T.C.
REPUBLIC OF TURKEY
HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF HEALTH SCIENCES

LATE BILINGUALS' ABILITY TO DISCRIMINATE SPEECH IN NOISE

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Audiology Program

MASTER of SCIENCE THESIS

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ETHICAL DECLARATION

In this thesis study, I declare that all the information and documents have been obtained in the base of the academic rules and all audio-visual and written information and results have been presented according to the rules of scientific ethics. I did not do any distortion in data set. In case of using other works, related studies have been fully cited in accordance with the scientific standards. I also declare that my thesis study is original except cited references. It was produced by myself in consultation with supervisor (Assoc. Professor Meral Didem TÜRKYILMAZ) and written according to the rules of thesis writing of Hacettepe University Institute of Health Sciences.

Diala HUSSEIN

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ABSTRACT

Hussein, D., Late Bilinguals' Ability to Discriminate Speech in Noise, Hacettepe University Graduate School of Health Sciences, Master Thesis of Audiology, Ankara, 2019. As the bilinguals are more affected by noise while listening to a speech in their non-native language, this study examined the performance of late bilinguals whose native language is Arabic and acquired Turkish later in life on the Turkish Matrix Test. The study was consisted of a study group which contained 15 participants whose Turkish is their non-native language, and of a control group which contained 13 participants whose Turkish is their native language. The Turkish Matrix test, RAVEN test, SDQ and KAS tests, VADS -B test, were performed for each participant in the study group. The Arabic version of Language Experience and Proficiency Questionnaire (LEAP-Q) was also completed by each participant in the study group. For the Control Group, only Matrix tests' protocols were applied for each participant. The results of this study showed a significant difference between the study and control groups on all Turkish Matrix test protocols'. Also, a significant difference was found between the Turkish and Arabic VADS test, as well as a significant difference between the KAS results of this study and the test's normative data. These results indicate that the performance of the study group was affected by the working memory and the age of Turkish acquisition in addition to the effect of the noise. Thus, the acquiring of language in younger age and having a larger working memory capacity give an advantage for understanding speech in noise.

Key Words: Bilingualism, Bilinguals, Speech Perception in Noise, Matrix Test, Normal Hearing.

ÖZET

Hussein, D., Geç Iki Dillilerde Gürültüde Konuşmayı Ayırt Etme Becerisi, Hacettepe Üniversitesi Sağlık Bilimleri Enstitüsü Odyoloji Programı Yüksek Lisans Tezi, Ankara, 2019. İki dilli kişiler anadillerinde olmayan bir konuşmayı dinlerken gürültüden daha fazla etkilendiklerinden, bu çalışma anadili Arapça olan ve daha sonra Türkçe öğrenen iki dil bilenlerin Türkçe Matrix Testindeki performansını incelemektedir. Bu çalışma anadili Türkçe olmayan 15 kişilik bir çalışma grubundan ve anadili Türkçe olan 13 kişilik bir kontrol grubundan oluşmaktadır. Çalışma grubundaki her katılımcıya Türkçe Matrix testi, RAVEN testi, SDQ ve KAS testleri, VADS -B testi uygulanmıştır. Dil Deneyimi ve Yeterlik Anketinin Arapça versiyonu (LEAP-Q) çalışma grubundaki her katılımcı tarafından tamamlanmıştır. Kontrol Grubu için, her katılımcı için yalnızca Matrix testinin protokolleri uygulanmıştır. Bu çalışmanın sonuçları, tüm Türkçe Matrix test protokollerinde yer alan çalışma ve kontrol grupları arasında anlamlı bir fark olduğunu göstermektedir. Ayrıca, Türkçe ve Arapça VADS testi arasında anlamlı bir fark olduğu gibi, bu çalışmanın KAS sonuçları ile testin normatif verileri arasında da anlamlı bir fark olduğu görülmüştür. Bu sonuçlar çalışma grubunun performansının gürültünün etkisine ek olarak, çalışma belleğinden ve Türkçe ediniminin yaşından etkilendiğini göstermektedir.

Anahtar Kelimeler: Iki Dillilik, Iki Dilliler, Gürültüde Konuşmayı Ayırt Etme, Matrix Test, Normal İşitme.

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SYMBOLS and ABBREVIATIONS

A-O	Aural-Oral
A-W	Aural-Written
AINHB	Adaptive in Noise Headphone Binaurally
AINHML	Adaptive in Noise Headphone Monaurally –Left-
AINHMR	Adaptive in Noise Headphone Monaurally –Right-
AIQHB	Adaptive in Quiet Headphone Binaurally
BG	Bilingual Group
BKB-SINT	BKB Speech-in-Noise Test
CST	Connected Sentence Test
E-HINT	English Hearing in Noise Test
EB	Early Bilinguals
EBG	Early Bilingual Group
F0	Fundamental Frequency
HINT	Hearing in Noise Test
HL	Hearing Level
KAS	Turkish Verbal Fluency Test
L1	The First Language
L2	The Second Language
LB	Late Bilinguals
LEAP-Q	Language Experience and Proficiency Questionnaire
LISN-S	Listening in Spatialized Noise–Sentence test
	Message
MG	Monolingual Group
MOC	Medial Olivocochlear
OCB	Olivocochlear Bundle
Quick-SIN	Quick Speech-in-Noise test
RPM	Raven Progressive Matrices
S-HINT	Spanish Hearing in Noise Test
S0N0	Both Speech and Noise Presented from 0 degree
S0N270	Speech Presented from 0 degree And Noise from 270 degree

S0N90	Speech Presented from 0 degree And Noise from 90 degree
SDQ	Arabic Verbal Fluency Test
SIN	Speech-in-Noise
SLNR	Speech to Left and Noise to Right
SNR	Signal to Noise Ratio
SPIN	Speech Perception in Noise test
SRNL	Speech to Right and Noise to Left
SRT	Speech Reception Threshold
SSI-ICM	Synthetic Sentence Identification—Ipsilateral Competing
TG	Trilinguals
USLT	Understanding Spoken Language in Turkish
VCV	Vowel Consonant Vowel
V-O	Visual-Oral
V-W	Visual-written
VADS –B	Visual Aural Digit Span Test (Form B)
WIN	Words-in-Noise test
WRS	Word Recognition Score
YTB	Presidency for Turks Abroad and Related Communities

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1. INTRODUCTION

Daily speech communication is unfortunately not always happening in quiet, thus, it often takes place in noisy environments. Additionally, it is well known that the competing continuous noise and reverberation are negatively affecting the perception of speech (1), which make it a challenge for almost everyone to percept speech in noise, but it is harder for those with hearing impairments, and also for those who are foreign listeners (2, 3). In this field, different studies had proved that the non-native listeners perform worse than native listeners in speech perception in noise tasks, when the speech is in their non-native language. For example; Weiss and Dempsey (4) in their study found that listeners who learned English later in life performed poorer than those who learned English early in their life on English-HINT, but, both late and early bilinguals performed better on Spanish-HINT, as Spanish is their native language. Otherwise, there are different tests that could be used to evaluate speech perception in noise, such as; Words-in-Noise test (WIN), Speech Perception in Noise test (SPIN), Hearing in Noise Test (HINT) (5), and International Matrix tests (6). Indeed, speech perception in noise is not the only problem that bilinguals are facing, for example, in Gollan et al. (7) bilinguals shown to be slower in picture naming. also, in Rosseli et al. (8) they obtained lower scores on verbal fluency tasks, and in Gollan and Acenas (9) they encountered more experiences of tip of the tongue.

As what was posted on the web site of Presidency for Turks Abroad and Related Communities (YTB), the number of foreign students in Turkey is increasing, as there were 48 thousand foreign students before 4 years ago, and by 2019 it became 148 thousand (10). Furthermore, according to the statistics of Republic of Turkey Ministry of Interior Directorate General of Migration Management, the total number of Syrian refugees in the scope of temporary protection by the date of 25.4.2019 was 3.605.615 (11), and the total number of foreigners with Turkish residence permit by the date of 03.04.2019 was 934.626 (12). Due to this increment in numbers of foreigners here in Turkey, we decided to evaluate how those foreigners are affected by the noise which surrounding them, especially those who are students

as they can be affected by noise more than their native classmates during lessons. On the other hand, how the performance of those foreigners could be on speech in noise tests, as some of them could need to be tested by such tests to evaluate the benefit of a used amplification systems, or even to diagnose auditory problems such as central auditory processing disorder.

This study aims to compare the difference in performance on Turkish Matrix test between native listeners (Turks whose native language is Turkish), and non-native listeners whose Arabic is their native language and acquired Turkish later in life.

The goals of this study:

1- To evaluate the performance of non-native listeners on Turkish Matrix Test.

2- To recognize factors that could affect speech perception in noise.

3- To compare the performance of bilinguals on Arabic and Turkish digit-span test

4- To compare the performance of bilinguals on Arabic and Turkish verbal fluency test.

2. LITERATURE REVIEW

2.1. Bilingualism and Multilingualism

Bilingualism and Multilingualism are terms that can be used to describe a societal or an individual phenomenon, also called individual bilingualism and societal bilingualism (13). Furthermore, to distinguish between the individual or societal bi/multilingualism, the term bilinguality was used to describe individual bilingualism (14). In this study, the terms bilingualism and multilingualism were used to talk about the individual phenomenon.

Defining the term bilingualism is a problematic domain, as there are wide and restrictive definitions for it. Over time, the definition ranged from being very restricted, as it was the ability to use the second language as fluently as the native one (15), to broad definition, as it became having a minimal proficiency in the second language (16). In Myers-Scotton (17) bilingualism was defined as "*the ability to use two or more languages sufficiently to carry on a limited casual conversation*". Whereas in Mishra (18) bilingualism was defined as "*the fluent and voluntary use of two languages*". Furthermore, in Cook and Bassetti (19) the term 'Bilingual' was used "*to talk about someone who knows more than one language, whether spoken, written or signed, regardless of the number of languages known, the level of proficiency, how they were learned, and whether knowledge is productive or receptive*". Thus, the individual who has the ability to use more than one language is a bilingual person. On the other hand, the well-known definition for the term multilingualism is "*the ability of societies, institutions, groups, and individuals to engage on a regular basis, with more than one language in their day-to-day lives*" which is given by the European Commission (20). In another reference, the multilingual individual was defined as "*anyone who can communicate in more than one language, be it active (through speaking and writing) or passive (through listening and reading)*" (21).

While the terms bilingualism and multilingualism were used as a synonymous (22), we decided in our study to use the term bilingualism to refer to the phenomenon itself, and bilinguals to refer to the individuals.

2.1.1. Types of Bilingualism

As the bilingualism has different dimensions, therefore, the researchers have suggested different classifications for it according to the dimension that each researcher was concentrating on (23).

Fluency and Proficiency

Bilingualism could be classified according to the relationship between fluency and proficiencies of the mastered languages into dominant and balanced bilingualism (24). Thus, balanced bilingual is the one who has equal proficiencies in two languages, and dominant bilingual is the one who has higher proficiency in one of his/her languages than the other (25).

Age of Acquisition

Bilingualism could be classified based on the age of language acquisition into early and late bilingualism (26). Early bilingualism is divided into simultaneous bilingualism and sequential bilingualism. simultaneous bilingualism occurs when a child acquires two languages together during their early childhood development, while sequential bilingualism occurs when a child becomes proficient in the second language after acquiring the first one (27). Late bilingualism defined as the acquisition of the second language after eight years old and after having acquired the first language (25).

For other classifications of bilingualism see Appendix 1.

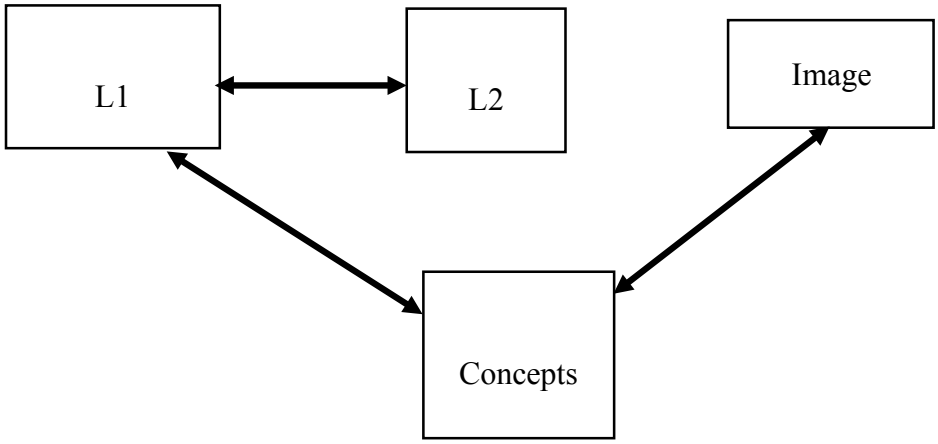
2.2 Memory

As the managing of two languages during speaking is what distinguishes bilinguals, accordingly, this managing depends on different factors such as; age of acquisition, current age, environment, current proficiency, how the language was acquired, etc. (18).

