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Research Article

Inter-relationship between Inter-stimulus duration and Performance on Semantic Judgment

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Received date: July 29, 2024; Accepted date: October 14, 2024; Published date: October 24, 2024

Citation: Abhishek B. Panchakshari, (2024), Inter-relationship between Inter-stimulus duration and Performance on Semantic Judgment, *Psychology and Mental Health Care*, 8(8): **DOI**:10.31579/2637-8892/296

Abstract

The present study addressed the effect of duration of SOA (Stimulus Onset A synchrony) on the performance of semantic judgment measured through mean reaction time and accuracy scores. Neurologically healthy individuals were enrolled for the study. The participants wree divided into 2 groups of 21 participants each. The first group comprised of individuals between 30-45 years. While the second group comprised of individuals between 46-60 years. The participants were supposed to carry out semantic judgment task on two set of stimuli comprising of semantically related and unrelated words. SOA was kept shorter for the first set of stimulus; for the second set of stimuli, SOA was kept long. The performance on these two set of programs was measured through reaction time and accuracy scores. Statistical analysis carried out by employing Wilcoxon's signed rank test revealed that there was no significant difference between the two semantic judgment tasks with shorter SOA and longer SOA showing the duration of SOA would have influence the performance on semantic judgment tasks.

Keywords: stimulus onset asynchrony; age; semantic priming; prime-target relationship

Introduction

Priming is known to enhance the performance in perceptual or cognitive task, in relation to a particular context or prior experience. Semantic priming refers to the improvement in speed and accuracy in response to a target stimulus. The target stimulus can either be a word (orthographic form) or a picture, when this target stimulus is preceded by a semantically related prime, then the target stimulus is retrieved easily compared to conditions, where the prime and target are not related semantically [1]. The word semantic in the term semantic priming suggests that priming is produced by convergence in meaning, as in the examples cow and cat (both are mammals, animals, domestic, herbivorous etc.). Whenever prime and target words are related, responses are often elicited in a faster manner compared to conditions, where the prime and target are semantically unrelated. E.g. if the prime word is 'Doctor' and target word is nurse, activation of the target word takes place faster and is known as positive priming. Semantic priming principle is often incorporated insemantic judgment task. In this task the prime-target word pairs (related and unrelated) are displayed on the computer screen and the participants are instructed to read the prime and decide on the relatedness with the target word. Most of the studies infer that responses for semantic judgment task are faster and more accurate, when prime and target are semantically related (E.g. fruit-apple) compared to semantically unrelated prime-target conditions (E.g. fruit-road). Yet another frequently used task is naming or pronunciation. In this task, participants are instructed to read the target word aloud as rapidly as possible (Non words are not presented unlike the lexical decision task). Even in these instances, studies have reported that participants can name the target word faster, when the semantic callzyrelated prime word occurs before the target. Semantic priming is used as a tool to investigate pivotal aspectssuch as word recognition, sentences and discourse, comprehension, and knowledge representation related to perception and cognition domains. The marked influence of semantic priming is seen when the participantsare not aware of occurrence of the semantic priming. This is especially true when is prime is presented so briefly that participants claim to have not experienced it. Researchers have explained the facilitation effects onprime target pair as combination of two processes namely spreading activation and conscious attention [2]. The spreading activation principle emphasizes on automatic processing. According to this principle, when a word is encoded (prime) it activates similar, closely related featural nodes in the lexical memory. Henceforth activation of a node results in spread of activation from a node to the neighbouring nodes in the lexical memory, assuming the neighbouring locations are related in terms semantics or association in the lexical memory. This activation which

