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Are General Intelligence and Implicit Memory Related?: The Effect of Age [*]

Zekâ, Örtük Bellek Performansıyla İlişkili midir?: Yaşın Etkisi

Hande KAYNAK [**]

Abstract

This study investigated the relationship between general intelligence and implicit memory performance in conjunction with aging. Data have been collected from 95 volunteers (49 young-46 older adults). General intelligence was measured by the Raven Standard Progressive Matrices (RSPM) test. Participants' implicit memory performance was measured by the Word Stem Completion (WSC) task, in which the participants were presented with first three letters of a word and asked to complete this stem with the first word that comes to their mind. Explicit memory performance was also measured to be able to make a comparison with implicit memory performance and to document the differentiation between implicit and explicit memory. Although the same WSC task was used to measure implicit and explicit memory performance separately, the different instructions were used to deduce the different memory types. According to the results of factorial ANOVA, the main effect of age on general intelligence score was found to be statistically significant. After running further analyses by Pearson product-moment correlation coefficients, results indicated that RSPM test total correct score had a tendency to decrease with increasing age and RSPM test completion time had a tendency to increase with aging. Results also showed that implicit WSC task score and RSPM test total correct score were positively correlated. Similarly, explicit WSC task score and RSPM test total correct score were positively correlated, too. However, RSPM test completion time did not differ depending on implicit and explicit memory performances which were measured by WSC task. The present study indicated the relation between implicit WSC task and general intelligence. Within this context, this study is important to draw attention to the contribution of implicit memory measurement which is in the shadow of traditional explicit memory measurements to general intelligence, especially in older population.
Keywords: Cognitive aging, general intelligence, implicit memory, explicit memory, word stem completion task.

Öz

Bu araştırmada, genel zekâ ve örtük bellek performansı arasındaki ilişki yaşlanmayla birlikte incelenmektir. Araştırmanın verileri 49 genç, 46 yaşlı olmak üzere toplam 95 gönüllü yetişkinden toplanmıştır. Genel zekâ puanı, Raven Standart Progresif Matrisler (RSPM) testi kullanılarak ölçülmüştür. Katılımcıların bellek performansını ölçmek için, Kelime Kökü Tamamlama (KKT) görevi kullanılmıştır. Örtük bellek görevinde, katılımcılardan kendilerine ilk

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üç harfi sunulan kelime köklerini akıllarına gelen ilk kelimeye tamamlamaları istenmiştir. Ayrıca, örtük bellek performansıyla karşılaştırma yapabilmek ve örtük ve açık bellek arasındaki ayrımı belgelemek için açık bellek performansı da ölçülmüştür. Örtük ve açık bellek performansını ayrı ayrı ölçmek için aynı KKT görevi kullanılmış, ancak bu görev farklı yönergeler altında uygulanmıştır. Faktöriyel varyans analizi (ANOVA) bulgularına göre, yaşın genel zekâ puanları üzerindeki temel etkisi istatistiksel olarak anlamlı bulunmuştur. Pearson momentler çarpımı korelasyon hesaplamaları sonucunda, ilerleyen yaşla birlikte RSPM testinden alınan toplam doğru puanın azaldığı, testi tamamlama süresinin ise arttığı görülmüştür. Örtük KKT görevi puanları ile RSPM testi toplam doğru puanları arasındaki ilişki ve açık KKT görevi puanları ile RSPM testi toplam doğru puanları arasındaki ilişki de istatistiksel olarak anlamlı bulunmuş, aralarındaki ilişkilerin pozitif olduğu kaydedilmiştir. Buna karşın, örtük KKT görevi puanı ile RSPM testi tamamlama süresi ve açık KKT görevi puanı ile RSPM testi tamamlama süresi arasındaki ilişki istatistiksel olarak anlamlı değildir. Mevcut çalışma bulguları, örtük KKT görevi ölçümünün genel zekâyla olan güçlü ilişkisini göstermektedir. Çalışma, bu kapsamda, özellikle yaşlı nüfusta, geleneksel açık bellek ölçümlerinin gölgesinde kalan örtük bellek ölçümünün genel zekâya olan katkısına dikkat çekmesi açısından önemlidir.
Anahtar sözcükler: Bilişsel yaşlanma, genel zekâ, örtük bellek, açık bellek, kelime kökü tamamlama görevi.

