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An Investigation of Memory Retrieval of Linguistic Structures among Yemeni Adults through Spreading Activation: A Psycholinguistic Study

دراسة استرجاع الذاكرة للتركيبات اللغوية لدى البالغين اليمنيين من خلال تنشيط الانتشار: دراسة نفسية لغوية

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Abstract:

Objectives: This study aimed to address a gap in psycholinguistics by investigating linguistic structures (LSs) retrieved from memory among Yemeni adults, using Anderson's (1976) Spread Activation Theory. The primary objectives were to determine the frequency of LSs in memory retrieval and to measure the time required for this process.

Methods: A quantitative descriptive approach was used, involving thirty-three English-speaking adults from Mahrah University. Participants completed three written tests based on Spread Activation Theory: Fact Retrieval (FR) test, Configured Cue (CC) test, and Schemata Sentences (SS) test.

Results: Findings showed that the most frequently retrieved structure was the word level, with a retrieval rate of (81.01%), followed by sentence structure (71.01%), phrase structure (68.18%), independent clause (62.84%), and dependent clause (58.62%). The average time taken to retrieve twenty-five simple sentences was three minutes and nine seconds, with an accuracy rate of 73% and an error rate of 24%.

Conclusions: This study highlighted the varying retrieval frequencies of linguistic structures and provided insights into memory retrieval times, emphasizing the effectiveness of Spread Activation Theory in analyzing linguistic memory.

Keywords: Linguistic Structures; Memory Retrieval; Spread Activation Theory.

الملخص:

الأهداف: هدفت هذه الدراسة إلى سد فجوة علمية في علم اللغة النفسي من خلال دراسة التركيبات اللغوية (LSs) التي يتم استرجاعها من الذاكرة لدى البالغين اليمنيين، باستخدام نظرية تنشيط الانتشار لأندرسون (1976). الأهداف الأساسية هي تحديد تكرار التركيبات اللغوية في عملية الاسترجاع وقياس الزمن المطلوب لاسترجاعها.

المنهجية: اعتمدت الدراسة على المنهج الوصفي الكمي، بمشاركة ثلاثة وثلاثين بالغًا يتحدثون اللغة الإنجليزية من جامعة المهرة. خضع المشاركون لثلاثة اختبارات كتابية مبنية على نظرية تنشيط الانتشار، وهي: اختبار استرجاع الحقائق، اختبار المثير والاستجابة، واختبار الجمل النمطية.

النتائج: أظهرت النتائج أن التركيب الأكثر تكرارًا في الاسترجاع هو تركيب الكلمة بنسبة 81.01%، يليه تركيب الجملة بنسبة 71.01%، ثم العبارة بنسبة 68.18%، والجملة المستقلة بنسبة 62.84%، وأخيرًا الجملة التابعة بنسبة 58.62%. بلغ متوسط الوقت المستغرق لاسترجاع خمس وعشرين جملة بسيطة ثلاث دقائق وتسع ثوانٍ، بنسبة إجابات صحيحة بلغت 73% وخاطئة 24%.

الخلاصة: سلطت الدراسة الضوء على التفاوت في تكرار التركيبات اللغوية أثناء الاسترجاع وأتاحت فهمًا أعمق لأزمنة استرجاع الذاكرة، مما يبرز فعالية نظرية تنشيط الانتشار في تحليل الذاكرة اللغوية.

الكلمات المفتاحية: التركيبات اللغوية؛ استرجاع الذاكرة؛ نظرية تنشيط الانتشار.

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1   Introduction

1.1 Background of the Study

Memory retrieval is a process when a memory recalls a piece of information that has been stored in the long-term memory. This retrieval can be done through some motivations suggested by the theory of Spreading Activation. In this theory a code, a prose, a cue, or a stimulator is given to a target to relate it to a component, an image, or a term. The stimulation could spread through a network that are connected in the memory to recall the information. Spreading Activation Theory has first been applied by Collins and Quillian (1972). A model that incorporated a spreading activation mechanism that played a comparable role to that in activation (ACT) was proposed by Posner and Snyder (1975). In (1976), Anderson tested the Human Association Memory (HAM) Theory and developed Spread activation theory in his book Language, Memory and Thought.

1.2 Problem Statement

Investigating how memory retrieves linguistic structures (LS) was a gap that needed to be filled in the studies of psycholinguistics as Polisenska et al, (2015) reported. Also, most of the previous studies recommended studying the LS and memory, particularly the syntactic structure in memory, i.e Levelt, Roelof & Meyer (1999), Ferreia & Engelhardt (2006), Slevc & Ferreira (2013), and Catan (2019). Research problem was identified by three aspects. First, the memory mechanism, how it processes with the linguistic structures LSs through the retrieval operation. Second, the nature of memory retrieval of the linguistic structures among members. Third, the span of activation that the memory spends to make the recall and the retrieval of LS.

1.3 Research Objectives

The purpose of this study was to analyze statistically the LSs retrieved from the memory. The study employed the Spreading Activation Theory (SAT) which was suggested by Anderson (1976). It has applied several tests to generate its results. The present study attempted to achieve the following objectives:
- To illustrate the frequency of LSs (words, phrases, sentences or clauses) in the memory retrieval.
- To measure the span, the memory needs to retrieve the LS.

1.4 Research Questions

This study aimed to answer the following two research questions:
- What is the frequency of each LSs (words, phrases, sentences or clauses) in the memory retrieval?
- How much time does the memory need to retrieve the LSs?

