Construct Validity of Auditory Verbal Learning Test

Handan CAN[1], Elvin DOĞUTEPE[2], Nakşidil TORUN YAZIHAN[3], Hamdi KORKMAN[4], Emel ERDOĞAN BAKAR[5]

SUMMARY

Objective: Auditory Verbal Learning Test (AVLT) is frequently used in the neuropsychology literature to comprehensively assess the memory. The test measures verbal learning as immediate and delayed free recall, recognition, and proactive and retroactive interference. Adaptation of AVLT to the Turkish society has been completed, whereas research and development studies are still underway. The purpose of the present study is to investigate the construct validity of the test in order to contribute to the research and development process.

Method: In line with this purpose, the research data were obtained from 78 healthy participants aged between 20 and 69 years. The exclusion criteria included neurological and/or psychiatric disorders as well as untreated auditory/visual disorders. AVLT was administered to participants individually by two trained psychologists.

Results: Principal component analysis used to investigate the components represented by the AVLT scores consisted of learning, free recall, and recognition, in line with the construct of the test. Distractors were also added to these components in a structural equation model. Analyses were carried out on a descriptive level to establish the relationships between age, education, gender, and AVLT scores.

Conclusion: These findings, which are consistent with the literature indicating that memory is affected by the developmental process, suggest that learning/free recall, recognition, and distractor scores of the AVLT demonstrate a component pattern consistent with theoretical knowledge. This conclusion suggests that AVLT is a valid measurement test for Turkish society.

Keywords: Rey Auditory Verbal Learning Test, standardization, recognition, recall, construct validity

INTRODUCTION

Information processing in a healthy individual involves attention, consciousness, interpretation, memory, and control and integration processes, and connects the past, present, and future to one another (Karakaş 2008). The memory processes involved in information processing is the foundation of perception of identity and compliance, and, consequently, mental health (Karakaş and Aydın 1999). Therefore, it is observed that impairment of memory processes accompanies many psychiatric and neurologic disorders (Mitrushina et al. 1991, Schoenberg et al. 2006). While memory impairments comprise the core of some diseases (such as amnesic syndrome) (Giovagnoli and Avanzini 1999), it develops secondary to basic symptoms (as in alcoholism) (Gudeman et al. 1977, Sullivan et al. 2000). In addition to psychiatric and/or neurologic diseases, impairments of memory are also frequently seen in normal ageing, which is a developmental period (Staruss et al. 2006, Vakil and Blachstein 1997).

According to the theory establishing the operation of memory, a well-performed memory assessment – that is examination – must include encoding, storing, and retrieval mechanisms, and assessment procedures must be performed separately for verbal and visual skills (Lezak et al. 2004). One of the most frequently used memory tests is the Rey Auditory

Received: 01.04.2014 - **Accepted:** 11.02.2015

[1]Assist. Prof., Uludağ University, Psychology Department, Bursa. [2]Assist. Prof., Cyprus International University, Psychology Department, Lefkoşa., [3]Master of Science, Gülhane Military Medical Academy Psychiatry Department, Ankara., [4]PhD, Zübeyde Hanım Obstetric and Children's Hospital, Pediatry Department, Afyonkarahisar., [5]Assoc. Prof., Ufuk University, Psychology Department, Ankara.

e-mail: *handancan1@gmail.com*

doi: 10.5080/u8020

Verbal Learning Test, AVLT (Rey 1964; Auditory), based on the facts that it has the power to assess information processing related to verbal materials in many aspects including verbal learning, short- and long-term memory based on free recall, retroactive interference effect, and recognition-type recall, as well as being relatively applicable (Lezak et al. 2004).

AVLT includes the receptive and motor types of language, and in this sense, it is based on the functionality of the premotor and temporal regions in the left hemisphere (Kolb and Whishaw 2003). Accordingly, AVLT scores are lower in patients with damaged left hemispheres (Spreen and Strauss 1991); patients with epilepsy and particularly after temporal lobectomy (Lüders 1992); patients with Alzheimer-type dementia (ATD) and dementia with Lewy bodies (Ferman et al. 2006); and patients with ATD and frontotemporal dementia, amnesia and head trauma (Rosenberg et al. 1984). AVLT is also used as diagnostic criteria in patients with depression and alcoholism, in which memory functions are affected.

AVLT performance is primarily affected by age and number of years of education, and, to a lesser degree, by demographic variables including level of intelligence and gender (Schmidt 1996, Van der Elst et al. 2005). Findings in the literature show that AVLT scores display development that increases gradually during childhood, and display a trend of decreasing with age in adults (Strauss et al 2006); also, they show that the rate of decrease gradually increases, particularly in participants older than 60 years of age, while the change in AVLT performance is smaller in participants younger than 60 years of age (Vakil and Blachstein 1997). In another study, it was observed that the rate of forgetting words during delayed recall is higher in healthy elderly participants compared to younger ones (Lezak et al. 2004).

In our country, AVLT research and development (R&D) studies are still ongoing in the context of validity and normalization. The Öktem Verbal Memory Processes Test (Öktem-SBST, 2011), which has been published recently and in which the words from the AVLT lists have been used, cannot contribute to the AVLT psychometric studies because the Öktem-SBST does not target measurement of learning ability, explicit memory, or interference; rather, it targets the measurement of the normal and interfered prefrontal executive functions. In the adaptation study of Öktem-SBST, some of the words have been changed accordingly, and novel application and assessment forms have been developed. As a result of all the above, Öktem-SBST has become distinctive from AVLT regarding both the cognitive processes targeted for assessment and the application processes of the verbal material (Karakaş et al. 2013).

