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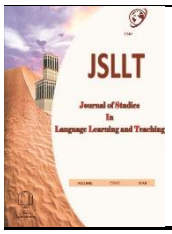

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The Effect of Auditory Distraction and Working Memory on Iranian EFL Learners' Listening Comprehension

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Abstract

Perceiving the spoken language, as a key challenge in acquiring a second language, is affected by numerous variables. The current study aimed to explore the impacts of auditory distraction and working memory on the Iranian (EFL) learners' listening comprehension. It further explored the effects of different item types (content, integrated, and inferential) and their interactions with working memory on listening comprehension under adverse conditions. To achieve these objectives, a convenient sample of 54 advanced language learners was selected via a listening placement from a TOEFL test. Their working memory capacity (high/low span) was measured using Daneman and Carpenter's (1980) reading span test. The participants took part in a listening task under both adverse (with auditory distraction from babble noise) and normal conditions. The results revealed the significant and negative impact of auditory distraction on listening comprehension. Moreover, no statistically significant difference was observed for the working memory and item type effects. These findings contribute to our understanding of the intricate relationship between auditory distractions, working memory, and listening comprehension among Iranian EFL learners.

Keywords: Auditory distraction, Listening comprehension, Persian EFL learners, Working memory.

I | INTRODUCTION

Language acquisition is a multifaceted process influenced by several factors, among which listening is often highlighted as one of the most challenging skills to develop (Vandergrift, 2004). Despite its fundamental importance in effective communication, many learners find that their listening comprehension falters in real-life situations, primarily due to environmental distractions and background noise. These factors can disrupt the clarity of spoken language, leading to distorted signals that hinder understanding and create significant cognitive burdens (Jones & Macken, 1993; Jones & Morris, 1992; Oswald et al., 2000). A pivotal aspect of this cognitive challenge is working memory capacity (WMC), which plays a crucial role in language learning by enabling learners to process and retain essential information during listening tasks (Just & Carpenter, 1992). A substantial body of research underscores the positive correlation between WMC and listening comprehension, suggesting that individuals with greater memory capacity are better equipped to navigate the intricacies of spoken language (Engle et al., 1999). By delving into the challenges associated with listening skills and recognizing the significant influence of working memory, educators and researchers can develop

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effective strategies that not only enhance language learning experiences but also empower learners to overcome these barriers.

The significance of listening skills in language acquisition gained recognition in the 1970s, as emphasized by studies conducted by scholars such as Asher (2000), Winitz (1981), Vandergrift (2006), and Krashen et al. (1984). Listening comprehension is a complex, dynamic process that encompasses various elements, including distinguishing sounds, identifying vocabulary and grammar, interpreting stress and intonation, and contextualizing information (Vandergrift, 1999).

Nevertheless, a substantial gap exists in our understanding of the traits that underlie successful L2 listening comprehension (Vandergrift & Baker, 2015).

Non-native L2 listeners encounter distinct challenges in perceiving speech, particularly when surrounded by noise, as demonstrated by Lecumberri & Cooke (2006). This challenge is due to various factors, with gender matching between the target speaker and the noise source being one of the influencing variables (Cooke et al., 2008). Despite noise propensity to divert cognitive resources from content processing, some studies propose that low-level noise may actually heighten arousal levels, thereby improving hearing performance (Alain et al., 2009; Ries, 2007). Moreover, Nagaraj's (2021) study goes as far as suggesting that certain ambient noise types might enhance listeners' inference-making abilities.

Second language (L2) listening performance is influenced by complex processes, including word recognition, intonation perception, and the interpretation of topic relevance (Lynch & Mendelsohn, 2002). Listeners actively engage with auditory input, connecting it to their existing knowledge (O'Malley et al., 1989). Notably, the role of working memory in predicting L2 listening comprehension is underscored, with individuals possessing higher WMC to demonstrate superior performance (Namaziandost et al., 2018). A comprehensive grasp of these factors is critical for the development of effective strategies to enhance L2 listening skills among language learners.

Working memory capacity (WMC) has been identified as a predictor for various intricate cognitive functions, such as language comprehension, reasoning, fluid intelligence, and problem-solving (Daneman & Carpenter, 1980; Kane et al., 2004; Unsworth et al., 2009). This strong correlation between WMC and complex cognitive tasks is attributed in part to the domain-general executive attention mechanism, which aids in managing distractions or interferences across a wide range of tasks (Kane et al., 2004).

The executive attention system plays a vital role in regulating and structuring the processing of incoming information within the working memory system (Barrouillet & Camos, 2010; Colflesh & Conway, 2007). Effective comprehension of spoken discourse necessitates the successful engagement of various levels of linguistic analysis, encompassing semantic, syntactic, lexical and phonological processing of the incoming speech. Moreover, the contextual cues stored in the long-term memory, such as semantic, syntactic, prosodic and lexical information, significantly contribute to speech understanding (Treiman et al., 2003). In order to comprehend speech amidst noise, these linguistic analyses must be executed with appropriate allocation of cognitive resources, including working memory and attention (Arlinger et al., 2009; Rönnberg et al., 2013). The real-time nature of such processing renders listening comprehension in noise both dynamic and intricate. Working memory emerges as indispensable for executing complex tasks like listening and reading comprehension, as it is essential for maintaining the intermediate linguistic processing output until the listener/reader can fully grasp the entire message (Daneman & Merikle, 1996; Just & Carpenter, 1992).

