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Exploring the Relationship among Multimedia Input, Working Memory and L2 Vocabulary Learning

Shahid Nawaz
Assistant Professor, Dept of English Linguistics, The Islamia University of Bahawalpur, Pakistan.
Email: shahidnawaz@iub.edu.pk
Sumaira Qanwal
Lecturer, Dept of English Linguistics, The Islamia University of Bahawalpur, Pakistan.
Email: sumaira.qanwal@iub.edu.pk
Sadia Parveen
Lecturer, Dept of English Linguistics, The Islamia University of Bahawalpur, Pakistan.
Email: sadia.parveen@iub.edu.pk

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Abstract:
With the advancement in online educational platforms in the present world, multimedia technologies have become a more easily accessed resource in language learning pedagogy than before. Different areas of language pedagogy are benefitting from the use of these multimedia technologies. The present research aims to explore the pertinent effect of multimedia language teaching input on L2 vocabulary building of learners by examining the way they enhance the learners' working memory efficacy. The study employs an experimental research design by giving two types of WM strategic input (i.e., traditional verbal input and multimedia input) separately to two homogenous groups of 50 graduate ESL learners and observing their effectiveness in their vocabulary development. The study has used two research tools to collect data from the participants. The first is Wesche and Paribakht's (1996) The Vocabulary Knowledge test which rates the vocabulary knowledge of the participants, and the second is a self-designed Working Memory cloze test to check the efficacy of the participants' working memory through their vocabulary achievement. The participants are judged twice on the two scales, first before the treatment (pre-test 1 & 2), and second, after the treatment (posttest1 & 2). The results are obtained by comparing the participants' mean scores of the vocabulary knowledge and working memory in pre and posttests of both variables. T-tests have also been run to see the improvement in learners' VK and WM, and regression analysis has been carried out to see the relationship among the variables. The findings reveal that

both WM strategies, i.e., verbal input and multimedia input are helpful in the development of learners' vocabulary and working memory efficacy, and that verbal input and multimedia input are both positively related with VK and WM. However, the former (multimedia input) is more effective in enhancing the learners' vocabulary knowledge and working memory efficacy as compared to the latter (verbal input). The findings are significant for the L2 learners, teachers, administrators, and the policy makers alike because they suggest that multimedia technologies should be incorporated to the maximum level of use in L2 classes for the learners' vocabulary building.

Keywords: *Vocabulary knowledge; working memory; multimedia input; verbal input; working memory strategies*

Introduction

The relevance of vocabulary knowledge in foreign and second language teaching and learning cannot be disregarded. However, the nature of vocabulary knowledge is complex and the process through which it is learned is even more challenging (Milton, 2013). Mastering L2 vocabulary, whether receptive or productive is categorized by Nation (1990) and Schmitt (2014), into two skillsets, i.e. identifying word form and comprehending word meaning. Where the former deals with recognizing the external word structure, the latter speaks about learners' capacity to accurately understand connotation of particular words and their use it in different circumstances (Laufer and Paribakht 1998). Realizing the complexity of vocabulary acquaintance which language instructors have struggled with different methodologies and techniques to deliver vocabulary training as effectively as possible. In this context, researchers have tried to increase the effectiveness of vocabulary education with the help of current rise in multimedia technologies by incorporating online verbal and visual aids into the circumstances of learning and teaching (Boers et al. 2017, Ramezanali and Faez 2019, Yoshii and Flaitz 2002, Yanguas 2009).

The stimulant behind using multimedia programs in vocabulary teaching is Paivio's (1990) dual-coding hypothesis states that the visual and verbal aids (such as text, images, videos, and sound) may initiate, excite, and reinforce the learning processes which assists in overcoming the obstacles in learning L2 vocabulary. Even though verbal and visual encouragements can be a part of outmoded vocabulary education, the use of online technological tools or other resources may aid students in learning new words, developing learning strategies that will allow them to take charge of their learning, and deepening their understanding of those concepts (Teng, 2018). Additionally, comprehending a term entails much more than merely knowing the definition of particular terms along with simply knowing the definition of word does not ensure that the learner will be able to utilize this particular comprehension in reading

and writing. Here comes the role of cognitive capabilities, especially memory, which will enable learners to store newly learned vocabulary items and utilize them in various linguistic tasks.

