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RESEARCH ARTICLE

The interplay of mindsets, aptitude, grit, and language achievement: What role does gender play?

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Abstract

The study aimed to examine the interrelationships between growth mindset, L2 aptitude, L2 grit, and L2 achievement, while also exploring the moderating role of gender in these interactions. A sample of 236 English-major students participated in the study by completing a language aptitude test and a questionnaire. The results of path analyses indicated that both aptitude and L2 grit similarly and positively predicted L2 achievement. The growth mindset had no direct effect on L2 achievement, whereas its indirect effects reached statistical significance. Moreover, growth mindset and L2 grit were found to be unrelated to L2 aptitude. Although female and male students did not differ significantly in their growth mindset, L2 aptitude, L2 grit, and L2 achievement scores, Multi-Group Path Analyses unveiled subtle gender differences.

Introduction

Mastering a new language is an arduous endeavor, where the key to success largely depends on the interplay of language learners' cognitive abilities, attitudes, passion, and perseverance. Language aptitude, for instance, is commonly considered a potent predictor of L2 learning outcomes (Li, 2016). The notion of mindsets, which refers to individuals' beliefs toward the malleability of intelligence, personality, and other human traits, has recently emerged as another influential factor in L2 learning (e.g., Lou & Noels, 2016). Furthermore, the combination of passion and perseverance for L2 learning—L2 grit—has garnered recognition as a pivotal trait for L2 development (Teimouri et al., 2021, 2022a). Although aptitude research in L2 learning has been widely explored spanning six decades, the study of mindsets and L2 grit is still in its early stages—although rapidly expanding. In the domain of individual differences (IDs) research, traditionally, the effects of cognitive and non-cognitive factors on L2 learning outcomes have predominately been examined in isolation (Dörnyei & Skehan, 2003), leaving a gap in our understanding of their comparative influence on language achievement (Teimouri et al., 2022b). The first objective of the current study is thus to

shed light on the comparative effects of mindsets, L2 aptitude, and L2 grit on L2 achievement.

Are students' aptitude, mindsets, and personality traits interrelated? Because of the primarily isolated examination of cognitive and non-cognitive factors in L2 learning research, our insights into the intricate connection between cognitive and non-cognitive factors have also remained limited. For instance, in his meta-analysis of L2 aptitude research, Li (2016) concluded that most studies have focused primarily on the links between aptitude and L2 learning, encouraging scholars to further investigate the interactions between aptitude and other ID factors. May someone's cognitive abilities be affected as a function of their personality trait—say, neuroticism or grit? Although many studies in social psychology have investigated the potential links between cognitive abilities and personality traits, research in this area remains scarce in the L2 context (e.g., Biedroń, 2011; Lalonde & Gardner, 1984). Likewise, a research void exists concerning the links between students' aptitude and mindsets: Could the possession of a growth mindset—the belief that one's intellectual ability can be enhanced through committed, hard work—lead to tangible increases in one's aptitude over time? Furthermore, mindsets and grit have been hypothesized to be related because both underscore diligence and resilience toward one's goal despite obstacles and setbacks (Duckworth, 2016; Dweck, 2013). Yet, apart from a select few studies (e.g., Khajavy et al., 2021; Teimouri et al., 2022a), the reciprocal relationship between these two motivational constructs remains largely unexplored. In short, despite the theoretical webs connecting aptitude, mindsets, and personality, L2 research has seldom delved into exploring their interrelationships. As such, as our second objective, we aim to unravel the intricate relations between students' mindsets, L2 aptitude, and L2 grit.

Finally, our third research objective is to examine gender differences concerning the students' mindsets, L2 aptitude, L2 grit, and L2 achievement. Although a handful of studies in SLA have explored gender differences in these areas (e.g., Grañena, 2013; Khajavy et al., 2021; Lou & Noels, 2019), additional research is needed to attain conclusive findings. We further advance this line of inquiry, however, by scrutinizing the interplay of mindset, L2 aptitude, L2 grit, and achievement between female and male students. This approach will facilitate the detection of nuanced gender differences that often elude observation when solely comparing the scores of men and women on a set of variables. In other words, although there may appear to be no visible differences in men's and women's scores on a set of variables, it remains plausible that their interactions could still have varying effects on outcome variables.

Mindsets, L2 aptitude, and L2 grit

Mindsets

According to the mindset theory, people believe that human attributes such as intelligence and personality traits are either fixed or malleable (Dweck, 2013; Dweck et al., 1995, 2014). A fixed mindset (i.e., entity theory) is the belief that one's mental abilities are firmly established from birth and cannot be developed over time. A growth mindset (i.e., incremental theory), in contrast, is the belief that one's mental abilities are malleable and can be developed over time (Dweck, 2013). The effects of mindsets have been extensively examined in various contexts, including intergroup relations (e.g., Rattan & Georgeac, 2017), interpersonal relationships (e.g., Yeager et al., 2013), well-being (e.g., Lee et al., 2018), classroom learning (e.g., Dweck et al.,

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2014), and academic achievement (Constantine, 2017; Yeager et al., 2018). Research findings, overall, have ascribed a positive role to growth mindsets in diverse social and educational contexts.

The influence of mindsets on L2 learners' progress and achievements, however, has been recently brought into systematic investigations in SLA research (Lou & Noels, 2016). In their systematic investigation of the role mindsets play in L2 learning, Lou and Noels (2016) demonstrated that a growth mindset was strongly and positively associated with learners' learning goals, which, in turn, reduced feelings of helplessness among the students when confronted with failures. In contrast, a fixed mindset was found to be associated with performance goals and competence demonstration behaviors among the students who believed they had sufficient or superior L2 skills. In a large-scale study, Lou and Noels (2020) investigated the relationships between the mindset orientations of 2,163 migrants learning English in Canadian universities and their language anxiety, language use, and self-perceived proficiency. They found that ESL learners with a stronger growth mindset had less anxiety, were more likely to use English, and reported slightly higher proficiency levels in English. In another study, Khajavy et al. (2021) found growth mindset as a weak, positive predictor of L2 achievement among 1,178 university students in Iran.

In their review of mindsets research in L2 learning, Lou and Noels (2019) concluded that a fixed mindset engenders maladaptive motivation, whereas a growth mindset fosters adaptive motivation in the context of L2 learning. They further emphasized that intervention programs can alter students' mindsets about intelligence, thereby increasing the likelihood of greater L2 performance and achievement (Lou & Noels, 2016). Although several meta-analyses have exhibited weak associations between growth mindset interventions and academic achievement (e.g., Sisk et al., 2018), Lou and Noels (2019) eventually argued that L2 teachers should endorse and cultivate a growth mindset in their classrooms to counteract the detrimental consequences associated with a fixed mindset. By doing so, they sought to empower students to rebound from failures to continue their L2 learning with diligence. Although growth mindset research in L2 learning has yielded promising results regarding its influence on L2 learners' motivational behaviors and emotional experiences, there is a paucity of research examining its link to actual L2 achievement.