Masrai (2020) identifies WMC as the second-best predictor of listening comprehension, while Namaziandoust et al. (2018) position it as a paramount predictor for English as a Foreign Language (EFL) listening comprehension. However, Andringa et al. (2012) report conflicting findings, suggesting a complex interplay of working memory and listening comprehension.

Building on these ideas, while low levels of noise can enhance cognitive performance, distracting background noise tends to detrimentally affect cognitive tasks. This effect is not predicted to be related to WM capacity, as studies have revealed no substantial association between WM capacity and the extent of the irrelevant sound effect. Further investigation is warranted to delve into the mechanisms governing the effects of noise on cognitive performance and to pinpoint strategies for alleviating the adverse effects of distracting background noise. Researchers like Yang et al. (2017) have delved into the impact of noise on English listening comprehension, revealing notably poorer performance in noisy environments. Nonetheless, there is a pressing need for more extensive research with larger sample sizes to attain a nuanced understanding of how noise affects cognitive processes, particularly the allocation of working memory.

Although the significance of working memory in first language (L1) acquisition is widely acknowledged, its role in second language (L2) acquisition has received less attention. Additionally, the interaction between working memory and auditory distractions in L2 learners remains shrouded in ambiguity, necessitating further exploration.

II. STATEMENT OF THE PROBLEM

It seems crucial to acknowledge the lack of consensus regarding the impact of noise on cognitive processes, particularly with respect to working memory. While some studies suggest that noisy environments may enhance attention and recall (Nagaraj, 2021), others present contradictory findings (Francart et al., 2011; Oswald et al., 2000; Sörqvist, 2010).

Given the above, a critical research gap exists in understanding how cognitive factors contribute to individual differences in L2 listening under adverse conditions. To bridge this gap, further research concerning these cognitive factors is essential. While prior studies have examined L2 listeners' performance at various linguistic levels, there is a scarcity of research at the discourse level, which is crucial level for everyday communication.

To address the gaps, this study set out to examine L2 listeners' performance at the discourse level in noisy environments. The research aimed to unravel how different cognitive factors influence L2 listening abilities in challenging conditions, promising to provide valuable insights for educators and language researchers.

III. REVIEW OF THE RELATED LITERATURE

Numerous investigations have explored the influence of noise on cognitive functioning. While mild levels of noise have been observed to heighten arousal levels, resulting in faster and more effective auditory performance (Ries, 2007; Alain et al., 2009), the existence of distracting background noise has been demonstrated to adversely impact cognitive task execution, including reading comprehension, recall from verbal short-term memory, and speech recognition (Francart et al., 2011; Jones & Morris, 1992; Oswald et al., 2000; Salamé & Baddeley, 1982).

The anticipated impact of irrelevant sounds on cognitive performance is presumed to be inversely related to working memory capacity (WMC). Specifically, it is theorized that high-WMC individuals would be less susceptible to the effects of irrelevant sounds compared to those with low WMC. Nevertheless, the research examining the correlation between the extent of the irrelevant sound effect in adults WMC (Beaman, 2004; Elliott & Briganti, 2012; Sörqvist, 2010; Sörqvist et al., 2013) has invariably yielded no significant relationship between the magnitude of the irrelevant sound effect and WMC.

Moreover, WM capacity is crucial for successful performance across a range of complex cognitive tasks, such as listening comprehension. The executive attention system, tasked with organizing and controlling incoming information, plays a central role in this process. Successful understanding of spoken discourse requires the allocation of cognitive resources such as attention and working memory. Furthermore, contextual cues stored in long-term memory significantly contribute to speech comprehension. The real-time processing of linguistic information in noisy environments renders listening comprehension a complex and dynamic task. In tasks such as reading and listening comprehension, working memory assumes a critical role, allowing for the retention of intermediate linguistic processing outputs until the listener/reader can fully grasp the message.

The attention-mediated component of the executive mechanism within the working memory (WM) system is tasked with preventing information decay and actively processing incoming speech information. It is posited that individuals swiftly shift between storing and processing information during complex cognitive tasks such as listening and reading (Baddeley, 2012; Barrouillet et al., 2011). When processing becomes unnecessary, attention is switched to a maintenance mode to refresh memory before resuming the processing of new information. The executive attention system oversees the control and organization of how incoming information is processed within the WM system (Barrouillet & Camos, 2010; Colflesh & Conway, 2007).