It this vein, it is important to review cognitive theory of multimedia-learning by Mayer (2001), which points out that the procedure of combining the sources of linguistic and cognitive knowledge for multimedia-learning, necessitates the involvement of working memory (WM) which is a cognitive device for online processing and retrieval of information. The theory explains that the students first store new information in sensory memory before choosing and transferring pertinent auditory and visual information to specific modality subsystems of working memory such as phonological loop, the central executive and the visuospatial sketchpad, where it can be preserved and processed. The capacity of each of these WM outlets or subsystems is constrained. Before integrating new data with the existing knowledge sets, learners must construct the information in the relevant area of their working memory (Baddeley and Hitch, 1974). Mayer (2001) states that when the integration among the three subsystems of WM has taken place, learning realization occurs. WM comprises conscious awareness and is essential for supporting knowledge acquisition and manipulating multimedia input (Mayer, 1997, 2001).

Academic research has shown that working memory strategies (of which visualization and imagery is the one) can enhance learners' working memory capabilities. Therefore, combining linguistic and cognitive resources is important for vocabulary learning via multimedia information, andThus, it makes sense to use multimedia materials, such as texts, audio files, images, and videos, to help students acquire various facets of vocabulary (Ramezanali and Faez, 2019). It is possible that learners with varied levels of WM capacity will execute and coordinate these processes with varying degrees of effectiveness, which will affect how they respond to multimedia input. Furthermore, the outcomes of vocabulary learning using multimedia input may be obstructed by WM overload (i.e., cognitive strain and demand on learners' WM resources) during processing, which may modify learners' views or interpretations of the Multimedia-Input. Therefore, it is important to investigate the influences of multimedia knowledge on WM (Schüler et al. 2011), especially in L2 vocabulary acquisition context. In relation to this, it is crucial to investigate effects of WM on vocabulary learning through Multimedia-Input while maintaining a cognitive balance.

Examining the prevalent situation in ESL teaching in Pakistan, it is observed that under the pressure of exams, teachers and students usually rely on grammar translation teaching methods to teach new word forms. A little amount of consideration has been given to multimedia technologies, which provide various websites, applications, and online learning platforms as resources for teaching L2 vocabulary to students.

This gap is attempted to be filled by determining the effects of two different input conditions such as verbal input which includes "Definition + Word information" and multimedia input which includes "Definition + Word information + Video" as a working memory strategy on vocabulary learning and by examining how the two distinct WM components i.e., the phonological loop and the visuospatial sketch map (i.e. multimedia input) may vary in their effect on learners'' working memory efficacy. The findings have ramifications for educational practice as well as theoretical comprehension.

Literature review:

Working memory:

In psychology, one of the most often used ideas is working memory. Unlike long-term memory, which retains a vast amount of information during an individual's lifetime, working memory is capable of holding a smaller or more constrained amount of information in memory while performing cognitive activities. Working memory has often been associated with intellect, information processing, executive function, understanding, problem-solving, and learning in humans of all ages as well as in various animal species. The concept is so ubiquitous in the field that its fundamental characteristics and limits must be thoroughly investigated, both historically and in terms of definition. In this manner, let us try to give a clear picture of the notion of working memory by a combined overview of the history, diminutive philosophy, and empirical psychological research in the area.

According to Baddeley (1998) and Baddeley (2003), working memory (WM) is the cognitive mechanism for information storage, processing, and manipulation for the temporary conservancy of task related elements in the presence of extraneous diverting evidence. According to Baddeley (2003), WM is operationalized as learners limited cognitive ability, which enables the learners to simultaneously process and store information to become conscious and carry out mental activities. The North American tradition advises using challenging memory span exercises to access the WM's dual functions, i.e., information storage and processing. Williams (2012) asserted that as it is not always easy to distinguish between British and North American criteria, the explanation of WM must be based on processing and storage capabilities.

