Iranian Educational Psychology Association

Iranian Journal of Learning and Memory

Print ISSN: 2645 - 5455
Online ISSN: 2645 - 5457

Homepage: https://journal.iepa.ir

The Effect of Foreign Language Anxiety on EFL Students' Cognitive Processing in Working Memory

Vahid Rahmani Doqaruni[1]✉

1. *Corresponding author*, Department of English Language and Literature, Faculty of Humanities, University of Gonabad, Iran. E-mail: rahmani@gonabad.ac.ir

Article Info

Article type:
Research Article

Article history:
Received June 06, 2024
Received in revised form August 10, 2024
Accepted August 14, 2024
Published online August 17, 2024

Keywords:
Foreign Language Anxiety,
Cognitive Processing,
Working Memory,
Attentional Control Theory,
Cognitive Interference Theory

ABSTRACT

Objective: The aim of the present study was to investigate the effect of foreign language anxiety (FLA) on English-as-a-foreign-language (EFL) students' cognitive processing of linguistic stimuli.

Methods: The participants were 179 upper-intermediate or advanced EFL learners from different branches of an English language teaching institute. They were asked to fill out the Foreign Language Classroom Anxiety Scale (FLCAS) questionnaire and then, considering their scores, were randomly assigned to high-anxiety and low-anxiety groups. To analyze the EFL learners' cognitive processing of linguistic stimuli, a semantic decision task was used in the present study. In this task, participants saw a pair of words presented one after each other and were asked to decide whether the target word was related in meaning to the preceding prime word. Mixed Factorial Repeated Measure ANOVA was run on error rate (ER) data to establish the potential interaction between primes and targets. To reveal any potential anxiety effects, anxiety was run as a between-subject factor in the analysis.

Results: The findings showed a statistically significant effect of anxiety on cognitive processing of linguistic stimuli with respect to ER. More specifically, the EFL students in the low-anxiety group made fewer errors in comparison to their counterparts in the high-anxiety group.

Conclusion: The findings are attributed to the attentional control theory and cognitive overload of working memory, cognitive interference theory, and the specific nature of the task used in the present study. The results emphasize the fact that FLA could result in deficits in cognitive processing of linguistic stimuli by foreign language learners.

Cite this article: Rahmani Doqaruni, V. (2024). The Effect of Foreign Language Anxiety on EFL Students' Cognitive Processing in Working Memory. *Iranian Journal of Learning and Memory*, *7* (26), 35-54. DOI: http//doi.org/10.22034/IEPA.2025.472940.1497

© The Author(s).
Publisher: Iranian Educational Research Association.
DOI: http//doi.org/10.22034/iepa.2024.477074.1500

Introduction

Foreign language anxiety (FLA) has always been considered an important factor in affecting second/foreign language (L2) learners' learning (Fallah, 2017; Horwitz, 2010; Horwitz & Nassif, 2018). This specific kind of anxiety is usually aroused by a certain type of situation (e.g., speaking a foreign language) in the context of the L2 classroom (MacIntyre, 1998). In particular, the concept of FLA is defined as a "distinct complex of self-perceptions, beliefs, feelings, and behaviors related to classroom language learning arising from the uniqueness of the language learning process" (Horwitz et al., 1986, p. 128).

As previous literature has shown that there is a negative relationship between FLA and L2 learners' performance (e.g., Elkhafaifi, 2005; Frantzen & Magnan, 2005; Kondo & Yang, 2004; Li et al., 2023; Matsuda & Gobel, 2004; Pyun et al., 2014; Teimouri et al., 2019; Woodrow, 2006, 2011), L2 researchers have shown interest in investigating variables which might affect such a relationship including emotional intelligence (Han et al., 2022; Li et al., 2021; Resnik & Dewaele, 2020), language proficiency (Jiang & Dewaele, 2020), learner autonomy (Ahmadi & Izadpanah, 2019), learner beliefs (Aslan & Thompson, 2021), learning strategies (Abdurahman & Rizqi, 2020), motivation (Alamer & Almulhim, 2021; Tsai & Liao, 2021), personality (Safranj & Zivlak, 2019), self-confidence (Bensalem & Thompson, 2022), self-efficacy (Eginli & Solhi, 2020; Wang et al., 2023), self-esteem (Rubio-Alcala, 2017), and willingness to communicate (Kalsoom et al., 2020; Lee & Hsieh, 2019; Wang et al., 2021; Zhou et al., 2023).

There is a considerable body of research on the relationship between anxiety and cognitive performance in the general field of psychology (for a review see Derakshan & Eysenck, 2009). However, despite the existence of many studies on FLA in L2 education, the effect of FLA on cognitive processing in L2 literature has mainly been neglected. This is surprising because previous research has shown that cognitive processing has a significant effect on L2 learners' working memory and it can be influenced by different factors such as linguistic affection (Rahmani Doqaruni, 2021a), semantic relatedness (Rahmani Doqaruni, 2021b, 2022), learners' age (Rahmani Doqaruni, 2023), modality type (Rahmani Doqaruni, 2024a), gender (Rahmani Doqaruni, 2024b), and mode of presentation (Rahmani Doqaruni, in press). This makes it necessary to investigate the effect of anxiety on cognitive processing in L2 research as it might have a significant effect, like other factors investigated in previous research, on cognitive processing of L2 learners. Moreover, despite the existence of many other psychological features, previous research has emphasized on the importance of cognitive approaches for understanding anxiety (Heimberg, 2002; Hofmann, 2007; Maher & King, 2023). Thus, in line with previous research, exploring the effect of anxiety on cognitive processing of linguistic stimuli is of particular interest. More importantly, as L2 learning involves complex cognitive functions, it is important to explore the effect of FLA on L2

learners' cognitive processing in their working memory. In this way, the aim of the present study was to investigate the effect of FLA on English-as-a-foreign-language (EFL) students' cognitive processing of linguistic stimuli.

In order to achieve the aim of the present study, the following research question was formed:

Is there any statistically significant effect of foreign language anxiety on Iranian EFL students' cognitive processing of linguistic stimuli?