The objective of our study was to establish the construct validity of AVLT in healthy individuals from a wide range of ages and a balanced distribution of educational levels. In this context, our aims were to investigate whether learning and memory, which are known to change with age, also follow the same course in AVLT scores; to examine the structure of the test using principal component analysis (PCA); to determine the characteristics represented by factors or components; to create a theoretical model based on the factor structure; and to test the compliance of the structural equation modeling with data.

METHOD

Sample

The study sample consisted of 78 healthy participants ages ranging between 20 and 69 years of age (41.88 ± 17.17). Of the predictive variables, gender was handled in two levels (females, n=24; and males, n=54), age in three levels (20-34, n=28; 35-54, n=25; and 55 and older, n=25); and education was handled in three levels (5-8 years, n=17; 9-11 years, n=27; and 12 years and over, n=34). The sample was created using the snowball method. With this purpose, the core sample was created from individuals living in Ankara and Afyonkarahisar, the provinces in which the study was implemented. Through the individuals of this sample, other individuals of the sample were reached. Exclusion criteria included psychiatric or neurologic disorders based on the statements of participants, clinical depression [scoring over 7 on the Hamilton Depression Rating Scale (HDRS)], using drugs that affect cognitive processes, and visual and/or auditory disorders.

MATERIALS

Auditory Verbal Learning Test (AVLT): The original form of the Auditory Verbal Learning Test (AVLT) consisting of word lists was developed by Rey (1941, 1964). The test was translated into English by Taylor (1959) and Lezak et al. (2004). The Turkish version was prepared by Genç-Açıkgöz and Karakaş (1996a,b). As in both the original form as well as in the adapted form, words were determined according to the difficulty, concreteness, length, and frequency of use.

The Turkish version of AVLT, like the original version, consists of lists A and B (15 words each) measuring learning (L) and free recall (FR), List A6 measuring free recall under proactive interference, and List A7 measuring recall after a very long time, and the Recognition List measuring recognition over recall (RR) (50 words). (Please see Table 1 for abbreviations.) In "learning – free recall" (L-FR), which is the first stage of the test application, List A is presented to the participants five times and they are asked to repeat the words they can recall. Following this, List B is presented, and the participants are again asked to recall the words. Immediately after List B, participants are asked to recall the words in List

Table 1. AVLT Scores used in the study and their abbreviations

	Abbrevation	Score
1.	A1/L-FR: T	List A, Learning/Free Recall A, 1. Repetition: True Score
2.	A2/L-FR: T	List A, Learning/Free Recall A, 2. Repetition: True Score
3.	A3/L-FR: T	List A, Learning/Free Recall A, 3. Repetition: True Score
4.	A4/L-FR: T	List A, Learning/Free Recall A, 4. Repetition: True Score
5.	A5/L-FR: T	List A, Learning/Free Recall A, 5. Repetition: True Score
6.	A1-A5/L-FR: MeanT	List A, Learning/Free Recall A, 1-5. Repetitons: Mean True Score
7.	B/L-FR: T	List B, Learning/Free Recall: True Recall Score
8.	A6/FR: T	List A, Learning/Free Recall A, 6. Repetition: True Score
9.	A7/FR: T	List A, Learning/Free Recall A, 7. Repetition: True Score
10.	A/RR: T	List A, Recognition over Recall: True Score
11.	B/RR: T	List B, Recognition over Recall: True Score
12.	A+B/RR: T	Lists A and B, Recognition over Recall: True Score
13.	A/SD	List A, Semantic Distractor Effect
14.	A/PD	List A, Phonetic Distractor Effect
15.	B/SD	List B, Semantic Distractor Effect
16.	B/PD	List B, Phonetic Distractor Effect
17.	A/SD+PD	List A, Unified Distractor (Semantic and Phonetic) Effect
18.	B/SD+PD	List B, Unified Distractor (Semantic and Phonetic) Effect
19.	A+B/SD+FD	Lists A and B, Sum of Distractor Effect

A (free recall: FR). For the delayed recall, the participants are asked to recall the words in List A after 20 minutes (FR), after which they are shifted to the Recognition List. The Recognition List includes three types of distractors (D) in addition to the words in Lists A and B (semantic: SD, phonetic: FD, and semantic and phonetic: SD+FD). In this stage, the participant is required to make an evaluation for each word in the Recognition List (recognition over recall: RR), and to determine which list includes the words (if present in the lists) or whether they have not been presented previously.

As in the original form of AVLT, in the Turkish version, the scores of correct answers for each of L-FR, FR and RR are calculated (Table 1). The Turkish version of the test also includes scores for the number of wrong responses, number of repeated words, number of repeats of the same word, the number of words inquired by the tested participant, and the number of words corrected with repeats; however, the use of these are optional. The distractor scores in the test are calculated separately for lists (A and B) and distractor types (FD, SD, FSD).

The highest scores possible in AVLT regarding the words recalled correctly are 15 for List A, 15 for List B, and 30 for the Recognition List. Distractor scores are expected to be small. The application time for AVLT in healthy individuals is approximately 20 minutes (Karakaş and Doğutepe Dinçer 2011).

