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Comparison Between Phonological Priming and Semantic Priming in the Short Verbal Memory Span

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Abstract: The purpose of this study was comparing the phonological and semantic priming on the short verbal memory span. The research was conducted on sixty four male students of Tehran University of Medicinal Science. Due to some distorting factors on the reaction time, some exclusion criteria were adapted such as bilingualism, stuttering, articulation problems, etc. The qualified subjects were tested by auditory-discrimination test (Wepman test). Then all subjects were performed a test that was prepared under second version of DMDX software and the reaction time and accuracy were recorded. The results reveal that the semantic tasks were retrieved faster and better than the other tasks in lexical access. Then, rime tasks were retrieved. There was no significant difference between the alliteration and unrelated prime. In accuracy tasks, the difference between rime-alliteration and alliteration-unrelated tasks were not significant. The result of this research indicates that the semantic level is activated faster than rest of the levels and the phonological level is activated right after that.

Key words: Semantic priming, phonological alliteration priming, phonological rime priming, unrelated priming, short-term memory

INTRODUCTION

Complex mental operations require the ability to hold information of various kinds for brief period of time (Mayer, 2000). During the last 3 decades, considerable progress has been made in understanding the formation and functions of memory.

We should consider that problems of human memory have brought with them a concern with retrieval processes.

There are some investigation imply that memory is a single process unit but the other research believe that we have some kind of process units related to memory. According to these investigations, the memory can be divided into separate types, which we mention them.

Shiffrin and Atkinson (1969) in their research describe a theory of human memory that can be stored in three distinct components: the sensory register, the short and long-term stores. Among these stores, short-term store, sometimes referred to as primary, working or active memory, is that part of memory which is said to be able to hold a small amount of information for about 20 sec. It is widely held that Short-Term Memory (STM) is involve in the maturation and performance of a series of cognitive abilities such as

language, mental calculation and problem solving (Carlesimo *et al.*, 2006). Within one influential model of working memory there are three short-term memory storage mechanisms, the phonological loop (verbal and acoustic information), visiospatial sketchpad and central executive. These three separable components assumed to work together as a part of a unified working memory system that served the function of facilitating the performance of a range of complex tasks (Baddeley, 2003; Baddeley and Hitch, 1994; Mayer, 2000). This research was conducted in phonological loop of short-term verbal memory.

In cognitive psychology, there are some investigations indicating some methods to improve our learnings. For instance, mnemonics is a method of remembering based on creating an association between the elements. We can mention about some method such as peg-word, link or story mnemonic, first-letter recording, rhymes and invertibility.

According to above mentioned, in order to access a certain element of memory, speech-language pathologist should use some techniques or strategies to memorize the elements faster and easier. For instance, Bandur and Shewan developed a therapeutic method. LOT (Language-Oriented Treatment) to facilitate optimal responding by

patient. In this method clinician uses some cues such as repetition, phoneme, semantic association, description and rhyming (Bandur and Shewan, 2001).

The other task, which we can use in some patients to improve lexical access, is priming. Priming is the process related to implicit aid in its subsequent recall or recognition (Fromkin *et al.*, 2003) and this process automatically will be proceed by the system (Kouider and Dupoux, 2001). A word may prime another word if the words are related in some way such as semantically, phonetically, or even through similar spelling. It has been found, for example, that priming effect is shown by experiments in which a word such as nurse is spoken in a sentence and it is found that words related to nurse such as doctor have lower reaction times (RTs) in lexical decision tasks. So, RT is measured using a priming technique (Fromkin *et al.*, 2003). In this research, we consider to Semantic and phonological (alliteration and rime) primes and unrelated prime as a control group.

Lexical access is a process of searching the mental lexicon for a phonological string to determine if it is an actual word (Fromkin *et al.*, 2003). It `s not a single, uniform process and it can be seen to have some different properties in some different situations (Swinney *et al.*, 2000).

It would be essential to pay attention to some models of lexical access at first.