Indeed, there has been a dispute between the researchers on how the

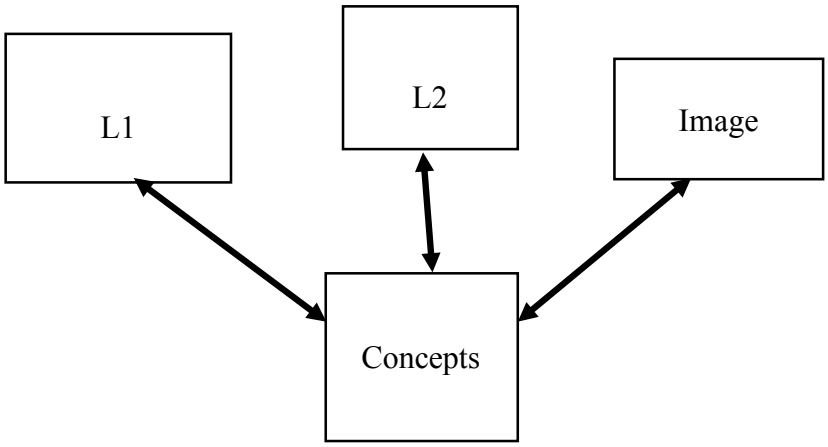
languages are reserved in the bilingual's mind (28). In this field, there are two main hypotheses. The first is that the bilingual has a common memory system for both languages (interdependence hypothesis), the other is that there is a different memory system for each language (independence hypothesis) (29, 30). As there was a debate between those hypotheses, the hierarchical models were arisen. The hierarchical models assume that in the bilinguals' memory, the bilingual can manage two languages by separated lexicons and a shared conceptual system (31). Thus, two hypotheses were proposed, Word Association hypothesis, and Concept Mediation hypothesis (32). The word association model supposes that the second language words can only gain access to concepts by first language mediation, as second language words are correlating to first language words (28), however, the concept mediation model supposes that the concept can be accessed directly by the second language words (28). (See figure 2.1.).

A



Word Association Model

B



Concept Mediation Model

Figure 2.1. A: Word Association Model, B: Concept Mediation Model (28). L1= Native or the first language, L2= Non-native or the second language.

Table 2.1. Data from Kroll and Curley (1986) and Kroll and Stewart (1989) on the time to perform bilingual translation (in milliseconds) as a function of the direction of translation task (28).

Study	L1 to L2 ms	L2 to L1 ms
Kroll and Curley (1986)		
More fluent subjects	1729	1318
Less fluent subjects	2079	1596
Kroll and Stewart (1989)		
More fluent subjects	1267	1175
Less fluent subjects	1612	1230

L1= First language, L2= Second language, ms= Millisecond

Nevertheless, in Kroll and Curley, and Kroll and Stewart in (28), the results showed that there was an asymmetry in bilingual's translation ability (see table 2.1), as the translation from the first language to the second language was slower than the opposite. To accommodate this asymmetry in translation between first and second language, Kroll and Stewart (1990) proposed another model which is the Revised Hierarchical Model (RHM) (see figure 2.2) (28).

According to the Revised Hierarchical Model (RHM) (see figure 2.2.), there are both lexical and conceptual active links in bilingual memory, but the strength of these links differ according to second language proficiency, and the dominance of the first language over the second language. Thus, at early stages of learning the second language, second language words are connected to the system by lexical links through the first language, so the lexical links are stronger than the conceptual links, but, while acquiring more advanced level in the second language the conceptual links become stronger (28).

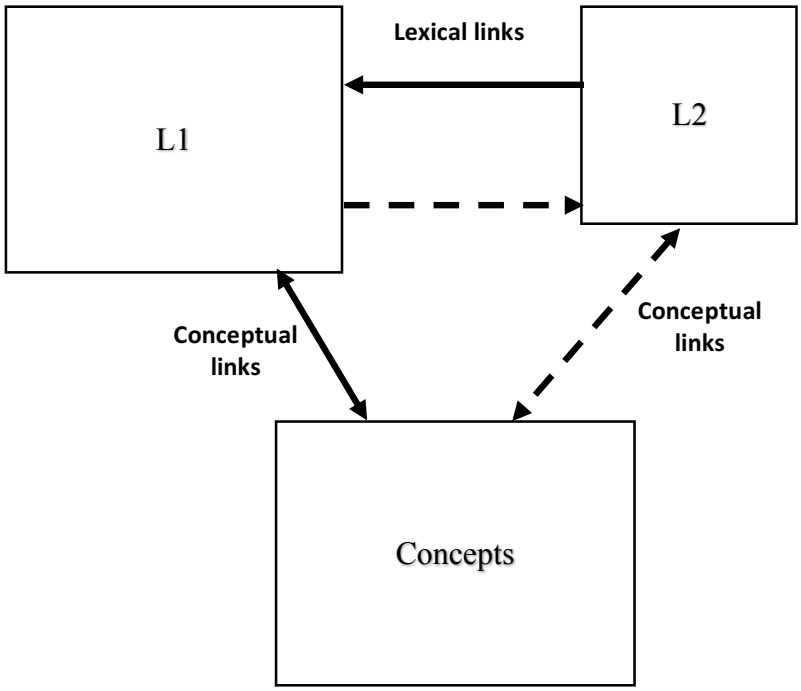


Figure 2.2. Revised hierarchical model of lexical and conceptual representation in bilingual memory (28).

2.2.1. Long -Term Memory

Long-term memory "*refers to what can be recalled from the past when the information to be learned no longer occupies the current stream of thought, either because immediate memory capacity was exceeded or because attention was diverted from the memoranda*" (33).

Furthermore, it includes implicit memory and explicit memory, implicit memory for routines, associations, and skills, while explicit memory for events and facts (34). Moreover, there is an important role that explicit and implicit memory play in language acquisition and processing as well (35). In a study that was done on undergraduate students whose first language were English and the second being French, students had made memory of things that were not actually mentioned, in addition to having remembered less information from conversation presented to them in their second language as opposed to their first (36).

2.2.2 Working Memory and Short -Term Memory

The term Working Memory is being used to refer to the temporary processing and storage of information (37). Also, the term working memory was mentioned in Richardson (38) as one of human information processing system component, which is responsible for the executive control and behavior, and also served as a form of short-term memory. Wherever, the short-term memory is a term that refers to the ability to remember a small number of items through a relatively short period of time (38). In Kolb and Mishaw (39) the terms short-term memory, working memory, and temporal memory were used as alternatives. Likewise, Baddeley in (40) said that the short-term memory serves as a working memory. The working memory is comprised of 4 interrelated parts; central executive, visuospatial sketchpad, episodic buffer and phonological loop (41). The central executive is a controller for the other three systems, the visuospatial sketchpad is responsible for visuospatial information (like images, color, shape), the episodic buffer is responsible for allowing information from long-term memory to interact with the other two systems, and the phonological loop is responsible for phonological encoding and rehearsal of information that based on speech, and it has a role too in the acquisition of native and second language (41-43). The digit span forward test is being used to assess attention and auditory short-term memory, in addition to the use of the digit span test in the assessment of verbal short-term memory (38, 44). Miller (45) showed that the capacity of human information processing ranges between 5-9 items, which called the magic number 7 plus or minus 2. Moreover, it is suggested that there is a relation between vocabulary performance and phonological short-term memory, as the performance of participants on the receptive vocabulary task was correlated with their performance on the phonological memory task (46). In a study that was done by Olsthoorn et al. when the visual and auditory digit span tests were used, the native participants obtained significantly higher scores in the auditory tests than the non-native participants, but this significant difference did not appear in the visual tasks (47).

2.3. Speech Perception

Speech perception (SP) "*most commonly refers to the perceptual mapping from the highly variable acoustic speech signal to a linguistic representation, whether it be phonemes, diphones, syllables, or words*" (48).

There are two main theories of speech perception; the first is that speech perception is an auditory processing's results, and it can be understood within the framework of auditory processing (49). The second theory supposes that speech perception depends on the processing of the speaker's intended articulations which requires motor representations' processing (50). The findings of a study that was done by Agnew et al. (51) suggest that the sensitivity of auditory and motor cortices to speech stimuli is different, which make it hard to agree with the models that suppose the critical role of motor representation in the perception of speech.

2.3.1 Speech Perception in Noise

There are some auditory and language-based compensatory mechanisms, which help to simplify speech perception when the background noise is affecting it as a masker, which causes degrading in the acoustic speech signal (5).

Language-Based Mechanism

Semantic and lexical expectations about words that a context contains, can simplify speech perception in noise (52, 53). For example; in difficult listening conditions, it is harder to understand a word that presented in isolation or carrier phrases than having been presented in a sentence (52).

Auditory Based Mechanisms

Auditory encoding and decoding are counting as speech perception's main factors, for example; having a low decoding ability causes less receiving of speech information in a noisy environment (54). Furthermore, the neural decoding ability at cortical and subcortical levels is necessary for speech understanding in noise (55-57). As well as there is a clear role of the fundamental frequency (F0) in helping in SPIN

(58). Song et al. in their study found that there is a relation between the accuracy of SPIN and the power of F0 representation of speech (59). Moreover, the left and right auditory cortices are working simultaneously to process acoustic features at different time scales just like those transferred by speech (60). Converging evidence proposes that fast, high-frequency temporal features (~20- 50ms; 20-50Hz; phonemes) are biased to the left hemisphere auditory cortex, whilst slow, low-frequency temporal features (~200ms; 3-7Hz; syllables) are biased rightward (61, 62). In Thompson, et al. (60) they found that in children who got better results in SPIN the activity of high-frequency cortical oscillatory was more left lateralized. In addition to all of what was mentioned before, the centrifugal pathways have its role too, as one of the most important pathways which prolonging from superior olive to the hair cells is the Olivocochlear bundle (OCB) (54). It is believed that the OCB has its role in selective attention, protecting the cochlea from acoustic trauma and in detecting signal in noise (63). Furthermore, the medial olivocochlear (MOC) efferent system might work as a nonlinear adaptive filter through the processing of speech in a noisy environment (64).

According to all those mechanisms, it is not surprising to know that individuals who were identified as suffering from auditory disorders, and language-based problems, are having difficulties in speech perception in noise (5).

Pure-tone thresholds are a gold standard for measuring hearing sensitivity at specific frequencies that have been long used by audiologists, but, despite the importance of it, it is insufficient in the process of predicting speech understanding especially in noise (2). In some cases, the damage happens to the inner hair cells which have the responsibility for sending the auditory signals to the brain, thus this damage results in the loss of signal clarity than the loss of signal sensitivity (65). On the other hand, Kujawa and Liberman (66) suggest that the loss of primary auditory nerve fibers is contributing to the loss of clarity, through its effect on how the speech signal is encoded in the auditory nerve. But, this loss of clarity is not detectable by the audiogram, and sometime speech perception in quiet test is not enough to detect

it. Wherefore, speech perception in noise tests are important to detect such problems (67). But also, this problem was noticed in normal populations who are bilinguals, as they showed poor performance on speech perception in noise (3).

2.3.2. Tests Used to Evaluate Speech Perception in Noise

There are different tests which were used and are still being used to test the performance in speech perception in noise, for example, Words-in-Noise (WIN), Speech Perception in Noise (SPIN), and Quick Speech-in-Noise (Quick-SIN) tests. The task of these tests is to repeat a polysyllabic or monosyllabic target word. Other tests are using with the task to repeat a complete sentence or sentence keywords such as Listening in Spatialized Noise–Sentence (LISN-S), Hearing in Noise Test (HINT), BKB Speech-in-Noise Test (BKB-SINT), Speech-in-Noise (SIN), Connected Sentence Test (CST), Synthetic Sentence Identification—Ipsilateral Competing Message (SSI-ICM) tests (5), and International Matrix tests (6). In Turkish, there are only three used speech in noise tests, Turkish digit triplet test, Turkish-HINT, and the Turkish Matrix Test (68-70).

2.3.3. Bilinguals and Speech Perception in Noise

In a study that was done among monolingual group (MG) and early bilingual group (EBG), whilst the two groups obtained high scores in word recognition test in quiet, both groups showed a decrease in their performance when the signal to noise ratio (SNR) was decreased, however, the bilingual group (BG) performed worse than the MG (71). Another study which was done among monolinguals, early bilinguals (EB), and late bilinguals (LB) groups by using English-HINT and Spanish-HINT, showed that there was a significant difference between monolinguals and bilinguals groups' performance on E-HINT. The BG however, performed better on S-HINT as Spanish is their first language. Furthermore, while the EB group outperformed the LB group on E-HINT, the LB group outperformed the EB group on S-HINT (4). When a study was done by using the revised version of the Speech Perception in Noise (SPIN) test

among three groups that contained monolingual, bilingual, and trilingual listeners (TG), three groups performed similarly in quiet. Unless in noise, BG and TG performed worse than the MG, also, the TG performed worse than the BG, but the difference was not significant, likewise, 5 participants in BG who acquired their second language since birth, performed worse than the MG and better than other bilinguals (72). In a different study, two sentence-in-noise perception tests (Quick-SIN and HINT), one word-in-noise test (WIN), and two tone-in-noise perception tests were performed to each participant in MG and BG (participants in bilingual group were early bilinguals), while the MG outperformed the BG on speech in noise perception tests, the opposite results were seen in tones-in-noise tests while the bilinguals outperformed the monolinguals (3). Another study was done among MG and BG as the participants in BG were a collection of early and late bilinguals, and by using Quick-SIN, BKB-SIN, and WIN tests, results reviewed that no matter what the used test was, SNR-50 and SNR loss results were significantly better for the monolinguals compared to the bilinguals (2). and also, the reverberation affects even EBG more than MG (71).

2.3.4 Factors Could Affect Bilinguals' Performance in Noise

Bilinguals' performance on speech in noise tests is affected by external and internal factors (73).

External Factors

Regarding the external factors, the type of masker playing an essential role in affecting speech perception in noise, likewise, there are two types of maskers: energetic masker and informational masker (74). Energetic masking refers to the spectrotemporal overlapping between the target speech and the meddlesome maskers like fluctuating noise, multi-talker babble, or stationary noise (73). In this type of masking, the listener can take advantage of glimpses which are the spectrotemporal regions where the least effect by the background happens to the target signal (75). Otherwise, the informational masking is a term that used for the meaningful words or sentences that could be competing with the target signal as a

result of being understood by the listener(73). As it contains understandable words or sentences, informational maskers could result in semantic intrusion, increased cognitive load and attention distraction (76).