In the context of validity studies (Genç Açıkgöz and Karakaş 1996b), it has been observed that the interference score in the test (List B) is charged on factors that are the same with Wechsler Memory Scale-Revised Form (WMS-R; Wechsler 1987) subtests, and other AVLT scores involving learning and recall are charged on factors that are the same as the Serial Digit Learning Test (SDLT; Karakaş et al. 2013), which is used to measure learning ability.

Hamilton Depression Rating Scale (HDRS): HDRS was developed in the late 1950s to measure the severity of depression symptoms and is based on ratings by a specialist (Hamilton, 1960). HDRS is used to assess the severity of depression in the patient during the psychiatric interview. This scale was originally drawn up so as to give a total score based on 17 items out of 21, and was used in many studies on depression (Williams, 1978). After the psychiatric interview with the case, depressive mood, feelings of guilt, thoughts of suicide, regularity of sleep, activity, anxiety level, somatic symptoms, appetite, libido, and insight are scored. It is accepted that depression is not present if the score obtained is smaller than 13 (Hamilton, 1960). The standardization study performed on the Turkish version of HDRS has shown that HDRS can be used as a valid and reliable tool in the evaluation of depression at clinical levels (Akdemir et al. 1996). In this study, the revised form of HDRS by Yüksel and Karakaş (2002) was applied.

Procedure

Potential participants were interviewed and informed about the procedures included in the study, and those accepting these conditions verbally were included in the study sample in "volunteer" status. Participants who accepted to participate in the study as volunteers signed the informed consent form. The Information Collection Form and Hamilton Depression Rating Scale (HDRS; Hamilton, 1960) were applied to participants from whom informed consent was obtained, and participants not meeting the exclusion criteria were included in the study. AVTL was applied according to standard instructions to 78 participants who met all these conditions.

Statistical Method

Orthogonal and correlation analyses used to analyze the data were carried out using "Statistical Package for Social Sciences" (SPSS / PC 17.0) (Norusis 2008) and "AMOS V21" (Arbuckle 2012) package programs.

Statistics of the study were grouped under two separate headings. In the first group, Findings Related to Construct Validity, principal component analysis and confirmatory

factor analysis were applied to examine the clusters of characteristics represented by AVLT scores and the relationships between such clusters. In the Findings Related to the Relationships of Demographic Variables with AVLT Scores, which constitute the second group, descriptive studies were performed and summary graphs were prepared related to the means of the scores obtained from different age groups, genders, and educational levels.

RESULTS

Findings Related to Construct Validity

Principal Component Analysis: In this stage, principal component analysis (PCA) was applied to the learning, free recall, and recognition (10 scores), and to the distractor effect scores. With the purpose of ensuring maximum component variants in PCA and reaching the simplest structure providing a better interpretation, the varimax method, which is one of the orthogonal axis rotation methods, was applied. Those participants with component loads smaller than 31 were excluded from the interpretation because their contributions to the variance was under 10%, and such values were displayed in relevant tables "0.00".

The PCA results given for learning, free recall, and recognition scores of AVLT show that there are two components with an eigenvalue greater than 1, explaining 76.97% of the total variance (Table 2). The learning/free recall scores of lists A and B and the delayed free recalled score were charged to the first component with greater loads, and this component is called the "Learning and Free Recall" component. The recognition scores, however, were charged to the second component with higher loads, and this component was called the "Recognition Type Recall".

The TBA results of the distractor scores of AVLT show that there are three components with an eigenvalue greater than 1, explaining 75.38% of the total variance (Table 3). The first component included the scores of semantic distractors, and this component was named the "Semantic Distractor"; the second component included the scores of phonetic distractors, and this component was named the "Phonetic Distractor"; and the third component included the scores of semantic-phonetic distractors, and this component was named the "Semantic-Phonetic Distractors".

Confirmatory Factor Analysis (CFA): Components established in exploratory PCA (Tables 2 and 3) were used as latent variables in CFA (Figure 1). Through CFA, it was determined whether the observed variables constituted the latent variables, and the presence of the relationships between the latent

Table 2. Principal Component Analysis For Learning-Free Recall, Free Recall and Recognition Scores of AVLT (n=78)

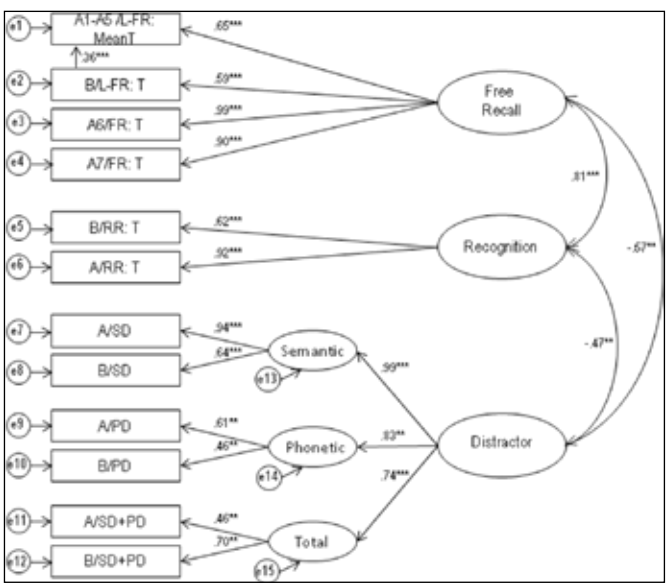
Variable	Factor 1	Factor 2
A1/L-FR: T	0.67	0.44
A2/L-FR: T	0.77	0.39
A3/L-FR: T	0.82	0.39
A4/L-FR: T	0.86	0.31
A5/L-FR: T	0.91	0.00
B/L -FR: T	0.58	0.57
A6/FR: T	0.86	0.35
A7/FR: T	0.80	0.37
A/RR: T	0.50	0.63
B/RR: T	0.00	0.93
Eigenvalue	5.25	2.44
Explained variance (%)	52.52	24.44
Cumulative variance (%)	52.52	76.96