1.5 Significance of the Study

The investigation of LS's frequency through the activation process could highlight the regulation of language in the brain. This regulation could contribute to both language learning and language acquisition. The span of the time memory required to recall and reform the LSs, could participate in memory retention of the information in linguistic units. Identifying the span could serve in reducing the effort and accelerate the process. This study could be essential to teachers who need to understand students' memorizing process. Also, it could benefit neurolinguists to examine memory. As well as the psycholinguists could predict the behavior reflected on memory and language. In these days, it could be helpful for artificial intelligence.

1.6 Scope of the Study

The current study mainly focused on Yemeni adults aged above 18 years. It took the adults at Mahrah University as a representative of the Yemeni adults during the year 2024. Furthermore, the structures of English languages were tested. The study did not take other language domains, such as the phonetic, phonological, morphological or semantic domain. It was concerned with the syntactic structure (words, phrases, sentences and clause). The study analyzed memory process in only retrieval. It did not explain or study its ability, weakness, strength or constrain. It concentrated on its way of retaining the structures, not its operation in comprehension, conscious or intelligence.

2 Literature Review

2.1 Spread Activation Theory (SAT)

Anderson (1984) explained that, when information is processed, it activates networks in the mind, resulting in the formation of mental images or words. These mental representations are then stored in working memory for a short period of time before being transferred to long-term memory. In long-term memory, information is organized as a network of connections between concepts. To retrieve information, the activation of concepts in working memory spreads through this network structure. The time it takes to retrieve information is influenced by the level of activation.

Spreading Activation Theory has been influential internationally in areas such as psycholinguistics, artificial intelligence, and neuropsychology, with researchers from diverse linguistic and cultural backgrounds studying its implications on language and memory. For example, the theory is widely used to understand multilingual language processing, where associations between concepts may differ based on cultural context and language structure. In multilingual societies, the activation patterns can vary significantly because words in different languages might not share the same semantic networks. This phenomenon is particularly relevant in bilingualism studies, such as in Canada, where English and French speakers display unique spreading activation patterns due to bilingual language networks (De Groot, 2011).

In artificial intelligence, spreading activation has been applied to multilingual NLP (Natural Language Processing) systems used worldwide. For instance, the EU's multilingual digital services use spreading activation-inspired models to interpret and translate languages accurately, helping bridge language barriers across member states. Similarly, in China, AI research integrates spreading activation principles to enhance conversational AI, adapting responses to the cultural and linguistic context of Chinese dialects and semantic structures (Sun, Huang, & Luo, 2023).

2.2 Spreading Activation

Spreading activation is a concept used in Psychology, Psycholinguistics, and Cognitive Linguistics that explains how language production and comprehension occur. This model suggests that, when we focus on a particular word, other related words are also activated to some extent through a process of activation spread or retrieval. Consequently, we respond more quickly to these related words than to completely unrelated ones. For example, processing the word "learning," will activate related words in terms of meaning, semantically, morphology, and syntax, such as vocabulary, structures, shapes. Thus, words in our mental lexicon bring along their synonyms and related terms (Schmid, 2005).

2.3 Memory

According to Field (2022), early research on memory had led to the development of a model that included three types of memory: sensory memory, short-term memory, and long-term memory. The transfer of information between these memory stores was often depicted as being controlled by a central operator.

Sensory memory is a very brief form of memory that allows individuals to retain fleeting impressions of speech sounds (referred to as echo memory) or the arrangement of words on a page (referred to as image memory).

Short-term memory:

Also known as working memory, can hold a limited number of items for immediate processing. These items can come from incoming signals or be retrieved from long-term memory. Current theories view short-term memory as an active participant in cognitive activities, rather than just a passive storage system.

Long-term memory has an unlimited capacity and can hold information for extended periods of time. The duration of information in long-term memory is reinforced through its use. Long-term memory is believed to contain two types of knowledge: declarative knowledge, which allows access to facts, and process knowledge, which enables the execution of tasks or processes.

2.4 Recall and Retention

Recalling and retention are key concepts in cognitive psychology, particularly in the context of memory processes.

Recalling: refers to the process of retrieving information from memory without the aid of explicit cues. It involves bringing previously learned material back into conscious awareness. Recalling can be tested through

various methods, such as free recall (retrieving information without any cues), cued recall (retrieving information with the help of cues), and serial recall (retrieving information in a specific order).

Retention: on the other hand, refers to the ability to maintain and store information over time. It is the process by which information is preserved in the memory system. Retention is often measured by the extent to which information can be accurately recalled or recognized after a certain period.

2.5 Linguistic Structures

Language is structured in different levels, phonemes, morphemes, words, syntax, grammars and semantics. These linguistic units can be combined to generate an infinite set of expressions with a limited set of building blocks: morphemes into a new word, and words into a new phrase. The study was concerned with syntax and its analysis, phrases, sentences and clause.

2.5.1 Syntax

According to Bornstein (1977), syntax is the process of combining words and grammatical categories to create sentences, clauses, and phrases in a language. Chomsky (1966) defined syntax as the study of the principles and processes involved in constructing sentences in specific languages. Matthews (1974) explained that syntax was concerned with the external functions of words and their relationships within a sentence. It also involved the grammatical components that contribute to the structure of grammatically correct sentences. The starting point in studying syntax is the widely accepted notion that words belong to different categories (such as nouns and verbs) and come together to form sentences.

2.6 Overview of Relevant Studies in Memory and Language

Recent neurophysiological and neuroimaging studies have shown that neural activity can follow the structure of a sentence, providing evidence that the brain organizes words hierarchically. However, the specific computation responsible for this activity is still debated.