Working memory and vocabulary learning:

Cognitive ability varies greatly amongst people, which has an impact on vocabulary acquisition outcomes (Teng & Zhang 2021). One of the aspects of individual cognitive diversity that has been most thoroughly studied in connection to learners' cognitive abilities is WM capability. Baddeley's (1998, 2003) model of Working Memory has been cited as the most prominent framework for comprehension of WM by the majority of academics. WM is accumulative form of the visuo-spatial sketchpad, central executive and the phonological loop. Both the

phonological loop and visuo-spatial sketchpad, which are designated for short-term memory, are crucial for information retention. The visuo-spatial scratchpad preserves spatial and visual information, but the phonological loop specifically saves phonological evidence (such as remembering a phone number) (Baddeley and Hitch 1974).

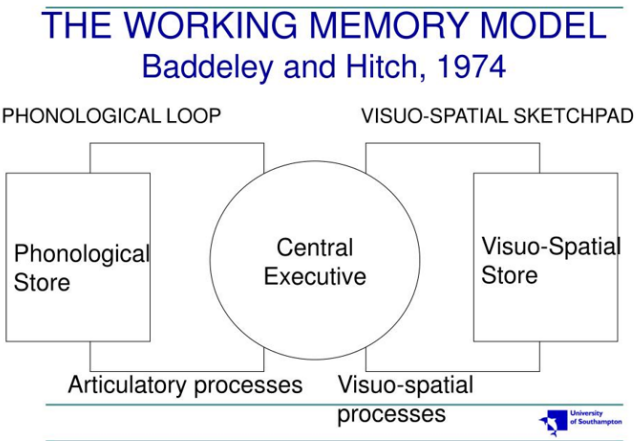


Fig. 1: Baddeley and Hitch's (1974) working memory model

Source: https://slideplayer.com/slide/7556826/

Researchers have focused on how WM influences learning of L2 vocabulary. For instance, Cheung (1996) used non-word span to test phonological memory in order to examine the association between phonological memory and spontaneous vocabulary growth in young learners. 84 Hong Kong high school students in the seventh grade were chosen as participants of the study. The findings demonstrated that the development of L2 vocabulary is supported by phonological memory. Furthermore, in a study by Martin and Ellis (2012), PSTM was examined on the basis of non-word repetition, listening span, and non-word recognition. 50 native English speakers who had studied a few words and sentences in foreign language made up the study participants. The findings showcased that's had significantly contributed to the vocabulary acquisition of the participants. However, their study did not fully understand the underlying mechanisms of PSTM and WM.

Multimedia-Input and L2 Vocabulary Learning:

For a better understanding of L2 vocabulary comprehension through multimedia-input, it is required to review pertinent multimedia learning theories. According to dual-coding theory of Paivio (1972, 1986, 1990), people who have a variety of sensory modalities helps processing information through two different pathways. According to Sadoski and Paivio (2001), one channel is in charge of processing oral participations from speech and writing, and the other medium is in charge of dealing out non-verbal evidence of data from visuals. The processing of both vocal and visual information is featured in multimedia learning from a cognitive standpoint (Paivio 1972, 1986, 1990). The two channels of information can help learners grasp various types of material better so they can learn L2 vocabulary.

Three important ideas that could affect learning are included in the cognitive theory of Multimedia-Learning (Figure 1), which was put forth by Mayer (2001). The first, referred to as "dual channels," is based on ideas from 'dual-coding theory' (Mayer 2001, Paivio 1972, 1986, 1990), and another referred theory is 'limited capacity', implies that learners are only able to procedure a finite quantity of visual and verbal evidence in working memory. The third point emphasizes that students actively participate in "the process of knowledge construction by doing things" like (1) choosing pertinent material, (2) organizing information, and (3) fusing information with previous knowledge (Mayer 2001).

