and error of reference.

Attention is the core cognitive processes involved in language production and comprehension (James, 1980). If there is finite attentional capacity which reduces with increasing age, then larger attentional demands will lead to larger age related deficits (Hasher & Zacks, 1988). Aging persons have been shown increased difficulty with selective attention and may attend to more irrelevant details than younger persons (Hamm & Hasher, 1990; Hartman & Hasher, 1990; McDowd, Oseas-Kreger, & Filion, 1995).

Selective attention refers to the ability to both focus on information of relevance to the organism and exclude or ignore information that is task irrelevant. This can be accomplished by facilitating the processing of specific objects and/or inhibiting other task-irrelevant objects (Armstrong, 1997). Houghton & Tipper (1994) stated that selective attention is necessary in daily life as there are an infinite number of stimuli in the environment that must be either attended to or ignored. Initially, all stimuli are attended to and facilitated, but then irrelevant stimuli are quickly suppressed so that further processing of the attended stimuli is proceeded. One such task which is employed in understanding the efficient selective attention is negative priming task.

The negative priming paradigm has served as a test tool by which age related differences in selective inhibition are measured. In the negative priming task, subjects are asked to respond to targets and ignore simultaneously presented distractor stimuli.

The critical comparison is between the semantically ignored condition and the control condition experiments. In general, longer reaction times are obtained in ignored repetition condition than in control condition, defining negative priming effect. This negative priming effect is theorized to be the result of intact inhibitory mechanisms (May, Kane & Hasher, 1995; Neill & Valdes, 1996). If inhibitory mechanisms are disrupted or slowed relatedness of the prime distractors and probe presentation should not have a significant effect on reaction time to judge the probe target. The distractors in the prime display are presumed to have been processed instead of inhibited so that semantically related probe displays do not exhibit reaction time delays.

Inhibitory mechanisms have been widely discussed in cognitive psychology as involved in attention, memory and language processes (Dagenbach & Carr, 1994). In the attentional domain, inhibition has been studied in connection to both the orienting and the executive functions in attention (Fuentes, 2004) and therefore appears to be essential to attentional selection and executive control.

The distractor inhibition model proposed by Tipper (1985) explains the underlying mechanism of negative priming effect. It suggests that negative priming is the result of a selective attention mechanism that inhibits the internal representation of distractor objects and thereby reduces access to response mechanisms. Although this is an efficient way to describe the detrimental effect of the distractor on the prime trial, residual inhibition from the prime trial is hypothesized to impede performance when object that was previously a distractor becomes a target on the probe trial. Thus the distractor inhibition model suggests that the mechanisms underlying the negative priming effects are engaged during the processing of the prime trial when the internal representations of the distractor are inhibited to aid in the selection of the target.

Initial aging studies found that elderly adults failed to produce a difference between semantically ignored and control conditions while younger adults responded more slowly to semantically ignored condition than control trials i.e., young adults showed negative priming effect while elderly adults did not (Hasher, Stoltzfus, Zacks & Rympa, 1991; McDowd & Oseas-Kreger, 1991; Tipper, 1991).

These initial results were interpreted as indicating a failure of selective inhibition by the elderly adults. In a typical negative priming experiment, younger participants (age 18-30 years) and elderly participants (age +60 years) were given a task in which the dependent variable was reaction time. The elderly participants were slower in a variety of tasks (Salthouse, 1985). This has led to the theory that elderly participants have absent or weakened inhibitory processes (Hasher, 1991).

However, contrasting studies (Kieley & Hartley, 1997; Sullivan, Faust & Balota, 1995) have reported equivalent negative priming effect for younger and elderly adults. In 1998, Verhaeghen & De Meearsman conducted a meta-analysis on 21 aging and inhibition studies. They reported that both younger and elderly adults displayed significant negative priming effect, although the effects were larger for younger than elderly population for identify discrimination tasks.