Given the finite nature of working memory capacity, resources must be distributed between processing and maintenance. As the complexity of the listening environment escalates, particularly with the existence of noise, the resources available for both maintenance and processing are heavily burdened, heightening the likelihood of errors or forgetting in speech comprehension. Additionally, attention is crucial for suppressing distracting stimuli like noise and selectively directing the focus toward speech to enhance the understanding of messages amidst noise (Colflesh & Conway, 2007; Shinn-Cunningham & Best, 2008). Many commonplace listening scenarios demand concerted efforts to direct attention towards pertinent information, inhibiting irrelevant stimuli, accessing and retrieving information from the long-term memory, and drawing from past experiences.

In this regard, Namaziandoust et al. (2018) explored the interplay between the listening comprehension abilities, anxiety and working memory of Iranian EFL learners. From an initial pool of 80 students, 60 pre-intermediate EFL learners were opted to participate in the study. The participants underwent some assessments that included two working memory span tests, the Oxford Quick Placement Test, and a language listening anxiety questionnaire. The results unveiled a significant negative correlation between anxiety and listening comprehension, giving direction to the idea that heightened levels of anxiety were associated with poor performance in the listening comprehension test. Furthermore, the study highlighted the pivotal role of working memory in predicting EFL listening comprehension, with learners possessing larger working memory capacities to demonstrate better listening abilities.

In a recent study, Nagaraj et al. (2020) examined the association of susceptibility to auditory distraction and working memory capacity (WMC) in school-age children. The study involved 125 children who completed a dichotic listening task, both with and without multi-talker babble (MTB). By analyzing intrusion errors from the overall errors and to-be-ignored ear in both scenarios, the researchers aimed to explore the effect of WMC and the potential mediating effect of MTB while controlling for the effect of age. Interestingly, they found that susceptibility to auditory distraction, denoted by the absolute difference in errors between the no-MTB and MTB conditions, had no association with age or WMC. This suggests that irrelevant sounds, such as babble, may have obligatory access to the verbal short-term memory regardless of attempts to suppress them through the attention-controlled WM system. For all that, however, upon analyzing the error ratio with and without MTB, it emerged that children with low WMC actually made fewer errors compared to those with high WMC. This unexpected observation implies that developmental improvements in children's WMC may not be necessarily translated into better performance with the existence of auditory distraction and background noise.

The results of Nagarag's study can have important implications for children's learning environments. It appears that simply enhancing children's WMC may not be sufficient to mitigate the negative effects of auditory distraction. Rather, it may be necessary to focus on improving the quality of the listening environment itself. This could involve strategies such as reducing background noise, using sound-absorbing materials, or implementing sound-masking techniques. By creating a more conducive listening environment, educators may be able to improve children's ability to focus on and comprehend the target speech.

In a similar vein, Nagaraj (2021) conducted another study to investigate the effect of non-informational speech spectrum noise as a distractor on cognitive and listening comprehension ability. To this end, he selected fifty-three young adults with normal hearing abilities. The study employed time-controlled tasks to gauge attention switching (AS) ability and auditory working memory (WM) capacity, while listening comprehension was evaluated through a spoken narratives test, interviews, and lectures. To ensure at least 90% speech intelligibility, the level of noise was calibrated individually.

According to the research findings, the participants had better listening comprehension, particularly on inference questions, when exposed to auditory distraction compared to a quiet environment. Moreover, their processing speed notably increased during working memory (WM) and attention switching (AS) tasks in noise. These findings support the notion that noise might elevate arousal levels, thereby facilitating faster information processing during cognitive tasks. However, the accelerated speed of attention switching in noise led to more errors in updating items. Nevertheless, the participants who processed information faster in noise and maintained accuracy were able to effectively shift their attention to refresh and rehearse the recall items within WM. This observed efficiency in processing amidst noise seemed to contribute to the improvement of WM performance and the capacity to make inferences during listening comprehension tasks.

Overall, Nagaraj's study provides further evidence that noise can have both positive and negative effects on cognitive performance. While noise may enhance arousal levels and improve processing speed, it can also lead to more errors in attention switching. These findings have important implications for understanding how noise impacts listening comprehension and cognitive performance, particularly in noisy environments where distractions are common.

The existing body of research has extensively explored the role of working memory capacity (WMC) in influencing individual differences and its impact on second language acquisition. Additionally, scholars have examined the influence of WMC on L2 learning skills, recognizing the necessity of developing strategies to aid learners in navigating such challenges. Despite considerable cognitive research on language acquisition and the documented variations in WMC and listening abilities, there remains a dearth of studies focusing on individual differences in WMC, particularly concerning Second Language (L2) listening comprehension with the presence of auditory distraction. This literature review underscores the need for further exploration into the extent to which working memory capacity and auditory distraction contribute to listening comprehension, especially in EFL contexts. Future research should aim to elucidate the relationship between memory and listening comprehension, as well as the role of distractors. The empirical findings concerning the association between L2 listening comprehension and L2 working memory capacity (WMC) are thought-provoking as they neither confirm nor refute the hypothesis of attentional resource limitations as a factor influencing listening comprehension performance.

