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EFFECTS OF GENDER AND AGE-OF-ACQUISITION ON WORD AND PICTURE-NAMING TASKS IN TURKISH DYSLEXIC AND NON-DYSLEXIC READERS

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Abstract: This research examined the effects of AoA on word and picture-naming tasks in individuals with and without dyslexia and is a replication of previous research by Raman (2011). A 2 × 2 × 2 × 2 mixed design was used, and the variables were: gender (male vs. female), reader status (dyslexic vs. non-dyslexic), AoA (early vs. late), and stimulus type (words vs. pictures). Participants (N = 32) were chosen from Eastern Mediterranean University, their ages matched, and they had a thorough dyslexia assessment. Participants named stimuli that were displayed on a computer screen, and their reaction times (RTs) were measured. The major impacts of reader status, AoA, and stimulus type on RTs were shown to be significant. individuals who were dyslexic had slower RTs than individuals who were not dyslexic, and both groups reacted more quickly to words than to visuals. Furthermore, RTs were faster for items learned earlier than for those learned later. RTs were not substantially impacted by gender. These results underline the significance of taking dyslexia and AoA into account while processing language and corroborate earlier studies. Future studies should examine the gender variations in dyslexia and how they affect language learning.

Introduction

The age-of-acquisition effect (AoA effect) is a well-known phenomenon in cognitive psychology demonstrating that objects learned at an earlier age have an advantage over ones gained later in life (Ellis & Morrison, 1998). This effect applies to various cognitive activities, including lexical retrieval, object recognition, face recognition, and semantic judgments (Ellis & Lambon Ralph, 2000). At the same time, it is important to understand the cognitive mechanisms underlying the development of dyslexia. Difficulties in acquiring reading skills characterize dyslexia and are closely related to deficits in phonological and naming speed (Vellutino et al.,2004). Word and picture writing tasks have become valid indicators of dyslexia and provide information about the cognitive mechanisms underlying it (Borowski et al.,2016). Developmental dyslexia affects literacy acquisition and lasts into adulthood (Felton, Naylor, & Wood, 1990; Korhonen, 1995; Monaghan & Ellis, 2002). It is distinguished by phonological and naming speed deficiencies (Torgesen, Wagner, and Rashotte, 1994; Bowers, Steffy, & Tate, 1988; Wolf & Bowers, 1999). The double deficiency hypothesis proposes that both contribute to dyslexia (Wolf & Bowers, 1999). Picture and word identification reveal dyslexic phonological and speed difficulties (Felton et al., 1990; Katz, 1986). Word shapes are accessed through phonological representations, whereas images activate semantic representations (Warren & Morton, 1982). According to recent research, word and picture-naming problems in dyslexia share the same brain region (McCrory et al., 2005). In the context of dyslexia, it is important to investigate the role of AoA in word and picture-naming tasks in adult readers with and without dyslexia, especially in languages with transparent orthography such as Turkish.

While previous studies have examined the effects of AoA in healthy adults in Turkish, the present study is the replication of the study by Raman (2011) which was the first attempt to examine the effects of AoA in adult readers with dyslexia. The hypothesis suggests that participants with dyslexia will have slower reaction times (RTs) than non-dyslexics despite comparable accuracy of transparent spelling display in Turkish (Raman, 2011). In addition, it is expected that there will be a main effect of AoA in which RTs will be faster for items learned early in the study compared to items learned late in the study, especially in non-dyslexic participants.

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However, it is critical to recognize that not including gender is a limitation of this study. Gender may influence language processing and cognitive task performance, and the inclusion of this variable may provide a more complete understanding of the results (Weismer & Evans, 2002). Future research could examine the potential interaction between gender and the AoA effect in word and picture-naming tasks in Turkish for adults with and without dyslexia. In addition, gender differences in dyslexia prevalence, brain morphology, functional asymmetries, and neurodevelopmental processes emphasize the complexity of a disorder such as dyslexia. Studies show that dyslexia is more common in males, although this depends on diagnostic criteria (Vogel et al.,2013). Postmortem studies of dyslexia have revealed microanatomical abnormalities in the brains of dyslexic patients, with differences observed between males and females (Galaburda et al., 2006).

