BMC Psychology

RESEARCH

Open Access

The impact of L2 motivation on bilingual creativity: A serial mediation analysis

Yilong Yang[1,2*] and Yadan Li[3*]

Abstract

Previous studies have shown that bilingualism can offer a cognitive advantage in creativity, yet the mechanisms underlying this effect remain unclear. The present study aims to investigate the influence of L2 motivation, language proficiency, and reflection on creativity among bilinguals, examining how these factors may contribute directly and indirectly to creative performance. Two sub-studies were conducted. In Study 1, 54 bilingual participants completed an L2 motivation survey, an L2 proficiency scale, and a creativity test. Results showed positive relationships between motivation, proficiency, and creativity, with proficiency serving as a mediator between motivation and creativity. In Study 2, a larger sample of 218 bilingual participants completed the same surveys along with additional measures of reflection and creativity. Findings reinforced those of Study 1, indicating that L2 motivation positively influenced creativity through both L2 proficiency and reflection, which acted as serial mediators. These results suggest that L2 motivation plays a crucial role in enhancing bilinguals' creative performance, both directly and indirectly, through its effect on L2 proficiency and reflection. The study provides novel insights into the cognitive mechanisms of bilingual creativity and underscores the importance of motivation and proficiency in L2 acquisition for fostering creativity.

Keywords Bilingual advantage, L2 motivation, L2 proficiency, Reflection, Creativity

Introduction

It has been about six decades since Peal and Lambert [63] explored the relationship between bilingualism and intelligence. Their work became a milestone in the studies of bilingual advantages in cognition. Since then this line of research has drawn the attention of more and more scholars and bilingual advantages have been confirmed in several cognitive domains, such as attention [10], memory, learning style, cognitive control, cognitive switching [12, 25]. The literature also showed that second language (L2) learners have a bilingual advantage in creativity [45, 53]. Nearly five decades have passed since the first few studies emerged in this field in the 1970 s, and now studies have started to investigate the relationship between bilingualism and creativity. They mainly paid attention to the influence of L2 acquisition on creativity, including cross-cultural experience [56], the age of L2 acquisition [26], the L2 proficiency [53], Yilong [94, 97, 98], and the comparisons among monolinguals, unbalanced bilinguals, and balanced bilinguals [77]. L2 motivation and proficiency are two important indicators in L2 acquisition. The question of how these factors influence creativity remains largely unknown. Therefore, the present study aimed to investigate this issue.

The literature review

(1) Bilingualism and creativity

*Correspondence:
Yilong Yang
smartison@outlook.com; yangyilong@xisu.edu.cn
Yadan Li
liyadan@snuu.edu.cn; yadanli@outlook.com
[1] Research Center for Linguistics and Applied Linguistics, Xi'an International Studies University, Xi'an, China
[2] School of English Studies, Xi'an International Studies University, Xi'an, China
[3] MOE Key Laboratory of Modern Teaching Technology, Shaanxi Normal University, Xi'an, China

In the literature, creativity is typically defined as the capacity to generate ideas that are both novel and useful [68]. This creative process involves a dynamic interplay of divergent and convergent thinking, and the combination of these two types of thinking generates ideas that satisfy two characteristics of a creative product: novelty and utility [78]. Divergent thinking refers to the expansive search for different solutions, making connections between disparate elements, and generating multiple innovative alternatives [32]. Extensive studies have used divergent thinking to represent creativity since it is central to creativity and its validity and reliability to predict participants' performance in problem-solving and creative achievement have been well confirmed [46, 85, 86]. Studies have also shown that measures of divergent thinking are more useful in evaluating creative potential [40, 61]. One commonly and widely used task to test divergent thinking is the Torrance Tests of Creative Thinking (TTCT; [85]). According to Torrance [85], divergent thinking consists of three components: flexibility, fluency, and originality.

Extensive empirical studies have provided solid evidence to support the bilingual advantage in creativity [45, 89]. These studies have shown a positive effect of L2 proficiency on creativity [94, 95, 97, 98]. They probed into topics such as bilingualism and figurative creativity [88], bilingualism and mathematical creativity [4], and bilingualism and language creativity [54, 77]. Previous studies have found positive associations between bilingualism and key elements of divergent thinking, including flexibility [42], fluency [42], and originality [43]. Such effects of bilingualism on creativity were found not only in children [48, 55] but also in teenagers [65] and adults [39]. However, the mechanisms through which bilingualism, and specifically factors like L2 motivation and proficiency, influence creativity require further investigation.