Internal Factors

In regards to internal factors, working memory is accounting to be an important predictor for the ability of speech perception in noise (77), and it has a primary role in perceiving language (42). Another internal factor that could affect speech perception in noise is the participant's proficiency in the non-native language, as a high proficiency in the non-native language is an apparent advantage for speech perception in noisy situations (73).

3. METHODS AND PARTICIPANTS

The aim of this study was to evaluate the ability of late bilinguals, whose native language is Arabic, and acquired Turkish later in life, to discriminate speech in their non-native language (Turkish in this study) in noise, by using the Turkish version of the International Matrix test. The study was done in Hacettepe University Faculty of Health Sciences, Department of Audiology.

The study was approved by Hacettepe University Non-Interventional Clinical Research Ethics Committee with the registration number of GO18 / 731 in 04.09.2018.

3.1. Study Type

The design of this study is a cross sectional study.

3.2. Participants

In this study, 28 participants, 15 females, and 13 males, with age range of 22-36 years, who finished at least high school level, participated in this study. The participants of this study were divided into two groups; Study Group and Control Group. Participants' demographic information are shown in the table (3.1.).

Table 3.1. Participants' demographic information.

Group (n)	Gender (n)	Average of age (years)	SD (years)
Study group 15	6 Females 9 Males	26,67	± 3.98
Control group 13	9 Females 4 Male	28,69	± 4.21

3.2.1. Study Group

In the study group, 15 participants, aged between 22-33 years old with Arabic as their native language participated in the study.

Participants in this group were recruited by snowball sampling. The researcher identified potential subjects among foreign students in Hacettepe University. Only 5 students could be found initially. The researcher asked those students to inform their friends about the study to participate in. They were not obligated to find another subject. After explaining our study to them, we referred them to Audiology Department in Hacettepe University in order to obtain their audiological test.

Study Group Inclusion Criteria

The participant had

-To be within the age range of 18-36 years.

-To have a normal hearing; as the pure tone average of 500, 1000, and 2000 Hz is less than 16 dB (78).

-To have normal development of speech and language.

-To have normal vision or corrected vision (to have a normal vision with glasses/contact lenses).

-To have a RAVEN test result within the normal limits.

-To not have any known neurological and psychiatric disease.

-To be finished at least high school level.

-To have physical and mental abilities to take the test.

-To have Arabic as a native language, and Turkish is their later in life acquired language.

-To be have been a resident in Turkey for at least a five-year period.

-To have TÖMER certificate with at least C1 level in Turkish (High proficiency).

-To be willing to participate in the research as a volunteer.

3.2.2. Control Group

In the control group, 13 participants in the age range 24-36 years, with Turkish as their native language participated in this study.

Participants in this group were students who were recruited from the Department of Audiology at Hacettepe University. After explaining our study to them, we referred them to the Audiology Department in Hacettepe University in order to obtain their audiological test.

Control Group Inclusion Criteria

The participant had

-To be within the age range of 18-36 years.

-To have a normal hearing; as the pure tone average of 500, 1000, 1nd 2000 Hz is less than 16 dB (78).

-To have normal development of speech and language.

-To not have any known neurological and psychiatric disease.

-To have completed at least high school level.

-To have physical and mental abilities to take the test.

-To have Turkish as a native language.

-To be willing to participate in the research as a volunteer.

The participants in both groups were asked about their speech and language development, health status and diagnosed problems (vision, neurological and psychiatric diseases, physical and mental abilities) as well as their learned languages. The demographic information for the study group were collected by using the Arabic LEAP questionnaire, and for the control group were collected by asking them and completing the form of the International Matrix test. Participants in both group were told about the goal and procedures of the study before it began and proceeded to sign a form stating their acceptance of participation. For the study group, tests ranged between two and a half to three and half hours. Some participants finished

all tests in the same session, whilst others needed more than one session. The duration of the control group tests was around forty-five minutes.

3.3. Tests and Methods

Matrix test, RAVEN test, Arabic version (SDQ) and Turkish version (KAS) of the Formal Verbal Fluency test, VADS -B test (visual-aural digit span Test Form B), were performed for each participant in the Study Group. The Arabic version of Language Experience and Proficiency Questionnaire (LEAP-Q) was also completed by each participant in the study group. The order of the tests was not specified.

For the Control Group, only Matrix tests' protocols were applied for each participant.

3.3.1. Study Group

Raven Test

The Raven Progressive Matrices (RPM) tests were developed as a tool that helps to measure the general cognitive ability (79). The RPM tests are directly measuring two main components of general cognitive ability. These are the Educative Ability and the Reproductive Ability. The first is "*the ability to make meaning out of confusion, the ability to generate high-level, usually nonverbal, schemata which make it easy to handle complexity*", while the other is the ability to realize, recollect, and reproduce explicitly and communicated information from one person to another (80). The test is composed of pictures which are incomplete. The task that the participants in this test should implement was to choose the correct part from a variety of options to fill the missing part in the main picture (80). (See figure 3.1.). The sets A, B, C, D, and E were used in this study. You can see the used test's set and the used answer form in Appendix 2.

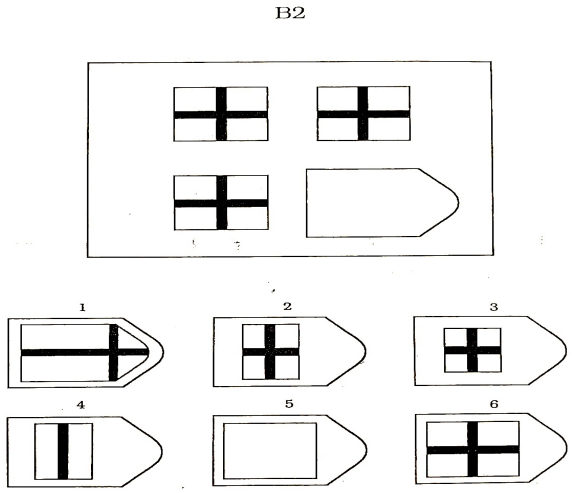


Figure 3.1. An example of Raven test's questions.

The Formal Verbal Fluency –FAS- Test (Arabic and Turkish)

Verbal fluency is a neuropsychological test which is usually used for research and clinical scopes (81). The test has two types, phonemic fluency, and semantic fluency. For the phonemic fluency test the participants are given 60 seconds and during this time they should produce as many words as they can that starts with a specified letter. These include: F, A, or S for English, K, A, or S for Turkish and S, D, or Q for Arabic. While in the semantic test, the participants should produce as many words as they could that belongs to a certain category such as animals' category (82-84). The verbal fluency test was used as a tool to support the diagnosis of different diseases, for example, it was used to assess cognitive impairment in patients who are affected by neurodegenerative diseases like Parkinson's disease and Alzheimer's disease(85, 86). Furthermore, verbal fluency test can be used as a screening tool for the general verbal functioning (87), and also as a verbal fluency test can be used to assess verbal ability and executive control (88). This test is also being used to examine lexical skills, semantic knowledge, and also long-term memory which is a part of cognitive functions (89, 90).

In our study, we decided to use both the Arabic phonemic verbal fluency test (SDQ) and the Turkish phonemic verbal Fluency test (KAS). Some participants started with the Arabic test while the others started with the Turkish one. The rules of the test were given to each participant, they were told not to use names, the names of countries, not to repeat the word and not to say words that share the same root. Every participant was given 6o seconds for each letter to produce as many words as they were able to that began with the given letter. Having completed the 3 letters of the language which they started in, we proceeded to complete the test in the remaining languages. A voice recording took place during the test in order to produce transcripts later.

The Arabic Version of Language Experience and Proficiency Questionnaire (LEAP-Q)

In order to collect information about participant's languages abilities and language histories, we used The Arabic version of Language Experience and Proficiency Questionnaire (LEAP-Q). The LEAP-Q was established to assess bilingual experience and proficiency profiles in the first and the second languages, regardless of the specific languages involved (91), while the questionnaire is available in different languages (92), we decided to use the Arabic version which is the participant's native language. The questionnaire was sent by email to each participant to be filled. You can find the Arabic, English and Turkish versions of the questionnaire in Appendixes 3, 4 and 5.

Matrix Test

''*Matrix Sentence Tests are adaptive speech in noise tests for determining the speech reception threshold (SRT) with a precision in the range of ±1 dB*'' (93). SRT is the signal to noise ratio at which 50% of the test items could be correctly repeated by the listener (94). The special thing of this test is that it is available in different languages and consists of 2 sets: open-set, and close-set. The close-set property removes the border of language between the subject and the tester as it is no longer

important to know the language of the subject to perform the test, therefore, by using the close-set choice, the subject can self-administer the test by choosing a suitable response by pressing on a keyboard or by using a touch screen (6). The words of matrix test sentences were chosen through the most commonly used words in everyday spoken Turkish (see figure 3.2.), and were arranged in the Turkish sentence order: name + numeral + adjective + object + verb (70). The noise which was used in this study is the TURMatrix noise (a quasi-stationary noise) (70).

Before the beginning of matrix test protocols, the daily clinically used speech reception threshold in quiet (SRT), and the word recognition score in quiet (WRS) were applied as the following:

A) Speech reception threshold in quiet (SRT), tri-syllabic words, mono-aural (both ears), was applied by presenting the speech signal (Recorded tri-syllabic word) to each ear separately. The speech signal firstly presented at 30dB, then decreased after each 3 correct responses by 10dB, until getting no response. The level was increased by 5dB and so on until getting 3 correct responses, thus the SRT in quiet was measured.

B) Word recognition score in quiet (WRS), monosyllabic words, mono-aural (both ears): this section was done by presenting 25 recorded monosyllabic Turkish words to each ear separately in a fixed audibility level which is 30 db or 35 db above speech reception threshold. The score was calculated as 4% for each word, so when all 25 words were correctly repeated, the score was 100%, when there was one wrongly repeated word the score was 96% and so on.

All tests in this part were applied by using Circum-aural earphones.

In our study, we applied the Turkish Matrix Test to each participant by using Protocol Validation TRMatrix form. The parts of Protocol Validation TRMatrix were applied as follows:

part 1:

A) Training with an adaptive procedure in quiet (headphones, binaurally) (AIQHB), was applied as only speech signal was presented binaurally; to the

right and left ears at the same time without noise, with a starting level of 40 dB for the speech signal.

B) Training with adaptive procedure (headphones, binaurally) (AINHB), this section was applied as mentioned in the protocol; where in this section the noise and the speech signal were presented together to the right and left ears at the same time.

C) Adaptive procedure mono-aural (headphones, monaurally, both ears): This section was also applied as in protocol, as it has two parts;

1) AINHMR: The noise and the speech signal were presented to the right ear without presenting anything to the left ear.

2) AINHML: The noise and the speech signal were presented to the left ear without presenting anything to the right ear.

D) The next section was named in our study as D and it has 2 sections 1 (SRNL) and 2 (SLNR), as they did not exist in the form as we required, we did not use section D as mentioned in the application form and therefore, created an alternative one.

-SRNL: speech signal was presented to the right side and noise to the left side.

-SLNR: speech signal was presented to the left side and noise to the right side.

All the tests in this part were done by using the Circum-aural earphones.

Part 2:

A) Adaptive procedure in quite (free field, binaurally):

this section was done by presenting speech to the two loudspeakers, while S0 was the left loudspeaker (participant's face toward the left loudspeaker).

B) Adaptive procedure in noise (free field, binaurally). Section B consists of 3 sections:

- Section 1 (S0N0): At the same time both speech signal and noise were

presented to the same loudspeaker (which the participant's face is toward).

- Section 2 (S0N90): The speech signal was presented to the loudspeaker which the participant's face is towards, and the noise was presented to the other one, which was 90 degree away from the speech signal.

- Section 3 (S0N270): the location of the participant was changed in opposition to that in 1 and 2, so, the speech signal was presented to loudspeaker which the participant's face is toward, and the noise was presented to the other one which is 270 degree away from the speech signal.

All the tests in this section were done in a sound booth (quiet environment), and all the used words and sentences were recorded by a native Turkish speaker.

Name	Number	Adjective	Noun	Verb	
Gönül	yedi	mavi	sepet	haketmiş	*Gönül earns seven blue baskets.*
Zuhal	bir	yeni	kilim	verdi	*Zuhal gives one new carpet.*
Fırat	sekiz	beyaz	yatak	satmış	*Fırat sells eight white beds.*
Hikmet	üç	küçük	çatal	getirdi	*Hikmet brings three small forks.*
Tuncay	altı	yeşil	cımbız	bulmuş	*Tuncay finds six green tweezers.*
Nurşen	beş	temiz	gömlek	çizdi	*Nurşen draws five clean shirts.*
Poyraz	dokuz	renkli	balon	fırlatmış	*Poyraz throws nine colorful balloons.*
Seyhan	on	bordo	minder	gördü	*Seyhan sees ten brown cushions.*
Meltem	iki	güzel	terlik	kazanmış	*Meltem wins two beautiful slippers.*
Dilek	dört	siyah	fincan	yolladı	*Dilek sends four black cups.*

Figure 3.2. The matrix of Turkish Matrix test (95).

Visual Aural Digit Span (VADS) Test (Form B)

The Visual Aural Digit Span (VADS) Test, is a tool that presupposed to evaluate the short-term memory, sequencing, intra- and inter-sensory integration (Koppitz 1977 in (96)).

In our study, we performed the test to each participant in study group as mentioned in (96). The digits were presented to each participant in two ways, aurally (A) and visually (V), and also the response was collected in two ways, orally (O) and

written (W). So, the test's subtests were; Aural-Oral (A-O), Visual-Oral (V-O), Aural-Written (A-W), and Visual-Written (V-W).

Subtests:

Aural-Oral (A-O):

In this subtest, the digits were presented aurally by the tester at the rate of 1/second. The participants were told to wait until the last digit's presenting by the tester, then to start repeating the listened digits orally as presented.