***p<0.001, **p<0.01, *p<0.05

Table 3. Principal Component Analysis for Distractor Scores of AVLT (n=78)

Variable	Factor 1	Factor 2	Factor 3
A/SD	0.78	0.39	0.00
B/SD	0.82	0.00	0.00
A/PD	0.00	0.84	0.00
B/PD	0.00	0.64	0.38
A/SD+PD	0.00	0.00	0.84
B/SD+PD	0.61	0.00	0.64
Eigenvalue	1.78	1.42	1.33
Explained variance (%)	29.58	23.61	22.19
Cumulative variance (%)	29.58	53.19	75.38

***p<0.001, **p<0.01, *p<0.05



***p<0.001, **p<0.01, *p<0.05

Figure 1. Structural Equation Modeling with the scores of the Auditory Verbal Learning Test

Table 4. Results of Confirmatory Factor Analysis for AVLT Scores

Components	Standardized factor loads	S.E.	T value	P
A1A5/L-FRMeanT <--Free Recall	0.651			
A6/FR: T<--Free Recall	0.991	0.22	10.173	***
A7/FR: T<-- Free Recall	0.903	0.264	9.359	***
B/L-FR: T<-- Free Recall	0.594	0.162	5.577	***
A/RR: T<--Recognition	0.924			
B/RR: T<-- Recognition	0.617	0.424	5.274	***
Semantic<--Distractor	0.986	0.228	2.763	0.006
A/SD<--Semantic	0.943			
B/SD<--Semantic	0.642	0.216	2.963	0.003
Phonetic<-- Distractor	0.827			
A/PD<-- Phonetic	0.614			
B/PD<-- Phonetic	0.463	0.144	5.227	***
Total<--Distractor	0.736			
A/SD+PD<--Total	0.457	0.557	3.23	0.001
B/SD+PD<--Total	0.7	0.266	3.467	***
CORRELATION				
Free Recall<--> Recognition	0.805	0.626	4.669	***
Distractor <--> Recognition	-0.466	0.181	-2.599	0.009
Distractor <--> Free Recall	-0.568	0.085	-2.828	0.005

variables was determined (Meydan and Şeşen, 2011). The chi-square test, which is one of the analyses performed to test the compliance of the constructed first level multifactor model with the data [$\chi^2(47, N=78)=58.163$, $p=0.127$], did not provide a significant result; and this result showed that there was no difference between the data and the model constructed. Other indicators of compliance used for CFA were also in levels of acceptable or good compliance [GFI=0.89, AGFI=0.81, CFI=0.98, TLI=0.97, NFI=0.90, RMSEA=0.06 (confidence interval 90%: 0-0.098)]. These values have shown that the model can be considered as compliant with data.

In the model, the regression values related to the latent variables, including free recall, recognition, and distractor effect – that is, the factor loading – have been found to be significant (Table 4). This finding shows that the predictive power displayed by the regression values is significant; that is, the observed variables are predicted by the latent variables. When these values are examined, it is seen that the most powerful predictors of free recall are the free recall of Lists A6 and A7 (A6/FR: D and A7/FR: D). This finding indicates that, when predicting the latent variable of free recall, the effect of scores including learning (A1-A5/L-FR: Mean D and B/L-FR: D) are relatively small. When the recognition and distractor effects on indicator variables of the latent variables are examined, it is noted that the variables related to List A have greater predictive power in general. Since List A involves a greater number of repeats, this is expected.

The correlations between the latent variables were also found to be significant. The level of correlation between free recall and recognition is high. The correlations between the types of recall and the distractor effect are negative at a medium-level. In other words, while recall (free or through recognition) scores are increasing (or decreasing), the distractor effect decreases (or increases).

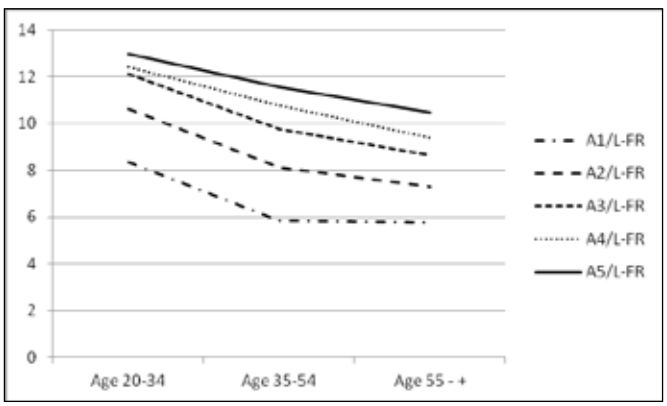


Figure 2. Means of learning (L) and free recall (FR) scores of Auditory Verbal Learning Test for List A for age groups.

Findings Related to the Relationships of Demographic Variables with AVLT Scores

Since the data obtained from the sample do not meet the assumptions required by the orthogonal techniques (e.g. variance analysis), effects of demographic variables on AVLT scores could not be analyzed; it was preferred to display descriptive characteristics with graphs.