Research using functional fMRI reveals that there are gender differences in the way the left and right hemispheres of the brain are activated during reading tasks (Shaywitz et al., 1995). Gender variations exist in the morphology of the corpus callosum, especially in the left temporal lobe, according to structural fMRI studies (Leonard et al., 2006). These results show that gender differences may exist in the organisation of the brain regions involved in language, which may have implications for understanding dyslexia. Neuropsychological research suggests that there are gender differences in the processing of rapidly changing acoustic stimuli, which may be due to functional asymmetry and differences in synaptic connections (McArthur & Bishop, 2005). Specifically, a bimodal listening task has shown that the right ear is better at perceiving rapidly changing auditory information in right-handed males (Hugdahl et al., 2009). Studies in primates, rats, and other animals also support the specialization of the left hemisphere in processing rapid acoustic changes (Heffner & Heffner, 1984). The timing of cortical maturation and the influence of sex hormones play an important role in neurodevelopmental differences between males and females, affecting brain morphology, function, and laterality (McCarthy et al., 2017). Abnormal sex hormone levels throughout development, like in Klinefelter syndrome, might impact one's capacity to speak and create functional asymmetries. Men with dyslexia and controls have different brain activity patterns in imaging tests, such as PET and fMRI, especially in language-related areas of the brain (Paulesu et al., 2001). Despite these limitations, structural fMRI investigations on dyslexic men reveal variations in the morphology of the corpus callosum (Hynd et al., 1995).

Overall, understanding gender differences in brain organization and neurodevelopment is essential to understanding illnesses like dyslexia. Findings from published research suggest that gender is an important variable in language comprehension, reading ability, and dyslexia. Functional and structural imaging studies have revealed differences in brain activation and anatomical structure between dyslexic patients and controls, particularly in areas related to language processing. These differences include decreased activation in certain brain regions, changes in asymmetric patterns, and changes in the size of the corpus callosum. In addition, there is evidence to suggest that sex differences in brain development and organization are associated with dyslexia. However, additional studies with larger numbers of subjects of both sexes are needed to understand these complex issues fully.

Method

Design

The study employed a 2 × 2 × 2 × 2 mixed design, where the between-subjects factors were Reader Status (dyslexic vs. non-dyslexic) and gender (males vs. females), and the within-subjects factors were AoA (Early vs. Late) and Stimuli Type (Pictures vs. Words). The experimenter recorded the RTs, or dependent variables, and measured them in milliseconds.

Participants

32 Participants were recruited from the Eastern Mediterranean University campus: 16 participants were dyslexic (8 males and 8 females), and 16 participants were non-dyslexic (8 males and 8 females).

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Readers whose RTs fell within one standard deviation of the mean (N = 16) were classified as non-dyslexic, regardless of gender. RTs 2.5 standard deviations above the mean (N = 16) were used to identify dyslexic readers, both male and female. The ages of the participants were matched.

The participants had been in school for an average of 13 years. The two groups were closely matched to eliminate confounding variables to ensure that the two groups only differed significantly on dyslexia-sensitive measures. The study assumed that participants' academic achievements ensured normal IQ, as they had to pass an end-of-year exam between 14 and 17 to complete secondary education and be eligible for university entrance exams, and admission to EMU was contingent on passing the exam.

Materials

The socio-demographic questionnaire was used to obtain demographic information about participants such as gender and age. Turkish norms, derived from the Snodgrass and Vanderwart (1980) cohort, were used to select a total of 30 Early and 30 Late Acquired stimuli. The norms, which were initially obtained for independent study (Raman, 2003), corresponded to norms obtained in other languages, such as Spanish (Cuetos, Ellis, & Alvarez, 1999). 50 university students who did not take part in the experiment were asked to rate picture agreement, AoA, familiarity, and visual complexity, subjectively using methods adapted from Gilhooly and Logie (1980). The amount of phonemes and syllables, picture agreement, familiarity, complexity, and AoA counts for both Early and Late items are listed in the Appendix.

Procedure

After ethical approval from EMU SOBIB ethics committee was obtained, informed consent was provided to participants. An e-mail was provided on the debriefing form so that participants could contact it for any information needed about the research after consent was given and for any psychological help. Over two weeks, each participant finished the experiment in two sessions. Participants of both genders underwent the same experiment. Participants who started the word naming task in the first session finished the picture-naming task in the second, and vice versa, according to a counterbalanced design. The task given to participants was to accurately and quickly shout out a word or picture that was displayed on the computer screen. Using SuperLab experimental software, each stimulus was presented one at a time. Every word was shown in Times New Roman, black, 32-point lowercase font in the center of an Acer notebook screen. Similarly, images were displayed in the center of the computer screen, one at a time.