Theoretical Foundation

Eysenck (1979) was the first scholar who noticed the cognitive dimension of anxiety. He categorized anxiety into two distinct components, namely 'worry' and 'emotionality'. The former includes cognitive manifestations, such as having low level of confidence in performance, making comparisons between personal performance to others, excessive worry of evaluation, and worrying about the consequences of failure. The latter is shown through physiological functioning, such as increased heart rate, nausea, dizziness, and feeling panic. Eysenck argued that anxious students are more likely to engage in task-irrelevant cognitive processing than non-anxious students. As a result, the task-irrelevant cognitive processing activities "preempt some of the available effort and capability of working memory" (p. 378). In other words, anxiety hampers the working memory capacity of anxious learners. More specifically, "anxious learners are usually more easily distracted, and the defense mechanism triggered by anxiety will interfere with the cognition threshold in learning" (Zheng & Cheng, 2018, p. 3).

In line with the general field of education, L2 researchers have also tried to explain why FLA has a negative effect on students' language learning and performance. For example, according to Krashen's (1987) affective filter hypothesis, when the affective filter is high, L2 students have problems in processing the input information. In this way, FLA as an important affective variable might raise L2 students' affective filter and, as a result, hinder their understanding of the input information. MacIntyre and Gardner (1994a) proposed a three-stage model (including input, processing, and output stages) to explain the interference of FLA with L2 learners' cognitive systems. According to their model, students' attention might be distracted by task-irrelevant concerns (such as fear of negative evaluation from their peers or teachers) in the input stage. In addition, FLA can also influence students' speed and accuracy in storing information in the processing stage and the quality of their products in the output stage.

Literature Review

The field of L2 education has witnessed a growth of interest in the effect of FLA on L2 learners' cognitive processing in the last two decades. For example, Khan and Zafar (2010) examined the arousal of anxiety caused by the presence of a video camera at various points in a vocabulary recall

task as a kind of cognitive performance. One hundred Hindi university EFL students were randomly assigned to one control group and three experimental groups formed by exposing them to the camera prior to the input, processing, or output stages of learning. The results showed that the introduction of the camera in each experimental group caused the highest anxiety rating. However, the effect of camera on anxiety ratings was reduced by introducing the intervening tasks which suggests that the participants eventually were able to cope with the anxiety aroused by the camera.

Li's (2015) study explored the effect of anxiety-producing conditions on cognitive function of L2 learners by focusing on their ability to produce vocabulary. Using the Foreign Language Classroom Anxiety Scale (FLCAS), the participants were divided into high-anxiety and low-anxiety groups. The participants of both groups were asked to write down as many English vocabulary words beginning with 'b' as they could think of in two minutes under two anxiety-producing conditions. In the first condition, half of the both groups (i.e., high-anxiety and low-anxiety groups) were told that an average score on this English vocabulary recall test was ten words. To increase the tension level, the other half in the second condition was told that the average score was forty words. The findings showed that foreign language anxiety generally had negative effects on L2 learners' output performance. However, the results of the second condition (i.e., high anxiety-producing situation) showed that anxiety could also be facilitative.

As the relationship between L2 teaching and interpretation training is intertwined, Yan and Liang (2022) investigated the specific impact of FLA on interpretation learning. They specifically studied the effect of the interpretation classroom FLA (ICFLA) on two distinct factors: first, interpretation learning and, second, dependency distance (DD) as a sign of learners' cognitive load. An adapted FLCAS was used to measure the specific ICFLA. The participants were 49 university students who enrolled in interpretation classes at a university in Hong Kong. The results showed a significant negative correlation between ICFLA and both interpretation achievement (i.e., higher anxiety levels were related to lower consecutive test scores), and DD (i.e., higher ICFLA levels were related to shorter DD and higher cognitive load).

In a more recent study, Borisova et al. (2024) investigated the effect of FLA on learners' cognitive processes in an EFL context. The participants were 306 EFL university students who were asked to fill out the FLCAS. The cognitive processing of the foreign language anxiety was examined in three stages: input anxiety stage (which included psychological factors affecting cognition), processing anxiety stage (which included behaviors such as test taking and willingness to improve), and output anxiety stage (which included factors such as confidence and uncomfortable feelings in front of other students). The findings showed a statistically significant effect of anxiety on EFL students' language performance in classroom context. More specifically, it was found that foreign language anxiety had negative effects on cognitive processing in an EFL

classroom context. In order to reduce anxiety, the study suggested to provide L2 students with more opportunities to deal with L2 in classroom context.

In contrast to previous research focusing on the effect of FLA on L2 learners' cognitive processing, Castillejo (2023) investigated the effect of prior cognitive processing, which was defined as using L2 earlier in discourse, on L2 learners' foreign language classroom anxiety (FLCA) and fluency. The participants were divided into two groups with similar FLCA and proficiency scores, and they were asked to do the same narrative task. One group completed just one task, and the other group completed the same task after responding to a similar task to explore the effect of prior cognitive processing. To analyze the participants' speech, three factors of breakdown, speed, and repair fluency were measured. The findings showed that prior cognitive processing reduced the L2 learners' FLCA during L2 production. However, prior cognitive processing did not have a significant effect on L2 learners' fluency gains but instead had a positive effect on message conceptualization. Based on the results, it was argued that prior cognitive processing can moderate FLCA in L2 production as it changes the way attentional resources are allocated in subsequent performance.

Ayllon-Salas et al. (2024) studied the relationship between anxiety and cognitive emotion regulation strategies used by bilingual and non-bilingual students. The participants were 262 Spanish primary school students from bilingual and non-bilingual schools. The Spanish versions of FLCAS and Cognitive Emotion Regulation Questionnaire (CERQ) were used to measure the anxiety level of the students and their cognitive coping strategies, respectively. The results showed statistically significant differences between bilingual and non-bilingual groups of students considering their anxiety levels. More specifically, it was found that non-bilingual students tend to experience higher levels of anxiety in the foreign language learning processes and situations than their bilingual counterparts. Moreover, the results revealed that there were significant differences in cognitive emotional regulation strategies used by the two groups. In general, non-bilingual students used more cognitive emotional regulation strategies than bilingual students.