Visual-Oral (V-O):

In this subtest, the digits were printed on cards and collected as a booklet. The cards were presented to the participants at the rate of 1 / second. The participants were instructed to wait until reaching the empty card, then to start repeating the tracked digits.

Aural-Written (A-W):

In this subtest, the digits were presented aurally by the tester at the rate of 1/second. The participants were told to wait until the last digit's presenting by the tester, then to start writing the digits as presented.

Visual-written (V-W):

In this subtest, the digits were printed on cards and collected as a booklet. The cards were presented to the participants at the rate of 1/second. The participants were told to wait until reaching the empty card, then to start writing the digits as presented.

In the test's form, there were two columns of trials for each subtest; trial 1 and trial 2. As for each visual subtest, there were two booklets, one for trial 1 and the other for trial 2. The test began with the first group of digits in trial 1 which contained 2 digits. When the response was correct, we moved to the next digits' group which contained one more digit than the previous group. The number of digits in each group increased with every correct answer, and so on until getting a wrong answer whereby we had then moved to the column of trial 2, and gave the participant another chance with new digits that consisted of the same number of the digits' group which was

repeated wrongly. After having obtained a correct answer from trial 2 the test continued with trial 1 and so on, until getting incorrect responses from both trial 1 and 2, or until repeating the 9 numbers correctly, the subtest ended.

The VADS test in our study was done by using two languages; Turkish and Arabic. For the Turkish test, the test's four subtests were applied to each participant as a beginning. After performing another thesis's test, we performed the Arabic test but without the last part which is V-W as we believed that it's not affected by language difference.

The used form can be found in Appendix 6.

3.3.2. Control Group:

In our study, only matrix tests' protocols were applied to each participant in control group, in the same way that was applied to those in study group.

3.4. Statistical Analysis:

Windows-based SPSS 21.00 package program was used to analyze the results.

Between groups' comparison of the normally distributed results was done by using parametric independent T-Test, and by Mann Whitney U Test for the abnormally distributed results.

In-group comparisons' for normally distributed results were done by using the Pearson Correlation Coefficient Test and One Sample T-Test. While for abnormally distributed results, the in-group comparisons were done by using Wilcoxon Signed Ranks Test for dependent groups.

4. RESULTS

The aim of this study was to evaluate the ability of late bilinguals, whose native language is Arabic and acquired Turkish later in life, to discriminate speech in their non-native language (Turkish in this study) in noise, by using the Turkish version of the International Matrix test.

4.1. LEAP-Q

LEAP questionnaire was filled out by each participant in the study group.

The answers to the questions which targeted all the languages that the participants know are shown in Graphs 4.1 and 4.2 below.

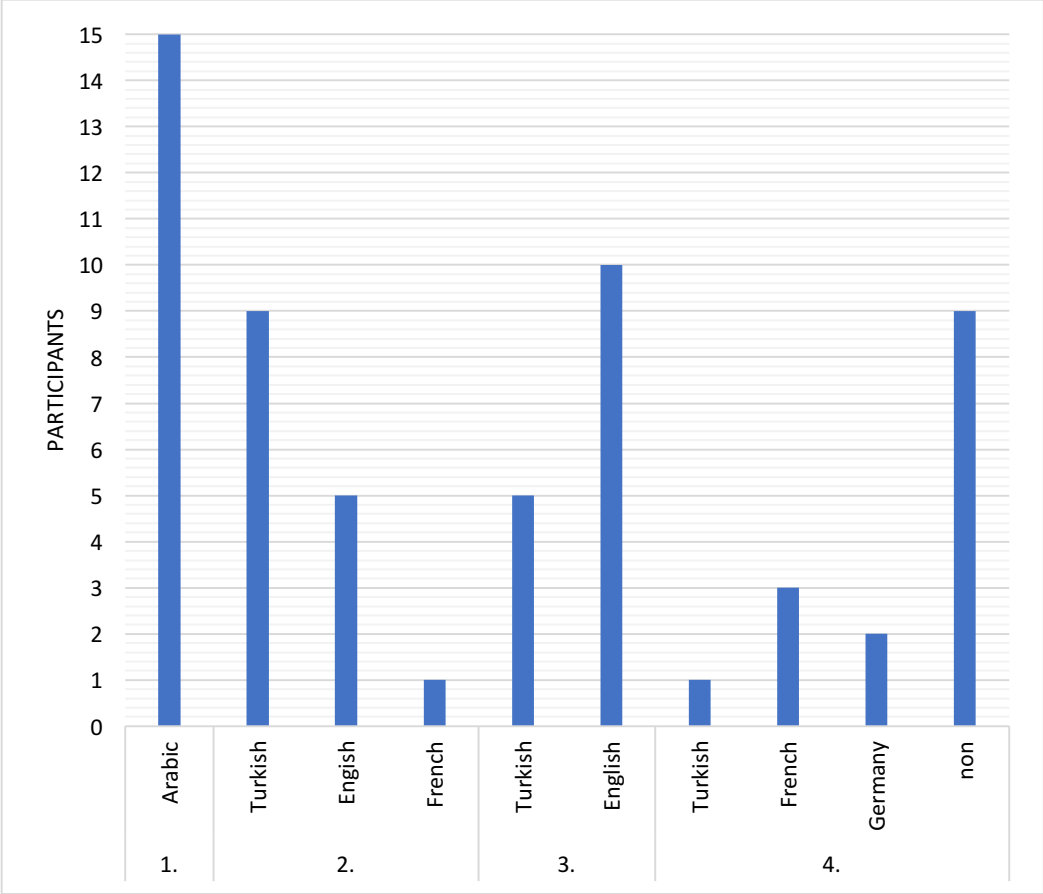


Chart 4.1. Order of the languages according to the dominance

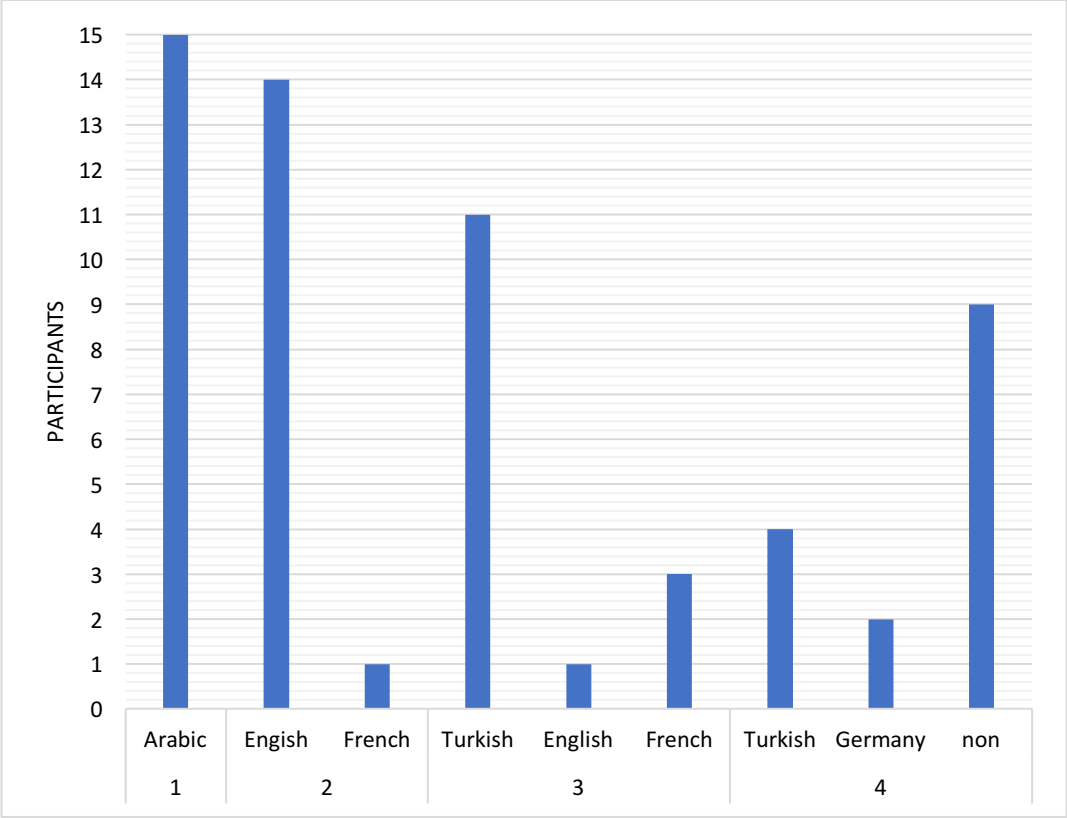


Chart 4.2. Order of the languages according to the acquisition

Chart 4.1. shows that all the 15 participants' first dominant language is Arabic. The second dominant language was Turkish for 9 participants, English for 5 participants, and French for only 1 participant. The third dominant language was Turkish for 5 participants and English for 10. While only 6 participants know 4 languages, the fourth dominant language was Turkish for 1 participant, French for 3 participants, and Germany for 2 participants. Chart 4.2. shows that all the 15 participants acquired Arabic as their first language, 14 acquired English as their second language while only for 1 participant French was the second acquired language. Turkish was the third acquired language for 11 participants, while only 1 participant acquired English as a third language, and for 3 participants French was the third acquired language. 4 participants acquired Turkish, and 2 participants acquired English as their fourth acquired language.

The answers to the questions which targeted the participants' Turkish are shown in the table 4.1. below, and the explanations are shown in charts 4.3., 4.4., 4.5., and 4.6.

Table 4.1. Answers to the questions which targeted the participants' Turkish

	Minimum	**Maximum**	**Mod**
YTT	2008	2014	2013
ATA (Year)	15	20	18
DET	10%	90%	60%
USLT	1	2	1

(YTT: Year of Traveling to Turkey, ATA: Age of Turkish Acquisition, DET: Daily Exposure to Turkish, USLT: Understanding Spoken Language in Turkish, YE: Years of Education, 1: Very Good, 2: Excellent)

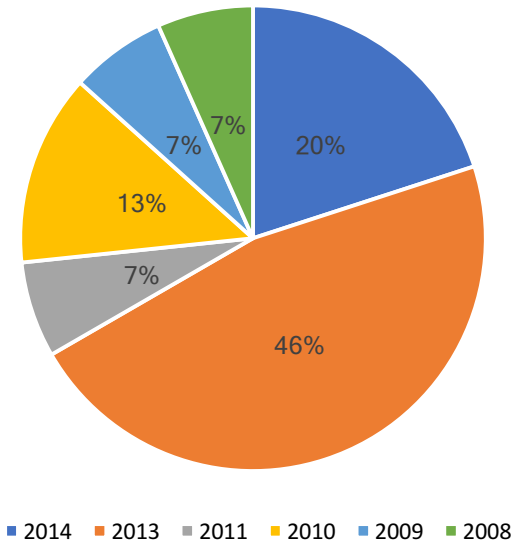


Chart 4.3. Year of traveling to Turkey for the 15 participants

Chart 4.3. shows that most of the participants (46% of them) have been traveled to Turkey in 2013, 20% of them traveled to Turkey in 2014, 13% in 2010, and the rest 21% of the participants have been traveled to Turkey in 2011, 2009 and 2008.

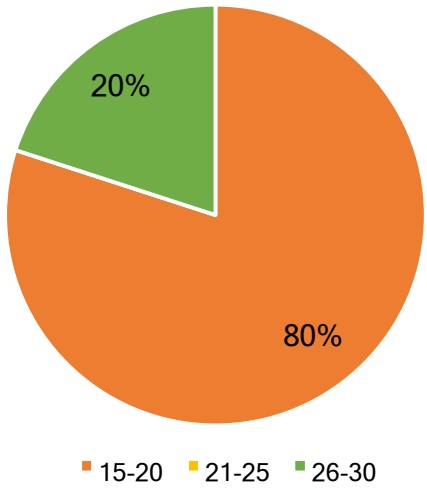


Chart 4.4. Age of Turkish acquisition for the 15 participants

Chart 4.4. shows that 80% of the participants acquired their Turkish language in the age range of 15-20, whilst the other 20% acquired it in the age range of 26-30.

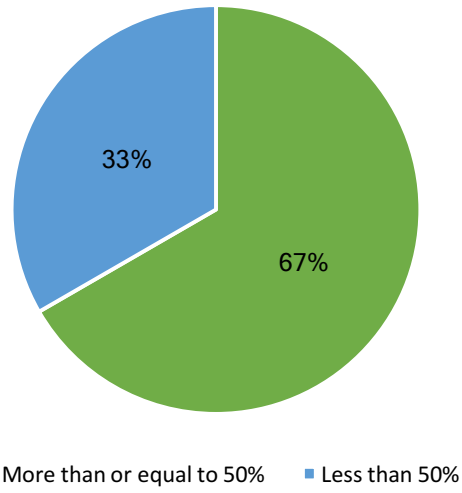


Chart 4.5. Daily exposure to Turkish

Chart 4.5. shows that 67% of the participants are exposed to Turkish for more than 50% per day, while the other 33% are exposing to Turkish for less than 50% per day.

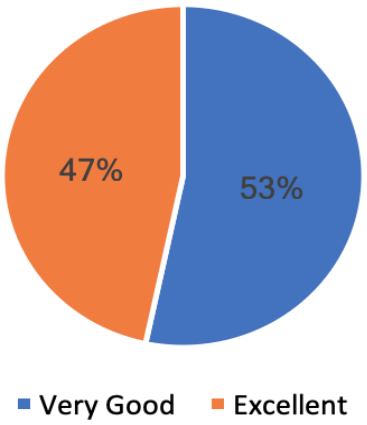


Chart 4.6. Understanding Spoken Language in Turkish

Chart 4.6. shows that 53% of the participants have a very good understanding of spoken language in Turkish, and 47% of participants have an excellent understanding of the spoken language in Turkish.

