

# Foreign Language Anxiety and Cognition: A Systematic Review and Meta-Analysis

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## Abstract

Many studies have investigated how cognitive factors (e.g., working memory and attention) and emotional-motivational factors (such as foreign language anxiety) may impact foreign language (FL) learning. Despite this progress, there is still much to be understood about the combined effect of these factors on the FL learning process. This systematic review aims to address this gap by analyzing the relationship between foreign language anxiety and cognition.

The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The search strategy identified 278 studies, of which only 13 eligible records were identified, after the screening process.

The eligible studies explored the relationship between foreign language anxiety and cognitive factors, such as cognitive load, working memory, attention, and need for cognition. These studies generally indicated that foreign language anxiety (FLA) is associated with higher cognitive load,

23 lack of attention and poorer working memory functioning. This result is fully supported by the  
24 metanalytic result ( $\theta = -0.28$ ,  $Z = -10.20$ ,  $SE = 0.027$ ,  $p < 0.001$ ).  
25 Future research should specifically examine the impact of FLA on cognitive abilities, focusing  
26 on intra-linguistic factors in native and foreign languages. Conducting rigorous experiments with  
27 robust random sampling and similar instruments will help making the results comparable and  
28 generalizable.

29

30 *Keywords:* foreign language anxiety; cognitive load; cognition; attentional control;  
31 working memory.

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## Introduction

For the past forty years, a growing emphasis on learning a foreign language (FL) and its related challenges (Cornoldi, 2019) has emerged. This emphasis relates the cognitive components (e.g., attention, memory, executive functions, etc.) as well as emotional and motivational factors (e.g., self-efficacy, perceptions of one’s FL ability, anxiety, etc.). Cognitive scientists and psycholinguistic experts have examined foreign language learning difficulties, with the first emphasizing the role of cognitive factors, such as working memory capacity and attentional shifting, and the former focusing on the impact of emotional and motivational aspects, including anxiety.

Numerous researchers have explored the role of working memory and its components in learning a foreign language, namely phonological loop, central executive, and visuospatial sketchpad (Atkins & Baddeley, 1998; Baddeley et al., 1998; I.-J. Chen & Chang, 2009; Cheung, 1996; Chow et al., 2021; Gathercole et al., 2003; Geva & Ryan, 1993; Harrington & Sawyer, 1992; Palladino & Cornoldi, 2004; Palladino & Ferrari, 2008; Service, 1992). Their findings indicate that working memory plays a more significant role in FL learning compared to learning one's mother tongue (L1) because of the dual linguistic analysis required (Dijkstra, 2005) and the higher cognitive resources needed to suppress interference between the two languages (Chen and Chang, 2009; Chow, Mo, and Dong, 2021). Many studies have indicated that verbal working memory has a greater impact on reading in a foreign language than the visuo-spatial component (e.g., Gathercole et al., 2003). These studies suggest a strong involvement of the phonological loop in foreign language reading processes. The phonological loop has been strongly associated with the development of vocabulary in second language acquisition, both in children (for example, Service, 1992; Cheung, 1996) and in adults (Atkins and Baddeley, 1998). The central

57 role of the phonological loop in learning words with unfamiliar sounds has also been  
58 acknowledged ( Baddeley et al., 1998).

59         Concerning the central executive, some researchers have discovered a relationship  
60 between fluency in a foreign language and the function of the central executive in both adults  
61 (Harrington and Sawyer, 1992) and children (Geva and Ryan, 1993). Some studies in Italy by  
62 Palladino and Cornoldi (2004) and Palladino and Ferrari (2008) sought to investigate the  
63 potential correlation between challenges in learning a foreign language and impairment in  
64 working memory. These studies included assessments of working memory using tests in the  
65 participants' native language. These studies revealed no deficiency in the central executive, as  
66 indicated by the "listening span test" (De Beni et al., 1998), suggesting that the working memory  
67 impairment in children with foreign language learning difficulties specifically impacts peripheral  
68 processes, notably the phonological loop. These results indicate that the deficit in verbal working  
69 memory is only limited to its passive component, as measured by the direct digit span.

70 According to Cornoldi and Vecchi (2003), the working memory model suggests that verbal and  
71 visual-spatial working memory processes can operate in passive and active modes. The first  
72 mode involves learning a sequence of digits or cube positions and then reproducing this sequence  
73 (e.g., direct digit span, direct Corsi task). It requires merely retaining verbal or visuospatial  
74 material without active processing (e.g., reproducing the series in the opposite order). In contrast,  
75 the active mode (i.e., reverse digit span, reverse Corsi task) involves processing the stored  
76 information through a simple manipulation. Palladino and Cornoldi (2004) and Palladino and  
77 Ferrari (2008) also explored the impact of the visual-spatial component of working memory,  
78 known as the visuo-spatial sketchpad. Their findings suggest that children with foreign language

79 learning difficulties do not exhibit a deficit in these processes, thereby providing evidence  
80 supporting the hypothesis that the working memory deficit is limited to phonological processes.

81 From a psycholinguistic perspective, numerous studies have concentrated on the role of  
82 emotional and motivational aspects in FL learning (Park, 2014). Many researchers have  
83 examined the concept of Foreign Language Anxiety (FLA), a feeling of tension and unease when  
84 dealing with tasks related to studying a foreign language (Horwitz et al., 1986). This anxiety can  
85 make learning a foreign language more complex and significantly impact a person's performance  
86 in that language (Horwitz et al., 1986; MacIntyre & Gardner, 1994; Williams & Andrade, 2008).  
87 As indicated by several research, anxiety seems to reduce working memory capacity (Moran  
88 2016). Similar effects have been primarily observed in learning mathematics, particularly  
89 concerning *math anxiety* (see Hill et al., 2016; Jameson & Fusco, 2014). Research in this field  
90 suggests that individuals may encounter a temporary decrease in their ability to process  
91 information when they experience a high level of math anxiety, impeding their performance in  
92 mathematical tasks that heavily depend on working memory (Ashcraft & Kirk, 2001; Ashcraft  
93 & Krause, 2007; Moran, 2016). Similarly, we can assume that the anxiety connected to speaking  
94 a foreign language temporarily decreases the accessibility of working memory. Indeed, FLA is a  
95 different type of anxiety as is not connected to a stereotype (e.g., “math is difficult”) learnt  
96 during childhood

97 Furthermore, according to the *Attentional Control Theory* (Eysenck et al., 2007; Eysenck  
98 & Calvo, 1992; Eysenck & Derakshan, 2011), high anxiety impairs the functioning of the two  
99 attentional control functions: inhibition, which reduces attention to task-irrelevant stimuli, and  
100 shifting, which consent to switch attention between different cognitive operations. In short, a  
101 high level of anxiety impairs processing efficiency (i.e., the relationship between performance



125           **Eligibility criteria**

126           To be considered eligible for the review, each study must have met the following  
127 conditions: All studies should be written in English, published within the last sixteen years, from  
128 2009 to the present, and focused on learning English as a foreign language (EFL). Finally, each  
129 study should focus on both foreign language anxiety and cognition, specifically on working  
130 memory, cognitive load, attention or need for cognition. Any study that did not meet all  
131 conditions mentioned was deemed ineligible for review and subsequently excluded.