Language aptitude

Second language aptitude is referred to as a set of cognitive and perceptual abilities that enable individuals to learn another language easily, quickly, and effectively (Wen, 2022). L2 aptitude has been further argued to be distinct from general intelligence—and other affective factors like motivation (Li, 2016). Systematic aptitude research in L2 learning began after the development of the Modern Language Aptitude Test (MLAT) by John Carroll and Stanly Sapon in the late 1950s.

Since the development of the MLAT, numerous aptitude tests have been created to investigate the role L2 learners' cognitive abilities play in L2 learning (Li, 2016). As an example, PLAB (Pimsleur's Language Ability Battery) was one of the first aptitude tests to incorporate students' grade point averages and motivation as part of its inventory (Pimsleur, 1966). Grigorenko et al. (2000) introduced the cognitive ability for novelty in the CANAL-F (language acquisition-foreign) model, which focused on learners' natural ability to handle novelty and ambiguity while learning an L2. According to Dörnyei and Skehan (2003), the CANAL-F test measures learners' recalling and inferencing

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abilities in processing and acquiring a new language under immediate and delayed conditions. Meara's (2005) LLAMA tests (Language Learning and Aptitude Measurement in Adults) is another instance—a computer-based language aptitude test widely used in SLA research. Lastly, Doughty and her team developed the Hi-LAB (Hi-Level Language Aptitude Battery), which is specifically designed to forecast high levels of L2 mastery (Doughty et al., 2010; Linck et al., 2013).

L2 aptitude research has been categorized as correlational and experimental approaches (Li, 2016). In correlational research, the direct links between aptitude and its components with L2 learning were mostly investigated. In his meta-analysis of language aptitude research, Li (2016) found aptitude and L2 proficiency to be positively correlated at about .50. Overall, aptitude has been underscored as one of the strongest predictors of L2 proficiency in SLA along with motivation (Dörnyei & Skehan, 2003; Li, 2016). However, while the links between aptitude and achievement have been examined extensively in past research, the links between aptitude and other learner factors—in particular, personality traits and mindsets—have remained highly limited (Li, 2016).

L2 grit

Grit has been conceptualized as the combination of perseverance and passion toward long-term goals (Duckworth et al., 2007). Grit has been hypothesized to be as important as talent in predicting success outcomes (Duckworth et al., 2007). The two subcomponents of grit are perseverance and passion. Perseverance refers to a person's propensity to exert consistent effort over an extended period of time, and passion refers to a person's continued passion for achieving a long-term goal despite obstacles and setbacks (Duckworth & Gross, 2014; Duckworth et al., 2007). Grit has been argued to be distinct from similar personality traits like resilience, self-control, and conscientiousness (Duckworth et al., 2007). Grit research has grown exponentially in various social and educational domains, including L2 learning, despite criticisms regarding the construct and predictive validity of the domain-general grit scale, and its close association with conscientiousness (e.g., Credé et al., 2017).

Given that success in L2 learning is highly dependent on one's sustained effort and passion over a long time (e.g., Dörnyei, 2020), the notion of grit becomes highly relevant in the L2 learning context (Teimouri et al., 2021, 2022a). Grit research in SLA has grown exponentially during the past 5 years (e.g., Alamer, 2021; Khajavy et al., 2021; Mikami, 2023; Pawlak et al., 2022; Teimouri et al., 2022a, 2022b; Wei et al., 2019). In a brief time, grit has become the most researched personality trait in SLA, with at least over 100 studies incorporating the terms "grit" or "L2 grit" in their titles. The findings of this vast body of research, overall, have showcased the numerous beneficial effects of grit on L2 learners' motivational behavior, emotional experiences, and L2 achievement (for a review, see Teimouri et al., 2021).

Of particular significance is the research examining the direct links between grit (and its subcomponents) and L2 achievement. In their investigations, grit researchers have either used a domain-general or a domain-specific measure of grit—or both. As noted by Teimouri et al. (2021, 2022a), research that used a domain-general measure of grit has yielded inconsistent results on the relationship between grit and L2 learning outcomes. For instance, although some studies identified a positive association between domain-general grit and L2 accomplishment (e.g., Wei et al., 2019), other studies found no such relationships (e.g., Khajavy et al. 2021). In contrast, research that has used a

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domain-specific measure of grit has shown a consistent, positive correlation between L2 grit and L2 proficiency (e.g., Alamer, 2021; Sudina & Plonsky, 2020, 2021; Sudina et al., 2021; Teimouri et al., 2022a, 2022b). Moreover, in those studies that have used both domain-general and domain-specific measures of grit, the domain-specific grit was found to be much more strongly related to L2 learning outcomes than the domain-general grit (e.g., Mikami, 2023; Pawlak et al., 2022; Teimouri et al., 2022a).

How are mindsets, L2 aptitude, and L2 grit interrelated?

Mindsets and aptitude

"You have a certain amount of intelligence, and you can't do much to change it"; "Intelligence is something that you can develop through hard work and effort." Such statements are used commonly in mindset scales to assess people's beliefs regarding the malleability of intelligence (e.g., Dweck, 1999). Although possessing a mindset (growth vs. fixed) has a significant impact on one's behavior and performance (Lou & Noels, 2016, 2019), its motivational impact does not necessarily substantiate the truth of its content. Does having a growth mindset positively influence one's aptitude? Or, as Lou and Noels (2017) hypothesized, do students with low aptitude develop a fixed mindset because of experiencing repeated L2 failures? Unfortunately, there is a paucity of research examining the truth content of such mindsets, and the few studies that have attempted to do so failed to find a correlation between mindsets and cognitive abilities (e.g., Bahník & Vranka, 2017; Burgoyne et al., 2018; Li & Bates, 2019; Macnamara & Rupani, 2017). Bahník and Vranka (2017), for instance, found no correlation between mindsets and aptitude tests of 5,653 Czech university applicants. Likewise, Li and Bates (2019) found no association between students' mindsets and their intellectual performance. In another study, Burgoyne et al. (2018) observed no correlation between a growth mindset and crystallized intelligence (i.e., skills necessary for abstract thinking and quick problem-solving) and fluid intelligence (i.e., knowledge, skills, and understanding gained through experience and education). Similarly, Macnamara and Rupani (2017) found no relationship between a growth mindset and fluid intelligence. In the current study, we investigate the relationship between a growth mindset and language aptitude for the first time in the L2 context.

Mindsets and L2 grit

Mindsets and grit are theoretically related because both constructs emphasize the value of continuous, hard work for success despite challenges and failures (Duckworth, 2016; Dweck, 2013). To develop grit, one needs to embrace a growth mindset, and to develop a growth mindset, one needs to be gritty (Duckworth, 2016; Park et al., 2020). The positive path between a growth mindset and grit has been reported in previous research (West et al., 2016; Yeager et al., 2016). In a longitudinal study, for instance, Park et al. (2020) found that growth mindset and grit reciprocally predicted each other's developmental trajectories among a sample of 1,667 US adolescents from different middle schools. Limited research in SLA has also shown that a growth mindset has a positive link, and a fixed mindset has a negative relation with grit (Khajavy et al., 2021; Teimouri et al., 2022a). In the current study, we further investigate the relationships between mindsets and L2 grit.