4.2. Arabic and Turkish versions of Visual - Auditory Digit Span Test

The results of Arabic and Turkish digit-span test are shown in table 4.2. below. Through all the subtests, the Arabic subtests had a higher mean than the Turkish. For the Turkish subtests, the AW subtest had the lowest mean, while for Arabic subtests, the AV and AW had the lowest mean.

Table 4.2. General Descriptive Statistics of VADS tests

	n	Mean	Median	Std. Deviation	Minimum	Maximum
AOT	15	5.93	6	± 0.88	5	8
VOT	15	5.67	5	± 1.18	4	8
AWT	15	5.60	6	± 1.59	3	9
VWT	15	6.27	6	± 1.53	4	9
AOA	15	6.67	7	± 1.05	5	8
VOA	15	7.00	7	± 1.13	5	9
AWA	15	6.67	6	± 1.45	4	9

(AOT: Aural-Oral Turkish, VOT: Visual-Oral Turkish, AWT: Aural-Written Turkish, VWT: Visual-Written Turkish, AOA: Auditory-Oral Arabic, VOA: Visual-Oral Arabic, AWA, Auditory-Written Arabic).

By using the Wilcoxon Signed Ranks Test, the difference between Arabic and Turkish digit-span tests was found. A significant difference was found between Arabic and Turkish AO, VO, AW. Otherwise, AWT correlated negatively with ATA, r (15) = -.735, p < .002. Also, AWA negatively correlated with ATA, r (15) = -.519, p < .047.

Table 4.3. Results of Wilcoxon Signed Ranks Test for the difference between Arabic and Turkish digit-span test.

	AOA - AOT	VOA - VOT	AWA - AWT
Z	-3.051*	-3.407*	-2.269*
Asymp. Sig. (2-tailed)	.002	.001	.023

*P<0.05

4.3. Verbal Fluency Tests (KAS and SDQ)

To find the difference in the results of KAS and SDQ, the Wilcoxon Signed Ranks Test was applied, and to find the difference between the tests' results and tests' normative data, the One Sample T-Test was applied.

No significant difference was found between the results of KAS and SDQ tests, but the significant difference was found between the KAS results and the test's normative data p< .01. Furthermore, the KAS test's results correlated positively with both VWT, r (15) = .566, p < .028, and USPLT, r (15) = .724, p < .002.

Table 4.4. The performance of the study group on KAS and SDQ tests.

	Minimum	Maximum	Mean	Median	Std. Deviation
KAS	17	43	29.20	26	± 7.76
SDQ	20	46	30.07	25	± 9.66

KAS: Turkish Verbal Fluency Test, SDQ: Arabic Verbal Fluency Test.

4.4. Daily Applied SRT and WRS, and Turkish Matrix Test

The statistical analysis of the results of the daily applied SRT and WRS was done by using Mann Whitney U Test. No significant differences were found between the study's two groups on these tests. The results are shown in table 4.5. below.

Table 4.5. The results of SRT and WRS for the two groups.

	Study group		Control group		
Tests	Mean	Median	Mean	Median	Sig.
SRT R	1.67	0,00	.77	0,00	.387
SRT L	1.33	0,00	1.46	0,00	.928
WRS R	.99	1,00	.99	1,00	.892
WRS L	.98	1,00	.99	1,00	.586

(SRT R-L = speech reception threshold right and left ears, WRS R-L: word recognition score right and left ears), P<0.05

By using the independent sample t-test, the results of Turkish matrix test were analyzed to find the difference between the study's two groups. Also, to test the relations between the results of the study group, the Pearson Correlation Coefficient Test was used.

In all Turkish Matrix test protocols, the control group had lower SRTs than that the study group had, the difference was significant as $p < .005$.

For the study group, AIQHB correlated positively with each of AINHB, $r(15) = .630$, $p = .012$, AINHMR, $r(15) = .607$, $p = .016$, AINHML, $r(15) = .544$, $p = .036$, SRNL, $r(15) = .565$, $p = .028$, and also with S0N0 as $r(15) = .694$, $p = .004$. Likewise, it also significantly correlated with ATA $r(15) = .609$, $p = .016$. A negative correlation was found between AINHB and each of AOA, $r(15) = -.562$, $p = .029$, and AWA $r(15) = -$

.532, p = .041. Other negative correlations were found between AINHMR and each of AWT, r (15) =-.639, p= .010, VWT, r (15) = -.533, p = .041, and AOA, r (15) = -.641, p = .010, while positively correlated with ATA, r (15) = .596, p= .019. The protocol AINHML was positively correlated with ATA, r (15) = .570, p=.026, and negatively correlated with AWT, r (15) = -.534, p = .040, and AOA, r (15) = -.674, p = .009. The AOT, VOT, AWT, AOA and AWA were negatively correlated with the protocol SRNL, wherever, ATA positively correlated with the same protocol. While the AIQFB protocol correlated positively with SDQ r (15) = .530, p< .042, the S0N0 protocol correlated negatively with AWT r (15) = -.618, p< .014, and positively with ATA r (15) = .674, p< .009.

The groups' performance on Turkish Matrix test is shown in the table 4.6 below.

Table 4.6. The difference between performance of control and study group on Turkish Matrix test.

	Study Group				Control Group				
Tests protocols	Min	Max	Mean	Median	Min	Max	Mean	Median	Sig. (2-tailed)
AIQHB	15.50	28.20	21.49	22.35	11.00	21.70	15.28	15.3	.000
AINHB	-8.40	-4.80	-6.89	-7	-9.30	-5.50	-8.39	-8.7	.001
AINHMR	-5.90	-.10	-4.25	-4.45	-8.30	-5.40	-7.12	-7	.000
AINHML	-6.40	.70	-4.59	-5.3	-8.00	-5.50	-7.11	-7.2	.000
SRNL	-49.20	-37.00	-41.84	-41.3	-47.80	-41.10	-44.50	-44.6	.041
SLNR	-49.30	-36.50	-41.21	-41.35	-48.70	-39.40	-44.42	-44.7	.009
AIQFB	30.60	19.10	24.76	24.45	15.90	23.30	19.58	19.6	.000
S0N0	-6.60	-3.20	-4.88	-5.15	-9.60	-6.50	-7.98	-8.3	.000
S0N90	-13.60	-6.30	-9.41	-9.2	-14.50	-9.20	-11.37	-11.6	.006
S0N270	-12.10	-7.60	-10.55	-10.7	-16.20	-11.50	-14.43	-14.4	.000

P<0.05

5. DISCUSSION

This study was conducted to assess the ability of late bilinguals to discriminate speech in noise in their non-native language, and to determine the factors that could affect this ability. Previous literature has shown that bilingual listeners perform poorer on speech-in-noise tasks than monolingual listeners of their second language. In the present study, we hypothesized that the difference between the native and non-native listeners on Turkish matrix test will be significant. The results showed that in all Turkish matrix test protocols, the control group obtained lower SRT than those which the study group had obtained.

Bilinguals are facing many difficulties, for example, they shown to be slower in picture naming (7), obtains lower scores on verbal fluency tasks (8), and encounters more experiences of tip of the tongue (9), as well as experiencing poorer word and sentence recognition in noise more than monolinguals (2, 71), which means that they have a poor speech perception in noise. The ability to understand speech signals in noise could be a challenge for people with hearing loss, even for individuals with normal hearing (2). Thus, the speech perception in noise is a challenge for almost everyone, but, it could be easier for monolingual individuals than bilingual individuals (3). Weiss and Dempsey (4) in their study found that listeners who learned English later in life performed poorer than those who learned English early in their life on English-HINT, but, both late and early bilinguals performed better in Spanish-HINT, as Spanish is their native language. Monolingual children in Bidelman and Dexter (97) performed 10 dB lower than the bilingual group on QuickSIN test, which means that the bilingual group really has a problem in speech perception in noise (12). Different factors could affect speech perception in noise, for example, the difference in the processing time duration, as a longer processing time was noticed for bilinguals in their first and second languages (98). Likewise, the acoustic signals of speech could play a role, as the non-native listeners depend on it more than their linguistic experience, which could affect the ability to understand speech in noise (99).

According to the results of this study, no significant difference was found between the study and control groups on the daily clinically used SRT and WRS results', which is consistent with Rogers et al. (71) as there was no difference between all participants on WRS in quiet, which mean that the high proficient bilinguals' performance on these tests should not be affected by the language.

For Matrix test, in regards to AIQHB protocol, the difference between study group and control group was significant, which means that the study group needed higher speech signal levels to achieve 50% threshold of speech intelligibility than control group. However, in Tabri et al. (72) all groups performed similar in quiet on revised version of SPIN test, but in their study, they used a fixed level of 70 dB SPL, while in our study we used an adaptive procedure which means that the level of speech signal was decreased or increased according to the number of correctly repeated words with a starting level of 40 dB Hl. On the other hand, AIQHB protocol correlated positively with each of AINHB, and also with S0N0. These results suppose that the performance in noise could be predicted from the performance in quiet. This result is compatible with the result of a study as they found that the ability to recognize VCV in quiet, has a clear relationship with the ability to recognize it in noise, thus, better recognizing in quiet means better recognizing in noise (100).

For AINHB, the difference between the two groups was significant. The result of this protocol is similar to the result of QuickSIN test in Krizman et al. (3), as the bilingual group performed poorer than the monolingual group when perceiving sentences in noise, in spite of that the bilinguals in their study were early bilinguals.

Whilst using the protocols which are specific for each ear like AINHMR and AINHML, the aim was to observe the role of each ear separately when the noise and the speech signal were presented at the same time to each ear without presenting anything to the other ear. On the other hand, the SRNL and SLNR protocols were used to observe the role of each ear while the noise is separated from the speech signal, and also to note if there is any right ear advantage that could be concluded from these protocols. The right ear advantage reflects the dominance of the left

hemisphere in speech perception, and the supremacy of the contralateral auditory pathway in the transmission of signals (101). The difference between the two groups was significant on all these protocols, otherwise, there was no significant difference between the right and the left ears on each protocol. Despite of this non-existing difference between the SRTs means on these protocols, there were negative correlations for the protocol SRNL while the speech signal was presented to the right ear, with digit span subtests, and a positive correlation with ATA. While for the protocol SLNR as the speech signal was presented to the left ear, no correlation was found with any variables at all, which means that when the signal is heard by the right ear there was a relying on the working memory, and this result is consistent with the result of Penner et al. (102) where an enhancement of right ear advantage occurred with a higher memory load. And also, increasing memory load caused a decreasing in left ear performance (103). Actually, it is thought that this happened as a result of the auditory pathway anatomy, as the bottom-up processing demands on phonological working memory maintenance will increase with the rising of memory input (102).

Regarding to the protocols which have been done by using the free field, the difference between the two groups was significant for all those protocols. For AIQFB, the significance of the difference between the groups agrees with the study that was done among bilingual Mandarin-English listeners on E-HINT, as the bilingual listeners had higher reception thresholds for sentences than the monolinguals when the test was done in quiet too (1). But, these results do not agree with the result of Hapsburg et al. (104) as the difference was not significant between the MG and BG in quiet on E-HINT. For the other protocols, while the noise was presented, S0N0, S0N90, and S0N270 the significant difference in results between the two groups is consistent with results of Krizman et al., Von Hapsburg et al. and Stuart et al. as when the test performed in participants' non-native language, the performance of BG was poorer and differed significantly from the performance of monolinguals or those who the test performed to them in their native language (1, 3, 104). And also for the same

protocols the late bilinguals group had higher thresholds than those of early bilinguals group in Weiss and Dempsey (4).

This difference in performance between our study groups on matrix test, disagrees with the results of Warzybok et al. (105), as in their study on German matrix test, the difference was significant between native and non-native groups only when the non-native group had a basic German skills, while in our study, despite having a high proficiency in Turkish, the difference was significant through all protocols.

The speech processing approaches could be one of the reasons for this performance, one of the approaches for speech understanding is the bottom-up approach, this approach requires the listener to use the information of the speech signal like analytic phonetic and phonemic information and collect it together to form a perception (2). When there is a noise, the speech signal is degraded and it interferes with this bottom-up approach causing a non-recognizable phoneme due to noise or distortion (2). In order to get the benefit from other information in the message, the listener employs the top-down processing approach. In this approach, to fill any missing in information, the listener must use context and knowledge of the language (2). But, of course there are other reasons for the bilinguals' poor performance in their non-native language in noise. In our study, there was a significant positive correlation between the age of Turkish acquisition and 5 of Matrix test protocols (AIQHB, AINHMR, AINHML, SRNL and S0N0), which means that those who learned Turkish in younger age, performed better on the test. This result agrees with the results of other studies, as they found that LB performance in noise was worse than the EB (4), and the performance of those who were simultaneous bilinguals was midway between other bilinguals and monolinguals (72). On the other hand, none of matrix test protocols correlated with the year of traveling to Turkey, daily exposure to Turkish, or understanding spoken language. A similar result was found in Bradlow and Bent (106), but in their study, no correlation was found neither with age of acquisition nor with the amount of exposure to the second language. However, in Schmidtke (107) they found that the bilinguals' reduced exposure to each of their

language, is the reason for the difference in performance in speech understanding in noise.

According to the verbal fluency tests, there was no significant correlation between the Turkish verbal fluency test (KAS) and any of matrix test protocols, which is contrary to the result of Schmidtke (107) who found that speech recognition in noise was affected by vocabulary size and lexical access. In Kaandrop et al. (108) for the sentences-in-noise test, the lexical access and vocabulary size was an important predictor of speech recognition in noise, but this was not the case for the digit in noise test, as the test was less affected by linguistic abilities. But, in our study, a positive correlation was found between KAS and the understanding of spoken language in Turkish (USLT), which is one of the LEAP questions, which means that more vocabulary knowledge gives rise to increase the understanding of spoken language.