spreads to the related words enhances subsequent processing of the words [3,4,5]. The time interval between the onset of prime and onset of target word, is known to be the stimulus onset asynchrony (SOA). Conscious attention is known to operate on the volitional mechanism of lexical retrieval A study [6] investigated the effect of SOA on semantic facilitation. According to this experiment, semantic facilitation at SOA's shorter than 250ms reflects the spreading activation mechanism. Whereas SOA's above 250ms involves conscious attention process. Further the distinction between the stimulus onset asynchrony was explored through semantic paradigm. When SOA is less than 250ms automatic mechanism of lexical retrieval is assumed to be activated, while a longer SOA (greater than 250ms) would activate the volitional mechanism of lexical retrieval. Efforts were made to see on context dependant processing of the prime and target (i.e. related vs. unrelated). Significant facilitation of target was noted at SOAs 90ms and 40ms by proponents [7,8].. Results of their experiment revealed reaction time (RT) in related prime- target pairs was 41ms faster than in unrelated prime-target pairs. Similar findings were reported by Warren (1977), with SOAs at 75ms, 112.5ms, 150ms and 225ms. When SOA is kept short it is assumed that semantic judgment task would operate on the principle of facilitation. Facilitation in turn would enable faster semantic judgment. Contrary to this, when SOA is kept long, decision on semantic judgment task can be derived through facilitation and inhibition (by inhibiting the lemma nodes which may not be related to the given target word). The reaction time is found to be longer while the accuracy of response is found to be better for shorter SOA's compared to longer SOA's [9,10]. Though there are handful number of studies on semantic priming and lexical decision tasks individually, the relationship between the duration of SOA and the performance on priming based tasks measured through the reaction time or accuracy of responses have not been studied [11,12]. The effect of duration of SOA in individuals with growing age has also has not been explored.

Need

On careful exploration of the above experiments and findings, further question arises on the effect of different SOA paradigm (short and long) on the performance on priming based tasks such as lexical decision of target across related and unrelated prime target pairs. The concept of SOA is often of special consideration in clinical population such as aphasia. Some researchers [13,14] claim that the automatic mechanism of lexical retrieval is preserved in some persons with aphasia predominantly in fluent type of aphasia, while other researchers claim that the volitional mechanism of lexical retrieval is preserved in certain types of aphasia predominantly non-fluent type. The activation of automatic and volitional mechanisms can be experimentally exercised by altering the duration of SOA. Many such studies may employ standard group comparison. Hence there is need to study the effect of the duration of SOA on the performance of priming tasks and also to verify if this variable (duration of SOA) has any role in altering the performance of priming tasks in individuals of different age group i.e. to verify if SOA would alter the performance as a function of age.

Aim: To see the effect of Stimulus onset asynchrony on mean reaction time for group I and group II individuals.

Objectives:

1. To study the relationship between the duration of SOA (longer and shorter SOA) on performance of lexical decision task measured through reaction time and accuracy of scores for group I (30-45 years).
2. To study the relationship between the duration of SOA (longer and shorter SOA) on performance of lexical decision task measured through reaction time and accuracy of scores for group II (46-60 years)

Method

participants

In the study, 42 participants (17 males and 25 females) were randomly selected between the age ranges of 30 – 60 years. The participants were further divided into sub groups. Group I consisted of 22 participants (8 males and 14 females) between age range of 30 – 45 years and Group II consisted of 20 participants (9 males and 11 females) between 46 – 60 years. The participants were native speakers of Kannada, with the ability to read, understand, speak and write Kannada.

Stimulus

Totally 200 pairs of prime-target paired were used as stimuli for the study. The words were derived from a primed based study in Kannada by Prema (2010). 200 pairs of words were divided into 2 sets of 100 prime-target pairs. The first set of prime-target pairs had SOA (duration between prime and target) of 250 ms. While SOA for the second set of prime-target pairs was 500 ms. Most frequently used words were selected as stimuli. These pairs of words contained meaningful words and non - meaningful words.

Procedure

The 200 paired word list were presented to the participants orthographically, displayed through laptop screen. DmDX Auto-mode Version 5.0 software was used to perform this task. 200 pairs of words were divided into 2 sets of 100 prime-target pairs. The first set of prime-target pairs had SOA (duration between prime and target) of 250 ms. While SOA for the second set of prime-target pairs was 500 ms. The prime word was aligned at the top of the screen and the target was aligned at the centre to enable identification. The participant was asked to concentrate on the words aligned at the centre screen (target). The participants were asked to press the key "one" in the keyboard if the target was a word and press "zero" if the word pair was non-word. Participants were instructed to perform the task as soon as possible after the target word was read by the participant on the screen for every pair of words. They were also instructed to keep their fingers not too far from the number keys. The study was conducted distraction free environment and quite in condition. The output files were subjected to statistical analysis after computing the mean reaction time and accuracy for shorter SOA and longer SOA stimuli of every individual who participated in the study.