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L2 grit and aptitude

The influence of personality traits—especially, the Big Five—on different types of intelligence has received particular attention from social psychologists (e.g., Ackerman & Heggestad, 1997; Chamorro-Premuzic & Furnham, 2014; DeYoung, 2020; Von Stumm & Ackerman, 2013). For instance, in a recent meta-analysis of 272 studies examining the links between personality traits and intelligence (N = 162,636), Anglim et al. (2022) reported that openness to experience (r = .17, p <.001) and neuroticism (r = −.08, p <.01) were associated with intelligence, whereas extraversion (r = −.01), agreeableness (r = .00, p >.05), and conscientiousness (r = −.02) showed no correlations with intelligence.

Of relevance to the current study, the personality trait grit has been hypothesized to be unrelated to intelligence (Duckworth et al., 2007). In a rare study, Zisman and Ganzach (2021) examined the links between grit and a measure of intelligence (i.e., Armed Forces Qualifying Test) among a representative sample of 6,748 participants of various ethnicities and found no correlation between the two constructs (r = -.002). Because grit and conscientiousness are closely related (e.g., Credé et al., 2017), the absence of correlation between conscientiousness and intelligence may suggest that grit and intelligence may also be unrelated. In this study, we further explore the link between L2 grit and aptitude.

What role does gender play?

Mindsets and gender

Do women and men hold different beliefs concerning the nature of intelligence? Mindsets theory speculates that women are more likely than men to maintain a fixed mindset because, starting in infancy, parents tend to give boys more process praise—an advantage that leads to a greater desire for challenge and a growth mindset later on in life (Dweck & Simmons, 2014). Likewise, the "Bright girl effect" phenomenon assumes that bright girls have a fixed mindset, believing that their abilities are innate and unchangeable, whereas bright boys have a growth mindset, believing that their abilities can be developed through effort and practice (Halvorson, 2011). Although several studies have provided partial evidence for such assumptions (e.g., Licht & Shapiro, 1982), several other studies found no evidence regarding gender differences in mindsets (e.g., Ablard & Mills, 1996; Constantine, 2017; Hwang et al., 2019). In the field of L2 learning, limited research has shown no significant differences between genders in their mindsets (Khajavi et al., 2021; Lou & Noels, 2019; Zarrinabadi et al., 2021). In this study, we further investigate gender differences in students' mindsets in the L2 context.

Aptitude and gender

SLA Research on the impact of gender on L2 aptitude has been notably limited (Biedroń, 2023). For instance, Chalmers et al.'s (2021) extensive review spanning 60 years of L2 aptitude research highlighted that while gender information was provided in about 70% of studies, a mere 3% considered gender as an independent variable in quantitative analysis. In some early attempts, Meara (2005) and Grañena (2013) found no significant differences between female and male students' scores in all subtests of the LLAMA. Likewise, Rogers et al. (2016, 2017) observed no gender differences in the performance of L2 learners on the LLAMA tests. In a rare study,

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Bell and McCallum (2012) investigated gender differences concerning the relationship between aptitude and language achievement. Using the short form of MLAT (Carroll & Sapon, 2002) to gauge the students' language aptitude, they found that gender exerted a meaningful effect: Although there was a significant, positive correlation (r = .40) between aptitude scores of female learners and their language achievement (MLAT IV), this correlation was not significant for male learners (r = .09). Overall, further research is needed to cast light on how language aptitude might be influenced by gender among L2 learners (Chalmers et al., 2021).

Grit and gender

Grit has been found to be unrelated or negligibly related to gender. In their pioneering studies on grit, Duckworth et al. (2007) and Duckworth and Quinn (2009) detected no differences between the two genders' grit levels. Hodge et al. (2018) also found no noteworthy gender differences in grit levels among Australian university students. Likewise, Usher et al. (2019) observed no significant correlation between grit and gender among elementary and secondary school students in the United States. Although a few studies have reported small gender differences in grit (e.g., Christensen & Knezek, 2014), Credé et al.'s (2017) meta-analysis of grit studies revealed that the relationship between grit and gender was very weak (k = 25, n = 18,750, ρ = .05, $SD\rho$ = .07). In the field of L2 learning, few studies have also examined the link between gender and grit, and their findings revealed no gender differences in language learners' grit level (e.g., Khajavi et al., 2021; Teimouri et al., 2022b).

L2 achievement and gender

In educational contexts, extensive research has examined gender differences concerning language performance, and several studies have shown that girls and women have surpassed boys and men in learning languages. For instance, in a meta-analysis conducted by Voyer and Voyer (2014), female students were found to have received higher teacher-assigned school marks for language courses (including marks obtained in native language and foreign-language courses) than male students at the tertiary level. The gender gap, however, decreased significantly at college levels, probably because college students are highly motivated in their self-selected majors (Voyer & Voyer, 2014). In the context of L2 learning, however, only a few studies have examined gender differences in L2 learners' achievements. Ryan and Bachman (1992), for instance, reported no meaningful differences between the scores of 575 male and 851 female students on the TOEFL (Test of English as a Foreign Language). Likewise, Sparks and Alamer (2022) reported that gender was not a significant factor in mediating the relationship between L2 learners' L1 skills and L2 anxiety and achievement. In contrast, Bećirović (2017) found girls more successful in learning English as a foreign language than boys in a sample of 185 students of elementary and high school levels in Sarajevo, Bosnia and Herzegovina.

The study

The first objective of the current study is to investigate the comparative effects of mindsets, aptitude, and L2 grit on L2 achievement. By doing so, we will provide more accurate estimates of the variance each of these cognitive and non-cognitive factors

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explained in L2 achievement. The second objective of the study is to shed light on the interrelationship among mindsets, aptitude, and L2 grit. For instance, does students' growth mindset predict their actual aptitude, or is students' grit related to their aptitude? Finally, the third objective of the study is to examine the gender differences concerning several key learner factors in L2 learning. As noted, only a limited number of studies in SLA have investigated gender differences in these areas, hindering the ability to draw conclusive results. Moreover, we advance gender research on IDs by focusing on gender differences regarding the interactions among mindsets, aptitude, L2 grit, and L2 achievement—in addition to comparing female and male students' scores on the relevant variables. In this study, we will answer the following research questions:

1. How do mindsets, language aptitude, and L2 grit predict language achievement?
2. How are mindsets, L2 aptitude, and L2 grit related to one another?
   a. Does a growth mindset predict L2 aptitude?
   b. Does a growth mindset predict L2 grit?
   c. Are L2 aptitude and L2 grit related?
3. What role does gender play in the students' mindsets, L2 aptitude, L2 grit, and L2 achievement?
   a. To what extent do female and male students' scores on mindsets, L2 aptitude, L2 grit, and L2 achievement differ?
   b. To what extent do mindsets, L2 aptitude, and L2 grit predict L2 achievement differently for female and male students?