Several factors related to L2 learning have also been shown to influence creativity. These factors include cross-cultural experience [76], the duration of exposure to L2 cultural settings [42], the age of L2 acquisition [42], the language of testing [41]. Previous studies have also demonstrated that individuals with higher levels of L2 proficiency tend to show increased creativity [53]. Kharkhurin [44] provided further insight by revealing that bilinguals with greater L2 competence performed better in originality and were more likely to deviate from standard category norms compared to those with lower proficiency. To explain such a difference of creativity in bilinguals, Kharkhurin [44] proposed that cognitive inhibition improves originality, while a facilitation mechanism enhances fluency. More importantly, bilinguals with different language competence levels might experience varying intensities of lexical access in memory. These findings suggest a direct link between the levels of L2 proficiency and creative performance, highlighting proficiency as a key variable to investigate.

Meanwhile, the role of L2 motivation in L2 learning outcomes, e.g., proficiency, is well-established [21, 28]. Language learners with higher motivation have demonstrated higher L2 proficiency compared to those with lower motivation [47, 69, 99]. Further evidence for the positive role of motivation is provided by research on demotivation, which shows a negative correlation between L2 learners'demotivation and language competence [93]. However, empirical studies directly linking L2 motivation to creativity, particularly in conjunction with L2 proficiency, have been less prevalent. The current study seeks to bridge this gap. Recent studies have begun to explore the interplay of motivation, proficiency, and creativity in L2 contexts. Liao et al. [59] investigated the effects of infusing creative pedagogy into EFL classrooms and found that such pedagogy not only enhanced learning performance and motivation but also significantly improved students'creativity. Their study highlights the potential of pedagogical approaches to simultaneously foster motivation and creativity in L2 learners, suggesting a possible indirect link between motivation and creativity through language learning. Zhao et al. [100], while primarily focusing on the relationship between motivational intensity and self-perceived Chinese proficiency, also underscore the importance of motivation in L2 learning success. Although their moderated mediation model doesn't directly measure creativity, it reinforces the critical role of motivation in achieving higher L2 proficiency, which in turn is linked to creativity. These recent studies call for further research that directly examines the integrated influence of L2 motivation and L2 proficiency on creativity within bilingual individuals.

Taken together, previous studies provide a compelling picture. While the bilingual advantage in creativity is increasingly supported, and the roles of L2 motivation and L2 proficiency in language learning are well-documented, the precise mechanisms through which L2 motivation and proficiency jointly influence bilingual creativity remain unclear. Specifically, the mediating role of L2 proficiency in the relationship between L2 motivation and creativity warrants deeper investigation.

(2) Reflection and creativity

Reflection, defined as the process of evaluating and analyzing one's thoughts, feelings, and behaviors, plays an essential role during the process of directed cognition [22]. The literature has shown that reflection is beneficial to individuals' creative cognition [75, 83]. When an individual completes a deep and thorough analysis of all related issues, exploring every possible approach and reasoning for the problem, reflection can lead to a moment

of concentration where a creative solution emerges [31]. Therefore, reflection serves as a catalyst for creativity, particularly for convergent thinking, which involves searching for the ultimate answer based on experience and known information [31]. This theory focuses on one major dimension of creativity, i.e., convergent thinking. Another perspective suggests that reflection helps individuals broaden and deepen their knowledge, leading to the generation of extensive and novel ideas or solutions [6, 37]. This theory emphasizes divergent thinking, where individuals generate various ideas from given information, some of which may be unique or unusual.

The potential relationship between bilingualism and reflection has also been explored, though direct evidence is limited. Numerous studies have focused on the link between L2 acquisition and metalinguistic reflection [3]. Metalinguistic reflection, or"reflection on language,"involves the use of linguistic or extralinguistic terminologies during language learning [7, 38]. If we consider ordinary reflection as domain-general and metalinguistic reflection as domain-specific (i.e., reflections on language), there may be an association between these two forms of reflection. The literature has suggested a positive link between L2 proficiency and metalinguistic reflection [3, 20, 66]. One possible explanation is that L2 learners talk themselves through difficulties during challenging L2 production tasks, benefiting from reflection to reach new levels of understanding [82]. Such findings suggest that metalinguistic reflection facilitates L2 acquisition, and as L2 proficiency increases, learners may employ more metalinguistic reflection [3]. This relationship has also been tested from another perspective, with studies showing that less proficient L2 learners prefer L1-based reflection, which can be a major source of L1-influenced errors [16, 18]. Therefore, the potential for L2 proficiency to foster domain-general reflection, which enhances creativity in bilinguals, needs further exploration.