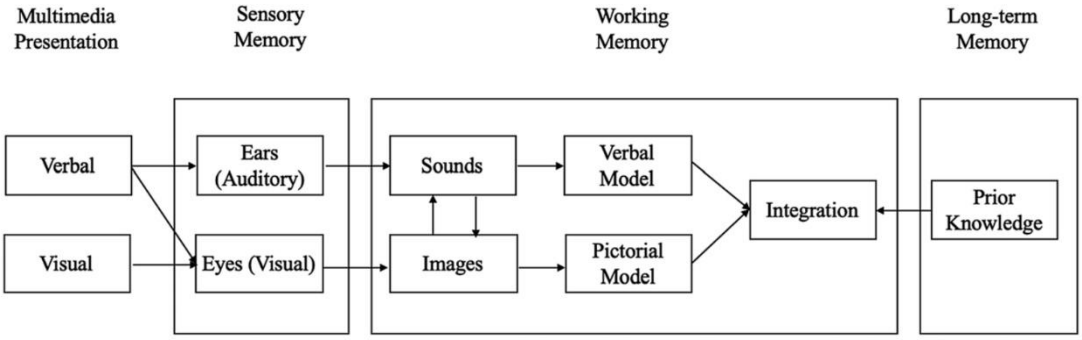


Fig. 2: Cognitive theory of multimedia learning (Mayer 1997, 2001).

Figure 2 illustrates how students process multimedia information through the medium of sensory organs before processing both visual and verbal data. The chosen information then enters the learners' WM. The data is then arranged into cohesive verbal and visual models. The information is then associated, combined, and retained in the long-term memory of the learners along with their preceding knowledge. Integrating the two forms of data sets with the prior knowledge of the learners is the last phase in the processing of multimedia inputs.

Multimedia Input in Language Learning:

Multimedia input in language education refers to the use of various digital media tools, such as images, videos, audio recordings, and interactive software, to enhance language learning. This approach has several benefits, including:

1. Engagement: Multimedia input can increase student engagement and motivation, making language learning more enjoyable and interactive.
2. Authentic materials: Multimedia input provides access to authentic materials, such as news clips, videos, and podcasts, which can help learners develop real-world language skills.
3. Visual aids: Images and videos can aid vocabulary acquisition and comprehension, especially for visual learners.
4. Pronunciation practice: Audio and video recordings can help learners improve their pronunciation and intonation.

5. Personalization: Multimedia input can be tailored to individual learners' needs and learning styles.
6. Cultural enrichment: Multimedia input can provide insights into the culture and context of the target language, promoting cultural understanding and awareness.
7. Accessibility: Multimedia input can reach a wider audience, including learners with disabilities, and can be accessed remotely.

Some examples of multimedia input in language education include:

1. Language learning apps like Duolingo, Babbel, and Rosetta Stone.
2. Interactive whiteboards and educational software like SMART Boards and Sanako.
3. Audio and video podcasts like "Coffee Break" and "News in Slow."
4. Online language courses like Coursera, edX, and Udemy.
5. Virtual reality (VR) and augmented reality (AR) experiences that simulate real-world language scenarios.

By incorporating multimedia input into language instruction, educators can formulate a more appealing, interactive, and effective learning environment for their apprentices.

It is better to employ a combination of word-based and visual input rather than just one kind, as several studies have demonstrated. Plass et al. (1998), for example, summarised that many kinds of information (pictorial, visual, and aural) might interact with the target word of L2, the image that conveys the meaning of the word, and the corresponding term in the first language (L1). Based on the data collected from interviews and questionnaires by Faez and Ramezanali (2019), students displayed a positive attitude towards the dual interpreting mode of L2 word definition and video simulation. Coming to the experimental mode of research, we may refer to Masrai (2020)’s study which investigated the comparative effectiveness of auditory and textual input on the learners’ vocabulary development and came up with the result that the technological auditory material is more advantageous in terms of L2 vocabulary development as compared to the textual signals. Extending the study, Shaojie et al. (2022) communicated that multimodal visual input is more beneficial in enhancing L2 learners’ listening capabilities than audio input only.