A recent study conducted by Polisenska et al., (2015) examined the impact of semantic effects on sentence recall in language assessment. Twenty-four adults native speakers of English participated in this study, equally divided between genders. All were employees from one department within a local authority council office in south-east England. Participants were aged between 18 and 50 years, The study findings highlighted the significance of presentation conditions for the different language levels being tested. The researchers suggested that while both immediate and delayed recall are relevant to all language expression levels, their contributions differ. Immediate sentence recall primarily relies on lexical phonology and morphological syntax, whereas delayed sentence recall is more dependent on semantics. This has implications for the use of recall tasks in language assessment.

A study conducted by Franck and Wagers (2015) explored the relationship between syntactic structure and memory in attraction. The researchers aimed to investigate the hypothesis that the memory access process involved in selecting a controller operates in a hierarchical structure. To test this, they designed a study to examine whether attractions located in a syntactic position that triggered more attractions were easier to retrieve. Forty-six participants took part in the experiment. They were all native French speakers aged between 20 and 40 with no reported hearing or language impairment. The study was approved by the Ethics committee of the University of Geneva. The findings of this study indicated that the memory access underlying sentence processing was constrained by grammar. Specifically, subjects had the highest prominence in memory, followed by c-elements of the verb, and then elements in precedence. These results provided direct support for the idea that attraction is influenced by the visibility of the attractor during memory retrieval, and that this visibility is dependent on its location in the syntax of the sentence. Overall, the study suggested that syntax theory plays a crucial role in shaping memory representations.

Catan (2019) discussed the effects of Arabic linguistic features verbal short-term memory. His study investigated the influence of both semantic and phonological features on STM by examining how readily people recalled lists of Arabic words that had varying degrees of semantic relatedness (e.g., chair, table, bed) or that incorporated common word construction patterns (root and pattern). The participants were between 20-25 male Iraqi-Arab postgraduate students from the University of Wollongong, (average age = 36.45). All of them were native Arabic speakers and none had speech or hearing defects. Most of them had been in Australia recently and finished their previous education in Iraq. Results indicated that both types of features had a significant impact on STM, demonstrating the close interplayed between LTM and STM in language processing.

A study done by Tamaoka, (2020) in Japan on spreading activation which has contributed to understanding kanji and kana processing, as the orthographic depth in Japanese requires different activation pathways for retrieving word meanings. Studies have found that spreading activation helps explain how Japanese speakers link complex kanji characters to their meanings and pronunciations, drawing on semantic networks that differ from those in alphabetic languages.

Li et al., (2022) conducted a study about Chinese-English bilinguals' recall of French vocabulary. They reported that, retrieval practice was more conducive to foreign language acquisition than recurrent study, according to a plethora of prior research. Three sessions of the experiment included sixty-two bilingual Chinese-English participants. First, 120-word pairs from French (L3) to English (L2) were used for encoding. In the second session, either repeated studying or retrieval practice conditions were applied to the 120 French-English word pairs from the first session. In the third session, they found that, retrieval practice improved French word learning more than repeated study.

Furthermore, neuropsychological studies in Europe and North America conducted by DelGaudio et al., (2023). have investigated the role of emotion in semantic memory, showing that emotionally charged words trigger stronger activation. This finding has universal implications, as it suggests that emotional context influences how memories are retrieved, regardless of cultural differences. For example, a recent study comparing emotional memory recall between American and Italian participants found that cultural factors and emotional valence impact activation patterns differently, with cultural associations affecting memory recall in unique ways.

3   Methodology

The study adopted the quantitative method to analyze the data. According to Kothari (1990), quantitative research involved measuring quantity or amount and it is suitable for phenomena that could be expressed in terms of quantity. It was used to determine the frequency of linguistic forms recalled from memory and the time taken for retrieval, it was also a form of statistical analysis. Consequently, utilizing quantitative instrument to measure activation test results was more reliable and informative. The numerical representation of the findings clearly revealed the research questions' answers.

3.1 Population

The finite population of the study were students from Faculty of Education and Faculty of Art at Mahra University, which were about seventy-four students. The population from which sample was selected had specific criteria. These criteria were:

All participants spoke English language because the study investigated English structures. They also had to be educated, with their memories trained in retaining and retrieving information, unlike the illiterate people, whose memories were influenced only by their environment. Furthermore, none of the participants should have had any mental disorder, because the study focused on the normal memories – a required in the academic field. Participants' age had be above 18. According to Fry, Hale & Braink (1995), memory development above 18 stops, so it becomes steady. This age is ideal for education and learning.

3.2 Sampling

The sampling design used in this study was simple random sampling, so that every individual had an equal probability of being selected from the finite population. According to Creswell (2012), "The intent of simple random sampling is to choose individuals to be sampled who will be representative of the population. Any bias in the population will be equally distributed among the people chosen", (p.143). Thirty-five participants were chosen randomly from the finite population which represented 47% of the population. Two participants did not complete.

Participants were seven males and twenty-eight females which represented 18% and 82% respectively of the sample. According to their level; six participants were in the first level, seven were in the second level, six were in the third level, eight were in the fourth level, eight were MA students. All participants' agreement was taken and all participants had signed an informed consent form. In summary, simple random sampling enhanced the reliability and specificity of the collected information. When selecting individuals each element of the finite population was written on a slip of paper, which was then thoroughly mixed in a box. The required number of slips for the sample was drawn one by one without replacement and without looking at them.

3.3 Data Source

The current research relied mainly on primary data collected through activation tests, while previously published studies were compared and discussed in relation to the primary data results.