132           **Search Strategy**

133           The research was conducted using Scopus, EBSCO, and Web of Science. Studies were  
134 retrieved through advanced research methods, including the following keywords:

135           Keywords<sub>1</sub>: foreign language anxiety, foreign language classroom anxiety, flcas.

136           Keywords<sub>2</sub>: working memory, cognitive load, attentional control, attention, cognition.

137           Each keyword from the keywords<sub>1</sub> group was combined with the ones from the  
138 keywords<sub>2</sub> group, inserting the keywords of the first group into the first search box and the  
139 second group ones into the second search box. The command “OR” was used in between  
140 keywords of the same group, while it was selected the option “AND” between the two search  
141 boxes to create the string used in each source: ("foreign language anxiety" OR "foreign language  
142 classroom anxiety" OR "flcas") AND ("working memory" OR "cognitive load" OR "attentional  
143 control" OR "attention" OR "cognition").

144           The publication filter setting was set (“from 2009 – to now”) to exclude studies published  
145 before 2008. Finally, the language filter was selected (LIMIT-TO (LANGUAGE, "english")) to  
146 exclude other languages.

147           **Risk of bias and quality assessment**

148 Two authors [BLINDED FOR REVIEW] independently scanned the literature and  
149 reported the eligible studies into a data sheet, indicating: the first authors of the study, year of  
150 publication, age of the samples, number of participants, sample's mother tongue, foreign  
151 language which they were studying, the type of foreign language anxiety (i.e., general, listening  
152 and reading FLA) and the cognitive factor included in the study.

153 Quality assessment was conducted by the two researchers, who independently screened  
154 the papers and judged the quality of each study through the CASP checklist, partially based on  
155 the Critical Appraisal Skill Programme standards (2018) (see Table 1). Disagreements in  
156 judgments were solved through discussion.

157 Out of the entire sample, 5 studies (38.46%) were rated as medium or medium-high  
158 quality, while most of the studies (61.54%) were assessed as low quality or very low quality.  
159 None of the studies included a robust, randomized sample. Only one study (Chan et al., 2024),  
160 which was assessed as "medium-high quality", clearly outlined the inclusion criteria used for  
161 sample recruitment.

## 162 **Data extraction and synthesis**

163 The characteristics of each eligible study were reported on a table, indicating the first  
164 author, the year of publication, sample size characteristics, mother tongue (L1), language learnt  
165 (L2), type of foreign language anxiety (FLA type), cognitive factors included, and result  
166 description. Meta-analysis was conducted through the package Metaphor of the R software  
167 (version nr. 2025.05.0+496) to detect the impact of FLA on cognitive functioning. The effect of  
168 each study was extracted and reported into an excel file in the form of Pearson's correlation  
169 coefficient with the type of cognitive feature (working memory, attention or cognitive load) and

170 the sample size. Then, for the analysis, a fixed effect estimation model was chosen, with  $I^2$  and  
171 Cochrane's Q as estimators of study heterogeneity.

## 172 **Results**

173 The search strategy (Fig. 1) identified 278 studies, of which 102 were duplicates and then  
174 removed. Out of 176 titles screened, a total of 73 titles were selected for abstract screening, out  
175 of which 46 were removed with reasons (e.g., not on FLA, no cognitive factors included, no EFL  
176 learners, and literature review). A total of 27 records were entirely read, and 15 were eliminated  
177 for this reason: not on foreign language anxiety ( $n = 1$ ), no cognitive factors included ( $n = 7$ ), not  
178 focusing on EFL ( $n = 4$ ), methodological issue ( $n = 1$ ), conference paper ( $n = 1$ ) and literature  
179 review ( $n = 1$ ). Of the 13 remaining records, 1 was sought for retrieval, but we could not retrieve  
180 it. Reading the retrieved records, 2 studies were identified via citation searching and added to the  
181 list of studies identified via databases and registers.

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183 INSERT FIG.1 HERE – FLOW CHART  
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185  
186 The final sample, listed in Table 2, consisted of 13 studies, published between 2009 and  
187 2024. Each study focuses on EFL learners with different L1 backgrounds: 8 papers investigated  
188 the effect of FLA on a sample of Chinese (Chan et al., 2024; Chang et al., 2017; I.-J. Chen &  
189 Chang, 2009; L. Chen, 2023; Chow et al., 2021; Fu & Li, 2023; Weng et al., 2022; J. X. Yan &  
190 Liang, 2022), while the remaining papers' samples included French (Simard et al., 2023; Zuniga  
191 & Simard, 2022), Spanish (Mora et al., 2024), and Persian (Namaziandost et al., 2018;  
192 Rezazadeh & Zarrinabadi, 2023).



216 another study (Namaziandost et al., 2018) found that listening comprehension had a negative  
217 correlation with FLA but a positive correlation with working memory capacity, hypothesizing  
218 about the possibility of an indirect relationship between anxiety and working memory.

219 One study (Mora et al., 2024) found that task complexity had a significant effect on  
220 anxiety. Another study (Weng et al., 2022) found that time pressure, a measure of anxiety in  
221 foreign language translation, had a significant effect on mental effort. Furthermore, foreign  
222 language anxiety (FLA) was a significant predictor of post-test scores on elicited imitation tests  
223 and on grammaticality judgment tests, but only in delayed corrective feedback conditions (Fu &  
224 Li, 2023). Finally the Authors found that anxiety partially mediated the relationship between  
225 verbal working memory and reading comprehension (Chow et al., 2021).