Methods

Participants

A total of 236[1] English-major undergraduate students from a private university in Tehran, Iran, participated in this study. The data were collected by the third author through the convenience sampling method. The sample consisted of 166 female and 70 male students, and their ages ranged from 18 to 66 (M = 31.10, standard deviation [SD] = 9). The participants reported between 1 and 15 years of English learning experience (M = 4.75; SD = 2.58) and rated their English proficiency from 1 (absolute beginner) to 5 (upper-intermediate), on average, being lower-intermediate (M = 3.32; SD = 1.02).

Instruments

We collected the data by administering a questionnaire and a language aptitude test to the students. A questionnaire was developed in Farsi—the official language of Iran. The first section of the questionnaire consisted of items measuring the students' mindsets and L2 grit: Five-point and seven-point Likert scales were used to elicit responses to each item (for a copy of the scales, see Supplementary Materials, Part 1). In the second section of the questionnaire, students' background information—such as age, gender, and perceived language proficiency—as well as their final grades in several language-related courses were collected. To assess the students' language aptitude, the LLAMA tests (Meara, 2005) were administered to the students. A detailed description of each measure is provided subsequently.

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Mindsets

To measure the students' mindsets, four items were adopted from Dweck's (1999) mindsets scale, consisting of growth mindset (e.g., *you can always greatly change how intelligent you are*) and fixed mindset (e.g., *you have a certain amount of intelligence, and you really can't do much to change it*). Mindsets are not all-or-nothing constructs; rather, they represent a continuum from fixed to growth with individuals being able to move between different points on the continuum (Yeager & Dweck, 2020). As such, a growth mindset index was calculated by averaging the four items of the growth mindset and the reverse-coded items of the fixed mindset, with 1 representing a pure fixed mindset and 7 representing a pure growth mindset (e.g., Blackwell et al., 2007).

L2 grit

To measure the students' grit level for learning English, we used the L2 grit scale (Teimouri et al., 2022a). The scale consists of nine items measuring the students' perseverance and passion for learning English. The scale's reliability and validity have been supported in several studies in various contexts, such as Canada, China, Iran, Japan, Poland, Russia, South Korea, Turkey, and the USA (e.g., Elahi Shirvan et al., 2021; Liu & Wang, 2021; Mikami, 2023; Pawlak et al., 2022; Solhi et al., 2023; Sudina & Plonsky, 2020, 2021; Sudina et al., 2021; Teimouri et al., 2022a, 2022b; Wei et al., 2020).

L2 aptitude

To measure the L2 aptitude, the LLAMA tests were used (the downloadable software version) (Meara, 2005). The software has four subcomponents: (a) LLAMA_A, which measures the ability to learn a number of words in a short period; (b) LLAMA_D, which measures the ability to recognize and recall short speeches that were heard a short while ago; (c) LLAMA_E, which measures the ability to establish relationships between sounds and their correspondence writing systems; and (d) LLAMA_F, which measures the ability to infer grammatical rules embedded in an unknown language. The predictive validity of the tests in determining language learning outcomes has been well established in the L2 research (Bokander & Bylund, 2020; Li, 2016).

Language achievement

The students' language achievements were assessed based on the students' final grades in three courses: Grammar, Speaking, and Listening. The course grades—ranging from 0 to 20—were calculated by averaging the students' midterm and final exam grades in each course (see Supplementary Materials, Part 2, for a complete list of all the tests used at midterm and final exams for each course).

Procedure

The data were collected at the onset of the university semester during classroom time. Before collecting the data, the students were informed about the purpose of the research, the anonymity and confidentiality of their responses, and the voluntary nature of their participation. The students first completed the questionnaire; they were given both written and oral instructions on how to complete it. On average, it took

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about 5 to 10 min for the students to answer all the questions. Next, the students took the LLAMA tests. Before administering the aptitude tests, the students were given all the necessary instructions on how to take each section of the test by the third author, who also supervised the whole process of test administration to ensure that all testing equipment (e.g., computers, headphones, LLAMA software) worked properly and that students understood the whole testing procedure without any difficulty.

Data analysis

Initially, descriptive and reliability analyses were run for all the measures included in the study. Because the students' mindsets, aptitude, L2 grit, and language achievement measures were gauged on different scales, for ease of comparison, we standardized all the scores by computing the T-score for each scale. Moreover, all the course grades were combined into a single measure due to their strong correlations ($r = .71–.82$). In the next step, correlational analyses were run to examine the relationships among mindsets, language aptitude, L2 grit, and L2 achievement. To probe the linear relationships among all the variables, path analysis was conducted. Finally, to investigate gender differences, two types of statistical analyses were run. First, four independent t-tests were run to examine the potential differences between female and male students' scores on mindsets, L2 aptitude, L2 grit, and L2 achievement. Finally, Multi-Group Path Analyses were run to assess whether the relationships among mindsets, L2 aptitude, L2 grit, and L2 achievement were moderated by gender.

Results

Table 1 presents the results of descriptive and reliability analyses for the mindsets, language aptitude, and L2 grit (raw scores). As seen, the students reported high levels of L2 grit, with their passion slightly higher than their perseverance of effort. Considering the students' L2 aptitude, they scored the highest on the LLAMA_E and the lowest on the LLAMA_F. Finally, the students scored higher on the growth mindset than the fixed mindset. Table 2 depicts the student's raw course grades (Grammar, Speaking, and Listening). As noted, because all the variables were measured using different scales, T-scores were computed for each scale to facilitate their comparisons. Table 3 lists the

Table 1. Descriptive and Reliability Analyses of Mindsets, Aptitude, and L2 Grit and Their SubComponents (Raw Scores)

Variables	Min	Max	Median	Mean	SD	95% CI Low Up	α
1. L2 Grit	**1.89**	**5**	**3.89**	**3.84**	**.64**	**3.76 3.92**	**.81**
Perseverance	1	5	3.60	3.63	.81	3.52 3.73	.85
Passion	2	5	4.25	4.11	.77	4.01 4.21	.72
2. Language Aptitude	**12.5**	**80**	**42.5**	**42.91**	**13.80**	**40.65 44.19**	**.86**
LLAMA B	10	90	35	39.72	16.28	37.61 41.83	—
LLAMA F	10	90	30	30.22	13.74	28.43 32.00	—
LLAMA E	10	100	70	67.88	20.27	65.15 70.51	—
LLAMA D	10	70	35	33.81	12.54	32.18 35.44	—
3. Mindsets	**2**	**7**	**5**	**4.88**	**1.24**	**4.72 5.04**	**.80**
Growth Mindset	1	7	5	4.94	1.42	4.76 5.12	.86
Fixed Mindset	1	7	3	3.17	1.48	2.99 3.36	.77

Note: $N = 236$. CI = confidence interval.

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Table 2. Descriptive Analyses of L2 Achievement Measures (Raw Scores)

Variables	Min	Max	Median	Mean	SD	95% CI Low Up
1. Grammar Course Grade	13	20	18	17.45	1.69	17.23 17.66
2. Speaking Course Grade	12	20	18	18.04	1.58	17.84 18.24
3. Listening Course Grade	12	20	18.5	18.10	1.59	17.89 18.30

Note: $N = 236$.