Results

The first objective of the present study was to see reaction time and accuracy of scores of shorter SOA in comparison to performance on longer SOA in group I.Descriptive statistics was applied to measure mean and standard deviation in the data obtained. Results revealed all the measures had good score of standard deviations in group I, which infers that none of the measures were in close relation with the mean values obtained and hence the data can be further subjected to statistical analysis. Further to check the normality of measures obtained, mean reaction time and accuracy were subjected to Kolmogorov-Smirnov[a] and Shapiro-Wilk's test. Results indicated that the data was skewed ($p<0.05$) and

hence abided the properties of non -normal distribution. There fore further statistical analysis included non-parametric tests (Mann-Whitney Test and Wilcoxon signed rank test) on mean reaction time and accuracy.

Group I

a) Mean Reaction Time:

The mean reaction time in group I, for shorter SOA was 948.81ms and 983.48ms for longer SOA. The Standard deviation scores for the SSOA and LSOA were 323.02 and 317.98 respectively. (For example: see Figure 1) Further in order to see if there was any significant difference in the mean reaction time measures in the group I. Mann-Whitney Test was applied with reference to p <0.05 value. The analysis revealed no significant difference in the mean reaction time within the subjects of the group across both short SOA and long SOA. (For example: see Table 1)

b) Accuracy

The mean accuracy (percentage) in group I, for shorter SOA was 90.41% and 91.64% for longer SOA. The Standard deviation scores for the SSOA and LSOA were 4.38 and 2.46 respectively. (For example: see Figure 2)

Group II

a) Mean Reaction Time

The average mean reaction time in group II, for shorter SOA was 1082.94ms and 1113.57ms for longer SOA. Standard deviations for longer and shorter SOAs were 372.43 and 256.92ms respectively. (For example: see Figure 3) Mann-Whitney Test was applied with reference to <0.05 p value. The analysis revealed no significant difference in the mean reaction time within the two groups of subjects across both short SOA and long SOA. (For example: see Table 3)

b) Accuracy

Mean accuracy in group II for shorter SOA was 90.05% and 90.95% for longer SOA. Standard deviations for longer and shorter SOAs were 5.59 and 2.80 respectively. (For example: see Figure 4) Non parametric Mann-Whitney Test was applied with reference to <0.05 p value. The analysis revealed no significant difference in the accuracy within the subjects of group II across both short SOA and long SOA. (For example: see Table 4).

Discussion

Further number time lapsed and errors committed by the subjects of both groups across SSOA and LSOA were statistically analysed and results revealed no significant difference in these measures.To observe the difference in mean reaction time, accuracy, time lapsed and errors on overall 42 subject scores, Wilcoxon Signed Rank test was applied. The test results revealed that there is no significant difference between all the above mentioned measures across shorter and longer SOA. For shorter SOA's the reaction time is assumed to be shorter but the accuracy scores are found to be poorer as it would tap facilitation alone (Granig, 2012; Fraser & Lardot, 2014). However the findings of the present study negates this view and suggests that there the performance on semantic judgment task did not vary as a function of SOA. Another likely explanation would be in grounds of automatic and volitional mechanisms of lexical retrieval. Shorter SOA's would activate the automatic mechanism of lexical retrieval and longer SOA would emulate the volitional mechanism of lexical retrieval. As both these mechanisms of likely intact in neurologically healthy individuals, no significant difference on short and long SOA's would be seen. The other claim is that speed of processing reduces with age. Considering this claim into consideration, the participants should have obtained better scores on semantic judgment task with long SOA as he/she gets more time to make the judgment. However the present study ruled out this claim as no significant difference was seen between group I and group II individuals.

Conclusions

The current study was carried with the aim of investigating the effect of stimulus onset asynchrony on magnitude of priming. The findings showed no significant difference was seen in performance of semantic judgment tasks carried out with short and long SOA's. The performance on semantic judgment was measured through the mean reaction time and accuracy scores. It is commonly assumed that the reaction time would be longer and accuracy scores would be better for long SOA's as it involves both facilitation and inhibition.

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DOI:10.31579/2637-8892/296