However, it is important to mention that individual variations in working memory (WM) capacity may affect the outcomes of multimedia learning, as demonstrated in a study by Anmarkrud et al. 2019 which pointed out that students with high Working Memory were recalling and transferring more knowledge during language learning through multimedia than students with poor WM capacity. The findings are later validated by Teng and Zhang’s (2021) proposition that there is always a variety in individuals’ cognitive skills that leads to the

differences in their vocabulary knowledge. Therefore, exploring the role of WM in learning L2 vocabulary through Multimedia-Input is important. In this context, Teng and Zhang (2023) proceeded to explore the connections between working memory, multimedia input and Chinese ESL learners' vocabulary building concluding that the multimedia techniques are beneficial in enhancing the WM and L2 Vocabulary of the learners. However, to the best of the researchers' knowledge, the associations among the three variables, i.e. working memory, multimedia input and L2 vocabulary building have not yet been explored in Pakistani context. Hence, the present study determines to explore answers to the following questions in Pakistani L2 learning context:

Research Questions

1. What is the role of the two working memory strategies (verbal input and multimedia input) in L2 vocabulary learning?
2. What is the comparative effect of verbal input strategy and multimedia input strategy on learners' working memory?
3. What is the interrelationship among multimedia input, working memory and L2 Vocabulary learning?

Research Methodology:

Research Site and Sample:

The participants of this particular study were selected from the Department of English Linguistics of the Islamia University of Bahawalpur. A sample of 120 students were chosen from graduate level. English was not their L1, and they were studying English as a Second language. Each class was given one input circumstances mentioned above at random. As 20 of the participants did not complete either the pre or post-test, they were eliminated from the sample. The final dataset, therefore, consisted of 100 students.

Target Words (The Vocabulary list):

102 words was selected as a target vocabulary set from the 'Mastery list section' of *The Reader's Digest*. This section is not only based on the definition of word, but also provides additional information related to the word, such as background stories, etymology, antonyms, synonyms and example sentences (See table 1 & figure 3).

Table 1. The Vocabulary set of 102 Target words

Slight	Whip	Repose	Slack	Premise	Infernal
Render	Grim	Rue	Delude	Gauge	Emblem
Intimate	Apt	Anguish	Steward	Lurk	Pretension
Reign	Tremble	Brood	revelation	exhort	Sinister
Explanation	Concede	Canon	Nigh	pretense	mirage

Deem	Reconcile	Petty	Rogue	envoy	Bland
Countenance	Contrive	Conjecture	recession	prodigious	Plight
Reap	Truce	Harbor	Gorge	peremptory	Scour
Straits	Vanquish	Extricate	Epithet	importune	Bequeath
Impute	Cloister	Repudiate	Canny	semblance	Flinch
Tenor	tremulous	Yen	torrid	hearten	Quail
Curate	Taunt	Gait	dwindle	demeanor	Brazen
Allegation	Laurel	Secede	prerogative	pensive	Precarious
Covet	Veto	preposterous	convulsion	conformity	Peremptory
Motley	corroborate	Zest	Lurch	shamal	Inducement
Cobble	Exhortation	contingency	garland	dissension	Snipe
Trudge	Chide	Grimace	sedition	devolve	Referendum

Fig. 3. Presentatioin of Vocabularly Items in Word Cloud.

Fig. 4: Reader's Digest Mastery list section

Research Tools:

The study employed two research instruments to investigate the problem at hand. The first tool used in the present study was the Vocabulary Knowledge Scale (VKS) to assess the participants' knowledge of the given vocabulary, while the second tool comprised of a cloze test to judge the participants' working memory skills in response to the target vocabulary items. The two research instruments are explained in detail below:

Vocabulary test:

The test for vocabulary employed in this study was the Vocabulary Knowledge Scale (VKS), which was modified from Paribakht and Wesche (1996). The VKS is recognised as a commonly used and widely acknowledged framework for assessing students' vocabulary knowledge and tracking their progress from total unfamiliarity to a level at which they can use a term in each context correctly and responsibly (see appendix A).

The Vocabulary Knowledge Scale (VKS) is a 5-point self-report scale that allows students to indicate their knowledge of vocabulary items in response to different vocabulary instructional techniques.

A = the learner knows the meaning of word/phrase, and he/she can use it in a sentence.

B = the learner knows the meaning of word/phrase, but he/she is not sure how to use it.

C = the learner knows the meaning of word/phrase before, but he/she does not know what it means.

D = the learner knows the meaning of word/phrase before.