With regard to the tests of the short-term memory, many of significant negative correlations were found between the two languages of the test and the results of Matrix test, especially for the auditory subtests. These correlations indicated that the better performance of speech perception in noise is correlated with better auditory memory for our group. As concluded in Besser et al. (109) the capacity of WM is correlated with the performance on speech in noise test, and a larger WM span is supposed to be an important agent that gives an advantage in various listening situations.

For the performed Arabic and Turkish verbal fluency tests, there was no significant difference between KAS and SDQ results. But, the significant difference existed when the comparison was made between the results of KAS of this study and the KAS's normative data, while no significant difference was found between SDQ results of this study and the test's normative data. This result is consistent with the result of Kisser et al. (110) as the monolinguals in their study outperformed the bilinguals on English verbal fluency test (FAS). Also, Sandoval et al. (111) in their study found that bilinguals produced fewer correct words than monolinguals, and also the

first response latencies were longer, as bilinguals were significantly slower than monolinguals in response producing. Our results also show that KAS tests result was positively correlated with VWT which is one of the digit-span test protocols, yet, this correlation did not exist for the SDQ, which could mean that bilinguals relayed on the short-term memory in order to perform a vocabulary retrieval task in their non-native language. This result agrees with the result of Kaushanskaya et al. (46) as a strong relationship between expressive vocabulary and the phonological short-term memory was found in all bilinguals. Likewise, a positive correlation was found in our study between KAS and the understanding of spoken language in Turkish, which means that more vocabulary knowledge give rise to increase the understanding of spoken language.

Relatively to the Turkish and Arabic digit span tests, significant differences were found between AOA-AOT, VOA-VOT, and AWA-AWT, with a higher mean for the Arabic tests. In Olsthoorn et al. (47) in spite of the response pattern of the participants was by typing the listened number into the computer, there was a significant difference between native and non-native participants when the presentation of digits was aurally, thus, this difference was diminished when the visual presentation of digits was applied. Their results are compatible with our results, as it concludes that the bilinguals' performance was weaker when the test was performed in participants' non-native language, and the difference was more significant when the response pattern was verbally. On the other hand, the VWT subtest in our study had the highest mean in Turkish subtests, which is also compatible with Olsthoorn et al. (47).

While conducting this study, we encountered different limitations:

1- As there is no available Turkish objective tool to assess the language proficiencies and abilities for each participant at the time of the thesis, we depended on the certificate of TÖMER for C1 level in Turkish, which is accepted by most universities in Turkey, and LEAP questionnaire which is a self-assessment tool.

2- According to the limited time and available tests location, the order of the applied test was not specified.

3- The duration of the tests was long, which we think that it affected the performance on some tests as a result of the participant's tiredness.

6. CONCLUSION

This study which titled as (Late Bilinguals' Ability to Discriminate Speech in Noise) is the first study that evaluates bilinguals' speech perception in noise by using the Turkish Matrix test. This study aimed to assess the performance of late bilinguals whose native language is Arabic and acquired Turkish later in life on Turkish Matrix test, and compare their results with the results of Turks whose native language is Turkish. Also in this study, we tried to understand the factors that could be affecting the bilinguals' ability to understand speech in noise. Thus, the following conclusions have been obtained;

1- On all Turkish Matrix test protocols, the performance of native Turkish listeners (control group) was better than the performance of high proficient non-native listeners (study group), and the performance of the study group was affected by short-term memory, and age of Turkish acquisition.

2- The performance of the study group participants on Arabic digit-span test was better than their performance on the Turkish test, which could be meaning that the short-term memory capacity is larger in the native language.

3- The performance of the study group on Turkish verbal fluency test did not differ from their performance on the Arabic verbal fluency test. But, the difference between the results of Turkish verbal fluency test was significant when compared with the test's normative data. Likewise, the Turkish verbal fluency test result correlated positively with understanding spoken language in Turkish and with the VWT part of the digit-span test.

According to the results we had, we concluded that the performance of bilinguals on speech perception in noise test is not affected only by noise, also, it is affected by other factors such as; the age of second language acquisition, and working memory.

We recommend a movement to increase lecturers' awareness to pay more attention to the foreign students listening skills during exams and lessons, as they are affected by noise and other acoustical factors such as reverberation more than other

native classmates. And also, we recommend sharing such results with audiologist as they should keep in mind the results what they could face when testing foreigners.

For future research, we planned to apply training programs that could help foreigners to cope with this problem and could improve their performance in noise, to redo this study with participants with different native languages, to apply dichotic listening tests to detect right ear advantage, and to test the factors of cognitive load on bilinguals' performance in noise.

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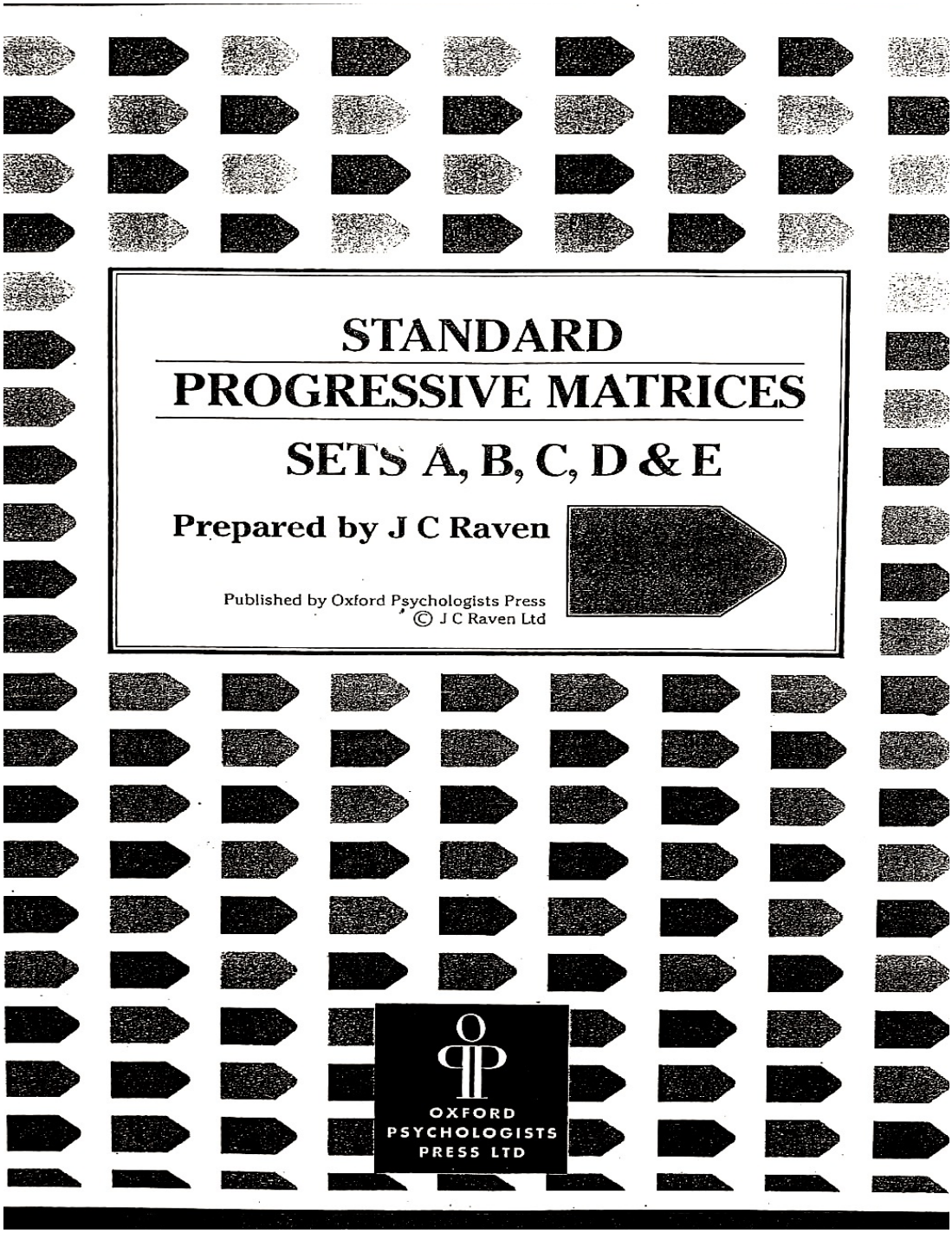
8. APPENDIXES

Appendix 1: Different classifications of bilingualism (from Bhatia & Ritchie (23))

Point of focus (Dimension)	*Typology*	*Definitions*	*Characteristics of SLA*	*Related issues and educational implications*	*Additional complications in multilingual contexts*
Relationship between proficiencies in two languages	Balanced Dominant (Peal and Lambert 1962)	Achieving equal level of proficiency in L2 with L1 (balanced); L2 proficiency varies but not the same as L1 (dominant)	Functional differences; related to age factors (?)	Conceptualizing and assessing language proficiency; Cummins' threshold hypothesis and interdependent hypothesis; Semi-lingualism	Greater complexity in conceptualizing and measuring multilingual competences
Functional ability	Receptive Productive	Understand but not produce L2 either in oral and/or written domains (receptive); understand and produce L2 (productive)	Functional and motivational differences	Language use irrespective of proficiency levels and identity	Greater diversity in functional differences across domains and across languages
Age of acquisition	Early Simultaneous Sequential Late (Genesee *et al.* 1978)	Exposed to two languages from birth (simultaneous); Exposed to L2 after L1 has some foundation (sequential); became bilinguals during adulthood (late)	Maturational differences; schooling differences	Neurolinguistic differences; critical period hypothesis	Greater diversity in the acquisition order; can have multiple L1s and/or L2s
Organization of linguistic codes and meaning unit(s)	Compound Coordinate Subordinate (Weinreich 1953)	Two sets of linguistic codes stored in one meaning unit (compound); stored separately (coordinate); L2 is accessed through L1 (subordinate)	Functional differences; differences in form-meaning mapping	Difficulties with operationalizing distinctions and testing differences	Greater complexity and diversity in multilingual memory organization according to typological differences among languages and proficiency levels
Language status and learning environment; literacy support of L1	Elite Folk (Fishman 1977); Circumstantial Elective (Valdés and Figueroa 1994)	No or little additive value of L1 as a language minority status (folk/circumstantial); additive value of L2 (elite/elective)	Differences in language status and value of bilingualism	Support for literacy in L1 and L2 literacy development	Greater diversity in social values attached to multiple languages
Effect of L2 learning on the retention of L1	Additive Subtractive (Lambert 1974);	L2 as enrichment without loss of L1 (additive); L1 is replaced by L2 (subtractive)	L2 as enrichment with or without loss of L1; status of a language in a given context	Social value of L1 greatly influences the retention of L1; support for literacy in L1 and L2 literacy development	Greater complexity of learning an additional language from previously acquired languages; greater diversity of status across languages
Cultural identity	Bicultural L1 monocultural L2 accultural Deculturated (Hamers and Blanc 2000)	Cultural identity shaped by two cultures (bicultural); identity in one culture (L1 monocultural); loss of L1 culture (L2 accultural); identity in neither cultures (deculturated)	Differences in acculturation process	High bilingual competence does not necessary coincide with dual identity	Multiple cultural identities coexist irrespective of competences

Appendix 2: Raven Test

The used sets of Raven test.



RAVEN STANDART PROGRESİF MATRİSLER TESTİ*

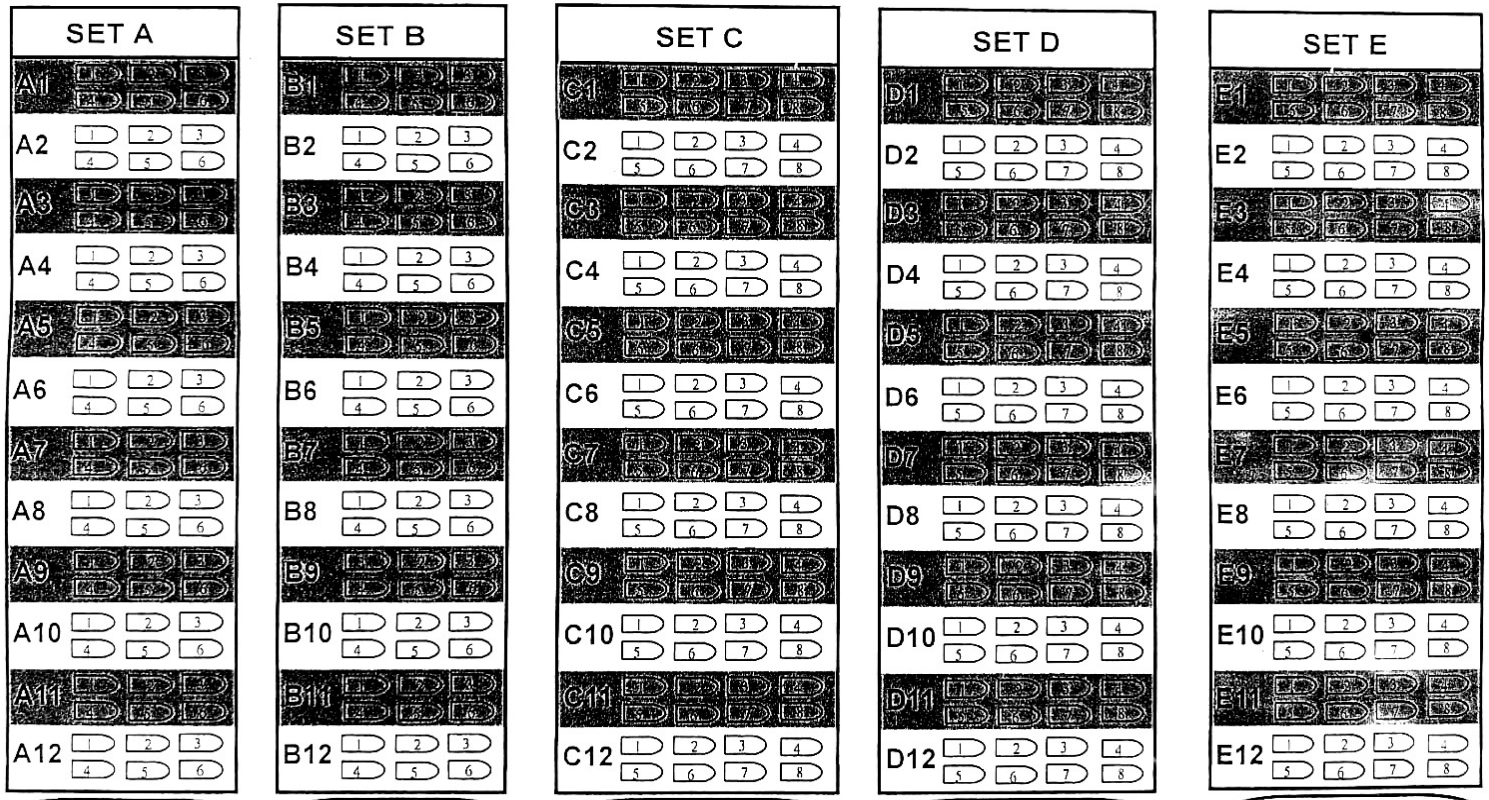
KAYIT FORMU

Adı Soyadı : .....
Doğum Tarihi : ...../...../.....
Yaşı : .....
Cinsiyeti : .....
Eğitim Düzeyi : .....