As reviewing the previous literature shows, anxiety has a negative effect on cognitive processing of L2 learners. In other words, anxiety causes problems in processing L2 stimuli for L2 learners. Although previous studies have provided us with an insightful perspective on the relationship between FLA and cognitive processing, no previous study has tried to show the effect of FLA on working memory directly. To fill this gap, a semantic decision task was employed in the present study to investigate the effect of FLA on cognitive processing. As showing the effect of FLA on working memory directly requires that EFL learners' attentional resources be investigated, a semantic decision task would be the best option as it permits the investigation of the underlying cognitive processes.

Materials and Methods

The present study is quantitative in nature and the data were gathered through a questionnaire. First, the participants were asked to fill out a questionnaire on FLA. Then, considering the results, they were divided into two equal groups, namely low-anxiety and high-anxiety groups. To analyze the participants' cognitive processing of linguistic stimuli, a semantic decision task was used in which the participants saw a pair of words presented one after each other and were asked to decide whether the target word was related in meaning to the preceding word. The following sections provide more information about the questionnaire and the data-gathering process.

Instrument

The present study used the Foreign Language Classroom Anxiety Scale (FLCAS) questionnaire, developed by Horwitz et al. (1986), to measure the EFL students' anxiety. The questionnaire includes three parts: apprehension in communication (e.g., I start to panic when I have to speak without preparation in language class), anxiety in tests (e.g., The more I study for a language test, the more confused I get), and fear of receiving negative feedback (e.g., I am afraid that the other students will laugh at me when I speak the foreign language). The questionnaire contains 33 items, each measured on a 5-point Likert scale, with responses ranging from "strongly agree" to "strongly disagree". The "strongly agree" option for positively worded items receives 5 points and the "strongly disagree" option receives 1 point, while the inverse applies for negatively worded items. The anxiety score was calculated by summing up the responses of each participant. In this way, total scores can range from 33 to 165, with higher scores indicating more anxiety and lower scores indicating less anxiety in a foreign language classroom context. Conducting several studies on validity and reliability of the FLCAS, Horwitz (1991) showed that it has satisfactory reliability, internal consistency, construct validity and test-rest reliability.

Participants

The participants were EFL learners from three branches of a private English language teaching institute in Mashhad, Iran. They were asked to participate in the present study through invitation. To eliminate any potential interfering effect of gender on the results of the present study, the data were only gathered from male participants whose age ranged from 16 to 21 years old. All the participants used Persian as their native language. They were studying at upper-intermediate or advanced levels of English based on the institute's own placement test. However, to ensure that the study participants were at the same proficiency level, the paper-and-pencil version of the Quick Placement Test (Cambridge Local Examinations Syndicate 2001) was administered to 193 students. In the test, participants were required to answer 60 items which assessed their English grammar, reading and vocabulary knowledge in 60 minutes. According to the scoring rubric of the test, participants with scores between 48 and 60 were considered to be upper-intermediate to

advanced learners, which corresponds to the C1 and C2 level of the Common European Framework of Reference for Languages. The test results showed that 179 EFL learners were qualified enough to fill out the FLCAS questionnaire. After taking the permission of the supervisor of the institute and teachers, the printed formats of the questionnaires were distributed to the qualified EFL learners at the end of each class session.

Analyzing the EFL learners' responses to the FLCAS questionnaires showed that 57 EFL learners scored 1 or more standard deviation above the overall sample mean; so, they were classified as the high-anxiety group. It was also found that 65 EFL learners scored 1 or more standard deviation below the sample mean whom were classified as the low-anxiety group. Then 30 EFL learners from each of these two groups were randomly chosen, and the data gathered from the 60 students were used for analysis in the present study. According to Brysbaert (2019), the number of participants required for repeated measures studies with traditional, frequentist statistics ($p < .05$) is 27 for each group. Thus, 30 participants for each group in the present study is appropriate.

All the participants of the present study were aware of the voluntary nature of the study and gave informed consent to participate. Their privacy was assured, and their private information was kept confidential. Their right to change their mind was respected, and they were informed that they could withdraw from the study without any penalty.

Linguistic Stimuli

The aim of the present study was to investigate the effect of FLA on EFL students' cognitive processing of linguistic stimuli. In order to achieve this aim, a prime word (which was a positive, negative, or neutral noun) preceded the target word (which was a positive or negative adjective). This resulted in three different categories which consisted of six different conditions: a) congruent noun-adjective English dyads, for example, *Hug-Friendly* (positive prime, positive target) or *Crime-Horrible* (negative prime, negative target), b) equally meaningful English noun-adjective pairs by putting neutral nouns before the same target adjectives, for example, *People-Friendly* (neutral prime, positive target) and *Consequences-Horrible* (neutral prime, negative target), and c) unrelated noun-adjective dyads by preceding target adjectives with semantically unrelated prime nouns of opposite valence (positive condition: *Hell-Friendly*; negative condition: *Love-Horrible*), and neutral valence (positive condition: *Bottle-Friendly*; negative condition: *Teaspoon-Horrible*). Following this procedure, 120 noun-adjective dyads were formed. The noun-adjective dyads used in the present study were adopted and adapted from Jonczyk (2016).

Procedure

The present study used a semantic decision task to investigate the EFL learners' cognitive processing of linguistic stimuli. As the main aim was to investigate the effects of FLA on cognitive

tasks especially dealing with attentional resources of the EFL learners, a semantic decision task would be the best option as it permits the investigation of the underlying cognitive processes. In this task, participants see a pair of words presented one after each other and are asked to decide whether the target word is related in meaning to the preceding word. PsychoPy (Peirce, 2007, 2009), version 3, was used to design and perform the task.

The participants were seated in a comfortable chair 100 cm away from a laptop monitor in a quiet room. To control any environmental interfering variables, all the participants were tested in the morning, rather than in the afternoon, so that to make sure their responses were not affected by the time of the day. In the same way, to control any contextual interfering variables, all the participants were tested in the same room under the same conditions. The participants were asked to read a sequence of two words appearing on the screen (first, a noun and then, an adjective) and decide upon the presentation of the second word whether the word pair was related in meaning, by pressing an appropriate button on the keyboard. Each noun-adjective dyad was preceded by a fixation point that lasted 2000 milliseconds. Subsequently, a prime noun was presented for 1000 milliseconds in the center of the screen followed by a target adjective. The target adjective stayed on the screen until participant responded, but no longer than 2000 milliseconds. The whole experimental session consisted of 120 noun-adjective dyads presented in randomized order in white letters (font Times New Roman, size 20) over grey background. The whole data gathering process took almost 15 minutes for each participant.

