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The contribution of cognitive abilities and general language proficiency to explaining listening comprehension in English as a foreign language

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Abstract: The present study aimed to investigate the relationship between a number of cognitive abilities (auditory/visual attention, processing speed, and fluid intelligence) and listening comprehension. A total of 97 undergraduate EFL students participated in the study. Tests of auditory and visual attention, processing speed, verbal and nonverbal fluid intelligence, overall English language proficiency, and listening comprehension were administered to the participants. The results indicated that the measure of English proficiency had the highest correlation with the listening test followed by measures of attention and processing speed. Hierarchical regression analysis indicated that 17% of the variance in listening comprehension was explained by the cognitive factors. The addition of second language proficiency to the regression model in the second step added another 25% to the total variance explained. That is, foreign language proficiency, after controlling for cognitive abilities, can explain 25% of the variance in listening comprehension. These findings suggest that understanding when listening in L2 involves cognitive information processing skills in addition to proficiency in that language.

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PB and ZZ are faculty members in the English Department of Islamic Azad University, Mashhad, Iran. MN was a master's student in TEFL (teaching English as a foreign language) in the department. The study reported here is based on MN's master's thesis. One of the main themes of research in our department is the role of individual differences in second language acquisition. An ongoing topic of interest is establishing the cognitive and neuropsychological correlates of foreign language skills. We also conduct research on the role of personality and other non-cognitive factors and their interplay with cognitive factors in explaining foreign language ability.

PUBLIC INTEREST STATEMENT

Listening comprehension (LC) in a foreign language is an extremely important skill. Communication in a foreign language is only possible when speakers can understand the messages they hear. Nevertheless, LC is a skill that is very difficult to master and generates a lot of anxiety in learners. In this study, we try to find out what mental abilities are related to successful listening comprehension. Our findings show that concentration and speed of thinking are related to LC while general intelligence is not.

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1. Introduction

Listening comprehension (LC) is the process of extracting meaning from spoken discourse (Snowling & Hulme, 2005). It is a complicated process in which a series of linguistic and cognitive skills are involved. Listening comprehension plays a key role in language learning, i.e., how well learners can communicate and learn from others is influenced by this ability (Rost, 2011). Graham (2011) states that listening is frustrating for foreign language learners and it is difficult for them to feel they are making progress in this skill. Research on the individual differences in LC, compared to reading comprehension, is scarce (Andringa, Olsthoorn, van Beuningen, Schoonen, & Hulstijn, 2012). Previous research has probed into the roles of vocabulary knowledge, proficiency, and metacognitive awareness (see Wang & Treffers-Daller, 2017) but the role of learners' cognitive information processing abilities in foreign language listening comprehension remains unclear.

LC is considered as a complex multidimensional process in which a myriad of factors including linguistic, affective and cognitive are involved. Several models have been proposed to describe LC and its underlying processes. The common key feature of all these models is a cognitive component which plays a central role in describing LC (Worthington, 2017). In Kintsch's (1988) construction-integration model successful LC is hypothesized to be attained in two stages. In the construction stage, with the help of language skills (grammar, vocabulary) the literal meanings of utterances are extracted and in the integration stage higher order cognitive skills are involved to link the meanings of utterances and create a unified meaningful speech.

Other researchers argued that in addition to basic language skills and higher order cognitive skills some basic cognitive skills for general information processing are also required for successful LC (Daneman & Merikle, 1996; Kim, 2016). It is apparent that the order of the processes from lowest to highest is basic cognitive skills, basic linguistic skills, and higher order cognitive skills (Kim, 2016; Kim & Phillips, 2014). Imhof's (2010) model of listening comprehension which is grounded in cognitive psychology also emphasizes the roles of attention and working memory in organizing and integrating signals to create meaning.

The basic cognitive skills which are deemed to contribute to LC are the multicomponent construct of attention, processing speed, and working memory. A major type of attention which is believed to play a fundamental role in LC is selective attention. Selective attention is the ability to focus on selected stimuli without being distracted by other background information. Listening research states that how we attend to a message affects the subsequent cognitive domains of listening, i.e., retention as well as comprehension (Worthington, 2017). In listening comprehension, selective attention helps us to attend to and process a series of important signals while we ignore irrelevant information. Since listeners are continuously bombarded by stimuli and a great deal of the signals they receive is redundant, deficiencies in selective attention could tax their cognitive resources and overwhelm them before meaning is extracted.

Another type of attention which could affect the achievement of successful LC is sustained attention. Sustained attention is the ability to maintain one's focus for an extended period of time on a task. The role of sustained attention has not been discussed in the listening literature.