Introduction

Comparisons of older and younger adults based on the scores obtained from the subtests of the Wechsler Adult Intelligence Scale (WAIS) have shown that older adults are much less successful than younger adults in performance subtests. On the other hand, older and younger adults show similar performance in verbal memory tests. In other words, while there is a decrease in scores related to age in the WAIS's five performance subtests, there is no significant difference in the scores in the six verbal subtests. This phenomenon is defined as "classical aging pattern" (Hayslip and Panek, 2002; Hoyer and Roodin, 2003; Papalia, Sterns, Feldman and Camp, 2002).

Another distinction with aging in intelligence is between fluid intelligence and crystalized intelligence. According to this classification, fluid intelligence, which is independent of any knowledge from past experiences declines with aging. On the other hand, crystalized intelligence which relies on stored information and experiences, and includes verbal and professional skills, is maintained or even developed, notwithstanding aging (Baltes, 1993; Gilhooly, 2005).

Many researchers have stated that older adults who manage to use a strategy in an effective and organizated way during encoding and who have a high level of personal skills or intelligence are able to compensate the decrement in memory functions as a result of aging (La Rue, 1995; Meyer and Rice, 1983; Taub, 1979).

Like the changes observed on types of intelligence with aging, changes in memory processes have become an interesting area of study. In a traditional memory measurement, participants are required to retrieve information stored in the memory consciously. However, experimental designs that enable the unconscious retrieval of information have also increasingly become the focus of attention. For such memory tasks, participants are asked to "provide the answer that first pops up in their minds" in a simple task (e.g., completing a fragment of a word), instead of explicitly recalling the stored information (Schacter, 1987). This differentiation between implicit and explicit memory was first defined by Graf and Schacter (1985). Based on this classification, implicit memory requires automatic and involuntary retrieval of previously acquired information, whereas explicit memory requires conscious and voluntary retrieval of such information (Graf and Schacter, 1985; Schacter, 1987). Automatic processes are unconscious and require less attention, while controlled processes are conscious and require more cognitive effort and attention (Light, Prull, La Voie and Healy, 2000).

Age has been an important variable for many years to date, especially in implicit and explicit memory researches. There is a broad consensus on the fact that explicit memory performance is negatively affected by increasing age (Gımzal and Yazgan, 2004; Light, 1991). Nevertheless, there are contradictory findings regarding the effect of age on implicit memory performance and/or the relationship between these two. Some studies argue that performance in explicit memory tasks deteriorates with age, while no effect of age on implicit memory tasks has been observed (Anooshian, 1999; Jelicic, Craik and Moscovitch, 1996; Light and Singh, 1987; Maki, Zonderman and Weingartner, 1999; Mitchell and Bruss, 2003). May, Hasher, and

Foong (2005) asserted that the age effect could be eliminated depending on the hour of the day that the measurement was conducted. On the other hand, some studies have demonstrated that both implicit and explicit memory performance declined with aging (Chiarello and Hoyer, 1988; O'Hanlon, Wilcox and Kemper, 2001; Russo and Parkin, 1993). Another group of researchers on the other hand claimed that implicit memory, like explicit memory, also declined with age (Chiarello and Hoyer, 1988; O'Hanlon, Wilcox and Kemper, 2001; Russo and Parkin, 1993).

According to the life-span developmental studies, decrement in free recall performance (explicit memory) and decrement in fluid intelligence scores have a parallel pattern (Salthouse, 1982). Since fluid intelligence is related to information processing speed (Jensen, 1987), the performance in explicit memory tasks is influenced by the adult's "general intelligence" rather than by his or her chronological age. It may occur because older adults with a high intelligence level are successful by compensating for a lower performance in explicit memory tasks defined as "difficult" by adults whose intelligence level is of a mid or low level. It is also expected that older adults with a high level of intelligence have a memory performance that is higher than that of younger adults with average intelligence. While tasks that require elaboration during encoding reflect individual differences in intelligence, tasks that do not require elaboration do not reflect individual differences in intelligence. It is for this reason that older adults with a high level of intelligence are more successful in explicit memory tasks, such as free recall, that are sensitive to elaboration rather than in explicit memory tasks, such as recognition, that are less sensitive to elaboration (Craik, 1987). According to the Wachs (1969), students from different grades and with a high level of intelligence, performed free recall task better than students with a low level of intelligence. In a similar way, in a free recall task, Hultsch (1969) proved that within every age group, adults with high verbal skills got higher scores than adults with lower verbal skills. It has been observed that existing research has focused mostly on the relationship between intelligence and explicit memory (Craik, 1987; Engle et al., 1999; Wachs, 1969) and between intelligence and working memory (Ackerman, Beier, and Boyle, 2005; Colom et al., 2005; Duncan et al., 2012; Fukuda et al., 2010). In fact, there is almost no research on the relationship between intelligence and implicit memory. This raises the following question which is not addressed in the literature to date: What is the relationship between general intelligence and implicit memory performance measured by a WSC task with increasing age?