According to the spreading activation model of Dell, (Dell and O`seaghdha, 1992) and the same theory of Collins and Loftus in 1975 (Ferrand and New, 2003) it distinguishes between semantic-conceptual unit, lemma or word unit and phonological unit. Regarding of this point, the units are organized into a network in which the connections allow for a bidirectional spread of activation between units at adjacent levels. Figure 1 shows a fragment of the proposal lexical access in Dell `s model (Dell and O`seaghdha, 1992; Levelt, 1999).

The other model, related to the theory of lexical access in speech production was conducted by Levelt (1999). It `s discussed that the preparation of a spoken word proceeds through a number of stages. After conceptually driven selection of the appropriate lemma from the mental lexicon, the target word is first phonologically encoded, which largely consist of computing its syllabification and prosody. This is incrementally followed by phonotic encoding, which includes the computation of the articulatory gestures for the target word `s syllables in their phonetic contex (Cholin *et al.*, 2004). The flow diagram presented in Fig. 2 shows the theory in outline. As you can see, the production of words is conceived as a staged process, leading from conceptual preparation to the initiation of articulation. Each stage produces its own characteristic output representation. These are lexical concepts, lemmas,

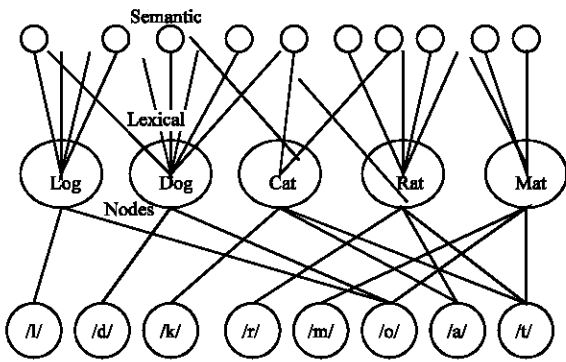


Fig. 1: Dell `s model of lexical network structure (spreading activation production model) (Dell and O`seaghdha, 1992)

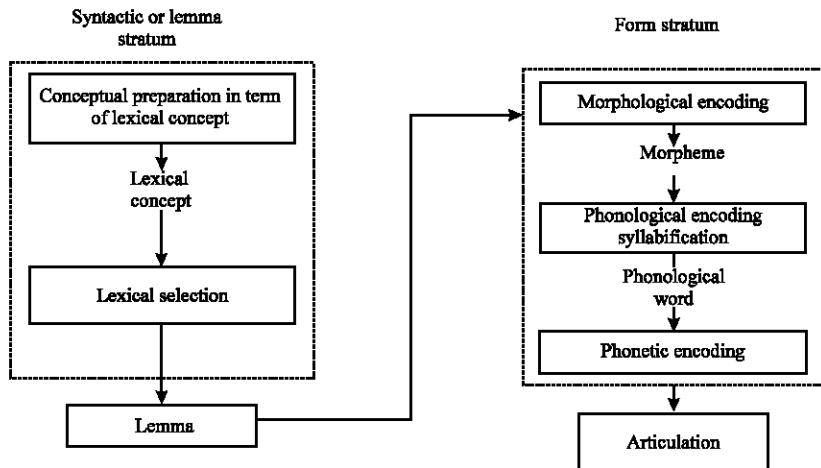


Fig. 2: Levelt `s model of lexical access (Levelt *et al.*, 1999)

morphemes, phonological words and phonetic gestural scores, respectively (Levett, 1999; Levett *et al.*, 1999).

There are some investigations related to priming that we can mention them in blew.

Wilshire and Saffran (2005) used two fluent aphasia to perform a phonological priming task in which they repeated an auditory priming then named target picture. The two patients responded very differently to phonological priming. The first patient, who has semantic and phonemic paraphasias, was facilitated only by beginning priming. The second one, who have phonemic and formal paraphasias, benefited significantly only from end related primes.

Radeau *et al.* (1998) used semantic, phonological and repetition priming for auditory presented words. The result showed that the reaction times were found to be faster for semantic, intermediate for rime and slowest for control targets.

O'seaghdha and Marin (1997) in six priming experiments, showed one-step semantic facilitation and phonological inhibition.

The other research related to the development of semantic and phonological priming conducted by Kang and Simpson (1996). This study shows the unusual accessibility of phonological information affects the word recognition processes of children learning to read written Korean.