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227 INSERT TABLE 2 HERE  
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230 Meta-analytic synthesis was conducted on 14 effects retrieved from 8 studies (Table 3).  
231 The results yielded a negative significant effect of FLA on cognitive functioning ( $\theta = -0.28$ ,  $Z = -$   
232  $10.20$ ,  $SE = 0.027$ ,  $p < 0.001$ ), meaning that people who reported high levels of FLA also reported  
233 less cognitive functioning (see Fig.2). Heterogeneity estimation resulted very high ( $I^2 = 88.95\%$ ,  
234  $Q = 117.66$ ,  $df = 13$ ,  $p < 0.001$ ), therefore a moderation analysis with type of cognitive function and  
235 spoken L1 was performed. The moderation analysis for cognitive feature was nonsignificant ( $\theta =$   
236  $-0.17$ ,  $Z = -1.18$ ,  $p = 0.06$ ) meaning that the effects did not differ according to the type of cognitive  
237 function involved in the study. The model explained roughly the 7% of variance. Concerning the  
238 type of spoken L1, nonsignificant differences were found ( $\theta = 0.26$ ,  $Z = 1.28$ ,  $p = 0.199$ ). This

239 model explained only the 3% of variance. Since the studies were very heterogeneous, we  
240 hypothesize that studies were very different for some characteristics that did not emerge across  
241 the studies.

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243 INSERT TABLE 3 HERE

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247 INSERT FIGURE 2 HERE

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## 250 **Discussions**

251 The present systematic review aimed to study the relationship between FLA and  
252 cognitive factors (e.g., cognitive load, working memory capacity, attention shift control, and  
253 need for cognition) that regulate the foreign language learning process. We included 13 studies  
254 published in the last 16 years through the search strategy and after checking study eligibility. The  
255 systematic review found a detrimental effect of Foreign Language Anxiety on cognitive  
256 functioning. This result was also confirmed by a meta-analytic synthesis with an effect of  $\theta = -$   
257 0.28. The heterogeneity of the studies was very high, therefore a moderation analysis with type  
258 of cognitive functioning and type of spoken L1 was performed. Moderation analysis was not  
259 significant in any case, meaning that FLA impacts cognitive functions in the same way and  
260 independently from L1.

261

262 **Foreign Language Anxiety and Cognitive Load**

263 Studies generally agreed on the positive relationship between FLA and cognitive load,  
264 meaning that students with higher levels of FLA tend to experience a heavier cognitive load  
265 while doing FL tasks. However, this relationship could vary depending on the learning task type  
266 (e.g., consecutive interpretation vs sight translation) or instructional interventions (e.g., delayed  
267 vs immediate corrective feedback). Moreover, cognitive load was positively correlated with  
268 FLA, showing fair (Chen & Chang, 2009; Yan & Liang, 2022) to moderate (Chen et al., 2022)  
269 correlation values in three out of five studies. These findings are coherent with the attentional  
270 control theory hypothesis (Eysenck et al., 2007; Eysenck & Calvo, 1992), suggesting that high  
271 levels of FLA consume working memory resources, leaving less storage capacity and fewer  
272 resources to process information effectively. One study (Chen et al., 2022) has further deepened  
273 this relationship, considering different types of cognitive load: intrinsic cognitive load (ICL),  
274 extraneous cognitive load (ECL) and germane cognitive load (GCL). According to Cognitive  
275 Load Theory (Sweller, 1988; Sweller et al., 1998), intrinsic cognitive load (ICL) depends on the  
276 inherent level of complexity and difficulty of the task; extraneous cognitive load (ECL) arises  
277 from inappropriate teacher instruction or task design; and germane cognitive load (GCL)  
278 emerges when students allocate adjunctive cognitive resources to form mental structures and  
279 regulate learning. Chen et al. (2022) found a consistent positive correlation between FLA and  
280 ICL over 15 weeks, meaning that the inherent complexity of learning material plays a stable role  
281 in students' anxiety. A moderate positive correlation has also been found between FLA and  
282 GCL, but only in the first half of the semester.

283

284 Two studies (Mora et al., 2024; Weng et al., 2022) have also investigated the relationship  
285 between anxiety and different task conditions (i.e., task complexity and time pressure) using  
286 physiological measures, indirectly suggesting a positive relationship between anxiety and  
287 cognitive load. Two physiological measures used by Weng et al. (2022) (i.e., galvanic skin  
288 response [GSR] and heart rate variability [HRV]) have been used as indicators of cognitive load  
289 or mental effort in various studies (Luque-Casado et al., 2016; Nourbakhsh et al., 2017). These  
290 measures have shown an inverted 'U-shaped' relationship with cognitive load, with the highest  
291 arousal being observed in moderately time-constrained tasks, suggesting a higher cognitive  
292 processing. The significant effect of time pressure on mental effort, which was significant in the  
293 moderately time-constrained task, also supports this hypothesis.

294 Similar results were reported by Mora et al. (2024), who found that the complex task  
295 yielded significantly higher anxiety variability on heart rate changes (HRsd) during learners' oral  
296 performance than the simple task, suggesting that the complex task caused a more frequent  
297 fluctuation of anxiety levels. A significant effect of task complexity was found on formulation  
298 problems and error rates, which were higher in the complex task. This suggests that the  
299 fluctuation in HRsd reflected a higher cognitive burden.

300 Taken together, these findings are coherent with the attentional control theory (Sweller,  
301 1988; Sweller et al., 1998), indicating that students tend to allocate more cognitive resources to  
302 complete the task when anxiety arises, as GCL optimizes learning efficiency.

303

### 304 **Foreign Language Anxiety and Working Memory**

305 According to the results included in the systematic review, working memory and foreign  
306 language anxiety (FLA) were important factors in predicting EFL reading comprehension.. No

307 significant correlations were found in three out of four studies (Chan et al., 2024; Mora et al.,  
308 2024; Namaziandost et al., 2018). However, Chow et al. (2021) found a significant but weak  
309 correlation between state reading anxiety and verbal working memory. Some authors (Chan et  
310 al., 2024; Mora et al., 2024; Namaziandost et al., 2018) have reported a negative correlation  
311 between foreign language anxiety (FLA) and performance in comprehension tasks, such as  
312 listening and reading.

313           Comprehensively, the studies report a negative effect of FLA on working memory, which  
314 is in line with previous literature, according to which the presence of anxiety while speaking a  
315 second language temporarily decreases the accessibility of working memory.

316

### 317           **Foreign Language Anxiety and Attention**

318           The findings on FLA and attention show different associations of FLA on sustained  
319 attention and attention shift capacity.

320           Chang et al. (2017) findings indicate that the association between FLA and sustained  
321 attention in conversation tasks depends on the task condition. They found that FLA was  
322 negatively correlated in the classroom practice condition but positively correlated in the real-  
323 world situated condition. This suggests that FLA plays a different role in the two task conditions:  
324 in the classroom condition, FLA seems to impair sustained attention, while in the real-context  
325 condition, it appears to enhance students' attention to the task.