Given the above, the current study aimed to address the following research questions:

1. What is the effect of auditory distraction on Iranian EFL learners' listening comprehension?
2. What is the impact of working memory on Iranian EFL learners' listening comprehension under adverse auditory conditions?
3. What is the role of working memory in language learners' ability to answer various item types in adverse conditions?

IV. METHODOLOGY

1. Participants

The study involved 54 advanced English learners from Iran, comprising 52 adults aged 19 to 31 and two adolescents aged 16 to 17. The participants were enrolled either at Yazd University or at a private language institution in Yazd. They were selected from a pool of 70 individuals. The study prioritized the advanced learners, given their proficiency in handling complex questions. All the participants, native Persian speakers with English as their second language, demonstrated high English proficiency through the TOEFL Practice Online (TPO) listening test. This rigorous selection aimed to ensure their advanced English proficiency for effective data collection and analysis.

2. Instruments

The study employed a quantitative research design to make inquiries about the impact of working memory capacity on advanced Iranian EFL learners' listening comprehension under adverse conditions. To collect the data, the researcher used three instruments: the listening section of TPO 23 (TOEFL Practice Online) in normal conditions, Daneman and Carpenter's working memory test, and the listening section of TPO 24 (TOEFL Practice Online) with multi-talker babble to simulate adverse conditions.

2.1. TOEFL Practice Online (TPO)

The TPO tests, accessible through the ETS TOEFL Practice Online website, are considered official TOEFL practice tests. They are sourced from authentic retired TOEFL tests and serve as valuable practice resources for TOEFL preparation. These tests assess reading, speaking, listening, and writing skills in English, providing a comprehensive evaluation of English language proficiency. They closely resemble real TOEFL exams in terms of content and format, aiding test-takers in familiarizing themselves with the exam structure and identifying areas for improvement. The reliability and validity of TPO tests ensure that the results effectively reflect true language abilities, making them a trusted resource for language assessment. By utilizing a standardized instrument like the TPO, this research confirms that findings can be robust, reliable, and comparable to those of other studies conducted in similar contexts.

2.2. Daneman and Carpenter's Working Memory Test (1980)

The Reading Span Test, adapted from Daneman and Carpenter's test, was used to evaluate participants' working memory capacity. This test assesses individuals' ability to retain and manipulate information in the short-term memory. It comprises processing and storage assessments, involving sentence evaluation for semantic correctness and recall of the final word from each sentence. The test consists of 27 sentences of varying lengths in the Persian language, allowing evaluation of processing and comprehension abilities across different text lengths. This version of test specifically measures the working memory capacity of L1 Persian EFL learners. The Persian version of Daneman and Carpenter's test of working memory was adapted by the Sina Research Institute of Cognitive Behavioral Sciences in a software package (see https://www.sinapsycho.com/). Its adaptation for L1 Persian EFL learners ensures relevance within this linguistic context. The standardized and objective nature of the test facilitates comparisons across studies and populations, enhancing its suitability for research purposes. The utilization of the Daneman and Carpenter's test in this research study offers a standardized and objective assessment of participants' working memory capacity. This enables comparisons to be made between individuals and across various studies, enhancing the reliability and validity of the findings. This enables researchers to build upon the existing knowledge and contribute to a broader understanding of the working memory capacity across diverse populations. Moreover, the efficiency and administration simplicity of the test make it highly suitable for implementation in research settings.

3. Procedures

The study comprised three sessions conducted in a computer lab at Yazd University, involving 54 advanced Iranian EFL learners selected from both Yazd University and a private language institution in Yazd from a pool of 70 students, based on language proficiency criteria. This included postgraduate TEFL students and the individuals enrolled in advanced English courses at the private language institute. Language proficiency was assessed using the listening section of the TOEFL Practice Online (TPO-23) test, whereby the participants scoring below 50% were excluded from further processing, while those scoring above 50% proceeded to subsequent sessions involving two additional tests.

In the initial stage, the participants completed the TPO-23 test, a computerized version of the TOEFL examination focusing solely on auditory stimuli, within a time limit of 60 minutes, utilizing headsets for optimal audio reception. This phase aimed to evaluate English proficiency and establish a baseline listening comprehension score without auditory distraction.

The subsequent session employed a computerized version of Daneman and Carpenter's working memory test adapted for Persian-speaking learners, assessing processing and storage aspects of working memory through sentence recall tasks, categorizing the participants into high and low working memory groups based on performance.

The final phase evaluated listening comprehension with auditory distraction using the TPO-24 test from TOEFL. The adverse condition was created utilizing multi talker babble as a distractor. It further involved the assessment of the participants' listening comprehension with auditory distraction, accomplished through the administration of the TPO-24 test from TOEFL. To simulate real-world challenges, an adverse condition was deliberately induced by utilizing multi-talker babble as a distractor during the test. This method was chosen to replicate common instances of auditory interference experienced during language processing tasks.

To minimize cognitive variances, all the tests were conducted in the morning in a controlled computer environment with adjusted volume settings. These procedures ensured a standardized and systematic approach to data collection, facilitating meaningful comparisons and robust analysis of the participants' listening comprehension and working memory capacity.