Uygulayıcının
Adı Soyadı : .....
Uygulama Tarihi : ...../...../.....
Uygulama Yeri : .....

Uygulama Türü : .....
Gruptaki Kişi Sayısı : .....

Tamamlama Süresi : .....
Toplam Puan : .....



SET A Puanı:..... SET B Puanı:..... SET C Puanı:..... SET D Puanı:..... SET E Puanı:.....

*BİLNOT Bataryasının araştırma ve geliştirme çalışmaları TBAG - Ü / 17-2 sayılı proje ile TÜBİTAK tarafından desteklenmiştir.

The used answer sheet to be filled.

Appendix 3: The used Arabic version of LEAP-Q

معمل أبحاث جنوب غرب للازدواجية اللغوية وعلم اللغة النفسي

نرجو الاستشهاد بماريان، بلامينفيلد وكوشانسكايا (٢٠٠٧). استبيان الخبرة والكفاءة اللغوية: تقييم الملفات اللغوية لدى ثنائيّ اللغة ومتعددي اللغات. مجلة أبحاث لغة الكلام والسمع، ٥٠ (٤)، ٩٤٠ – ٩٦٧.

استبيان الخبرة والكفاءة اللغوية

أسم العائلة		الاسم الأول		تاريخ اليوم	
السن		تاريخ الميلاد		☐ ذكر	☐ أنثى

(١) رجاء سرد كل اللغات التي تعلمها **بترتيب تمكنك** في كل واحدة منها:

١	٢	٣	٤	٥

(٢) رجاء سرد كل اللغات التي تعلمها **بترتيب اكتسابك لها** (لغتك الأم أولًا):

١	٢	٣	٤	٥

(٣) رجاء سرد النسبة المئوية للوقت الذي تتعرض فيه حاليًا لكل لغة في المتوسط.
(سوف يكون مجموع نسبك المئوية 100%):

أدرج اللغة هنا:					
ادرج النسبة المئوية هنا:					

(٤) عند اختيار قراءة أحد النصوص المتاحة في كل لغاتك، كم بالمائة من الحالات تختار فيها القراءة في كل واحدة من لغاتك؟ لنفترض أن النص الأصلي كان مكتوبًا بلغة أخرى غير معروفة لك.
(سوف يكون مجموع نسبك المئوية 100%):

أدرج اللغة هنا:					
ادرج النسبة المئوية هنا:					

(٥) عند اختيار أحد اللغات للحديث مع شخص في نفس مستوى الفصاحة في كل لغاتك، ما هي النسبة المئوية للوقت الذي تختاره للحديث بكل لغة من اللغات؟ رجاء وصف النسبة من إجمالي الوقت الكلي.
(سوف يكون مجموع نسبك المئوية 100%):

أدرج اللغة هنا:					
ادرج النسبة المئوية هنا:					

(٦) رجاء تسمية الثقافات التي تميزك. في مقياس من صفر إلى عشرة، رجاء تقدير درجة تميزك في كل ثقافة.

أدرج الثقافات هنا					
	(انقر هنا للمقياس)	(انقر هنا للمقياس)	(انقر هنا للمقياس)	(انقر هنا للمقياس)	(انقر هنا للمقياس)

(٧) كم عدد سنوات التعليم الرسمي الذين تلقيته؟ _____

رجاء اختيار على مستوي تعليمي حصلت عليه (أو المعادل الأمريكي التقريبي للدرجة التي حصلت عليها في دولة أخرى):

☐ أقل من مدرسة ثانوية ☐ جزء من تعليم جامعي ☐ درجة الماجستير
☐ مدرسة ثانوية ☐ تعليم جامعي ☐ دكتوراه في الفلسفة/الطب/القانون
☐ تدريب مهني ☐ جزء من دراسات عليا ☐ أخرى: _____

(٨) اكتب تاريخ هجرتك إلى الولايات المتحدة الأمريكية، إذا كان ينطبق _____
أبدًا إلى دولة أخرى، رجاء ذكر اسم الدولة وتاريخ الهجرة إليها هنا. إذا هاجرت
_____

(٩) هل تعرضت أبدًا لمشاكل في الرؤية ☐، أو إعاقة في التعلم ☐، أو إعاقة في اللغة ☐، أو ضعف في السمع ☐؟
إذا جاوبت بـ "نعم"، رجاء أشرح (بما في ذلك أي تصحيحات)
_____

اللـغة:

. (رجاء الاختيار من القائمة المنسدلة)هذه هي لغتي

كل الأسئلة التالية تشير إلى معرفتك بما يلي:

(١) السن الذي....:

بدأت فيه اكتساب :	أصبحت فصيحًا في :	بدأت القراءة في :	أصبحت فصيحًا في القراءة في :

(٢) رجاء سرد عدد السنوات والشهور التي أمضيتها في كل بيئة لغة:

	السنوات	الشهور
البلد التي يتحدث فيها باللغة		
العائلة التي يتحدث فيها باللغة		
المدرسة و/أو بيئة العمل التي يتحدث فيها باللغة		

(٣) على مقياس من صفر إلى عشرة ، رجاء اختيار مستوى **كفاءتك** في الحديث باللغة وفهمها وقرائتها من القوائم المنسدلة التالية:

الحديث	(انقر هنا للمقياس)	فهم اللغة المتحدث بها	(انقر هنا للمقياس)	القراءة	(انقر هنا للمقياس)

(٤) على مقياس من صفر إلى عشرة ، رجاء اختيار مدى إسهام العوامل التالية في تعلمك

التفاعل مع الأصدقاء	(انقر هنا للمقياس المنسدل)	شرائط اللغة/التعلم الذاتي	(انقر هنا للمقياس المنسدل)
التفاعل مع الأسرة	(انقر هنا للمقياس المنسدل)	مشاهدة التلفاز	(انقر هنا للمقياس المنسدل)
القراءة	(انقر هنا للمقياس المنسدل)	الاستماع إلى المذياع	(انقر هنا للمقياس المنسدل)

(٥) رجاء تقدير مدى تعرضك حاليًا لـ في السياقات التالية:

التفاعل مع الأصدقاء	(انقر هنا للمقياس المنسدل)	الاستماع إلى المذياع/الموسيقى	(انقر هنا للمقياس المنسدل)
التفاعل مع الأسرة	(انقر هنا للمقياس المنسدل)	القراءة	(انقر هنا للمقياس المنسدل)
مشاهدة التلفاز	(انقر هنا للمقياس المنسدل)	معمل اللغة/التعليم الذاتي	(انقر هنا للمقياس المنسدل)

(٦) في تصورك، كم عدد اللهجات الأجنبية لديك في ؟
(انقر هنا للمقياس المنسدل)

(٧) رجاء تقدير مدى تكرار المرات التي يميزك الأخرون على أنك متحدث غير أصلي بناءً على لهجتك في:

(انقر هنا للمقياس المنسدل)

Appendix 4: English version of LEAP-Q

Northwestern Bilingualism & Psycholinguistics Research Laboratory

Marian, Blumenfeld, & Kaushanskaya (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech Language and Hearing Research, 50* (4), 940-967.

Language Experience and Proficiency Questionnaire (LEAP-Q)

Participant Code		**Study Code**		Today's Date	
Age		Date of Birth		Male ☐	Female ☐

(1) Please list all the languages you know **in order of dominance**:

1	2	3	4	5

(2) Please list all the languages you know **in order of acquisition** (your native language first):

1	2	3	4	5

(3) Please list what percentage of the time you are *currently* and *on average* exposed to each language.
(*Your percentages should add up to 100%*):

List language here:					
List percentage here:					

(4) When choosing to read a text available in all your languages, in what percentage of cases would you choose to read it in each of your languages? Assume that the original was written in another language, which is unknown to you.
(*Your percentages should add up to 100%*):

List language here					
List percentage here:					

(5) When choosing a language to speak with a person who is equally fluent in all your languages, what percentage of time would you choose to speak each language? Please report percent of total time.
(*Your percentages should add up to 100%*):

List language here					
List percentage here:					

(6) Please name the cultures with which you identify. On a scale from zero to ten, please rate the extent to which you identify with each culture. (Examples of possible cultures include US-American, Chinese, Jewish-Orthodox, etc):

List cultures here					
	(click here for scale)	(click here for scale)	(click here for scale)	(click here for scale)	(click here for scale)

(7) How many years of formal education do you have? _____
Please check your highest education level (or the approximate US equivalent to a degree obtained in another country):

☐ Less than High School ☐ Some College ☐ Masters
☐ High School ☐ College ☐ Ph.D./M.D./J.D.
☐ Professional Training ☐ Some Graduate School ☐ Other:

(8) Date of immigration to the USA, if applicable _____
If you have ever immigrated to another country, please provide name of country and date of immigration here. _____

(9) Have you ever had a vision problem ☐, hearing impairment ☐, language disability ☐, or learning disability ☐ ? (Check all applicable). If yes, please explain (including any corrections):
_____

Language:

This is my (please select from pull-down menu) language.

All questions below refer to your knowledge of .

(1) Age when you…:

began acquiring :	*became fluent* in :	*began reading* in :	*became fluent reading* in :

(2) Please list the number of years and months you spent in each language environment:

	Years	Months
A country where is spoken		
A family where is spoken		
A school and/or working environment where is spoken		

(3) On a scale from zero to ten, please select your *level of* ***proficiency*** in speaking, understanding, and reading from the scroll-down menus:

Speaking	(click here for scale)	Understanding spoken language	(click here for scale)	Reading	(click here for scale)

(4) On a scale from zero to ten, please select how much the following factors contributed to you learning :

Interacting with friends	(click here for pull-down scale)	Language tapes/self instruction	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Watching TV	(click here for pull-down scale)
Reading	(click here for pull-down scale)	Listening to the radio	(click here for pull-down scale)

(5) Please rate to what extent you are currently exposed to in the following contexts:

Interacting with friends	(click here for pull-down scale)	Listening to radio/music	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Reading	(click here for pull-down scale)
Watching TV	(click here for pull-down scale)	Language-lab/self-instruction	(click here for pull-down scale)

(6) In your perception, how much of a foreign accent do you have in ?

(click here for pull-down scale)

(7) Please rate how frequently others identify you as a non-native speaker based on your accent in :

(click here for pull-down scale)

Appendix 5: Turkish version of LEAP-Q

Northwestern Bilingualism & Psycholinguistics Research Laboratory

Marian, Blumenfeld, & Kaushanskaya (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech Language and Hearing Research, 50*(4), 940-967.

Dil Becerisi ve Yeterlilik Anketi (DBVY-A)

translated by: Özlem Yüksel-Sökmen, The Graduate Center of the City University of New York, and Sercan Şerifoğlu, Haliç University, Istanbul)

Katılım Kodu		**Proje Kodu**		Bugünki Tarih	
Yaş		Doğum Tarihi		Bay ☐	Bayan ☐

(1) Lütfen, bildiğiniz dilleri **bilgi seviyenize göre**, sıralı bir şekilde yazınız:

1	2	3	4	5

(2) Lütfen, bildiğiniz **dilleri öğrenme sıranıza göre**, (anadil başta olmak üzere) sıralı bir şekilde yazınız.

1	2	3	4	5

(3) Lütfen, *halen* bildiğiniz dilleri yüzdesel *ortalama* değerlerle belirtiniz. (Vermiş olduğunuz yüzdeler toplamda %100 olmalı)

Dil					
Yüzde	1	2	3	4	5

(4) Eğer herhangi bir yazının, bildiğiniz tüm dillerde çevirisi varsa, hangisini tercih ederdiniz? Lütfen her dil için, yüzdelik bir değer giriniz. Yazının orijinal dilini bilmediğinizi farz ediniz. (Vermiş olduğunuz yüzdeler toplamda %100 olmalı)

Dil					
Yüzde	1	2	3	4	5

(5) Bildiğiniz dillerin hepsini bilen bir kişi ile hangi dilde konuşmayı tercih edeceğinizi, yüzdesel olarak belirtiniz. (Vermiş olduğunuz yüzdeler toplamda %100 olmalı)

Dil					
Yüzde	1	2	3	4	5

(6) Lütfen, kendinizi yakın hissettiğiniz kültürleri yazınız ve 0 ile 10 arasında derecelendiriniz. (Örnek kültürler; Türk, Laz, Kürt, Rum, Ermeni, Alman, Amerikan, vs.)