In a single block, every test item was randomly combined. Before the main experiment began, a block of practice trials containing ten words or pictures was given for naming. This made it possible for the voice key to be modified appropriately and for the participants to become acquainted with the experimental process. RTs were voice-activated microphone recordings. The target stimulus appeared on the screen after a 1,500 ms inter-stimulus interval and stayed there until it was named. The experimenter made notes about mistakes.

Results

Descriptive Statistics

Table 1. These descriptives include statistical data, divided by reader status and gender, about RTs for different stimulus types

	Gender	Reader status	RTs Early Acquired Words	RTs Early acquired Pictures	RTs Late Acquired Words	RTs Late Acquired Pictures
Mean	Female	Dyslexic	734	886	766	933

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		Non-dyslexic	593	821	635	858
	Male	Dyslexic	751	885	784	964
		Non-dyslexic	612	848	624	920
SD	Female	Dyslexic	70.6	65.5	74.3	66.2
		Non-dyslexic	61.1	95.6	37.9	52.2
	Male	Dyslexic	48.3	54.1	52.4	61.9
		Non-dyslexic	78.6	84.7	57.0	38.1

Inferential Statistics

The mixed ANOVA examining the effects of reader status (dyslexic vs. control), age-of-acquisition (early vs. late), gender (male vs. female), and stimuli type (pictures vs. words) on RT revealed significant main effects for reader status, AoA, and stimuli type ($F(1, 112) = 76.026$, $p < .001$; $F(1, 112) = 15.13$, $p < .001$; $F(1, 112) = 316.08$, $p < .001$, respectively). Dyslexic participants (837 ms) had slower RT on word and picture-naming tasks compared to non-dyslexic participants (738 ms). Additionally, participants responded faster to words (687 ms) compared to pictures (889 ms) indicating that words were named faster than pictures for both groups. Furthermore, items with an earlier age-of-acquisition (766 ms) were named significantly faster than items with a late age-of-acquisition (810 ms). Gender did not show a significant main effect ($F(1, 112) = 3.197$, $p = .076$).

Table 2. The findings of an analysis of variance on RTs with the following factors: gender, AoA, reader status, and stimulus type are displayed in this ANOVA table.

ANOVA - RTs

	Sum of Squares	df	Mean Square	F	p
Stimulus_type	1.31e+6	1	1.31e+6	316.07618	< .001
Reader_status	314142.1	1	314142.1	76.02580	< .001
AoA	62501.0	1	62501.0	15.12593	< .001
Gender	13210.2	1	13210.2	3.19702	0.076
Stimulus_type ✻ Reader_status	61103.5	1	61103.5	14.78772	< .001
Stimulus_type ✻ AoA	6578.8	1	6578.8	1.59213	0.210
Reader_status ✻ AoA	422.9	1	422.9	0.10234	0.750
Stimulus_type ✻ Gender	2834.6	1	2834.6	0.68600	0.409
Reader_status ✻ Gender	466.1	1	466.1	0.11280	0.738
AoA ✻ Gender	764.6	1	764.6	0.18505	0.668
Stimulus_type ✻ Reader_status ✻ AoA	10.3	1	10.3	0.00248	0.960
Stimulus_type ✻ Reader_status ✻ Gender	3717.9	1	3717.9	0.89978	0.345

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ANOVA - RTs					
	Sum of Squares	**df**	**Mean Square**	**F**	**p**
Stimulus_type ✻ AoA ✻ Gender	4477.5	1	4477.5	1.08361	0.300
Reader_status ✻ AoA ✻ Gender	381.7	1	381.7	0.09239	0.762
Stimulus_type ✻ Reader_status ✻ AoA ✻ Gender	557.6	1	557.6	0.13494	0.714
Residuals	462789.1	112	4132.0		

The analysis further revealed a significant interaction between reader status and stimuli type (F (1, 112) = 14.788, $p < .001$) as shown in Table 3.

Table 3. There are significant differences in mean RTs under different settings as shown by the post-hoc comparisons between stimulus type and reader status.