3.4 Procedures and Instrument of Data Collection

As has been clarified, the main data were collected from 35 participants, two participants did not complete, so the total number was 33 participants. The instrumental tool for collecting data was a group of tests suggested by Anderson and others (1976), in his book "Language, Thought and Memory" Language materials that used in conducting tests consisted of 54 set of sentences. Sentences ranged in length from 8 to 22 words, with the average length 13.1 words. Also, the researcher added two sentences with independent clauses (N.18 & 19) and two passive sentences (N.20 & 21) to vary the structures; because most sentences taken from the theory included active and dependent clauses.

The procedures of conducting the tests were in three phases; an initial study phase, a study phase and reaction time. The study took forty days from January 21st, to February 29th. The tests were varied in order to cover different types of sentences and examine different structures retrieval. These tests were conducted in the second and third phase. After the first phase in which participants saw the sentences and were encouraged to study them meaningfully, they moved to the study phase. In the second phase, participants were distributed into five different times to take the tests depending on their time table. Because the study required them to study and memorize the sentences carefully, away from exam stress or any responsibilities that could affect the results. The researcher was following them up regularly to check where they were in their studying process by creating five different groups at whatsup application.

The tests were described as experiments and paradigms by Anderson and others, to investigate memory. The researcher had selected the following tests among many other tests that Anderson had conducted, because each type of these tests examined different LS. Those tests were: Fact- Retrieval (FR) test, Configured Cues (CC) test; which was divided into two parts: a Word Cue and a Phrase Cue, and Schemata Sentences (SS) test. In which FR test examined memory ability in retrieving a single word. Word Cue (WC) test required a whole and complete sentence to be recalled. Phrase Cue (PC) demanded recalling different phrases: NP, VP, PP & dependent CP. SS test investigated memory ability in recalling independent clauses.

These tests were more reliable for the study than the others, because Anderson in these tests examined memory retrieval rather than memory comprehension or intelligence. Also, these tests serve in accomplishing the study aspects. In detail, based on Anderson experiment of FR test measures the strength of associations between words, i.e, between the person and his place, that helps the researcher to gain insights into the organization of memory. So, it serves the researcher in examining memory ability in words retrieval. While CC test as Anderson concluded that, by manipulating cues the researcher can observe which pathways are activated which highlights the hierarchical structure of memory. So, it helps the researcher to understand how the memory navigates sentences and phrases during retrieval. As for SS test, Anderson emphasized that, SS provide a structured and a coherent context that aids in understanding the role of a background knowledge in the recall process. So, it helps the researcher in examining different types of linguistic information that integrate semantic and syntactic. Thus, they are the most suitable for achieving the researcher objectives.

The structures which the participants recall also aimed to figure out what the frequent of the structures that participants could remember, which answered the first research question. The third phase of these tests aimed to make participants judge through a specific time whether they have studied the presented sentences or not. Thus, the second research question would be answered. The third phase was done by using quiz application. Below was more explanation about how the tests were conducted.

3.5 Validity and Reliability

In order to check the validity of the material to the community culture, the researcher had given it to five doctors. Many statements were changed to suit the community culture and to be easy for participants to understand. They noticed a repetition of two answers for the same question, so it was deleted. Also, they recommended to add marks for each question. As well as they asked the researcher to make it clear whether the test would be taken orally or written. Thus the researcher worked on their notes.

In order to check the reliability of the tests to participants' level, the researcher has conducted a pilot study. Ten participants were chosen randomly from the finite population. Then those participants were excluded from the finite population in order not to be selected again when choosing participants for the study. Then,

Cronbach's alpha was used to measure tests' reliability, the results were presented in table 1. The researcher has followed the same procedures of conducting the study. It took only two weeks to conduct the three phases

Additionally, the researcher gained several insights from the pilot study. The researcher found that, the study materials and tests were appropriate for the participants' level, as shown by the variation in their scores. The researcher also noted that time required to complete the tests - 20 to 45 minutes- was suitable for them. Furthermore, the researcher confirmed that the instructions and test format were clear to the participants.

Three questions had answer spaces that were too short, so the researcher adjusted this issue. One question, " where is the lawyer?" caused confusion among participants, because it allowed for three possible answers. To resolve third, it was changed to " Where are the lawyers?". Additionally, the final test question, originally worded as " Arrange the incidents related to the following statement" was unclear. Therefore, it was revised to "Write the incidents related to this statement".

Table 1: The Realibilty of Tests through Crnbach's Alpha

N	Tests	N. of Items	Cronbach's Alpha
1	T1	12	0.883
2	T2	5	0.884
3	T3	21	0.961
4	T4	6	0.794
	The four tests	**44**	**0.965**

From Table 1, it is noticed that the reliability coefficient of the tests as a whole scored more than (0.96) and it was a high score. As well as it scored high for each test. That meant the four tests in their final forms were reliable to be conducted on the study sample.

Furthermore, the researcher followed specific producers in correcting data. The researcher corrected them twice; the second time was after a week from the first one. The researcher corrected the results, test by test for all participants separately, then moving to the next test. Since the researcher's objective focused on recalling information, minor spelling mistakes were ignored, no marks were taken from these mistakes, such as writing "pank" instead of "bank", the word "pank" was written, using a lowercase letter for " Egyptian" or misspelling "president" was written as " presdent". Moreover, the minor grammatical mistakes were ignored and no marks were taken from them, such as writing the present tense instead of the past tense, such as " cook", 'examine" or "shock". Also, the minor lexical mistake such as writing the synonym of a word instead of writing the same word, such as the word " rat" the word " mouse" was written, the word "slept" instead of the phrase " took a nap" or using "the" instead of "a"

4   Results and Discussion

Each research question was answered by showing the quantitative data that were analyzed using Excel and presenting them in tables and figures. Frequencies, percentages, averages, and means were used to facilitate interpreting results. Additionally, ANOVA analysis and (Scheffe) tests were used to find out the statistical significance among participants. After that, data were discussed descriptively. Finally, the section ended with a summary.