In one of the few studies on the relationship between intelligence and implicit memory, young (students from a department of computer engineering with a high level of fluid intelligence level), nondemented elderly (normal people, the fluid intelligence levels of whom are within the limits of their own age group), "very intelligent" elderly (elderly adults, the fluid intelligence levels of whom are equivalent to those of young students from a department of computer engineering), and patients with dementia (pre-morbid intelligence) were compared in terms of their implicit and explicit memory performances. The results showed that explicit memory (the recognition task) was affected in nondemented participants by their general intelligence rather than by their chronological age. However, no difference was observed between the "very intelligent" elderly group and the "very intelligent" young group, as far as the implicit memory (the WSC task) was concerned (Christensen and Birrell, 1991). On the basis of these findings, when an encoding process depends on elaboration at the study session of the experiment, it is expected to affect explicit memory performance. Yet, since most implicit memory tasks are not influenced by an encoding process based on elaboration, it would be expected that individual differences in intelligence would not influence performance in these tasks. Nevertheless, in some implicit memory tasks that require encoding based on elaboration (for example, unrelated paired associates, generating words relevant to semantic categories), there might be individual differences caused by intelligence, just as in the case of explicit memory tasks (Christensen and Birrell, 1991). In light of all these findings, we aimed to observe the relationship between general intelligence and implicit memory with aging.

Method

Participants

The data have been collected from 95 volunteers; 49 young adults [mean age, 18.73 (range 18–24) years, 23 F, 26 M] and 46 older adults [mean age, 75.65 (range 65–89), years, 23 F, 23 M]. The healthy young adults were selected from among university students enrolled at Hacettepe University and Middle East Technical University. The healthy older adults were chosen among the residents of nursing homes in Ankara. The volunteering participants in both groups were individuals who received education for 11 or more years. All participants were native Turkish speakers with normal or corrected-to-normal vision and with no history of a neuropsychological or psychiatric disorder. Likewise, no participant reported taking any medication that affects the central nervous system. Furthermore, the participants did not report any history of alcoholism, or present treatment with centrally acting medication. The demographical information of the participants is shown in Table 1. Informed consent was obtained in a method approved by the Hacettepe University Ethics Committee.

Table 1: The Demographical Information of the Participants

		Young	Older
Age		M= 18.73 SD= 1.93	M= 75.65 SD= 6.71
Years of Education		M= 13.27 SD= 1.44	M= 13.61 SD= 1.56
Gender	Female	23	23
	Male	26	23
Marital Status	Married	-	9
	Single	49	3
	Widowed/Divorced	-	34

M = Mean; SD= Standard deviation

Materials

Materials Used as Screening Tests and/or Scales to Determine "Healthy Elderly" and "Healthy Young Adults"

The participants in the healthy older adult group were selected among those who fulfill the criteria for "healthy elderly." In order to determine whether the participants fulfilled this criterion, the following screening tests and/or scales were employed. In order to choose "healthy young participants", the Beck Depression Inventory was used. Table 2 presents the scores for all these tests.

The Standardized Mini Mental State Examination (SMMSE)

The SMMSE was first developed by Folstein et al. (1975) as a cognitive assessment tool to examine the elderly who especially suffer from delirium and/or dementia. The test is commonly used in clinical trials to evaluate cognitive impairment in older adults. Participants are evaluated out of 30 points. Reliability and validity studies of the SMMSE in differentiating mild dementia from normal controls in Turkish population were conducted by Güngen et al. (2002). In the present study, older adults who got at least 25 points were considered "nondemented" and thus included in the study.