Post Hoc Comparisons – Stimulus type and Reader status									
Comparison									
Stimulus type	Reader status		Stimulus type	Reader status	Mean Difference	SE	df	t	$p_{bonferroni}$
word	dyslexic	-	word	non-dyslexic	142.8	16.1	112	8.88	< .001
		-	picture	dyslexic	-158.3	16.1	112	-9.85	< .001
		-	picture	non-dyslexic	-102.9	16.1	112	-6.41	< .001
	non-dyslexic	-	picture	dyslexic	-301.1	16.1	112	-18.74	< .001
		-	picture	non-dyslexic	-245.7	16.1	112	-15.29	< .001
picture	dyslexic	-	picture	non-dyslexic	55.4	16.1	112	3.45	0.005

F(15, 112) = 1.29, $p = 0.217$, the result of Levene's test for homogeneity of variances, showed no statistically significant differences in variances between the groups in Table 4.

Table 4. Levene's test for homogeneity of variance
Homogeneity Test of variance

F	**df1**	**df2**	**p**
1.29	15	112	0.217

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Discussion

Building on earlier research by Raman (2011), this study examined the effects of gender and age-of-acquisition (AoA) on word and picture-naming tasks in Turkish readers who are dyslexic and those who are not. The results show that reader status, AoA, and stimulus type have a substantial impact on RTs, underscoring the significance of taking dyslexia and AoA into account while processing language. Furthermore, even though gender had no discernible impact on RTs, investigating gender variations in dyslexia and language acquisition opens up new study directions.

The complex interactions between cognitive processes, literacy development, and language comprehension are shown by the significant main effects for reader status, AoA, and stimulus type that were found. People with dyslexia had slower RTs than people without it, which is in line with other research linking dyslexia to problems with phonological and naming speed. The double-deficit hypothesis of dyslexia is supported by the delayed RTs for dyslexic participants in both word and picture tasks, which point to a widespread impairment in lexical retrieval and semantic processing. Furthermore, the main effect of AoA shows faster response times (RTs) for items learned earlier than those learned later, indicating the cognitive benefit of early-acquired stimuli.

This result supports the AoA effect found in cognitive psychology and highlights the long-lasting influence of early learning experiences on cognitive functions like semantic access and lexical retrieval. Additionally, the major effect of stimulus type clarifies how words and pictures are processed differently, with participants reacting to words more quickly than pictures. This suggests that linguistic stimuli play a facilitative function in cognitive activities.

A better understanding of the function of sensory modalities in dyslexia and language acquisition may result from examining the effects of various exposure types (such as auditory, visual, and multisensory) on language processing. It is predicted that exposure to many senses would improve lexical retrieval and semantic access, hence reducing the challenges dyslexic people face when doing language activities.

Future research could examine the relationship between working memory, executive functioning, attentional control, and reader status (dyslexic vs. non-dyslexic). It is predicted that people with dyslexia who also have co-occurring cognitive deficiencies will have shorter RTs and more variability in their performance on different language tests. This emphasises the need for tailored interventions that focus on particular cognitive domains.
Examining gender variations in the frequency of dyslexia, brain structure, and neurodevelopmental processes may shed light on the intricate aetiology of dyslexia. Gender-sensitive approaches in dyslexia research and intervention are necessary since predictions indicate that gender-specific differences in brain organization and functional connectivity would impact language processing and cognitive task performance.

The study reveals the cognitive mechanisms behind word and picture-naming tasks in Turkish readers, emphasizing the need to consider dyslexia and AoA when processing language. It enhances our understanding of dyslexia and language acquisition, opening new avenues for research into the relationship between reading abilities and cognitive development. Future research can guide evidence-based interventions tailored to individual patient needs.

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Appendix

Early Turkish item norms along with their English translations, including phoneme and syllable counts, image agreement, familiarity, complexity, and counts of areas of agreement (Raman, 2011)