Kültür					
Yüzde	(dereceler için	(dereceler için tı	(dereceler için tı	(dereceler için tı	(dereceler için tı

(7) Resmi olarak kaç yıl eğitim aldınız?
Lütfen, aldığınız en yüksek eğitim derecesini işaretleyiniz.

☐	İlkokul	☐	Meslek Lisesi	☐	Yüksek Lisans
☐	Ortaokul	☐	Önlisans	☐	Doktora/Doçent/Profesör
☐	Lise	☐	Lisans	☐	Diğer:

(8) Amerika Birleşik Devletleri'ne göç tarihinizi yazınız.
Eğer farklı bir ülkeye göç ettiyseniz, lütfen ülke adını ve göç tarihini yazınız.

(9) Daha önce hiç; görme sorunu☐, işitme sorunu☐, konuşma sorunu☐ ya da zihinsel sorununuz oldu mu? (Size uyan kutuları işaretleyiniz). Eğer varsa, lütfen açıklayınız:

Dil:

Bu benim (lütfen seçiniz) dilim.

Aşağıdaki tüm sorular, dilindeki bilginizi ölçme amaçlıdır.

(1) Dil gelişim dönemlerinizi yaş olarak giriniz:

İlk öğrendiğiniz yaş:	Akıcı konuşmaya başladığınız yaş:	Okumaya başladığınız yaş:	Akıcı olarak okumaya başladığınız yaş:

(2) Lütfen, dili öğrendiğiniz çevrelerde geçen süreyi yıl ve ay olarak yazınız.

	Yıl	Ay
.....dilinin konuşulduğu ülkede		
.....dilinin konuşulduğu ailede		
..... dilinin konuşulduğu okul ve/veya iş yerinde		

(3) Lütfen, dildeki konuşma-anlama-okuma yeterliliğinizi 1'den 10'a doğru ölçeklendiriniz:

Konuşma	(lütfen seçiniz)	Anlama	(lütfen seçiniz)	Okuma	(lütfen seçiniz)

(4) Aşağıdaki etkenlerin dil öğrenirken sizi ne kadar etkilediğini 1'den 10'a doğru ölçeklendiriniz:

Arkadaşlarla iletişim	(lütfen seçiniz)	Bireysel çalışmak	(lütfen seçiniz)
Aile ile iletişim	(lütfen seçiniz)	TV izlemek	(lütfen seçiniz)
Okumak	(lütfen seçiniz)	Radyo dinlemek	(lütfen seçiniz)

(5) Lütfen, dilini öğrenirken aşağıdaki içerikleri ne derece kullandığınızı seçiniz:

Arkadaşlarla iletişim	(lütfen seçiniz)	Radyo/müzik dinlemek	(lütfen seçiniz)
Aile ile iletişim	(lütfen seçiniz)	Okumak	(lütfen seçiniz)
TV izlemek	(lütfen seçiniz)	Kurs/ Bireysel çalışmak	(lütfen seçiniz)

(6) Sizce, dilinizdeki yabancı aksanınız ne düzeyde? (lütfen seçiniz)

(7) dilinizdeki aksanınızdan dolayı, çevrenizdeki kişilerin anadilinizde konuşmadığınızı anlamaları ne kadar çok başınıza geliyor? (lütfen seçiniz)

Appendix 6: The used form for Visual Aural Digit Span (VADS) Test:

IV. TEST PUANLARIYLA İLGİLİ KAYIT FORMU

Alt Testleri uygulamadan önce, V. Bölümü tekrar gözden geçirerek test performansının hangi özelliklerine dikkat etmeniz gerektiğini belirleyin. Alt Testleri uygularken V. Bölümdeki soruları yanıtlamada size yardımcı olabilecek notlar almayı ihmal etmeyin. Gözlemlerinizi, bu iş için ayrılan kısma not edin.

1. İŞİTSEL SÖZEL ALT TEST

Deneme 1	63	Deneme 2	25
	259		574
	8493		7296
	97852		41357
	367194		165298
	4579281		8591342
	38295174		69143258
	967143285		715462938

Puan:

Gözlemler:

2. GÖRSEL SÖZEL ALT TEST

Deneme 1	42	Deneme 2	35
	573		216
	3147		8516
	93148		68725
	471983		374697
	8324715		7964835
	94376258		31795482
	538712469		713942568

Puan:

Gözlemler:

5

ŞİTSEL YAZILI ALT TEST

Deneme 1	24	Deneme 2	31
	532		295
	5826		4937
	96183		38159
	473859		148352
	8372951		7294158
	72819653		29763154
	265937481		894763521

Puan:
Gözlemler:

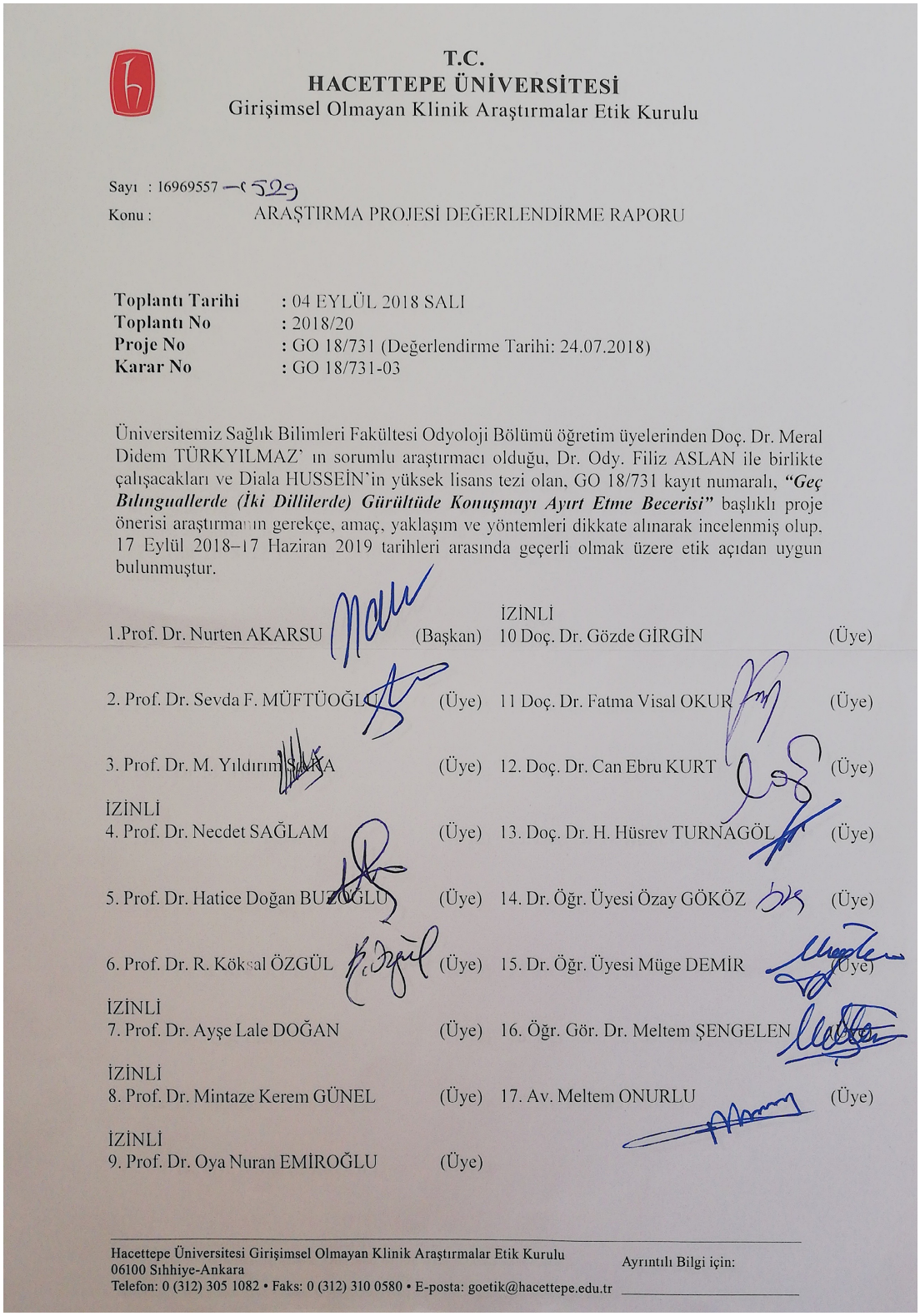
4. GÖRSEL YAZILI ALT TEST

Deneme 1	14	Deneme 2	32
	426		538
	9178		7624
	29763		16459
	517423		985216
	3891742		5618329
	16459763		58192647
	275862584		426917835

Puan:
Gözlemler:

DİKKAT: Yazılı Alt Testler için kullanılmış olan kağıdın altına, deneğin ADI ve SOYADI ile İMZASINI almayı unutmayınız.

Appendix 7: Non-Interventional Clinical Research Ethics Committee's permission



T.C.
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Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu

Sayı : 16969557 – 529
Konu : ARAŞTIRMA PROJESİ DEĞERLENDİRME RAPORU

Toplantı Tarihi : 04 EYLÜL 2018 SALI
Toplantı No : 2018/20
Proje No : GO 18/731 (Değerlendirme Tarihi: 24.07.2018)
Karar No : GO 18/731-03

Üniversitemiz Sağlık Bilimleri Fakültesi Odyoloji Bölümü öğretim üyelerinden Doç. Dr. Meral Didem TÜRKYILMAZ' ın sorumlu araştırmacı olduğu, Dr. Ody. Filiz ASLAN ile birlikte çalışacakları ve Diala HUSSEİN'in yüksek lisans tezi olan, GO 18/731 kayıt numaralı, ***"Geç Bılınguallerde (İki Dillilerde) Gürültüde Konuşmayı Ayırt Etme Becerisi"*** başlıklı proje önerisi araştırmanın gerekçe, amaç, yaklaşım ve yöntemleri dikkate alınarak incelenmiş olup, 17 Eylül 2018–17 Haziran 2019 tarihleri arasında geçerli olmak üzere etik açıdan uygun bulunmuştur.

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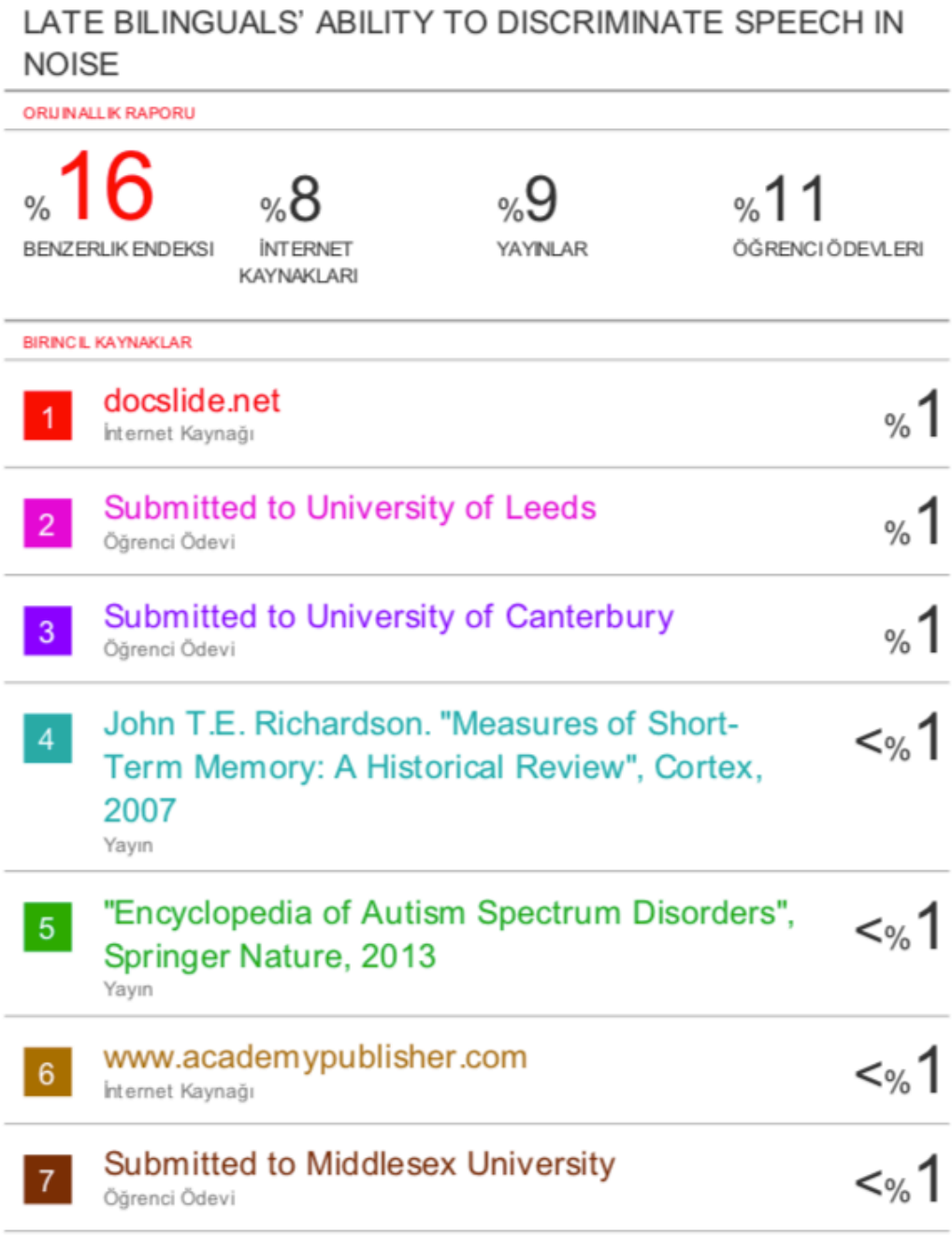

LATE BILINGUALS' ABILITY TO DISCRIMINATE SPEECH IN NOISE

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Appendix 9: Digital Receipt

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