Graphic displays of mean scores obtained from different age groups are given Figures 2 through 4. The highest performance

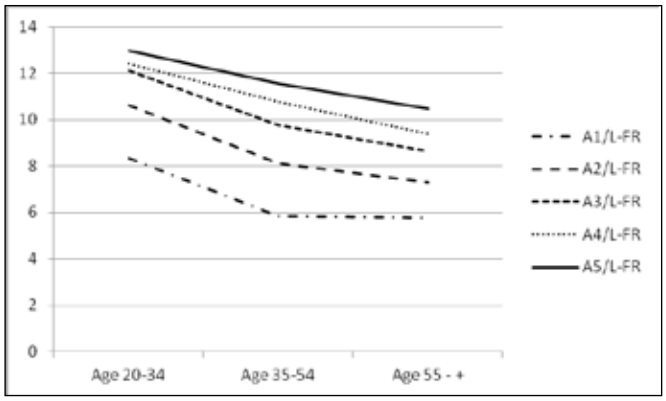


Figure 3. List A learning-free recall fifth repetition score for Auditory Verbal Learning Test, 1-5, repeat mean score, learning-free recall score for List B, and means of free recall scores for age groups.

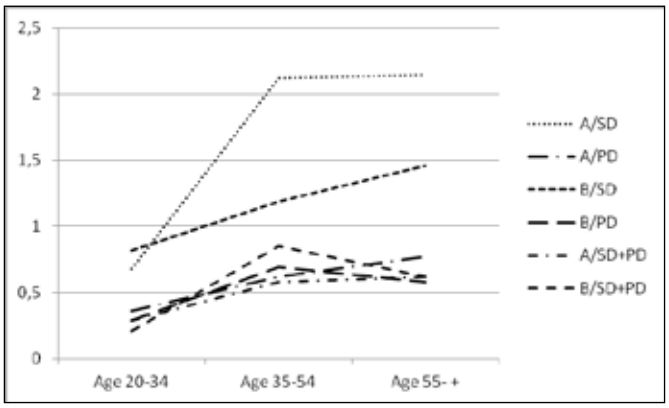


Figure 4. Means of distractor scores of Auditory Verbal Learning Test for age groups

in the five repeats of learning-free recall stage (L-FR) for List A was seen in the 20-34 year age group (Figure 2). The scores displayed a relatively rapid fall in the 35-54 year age group, and the fall continued for the participants aged 55 years or older with a gradually decreasing rate. The number of words recalled in the sixth repeat of List A that was involved only with free recall (A6/FR: D), and in the seventh repeat involved in delayed free recall (A7/FR: D) were lower than the same in the fifth repeat (A5/L-FR: D) (Figure 3). This fall is particularly notable in the sixth repeat in participants 55 years and older. Effects of semantic and phonetic distractors increased with increasing age (Figure 4). This increase is particularly notable for semantic distractors (A/SD and B/SD).

The graphic displays of the mean scores obtained from both sexes are given in Figures 5 and 6. While the mean scores in the learning and free recall stages for List A did not differ between genders, it was found that the scores involving only free recall and recall over recognition had a tendency for higher mean scores in males (Figure 5). When the mean scores of distractor scores were examined, it was noted that

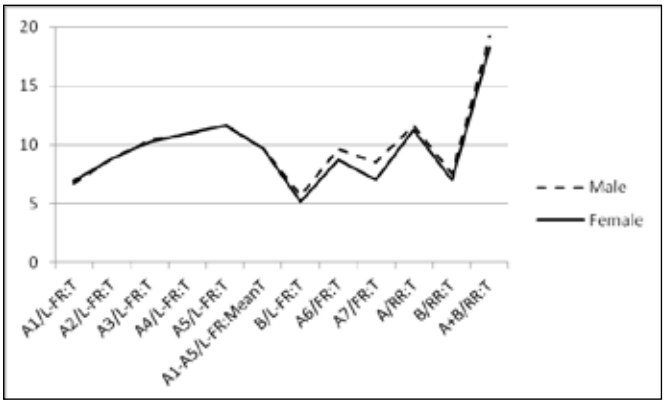


Figure 5. Means of learning (L), free recall (FR), and recall over recognition (RR) scores of Auditory Verbal Learning Test obtained for genders

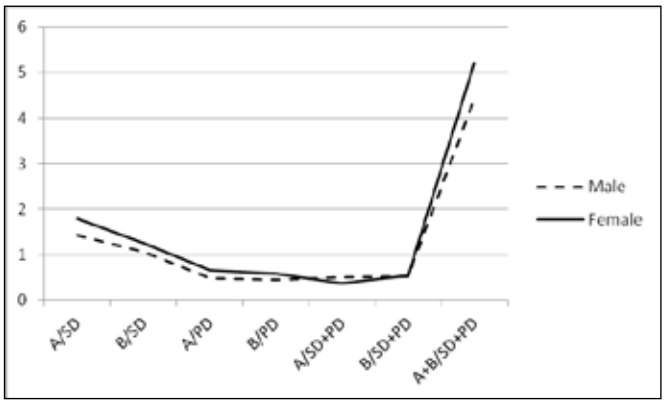


Figure 6. Means of distractor scores of Auditory Verbal Learning Test obtained for genders