Previous studies also revealed that different population have different levels of inhibitory control and that this can be measured through negative priming tasks. Reduced negative priming also been observed in patients with Alzheimer's disease (Vaughan & Tipper, 2006), depression (Tipper & Young, 2000) and in elderly (Verhaeghan & De Meearsman, 1998). This suggests that decline in inhibitory control is a general feature of many groups with reduced information processing efficiency. Since negative priming presumed to be a product of an intact selective attention mechanism, it makes sense to perform negative priming tasks with aging persons to determine if inhibitory processes contribute to this difficulty. Hence the present study was one attempt to account for negative priming in aging individuals.

Objectives of the Study

- To determine negative priming in elderly population.
- To study the negative priming differences between elderly population and young adults.

Method

A. Subjects: A total of 40 subjects were selected for the study. They were divided into two groups. Group I consisted of 20 elderly adults in the age range of 55 to 65 years (mean 60.3 years) and Group II consisted of 20 young adults in the age range of 20 to 25 years (mean 22.1 years). Those who not have any history of neurological, psychological, cognitive, behavioral problems were selected for the study. Mini mental state examination (MMSE) was administered to rule out dementia. The subjects who passed MMSE were included for the study. All were right-handed native speakers of Kannada language and had normal color vision and normal or corrected-to-normal acuity in both eyes. The young adults were selected from the college going students. The elderly population was chosen from student's parents, grandparents, and residents of old age homes. Informed consent was gained from all the participants prior to the commencement of the study.

B. Instrumentation: DmDx software version 3.2.6.4 developed and programmed by Jonathan Forster (1993) at the University of Arizona was installed in compaq laptop, running on Microsoft windows XP professional connected with creative computer associates microphone (model 1124) was used to record the participant's verbal responses to measure reaction time.

C. Stimulus material & presentation: Five categories of nouns with each five set of five line drawing pictures were selected from the Snodgrass & Venderwart's (1980) corpus. The five categories- *vehicles, fruits, musical instruments, clothing and animals* were selected (Appendix 1). For this study, prime and probe trial pictures were developed comprised of two superimposed pictures. The target was outlined with red colored ink and distractor was outlined with blue colored ink.

The stimulus was presented according to the following sequence: a crosshair was presented first for 500 msec, followed by an identical blank period, then superimposed prime target/distractor were presented for 750 msec, following this a pattern mask was presented for 250 msec, after which a blank interval of 1000 msec was inserted. Finally, probe target/distractor pictures were presented for 750 msec. Thus each trial was presented for 3750 msec, followed by a 4000 msec interstimulus interval during which the screen remained blank.

Prior to the presentation of the actual experimental test stimuli, participants were familiarized with the picture names by viewing them separately on a computer screen in a random order, with the appropriate name printed beneath. A practice block of 10 trials consisting of prime and probe trial superimposed line drawings were presented to the subjects prior to the actual administration of the test. The subjects were instructed to name for red colored outlined picture as soon and as accurately as possible by ignoring blue colored picture. The stimuli used for the practice block were not used in the actual experiment. Trial pairs were presented in pseudorandom order such that targets on adjacent trials did not share the same picture name.

D. Test environment: Testing was performed in silent room with minimal background noise. Before testing, microphone sensitivity check was carried out for background noise within the DmDx software. Subject was seated 60 cm away from the computer monitor.

E. Procedure: All the prime and probe superimposed line drawings were presented in a sequence on the centre of the computer monitor in two conditions. Condition I is semantically ignored condition in which ignored picture in the prime trial and target picture in the probe trial was categorically related (Figure 1). For condition 2, it is control condition where unrelated picture in prime and probe trial were presented (Figure 1). Thus, the difference in reaction time between the conditions represents negative priming effect. Thus, a total of 50 responses (25 from condition I and 25 from condition II) were collected from each subject.