Words	A	B	C	D
anguish				
Brood				
Canon				
Petty				
conjecture				
Harbor				

The Working Memory Test:

The present study used a self-designed cloze test to examine the extent to which the participants' working memory is functioning to recall the learnt vocabulary items and use them in the given context. The test consisted of ten context-based sentences with blanks to fill in. The participants were given 5 options or words to choose from. These options were extracted from the target vocabulary set of 102 words taught to the participants (see appendix B)

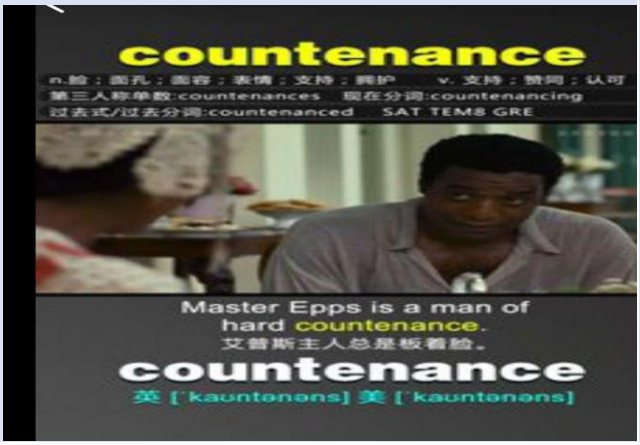
Pretests:

The 100 participants were tested for two variables before any treatment was given to them. The first was The Vocabulary Knowledge Scale (VKS) (from here onwards named as pretest 1) to know the level of their familiarity with the target vocabulary set, and the second was a self-designed working memory test (pretest 2), which aimed to test their working memory capability. To administer the latter, the participants were given the target 102-word list having the relevant meaning parallel to each word, and they were asked to learn all words by themselves along with their meanings. After the lapse of two weeks, the participants were given a cloze test based on the target vocabulary use to check their working memory capability. In the test, participants were asked to fill in the blanks by choosing the most appropriate word from the given list in accordance with the co-text. This is how the participants' independent working memory was assessed in vocabulary learning before any treatment. The participants' scores were recorded in both the Vocabulary Knowledge Scale (VKS) and the working memory cloze test (WMCL).

Treatment:

After the administration of pretest 1 and pretest 2, the 100 participants were split into two treatment groups to be taught the target vocabulary set through two different WM strategies, i.e. verbal input and multimedia input 50 participants (group 1) were taught the selected vocabulary set through the first WM strategy, i.e. verbal input (word+ verbal Definition + verbal Word Information), while the remaining 50 participants were exposed to the second WM strategy, i.e. multimedia input (word + oral and written definition + oral and written Word Information + Video) to learn the target words.

Table 2: Treatment details of two groups: an example.

Group	Treatment details	Example of treatment	Number
1.(Definition + extra information)	Input: 'definition + extra information about the word'	Target word: countenance (the appearance conveyed by a person's face + Countenance comes from a French word for "behavior," but it has become a fancy term for either the expression of a face or the face itself: "He had a puzzled countenance," or "what a charming countenance!" Countenance can also be a verb meaning to tolerate or approve. If someone does something offensive, tell them, "I'm afraid I can't countenance that.")	50
2.(Definition + extra information + video)	Input: 'definition + extra information about the word + video'	Target word: countenance (the appearance conveyed by a person's face + Countenance comes from a French word for "behavior," but it has become a fancy term for either the expression of a face or the face itself: "He had a puzzled countenance," or "what a charming countenance!" Countenance can also be a verb meaning to tolerate or approve. If someone does something offensive, tell them, "I'm afraid I can't countenance that.") + 	50

Posttests:

After the treatment, the participants in each group were assessed in the two protests. Post-test 1 involved the administration of the Vocabulary Knowledge scale (VKS) again to check the participants' receptive and productive knowledge of the concerned vocabulary set taught to them through two different working memory strategies. Post-test 2 included the same working memory cloze test as was administered as the pretest for assessment of the efficiency of the participants of working memory after the treatment.