Spitzer *et al.* (1994) used a lexical decision task involving semantic and phonological primes in 70 schizophrenia patients. Results support the hypotheses of an increase in activation or decrease in inhibition in the spreading of semantic and phonological association in schizophrenia patients.

MATERIALS AND METHODS

The present study is a descriptive-analytic study of a binary type, which concerns with the Reaction Time (RT) and accuracy of the participants with respect to four primes. During these processes, different semantic, alliteration and rime primes were the experimental groups and the unrelated primes were used as the control group.

In the priming test, participated 72 male students (between 18-25) from Tehran University of Medical science. We have some exclusion criteria articulation problem, stuttering, using some special drugs, addiction to narcotic substances, having the history of neurological problems and some psychological disorders e.g., depression. All of these items as distortion factors may have affected the reaction time, so we pay attention them as much as possible. After the basic study, 64 of participants who met the requirements of the test selected for this research.

The reasons beyond this age selection were the distribution of normal intelligence and the proper lexicon of subjects. The participants were tested individually in a quiet room.

Qualified subjects were taken the Wepman 's auditory-discrimination test, in order to examine the probable auditory problems.

In order to make a list of words for conductive the test, a logiest colleague was consulted and the following criteria for word selection emerged:

- Items starting with a glottal stop should be eliminated as possible as much as possible, such as âb means water
- Items which do not have a coherent frequency of occurrence should be eliminated, such as Beaupre means jump and separ means shield

Among the words which were mutually related to each other with respect to alliteration and rhyming, we used some words that were only related to the basis of voicing.

After the preparation of the audio files, we defined each of them to the DMDX software (revised edition). The software provided the eight initial words. Then, after a 3-second pause, it targeted the first word. The period between the speaker action and the answer of the subjects will be recorded as RT. In case the subject provided the audio response, the instrument would record the reaction time, if not, after a 3000 msec pause, the software automatically targeted the next item.

The subjects were asked to listen to 4 couple of words, broadcasted by the speaker and try to memorize them. Then, from those couples, one word was offered and the subjects were supposed to remember the second word and tell it as quickly as possible. In order to prevent any sort of stress or other problems, the words were provided without the use of headphones and were displayed by the speakers of computer with the same intensity for all participants.

After using the first set of words, the main test was conducted by the words which were randomly selected and the RT was recorded by the software. Then the reaction gap was saved in a word-file. Correct answers of the subjects simultaneously will be recorded that is uncertain for participants to reduce the amount of stress among them. Also, the voice of each subject was recorded by an MP3 player.

Statistical analysis: The data derived from the RTs were analyzed with the repeated measure test (version 13 SPSS software). In order to compare the accuracy, Willcoxon test was used for the study of the accuracy of the research.

In this research, one error was liable to happen: Individual errors, such as problems in remembering the words. These responses were not included in the research process. Naturally, Mean times of RTs were used on the basis of the remaining words.

RESULTS

Reaction time: Descriptive results of participants for reaction time; Mean RTs of primes: on semantic priming, 307 (SD: 75) and 326 for rime priming (SD: 72), 383 for alliteration priming (SD: 67) and 378 for unrelated priming (SD: 66). The score differences between two groups did not indicate any differences between their abilities in those areas.

The results of this study reveal that the semantic tasks were retrieved faster than the other tasks in lexical access (307 vs. 326, 378 and 383 msec, respectively for riming, alliteration, unrelated tasks) and these differences were significant (p-value<0.001).

Also, riming tasks were retrieved (326 msec) significantly (p-value<0.001). There was no significant difference between the alliteration and unrelated primes (378 vs 0.383 msec). You can see it in (Table 1).

Accuracy: The data in Accuracy was analyzed with Willcoxon subtest in SPSS software.

Descriptive results of participants for accuracy in the study (Table 2) were as follows.

We have four tasks in each of priming test. In semantic tasks, 73% of responses have four correct answers (all tasks), 20% of responses; three correct answers and 7% of responses, two correct answers.

In rime tasks, 52% of responses; four correct answers (all tasks) 37% of responses; three correct answers and 11% of responses; two correct answers.