F. Response: Reaction time was triggered by a microphone that was connected to the laptop. Reaction time was measured in terms of the time elapsed between the beginning of the presentation of the stimulus and the first sound produced by the subject. Reaction time in milliseconds was recorded and saved in Microsoft excel by the software. Reaction time data excluded error and lost trials. Errors were trials in which subjects used words other than the target picture (e.g. repeating the distractor picture), repetition at the onset of the picture or self-corrected on the earlier response. Lost trials were trials in which the subjects produced cough or mouth clicks (i.e., clicking or smacking non-speech sounds produced by the lips or the tongue that stopped the time counter prematurely), stopped performing the task (e.g. talking to the experimenter).

The analyzed data were tabulated for each subject in two experiments and subjected to statistical analysis using SPSS (Version 17). Mean reaction time was calculated for condition I and condition II. Statistic t-test was administered to note any significant difference between the groups and conditions.

Results

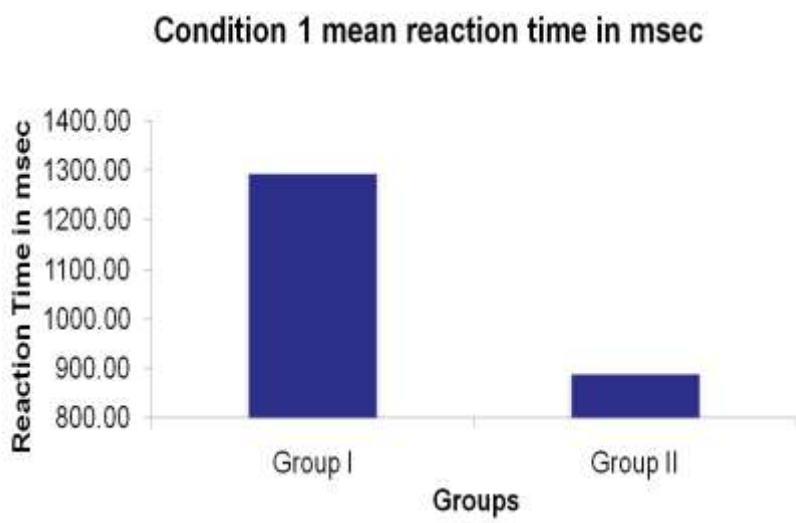
The aim of the study was to determine the negative priming using DmDx software and to compare between elderly population (group I) and young adults (group II) across two negative priming conditions. The mean reaction time in milliseconds was measured for each condition separately across groups. The results are discussed under three domains:

A. Semantically related (Condition I)
B. Control condition (Condition II)
C. Negative priming effect

A. Semantically related (Condition I): The mean reaction time values in milli seconds are displayed in the Table 1 and Graph 1 for both the Groups. The reaction time was faster for group II subjects. The mean reaction time for Group I was 1296.16 m sec and for Group II it was 889.45 msec. On treating the data with independent t-test, a statistical significant difference was observed between Group I and Group II (t=3.128, p=0.003).

Groups	Mean reaction time (msec)
Group I	1296.16
Group II	889.45

Table 1: Mean reaction time in milli seconds for condition I across groups.



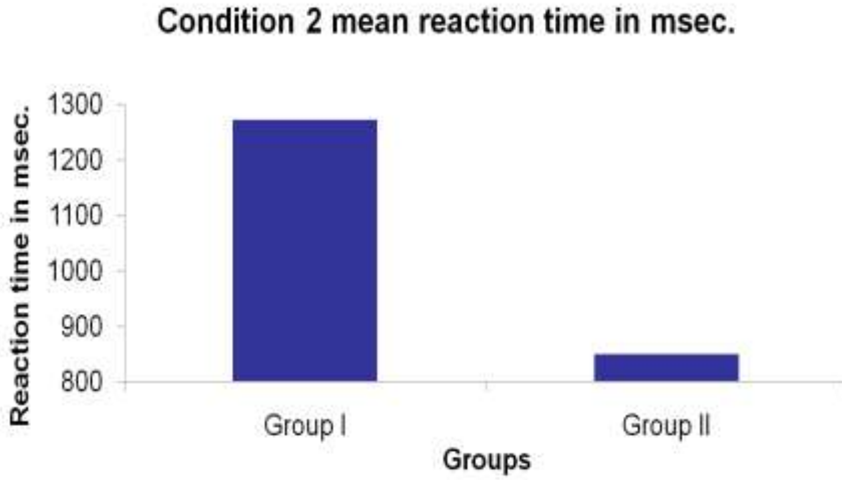
Graph 1: Mean reaction time for condition I across groups.