Data Collection

The data collection procedure in the present study comprised of two Pre-tests, two types of treatment, and two post-tests. However, the participants were provided with the target

vocabulary list of 102 words along with their basic meanings to be learnt independently without any pedagogical instruction for 1 week. Pre-tests (i.e., the vocabulary test and the WM test) were conducted in week 2, i.e., 1 week before the start of the experiment. In weeks 4 and 5, the two different treatment sessions (verbal input & multimedia input) were carried out simultaneously with the respective groups (group 1 & group 2). The post-tests were carried out one week after the treatment session, that is, in week 7, the subjects carried out both posttests (i.e., the vocabulary test and the WM test). The reason behind delaying the posttests was to reduce the possibility that the treatment session may have imposed a cognitive load which may influence their WM.

Data analysis:

Data were analyzed through SPSS version 16. Regression analysis had been used to test the relationship of variables. The two different input conditions of the working memory strategies i.e. verbal input and multimedia input served as the independent variables. While the vocabulary learning with its two components, i.e., receptive and productive vocabulary knowledge, a dependent variable in the present study. Additionally, the working memory with its two components. i.e., phonological short-term memory and complex working memory served as the intervening variable while observing the effect of the two WM strategic conditions on vocabulary learning. However, WM serves as a dependent variable when the participants are subjected to the two different working memory strategies (verbal input and multimedia input) to see their effect upon their WM efficacy. The findings provided the opportunity to investigate the potential effects of (1) two different WM strategies on vocabulary learning and (2) to see how the two WM input conditions enhance the working memory efficacy.

For both the vocabulary knowledge and the WM tests, the results are described in terms of the mean score (Mean) and standard deviation (SD) in table 3.

Table 3: Statistical data.

Skill	Group	Mean	SD	R	N
Receptive knowledge	Definition + word information	56.33	4.39	.4132	50
	Definition + word information + video	45.67	5.43	.6702	50
Productive knowledge	Definition + word information	48.37	3.83	.3505	50
	Definition + word information + video	57.17	5.29	.5670	50
Complex Working Memory	Definition + word information	43.09	3.05	.4680	50
	Definition + word information + video	56.57	4.62	.6512	50
Phonological short-	Definition + word information	48.64	7.45	.3901	50

term memory (PSTM)	Definition + word information + video	41.46	9.76	.6621	50

Table 3 demonstrates the statistical results with respect to mean, standard deviation and total numbers. The results show the higher performance of learners in productive knowledge (and complex working memory (M= 57.17 & 56.57 respectively) by the multimedia input group as compared to the verbal input group (M = 48.37 & 43.09 respectively). However, the latter, i.e., verbal input group outperformed the former, i.e. multimedia input group in the receptive vocabulary knowledge (M =56.33) and phonological short-term memory (M = 48.64), while the multimedia input group in these two variables were M = 45.67 and M = 41.46 respectively. In short, the verbal input strategy was found to be effective in lower order vocabulary learning (receptive knowledge) and working memory skills (PSTM), while the multimedia input strategy was revealed to enhance the higher order vocabulary learning (productive knowledge) and working memory (complex working memory).

The results of regression analysis show a positive relationship between the variables in concern. The value of r (.6702) in Definition + word information + video group shows a higher and positive relationship with Receptive knowledge as compared to Definition + word information group. The value of r (.5670) in Definition + word information + video group shows a higher and positive relationship with productive knowledge as compared to Definition + word information group. Complex Working Memory shows a high and positive relationship with Definition + word information + video group with greater r (.6512) value as compared to Definition + word information group. Phonological short-term memory (PSTM) shows a high and positive relationship with Definition + word information + video group with greater r (.6621) value as compared to Definition + word information group.

In the second phase of analysis, t- test were computed to see the comparative effect of two different WM strategies on the participants' overall working memory. Table 4 shows the paired samples statistics for pre and post test scores of G1 (verbal input) and G2 (multimedia input).

Table 4: Paired Samples Statistics for both groups pre and posttests.