326           Attention shift capacity does not seem directly related to FLA (Simard et al., 2023;  
327 Zuniga & Simard, 2022). However, as for working memory, some studies found that attention  
328 shift capacity could mediate the relationship between FLA and speech production errors. The  
329 two variables were only significantly correlated with low attention-shift L2 speakers, meaning

330 that when foreign language anxiety increases, speakers with lower attention-shift capacity tend to  
331 make more significant repairs at the discourse level (Zuniga & Simard, 2022). This can result in  
332 difficulties in finding the right words and decreased speech production quality among anxious  
333 individuals. Additionally, attention shift capacity was found negatively associated with the  
334 production of self-initiated self-repairs (SISRs) in language production. Individuals with slower  
335 attention shift capacity may experience more FLA and produce more SISRs compared to those  
336 with faster attentional control. Therefore, anxious individuals often split their attention between  
337 task-related and self-related thoughts, reducing cognitive efficiency (Dewaele, 2002), but higher  
338 attention capacity seems to mitigate those negative effects (Zuniga & Simard, 2022).

### 339 **Foreign Language Anxiety and Need for Cognition**

340 Need for cognition refers to one's natural inclination to seek and enjoy thinking,  
341 analytical reasoning, and cognitive challenges (Cacioppo & Petty, 1982).

342 Rezazadeh & Zarrinabadi (2023) found a fair negative correlation between need for  
343 cognition and FLA, meaning that learners with a high need for cognition tend to experience  
344 lower levels of FLA. Moreover, the need for cognition was shown to significantly predict FLA.  
345 These findings are coherent with previous studies on the relationship between need for cognition  
346 and anxiety in different contexts, such as math anxiety (Lin et al., 2016) and trait anxiety  
347 (Johansson & Ölund, 2017).

348 of the Authors pointed out the mediational role of need for cognition in the relationship  
349 between discomfort with ambiguity and FLA (Rezazadeh & Zarrinabadi, 2023). Specifically,  
350 when individuals with a high need for cognition encounter uncertainty, they are more likely to  
351 engage with the material in a manner that enhances their enjoyment, as they thrive on the  
352 cognitive challenges presented by such situations. On the contrary, learners with a low need for

353 cognition prefer to engage in difficult and effortful tasks, which may lead them to experience  
354 higher levels of FLA.

### 355 **The impact of L1-FL linguistic distances on EFL learners' anxiety**

356 Research has also shown that intralingual factors, which are related to the internal  
357 structure and linguistic system of the foreign language (e.g., grammar, vocabulary, and  
358 phonetics) contribute to FLA (see, (Kralova & Petrova, 2017). Specifically, the greater the  
359 difference between the linguistic systems (i.e., between the foreign language and the learner's  
360 native language), the higher the FLA levels in several languages, including Chinese (X. Yan &  
361 Wang, 2001), Spanish (Sellers, 2000) and Arabic (Alrabai, 2014). This distance is called  
362 “typological distance”, which can increase FLA, as learners may feel more anxious when faced  
363 with significant differences between their native language and the target language.

364 Typological differences between languages can manifest in several linguistic domains  
365 (Lee, 2022), including writing systems type and orthographic depth. First, the differences  
366 between L1 and FL writing system types can vary largely, increasing the cognitive demand on  
367 FL learners. For instance, in the Chinese language, the writing system is logographic. This means  
368 that each character represents a word or a meaningful unit of language, and not a phoneme. This  
369 system requires learners to memorize many characters, each with its own meaning and  
370 pronunciation which are context-dependent. In contrast, many Indo-European languages, such as  
371 English, Spanish, and French, use alphabetic scripts. In these systems, letters represent individual  
372 sounds (phonemes), and words are formed by combining these letters. This phonetic feature  
373 enables learners to decipher words by applying rules for converting graphemes to phonemes. In  
374 most of the cases studied in this review (8 out of 13 studies), the EFL students spoke Chinese as  
375 their first language. This indicates that switching from the Chinese logographic writing system to



399 seems that FLA plays a role in mediating the connection between working memory and  
400 performance in listening comprehension, as well as attentional shift capacity and task  
401 complexity. Finally, the need for cognition could be a mediator of the relationship between FLA  
402 and task complexity. The results of the systematic review were confirmed through the meta-  
403 analysis which confirmed a significant negative relationship between FLA and cognitive  
404 functioning.

405         Unfortunately, the studies were too heterogeneous, and it was not possible to perform  
406 metaregression to detect significant mediators in this relationship. Moreover, other limitations  
407 should be noted: for instance, none of the studies tested their hypothesis on a robust, randomized  
408 sample size, resulting in non-generalizable findings in most cases (i.e., in 11 out of 13 studies).  
409 Finally, the studies needed to be balanced in terms of students' mother tongue, primarily Chinese  
410 (i.e., in 8 out of 13 studies).

411         Future research should investigate the impact of FLA on cognitive abilities, mainly  
412 focusing on intra-linguistic factors in various native and foreign languages, to better comprehend  
413 to comprehend better the influence of different intra-linguistic factors on FLA levels.  
414 Additionally, conducting experiments on FLA with greater rigor, including robust random  
415 sampling and using similar instruments, will help make the results comparable and generalizable.  
416 The results of this study might be useful for foreign language teachers that are aware of the  
417 detrimental effects of foreign language anxiety on their students' performance. For example, they  
418 might choose to adopt game solutions to decrease foreign language anxiety, such as role playing,  
419 group activities, breathing techniques, and other tools to make a more relaxed environment.  
420 Moreover, foreign language teachers might reduce anxiety in specific tasks by modulating task  
421 complexity according to need for cognition, therefore each student might have a different task in

422 case of higher or lower need for cognition. Finally, the introduction of flexible tasks presented in  
423 different forms (such as video sources, audio, movies) in small groups can help students in  
424 familiarizing with the foreign language.