4. Ethical Considerations

To conduct the current research, several ethical considerations were prioritized to ensure the protection and rights of the participants involved in the study.

Prior to participation, all the 54 learners were provided with a comprehensive informed consent form detailing the purpose of the study, the procedures involved, and the expected duration of their participation. The consent form clearly outlined the voluntary nature of participation, allowing the participants to withdraw from the study at any time without any negative consequences. They were given the opportunity to ask questions to clarify any concerns regarding the research process.

The confidentiality of the participants was rigorously maintained throughout the study. Their identity was anonymized in the data collection and reporting stages, ensuring that no personal identifiers were linked to the results.

After the completion of the study, the participants were debriefed regarding the findings and implications of the research, fostering transparency and knowledge sharing. By implementing these ethical considerations, the study strived to uphold the integrity of the research process while ensuring the well-being and rights of all the participants involved.

V. RESULTS

1. Analysis of The Data on The First Research Question

The initial research question addressed the impact of auditory distraction on the listening comprehension of the EFL learners. Two sets of listening tasks, derived from the Test of English as a Foreign Language (TOEFL), were employed to evaluate the participants' listening comprehension under both normal and adverse conditions.

As the descriptive statistics indicated, the participants performed notably better in the first task conducted under normal conditions compared to the adverse conditions (Mean difference = 5.67).

Table 1. Descriptive statistics of the listening comprehension tasks in normal and adverse conditions.

	Mean	N	Std. deviation	Std. error mean
TPO23_percentage_normal condition	64.0523	54	12.32	1.6
TPO24_percentage_ adverse condition	58.39	54	12.77	1.74

To ensure the appropriateness of the inferential tests, a preliminary assessment of normality was conducted. The results revealed that the performance of the learners in the first test (under normal auditory conditions) was based on the assumption of normality, as indicated by skewness and kurtosis values (Skewness = 0.846, Kurtosis = -0.287).

Similarly, the normality assumption of the second listening test (in adverse conditions) was met, as evidenced by the skewness and kurtosis values (Skewness = 0.395, Kurtosis = 1.394). Although slight deviations from perfect symmetry were observed in the score distributions, these discrepancies did not preclude the application of parametric statistical tests, specifically the paired sample t-test.

A paired sample t-test was executed to compare the listening comprehension scores in adverse and normal conditions. This test facilitated the examination of the within-subject differences among the participants exposed to both conditions. The outcomes of the paired-sample t-test (Table 1) demonstrated a significant difference in the performance of the participants under normal conditions (M = 64.05, SD = 12.31) and adverse conditions (M = 58.39, SD = 12.76) (t = 3.28, p = 0.002, df = 53). It is deduced that the learners performed better in the initial listening test under normal conditions without auditory distraction. Furthermore, considering the effect size, the results revealed a substantial effect on the means (eta squared = 0.17).

In conclusion, the findings strongly suggest a negative impact of auditory distraction on the listening comprehension of EFL learners, with significantly better performance observed in the absence of auditory distraction during the first listening test conducted under normal conditions.

Table 2. Results of the paired samples T-test for listening comprehension task in normal and adverse conditions.

	Paired differences					t	df	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	95% confidence interval of the difference				
				Lower	Upper			
TPO23_percentage - normal condition TPO24_percentage- adverse condition	5.66	12.697	1.73	2.199	9.13	3.278	53	.002

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2. Analysis of The Data on The Second Research Question

This section presents the analysis pertaining to the second research question, which aimed to explore the influence of the working memory on the listening comprehension abilities of Iranian EFL learners. Additionally, the study aimed to investigate whether the participants' capacity to block distractions was associated with their working memory. To address these objectives, the participants were categorized into two groups based on their scores in Daneman and Carpenter's working memory test: high working memory and low working memory.

The descriptive statistics of the participants' working memory scores revealed a mean score of 79.01, with a range from 59.3 to 94.4. Furthermore, the skewness and kurtosis values indicated that the distribution of the working memory scores was normal.

To address the second research question effectively, the participants were divided into high and low working memory groups. Those surpassing the mean score were classified as part of the high working memory group, while those scoring below were categorized as the low working memory group. To ensure the reliability of this categorization, a band score around the mean (band score: 77.7 - 81.5) was established, and the participants within this range were excluded from the analysis.

Table 3 presents the descriptive statistics based on which the higher span group outperformed the lower span group with a mean difference of 5.44.

Table 3. Descriptive statistics of high and low working memory groups.

TPO23_percentage

WM	Mean	N	Std. deviation
Low working memory	61.50	22	11.367
High working memory	66.94	25	13.11
Total	64.39	47	12.497

To examine the potential differences in listening comprehension test scores under adverse conditions between the Iranian EFL learners with low and high working memory capacities, an independent-samples t-test was conducted. The analysis confirmed the assumptions of normality, and Levene's test verified the homogeneity of variances (p = 0.603). There was no significant difference between the participants with high working memory capacity (M = 58.0, SD = 13.43) and those with low working memory capacity (M = 59.1, SD = 12.54). Specifically, the labeled sig. (2-tailed) in Table 2 exceeded the significance level of 0.05, demonstrating no statistically significant difference in mean scores between the two groups (t_{45} = 0.286, p = 0.603).