The mean reaction time values shows that the Group I had slower reaction time than the Group II. The results are consistent with previous research done by Tipper (1985), which shows reduced reaction time in older population. The reaction time data from semantically ignored condition indicate that the time taken to name a selected object is increased when that object is identical to one previously ignored. It has been reported that age related deficits in semantically ignored condition was observed because of inhibitory selective attention mechanism involvement to deal with identity based judgments (Kane, May, Hasher, Rahhal & Stoltzfus, 1997).

B. Control condition (Condition II): The control condition, involved the presentation of target/distractor of prime trial pictures not related to target/distractor of the probe trial picture. The mean reaction time values are displayed in the Table 2 and Graph 2 for both groups. The reaction time value shows that the elderly population had slower reaction time than the young adult's reaction time.

Groups	Mean Reaction Time (msec)
Group I	1272.85
Group II	849.51

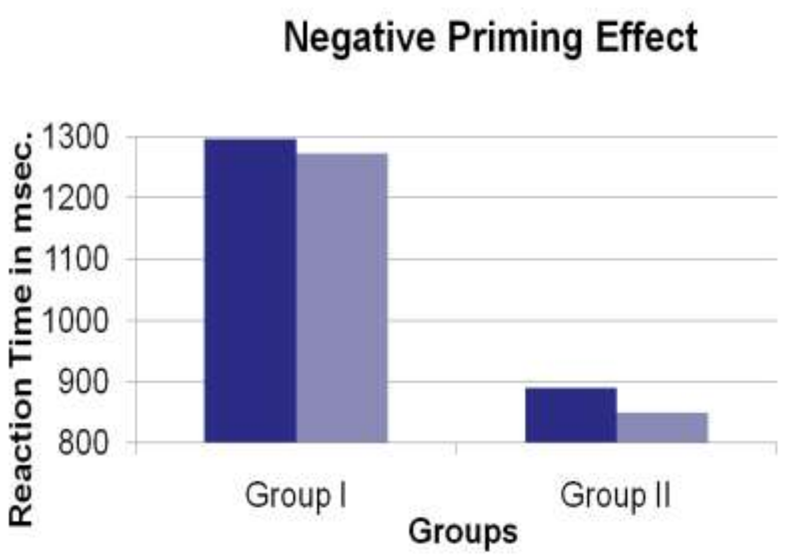
Table 2: Mean reaction time in milli seconds for condition II across groups.



Graph 2: Mean reaction time for condition II across groups.

The mean reaction time for Group I was 1272.85 msec and for Group II it was 849.51 msec. When data was subjected to independent t-test, a statistical significant difference between Group I and Group II (t=5.29, p=0.000) was observed.

C. Negative priming effect: The central concern of the two conditions was to test for negative priming effect. To find the significance of negative priming effect the condition I and condition II of both the groups were compared. Graph 3 represents mean reaction time in milliseconds for condition I and condition II for two groups.



Graph 3: Displaying the reaction time in milliseconds for across groups condition I and condition II.

Paired t-test was administered to note the statistical significance. Results revealed significant difference for young adults between condition I and condition II (t=2.80, p=0.006) where as in elderly population no statistical significant results were noted between conditions (t=0.194, p=0.847). The negative priming effect was observed for young individuals and naming of the probe was 40 msec longer whereas for elderly population the difference was 23 msec, when the selected probe was semantically related to the ignored prime compared to the control condition.