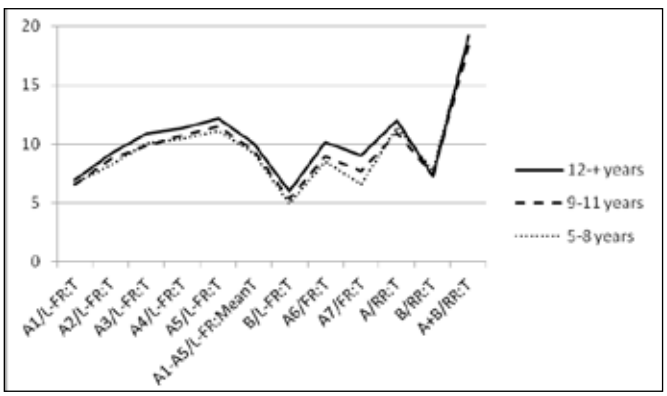


Figure 7. Means of learning (L), free recall (FR), and recall over recognition (RR) scores of Auditory Verbal Learning Test obtained for education levels

males displayed relatively higher performances (lower distractor effect) (Figure 6).

The graphic displays of the mean scores for different educational levels are given in Figures 7 and 8. It was noted that education had a tendency for affecting performance positively for both learning and free recall, as well as distractor scores. No differentiation was observed in recall over recognition scores.

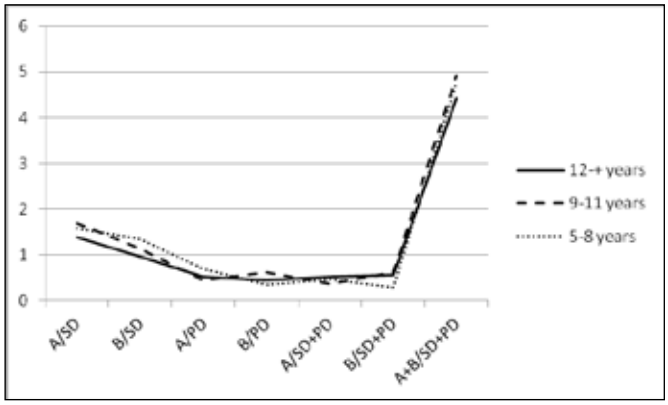


Figure 8. Means of distractor scores of Auditory Verbal Learning Test obtained for education levels

DISCUSSION

In our country, AVLT is primarily used as a measurement tool for pediatric clinical samples (Okuyaz 2003, Turgut 2008) and adult clinical samples (Açıkgöz 2006, Keighobadi 2008, Keighobadi et al. 2006, 2008, Torun Yazıhan 2003, Torun Yazıhan et al. 2007, Uysal 2005). Validity studies on Turkish samples are rather scarce (Genç Açıkgöz and Karakaş 1996a and b, Korkman personal interview, February 2013). Construct validity of AVLT was examined with experimental and statistical methods in our study.

Characteristics Measured in Healthy Samples: AVLT is a psychometric tool developed to measure processes including verbal learning (A1/L-A5/L), delayed memory (A7/FR), retroactive interference (A6/FR), and recall over recognition (A/RR, B/RR) (Lezak et al. 2004, Rey 1964). In the validity study of AVLT in Turkish samples (Genç Açıkgöz and Karakaş 1996a), the free recall throughout the learning trials and the trials involving only free recall (A6 and A7) have been included within different components. In our study, the free recall and recall over recognition scores were charged on two separate components of PCA; however, the free recall during learning and pure free recall were not further differentiated.

It is probable that the limited age range (university students) of the sample in the study by Genç Açıkgöz and Karakaş (1996a) and the age range of participants in our study (20-69 years of age) have played a role in the inconsistency regarding the structure of components. Findings of the exploratory analysis were tested with confirmatory factor analysis (CFA) in our study. CFA results showed that the predictive power of pure free recall (A6 and A7) was higher; however, they showed that scores related to pure free recall and free recall during learning (A1-A5) predicted the same latent variables. It is thought that this finding is related to the fact that learning and recalling are "two sides of the same coin" and the impossibility of differentiating these two processes, at least under natural conditions.

The model test carried out with CFA shows that the recognition-type memory and distractor effect on verbal learning measured with AVLT are different processes. These processes are the other processes that AVLT targets, and such findings favor the construct validity of the test. The nature of the correlations between the latent variables in CFA is the testing of approval that AVLT is an integrated tool measuring the entire body of processes consisting of the learning-memorizing-recall sequence. The conclusions in this area are consistent with the findings of some international studies that are limited in number (Ryan et al. 1984, Vakil and Blachstein 1993).

Effects of Development: The demographic variables that AVLT performance is affected by the most include age and education (Schmidt 1996). It was not possible to apply inferential statistics in this study because of the limitations of the sample and inability of the data to meet the assumptions of the orthogonal statistical techniques; however, data were shown in a descriptive manner. It was seen that age could have an effect, particularly on learning-free recall and recall over recognition scores; in other words, on the processes of acquisition and retrieval of knowledge. In the international literature, it has been found that age is related to verbal learning and free recall (Van der Elst et al. 2005, Vakil and Blachstein 1997, Lezak et al. 2004), acquisition rate in learning trials (Geffen et al. 1990, Mitrushina et al. 1991, Wiens et al. 1988), and on proactive interference effect (Geffen et al. 1990). Consistent with these findings, Strauss et al (2006) have reported that performance obtained in AVLT trials developed in children with increasing age while it declined in adults with increasing age. In this study also, although the effect of the demographic variables required by orthogonal techniques on AVLT findings were not examined, it was determined according to the descriptive characteristics of the data shown in the figures that there are periods in which the free recall scores of AVLT increase or decrease. It was seen that learning and free recall scores in the age range of 20-34 years are higher as compared to those in the age range of 35-54 years and the group 55 years and older; the scores begin to decline in the age range of 35-54 years (see Figures 2 and 3).