Turkish name	English translation	Phon.	Syl.	Imag. agree	Fam.	Comp.	AoA
Araba	Car	5	3	2.87	4.44	3.85	3.51
Ayakkabı	Shoe	8	4	3.20	4.46	3.17	3.20
Balon	Balloon	5	2	4.54	2.57	1.14	3.04
Banana	Banana	6	3	4.36	4.16	1.34	3.33
Bardak	Glass	6	2	3.92	4.83	1.95	2.98
Bıçak	Knife	5	2	3.04	4.60	1.49	3.12
Burun	Nose	5	2	4.09	4.59	1.73	3.32
Çatal	Fork	5	2	3.64	4.75	3.37	3.14
Çiçek	Flower	5	2	3.08	3.90	2.71	3.18
Çorap	Sock	5	2	3.98	4.69	1.61	3.28
El	Hand	2	1	4.16	4.75	2.78	3.17
Elma	Apple	4	2	4.40	4.24	1.54	2.94
Ev	House	2	1	2.84	4.48	3.36	3.26
Fil	Elephant	3	1	4.16	1.61	4.15	3.55
Fincan	Cup	6	2	3.24	4.68	2.42	3.23
Göz	Eye	3	1	4.05	4.74	3.00	3.02
Güneş	Sun	5	2	3.22	4.46	2.32	3.08
Kalem	Pencil	5	2	4.20	4.65	1.68	3.48
Kapı	Door	4	2	3.40	4.72	2.05	3.50
Kaşık	Spoon	5	2	4.18	4.72	1.86	3.16
Kedi	Cat	4	2	3.65	3.67	2.71	3.33
Kitap	Book	5	2	3.95	4.82	1.98	3.62
Köpek	Dog	5	2	3.40	4.09	2.88	3.00
Kulak	Ear	5	2	4.42	4.49	2.71	3.29
Masa	Table	4	2	4.27	4.69	1.41	3.55
Ördek	Duck	5	2	3.98	2.39	3.17	3.44
Palyaço	Clown	7	3	3.11	1.86	4.22	3.44
Sandalye	Chair	8	3	4.47	4.70	2.25	3.37
Tavuk	Chicken	5	2	4.00	2.46	3.41	3.43
Yatak	Bed	5	2	3.49	4.86	2.69	2.49

Late Turkish item norms along with their English translations, including phoneme and syllable counts, image agreement, familiarity, complexity, and counts of areas of agreement (Raman, 2011).

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Turkish name	English translation	Phon.	Syl.	Imag. agree	Fam.	Comp.	AoA
Akordiyon	Accordion	9	4	3.65	4.48	4.25	6.31
Ananas	Pineapple	6	3	4.35	3.21	3.95	4.83
Askı	Hanger	4	2	3.89	1.92	1.17	4.88
Atlet	Vest	5	2	3.80	3.73	2.46	5.78
Bayrak	Flag	6	2	3.56	4.03	1.42	4.85
Demir	Anchor	5	2	4.18	4.30	2.07	5.61
Fırça	Paintbrush	5	2	3.25	3.72	1.81	4.91
Fog (balığı)	Seal	3	4	3.50	4.55	2.86	5.34
Gergedan	Rhinoceros	8	3	3.95	4.58	3.00	5.27
Gitar	Guitar	5	2	4.67	3.18	2.78	4.85
Helikopter	Helicopter	10	4	3.95	4.28	3.81	5.00
Kabak	Pumpkin	5	2	4.24	4.16	2.12	5.45
Kangaru	Kangaroo	7	3	4.40	4.57	3.86	4.92
Kaplan	Tiger	6	2	3.06	4.50	2.46	4.85
Kıravat	Tie	7	3	4.19	3.99	2.32	5.10
Kuğu	Swan	4	2	4.34	3.80	3.07	5.11
Mantar	Mushroom	6	2	3.87	3.59	3.71	5.25
Ok	Arrow	2	1	1.74	3.07	1.08	4.90
Pipo	Pipe	4	2	4.30	4.50	1.71	5.72
Puro	Cigar	4	2	3.22	4.06	2.85	5.70
Raket	Tennis racket	5	2	4.27	3.80	3.19	5.10
Soğan	Onion	5	2	4.24	2.42	2.36	5.06
Tabla	Ashtray	5	2	3.00	2.72	2.03	4.86
Taç	Crown	3	1	3.31	4.66	4.34	4.88
Trampet	Trumpet	7	2	3.11	4.32	4.19	5.15
Tuzluk	Saltshaker	6	2	3.42	2.79	2.51	5.08
Ütü	Iron	3	2	3.09	2.58	3.15	4.84
Yüksük	Thimble	6	2	4.34	3.62	2.22	5.10
Zarf	Envelope	4	1	3.93	2.14	2.19	5.16
Zincir	Chain	6	2	4.18	4.06	2.31	5.06

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