Data Analysis

In any research study, the characteristics of the design and the variables determine the appropriate statistical analysis. Considering the aim and the variables of the present study, a Mixed Factorial Repeated Measure ANOVA was the right data analytic approach as it contains (a) a continuous dependent variable (i.e., error rate which is the indicator of the cognitive processing), (b) two or more categorical independent variables (i.e., prime, target, and anxiety), (c) at least one independent variable that varies between-units (i.e., anxiety), and (d) at least one independent variable that varies within-units (i.e., prime and target).

IBM SPSS (version 24) was used for data analysis. Mixed Factorial Repeated Measure ANOVA was run on error rate (ER) data to reveal whether there is any interaction between primes and targets. Anxiety was run as a between-subject factor in the analysis to show any potential effects.

Results

Mauchly's test showed that sphericity was assumed (p=.707) and, therefore, it can be concluded that there are not significant differences between the variances of the differences. Table 1 shows the means and standard deviations of ERs (in percentage) for different conditions of prime-target

interaction for both anxiety conditions (i.e., high and low). As the table shows, the low-anxiety EFL students had fewer errors in comparison to the high-anxiety EFL students in all the conditions. On average, the EFL students in the low-anxiety group (M = 24.3%, SD = .13) made fewer errors in comparison to their counterparts in the high-anxiety group (M = 32.3%, SD = .17).

Table 1. Means and Standard Deviations of ERs for Prime-Target

	High Anxiety (N=30)		Low Anxiety (N=30)	
	ER(%)	SD	ER(%)	SD
Positive-Positive	27.9	.19	17.4	.11
Positive-Negative	28.9	.20	19.5	.13
Negative-Positive	27.2	.18	23.8	.13
Negative-Negative	40.4	.21	32.6	.19
Neutral-Positive	28.2	.13	20.6	.10
Neutral-Negative	41.6	.13	31.9	.13
Total Mean	32.3	0.17	24.3	0.13

The analysis of the data revealed a main effect of prime (Table 2), $F(1, 58) = 17.197$, $p = .00$, $\eta^2 = .22$, with the highest ER related to neutral primes for the high-anxiety group (M = 35.0%, SE = .02) and negative primes for the low-anxiety group (M = 28.3%, SE = .02). The further analysis showed that the second highest ER for the high-anxiety group belonged to negative primes (M = 33.9%, SE = .02) followed by positive primes (M = 28.4%, SE = .02). However, the results for the low-anxiety group showed that the second highest ER belonged to neutral primes (M = 26.3%, SE = .02) followed by positive primes (M = 18.5%, SE = .02). An interesting finding is that positive primes resulted in the lowest ER for both high-anxiety and low-anxiety groups.

Table 2. Interaction between Prime and Anxiety

				95% Confidence Interval	
Anxiety	**Prime**	**Mean**	**Std. Error**	**Lower Bound**	**Upper Bound**
High	**Positive**	.284	.024	.236	.333
	Negative	.339	.028	.282	.395
	Neutral	.350	.020	.310	.390
Low	**Positive**	.185	.024	.136	.234
	Negative	.283	.028	.226	.339
	Neutral	.263	.020	.223	.303

The analysis also revealed a main effect of target, $F(1, 58) = 66.306$, $p = .00$, $\eta^2 = .53$. The follow-up analysis (Table 3) showed that both high-anxiety and low-anxiety groups follow a similar pattern, as they were more accurate at identifying positive target adjectives (High-Anxiety: M = 27.8%, SE = .02; Low-Anxiety: M = 20.6%, SE = .02) compared to negative target adjectives (High-Anxiety: M = 37.0%, SE = .02; Low-Anxiety: M = 28.0%, SE = .02).

Table 3. Interaction between Target and Anxiety

Anxiety	Target	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
High	**Positive**	.278	.020	.237	.319
	Negative	.370	.022	.326	.414
Low	**Positive**	.206	.020	.166	.247
	Negative	.280	.022	.236	.325

The data showed a statistically significant relationship between prime and target, $F(1, 58) = 14.943$, $p = .00$, $\eta^2 = .20$. The follow-up analyses (Table 4) revealed that the highest number of errors belonged to negative target adjectives preceded by neutral prime nouns (M = 36.8%, SE = .01). On the other hand, the lowest number of errors belonged to positive target adjectives preceded by positive prime nouns (M = 22.7%, SE = .02).

Table 5. Interaction between Prime and Target

Prime	Target	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Positive	**Positive**	.227	.020	.186	.268
	Negative	.242	.022	.198	.287
Negative	**Positive**	.255	.021	.214	.297
	Negative	.366	.027	.313	.419
Neutral	**Positive**	.244	.015	.214	.275
	Negative	.368	.017	.333	.403

Finally, the analysis revealed a statistically significant three-way interaction between prime, target, and anxiety, $F(1, 58) = 12.276$, $p = .00$, $\eta^2 = .17$. The follow-up pairwise comparisons (Table 5) revealed that the highest ER for the high-anxiety group was related to negative target adjectives preceded by neutral prime nouns (M = 41.7%, SE = .02) and for the low-anxiety group was related to negative target adjectives preceded by negative prime nouns (M = 32.7%, SE = .03). The second highest ER for the high-anxiety group belonged to negative prime nouns followed by negative target adjectives (M = 40.5%, SE = .03) and for the low-anxiety group belonged to neutral prime nouns followed by negative target adjectives (M = 31.9%, SE = .02). On the other hand, the lowest ER for the high-anxiety group was found in positive target adjectives preceded by negative prime nouns (M = 27.2%, SE = .02) and for the low-anxiety group was found in positive target adjectives preceded by positive prime nouns (M = 17.5%, SE = .02). The second lowest ER for the high-anxiety group was found in positive target adjectives preceded by positive prime nouns (M = 28.0%, SE = .02) and for the low-anxiety group was found in negative target adjectives preceded by positive prime nouns (M = 19.5%, SE = .03). Considering all the conditions, the low-anxiety group outperformed the high-anxiety group in ER.