Table 3. Descriptive and Reliability Analyses of Mindsets, L2 Aptitude, L2 Grit, and L2 Achievement Measures (T-Scores)

Variables	Min	Max	Median	Mean	SD	95% CI Low Up	α
1. Growth Mindset	26.82	67.01	50.94	50	10	48.72 51.28	.80
2. Language Aptitude	38.71	63.61	50.02	50	5	49.35 50.64	.86
3. L2 Grit	34.88	58.97	50.36	50	5	49.36 50.64	.81
4. L2 Achievement	16.05	64.41	51.35	50	10	48.72 51.28	.90

Note: $N = 236$.

Table 4. Results of Correlational Analyses Among All the Variables

	Growth Mindset	L2 Aptitude	L2 Grit
Growth Mindset	1		
L2 Aptitude	.07	1	
L2 Grit	.10	.08	1
L2 Achievement	.03	.34*	.34*

*$p < .01$.

T-scores for all the measures included in the study, along with their computed Cronbach's alphas. Cronbach's alphas ranged from. 80 to. 93, substantiating the internal consistencies of the measures for further statistical analyses (Field, 2013).

In our first and second research questions, we aimed to empirically examine the interrelationships among growth mindset, language aptitude, L2 grit, and L2 achievement. To answer these two research questions, initially, correlational analyses were run among all the variables. As exhibited in Table 4, the L2 aptitude and L2 grit were found to be similarly and positively related to L2 achievement, whereas the correlations among the growth mindset, aptitude, and L2 grit were all negligible and statistically nonsignificant.

Next, path analyses were run to further probe the linear paths among mindsets, aptitude, L2 grit, and L2 achievement. Figure 1 demonstrates a schematic representation of the model. The maximum likelihood method was used to estimate the model's parameters, and the expectation-maximization algorithm was applied to handle the missing data. Because of the large sample size ($N = 236$), the chi-square to degrees of freedom ratio was used to measure the overall model's fitness. To further assess the overall model's fitness, several other indices were used, such as the goodness of fit index, comparative fit index, and root mean square error of approximation. As indicated in Table 5, the chi-square to degrees of freedom ratio displays a value below the proper level of 3. In addition, all the fit indices exceeded the acceptable criteria.

Figure 2 illustrates the overall model with the regression values. The growth mindset had weak but non-significant effects on the L2 aptitude ($p = .28$) and L2 grit ($p = .12$). In addition, both L2 aptitude and L2 grit similarly and positively predicted L2

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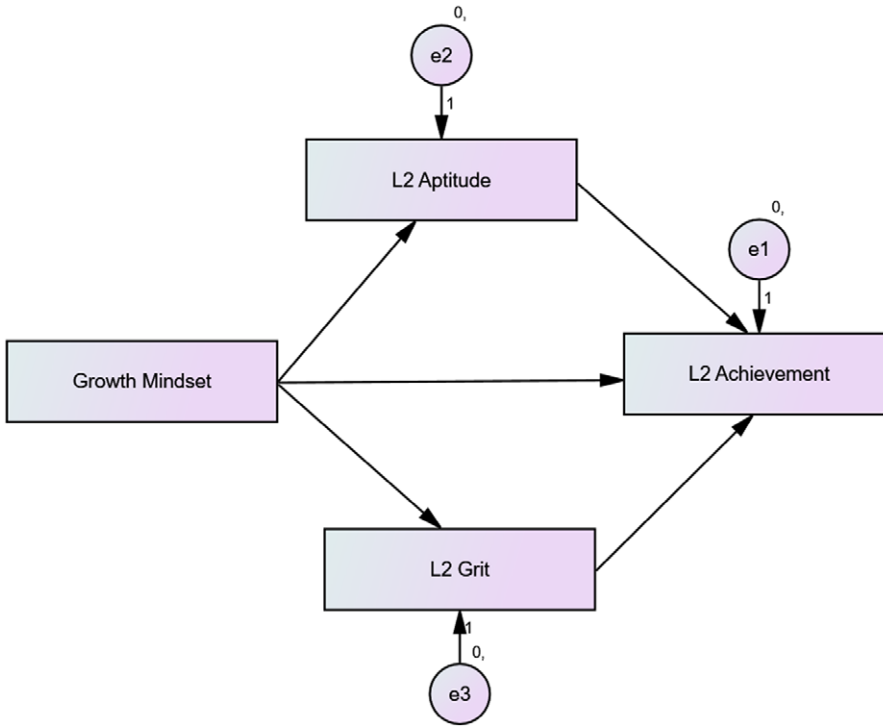

Figure 1. The measurement model of growth mindset, L2 aptitude, L2 grit, and L2 achievement (e1, e2, and e3 refer to residuals).

Table 5. Selected Fit Measures for the Final Model

Index	Current	Accepted Level	Evaluation
χ^2	$p < .001$	$p > .05$	Very poor
χ^2/df	1.31	< 3.00	Very good
GFI	1	> .90	Very good
AGFI	.97	> .90	Very good
NFI	.98	> .90	Very good
IFI	.96	> .90	Very good
TLI	.97	> .90	Very good
CFI	.99	> .90	Very good
RMSEA	.04	< .07	Very good

CFI = Comparative Fit Index; GFI = Goodness of Fit Index; AGFI = Adjusted Goodness of Fit Index; IFI = Incremental Fit Index; NFI = Normal Fit Index; RMSEA = Root Mean Square Error of Approximation; TLI = Tucker-Lewis Index.

achievement ($p <. 001$), whereas the growth mindset did not exert any direct effect on L2 achievement ($p = .65$). Finally, the indirect effect of growth mindset on L2 achievement either through L2 aptitude or L2 grit did not reach statistical significance ($p = .22$ and $p = .12$, respectively). Nonetheless, the overall indirect effects of growth mindset on L2 achievement reached statistical significance ($p = .04$).

The third research question probed gender differences concerning mindsets, L2 aptitude, grit, and L2 achievement as well as their interactions. To answer this question, first, four independent t-tests were run. To avoid Type 1 error due to running multiple

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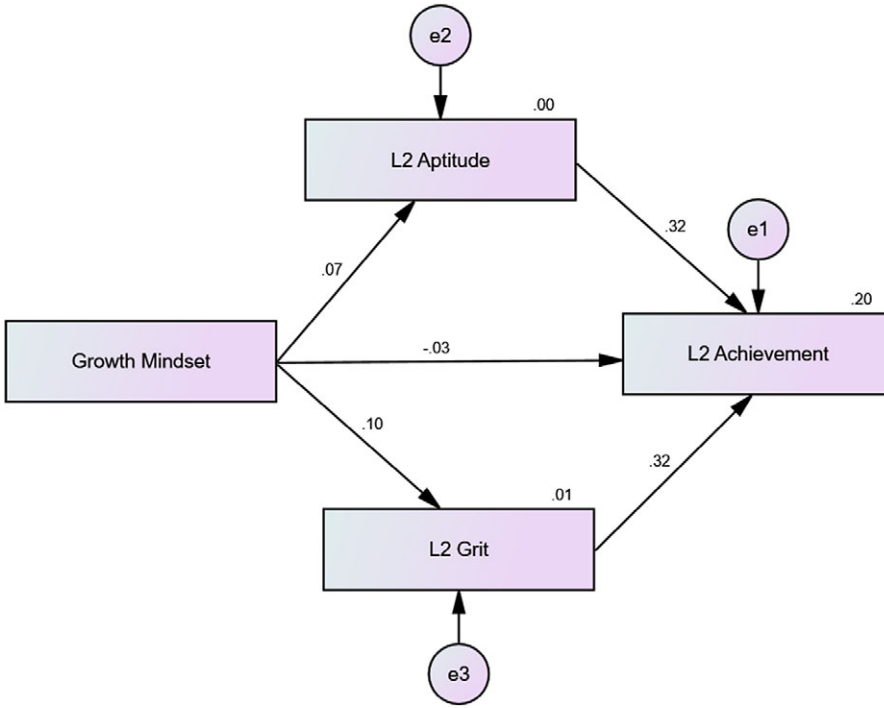

Figure 2. Measurement model of growth mindset, L2 aptitude, L2 grit, and L2 achievement for all students. ***p <. 001.