Pair	Test	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Verbal input strategy	Group1 Pretest	2.16	50	.850	.170
	Group1 Posttest	4.76	50	.879	.175
Pair 2 Multimedia input strategy	Group2 Pretest	2.16	50	.898	.179
	Group2 Posttest	6.08	50	1.255	.251

The results of table 4 display that the verbal input group scored higher in the working memory

posttest (M = 6.08) than the verbal input group (M = 4.66). This implies that in comparison to verbal input strategy, multimedia input strategy in more effective in enhancing the learners' working memory efficacy.

Table 5: Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Group1Pretest – Group1Posttest	-2.60	1.32288	.26458	-3.14606	-2.05394	-9.827	24	.000
Pair 2	Group2Pretest – Group2 Posttest	-3.92	1.44106	.28821	-4.51484	-3.32516	-13.601	24	.000

Table 5 above reveals the difference of results in pre and posttest scores of both groups. The difference in mean score values of G1 (verbal input) in pre and posttest is M = -2.60000. While the difference in mean score values of G2 (multimedia input) in pre and posttest is M = -3.9200 which is greater than the first group. The p-value for both groups was found to be .000, that is less than 0.05. This shows a highly significant variance in pre and posttest mean scores of both groups. Overall, the mean difference in pre and posttest scores of groups 2 (multimedia input) is greater than the mean difference of group 1 (verbal input) which shows that the learners who were taught L2 vocabulary through multimedia input strategies improved their working memory efficacy to a greater extent than the learners who were taught L2 vocabulary through verbal input.

Discussion:

This particular research elaborates the effect of two input conditions, i.e., verbal input and Multimedia-Input on L2 Vocabulary learning and the relationship between multimedia input and working memory in L2 Vocabulary learning. The working memory includes receptive and productive knowledge in it along with phonological short-term memory (PSTM). It has been discovered that (1) the multimedia input 'Definition + Word Information + Video' condition had a greater impact on vocabulary acquisition and retention, and (2) complex and PSTM also have an impact on vocabulary learning and maintenance under the various input circumstances. The results further elaborate that multimedia pedagogy is more effective in enhancing learners' higher order vocabulary skills that is productive word knowledge as

compared to the verbal input. In the same way, multimedia pedagogical input in more beneficial in enhancing learners' higher order working memory efficacy as compared to verbal input which is found to be effective only in sharpening learners' phonological short term memory skills. The findings of the study align with those of the earlier research in the area that show the effectiveness of multimedia input in second language learning. The results are consistent with the assumption that presenting word definitions + information along with linked visuals in the form of video enhances receptive and productive vocabulary knowledge more effectively than just providing definition of the words. One particular explanation for this aspect can be that the availability of a variety of input modalities may motivate students to actively capture the definition word, which would reinforce learning and retention. The other point can be the hypermnesia effect, which predicts that visual input would be more easily remembered over time than written input because sound or text alone tends to be disremembered.

Conclusion:

The study concludes that multimedia input conditions help learners to learn L2 vocabulary in a better way. The results show greater tendency to learn L2 vocabulary with multimedia input (Definition + word information + video) as compared to verbal input (Definition + word information). The other conclusion that can be drawn from the results is the positive relationship of multimedia input conditions with working memory in learning L2 vocabulary with greater r value for definition + word information + video group as compared to definition + word information group. Furthermore, Phonological short-term memory (PSTM) displays a high and positive association with Definition + word information + video group with greater r value as compared to Definition + word information group.

The fact that the target words can be used in a variety of contexts is probably what is behind the reinforcement of their vocabulary acquisition results. In accordance with Mayer's (2001) cognitive theory of language learning through multimedia, the presentation of visual and verbal information can draw the attention of learners, assisting them in creating psychological representations that portray links or offer whole information rather than just definition. Students who received word definitions and information through movies that included narration and animation in the current study were better able to retain information since they heard the same material at least twice, either verbally or visually.

Based on the findings, WM assumed that individuals in both groups would pick up and retain new vocabulary. In the study, students had to retrieve and encode new knowledge into their long-term memory while simultaneously processing multimedia input in the form of word definitions and video content. This specific study demonstrates how well definitions, word definitions, and videos work together to help learners retain and acquire new vocabulary.

Conversely, phonological working memory and short-term memory fluctuate across students based on personal characteristics under various input scenarios.

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