Table 1: Data static of reaction time (all of data are in millisecond)

Central parameters	Primes			
	Semantic	Rime	Alliteration	Unrelated
Mean	307	326	383	378
Standard deviation	75	72	67	66
Minimum	146	164	201	178
Maximum	448	471	516	495

Table 2: Data static of accuracy

Primes	Correct answers			
	1	2	3	4
Semantic	0	4 (7%)	13 (20%)	47 (73%)
Rime	0	7 (11%)	24 (37%)	33 (52%)
Alliteration	1 (2%)	5 (8%)	32 (50%)	26 (40%)
Unrelated	1 (2%)	6 (9%)	34 (53%)	23 (36%)

In alliteration tasks, 40% of responses, four correct answers (all tasks) 50% of responses, three correct answers, 8% of responses, two correct answers and 2% of responses; one correct answer.

In unrelated tasks, 36% of responses, four correct answers (all tasks) 53% of responses, three correct answers, 9% of responses, two correct answers and 2% of responses one correct answer.

We can compare the data of each prime binary. According to analyses the semantic tasks done by participants were better and it was significant between semantic and the others (p-value<0.001). The differences between rime and alliteration primes was not significant (p-value = 0.127). But the participants did better in rime rather than unrelated primes (p-value = 0.041) and there were no significant differences between alliteration and unrelated primes (p-value = 0.360).

DISCUSSION

In generally, the present study was intended to investigate the role of kind of primes in memory processing.

In reaction time and accuracy; our findings were similar to those of Radeau *et al.* (1998) and Dell and O'seaghdha (1992), which indicate that semantic information being accessed and used at earlier stage of lexical access than phonological information.

In comparison with rime and unrelated tasks, it was shown that a rime task was faster than the unrelated one (Radeau *et al.*, 1998).

Relating to alliteration task, it was accessed slower than the other that is similar to Carlesimo *et al.* (2006), Gathercole *et al.* (2001), Baddeley(1966) and Dell and O'seaghdha (1992) reports.

In the Carlesimo's study, it was indicated that the normal children exhibited classical phonological similarity effect. It means that normal children had better performance on acoustic dissimilar than similar word lists. In Gathercole's study, it was shown that the phonological similarity effects in serial recall was found that will the phoneme order errors.

Dell and O'seaghdha (1992) used phonological inhibition effect as a competition between the discrepant phonological segment of the prepared word (the prime) and the present word (the target). They believe that the phonological inhibition effect is like the repeated phoneme effect in phonological speech errors.

All pervious studies have documented that a function of phonological tasks in processing have adverse effect.

The other studies related to primes have similar results, but all of them were investigated in abnormal participants such as schizophrenia (Spitzer *et al.*, 1984), word-finding deficits children (McGregor and Windsor, 1996) and aphasia patients (Baum, 1997). All of these studies investigated effects of primes in lexical access processing.

Although, the research result is not in agreement with Kang and Simpson (1995) report, whose study indicated an unusual accessibility of phonological information in Korean children. Maybe we can explain it by isolated languages which have special grammatical role.

We have made some additional conclusions that will be useful for future researches:

- The present study match with the model of Level *et al.* (1999) that was shown in Fig. 2. In this model, information flows unidirectional and discretely between stages. That is, activation flow from one layer to another only begins when a node has been selected and it flows from one layer to another. Thus, this model differs from models that assume cascading activation flow and those that assume interactive activation (Caramazza, 2000). This model discusses that some levels were activated to produce a word, conceptual preparation, lexical selection, phonological and phonemic encoding. The present study covers this model of processing and it confirms this model in Farsi. In contrast with Dell and O' Seaghdha 's model of lexical network structure
- RT measures in naming experiments shows that each of the semantic, grammatical and phonological effects are independent from the others (Caramazza *et al.*, 2004)
- Phonological similarity and word length are two factors known to diminish the capacity of working memory and it was shown that these two factors also can retard acquisition of novel vocabulary in adults (Smith and Geva, 2000)

Thus, based on this study, it could be suggested that clinician can use different techniques of priming to increase the ability of their patients.

Further investigations need for the other primes of linguistic processing involved in word production. By the way, more researches in this area with some other disorders such as stuttering group will appear their linguistic characteristics and manner of processing.

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