## 425 References

- 426
- 427 Aida, Y. (1994). Examination of Horwitz, Horwitz, and Cope's Construct of Foreign Language  
428 Anxiety: The Case of Students of Japanese. *The Modern Language Journal*, 78(2), 155–  
429 168. <https://doi.org/10.1111/j.1540-4781.1994.tb02026.x>
- 430 Alrabai, F. (2014). A model of foreign language anxiety in the Saudi EFL context. *English*  
431 *Language Teaching*, 7(7), 82–101. <https://doi.org/10.5539/elt.v7n7p82>
- 432 Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety,  
433 and performance. *Journal of Experimental Psychology: General*, 130(2), 224–237.  
434 <https://doi.org/10.1037/0096-3445.130.2.224>
- 435 Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math  
436 anxiety. *Psychonomic Bulletin & Review*, 14(2), 243–248.  
437 <https://doi.org/10.3758/BF03194059>
- 438 Atkins, P. W. B., & Baddeley, A. D. (1998). Working memory and distributed vocabulary  
439 learning. *Applied Psycholinguistics*, 19(4), 537–552.  
440 <https://doi.org/10.1017/s0142716400010353>
- 441 Baddeley, A., Gathercole, S., & Papagno, C. (1998). The Phonological Loop as a Language  
442 Learning Device. *Psychological Review*, 105(1), 158–173. [https://doi.org/10.1037/0033-  
443 295X.105.1.158](https://doi.org/10.1037/0033-295X.105.1.158)
- 444 Brignoni-Perez, E., Jamal, N. I., & Eden, G. F. (2020). An fMRI study of English and Spanish  
445 word reading in bilingual adults. *Brain and Language*, 202.  
446 <https://doi.org/10.1016/j.bandl.2019.104725>
- 447 Burden, P. (2004). The teacher as facilitator: Reducing anxiety in the EFL university classroom.  
448 *JALT Hokkaido Journal*, 8, 3–18.
- 449 Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of Personality and Social*  
450 *Psychology*, 42(1), 116–131. <https://doi.org/10.1037/0022-3514.42.1.116>
- 451 Chan, K., Yeung, P. S., & Chung, K. K. H. (2024). The effects of foreign language anxiety on  
452 English word reading among Chinese students at risk of English learning difficulties.  
453 *Reading and Writing*, 38, 273–291. <https://doi.org/10.1007/s11145-024-10513-y>
- 454 Chang, H. C., Fang, W. C., Yang, B. H., Luo, B. R., Chew, S. W., & Chen, N. S. (2017).  
455 Examining the relationships between foreign language anxiety and attention during  
456 conversation tasks. *Lecture Notes in Educational Technology*, 1–11, 9789811024184.  
457 [https://doi.org/10.1007/978-981-10-2419-1\\_1](https://doi.org/10.1007/978-981-10-2419-1_1)
- 458 Chen, I.-J., & Chang, C.-C. (2009). Cognitive Load Theory: An Empirical Study of Anxiety and  
459 Task Performance in Language Learning. *Electronic Journal of Research in Education*  
460 *Psychology*, 7(2), 729–746. <https://doi.org/10.25115/ejrep.v7i18.1369>
- 461 Chen, L. (2023). Learner autonomy and English achievement in Chinese EFL undergraduates:  
462 the mediating role of ambiguity tolerance and foreign language classroom anxiety.  
463 *Language Learning in Higher Education*, 13(1), 295–308. [https://doi.org/10.1515/cercles-  
464 2023-2001](https://doi.org/10.1515/cercles-2023-2001)

- 465 Chen, Y., Zhang, L., & Yin, H. (2022). A Longitudinal Study on Students' Foreign Language  
 466 Anxiety and Cognitive Load in Gamified Classes of Higher Education. *Sustainability*  
 467 (Switzerland), 14(17). <https://doi.org/10.3390/su141710905>
- 468 Cheung, H. (1996). Nonword span as a unique predictor of second-language vocabulary learning.  
 469 *Developmental Psychology*, 32(5), 867-873. <https://doi.org/10.1037/0012-1649.32.5.867>
- 470 Chow, B. W. Y., Mo, J., & Dong, Y. (2021). Roles of reading anxiety and working memory in  
 471 reading comprehension in English as a second language. *Learning and Individual*  
 472 *Differences*, 92. <https://doi.org/10.1016/j.lindif.2021.102092>
- 473 Cornoldi, C. (2019). *I disturbi dell'apprendimento*. Bologna: Il Mulino.
- 474 Cornoldi, C., & Vecchi, T. (2003). *Visuo-spatial Working Memory and Individual Differences*.  
 475 Hove: Psychology Press.
- 476 De Beni, R., Palladino, P., Pazzaglia, F., & Cornoldi, C. (1998). Increases in intrusion errors and  
 477 working memory deficit of poor comprehenders. *The Quarterly Journal of Experimental*  
 478 *Psychology*, 51A, 305–320
- 479 Derakshan, N., & Eysenck, M. W. (2009). Anxiety, processing efficiency, and cognitive  
 480 performance: New developments from attentional control theory. *European Psychologist*,  
 481 14(2), 168-176. <https://doi.org/10.1027/1016-9040.14.2.168>
- 482 Dewaele, J. M. (2002). Psychological and sociodemographic correlates of communicative  
 483 anxiety in L2 and L3 production. *International Journal of Bilingualism*, 6(1).  
 484 <https://doi.org/10.1177/13670069020060010201>
- 485 Dijkstra, T. (2005). Bilingual Visual Word Recognition and Lexical Access. In J. F. Kroll & A.  
 486 M. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 179–  
 487 201). Oxford University Press.
- 488 Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and Performance: The Processing Efficiency  
 489 Theory. *Cognition & Emotion*, 6(6), 409–434.  
 490 <http://dx.doi.org/10.1080/02699939208409696>
- 491 Eysenck, M. W., & Derakshan, N. (2011). New perspectives in attentional control theory.  
 492 *Personality and Individual Differences*, 50(7), 955-960.  
 493 <https://doi.org/10.1016/j.paid.2010.08.019>
- 494 Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive  
 495 performance: Attentional control theory. In *Emotion* (Vol. 7, Issue 2).  
 496 <https://doi.org/10.1037/1528-3542.7.2.336>
- 497 Fu, M., & Li, S. (2023). The associations between foreign language anxiety and the effectiveness  
 498 of immediate and delayed corrective feedback. *Foreign Language Annals*, 57(1), 201-228 .  
 499 <https://doi.org/10.1111/flan.12708>
- 500 Gathercole, S. E., Brown, L., & Pickering, S. J. (2003). Working memory assessments at school  
 501 entry as longitudinal predictors of National Curriculum attainment levels. *Educational and*  
 502 *Child Psychology*, 20(3), 109-122. <https://doi.org/10.53841/bpsecp.2003.20.3.109>
- 503 Geva, E., & Ryan, E. B. (1993). Linguistic and Cognitive Correlates of Academic Skills in First  
 504 and Second Languages. *Language Learning*, 43(1), 5-42. <https://doi.org/10.1111/j.1467-1770.1993.tb00171.x>
- 505
- 506 Harrington, M., & Sawyer, M. (1992). L2 working memory capacity and L2 reading skill.  
 507 *Studies in Second Language Acquisition*, 14(1), 25-38.  
 508 <https://doi.org/10.1017/S0272263100010457>
- 509 Hill, F., Mammarella, I. C., Devine, A., Caviola, S., Passolunghi, M. C., & Szűcs, D. (2016).  
 510 Maths anxiety in primary and secondary school students: Gender differences,