Since the listening stimuli are continuous and could last for relatively long periods of time, in addition to selective attention listeners need to be able to maintain their focus on the stimuli. Thus, lapses in sustained attention could divert listeners' focus from the task at hand and wear them out before meaning is constructed.

In the definitions of sustained attention working memory is also implied. Working memory is the ability to temporarily hold information in the mind for processing (Baddeley & Hitch, 1974). The role of working memory in LC has been emphasized by Kim (2016) and Kim and Phillips (2014). Sohlberg and Mateer (2001) state that sustained attention has two components: vigilance and working memory. Apart from the ability to keep attending to continuous or repetitive tasks

(vigilance), sustained attention also subsumes working memory. In the Attention Process Training Program (Sohlberg & Mateer, 1987/2001), a rehabilitation programme to reduce the attention deficits of patients with brain injury, there was emphasis on working memory tasks. However, in the works on the relationship between working memory and LC the role of the vigilance component, which seems to have a pivotal role in LC, is ignored. In effect, by studying the contribution of sustained attention both working memory capacity and vigilance are taken into account.

As far as listening as processing speech is concerned, there is the inevitable fact that speakers speak rapidly which imposes a time constraint on listeners to consider all the syntactic, semantic, and pragmatic dimensions of each word. Therefore, to understand what is said, listening processes must practically be done automatically (Buck, 2001). Alderson (2005) states that:

"Listing to a foreign language clearly involves the ability to process sounds and meaning in real time, and automaticity of processing in such circumstances is generally recognized as being crucial. If a leaner has to process, think, translate or reflect before being able to process meaning and respond, then that learner is clearly in some sense handicapped, and less proficient than a learner who does not need such time" (p. 260).

Second language learners, who rarely go through automatic processing, will face more comprehension difficulties. Since they are not able to follow the speed rate, they will miss the meaning because they pay more attention to grammatical and lexical processing (Lynch, 1988). In contrast to readers, listeners do not have enough time to process what is being told, and if they miss something, it is not repeated. Therefore, listening comprehension puts heavy demands on a listener's processing system and requires careful attention. Thus, as cognitive factors seem to play a crucial role in listening comprehension, their role requires a thorough empirical examination.

In terms of the factors affecting LC, Rubin (1994) mentioned task characteristics, text characteristics, process characteristics, interlocutor characteristics, and listener characteristics. Here, the focus is on differences in listener characteristics, as these have gained little attention (Andringa et al., 2012). The factors that have been investigated in relation to listener characteristics are learner's general language proficiency (Wang & Treffers-Daller, 2017), knowledge of vocabulary (Bonk, 2000; Staehr, 2009; Vandergrift & Baker, 2015), the use of listening strategies (Graham, Santos, & Vanderplank, 2008), metacognitive awareness (Vandergrift, Goh, Mareschal, & Tafaghodtari, 2006; Vandergrift & Tafaghodtari, 2010), working memory and processing speed (Andringa et al., 2012).

Moreover, the role of cognitive abilities in LC has mostly been examined in the native language (Kim, 2016; Kim & Phillips, 2014). The contribution of these abilities above and beyond basic linguistic skills has not thus been examined empirically among learners of a second or foreign language. For example, a qualitative research by Goh (2000) based on learners verbalizations, diaries, and interviews revealed 10 problems that learners of English as a second language reported. The dominant ones included attention, working memory, and short term memory.

Worthington (2017) states that metacognition, i.e., awareness of our cognitive processes and resources, is a crucial point in LC. Individuals who are conscious about their cognition are able to plan and manage their cognitive resources to fulfill a listening task. "Individuals who are more metacognitively aware of their listening resources and abilities may be better able to address instances when their listening is challenged" (Worthington, 2017, p. 88). Vandergrift (2003) also states that students with higher metacognitive awareness are better listeners. In order to foster metacognitive awareness in learners' understanding the cognitive underpinnings of listening comprehension are in order. Understanding the cognitive underpinnings of LC can also help in improving it by providing targeted intervention to enhance the cognitive abilities underlying LC.

In relation to the construction-integration model of Kintsch (1988), effective listening comprehension is accomplished in two phases: a construction and an integration phase. The former deals

with foundational language skills such as grammar and vocabulary to formulate initial and literal propositions on the basis of the phrases and words of the discourse (Kim, 2016); whereas, the latter deals with a set of higher order cognitive skills to formulate the initial propositions across the discourse to build an integrated and coherent whole (Kim, 2016; Strasser & Del Rio, 2014). The purpose of the present study is to examine the contribution of attention to listening in English as a second language after the impact of basic linguistic knowledge is controlled.