Geriatric Depression Scale (GDS)

The GDS developed by Scheikh and Yesavage (1986) is a 30-item self-report assessment used to identify depression in the older adults. As a basic screening scale for depression, it consists of 30 questions. The GDS questions are answered "yes" or "no". In this sense, the lower score is 0 and the highest score is 30. Reliability and validity studies of the GDS in Turkish population were conducted by Ertan and Eker (2000).

The Functional Activities Questionnaire (FAQ)

The FAQ serves as a screening tool for evaluating physical functions in the elderly. It was developed by Pfeffer et al. (1982) to assess independence in 10 daily activities designed for community studies of normal aging and mild senile dementia. The normative values for FAQ on Turkish adult sample were determined by Selekler, Cangöz and Karakoç (2004).

Beck Depression Inventory (BDI)

The inventory was developed by Beck in 1961. It is a 21-question multiple-choice self-report inventory, which is used to measure the severity of depression. It is composed of items relating to symptoms of depression. For each item, four levels ranging from non-severe (scored 0) to severe (scored 3) are specified. In this sense, the lowest score is 0 and the highest score is 63. Reliability and validity studies of the BDI in Turkish population were conducted by Hisli (1988); Şahin and Şahin (1992).

Table 2: Means and Standard Deviations of the Scores that Participants Got from Screening Tests and/or Scales and the Cut-off Points for Healthy Young and Older Participants

SMMSE (Older)	M= 27.48 SD= 1.30	Cut-off point ≥25
GDS (Older)	M= .85 SD= .87	Cut-off point ≤11
FAQ (Older)	M= .30 SD= .87	60–69 years old= 2 or more activities ≤ 5 points 70 years old and above=2 or more activities ≤9 points
BDI (Young)	M= 5.52 SD= 1.45	Cut-off point ≤17

M = Mean; SD= Standard deviation

Materials Used to Measure Implicit and Explicit Memory

A total of 50 words selected from the Turkish Word Norms list (Tekcan and Göz, 2005) were used in the study session. The mean of letters in the word list was 5.68, and the range was 4–10. The mean of syllables in the word list was 2.28, and the range was 2-4. The words of the study session were presented on the screen of a 15.4 inch laptop computer, on a light gray background, and with letters in 'Arial' font and black color and all in the upper case. In the test session, 50 previously studied and 50 unstudied words –a total of 100 words – were used (Tekcan and Göz, 2005). Thus, 50 of the words were old, while the other half was new to the participants. Moreover, while selecting the 100 word stems for the WSC task, it was also important to consider that there exist at least three words beginning with the first three letters of these words in the Turkish Dictionary of the Turkish Language Association (TDK, 1983). In both studied and unstudied word lists, the words were controlled for number of letters, syllables, frequency and concreteness levels.

Material Used for Measurement of General Intelligence

The RSPM test is widely used as an assessment tool to measure general intelligence. It measures an individual's ability and speed in the formation of perceptual relations and in reasoning by analogy. In this sense, it assesses abstract reasoning. The test estimates fluid intelligence and cognitive abilities, independent of language, reading and writing skills (Raven, Court and Raven, 1992; Ven and Ellis, 2000). Therefore, the RSPM test is described as a "general intelligence test". Reliability and validity studies of the RSPM test in Turkish population were conducted by Karakaş et al. (2004). The RSPM test consists of 60 items arranged in 5 sets. Each set consists of 12 items. These items are matrices of related geometric designs. For each item, there exists a missing piece in the large rectangle, and participants are supposed to choose the answer to fill the missing part from an array of 6 possible answers in the first 2 sets of the test and from an array of 8 possible answers in the last 3 sets of the test.