Table 5. Interaction between Prime, Target, and Anxiety

Anxiety	Prime	Target	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
High	**Positive**	**Positive**	.280	.029	.222	.337
		Negative	.289	.032	.226	.352
	Negative	**Positive**	.272	.029	.214	.331
		Negative	.405	.037	.330	.480
	Neutral	**Positive**	.283	.022	.240	.326
		Negative	.417	.025	.367	.466
Low	**Positive**	**Positive**	.175	.029	.117	.232
		Negative	.195	.032	.132	.258
	Negative	**Positive**	.238	.029	.180	.297
		Negative	.327	.037	.252	.402
	Neutral	**Positive**	.206	.022	.163	.249
		Negative	.319	.025	.270	.369

The aim of the present study was to investigate the effect of FLA on EFL students' cognitive processing of linguistic stimuli. The findings of the present study showed a statistically significant effect of anxiety on cognitive processing of linguistic stimuli with respect to ER. In other words, the results of the present study showed that the high-anxiety and low-anxiety groups follow different patterns in processing affective meaning of single words in their second language. Specifically, according to the data, the EFL students in the low-anxiety group made fewer errors in comparison to their counterparts in the high-anxiety group.

This finding is in line with previous research as anxiety has been shown to have negative effects on different aspects of L2 learners' performance. MacIntyre and Gardner (1994b) found that exposing L2 learners to a video camera while they were working on a vocabulary learning task resulted in anxiety. Consequently, this anxiety adversely affected the L2 learners' task performance at the input, processing, and output stages of vocabulary learning. In another study, Gregersen and Horwitz (2002) found that more anxious learners tried to avoid making mistakes by not using the target language at all while less anxious learners were more likely to talk without worrying about making mistakes. More recently, Papi and Khajavy (2021) found that anxiety made L2 learners be more careful in using the target language. In other words, anxious students tended to use the target language only when necessary.

The findings of the present study might be attributed to the attentional control theory (Eysenck et al., 2007). According to this theory, anxiety impairs attentional control, which in turn leads to a reduced working memory capacity. The theory suggests that anxiety distracts attention from relevant information and reduces the ability to inhibit irrelevant information. As a result, working memory capacity decreases and cognitive overload is inevitable. This can have negative effects on various cognitive tasks, including cognitive processing of linguistic stimuli in the present study which is mirrored in higher ER of the high-anxiety group in comparison to the low-anxiety group.

This is in line with previous research as it has been shown that high levels of anxiety have negative effects on cognitive processing and impair working memory (Guvendir & Uzun, 2023; Stout et al., 2017; Vytal et al., 2013).

Yet, the cognitive interference theory (Sarason, 1988) might be another explanation for the results obtained in the present study. The central assumption of this theory is that when learners have various task-irrelevant thoughts, they experience anxiety as these task-irrelevant thoughts have adverse effect on their performance by reducing the amount of attention available for doing an ongoing task. As Derakshan and Eysenck (2009, p. 169) pointed out, "the main prediction of the theory is that task-irrelevant processing in the form of worry causes anxious individuals to perform tasks worse than nonanxious individuals who are believed to experience fewer task-irrelevant thoughts". In the same way, it can be argued that the EFL learners in the high-anxiety group in the present study focused on task-irrelevant thoughts more than the EFL learners in the low-anxiety group which made them make more errors in their cognitive processing of the linguistic stimuli.

In addition, due to the nature of the specific task used in the present study (i.e., a semantic decision task), it can be argued that vocabulary recall plays an important role in cognitive processing. In other words, it is expected to see higher ER in the high-anxiety group in comparison to the low-anxiety group as the former have more problems in vocabulary recall due to their higher anxiety. As Maher and King (2023, p. 108) pointed out, "with attention resources directed inwards, cognitive symptoms of anxiety, such as inability to recall vocabulary or concentrate on what an interlocutor is saying, may also result". This is in line with previous research as high-anxiety L2 learners in Li's (2015) study had lower scores on the vocabulary recall test than low-anxiety L2 learners. According to Li (2015, p. 29), this is because "language anxiety can intrude on learner ability to retrieve appropriate L2 items from long-term memory, and the division of cognitive resources for those high in anxiety results in lower vocabulary production scores, compared with less anxious students".

Moreover, as explained in the procedure section, the participants of the present study were required to answer to the linguistic stimuli within time limitations (i.e., the targets stayed on the screen not longer than 2000 milliseconds). As it has been shown that pauses tend to reflect reduced cognitive efficiency during lexical retrieval (Kahng, 2014), it can be argued that more ER in the participants' responses is the result of more pauses by more anxious students. As Castillejo (2023, p. 536) mentioned, "any interference taxing attention control during L2 speech production, such as anxiety, may impact pausing behavior". In this way, it is not surprising to see more ER in the high-anxiety group in comparison to the low-anxiety group as the former have more pauses in vocabulary recall due to their higher anxiety.

Conclusion

The present study investigated the effect of FLA on EFL students' cognitive processing of linguistic stimuli. The findings showed that there was a statistically significant effect of anxiety on cognitive processing of linguistic stimuli with respect to ER. In other words, high-anxiety and low-anxiety learners followed different patterns in their cognitive processing of linguistic stimuli. It was specifically shown that the EFL students with low anxiety made fewer errors in comparison to the ones with high anxiety. The findings are attributed to the attentional control theory, cognitive interference theory, and the specific nature of the task used in the present study. The results emphasize on this fact that FLA could result in deficits in cognitive processing of linguistic stimuli by L2 learners.

Theoretical and Pedagogical Implications

The theoretical contribution of the present study is that it provides a clear focus on the effect of anxiety on cognitive processing in a theoretically meaningful way that distinguishes it from more physiological and behavioral aspects of anxiety. This is worthwhile as there is a confusion among researchers and practitioners on the concept of anxiety at the moment (Sudina, 2023). This is due to the fact that integrating cognitions (e.g., afraid of peer evaluation) with situations (e.g., doing a difficult task) that occur before the experience of anxiety, or the integration of emotions (e.g., embarrassment) with cognitions (e.g., being unable to do a task) that follow the actual experience of anxiety have resulted in a big confusion in L2 education which should be avoided. In this way, gaining insight into the realm of anxiety through the lens of cognitive processing can help us have a deeper understanding of this concept.