Table 6. Gender Differences of Mindsets, L2 Aptitude, L2 Grit, and L2 Achievement.

Variable	Males *M/SD*	Females *M/SD*	M Difference	t	df	*p*	Cohen's *d*
Growth Mindset	50.88/9.58	49.62/10.17	−1.25	−.88	234	.38	.13
L2 Aptitude	50.36/4.38	49.84/5.24	−.51	−.72	234	.47	.11
L2 Grit	49.15/4.87	50.35/5.02	1.21	1.70	234	.09	.24
L2 Achievement	50.29/9.72	49.87/50.29	−.42	−.30	234	.77	.04

t-tests, the p-value was corrected using the conservative Bonferroni correction method —dividing the p-value by the number of t-tests. Thereby, the p-value was set at 0.0125 to reject the null hypothesis for each independent t-test. Cohen's d effect size for each t-test was also calculated to better understand the magnitude of the difference. Overall, the results revealed no statistical differences between female and male students' scores on any of the variables. The results of independent t-tests are presented in Table 6.

To examine gender differences regarding the comparative effects of mindsets, L2 aptitude, and L2 grit on L2 achievement, Multi-group Path Analyses in AMOS (Version 29) were conducted. Two models—an unconstrained model and a restricted structural weights model—were compared to test the moderating role of gender. The chi-square tests and associated fit indices were used to evaluate the differences in model fit. The results of path analyses for male and female students are illustrated in Figures 3 and 4,

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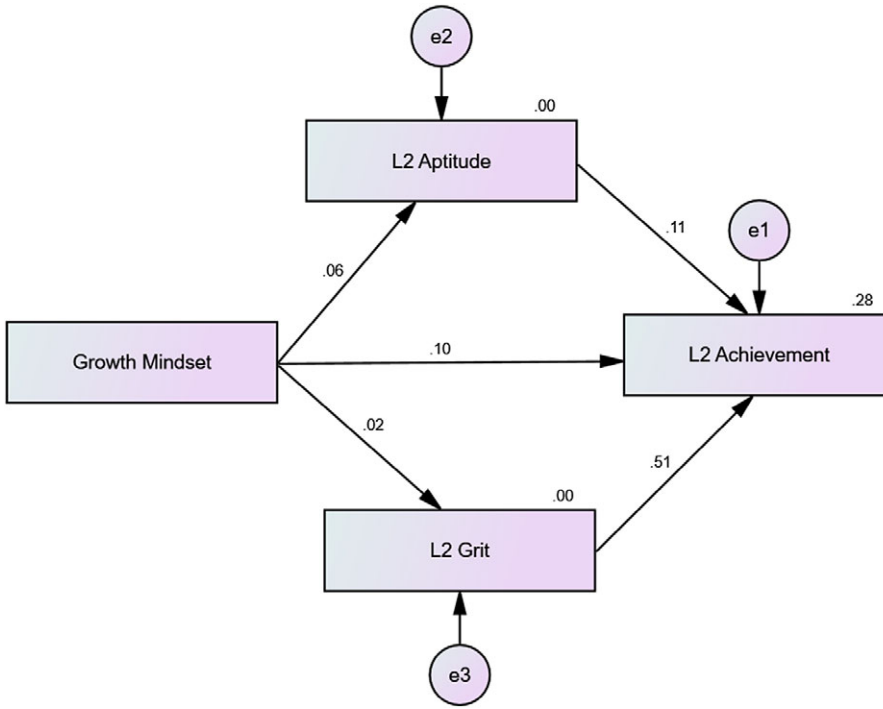

Figure 3. Measurement model of growth mindset, L2 aptitude, L2 grit, and L2 achievement for male students. ***p <. 001.

respectively. For male students, while L2 grit strongly and positively predicted L2 achievement, L2 aptitude had negligible effects (p = .30). For female students, on the other hand, both L2 aptitude and L2 grit positively predicted L2 achievement. Growth mindset had no direct, statistically significant effects on L2 achievement, L2 grit, and L2 aptitude—although the effects of mindsets on L2 grit for female students were approaching significance level (p = .07). Of note, however, the chi-square difference test between the unconstrained model and the structural weights model did not yield statistical significance (χ^2 = 8.88, p = 0.11), and the fit indices did not demonstrate substantial improvements in model fit when gender-based structural weights were constrained, suggesting that gender may not exert a moderating influence on the relationships among growth mindset, L2 aptitude, L2 grit, and L2 achievement. Nevertheless, the lack of statistical significance can be attributed to the limited sample size for the male students (n = 70), considering that the p-value was approaching below. 10 and that noticeable differences in regression weights between female and male students' models are evident. For instance, when the same multigroup analyses were conducted only on the paths from the L2 grit to L2 achievement and the L2 aptitude to L2 achievement, the chi-square differences between the unconstrained model and the structural weights model yielded statistical significance (χ^2 = 4.02, p = 0.04) for the former and approaching significance for the latter (χ^2 = 3.51, p = 0.06), suggesting while L2 grit appears to have a greater impact on the L2 achievement of male students, and L2 aptitude appears to exert a stronger influence on the L2 achievement of female students.