511 developmental changes and anxiety specificity. *Learning and Individual Differences*, 48,  
512 45–53. <http://dx.doi.org/10.1016/j.lindif.2016.02.006>

513 Horwitz, E. K., Horwitz, M. B., & Cope, J. (1986). Foreign Language Classroom Anxiety. *The*  
514 *Modern Language Journal*, 70(2), 125–132. <https://doi.org/10.2307/327317>

515 Hwang, M. Y., Hong, J. C., Cheng, H. Y., Peng, Y. C., & Wu, N. C. (2013). Gender differences  
516 in cognitive load and competition anxiety affect 6th grade students' attitude toward playing  
517 and intention to play at a sequential or synchronous game. *Computers and Education*, 60(1),  
518 254-263. <https://doi.org/10.1016/j.compedu.2012.06.014>

519 Iizuka, K. (2009). Foreign language anxiety: A case study of Japanese EFL students. *Language,*  
520 *Communication, and Culture (Kwansei Gakuin University)*, 7, 79–95.

521 Jameson, M. M., & Fusco, B. R. (2014). Math Anxiety, Math Self-Concept, and Math Self-  
522 Efficacy in Adult Learners Compared to Traditional Undergraduate Students. *Adult*  
523 *Education Quarterly*, 64(4), 306–322. <http://dx.doi.org/10.1177/0741713614541461>

524 Johansson, M., & Ölund, A. (2017). Thinking about thinking – a study of anxiety, neuroticism  
525 and Need for Cognition. In *Umeå Universitet*.

526 Kralova, Z., & Petrova, G. (2017). Causes and consequences of foreign language anxiety.  
527 *XLinguae*, 10(3), 110–122. <https://doi.org/10.18355/XL.2017.10.03.09>

528 Lee, Y. Y. (2022). A conceptual analysis of typological distance and its potential consequences  
529 on the bilingual brain. *International Journal of Bilingual Education and Bilingualism*,  
530 25(9), 3333-3346. <https://doi.org/10.1080/13670050.2022.2052790>

531 Lin, Y., Durbin, J. M., & Rancer, A. S. (2016). Math Anxiety, Need for Cognition, and Learning  
532 Strategies in Quantitative Communication Research Methods Courses. *Communication*  
533 *Quarterly*, 64(4), 390-409. <https://doi.org/10.1080/01463373.2015.1103294>

534 Luque-Casado, A., Perales, J. C., Cárdenas, D., & Sanabria, D. (2016). Heart rate variability and  
535 cognitive processing: The autonomic response to task demands. *Biological Psychology*,  
536 113, 83-90. <https://doi.org/10.1016/j.biopsycho.2015.11.013>

537 MacIntyre, P. D., & Gardner, R. C. (1991). Language Anxiety: Its Relationship to Other  
538 Anxieties and to Processing in Native and Second Languages. *Language Learning*, 41(4),  
539 513–534. <http://dx.doi.org/10.1111/j.1467-1770.1991.tb00691.x>

540 MacIntyre, P. D., & Gardner, R. C. (1994a). The Effects of Induced Anxiety on Three Stages of  
541 Cognitive Processing in Computerized Vocabulary Learning. *Studies in Second Language*  
542 *Acquisition*, 16(1), 1–17. <http://dx.doi.org/10.1017/s0272263100012560>

543 MacIntyre, P. D., & Gardner, R. C. (1994b). The Subtle Effects of Language Anxiety on  
544 Cognitive Processing in the Second Language. *Language Learning*, 44(2), 283–305.  
545 <http://dx.doi.org/10.1111/j.1467-1770.1994.tb01103.x>

546 Meschyan, G., & Hernandez, A. E. (2006). Impact of language proficiency and orthographic  
547 transparency on bilingual word reading: An fMRI investigation. *NeuroImage*, 29(4), 1135-  
548 1140. <https://doi.org/10.1016/j.neuroimage.2005.08.055>

549 Mora, J. C., Mora-Plaza, I., & Bermejo Miranda, G. (2024). Speaking anxiety and task  
550 complexity effects on second language speech. *International Journal of Applied Linguistics*  
551 *(United Kingdom)*, 34(1). <https://doi.org/10.1111/ijal.12494>

552 Moran, T. P. (2016). Anxiety and working memory capacity: A meta-analysis and narrative  
553 review. *Psychological Bulletin*, 142(8), 831-864. <https://doi.org/10.1037/bul0000051>

554 Namaziandost, E., Hafezian, M., & Shafiee, S. (2018). Exploring the association among working  
555 memory, anxiety and Iranian EFL learners' listening comprehension. *Asian-Pacific Journal*

556 of *Second and Foreign Language Education*, 3(1). [https://doi.org/10.1186/s40862-018-](https://doi.org/10.1186/s40862-018-0061-3)  
557 [0061-3](https://doi.org/10.1186/s40862-018-0061-3)

558 Nishitani, M., & Matsuda, T. (2011). The Relationship between Language Anxiety,  
559 Interpretation of Anxiety, Intrinsic Motivation and the Use of Learning Strategies. *Online*  
560 *Submission*.