Discussion

It can be inferred from the present results that the inhibitory difficulties were more apparent among older individuals than young adults. The negative priming can be explained with the process of 'spreading inhibition' in semantic memory networks, analogous to that of 'spreading activation' (Meyer & Schvaneveldt, 1975; Collins & Loftus, 1975). When an internal representation is activated this can lead to a spread of activation to related concepts in semantic memory space (Osgood, Suci & Tannenbaum, 1955) or hierarchical networks (Collins & Loftus, 1995). However, if a stimulus has been ignored during selection of a simultaneous target, the internal representation (of the ignored object) is associated with inhibition, which may spread to related concepts, causing a slower reaction time during negative priming which is seen in young adults. This slower in reaction time is because of intact spreading inhibition system. Hence the reason behind the absence of negative priming in older adults can be attributed to the absence of this spreading inhibition system. And also the decline in inhibitory control is a general feature of many groups with reduced information processing efficiency. Because of reduced information processing efficiency which is seen in aging population may also have lead to decline in inhibitory control. Slowed reaction time on negative priming trials are either due to retrieval of incompatible response tags or of mismatching perceptual information, or due to extra processes needed to distinguish past from present information (Tipper, 2001). The present study methodology can be implemented to assess the negative priming in cognitive impaired clinical populations that reflects general failure of inhibitory processes in clinical populations like children with attentional deficits and schizophrenics.

Conclusion

Reaction time was measured for 20 older individuals (mean 60.3 years) and 20 young adults (mean 22.1 years) for two negative priming conditions (sematically ignored and control condition). Results indicated that young adults showed a statistical significant difference for negative priming effect whereas older population didn't show any significant differences between conditions. The absence of negative priming effect may be attributed to reduced 'spreading inhibition' process and information processing efficiency in older individuals. Further study needs to be conducted with increased sophistication of measurement, subject size and variety needs to be increased.

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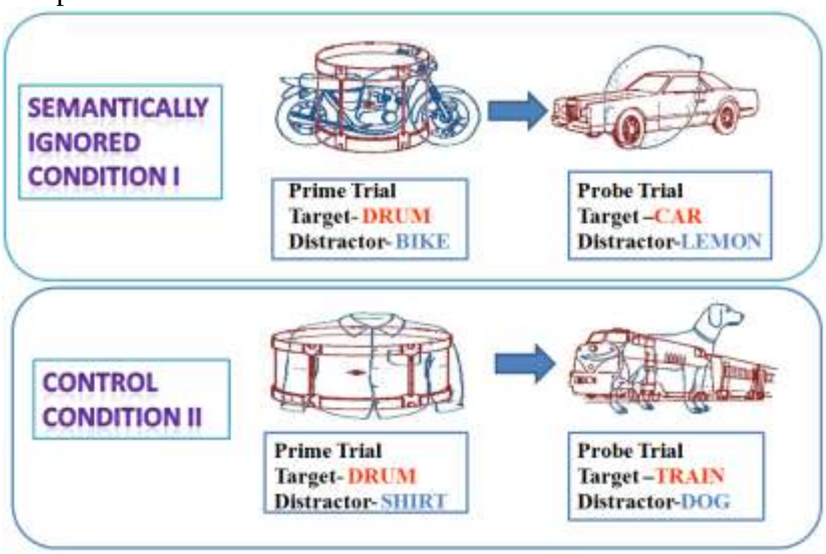
Appendix-1

Category labels and stimuli used in the experiment:

ANIMALS: cat, cow, dog, horse, mouse.
FRUIT: apple, banana, grape, lemon, orange.
VEHICLES: bus, car, motorcycle, train, truck.
CLOTHING: belt, dress, shirt, sock, tie.
MUSICAL INSTRUMENTS: drum, guitar, harp, piano, trumpet

Appendix-2

Overlapping picture presented in condition I and condition II



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Manjunath.N., M.Sc. (Speech & Hearing)
Lecturer
Department of Speech Language Pathology
Nitte Institute of Speech and Hearing
Deralakatte
Mangalore
Karnataka, India
man_n94@yahoo.com