Procedure

Participants were taken one-by-one into a quiet room for the experiment. The participants first completed the informed consent form. After the administration of the screening tests, the participants from two age groups were randomly assigned to either implicit or explicit condition. Then, the experiment started with the study session. During the study session, 50 words were presented one at a time on the computer screen for 2 seconds, followed by an inter-stimulus interval of 1 second for each word. The participants in implicit condition were asked to simply look at the words and to say them aloud. In the subsequent distractor session, they were given the simple four arithmetical operations such as (4+5), (12/2). In the test session, both as a measure of implicit and explicit memory, the same WSC task, with different instructions, was used (Kaynak and Cangöz, 2010). The WSC task consisted of 100 word stems for which only the first three letters were provided. In the test session, 100 word stems were presented on the screen for 5 seconds, with an interval of 1 second between the presentations of each item. Under the implicit instruction, participants were asked to complete the given letters "to the first word that pops up in their minds" and under the explicit instruction, they were asked to "complete them to form the words presented previously in the study session". The number of word stems completed to target word was recorded as the dependent variable measure. Only participants in the implicit condition who had answered the question, "Did you know your memory would be tested?" negatively in the debriefing forms, after the task, were included in the statistical analyses. All participants in the implicit condition indicated that they were 'surprised' that their memory performance was assessed. Since we needed to ensure that implicit instruction worked well, first the memory task was employed to continue further. The memory task lasted approximately 15 minutes. Then, the participants were administered the paper version of the RSPM test individually; the average time for completion was approximately 20 minutes for young participants and 40 minutes for older participants. Both total correct score (out of 60) and total completion time (in minutes) were regarded as dependent variables in this study. After a debriefing, the participants were thanked and dismissed.

Results

Firstly, the data were analyzed in a 2 (age: young and older adults) X 2 (memory instruction: implicit and explicit) factorial analysis of variance (ANOVA). The independent variables "age" and "memory instruction" were between groups. Participants' general intelligence was measured by the RSPM test and memory performance was assessed with the WSC task. In this regard, the analyses were performed on the RSPM total correct score, the RSPM completion time and the WSC task score. For all of the analyses in this study, a .05 alpha level and $\eta\rho^2$ to measure effect sizes were used.

Results indicated a main effect of age on the RSPM total correct score and the RSPM completion time ($F(1.91)= 222.81$, p= .000, $\eta\rho^2 = .71$, $F(1.91)= 10.97$, $p < .001$, $\eta\rho^2 = .11$) respectively. The main effect of age on the WSC task score was also found significant ($F(1.91)= 37.78$, $p = .000$, $\eta\rho^2 = .29$).

On the other hand, there was no main effect of memory instruction on the RSPM correct score and the RSPM completion time. Although no main effect of memory instruction on the WSC task score was found, there was also a significant age × memory instruction interaction ($F(1.91)= 6.70$, $p < .05$, $\eta\rho^2 = .07$). According to the results of the Bonferroni-adjusted post-hoc comparisons, the WSC task score of older adults in the explicit condition (M=26.52) were significantly better than the WSC task score of older adults in the implicit condition (M=20.65). The WSC task score of young adults in the explicit condition (M=31.46) and young adults in the implicit condition (M=32.78) did not differ significantly. The WSC task score of young adults in the implicit condition (M=32.78) were significantly better than the WSC task score of older adults in the implicit condition (M=20.65). Similarly, the WSC task score of young adults in the explicit condition (M=31.46) were significantly better than the WSC task score of older adults in the explicit condition (M=26.52).

Then, correlational analyses were used to examine the relationship between the ages of younger and older adults and their RSPM test scores (total correct score and completion time) and the WSC task score. The Pearson correlation coefficients were calculated to measure the strength between the RSPM test scores and the WSC task score. According to the results, age and the RSPM total correct score were strongly and negatively correlated ($r = -.86$, $p < .01$). As age increased, the total correct score of the RSPM test decreased. The correlation between age and the RSPM completion time was found to be statistically significant ($r = .34$, $p < .01$). In other words, as age increased the RSPM completion time also increased.

The Pearson correlation coefficients were also calculated to evaluate the relationship between the age, the implicit and explicit WSC task scores of young and older adults. The results indicated a negative relationship between age and implicit WSC task score ($r = -.54$, $p < .01$) and between age and explicit WSC task score ($r = -.37$, $p < .01$). As age increased, both implicit and explicit WSC task scores decreased. The means and standard deviations of the RSPM test scores of the young and older participants, and the means and standard deviations of the implicit and explicit WSC task scores are given in Table 3.