In summary, the analysis did not reveal a significant difference in listening comprehension test scores under adverse conditions between the Iranian EFL learners with low and high working memory capacities, indicating that working memory did not substantially influence performance in this context.

Table 4. Results of the independent-samples T-Test for listening comprehension test under adverse conditions.

		Statistics						
		Levene's test for equality of variances		T-test for equality of means				
Dependent variables	Assumptions	F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference
TPO24_percentage-adverse condition	Equal variances assumed	.274	.603	.286	45	.776	1.091	3.81
	Equal variances not assumed			.288	44.83	.775	1.091	3.79

3. Analysis of The Data on The Third Research Question

The final research inquiry in this study aimed to investigate the impact of working memory on the language learners' ability to respond to various question types under adverse conditions. To achieve this objective, a two-way mixed between-within subject analysis of variance (ANOVA) was conducted.

Descriptive statistics were used to depict the participants' performance on different item types, categorized based on their working memory capacity. Figure 1 demonstrates the overall disparities in the average scores. The individuals with low working memory exhibited superior performance in inferential questions, while those with high working memory outperformed in content questions.

The preliminary analysis indicated no violations of homogeneity of variance and equality of covariance matrices, underscoring the validity and reliability of the study. However, inferential statistics served to determine the statistical significance of the mean differences and differences in item types. The analysis of the between-subjects effect for working memory span group revealed a non-significant result ($F_{(1,45)} = 0.13$, $p = 0.72$), suggesting no significant distinction in working memory capacity between the two groups.

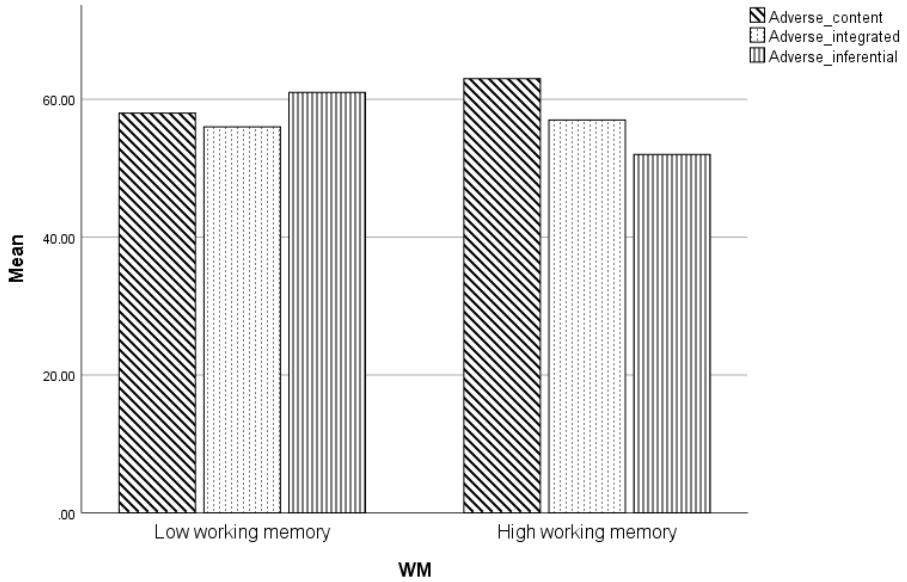

Figure 1. Mean score of the participants across different item types and working memory capacity.

Further analysis showed that the main effect of item type was not statistically significant (Wilks' Lambda = 0.959, $F_{(2,44)} = 0.94$, $p = 0.398$). This indicates that the participants treated all the three item types similarly, regardless of their memory span groups.

Additionally, the effect of interaction between the item types and the two working memory groups (high and low memory spans) was not statistically significant (Wilks' Lambda = 0.895, $F_{(2,44)} = 2.58$, $p = 0.087$), implying no need for pairwise comparisons.

It is worth noting that, while the probability value (0.087) exceeds the conventional significance level of 0.05, it is close to the critical value, suggesting a potential trend.

Figure 2 represents the participants' performance and suggests that the individuals with higher working memory had slightly better performance in content (coded as 1) and integrated questions (coded as 2) compared to those with low working memory. However, their performances were reversed when it came to inferential questions (coded as 3).