4.1 First Research Question
What is the frequency of each LS (words, phrases, sentences, or clauses) in the memory retrieval?
To answer the question, Linguistic Structure (LS) for each test were analyzed and then discussed. Table 2 presented the structures of words, phrases, sentences, dependent clauses and independent clauses that retrieved from memory.

Table 2: The Frequency of each Linguistic Structure Retrieved from Memory

N	LS	N	Total Frequency	Mean Frequency	Percentage Frequency	
1	Words	15	401	12.15	81.01	1
2	Phrases	34	765	23.18	68.18	3
3	Sentences	30	703	21.31	71.01	2
4	Dependent Clauses	32	619	18.76	58.62	5
5	Independent Clauses	19	394	11.94	62.84	4

It is noticed from table 2 that, the total frequency of LS that were retrieved from memory ranged between (394 and 795) LS; their means ranged between (11.94 and 23.18); and their percentages ranged between (58.62% and 81.01%). More details were explained below:

The highest rate was for the word structure with a total frequency of (401) and a mean frequency score (12.15). representing (81.01%). This was followed by the structure of a sentence, which had a total frequency of (703), a mean frequency scored (21.31) and a percentage of (71.01%). Phrase structure ranked third with a medium rate, a total frequency of (765), a mean scored of (23.18) and a percentage of (68.18%). The two types of clauses, whether the dependent or the independent had the lowest rates. The independent clause ranked fourth, with a total frequency of (394) a mean scored of (11.94) and a percentage of (62.84 %). The dependent clause ranked fifth and last, with a total frequency of (619), a mean scored (18.76) and a percentage of (58.62%), see Figure 1.
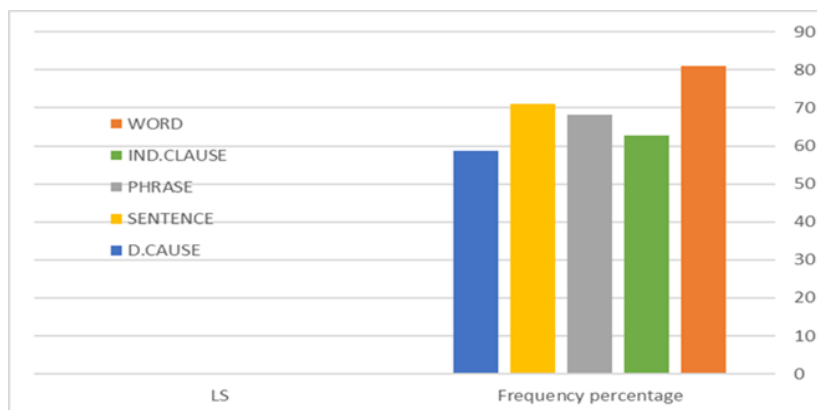
Figure 1: The Frequency of each Linguistic Structure Retrieved from Memory.

The researcher claimed that, based on these results, the easiest structure that can be stored and then retrieved from memory was the structure of word. This result associated with Dual-Coding Theory proposed by Paivio (1971), who suggested that information was better remembered when it was encoded both visually and verbally. Words can often be visualized, creating a dual representation that enhances recall. Furthermore, all words in this study were formed in sentences not individually, which enhanced the process of recalling them, as a study done by Craik et al., (1972) indicated that, information processed at a deeper, more semantic level (e.g., the meaning of a word) was more likely to be remembered than information processed at a shallow level (e.g., the appearance of a word).

Then the structure of a whole and complete sentence which was considered the perfect for memory to store and recall, where all the units within a sentence are linked together. So they worked as a string, this could be supported by Chomsky's (1957) transformational-generative grammar theory. It posited that our memory for language was deeply tied to these syntactic structures. Chomsky emphasized the hierarchical nature of sentence structures, where sentences were composed of nested phrases. This hierarchical structure aided in processing and recalling sentences, as it aligned with how our cognitive systems organize and store information.

As it was noticed, the sentence structure was better in recalling than the phrase structure, which indicated that, a whole and complete structure provided a strong connection between units in the memory unlike phrase which was a part and a constituent of a sentence. That was explained by Bransford and Johnson (1972) in which sentences provide a richer context than isolated phrases, which could aid in memory. Also, this result supported the studies in episodic memory done by Tulving & Thomson (1973), which showed that narratives (which were composed of whole sentences) were better recalled than fragmented information.

The independent clause had the lowest rate, where the independent clause ranked fourth while the dependent clause ranked fifth and last. It interpreted that, the dependent clause was the hardest and the most difficult for memory to be stored and retrieved followed by the independent clause. It showed that, memory could manipulate a structure that works alone in which the confusion is less than with a structure that depend on another form to build its form. This could be justified by what Gibson (1998) reasoned; complex sentences with multiple clauses require more cognitive resources to process and recall. As well Just & Carpenter (1992) concluded that, sentences with dependent and independent clauses could place a higher load on working memory, making them harder to recall. This was particularly true when sentences had multiple embedding.