The findings of the present study have also some pedagogical implications for L2 teachers and material designers. First, teachers should know that L2 learners with high levels of anxiety, in comparison to low-anxiety learners, need more time to compensate for their distracted attention during the memory retrieval as they are processing linguistic stimuli in their working memory. Second, previous research has shown that teachers play an important role in reducing their learners' high levels of anxiety by telling them that they are not the only ones who experience anxiety when learning a foreign language and assuring them that making a mistake in the foreign language classroom is part of the natural process of learning an L2 (Horwitz, 1999; Li, 2015). In the same way, school administrators also play an important role in school community settings by identifying anxious students and enacting support for such students. Third, teachers can support their anxious learners by using different coping strategies in the classroom to help them recognize their negative feelings of contextual factors. For example, teachers can ask their students with high anxiety to reflect on anxiety-provoking activities in the classroom by writing down their negative assumptions about those activities to identify underlying factors (Maher & King, 2023). Fourth, good teachers are always aware of their classroom atmosphere and try to create positive social interactions among

their students by putting them in appropriate pair and group works so that their students feel less anxiety in the classroom context. At the same time, EFL learners must try to foster more positive attitudes toward language learning rather than focusing on negative attitudes which induce anxiety. Finally, teaching materials should be designed so that L2 learners' anxiety is reduced. In this way, material designers should design meaningful tasks at appropriate level of difficulty to both motivate students' language learning and reduce the arousal of unwelcome anxiety.

Limitations and Suggestions for Future Research

The findings of the present study should be interpreted considering the following limitations. First, the participants of the present study were at upper-intermediate or advanced levels of English proficiency. Therefore, the results cannot be generalized to beginner or intermediate EFL learners as proficiency is a variable which might affect other variables of the present study. For example, semantic decision tasks, as used in the current study, might induce more anxiety in the beginner or intermediate proficiency EFL learners as they might result in more cognitive overload due to their more complexity for such proficiency levels. Second, the generalizability of the findings is also restricted by the gender of the participants as only males participated in the present study. Future studies could investigate the gender issue in a semantic decision task to determine whether gender differences play a role in L2 learners' ability to process linguistic stimuli considering their anxiety. For example, high-anxiety and low-anxiety females might follow different ER patterns in comparison to the males in the present study. Third, the present study used only quantitative methodology. It is suggested that future studies use qualitative and mixed-methods methodologies to improve our understanding of cognitive processing of linguistic stimuli in high-anxiety and low-anxiety L2 learners. For example, interviewing the EFL learners on their answers to the linguistic stimuli might help us gain a deeper insight into the effect of anxiety on cognitive processing.

Data Availability Statement

Data available on request from the authors.

Acknowledgements

The author would like to thank all participants of the present study.

Ethical considerations

The author avoided data fabrication and falsification.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest

The author declares no conflicts of interest.

References

Abdurahman, N. H., & Rizqi, M. A. (2020). Indonesian students' strategies to cope with foreign language anxiety. *TEFLIN Journal, 31*, 1–18. https://doi.org/10.15639/eflinjournal.v31i1/1-18

Ahmadi, M., & Izadpanah, S. (2019). The study of relationship between learning autonomy, language anxiety, and thinking style: The case of Iranian university students. *International Journal of Research in English Education, 4,* 73–88. https://doi.org/10.29252/ijree.4.2.73

Alamer, A., & Almulhim, F. (2021). The interrelation between language anxiety and self-determined motivation: A mixed methods approach. *Frontiers in Education, 6*, 618655. https://doi.org/10.3389/feduc.2021.618655

Aslan, E., & Thompson, A. S. (2021). The interplay between learner beliefs and foreign language anxiety: Insights from the Turkish EFL context. *Language Learning, 49*, 189–202. https://doi.org/10.1080/09571736.2018.1540649

Ayllon-Salas, P., Olmo-Espinosa, A., & Fernandez-Martin, F. D. (2024). Anxiety and use of cognitive emotion regulation strategies within the foreign language classroom. *Porta Linguarum, 41*, 313-325. https://doi.org/10.30827/portalin.vi41.27966

Bensalem, E., & Thompson, A. S. (2022). Multilingual effects on EFL learning: A comparison of foreign language anxiety and self-confidence experienced by bilingual and multilingual tertiary students. *International Journal of Bilingual Education and Bilingualism, 25*, 2653–2667. https://doi.org/10.1080/13670050.2021.1943306

Borisova, A. S., Moskvitcheva, S. A., Aleksandrova, O. I., & Soomro, M. A. (2024). Influence of foreign language anxiety on university students' cognitive processing in English language classrooms. *Eurasian Journal of Applied Linguistics, 10*(1), 299-307. https://doi.org/10.32601/ejal.10125

Brysbaert, M. (2019). How many participants do we have to include in properly powered experiments? A tutorial of power analysis with reference tables. *Journal of Cognition, 2*(1), 1-38. https://doi.org/10.5334/joc.72

Cambridge Local Examinations Syndicate (2001). *Quick placement test*. Retrieved from http://www.vhsaschaffenburg.de/cms/media/download/238/oxford-test.pdf.

Castillejo, S. P. (2023). Prior processing, foreign language classroom anxiety, and L2 fluency. *International Review of Applied Linguistics in Language Teaching, 61*(2), 519-544. https://doi.org/10.1515/iral-2021-0091

Derakshan, N., & Eysenck, M. W. (2009). Anxiety, processing efficiency, and cognitive performance: New developments from attentional control theory. *European Psychologist, 14*(2), 168–176. https://doi.org/10.1027/1016-9040.14.2.168

Eginli, I., & Solhi, M. (2020). Perceived social self-efficacy and foreign language anxiety among undergraduate English teacher candidates: The case of Turkey. *Novitas Royal, 14*, 13–24.

Elkhafaifi, H. (2005). Listening comprehension and anxiety in the Arabic language classroom. *Modern Language Journal, 89*, 206–220. https://doi.org/10.1111/j.1540-4781.2005. 00275.x

Eysenck, M. W. (1979). Anxiety, learning, and memory: A reconceptualization. *Journal of Research in Personality, 13*, 363–385. https://doi.org/10.1016/0092-6566(79)90001-1.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7,* 336–353.