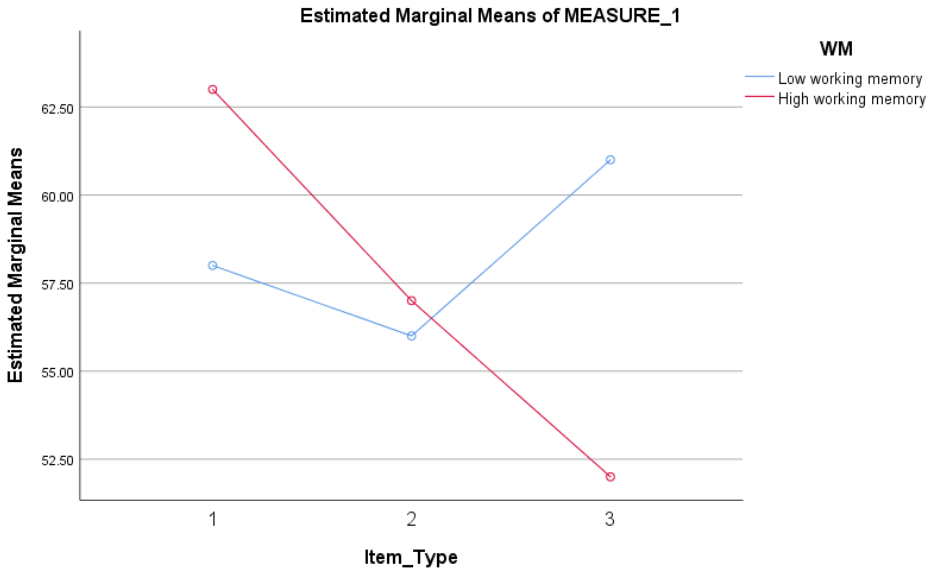

Figure 2. Interaction effect of working memory capacity and item types.

VI. DISCUSSION AND CONCLUSION

The principal aim of this study was to examine the influence of auditory distraction on the listening comprehension abilities of advanced Iranian EFL learners. The results revealed a significant difference in mean scores between the listening comprehension tests conducted under normal and adverse conditions, irrespective of the item types used. Specifically, the participants had slightly better performance on the listening test administered under normal conditions, with a mean difference of 5.67. A paired sample t-test confirmed the significance of this difference (p = 0.002), with a large effect size (eta squared = 0.17), underscoring the detrimental effect of auditory distraction, specifically babble noise, on EFL learners' listening task performance.

The findings of this study align with those of the previous research by Francart et al. (2011), Oswald et al. (2000) and Sörqvist (2010), who also reported negative effects of auditory distraction. Francart et al. (2011) found that background noise impaired the participants' concentration and cognitive task performance. Oswald et al. (2000) observed difficulties in memory retention and recall in the presence of distracting sounds, while Sörqvist (2010) noted reduced reading comprehension abilities in the students exposed to background noise. These studies collectively emphasize the disruptive nature of auditory distraction on various cognitive processes, including concentration, memory, and comprehension, highlighting the importance of a quiet learning environment for optimal outcomes.

Interestingly, the results of this study contradict those of Nagaraj (2021), who reported that distracting noise, including multi-talker babble, had a positive impact on listening comprehension among native speakers. Nagaraj's study, conducted with young adults with normal hearing, suggested that noise could elevate arousal levels and expedite information processing during cognitive tasks. The study provides evidence supporting the adverse influence of auditory distraction, specifically babble noise, on advanced EFL learners' listening task performance. However, these findings differ from Nagaraj's (2021) results, raising the need for further research to explore the complex relationship between auditory distraction and cognitive processes involved in language learning. It is important to consider variables such as language background and learning context when interpreting these findings, as these factors may contribute to discrepancies in results.

The second research question of this study addressed the impact of working memory capacity on performance in a listening comprehension test conducted under adverse conditions. The findings suggest

that working memory capacity does not significantly influence an individual's ability to filter out distracting noise. While low-span participants achieved a slightly higher mean score (M = 59.1) than high-span ones (M = 58.0), the statistical analysis revealed no significant difference (p = 0.776). Thus, working memory capacity does not appear to be a substantial factor affecting the listening comprehension abilities of EFL learners in challenging environments. Interestingly, contrary to common expectations, lower-span participants had slightly better performance, highlighting the need for further investigation into this unexpected outcome.

To contextualize these findings, it is crucial to compare them with previous studies exploring the relationship between listening comprehension and working memory in adverse conditions. These investigations have yielded divergent outcomes, with some suggesting a positive relationship between task performance and working memory capacity. This suggests that individuals with higher working memory capacities can better filter distractions and maintain focus (Sörqvist, 2010). In contrast, other studies have found no significant relationship in similar contexts (Nagaraj, 2020).

Nagaraj's (2020) study on children revealed that susceptibility to auditory distraction was not associated with working memory capacity, contrary to Sörqvist's (2010) findings. Banbury et al. (2001) proposed that irrelevant sounds disrupt selective attention and impair cognitive performance, with the interference depending on the characteristics of both the sound and the cognitive task.

Inconsistencies among these studies may be attributed to variations in sample characteristics, experimental techniques, and small sample sizes. In conclusion, this study suggests that working memory capacity does not significantly affect EFL learners' ability to block out distracting noise in adverse listening comprehension tasks, but caution is needed in interpreting these findings due to the inconsistencies observed in prior research.