Moreover, Cowan (2008) found this out, in complex sentences, information in dependent clauses, which might come earlier in the sentence, could be harder to recall than information in the main clause. Also, Murdock

(1962) justified that, this effect suggested that items at the beginning and end of a list were more easily remembered than those in the middle. In complex sentences, dependent clauses often appear in the middle, making them harder to recall.

Furthermore, it was noticed that, phrase structure got a medium rate and the third rank which clarified that, memory works in a good and medium ability when storing and recalling phrase structures. Phrase structure would be discussed in detail in this section. More explanation about the constituents of LS throughout the four tests which were analyzed and then presented. Table 3 shows Linguistic Structure Constituent (LSC) overall the tests.

Table 3: The Frequency of each Linguistic Structure Constituent Retrieved from Memory.

N	LSC		N	Total Frequency	Frequency Mean	Frequency Percentage	
1	Noun Phrase (NP)		24	551	16.70	69.57	2
2		Verb	27	607	18.39	68.13	3
	Verb Phrase (VP)	NP	24	553	16.76	69.82	
		VP	51	1160	35.15	68.92	
3	Preposition Phrase (PP)		23	552	16.73	72.73	1
4	Clause Phrase (CP)		32	619	18.76	58.62	4

As seen in table 3; the frequency of each LSCs that were retrieved from memory ranged between (551 and 1160) LSC; their means ranged between (35.15 and 16.70); and their percentages ranged between (72.73% and 58.62%). More details were explained below:

- Total frequency of Noun Phrases (NPs) that were retrieved from memory overall the four tests was (551) with frequency mean of (16.70). It represented a percentage of (69.57%).
- Total frequency of Verb Phrases (VPs) that were retrieved from memory throughout the four tests was (1160) with frequency mean of (35.15), where the Vs scored a mean of (18.39) and (16.76) NPs. VP represented a percentage of (68.92%).
- Total frequency of Prepositional Phrases (PPs) that were retrieved from memory throughout the four tests was (552) with frequency mean of (16.73). It represented a percentage of (72.73%).
- Total frequency of Clause Phrases (CPs) that were retrieved from memory throughout the four tests was (619) with frequency mean of (18.76). It represented a percentage of (58.62%).

As has been discussed above, the PP got the highest frequency constituent retrieved from memory, followed by NP and then VP, last was CP; see figure 4-3. These results agreed with Miller's (1956) study, who reported that prepositional phrases often function as chunks of information that described relationships between objects, actions, and contexts. Chunking information into meaningful units has been shown to improve memory recall. Anderson, (1983) as well claimed that, prepositional phrases could create associations with other elements in a sentence, facilitating recall through connected concepts and imagery. Ellis (2002) supported that, prepositional phrases were likely easier to recall due to their common usage and straightforward structure. Frequent exposure to these phrases reinforces memory retention.

As the result presented that, NP was recalled more than VP. This was supported by Franck and Wagers' (2015) study, even though their study was done on English native speakers, while the current study was done on Arabic native speaker who study English language as a foreign language. Their findings indicated that, the memory access underlying sentence processing was constrained by grammar. Specifically, subjects had the highest prominence in memory, followed by constituents of the verb, and then elements in precedence.

While CP got the last rank due to its complex structure as has been discussed previously in this section. In addition to the illustration of Kintsch's model (1988) of text comprehension, it suggested that, the difficulty in recalling clauses could be linked to the number of propositions and the connections between them.

More detail and discussion about the LSC in each test separately were discussed below.
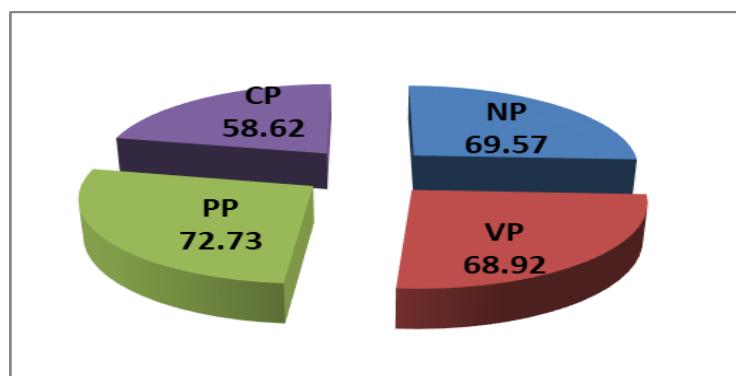
Figure 2: The Frequency of each Linguistic Structure Constituent Retrieved from Memory.

4.1.1 Results of the First Test

FR was used to figure out memory ability to recall words within a sentence. The required words were in NP shell and PP shell. Table 4 showed the results.

Table 4: Constituent Frequency in the First Test:

N	C	N	Total Frequency	Frequency Mean	Frequency Percentage	Frequency Rank
1	A word in Noun Phrase	3	80	2.42	80.81	2
2	A word in Preposition Phrase	12	321	9.73	81.06	1
	Total Words	**15**	**104**	**12.15**	**81.01**	

The analysis demonstrated that, the structures of a word in NP shell & PP shell were very close. Their frequency means ranged between (9.73-2.420). Their percentage ranged between (80-81). So that memory recalls the structure of a word easily wherever it exits in a structure. This result could be benefit in studying and teaching vocabulary, when the words are put in a text, it would be easier to be stored and recalled.

4.1.2 Results of the Second Test

This test was mainly used to investigate memory ability in recalling a whole and a complete sentence which consisted of three constituents: NP, VP & PP. Table 5 presented the analysis of these constituents.

Table 5: Constituent Frequency in the Second Test.