Fallah, N. (2017). Mindfulness, coping self-efficacy and foreign language anxiety: A mediation analysis. *Educational Psychology, 37*(6), 745–756. https://doi.org/10.1080/01443410.2016.1149549

Frantzen, D., & Magnan, S. S. (2005). Anxiety and the true beginner-false beginner dynamic in beginning French and Spanish classes. *Foreign Language Annals, 38*, 171–190. https://doi.org/10.1111/j.1944-9720.2005.tb02483.x

Gregersen, T., & Horwitz, E. K. (2002). Language learning and perfectionism: Anxious and non-anxious language learners' reactions to their own oral performance. *The Modern Language Journal, 86*(4), 562–570.

Guvendir, E., & Uzun, K. (2023). L2 writing anxiety, working memory, and task complexity in L2 written performance. *Journal of Second Language Writing, 60*, 101016.

Han, S., Li, Y., & Haider, S.A. (2022). Impact of foreign language classroom anxiety on higher education students' academic success: Mediating role of emotional intelligence and moderating influence of classroom environment. *Frontiers in Psychology, 13*, 1-12. https://doi.org/10.3389/fpsyg.2022.945062

Heimberg, R. G. (2002). Cognitive-behavioral therapy for social anxiety disorder: Current status and future directions. *Biological Psychiatry, 51*(1), 101–108. Doi: 10.1016/s0006-3223(01)01183-0

Hofmann, S. G. (2007). Cognitive factors that maintain social anxiety disorder: A comprehensive model and its treatment implications. *Cognitive Behavior Therapy, 36*(4), 193–209. https://doi.org/10.1080/16506070701421313

Horwitz, E. K. (1991). Preliminary evidence for the reliability and validity of a foreign language anxiety scale. In E. Horwitz & D. Young (Eds.), *Language anxiety: From theory and research to classroom implications* (pp. 37-39). Prentice Hall.

Horwitz, E. K. (1999). Preface. In A. J. Young (Ed.), *Affect in foreign language and second language learning: A practical guide to creating a low-anxiety classroom atmosphere* (pp. xi-xiii). McGraw-Hill.

Horwitz, E. K. (2010). Foreign and second language anxiety. *Language Teaching*, *43*(2), 154–167. https://doi.org/10.1017/S026144480999036X

Horwitz, E. K., Horwitz, M. B., & Cope, J. (1986). Foreign language classroom anxiety. *Modern Language Journal, 70*, 125–132. https://doi.org/10.1111/j.1540-4781.1986.tb05256.x

Horwitz, E. K., & Nassif, L. (2018). Language anxiety. In A. Burns & J. C. Richards (Eds.), *The Cambridge guide to learning English as a second language* (pp. 73–80). Cambridge University Press.

Jiang, Y., & Dewaele, J. M. (2020). The predictive power of sociobiographical and language variables on foreign language anxiety of Chinese university students. *System, 89*, 102207. https://doi.org/10.1016/j.system.2020.102207

Jonczyk, R. (2016). *Affect-language interactions in native and non-native English speakers: A neuropragmatic perspective.* Springer International Publishing.

Kahng, J. (2014). Exploring utterance and cognitive fluency of L1 and L2 English speakers: Temporal measures and stimulated recall. *Language Learning, 64*(4), 809–854.

Kalsoom, A., Soomro, N. H., & Pathan, Z. H. (2020). How social support and foreign language anxiety impact willingness to communicate in English in an EFL classroom. *International Journal of English Linguistics, 10*, 80–91. https://doi.org/10.5539/ijel.v10n2p80

Khan, Z. A., & Zafar, S. (2010). The effects of anxiety on cognitive processing in English language learning. *English Language Teaching, 3*, 199-209.

Kondo, D. S., & Yang, Y. L. (2004). Strategies for coping with language anxiety: The case of students of English in Japan. *ELT Journal, 58*, 258–265. https://doi.org/10.1093/elt/58.3.258

Krashen, S. D. (1987). *Principles and practice in second language acquisition.* Prentice-Hall International.

Lee, J. S., & Hsieh, J. C. (2019). Affective variables and willingness to communicate of EFL learners in in-class, out-of-class, and digital contexts. *System, 82*, 63–73. https://doi.org/10.1016/j.system.2019.03.002

Li, C. (2015). The effect of anxiety on university-level L2 learner ability to recall items in the lexicon. *The Journal of Language Teaching and Learning, 1, 24-33.*

Li, C., Huang, J., & Li, B. (2021). The predictive effects of classroom environment and trait emotional intelligence on foreign language enjoyment and anxiety. *System, 96*, 102393. https://doi.org/10.1016/j.system.2020.102393

Li, C., Wei, L., & Lu, X. (2023). Contributions of foreign language writing emotions to writing achievement. *System, 116*, 103074. https://doi.org/10.1016/j.system.2023.103074

Maher, K., & King, J. (2023). Language anxiety and learner silence in the classroom from a cognitive-behavioral perspective. *Annual Review of Applied Linguistics, 43*, 105–111. https://doi.org/10.1017/S0267190523000077

MacIntyre, P. D. (1998). Conceptualizing willingness to communicate in an L2: A situational model of L2 confidence and affiliation. *The Modern Language Journal, 82*, 545–562. https://doi.org/10.1111/j.1540-4781.1998.tb05543.x.

MacIntyre, P. D., & Gardner, R. C. (1994a). The subtle effects of language anxiety on cognitive processing in the second language. *Language Learning, 44*, 283–305. https://doi.org/10.1111/j.1467-1770.1994.tb01103.x

MacIntyre, P. D., & Gardner, R. C. (1994b). The effects of induced anxiety on cognitive processing in computerized vocabulary learning. *Studies in Second Language Acquisition, 16*(1), 1–17.

Matsuda, S., & Gobel, P. (2004). Anxiety and predictors of performance in the foreign language classroom. *System, 32*, 21–36. https://doi.org/10.1016/j.system.2003.08.002

Papi, M., & Khajavy, G. H. (2021). Motivational mechanisms underlying second language achievement: A regulatory focus perspective. *Language Learning, 71*(2), 537–572.