561 Nourbakhsh, N., Chen, F., Wang, Y., & Calvo, R. A. (2017). Detecting users' cognitive load by  
562 galvanic skin response with affective interference. *ACM Transactions on Interactive*  
563 *Intelligent Systems*, 7(3), 1-20. <https://doi.org/10.1145/2960413>

564 Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D.,  
565 Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw,  
566 J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S.,  
567 ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting  
568 systematic reviews. In *The BMJ* (Vol. 372). <https://doi.org/10.1136/bmj.n71>

569 Palladino, P., & Cornoldi, C. (2004). Working memory performance of Italian students with  
570 foreign language learning difficulties. *Learning and Individual Differences*, 14(3), 137-151.  
571 <https://doi.org/10.1016/j.lindif.2004.01.001>

572 Palladino, P., & Ferrari, M. (2008). Phonological sensitivity and memory in children with a  
573 foreign language learning difficulty. *Memory*, 16(6), 604-625.  
574 <https://doi.org/10.1080/09658210802083072>

575 Park, G.-P. (2014). Factor Analysis of the Foreign Language Classroom Anxiety Scale in Korean  
576 Learners of English as a Foreign Language. *Psychological Reports*, 115(1), 261–275.  
577 <http://dx.doi.org/10.2466/28.11.pr0.115c10z2>

578 Rezazadeh, M., & Zarrinabadi, N. (2023). Examining need for closure and need for cognition as  
579 predictors of foreign language anxiety and enjoyment. *Journal of Multilingual and*  
580 *Multicultural Development*, 44(2), 83–95. <https://doi.org/10.1080/01434632.2020.1798972>

581 Sellers, V. D. (2000). Anxiety and reading comprehension in Spanish as a foreign language.  
582 *Foreign Language Annals*, 33(5), 512-520. [https://doi.org/10.1111/j.1944-](https://doi.org/10.1111/j.1944-9720.2000.tb01995.x)  
583 [9720.2000.tb01995.x](https://doi.org/10.1111/j.1944-9720.2000.tb01995.x)

584 Service, E. (1992). Phonology, Working Memory, and Foreign-language Learning. *The*  
585 *Quarterly Journal of Experimental Psychology Section A*, 45(1), 21-50.  
586 <https://doi.org/10.1080/14640749208401314>

587 Simard, D., Zuniga, M., & Hameau, F. (2023). How do attention-shift and foreign language  
588 anxiety interact with objective and subjective measures of fluency? *Language Teaching*  
589 *Research*. <https://doi.org/10.1177/13621688221146379>

590 Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive*  
591 *Science*, 12(2). [https://doi.org/10.1016/0364-0213\(88\)90023-7](https://doi.org/10.1016/0364-0213(88)90023-7)

592 Sweller, J., Van Merriënboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive Architecture and  
593 Instructional Design. *Educational Psychology Review*, 10(3), 251 – 296.  
594 <https://doi.org/10.1023/A:1022193728205>

595 Weng, Y., Zheng, B., & Dong, Y. (2022). Time pressure in translation. *Target. International*  
596 *Journal of Translation Studies*, 34(4), 601 – 626. <https://doi.org/10.1075/target.20148.wen>

597 Williams, K. E., & Andrade, M. R. (2008). Foreign language learning anxiety in Japanese EFL  
598 university classes: Causes, coping, and locus of control. *Electronic Journal of Foreign*  
599 *Language*, 5(2).

- 600 Yan, J. X., & Liang, J. (2022). Foreign language anxiety and dependency distance in English–  
601 Chinese interpretation classrooms. *Frontiers in Psychology, 13*.  
602 <https://doi.org/10.3389/fpsyg.2022.952664>
- 603 Yan, X., & Wang, P. (2001). The impact of language anxiety on students' Mandarin learning in  
604 Hong Kong. *Language Teaching and Research, 6*, 1–7.
- 605 Zhu, L., Nie, Y., Chang, C., Gao, J. H., & Niu, Z. (2014). Different patterns and development  
606 characteristics of processing written logographic characters and alphabetic words: An ALE  
607 meta-analysis. *Human Brain Mapping, 35*(6), 2607-2618.  
608 <https://doi.org/10.1002/hbm.22354>
- 609 Ziegler, J. C., Bertrand, D., Tóth, D., Csépe, V., Reis, A., Faisca, L., Saine, N., Lyytinen, H.,  
610 Vaessen, A., & Blomert, L. (2010). Orthographic depth and its impact on universal  
611 predictors of reading: A cross-language investigation. *Psychological Science, 21*(4), 551-  
612 559. <https://doi.org/10.1177/0956797610363406>
- 613 Zuniga, M., & Simard, D. (2022). Exploring the intricate relationship between foreign language  
614 anxiety, attention and self-repairs during L2 speech production. *System, 105*.  
615 <https://doi.org/10.1016/j.system.2022.102732>  
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618 Table 1 – Quality assessment of the included studies

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Study N	First Author	Clear Objective and Rationale	Eligibility criteria (Inclusion/Exclusion )	Sample characteristics	Random sampling	Robust sample size	Ethic approval	Response rate	Analytical Plan	Main finding	Generizability	Overall quality
1	Chen	Yes	No	No	No	No	No	No	Yes	Yes	No	Very Low
2	Chang	Yes	No	Yes	No	No	No	No	Yes	Yes	No	Low
3	Namaziandost	Yes	No	Yes	No	No	No	No	Yes	Yes	No	Low
4	Chow	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Medium
5	Chen	Yes	No	Yes	No	No	No	Yes	Yes	Yes	No	Medium
6	Zuniga	Yes	No	Yes	No	No	No	No	Yes	Yes	No	Low
7	Yan	Yes	No	Yes	No	No	Yes	No	Yes	Yes	No	Medium
8	Weng	Yes	No	Yes	No	No	Yes	No	Yes	Yes	No	Medium
9	Rezazadeh	Yes	No	Yes	No	No	No	No	Yes	Yes	No	Low
10	Simmard	Yes	No	Yes	No	No	No	No	Yes	Yes	No	Low
11	Mora	Yes	No	Yes	No	No	No	No	Yes	Yes	No	Low
12	Fu	Yes	No	Yes	No	No	No	No	Yes	Yes	No	Low
13	Chan	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Medium-High