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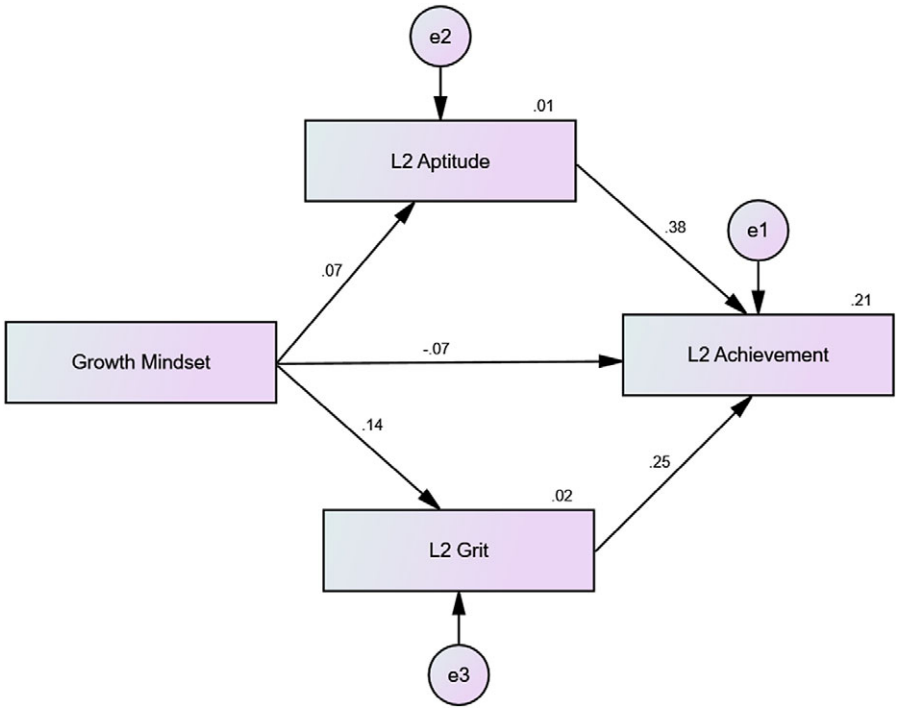

Figure 4. Measurement model of growth mindset, L2 aptitude, L2 grit, and L2 achievement for female students. ***p <. 001.

Discussion

RQ1: How do students' mindsets, aptitude, and L2 grit predict their language achievement?

As expected, L2 aptitude emerged as a significant, positive predictor of L2 achievement —a finding reported in L2 research repeatedly using either the LLAMA tests or other aptitude tests (Abrahamsson & Hyltenstam, 2008; Grañena, 2014; Li, 2016; Saito, 2017, 2019; Yalcin & Spada, 2016). Likewise, L2 grit was found as a significant, positive predictor of L2 achievement. The positive path from L2 grit to L2 achievement has been established in the fast-growing L2 grit research (e.g., Alamer, 2021; Cheng, 2021; Mikami, 2023; Sudina & Plonsky, 2021; Sudina et al., 2021; Teimouri et al., 2022a; Wei et al., 2020). Of note, both aptitude and L2 grit had similar effects on L2 achievement, substantiating Duckworth et al.'s (2007) hypothesis on the incremental validity of grit in predicting success beyond talent. In short, these findings highlight the roles played by perseverance and passion for L2 learning, and innate talent in attaining successful L2 outcomes (Teimouri et al., 2022b).

Although a growth mindset had no significant direct effects on language achievement, its total indirect effects were found to be statistically significant. Such a lack of direct relationship between the growth mindset and achievement has also been reported in the L2 research (e.g., Lou et al., 2022) as well as multiple studies in other socio-educational contexts (e.g., Bahník & Vranka, 2017; Li & Bates, 2019; Macnamara & Rupani, 2017). Overall, research findings on the power of growth mindsets in

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predicting achievement outcomes have yielded inconsistent results. Sisk et al.'s (2018) meta-analysis of mindsets research, for instance, has shown that effect sizes regarding the impact of growth mindsets on achievement were heterogeneous. In their analysis of controversies regarding the effects of growth mindsets on student outcomes, Yeager and Dweck (2020) emphasized that researchers need to interpret their findings with respect to the unique features of the context of the study. They maintained that the mindset theory is a theory about responses to challenges or setbacks, and it was not proposed to account for the main variance in students' grades. Therefore, they argued that the predictive power of mindsets on achievement becomes much more salient in challenging contexts. Thus, the lack of a direct relationship between the growth mindset and achievement in the current study should not undermine the motivational power of the students' mindsets—especially in challenging environments. As argued by Lou et al. (2022), a growth mindset affects learning outcomes indirectly via interaction with other motivational components. In fact, the statistical significance of the total indirect effects of a growth mindset on L2 achievement—primarily through L2 grit—in our results offers partial evidence to Lou et al.'s argument.

RQ 2: How are mindsets, L2 aptitude, and L2 grit related to one another?

Given that people who possess a growth mindset believe that intelligence can be improved as a function of hard work, it then makes sense to postulate that students with high growth mindsets might also have a high language aptitude—or the reverse. Likewise, Lou and Noels (2017) hypothesized that students with low language aptitude might develop fixed mindsets due to repeated failures. In this study, we empirically tested the relationship between the students' growth mindset and their language aptitude, and the results did not support any association between the two constructs. This finding is consistent with the results of limited research in social and educational contexts that have found growth mindsets to be unrelated to measures of cognitive abilities (Bahník & Vranka, 2017; Furnham et al., 2003; Li & Bates, 2019; Macnamara & Rupani, 2017). The lack of a relationship between mindsets and aptitude, therefore, is not supportive of Lou and Noels's (2017) hypothesis—at least in the context of the current study.

The growth mindset had negligible, positive effects on the L2 grit for the whole sample, but the effects were not statistically significant; for female students, however, the effects were approaching statistical significance. Overall, these findings are partially in line with the findings of the handful of studies in the L2 context (e.g., Khajavy et al., 2021; Teimouri et al., 2022a) and educational contexts (e.g., Park et al., 2020) regarding the reciprocal, positive path between a growth mindset and grit. In short, the theoretical overlap between a growth mindset and grit (Duckworth, 2016; Dweck, 2013) concerning sustaining one's effort despite challenges is backed by some empirical evidence.

L2 aptitude was not found to be associated with grit, supporting the hypothesis that the two constructs are unrelated (Duckworth et al., 2009). Considering the links between intelligence and personality, openness to experience/intellect and neuroticism have been found consistently as positive and negative correlates of intelligence, respectively (Ackerman & Heggestad, 1997; Anglim et al., 2022; DeYoung, 2011). Of particular relevance here is the lack of correlation between conscientiousness and intelligence (Anglim et al., 2022). Given that conscientiousness has been argued to be closely related to grit (Credé et al., 2017), a lack of correlation between grit and intelligence can also be interpreted within these lines.

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RQ 3: What role does gender play in the students' mindsets, L2 aptitude, L2 grit, and L2 achievement?

In our third research question, we scrutinized gender differences regarding the students' mindsets, aptitude, L2 grit, and L2 achievement as well as their interactions. As noted, the mindsets theory postulates that female students might have a fixed mindset due to their upbringing (Dweck & Simmons, 2014). The "Bright girl" phenomenon also emphasizes that talented girls are more likely to have a fixed mindset about their intellectual abilities. The findings of our study, however, did not support such assumptions—at least in the L2 domain—resonating with the findings of past L2 research that examined gender differences in mindsets (e.g., Khajavy et al., 2021; Lou et al., 2022; Lou & Noels, 2019; Zarrinabadi et al., 2021). Likewise, consistent with the findings of past research, no gender differences were detected regarding the student's language aptitude and its subcomponents (e.g., Grañena, 2013; Meara, 2005; Rogers et al., 2016, 2017). Furthermore, no gender differences were detected regarding students' grittiness in L2 learning, which is in line with research findings in social and educational psychology (Credé et al., 2017; Duckworth & Quinn, 2009; Duckworth et al., 2007; Hodge et al., 2018) as well as in the L2 domain (Khajavi et al., 2021; Teimouri et al., 2022b). Finally, no gender differences were found between female and male students' L2 achievement scores, a finding also reported in past research (e.g., Ryan & Bachman, 1992).