Peirce, J. W. (2007). PsychoPy—psychophysics software in Python. *Journal of Neuroscience Methods*, *162* (1), 8–13. https://doi.org/10.1016/j.jneumeth.2006.11.017

Peirce, J. W. (2009). Generating stimuli for neuroscience using PsychoPy. *Frontiers in Neuroinformatics*, *2*, 1-8. https://doi.org/10.3389/neuro.11.010.2008

Pyun, D. O., Kim, J. S., Cho, H. Y., & Lee, J. H. (2014). Impact of affective variables on Korean as a foreign language learners' oral achievement. *System, 47*, 53–63. https://doi.org/10.1016/j.system.2014.09.017

Rahmani Doqaruni, V. (2021a). Investigating bilinguals' cognitive processing of affective words in minimal linguistic contexts. *The Mental Lexicon*, *16*(2-3), 422-447. https://doi.org/10.1075/ml.20026.doq

Rahmani Doqaruni, V. (2021b). The cognitive ease of processing semantically related words in second language education. *Iranian Journal of Learning & Memory*, *4*(15), 77-83. https://doi.org/10.22034/iepa.2021.143987

Rahmani Doqaruni, V. (2022). The effect of semantic relatedness on EFL learners' cognitive processing of L2 words. *Iranian Journal of Learning & Memory, 5*(19), 63-73. https://doi.org/10.22034/iepa.2022.168321

Rahmani Doqaruni, V. (2023). The effect of age on cognitive processing of ambiguous relative clauses in second language education. *Lingue e Linguaggio, 22*(1), 3–18. https://doi.org/10.1418/107016

Rahmani Doqaruni, V. (2024a). The effect of modality type on cognitive processing of L2 single words. *Journal of Cognition, Emotion & Education, 2*(1), 29–39. https://doi.org/10.22034/cee.2023.429524.1014

Rahmani Doqaruni, V. (2024b). The role of gender in cognitive processing of affective linguistic stimuli in bilinguals. *Cognition, Brain, Behavior. An Interdisciplinary Journal, 29*(2), 1–23. https://doi.org/ 10.24193/cbb.2024.29.01

Rahmani Doqaruni, V. (in press). The effect of mode of presentation on EFL learners' cognitive processing of ambiguous relative clauses. *Cognitive Linguistic Studies.*

Resnik, P., & Dewaele, J. M. (2020). Trait emotional intelligence, positive and negative emotions in first and foreign language classes: A mixed-methods approach. *System, 94*, 102324. https://doi.org/10.1016/j.system.2020.102324

Rubio-Alcala, F. (2017). The links between self-esteem and language anxiety and implications for the classroom. In C. Gkonou, M. Daubney, & J. M. Dewaele (Eds.), *New insights into language anxiety* (pp. 198–216). Multilingual Matters. https://doi.org/10.21832/9781783097722-012

Safranj, J., & Zivlak, J. (2019). Effects of big five personality traits and fear of negative evaluation on foreign language anxiety. *Croatian Journal of Education, 21*, 275–306. https://doi.org/10.15516/cje.v21i1.2942

Sarason, I. G. (1988). Anxiety, self-preoccupation and attention. *Anxiety Research*, *1*, 3–7.

Stout, D. M., Shackman, A. J., Pedersen, W. S., Miskovich, T. A., & Larson C. L. (2017). Neural circuitry governing anxious individuals' mis-allocation of working memory to threat. *Scientific Reports, 7*, 8742. https://doi.org/10.1038/s41598-017-08443-7

Sudina, E. (2023). Scale quality in second-language anxiety and WTC: A methodological synthesis. *Studies in Second Language Acquisition, 45*, 1427-1455. https://doi.org/10.1017/S0272263122000560

Teimouri, Y., Goetze, J., & Plonsky, L. (2019). Second language anxiety and achievement: A meta-analysis. *Studies in Second Language Acquisition, 41*, 363–387. https://doi.org/10.1017/S0272263118000311

Tsai, P. S., & Liao, H. C. (2021). Students' progressive behavioral learning patterns in using machine translation systems– a structural equation modeling analysis. *System, 101*, 102594. https://doi.org/10.1016/j.system.2021.102594

Vytal, K. E., Cornwell, B. R., Letkiewicz, A. M., Arkin, N. E., & Grillon, C. (2013). The complex interaction between anxiety and cognition: Insight from spatial and verbal working memory. *Frontiers in Human Neuroscience, 7,* 93. https://doi.org/10.3389/fnhum.2013.00093

Wang, H., Peng, A., & Patterson, M. M. (2021). The roles of class social climate, language mindset, and emotions in predicting willingness to communicate in a foreign language. *System, 99*, 102529. https://doi.org/10.1016/j.system.2021.102529

Wang, C., Teng, M. F., & Liu, S. (2023). Psychosocial profiles of university students' emotional adjustment, perceived social support, self-efficacy belief, and foreign language anxiety during COVID-19. *Educational and Developmental Psychologist, 40*, 51–62. https://doi.org/10.1080/20590776.2021.2012085

Woodrow, L. (2006). Anxiety and speaking English as a second language. *RELC Journal, 37*, 308–328. https://doi.org/10.1177/0033688206071315

Woodrow, L. (2011). College English writing affect: Self-efficacy and anxiety. *System, 39*, 510–522. https://doi.org/10.1016/j.system.2011.10.017

Yan, J. X., & Liang, J. (2022). Foreign language anxiety and dependency distance in English–Chinese interpretation classrooms. *Frontiers in Psychology, 13*, 952664. https://doi.org/10.3389/fpsyg.2022.952664

Zheng, Y., & Cheng, L. (2018). How does anxiety influence language performance? From the perspectives of foreign language classroom anxiety and cognitive test anxiety. *Language Testing in Asia, 8*, 1-19. https://doi.org/10.1186/s40468-018-0065-4

Zhou, L., Xi, Y., & Lochtman, K. (2023). The relationship between second language competence and willingness to communicate: The moderating effect of foreign language anxiety. *Journal of Multilingual and Multicultural Development, 44,* 129–143. https://doi.org/10.1080/01434632.2020.1801697