Table 3: Means and Standard Deviations of the Participants' RSPM scores, and Implicit & Explicit WSC Task Score

	Young	Older
RSPM Total correct score	M= 51.45 SD= 5.17	M= 32.96 SD= 6.93
RSPM Completion time	M= 29.41 SD= 8.51	M= 34.82 SD= 10.40
Implicit WSC Task Score	M= 32.78 SD= 6.11	M= 20.65 SD= 8.96
Explicit WSC Task Score	M=31.46 SD= 5.73	M= 26.52 SD= 5.83

M= Mean; SD= Standard deviation

The Pearson correlation coefficients were also calculated to evaluate the correlations between the RSPM test scores (total correct score and completion time) and the WSC task scores obtained under the implicit and explicit instructions, separately. The correlation between the implicit WSC task score and the RSPM total correct score ($r = .31$, $p < .05$) and the correlation between the explicit WSC task score and the RSPM total correct score were found to be statistically significant ($r = .30$, $p < .05$). In other words, as implicit and explicit WSC task score increased, the RSPM total correct score increased as well. On the other hand, the correlations between the implicit WSC task score and the RSPM completion time ($r = -.07$) and between the explicit WSC task score and the RSPM completion time ($r = -.08$) were not found to be

significant. Furthermore, the Pearson correlation coefficients were calculated to see whether there is a correlation between the RSPM completion time and the RSPM total correct score. The results showed that the correlation between the two was statistically significant ($r = .27$, $p < .01$). That is, the longer the RSPM completion time was, the higher the RSPM total correct score were. The Pearson correlation coefficients were also calculated to observe the correlation between the implicit WSC task score and the explicit WSC task score. There was no significant correlation between the two variables ($r = .19$, $p = .09$). Table 4 shows the correlation matrix which indicates the relationships among all parameters analyzed in the current study.

Table 4: Correlation Matrix of the Relationships of the Variables and the Measures

Correlation Matrix	Age	RSPM Total Correct Score	RSPM Completion Time	Implicit WSC Task Score	Explicit WSC Task Score
Age		**-.86****	**.34****	**-.54****	**-.37****
RSPM Total Correct Score			**.27****	**.31***	**.30***
RSPM Completion Time				-.07	-.08
Implicit WSC Task Score					.19
Explicit WSC Task Score					

**p< .05; **p< .0*

Discussion

In the current study, we investigated the relationship between the RSPM test scores (total correct score and completion time) and the implicit WSC task score with increasing age. The results revealed that as age increased, the total correct score in the RSPM test decreased. This finding provides support for previous literature about the RSPM test (Hultsch, 1969; Salthouse, 1982) and also for the standardization study of this test in the Turkish culture (Karakaş et al., 2004). Moreover, the relationship between age and the RSPM test completion time has been found to be significant. According to this result, as age increased, the time needed to complete the RSPM test increased. This finding supports the results obtained by other studies which show that the fluid intelligence, corresponding to parameters that are sensitive to structural/physiological factors such as information processing speed and accuracy, decreases with age (Baltes, 1993). Moreover, it supports the findings of the standardization study for this test in the Turkish culture (Karakaş et al., 2004).

The relationship between the RSPM test, which is assumed to measure general intelligence, and explicit memory processes was demonstrated in previous studies (Craik, 1987; Christensen and Birrell, 1991; Wachs, 1969). However, the relationship between the RSPM test scores and implicit memory processes is not well researched; thus, it is an original part of this study. This study's findings have shown that the implicit WSC task score and the RSPM test total correct score are correlated. An increase in the RSPM test total correct score was accompanied by an increase in the implicit WSC task score. Similarly, an increase in the RSPM test total correct score was also accompanied by an increase in the explicit WSC task score. These findings can be considered to be an indicator that general intelligence is related not just with conscious retrieval processes (explicit memory), but also with automatic and unconscious retrieval

processes (implicit memory). According to Lezak (1995), the RSPM test total correct score is a strong precursor of general intelligence. Therefore, in this study we can state that implicit memory measurement was a candidate to become an important variable of general intelligence. Traditionally, memory performance is measured explicitly in general intelligence tests. Memory performance measured in an implicit way can also be added as a dimension of general intelligence.