As discussed previously, past research has primarily investigated gender differences at the surface value: focusing on differences between male and female students' scores on various variables. In our study, however, we addressed this issue at deeper levels by zooming in on potential differences concerning the interactions of key learner factors in L2 learning. The results revealed that while female and male students did not differ in their mindsets, aptitude, L2 grit, and L2 achievement scores, the underlying interactions among the variables revealed subtle gender differences. Both L2 aptitude and L2 grit were found as predictors of L2 achievement among girls, whereas only L2 grit predicted L2 achievement among male students.

Why did L2 aptitude have a weak effect on L2 achievement among male students—even though both genders scored similarly on the L2 aptitude tests? One explanation can be offered based on the notion of stereotype threat: When individuals, who are subject to a negative stereotype, experience pressure to avoid validating that stereotype, this causes reduced performance due to distraction from the task (e.g., Steele, 1997; Steele et al., 2002). In an experimental study, Li and McLellan (2021) found that priming female-language stereotypes among 427 students impaired the male students' performance on an English test. Of note, however, some L2 research has found no or partial evidence for the negative effects of stereotype threats on men's language-related performance (e.g., Chaffee et al., 2020; Kutuk, 2022). Assuming the potential negative effects of stereotypes in the context of the study, it can be argued that the female-language stereotypes might have inhibited the male students from fully using their cognitive abilities. In sum, the results of the study may not be indicative of any female advantage in L2 learning, but rather more supportive of a disadvantage for male students.

Limitations, future research, and theoretical and pedagogical implications

Before discussing the implications of the findings, a few specific limitations of the study should be noted for future research. First, the sample was unequal regarding gender: More female students participated in the study, which is representative of the student population majoring in English in Iran. Of particular significance, as highlighted in the

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discussion of the results, the sample size for the male students (n = 70) was notably limited. Consequently, any lack of statistically significant findings might be attributed to low statistical power rather than an absence of real differences, specifically, concerning the regression paths. Second, we used the LLAMA tests to assess the language aptitude of the students. The predictive validity of the LLAMA tests has been consistently verified in many studies (Bokander & Bylund, 2020; Li, 2016); however, some concerns have also been raised in the literature regarding the internal consistency and construct validity of some of its subtests (Bokander & Bylund, 2020). As a complementary approach, therefore, the use of other measures of cognitive abilities for addressing gender stereotypes in L2 learning is recommended for future research. Third, the L2 achievement of the students was measured by using a combination of course grades (i.e., midterm and final exams). Although course grades have been used extensively in L2 research as important indicators of L2 success in general (Brown et al., 2018), the use of more objective measures of L2 proficiency (language tests) will complement our findings.

In the current study, we tested a theoretical model examining the comparative effects of three interrelated, key factors in L2 learning: mindsets, L2 aptitude, and L2 grit. The study of ID factors in SLA has primarily branched on separate trajectories, examining the unique influences of each learner factor on L2 learning outcomes (Csizér & Dörnyei, 2005). Although each line of research has shed light on the unique contribution of each learner factor to L2 learning with important pedagogical implications, less is known about their interrelationships as well as their comparative effects on L2 learning. As a result, future research should prioritize examining the comparative impacts of cognitive and non-cognitive factors on L2 learning, as well as exploring the intricate interplay among these factors that can result in varying outcomes among different groups.

If I work harder, do I get smarter? Although the belief that one's cognitive abilities can be enhanced via hard work (i.e., a growth mindset) may result in positive changes in one's motivation, behavior, and performance (e.g., Lou et al., 2022; Teimouri et al., 2022a; Zarrinabadi et al., 2021), the truth of such a belief was not supported in our study —a finding that was also reported in past research (e.g., Bahník & Vranka, 2017; Burgoyne et al., 2018; Furnham et al., 2003; Macnamara & Rupani, 2017). Given that our study was the first to empirically examine the links between mindsets and aptitude in the L2 context, more research is needed in this area to better understand the direct and indirect links between mindsets and aptitude. In addition, in our study, we tested the link from growth mindset to aptitude; however, as one of the anonymous reviewers noted, it would also make sense to examine the link from aptitude to growth mindset. As such, a bidirectional relationship between mindsets and aptitude might be hypothesized for future research. As noted, mindset theories exhibit their true effects in challenging contexts: People may have similar basic cognitive abilities; however, differences in their intellectual performance may emerge in challenging contexts (Burnette et al., 2013). Hence, investigating the influence of mindsets on cognitive abilities in challenging contexts may offer different results. Furthermore, future research on mindsets and their relationships with aptitude, motivation, and achievement should consider the important part that socio-cultural norms inherent in each context might play in mediating those relationships. As argued by Yeager and Dweck (2020), mindsets may not be as influential in certain contexts.

Are girls and women more talented, passionate, hard-working, and successful in L2 learning than boys and men? Most likely, no—at least in the context of the present study. No mean differences were found between female and male students in their mindsets, aptitude, L2 grit, and L2 achievement scores. Yet, the SEM models detected

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differences regarding the effects of grit and aptitude on L2 achievement among female and male students. As such, future research needs to move beyond comparing female and male students' scores on certain variables, to focus on examining the gender differences concerning the complex, dynamic relations among those variables.

The results of the study, overall, highlighted the significant role that L2 grit plays in L2 achievement—especially when compared with L2 aptitude, thereby supporting its teaching in L2 learning environments. As noted by Teimouri et al (2022a), teachers can foster students' perseverance in diverse ways. This includes engaging students in inspirational stories of highly successful individuals whose perseverance and resilience were pivotal to their achievements. Educators can use specialized educational tools such as the Knowledge is Power program (Shechtman et al., 2013) to bolster students' determination. Assigning challenging, long-term language learning projects that necessitate sustained effort over a semester is another effective strategy. Furthermore, cultivating a growth mindset among language learners by commending their diligence instead of inherent abilities during class activities (Lou & Noels, 2016) has proven beneficial (Zarrinabadi et al., 2023).

Conclusion

In this study, we first examined the comparative effects of mindsets, L2 aptitude, and L2 grit on the students' L2 achievement. Both aptitude and L2 grit had similar positive effects on L2 achievement, suggesting that both talent and effort are necessary for succeeding in the course of L2 learning. Students' mindsets, on the other hand, were found to be unrelated to L2 aptitude but indirectly enhancing L2 achievement, warranting further research on examining such links in more challenging contexts. Moreover, aptitude and L2 grit were found to be unrelated—as hypothesized by Duckworth et al. (2007). Finally, we addressed gender differences concerning aptitude, L2 grit, and L2 achievement. The results, overall, revealed both genders scored similarly on all those factors. However, considering the comparative effects of ID factors in L2 achievement between genders, subtle differences were found, suggesting potential negative effects of stereotypes handicapping male students in fully using their cognitive abilities for learning English.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/S0272263124000330.

Note

1 The same dataset is used in Teimouri et al. (2022b).

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