The finding that the tendency for developmental effects on the free recall and recognition scores of AVLT in healthy individuals at adult ages in the Turkish population is consistent with the literature indicating that learning and memory are affected by development (Geffen et al. 1990, Van der Elst et al. 2005).

Effects of Educational Level and Gender: There are inconsistent findings related to the effects of education on AVLT scores. There are studies indicating that individuals with higher levels of education show better performance (Lannoo and Vingerhhoets 1997, Miatton et al. 2006), as well as

studies in which no effects of education have been observed (Mitrushina et al. 1991, 2005, Wiens et al. 1988).

In our study, the education variable influenced the scores positively, and the effect of education particularly noted scores related to learning and free recall. This finding is also consistent with the literature and has been interpreted as education results in the development of more effective learning strategies (Lannoo and Vingerhhoets 1997, Miatton et al. 2006).

Studies investigating the effect of gender on AVLT scores are not fully consistent with each other as regards the results. In a group of studies, it was found that females displayed better performance both in recall and recognition trials as compared to males (Miatton et al. 2006, Strauss et al 2006). In another group (Geffen et al. 1990, Lannoo and Vingerhhoets 1997), the higher performance in females could only be shown in recall trials. In our study, a gender difference was observed only for delayed free recall. These findings with varying results illustrate that the gender effect on AVLT scores have to be investigated with appropriate research designs in samples large enough in which females and males are represented with balanced distribution.

In summary, our study has shown that AVLT is a valid measurement tool in Turkish samples. Accordingly, AVLT is capable of measuring the effects of distractors on learning/free recall, recognition, and learning. However, the structure established in our study needs to be supported by further studies with larger samples and inferential statistics.

REFERENCES

Açıkgöz D (2006) Uyku ile aktive olan epileptik sendromların nöropsikolojik işlevlerle ilişkileri. Yayınlanmamış doktora tezi, Hacettepe Üniversitesi, Ankara.

Akdemir A, Örsel SD, Dağ İ et al (1996) Hamilton depresyon derecelendirme ölçeğinin geçerliliği-güvenilirliği ve klinikte kullanımı. Psikiyatri, Psikoloji ve Psikofarmakoloji Dergisi 4:251-259.

Arbuckle JL (2012) Amos (Version 21) [Computer Program]. Chicago: SPSS.

Ferman T, Smith G, Boeve B et al (2006) Neuropsychological differentiation of dementia with Lewy bodies from normal aging and Alzheimer's disease. Clin Neuropsychol 20:623-36.

Geffen G, Moar KJ, O'Hanlon AP et al (1990) Performance measures of 16-to 84 year-old males and females on the Auditory Verbal Learning Test. Clin Neuropsychol 4:45-63.

Genç Açıkgöz D, Karakaş S (Eylül 1996a) AVLT'nin Türk diline uyarlanmasına ilişkin bir çalışma. IX. Ulusal Psikoloji Kongresi (s. 79), İstanbul.

Genç Açıkgöz D, Karakaş S (1996b) Bellek ve dikkat fonksiyonlarını ölçen nöropsikolojik testlerin faktör yapısı. IX. Ulusal Psikoloji Kongresi (s. 591-596). Ankara: Türk Psikologlar Derneği.

Giovagnoli AR, Avanzini G (1999) Learning and memory impairment in patients with temporal-lobe epilepsy: Relation to the presence, type, and location of brain lesion. Epilepsia, 40: 904-11.

Gudeman HE, Craine JF, Golden CJ et al (1977) Higher cortical dysfunction associated with long term alcoholism. Int J Neurosci 8:33-40.

Hamilton MA (1960) Rating scale for depression. J Neurol Neurosurg Psychiatry 23: 56-62.

Karakaş S (2008) Kognitif nörobilimde açıklamalar: Kuram ve modeller (Bölüm 1). Kognitif Nörobilimler, S. Karakaş (Ed), Ankara. MN Medikal & Nobel.

Karakaş S, Aydın H (1999) Şizofrenide bilgi işleme bozuklukları. Şizofreni Dizisi 2:113-131

Karakaş S, Doğutepe Dinçer E (2011) BİLNOT Bataryası El Kitabı: Nöropsikolojik Testlerin Çocuklar için Araştırma ve Geliştirme Çalışmaları: BİLNOT-Çocuk, Ankara. Nobel Tıp Kitabevleri.

Karakaş S, Erdoğan Bakar E, Doğutepe Dinçer E (2013) BİLNOT Bataryası El Kitabı: Nöropsikolojik Testlerin Yetişkinler için Araştırma ve Geliştirme Çalışmaları BİLNOT Yetişkin, Konya. Eğitim Yayınevi.

Keighobadi M (2008) Şizofreninin negatif ve pozitif belirtili alt gruplarındaki bellek profili. Yayınlanmamış yüksek lisans tezi, Hacettepe Üniversitesi, Ankara.

Keighobadi M, Kısa C, Göka E et al (2008) Şizofreni alt gruplarının bellek süreçleri açısından karşılaştırılması. Genç Bilim İnsanları ile Beyin Biyofiziği II. Çalıştayı:Beyin Asimetrisi ve Kognitif Ölçümlerde Multidisipliner Yaklaşım (s.94), İzmir.