2. Methodology

2.1. Participants and setting
A total of 97 EFL bachelor's degree students at Islamic Azad University of Mashhad participated in the study; 70% of the participants were female and 30% of them were male. The candidates' age ranged from 19 to 52 (median = 22 years). The candidates were recruited by requests in lectures. Detailed instructions and practice material were provided for them before taking the tests. Participation in the study was voluntary and no financial compensation was made. On conclusion, participants were thanked for their cooperation and time and were provided with the profiles of their cognitive abilities and English language skills. The institutional review board approved of the study.

2.2. Instrumentation

2.2.1. Listening comprehension (LC) test
The Preliminary English Test of the Cambridge Assessment English is an intermediate level test to measures basic knowledge of English as a second language. Cambridge Assessment English is a recognized body that publishes materials for teaching and assessment for individuals learning the English language. The test is designed to show whether candidates "have mastered the basics of English and now have practical language skills for everyday use" (Cambridge Assessment English, 2017). The listening comprehension section of one of the past papers of the Preliminary English Test was employed to assess the participants' listening comprehension. The listening section of the test is composed of four parts. In part one, candidates are asked to listen to and answer multiple choice questions according to the given pictures. In the second part, they are required to listen to longer monologues or interviews and choose the correct answers. In the third part, they have to listen to an announcement and fill the missing information in the numbered spaces. In the last part, they are asked to answer true/false questions. The test contained 25 items and a single score out of a total of 25 was given to each test taker. The Cronbach's reliability for the listening scores in this study was 0.79.

2.2.2. C-test
A four-passage C-Test battery developed by Baghaei and Grotjahn (2014) was used as a measure of second language proficiency. A C-Test is a text completion test where examinees have to reconstruct broken words in 4 to 6 independent short passages. There is evidence in the literature on the validity of C-Test as a measure of overall second language proficiency (Eckes & Grotjahn, 2006). C-Tests highly correlate with other measures of second language ability especially with combined scores of language skills and components (listening, speaking, reading, writing, vocabulary, grammar). The Cronbach's reliability for the C-Test scores in this study, considering each passage as a super-item (Eckes & Baghaei, 2015), was 0.79.

2.2.3. The d2 test of attention
The d2 test (Brickenkamp & Zillmer, 1998) is a practical measure of attention and concentration processes which includes the simultaneous presentation of visually similar stimuli. The standard version of the d2 test is a paper-pencil cancelation test which consists of 14 rows with 47 "p" and "d" characters. There are one to four dashes above or below each letter. Candidates should cancel out "d's" (target symbol) with two dashes above or below them in 20s for each row. The test is a measure of attention and processing speed. The total number of characters canceled is

considered a measure of processing speed and the total number of characters correctly cancelled minus errors (concentration performance) is a measure of attention. These two scores are reported to be the most valid and reliable scores in the d2 test (Baghaei, Ravand, & Nadri, 2019; Steinborn, Langner, Flehmig, & Huestegge, 2018). In this study, the Cronbach's reliability index for the speed score was 0.93 and for the concentration score was 0.97.

2.2.4. Raven's standard progressive matrices
Mental ability and abstract reasoning (fluid intelligence) were assessed by the Raven's Standard Progressive Matrices (RSPM). The main focus in this test is on difficult pattern matching tasks rather than language abilities (Raven, 2000). Since the original RSPM is relatively long, Bilker et al. (2012) developed a short 9-item and a 12-item version of the test which are the best predictors of the full scale RSPM. In this study, the 12-item version of the test was employed. The Cronbach's reliability index for the scores was 0.65 in this study.

2.2.5. Persian adaptation of Baddeley's 3-min grammatical reasoning test
Baghaei, Khoshdel-Niyat, and Tabatabaee-Yazdi (2017) adapted Baddeley's (1968) 3-min. grammatical reasoning test for the Persian language by using the verbs "inscribe" and "circumscribe" and the shapes of a square inside a circle and a circle inside a square. Respondents have to mark whether the statements correctly describe the position of the square and the circle. Baghaei et al. (2017) demonstrated the validity and reliability of the Persian adaptation of the test. The Cronbach's reliability index for the grammatical reasoning test scores was 0.93 in this study.