N	Constituent		N	Total frequency	Frequency Mean	Frequency Percentage	Frequency Rank
1	NP		4	85	2.58	64.39	2
2	VP	V	11	264	8.00	72.73	1
		NP	10	249	7.55	75.45	
		VP	21	513	15.55	74.03	
3	PP		5	105	3.18	63.64	3
	Total Constituent		**30**	**703**	**21.31**	**71.01**	

As it is noticed, the total frequency of LSC was (703). It ranged between (85 and 513). Their frequency means ranged between (2.58 and 15.55). Their percentages ranged between (63.64 and 75.45). The highest LSC in the second test was for the VP and frequency percentage of (72.73%). NP got the second rank, with frequency percentage of (64.39%). The last constituent was PP with frequency percentage of (63.64%). They ranged between (63.64 and 74.03). it is noticed that, the VP which considered the head of a sentence was the most frequent C that the remaining units were built around it. In other words, retrieving a whole sentence is based on retrieving its head which is the V in VP shell.

4.1.3 Results of the Third Test

This test examined phrase structures retrieved from memory. It examined NP, VP, PP & D.CP. Table 6 showed the results.

Table 6: Constituent Frequency in the Third Test.

N	Constituent		N	Total Frequency	Frequency Mean	Frequency Percentage	Frequency Rank
1		NP	11	255	7.73	70.25	1
2	VP	V	10	219	6.64	66.36	2
		NP	8	182	5.52	68.94	
		VP	18	401	12.15	67.51	
3		PP	5	109	3.30	66.06	3
	Total C		**34**	**765**	**23.18**	**68.18**	
4	CP	Complementizer	4	73	2.21	55.30	3
		NP	9	180	5.45	60.61	1
5	VP	V	10	204	6.18	61.82	2
		NP	5	89	2.70	53.94	
		VP	15	293	8.88	59.19	
		PP	4	73	2.21	55.30	
	Total Constituent		**32**	**619**	**18.76**	**58.62**	**4**

Table 6 showed that, the total frequency of LSCs ranged between (73 and 401). Their frequency means ranged between (2.21 and 12.15). Their frequency percentages ranged between (53.94 and 68.94). The first rank of LSC in the third test was for NP with a frequency percentage of (70.25 %). Next was VP (67.51%). After that was PP (66.06%). Finally, was CP (58.62%). Even though, in CP, NP got the highest rate of (60.61%), followed respectively by VP (59.19%), PP (55.30%), & Com. (55.30%).

4.1.4 Results of the Fourth Test

This test inspected the independent clauses that were retrieved from memory, which consisted of NP, VP and PP. Table 7 presented the results.

Table 7: Constituent Frequency of the Fourth Test.

N	Constituent		N	Total Frequency	Frequency Mean	Frequency Percentage	Frequency Rank
1		NP	6	131	3.97	66.16	1
2		V	6	124	3.76	62.63	2
	VP	NP	6	122	3.70	61.62	
		VP	12	246	7.45	62.12	
3		PP	1	17	.52	51.52	3
	Total		**19**	**394**	**11.94**	**62.844**	

Table 7, showed that, total frequency of LSC was (394). Their means ranged between (.52- 7.45). Their frequency percentage ranged between (51.52- 66.16). The most frequent constituent in the fourth test was NP. Its frequency percentage scored (66.16%). Next was VP (62.12%). Finally, was PP (51.52%)

To sum up, the LSC overall the four tests have varied. NP was the most frequent constituent in the third and fourth test. While VP was the most frequent constituent in the second test. As for PP was the most frequent constituent in the first test. These results proved that; the nature of memory is shaped by language structures as well as Gorden. et al's (2002) study reported that, syntax processing was not independent but relied on working memory resources that were also used for non-syntax processes. In the same way, Franck and Wagers (2015) said that, syntax theory played a crucial role in shaping memory representations. In addition, Henderson et al., (2016) reported that, syntax influenced the activity in two brain regions that were typically involved in processing syntax. Furthermore, Polisenska, (2011) said "Once again it was shown that syntax played a major role in the remembering of verbal material", (p.57). Moreover, the studies of Kawakami, (2021), Ding et al (2016), Li et al., (2022) and Polisenska, et al., (2014) also supported that.

4.2 Second Research Question
How much time does memory need to retrieve the LS?

To answer this question, the researcher used Quiz Bot in telegram application, in which participants sat up on a screen. Sentences were displayed in front of them to determine whether they have studied them or not by clicking on Yes or No bottom. See the link in Appendix L. Twenty-five statements of simple structures were prepared. Eleven sentences were true while fourteen statements were false. Six participants could not take the quiz, due to some technical problems. So, the total number in this phase were twenty-seven participants.

Reaction time depending on time per minutes (T/M) that participants took to retrieve sentences. The percentage of the true answers (T) was found out through the following formula, whereas the false answers (F) was minus the percentage of true answer. See Table 8.

Table 8: Reaction Time

Participant's Number	True	False	Time/Minute
1	24	1	5.10
2	24	1	2.49
3	20	5	2.29
4	21	4	2.24
5	18	6	2.42
6	25	0	2.35
7	23	2	3.28
8	27	8	3.30
9	25	0	2.4
10	22	3	2.5
11	22	3	3.57
12	21	4	5.56
13	25	0	2.47
14	24	1	5.51
15	20	5	3.53
16	24	1	2.11
17	23	2	2.2
18	20	5	3.40
19	16	9	3.33
20	23	2	1.50
21	22	3	2.58
22	19	6	3.20
23	24	1	2.23
24	19	6	2.24
25	18	7	2.5
26	16	9	3.42
27	17	8	5.7
Total	**582**		**Mean= 3.09**
Percentage	**71%**	**29%**	

As seen in Table 8, the average of time participants took to retrieve the twenty-five sentences was three minutes and nine seconds, with percentage scored (73%) of true answers and (24%) of false answers. That showed that memory ability to retrieve twenty-five sentences ranged between (1 and 6) minutes. So that, the strong memory would take (1-3) minutes and weak memory would take (4-6) minutes. See Figure 3.