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622 Table 2 – Characteristics and results of the studies included in the review  
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N	Author (1 <sup>st</sup> )	Year	Age g	N	L1	L2	FLA Type	Cognitive factor/s	Results
1	Chen, I.J.	2009	18-22	88	Chinese	English	General FLA	Cognitive load (CL)	Significant negative correlation between <b>FLA</b> and <b>CL</b> [r = - 0.295, p < 0.05]
2	Chang, H.C.	2017	19-25	29	Chinese	English	General FLA	Attention level	Significant positive correlation between the <b>attention levels</b> and <b>FLA</b> (r = .38, p = .04) in the real-world situated condition
3	Namaziandost, E.	2018	19-24	30	Persian	English	Listening FLA	Working memory (WM)	The study did not directly measure the correlation between listening anxiety and working memory capacity.  <b>Listening comprehension</b> is significantly correlated to <b>listening anxiety</b> with [r = -.957, p < 0.01] and <b>WM capacity</b> [r = .871, p < 0.01]
4	Chow, B.W.Y.	2021	18-25	105	Chinese	English	Reading FLA	Working memory (WM)	Significant negative correlation between <b>state reading anxiety</b> and <b>verbal WM</b> [r = 0.22, p < 0.01]  <b>WM</b> was negatively associated with <b>FLA</b> [ $\beta$ = -0.23, p < 0.001], which is negatively associated with English reading comprehension [ $\beta$ = -0.44, p < 0.001]
5	Chen, Y.	2022	-----	37	Chinese	English	General FLA	Cognitive Load (CL)	Significant negative correlation between <b>FLA</b> and <b>CL</b> . Specifically: <b>ICL</b> - Pt1: r = .512*; Pt2: r = .540*; Pt3: r = .769*; Pt4: r = .508*; Pt5: r = .361* <b>ECL</b> - Pt1: r = .395*; Pt3: r = .509*; Pt4: r = .366 <b>GCL</b> - Pt1: r = .517*; Pt2: r = .462*; Pt3: r = .416* *p < 0.05
6	Zuniga, M.	2022	20-67	34	French	English	General FLA	Attentional Shift Capacity	No significant correlation between <b>FLA</b> and <b>Attention Slow Attention Group</b>  Strong correlation between <b>FLA</b> and <b>SISR ratios</b> [r (34) = 0.783, p = 0.004, r <sup>2</sup> = 0.613] and <b>C-Repair ratios</b> [r (34) = 0.694, p = 0.018, r <sup>2</sup> = 0.481]

7	Yan, J.X.	2022	-----	49	Chinese	English	Interpretation FLA (ICFLA)	Cognitive load (CL)	Significant negative correlation between <b>ICFLA</b> and <b>CL</b> [r = - 0.29, p < 0.05]
8	Weng, Y.	2022	21-34	45	Chinese	English	General FLA	Mental effort	Significant effect of <b>time pressure</b> (anxiety) on <b>mental effort</b> [ F (2, 88) = 4.46, p = .014]
9	Rezazadeh, M.	2023	18-26	232	Persian	English	General FLA	Need for cognition (NfC)	<b>NfC</b> negatively predicted <b>FLCA</b> [ $\beta$ = -.14, p < .01]
10	Simard, D.	2023	M-28	34	French	English	General FLA	Attentional shift	No significant correlation between <b>FLA</b> and <b>Attention</b>
11	Mora, J.C.	2023	M-22.4	42	Spanish, Catalano	English	General FLA	Working Memory (WM) + Cognitive load (CL)	<u>Working memory</u> No significant correlation between <b>FLA</b> and <b>WM</b> <u>Cognitive load</u> Significant effect of <b>task complexity</b> (CL) on <b>HRsd</b> [F (1, 41) = 7.41, p = 0.009] and <b>SRA</b> [F (1,41) = 0.850, p= 0.632]
12	Fu, M.	2024	12.8	102	Chinese	English	General FLA	Cognitive load (CL)	<b>Anxiety</b> was a significant, negative predictor of the post-tests (Pt) scores of the <b>Delayed CF</b> (high CL) group on the <u>Elicited Imitation Tests</u> [Pt2: $\beta$ = -.34, p = .04*; Pt3: $\beta$ = -.40, p = .03*] and <u>Grammaticality Judgment Tests</u> [Pt3: $\beta$ = -.35, p = .01*; Pt4: $\beta$ = -.48, p = .01**]
13	Chan, K.	2024	7.8 M	177	Chinese	English	Reading FLA	Working Memory (WM)	No significant correlation between <b>FLA</b> (both parent-rated and children-rated) and <b>WM</b>  <b>Parents' rated FLA</b> was a significant predictor of English word reading after controlling for <u>WM</u> performances:  <u>FLRA → T1 English word reading → T2 English word reading</u> $\beta$ = -.12, p < .000 <u>FLRA → Expressive vocabulary knowledge → T2 English word reading</u> $\beta$ = -.14, p < .000

624 Legend: intrinsic cognitive load (ICL), extraneous cognitive load (ECL), germane cognitive load (GCL), Interpretation FLA (ICFLA), Cognitive Load (CL), Need for cognition  
625 (NfC), Working Memory (WM), Heart Rate Standard Deviation (HRsd), Foreign Language Reading Ability (FLRA).  
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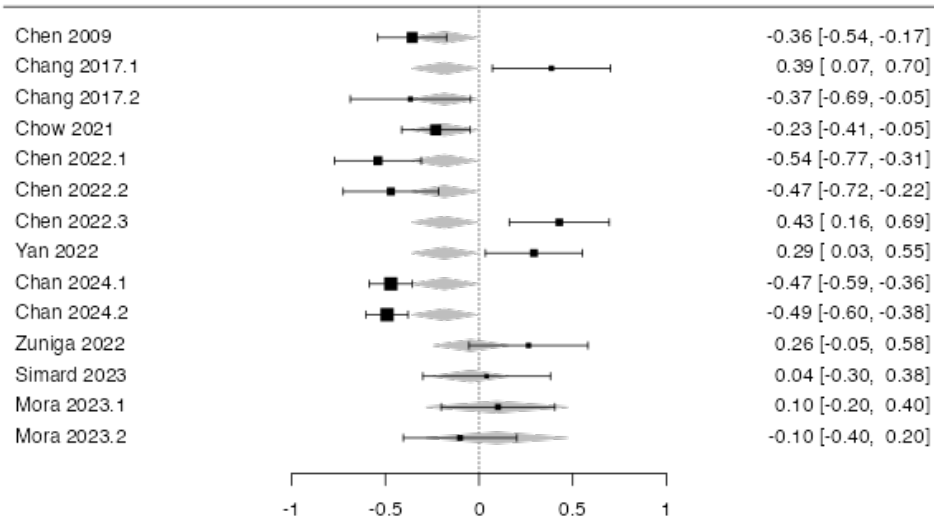
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Table 3 – Effects included in the meta-analysis (k=14 effects)

First Author	Year	Cognitive feature	Effect size (Pearson's r)	Sample size
Chen	2009	cognitive load	0,355	88
Chang	2017	attention	0,38	29
Chang	2017	attention	-0,36	29
Chow	2021	working memory	-0,23	105
Chen	2022	cognitive load	0,534	37
Chen	2022	cognitive load	0,465	37
Chen	2022	cognitive load	0,423	37
Zuniga	2022	attention	0,26	34
Yan	2022	cognitive load	-0,29	49
Simard	2023	attention	0,04	34
Mora	2023	working memory	0,1	42
Mora	2023	working memory	-0,1	42
Chan	2024	working memory	-0,47	177
Chan	2024	working memory	-0,49	177

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631 Figure 2 – Forest plot of the meta-analytic synthesis



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