The final research question aimed to investigate the influence of working memory capacity on the listening comprehension of L2 learners under adverse conditions, particularly when attempting various question types. This study sought to contribute to the understanding of the factors impacting listening skill mastery. The preliminary analysis indicated the mean scores for each item type under adverse conditions: 60.82 for content questions, 56.48 for integrated questions, and 57.23 for inferential questions. The probability value (p = 0.291) indicated no statistically significant difference across the various item types. This suggests that the participants were able to respond to questions of different types (content, integrated, and inferential) with similar levels of accuracy, indicating that the specific question type did not significantly impact their performance.

In contrast, Nagaraj (2021) documented dissimilar outcomes in his investigation on listening comprehension. He observed that the participants excelled in responding to information questions, followed by integration questions, but they struggled the most with inference questions in quiet conditions. However, when exposed to auditory distraction, the participants had notably better performance on inference questions compared to information or integration questions. These findings diverge from the findings of the current study, where the learners performed less satisfactorily when confronted with noise.

In the present study, the L2 learners performed the best in answering content questions, followed by inferential questions, and had the lowest performance when attempting integrated questions in both listening tasks (with and without auditory distraction). Furthermore, their performance was notably poorer in attempting listening questions in the presence of auditory distraction. These performance differences could be attributed to various factors, including the participants' language backgrounds, testing methodologies, or other unidentified reasons.

A two-way mixed between-within subjects ANOVA was employed to assess the impact of working memory capacity on the responses to different question types during a listening comprehension test in

adverse conditions. The investigation focused on the potential differences in working memory capacity between the high and low working memory groups and the effects of item types on performance.

The results indicated no statistically significant differences in working memory capacity between the high and low working memory groups ($p = 0.72$) or in performance across different question types ($p = 0.398$). Furthermore, there was no statistically significant interaction effect between working memory capacity and question types ($p = 0.087$).

The findings also showed that working memory capacity was not significantly different between the high and low working memory groups in the context of L2 learners' listening comprehension under adverse conditions. Additionally, no significant performance differences were observed among different question types. These findings suggest that working memory capacity may not be a significant factor to influence listening comprehension under these conditions, as the learners approached various question types similarly.

The current study aimed to examine the interplay between auditory distraction and working memory capacity in the context of Iranian EFL learners with advanced proficiency. To expand the research scope, future studies should encompass other language skills like speaking, writing, and reading. Investigating the impacts of working memory and auditory distraction on multiple language skills can offer a more comprehensive view of their influence on overall language proficiency. Additionally, the study setting was limited to universities and language institutes; exploring other educational contexts, such as high schools, may provide broader insights. Incorporating demographic variables like gender and age may uncover variations in how these factors affect listening comprehension. Future research might benefit from mixed methods, including the use of qualitative elements like follow-up interviews and alternative assessments for working memory capacity beyond those used in this study.

VII. IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

The findings of this study hold significant implications for both theoretical understanding and pedagogical practices in English as a Foreign Language (EFL). They highlight the complex nature of listening comprehension and the influence of individual differences, emphasizing the importance of considering these factors in research and instructional design. By illuminating the interplay between working memory and auditory distractions in EFL contexts, the study calls for a re-evaluation of the existing frameworks and methodologies in language acquisition.

Theoretically, the research enhances our understanding of how working memory impacts listening comprehension among Iranian EFL learners, providing empirical evidence that informs current theories on working memory and auditory distraction in second language acquisition. Furthermore, it evaluates the relevance of findings from studies involving native English speakers to Iranian learners, expanding the contextual scope of prior research. The insights suggest the need for a more nuanced view of cognitive processes in language learning, as solely relying on working memory may not adequately predict outcomes in challenging auditory conditions.

Practically, the implications of this study extend to pedagogical practices and curriculum development. Educators should adopt strategies to minimize auditory distractions, such as creating conducive learning environments and using scaffolding techniques. Curriculum designers should integrate activities aimed at enhancing the working memory during listening tasks to improve language proficiency. By addressing the diverse needs of learners, teachers can tailor their instruction and design materials that consider auditory distractions, ultimately improving listening skills among second language learners.

In light of the controversial findings regarding the impact of working memory capacity and auditory distraction on listening comprehension, further research is essential. Future studies should explore how these factors influence additional language skills, such as speaking, writing and reading, to provide a more comprehensive understanding of overall language proficiency. Investigations in diverse educational contexts, including high schools and vocational settings, will enhance the generalizability of the results. Additionally, research involving different age groups, particularly younger and older learners, could yield valuable insights into how developmental factors affect listening comprehension. It is also important to consider demographic variables like gender and socioeconomic background, as they may influence learning outcomes. Employing mixed-methods approaches, such as qualitative interviews or think-aloud protocols, could deepen our understanding of participants' experiences related to auditory distractions. Finally, utilizing varied assessment tools for measuring working memory could reveal new patterns, further illuminating its relationship with auditory distraction in language learning. Overall, these approaches would contribute to a more nuanced understanding of the complex dynamics between cognitive processes and language acquisition.

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