Figure 3: Reaction Time.

In examining the third research question about measuring the span of time the memory spent to make the retrieving, showed that, participants took average of (3.9m) to retrieve 25 simple sentences. This could be compared with Anderson's experiment in 1981, who asked participants to study sentences like "Ted Keddny is a senator" in nine days and in the tenth day, he gave them other sentences like "Bill Johe hated doctors" and compared between familiar and unfamiliar sentences, for familiar sentence they extended (1.00 sec) for each one, and for unfamiliar sentences they extended (1.06 sec). It was noticed that, there was a very small span between familiar and unfamiliar sentences. That agreed with the current study, in which memory span to recall

syntactic structure was short, whether to judge the true and wrong sentence as the current study, or the new and old sentences as Anderson's.

Moreover, Reaction Time of the current study mismatched with Franck and Wagers' (2015) study. They reported that, "In a probe recognition task, participants were trained to press the button 'yes' if the probe was in the sentence, or 'no' if it was not…spanning the full-time course of retrieval between about 100 ms to 3000 ms", (p.4). Meanwhile, the time the memory extended for their study was very small, it meant that, participants' memory to remember was very strong and fast, it equaled (.01s -1.25m), unlike the current study in which reaction time took (1-3 m) for strong memory, its mean was (3.09m). Reaction time of Franck and Wager' (2015) study supported Caplan and Waters' (1999) results, they reported that:

We report the results of two dual-task experiments. In Experiment 1, participant performed a self-paced reading task and a self-paced arithmetic…. In Experiment 2, they performed a self-paced reading task and a self-paced spatial-rotation task… In Experiment 1, data points that were less than 100 milliseconds n the raw data (indicating erroneous key presses) or more than 2.5 standard deviations away from the mean residual RT for a position within a condition were excluded from the analysis, affecting 3.3% of the data…. In Experiment 2, reaction time data points that were more than 2.5 standard deviations away from the mean residual RT for a position within a condition or less than 100 milliseconds in the raw data were excluded from the analyses, affecting 3.7% of the data. (p.4,6).

The difference between the current study and the previous studies in reaction time could be affected by the following reasons: The language used in Frank, Wager, Caplan, and Waters' experiments was their mother tongue, while the current study tested a foreign language. Their study demanded immediate response after reading and studying sentences. They focused in the comprehension more than retention. So that, the language, the time of studying, and the memory process, could be important variables that affected the time to retrieve information.

5   Conclusion

The researcher analyzed and discussed the results that achieved the goal of the study. The first objective was to illustrate the frequency of LS (words, phrases, sentences or clauses) in the memory retrieval, then the researcher found out that the most frequent structure that retrieved from memory was the word structure. It represented a percentage of (81.01%). Then it was followed by the structure of a sentence with a percentage of (71.01%). The phrase structure got a medium degree, its percentage scored (68.18%). After that, the independent clause structure, its percentage scored (62.84%). As for the dependent clause which was the last structure, its percentage was (58.62%). Additionally, the most frequent LSC was receptively for PP, NP, VP and CP.

The second objective was to measure the memory span needed to retrieve LSs. The researcher concluded the average time participants took to retrieve twenty-five sentences with simple structures. The result was three minutes and nine seconds, with percentage score of (73%) correct answers and (24%) incorrect answers.

5.1 Limitation

The limitations of the study the researcher faced were the following:

- The researcher could not cover different Yemeni adults who are studying in different Yemeni universities due to the lack of time and the rise in costs that were needed to fulfill the study. Therefore, the researcher was confined to Yemeni adults who are studying at Mahrah University.
- The study did not take any participant who had an implication or cognitive disease. Therefore, it could not be generalized to every adult. In addition, it investigated the adults only because the memory growth ends at 18 age Fry et al., (1995). In other words, the memory condition is stable at this age. The memory under the age of 18, is changeable and can be affected by internal or external factors. It can be enhanced and developed, or it can remain weak and slow.

Furthermore, the structures English languages was tested. The study did not take other language domains, such the phonetic, phonological, morphological or semantic domain. It was concerned on the syntactic structure (words, phrases, sentences and clause).

The study analyzed memory process in only retrieval. it did not explain or study its ability, weakness, strength or constrain. It concentrated with its way of retaining the structures, not its operation in comprehension, conscious or intelligence.

5.2 Suggestion for future research

The researcher suggested some future topics that cover different areas of the current study; such as:

- Studying memory retrieval of LSs on different Yemeni universities.
- Studying ability of memory retrieval on morphology and phonology.
- Studying memory retrieval of LSs on other languages.
- Comparing the memory retrieval process of LSs between languages.
- Studying memory retrieval of LSs on healthy and disorder children.

5.3 Recommendation

Based on the generalization, the researcher's recommendations were as follow:

- Design computer programs depend on time to examine memory ability.
- Set up courses that clarifies the suitable way in memorizing and restoring information, based on LSs to facilitate learning, and acquiring a foreign language.
- Get use from the results to treat and improve the weakness of the disorder adults or who have memory deficiencies.
- Set up sessions to diagnose adult's memory.

5.4 Acknowledgement

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