2.2.6. Auditory sustained attention test (ASAT)
The Auditory Sustained Attention Test (ASAT, Nadri, 2018) is a mental calculation test to measure sustained auditory attention and concentration. The auditory stimulus contains 50 items in which two simple addition operations are presented (like 2 + 3; 1 + 4). Examinees have to add up the results of both operations and write down the answer on the answer sheet. Computations should be done without the use of a pen and paper. The time interval between the presentations of the two operations within the item is 1 second and between items was 3 seconds. In order to minimize the computational load of the task, the digits were limited between 1 and 5 and only addition operation was used. The test runs for five minutes with a Cronbach's reliability index of .91 in this study.

3. Analyses and results
Table 1 depicts the descriptive statistics for the measures of the study. Correlational analysis was run to examine the association between cognitive variables and listening comprehension. As Table 2 shows that listening comprehension is highly and significantly related to C-test ($r = .63$, $p < .01$, $n = 97$). Visual attention was measured by the d2 test (d2-CP). The correlation between listening comprehension and d2 concentration performance scores (number of characters correctly canceled minus sum of the errors) was $r = .35$ ($p < .01$, $n = 97$). Therefore, there is a moderate significant relationship between listening comprehension and visual sustained attention. The mental calculation test was used as a measure of auditory sustained attention (ASAT). Table 2 indicates that the correlation between listening comprehension and the mental calculation test is small and non-significant ($r = .17$, $p = .09$, $n = 97$).

It needs to be mentioned that d2-Sp (total number of characters cancelled) is an indication of processing speed. As presented in Table 2, this measure correlates at $r = .27$ ($p < .01$, $n = 97$) with listening comprehension. Therefore, there is a small significant correlation between processing speed and listening comprehension.

Fluid intelligence was measured by Raven's Standard Progressive Mercies and the grammatical reasoning test. According to Table 2, the correlation between Raven and listening comprehension was non-significant ($r = .14$, $p = .15$, $n = 97$), but with the grammatical reasoning test was significant ($r = .27$, $p < .01$, $n = 97$). As a result, there is a small but significant relationship between listening comprehension and fluid intelligence as measured by the

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Table 1. Descriptive statistics for the measures used in the study

	LC	C-Test	d2-Sp	d2-CP	Raven	Gram Reasn	ASAT
Mean	12	36.5	173.8	166.3	5.71	30	40.5
SD	4.8	14.2	49.2	44.36	2.2	9.2	9.2
Range	22	67	311	233	9	46	43
Min	2	5	35	39	1	7	7
Max	24	72	346	272	10	53	50

LC = listening comprehension; d2-CP = d2-concentration performance; d2-Sp = d2-processing speed; Gram Reasn = Baddeley's 3-min. grammatical reasoning test; ASAT = auditory sustained attention test, n = 97.

Table 2. Matrix of correlations between the variables

	C-Test	d2-CP	d2-Sp	Raven	Gram Reasn	ASAT
LC	.63**	.35**	.27**	.14	.27**	.17
C-Test	-	.37**	.32**	.18	.45**	.23*
d2-CP		-	.90**	.46**	.25*	.42**
d2-Sp			-	.33**	.21*	.31**
Raven				-	.25*	.35**
Gram Reasn					-	.27**

LC = listening comprehension; d2-CP = d2-concentration performance; d2-Sp = d2-processing speed; Gram Reasn = Baddeley's 3-min. grammatical reasoning test; ASAT = auditory sustained attention test, *p < .05, **p < .01, n = 97.

Table 3. Hierarchical multiple regression analysis on listening comprehension (LC) scores

Model	R square	R square Change	F Change	p
Model 1	.17	.17	3.68	<.01
Model 2	.42	.25	39.14	<.01

Model 1 contains the d2-concentration performance, d2-processing speed, the Raven test, Baddeley's 3-min. grammatical reasoning test, and the auditory sustained attention test. Model 2 contains the C-Test.

grammatical reasoning test. It seems that listening comprehension is more related to reasoning with language and is less related to abstract nonverbal reasoning as measured by the Raven's test.

Furthermore, hierarchical multiple regression was used to assess the ability of the five independent variables and foreign language proficiency to predict the dependent variable, i.e., listening comprehension. Preliminary analyses were conducted to ensure that there has been no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

The five cognitive factors were entered in the first step (Model 1) which explained 17% of the variance in listening comprehension scores, F (5, 91) = 3.68, p < 0.01. After entering the C-Test in the second step (Model 2) the total variance explained by the model as a whole was 42%, F (6, 90) = 10.88, p < 0.01. As Table 3 shows, the C-Test explained and additional 25% of the variance in listening comprehension, after controlling for the influence of cognitive abilities, which was significant, R squared change = .25, F change (1, 90) = 39.15, p < 0.01.