Keighobadi M, Kısa C, Gürün D et al (2006) Prediction of symptom classes of schizophrenia on the basis of learning and memory capacity. 13th World Congress of Psychophysiology. The Olympics of the Brain. Int J Psychophysiol 61: 345.

Kolb B, Whishaw IQ (2003) Fundamentals of Human Neuropsychology, New York (USA). Worth Pub p. 525-51

Lannoo E, Vingerhoets G (1997) Flemish normative data on common neuropsychological tests: influence of age, education and gender. Psychol Belg 37: 141–155.

Lezak MD, Howieson DB, Loring, DW (2004) Neuropsychological assessment, 4. Baskı, New York, Oxford University Press.

Lüders HO (1992) Epilepsy Surgery. New York, Raven Pr.

Meydan CH, Şeşen H (2011) Yapısal Eşitlik Modellemesi AMOS Uygulamaları. Ankara: Detay Yayıncılık.

Miatton M, De Wolf D, François K et al (2006) Neurocognitive consequences of surgically corrected congenital heart defects: A review. Neuropsychol Rev 16:65-85.

Mitrushina M, Satz P, Chervinsky A et al (1991) Performance of four age groups of normal elderly on the Rey Auditory-Verbal Learning Test. J Clin Psychol 47: 351-57.

Norusis M (2008) SPSS Statistics 17.0 Guide to Data Analysis. Chicago, Prentice Hall

Okuyaz Ç (2003) Rolandik epilepsili çocuklarda nöropsikolojik ve davranışsal bulgular. Yayınlanmamış Tıpta Uzmanlık Tezi, Gazi Üniversitesi, Ankara. 119.

Öktem Ö (2011) Öktem Sözel bellek Süreçleri testi (Öktem SBST) El Kitabı. Ankara, Türk Psikologlar Derneği Yayınları.

Rey Al (1941) L'examen psychologique dans les cas d'encephalopathie traumatique. Archives de Psychologie 28: 286-340.

Rey AL (1964) L'examen Clinique en Psychologic Paris, Presses Universitaires de France.

Rosenberg SJ, Ryan JJ, Pnfitera A (1984) Rey Auditory-Verbal Learning Test performance of patients with and without memory impairment. J Clin Psychol 40: 785-787.

Ryan JJ, Rosenberg SJ, Mittenberg W (1984) Factor analysis of the Rey Auditory Verbal Learning Test. Int J Clin Neuropsychol 6: 239-341

Schmidt M (1996) Rey Auditory Verbal Learning Test: A Handbook Western Psychological Services, Los Angeles.

Schoenberg MR, Dawson, KA, Duff K et al (2006) Test performance and classification statistics for the Rey auditory verbal learning test in selected clinical samples. Arch Clin Neuropsychol 21: 693-703.

Schonfield D, Robertson BA (1966) Memory storage and aging. Can J Psychol 20:228-36.

Spreen O, Strauss E (1991) A compendium of neuropsychological tests: Administration, norms, and commentary. New York, Oxford University Press.

Strauss E, Sherman EMS, Spreen O (2006) A compendium of neuropsychological tests: Administration, norms, and commentary, III. Baskı, New York. Oxford University Press.

Sullivan EV, Rosenbloom MJ, Pfefferbaum A (2000) Pattern of motor and cognitive deficits in detoxified alcoholic men. Alcohol Clin Exp Res 24: 611-21.

Taylor EM (1959) Psychological appraisal of children with cerebral defects. Cambridge. Harvard University Press.

Torun Yazıhan N (2003) Apneye ilişkin parametrelerin ve apnenin oluştuğu uyku evresinin bilişsel süreçlere etkisi. Yayınlanmamış Yüksek Lisans Tezi, Hacettepe Üniversitesi, Ankara.

Torun Yazıhan N, Aydın H, Karakaş S (2007) Neuropsychological profile in levels of obstructive sleep apnea syndrome. Sleep and Biological Rythms 5: 85-94.

Turgut S (2008) Özgül Öğrenme Güçlüğü'nde nöropsikolojik profil. Yayınlanmamış yüksek lisans tezi, Hacettepe Üniversitesi, Ankara.

Uysal U (2005) Multipl sklerozda bilişsel fonksiyon bozukluğunun nöropsikolojik ve nörofizyolojik korelatları. Yayınlanmamış tıpta uzmanlık tezi, Dokuz Eylül Üniversitesi, İzmir.

Vakil E, Blachstein H (1997) Rey AVLT: Developmental norms for adults and the sensitivity of different memory measures to age. Clin Neuropsychol 11: 356-69.

Vakil E, Blachstein H (1993) Rey Auditory-Verbal Learning Test: Structure analysis. J Clin Psychol 49: 883-90.

Van der Elst W, Van Boxtel, MPJ, Van Breukelen et al (2005) Rey's verbal learning test: Normative data for 1855 healthy participants aged 24-81 years and the influence of sex, education, and model of presentation. J Int Neuropsychol Soc 11: 290-302.

Wechsler D (1987) WMS_R:Wechsler Memory Scale-Revised (The Psychological Corporation). New York: Harcourt, Brace, Jovanovich.

Wiens AN, McMinn, MR, Crossen, JR (1988) Rey Auditory-Verbal Learning Test: Development of norms for healthy young adults. Clin Neuropsychol 2, 67–87.

Yüksel, N Karakaş, S (2002) Hamilton Depresyon Derecelendirme Ölçeği. Klinik Psikiyatri Dergisi 5: 257-65.