Christensen and Birrell (1991) claimed that implicit memory tasks such as the WSC task were not affected by an elaboration-based encoding process, and individual differences in intelligence should not influence one's performance in these tasks. The results of the current study contradicted the claims of Christensen and Birrell (1991). Since performance on (most) implicit tasks is independent of elaboration at encoding, implicit memory and intelligence are mostly expected not to be related, so far in the literature. However, in some implicit memory tasks that require encoding based on elaboration (for example, unrelated paired associates, generating words relevant to semantic categories), there might be individual differences caused by intelligence (Christensen and Birrell, 1991). In this study, it was found that intellectual capacity in healthy elderly appeared to be associated with the performance in the implicit memory task and it may have been affected by degree or type of elaboration. The current findings, on the other hand, supported Komatsu, Naito and Fuke's (1996) findings, which showed that implicit memory's components associated with the conceptual processes are related to increasing age and intelligence. As a matter of fact, we have found a statistically significant correlation between the implicit WSC task score and the RSPM total correct score in our study. These findings are worthwhile because they underlines the contribution of automatic memory processes, to general intelligence, especially in older adults, which remains overlooked.

The relationship between the RSPM test completion time and the implicit WSC and explicit WSC task score was not found to be significant. The fact that the relation between RSPM completion time and explicit WSC task score was not found to be statistically significant, is in accordance with the finding of the RSPM test's validity study in the Turkish culture. According to validity study, the highest factor load (0.99) has been obtained from the total scores in participants.

It has been observed that there was a negative, yet statistically significant relationship between age, implicit and explicit WSC task scores. Results showed that as age increased, implicit and explicit WSC task scores decreased. This finding could be interpreted as a way that the aging influences negatively not just explicit memory performance, which requires consciousness and awareness, but also the implicit memory performance that is automatic and does not require awareness. This finding supported the findings showed that age had an effect in favour of young adults for both implicit and explicit WSC task performance (Chiarello and Hoyer, 1988; O'Hanlon, Wilcox and Kemper, 2001; Russo and Parkin, 1993).

The relationship between total correct score and completion time, which are the two types of scores obtained from the RSPM test, was found to be statistically significant. According to this result, an increase in the RSPM test total correct score was accompanied by an increase in the RSPM test completion time. In accordance with the results of the RSPM test's standardization study in the Turkish culture, these findings may provide information about the direction of the relationship between information processing speed and accuracy, together with aging in particular.

The correlation between the implicit and explicit WSC task scores was not found to be significant. This finding was an supporting evidence that manipulation used in the study for implicit and explicit instruction was successful. In addition, it also supported the Multiple Memory Systems Approach, which is one of the strongest theories explaining the distinction between implicit and explicit memory. According to the Multiple Memory Systems Approach, there should not be a relation between the task score which represents the implicit and explicit memory processes, because these two memory processes are different and independent from each other, in terms of both the experimental variables that have an effect on them and also of the brain structures to which they are associated with (Schacter, 1992; Schott et al., 2005).

One limitation is that the older participants in both implicit and explicit condition were chosen from among the residents of nursing homes in Ankara. This could lead to a decrement in the sample's representativeness of the entire elderly population. The years of education of both young and older participants were controlled in the present study. In this regard, the participants in both groups were

individuals who received education for 11 or more years. It was convenient to find older adults who had higher education in nursing homes. In future studies, it seems to be important to recruit older adults who do not live in nursing homes.

Conclusion

In summary, memory performance in an implicit WSC task was found to be a potent indicator of general intelligence. In this regard, the present study highlights the importance of implicit memory, which can be used to evaluate cognitive processes of young and older adults in various areas of modern life, such as education, justice, health and insurance systems, differential diagnosis, and rehabilitation and/or treatment of neurological illnesses (such as dementia).

There is an increasing need for scientific research on cognitive processes, especially in a country such as Turkey, where the increase in the over-65 population is 2.5 times greater than the increase in the general population. As the population of the elderly increases, ignoring their needs is impractical. Aging undoubtedly leads to certain changes in cognitive processes. However, these changes are not necessarily always negative. Older adults sometimes present a cognitive performance that is similar to that of young adults, and this change may even turn into an advantage for older adults. What is important for us to understand is the main mechanism underlying the cognitive change caused by aging; and it is memory processes that are at central in this effort. Findings pertaining to the relation between general intelligence, age, and memory, which are the basic areas explored in the present study, can contribute practical solutions to facilitate the life of the elderly.

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