4. Discussion
The purpose of this study was to investigate the contribution of foreign language proficiency and cognitive factors to listening comprehension in English as a foreign language. To this end,

a listening comprehension test along with the relevant measures of cognitive factors and proficiency were given to 97 bachelor's degree students of English as a foreign language.

Correlational analyses showed that language proficiency, visual selective attention, processing speed, verbal fluid intelligence, and auditory sustained attention had a medium but significant correlation with listening comprehension. Hierarchical regression showed that cognitive abilities explained 17% of the variance in listening comprehension. Furthermore, after controlling the influence of cognitive abilities language proficiency explained an additional 25% variance in LC. These findings suggest that cognitive factors significantly contribute to EFL listening comprehension.

According to Genesee (1976) and Lightbown and Spada (2006), metalinguistic knowledge, grammar, and vocabulary which require reasoning, language analyses and rule learning are more related to cognitive factors than communicative skills. Cognitive abilities are less important in contexts where emphasis is on communication and interaction. It seems that since listening is a component of communicative interaction, it is not as strongly associated with measures of cognitive abilities as reading comprehension. In a study on the relationship between cognitive factors and reading comprehension in English as a foreign language, Tabatabaee-Yazdi and Baghaei (2018) reported a correlation coefficients of $r = .35$ between reading comprehension and the short form of Raven's Advanced Progressive Matrices and a coefficient of $r = .44$ between reading comprehension and a Persian verbal analogies test. As these correlations and the correlations obtained in this study indicate the association between reasoning and reading comprehension is stronger than the association between reasoning and listening comprehension.

Hulstijn (2011) believed that world knowledge, intellectual skills and memory skills should not be involved in L2 tests for lower levels (A1, A2, & B1 CEFR). In other words, cognitive factors should be required only for the higher levels of L2 test. Therefore, since the listening section of the Preliminary English Test (B1 intermediate) was used in this research, the somewhat low correlations between cognitive factors and listening comprehension test seem logical. This may also contribute to the validity evidence of the listening component of the Preliminary English Test as its association with construct irrelevant factors, i.e., intelligence, is minimal.

Findings of the current study are consistent with Wang and Treffers-Daller (2017) who concluded that general language proficiency and vocabulary size are the best predictors of listening comprehension among L2 learners, while metacognitive awareness is less important. In the same vein, a qualitative study by Goh (2000) is in line with the current study where verbalizations, diaries, and interviews revealed that problems of attention, working memory, and short term memory prevail among learners with poor LC ability. The results of the current study indicated that cognitive factors like fluid intelligence, sustained attention, and processing speed may contribute slightly less than language proficiency to listening comprehension.

One explanation for why cognitive abilities are almost as important as proficiency in predicting LC could be because LC in general and LC tests in particular place heavy demands on cognition. Poor listeners often struggle to meet the attentional and reasoning demands of listening tasks under time constraint and as a result fail to understand spoken texts.

Although correlations are not indicative of causality future research should investigate the impact of targeted interventions on listening comprehension. Interventions that focus on supporting attention, reasoning and processing speed may be essential to minimize the adverse consequences of poor cognitive abilities on LC. For example, Dahlin (2011) demonstrated that working memory training positively affected the reading comprehension ability of children with special needs. While other researchers have demonstrated that improving the reading comprehension of second language learners with enhancing their vocabulary has not been very successful although reading comprehension and vocabulary knowledge are highly correlated (see Aryadoust & Baghaei, 2016) Likewise, effective teaching techniques for reducing cognitive loads in listening activities like simplifying

complex tasks by reducing speech rate and repeating tasks may also help learners overcome their cognitive failures. In addition, teaching and facilitating learners' use of listening strategies can mitigate the adverse consequences of cognitive failure in LC.

Future studies should include other cognitive abilities such as working memory, auditory sustained and selective attentions, and crystallized intelligence to more thoroughly examine the question of the contribution of cognitive abilities in predicting listening comprehension.

5. Conclusion

The present study examined the importance of the cognitive abilities and proficiency in listening comprehension. Based upon the results of this study, the assumption that cognitive factors contribute to listening comprehension is empirically supported. According to the analyses, the best predictor of listening comprehension is language proficiency which relates to the linguistic knowledge of vocabulary and grammar, i.e., the more proficient the learners are in English, the better their listening comprehension is. Next, come the cognitive factors which are actively involved in the fulfilment of successful listening comprehension among intermediate foreign language learners. Enhancing learners' vocabulary knowledge and cognitive functioning might lead to better listening comprehension. This, however, remains to be established with intervention studies.

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