Theoretical framework

The current study is grounded in Socio-Cognitive Theory (SCT) [5, 6] and Amabile's Componential Theory of Creativity [1, 2]. SCT provides a robust framework for understanding the interplay of personal, behavioral, and environmental factors in human learning and cognition, emphasizing self-regulation and reflective processes [5]. Central to SCT is the concept of self-efficacy, which aligns closely with L2 motivation. Learners with higher self-efficacy, or stronger beliefs in their ability to succeed in language learning, are typically more motivated, persistent, and engaged [6]. Furthermore, SCT highlights the role of reflection as a key self-regulatory mechanism, enabling individuals to analyze their thoughts, behaviors, and outcomes, thereby refining their cognitive strategies and enhancing learning [23]. In the current study, we propose that L2 motivation, reflecting self-efficacy beliefs, drives engagement in L2 learning, leading to increased L2 proficiency. Language proficiency, in turn, fosters enhanced reflective thinking as learners become more aware of their cognitive processes in L2.

Complementing SCT, Amabile's Componential Theory of Creativity (1988, 1996) offers a valuable lens for understanding the nature of creativity itself. This theory posits that creativity is a product of three key components: domain-relevant skills, creativity-relevant processes, and task motivation. In bilingual context of the present study, L2 proficiency can be considered a crucial domain-relevant skill. It provids the linguistic resources necessary for creative expression in L2. Reflection aligns with creativity-relevant processes, encompassing cognitive styles and thinking skills that facilitate novel and appropriate idea generation. Crucially, task motivation, distinct from general motivation, emphasizes the intrinsic drive to engage in a specific creative task. However, we argue that general L2 motivation, as explored in our study, provides the foundational energy and persistence that can fuel task motivation for creative endeavors in the L2.

By integrating SCT and Amabile's Componential Theory, the present study proposes a comprehensive framework for examining bilingual creativity. We hypothesize that L2 motivation, understood through the lens of self-efficacy in SCT, indirectly fosters creativity by first driving the development of L2 proficiency (a domain-relevant skill in Amabile's theory) and enhancing reflection (a creativity-relevant process potentially amplified by L2 proficiency, and a self-regulatory mechanism in SCT). This theoretical framework allows us to examine both the motivational antecedents and the cognitive mechanisms underlying the link between bilingualism and creativity, providing a more theoretically grounded and nuanced understanding of this complex relationship.

The present study

The present study, employing behavioral experiments and questionnaires, aimed to investigate the association between L2 motivation and creativity, as well as the potential cognitive mechanisms involved. The rationale for integrating L2 motivation, L2 proficiency, reflection, and creativity in the current study emerges from the existing literature, which suggests links between bilingualism, creativity, motivation, proficiency, and reflective processes, although often in isolation. We argue that these four variables are interconnected within the framework of bilingual cognitive development. L2 motivation is considered foundational for achieving L2 proficiency. Importantly, we extend this by suggesting that L2 proficiency, representing deeper linguistic and cognitive

engagement, may also foster enhanced reflective abilities. Literature further supports the role of reflection in boosting creative cognition. Therefore, by examining this constellation of variables together (i.e., motivation, proficiency, reflection, and creativity), we aim to unveil their systemic relationships. We propose that L2 proficiency and reflection act as sequential mediators in the pathway from motivation to creativity, allowing us to explore not only the presence of these relationships, but also the mechanisms by which they unfold and shape bilinguals'creativity.

Specifically, two research questions were addressed through two interrelated sub-studies. In Study 1, we sought to determine whether L2 motivation influences bilinguals'creativity through L2 proficiency. In Study 2, we further investigated whether L2 motivation influences bilinguals'creativity through L2 proficiency and reflection in sequence. To address these questions, we proposed the following hypotheses for the two sub-studies:

For Study 1 (H1): L2 proficiency mediates the relationship between L2 motivation and creativity among bilinguals.

For Study 2 (H2): L2 proficiency and reflection serially mediate the association between L2 motivation and creativity among bilinguals.

Study 1

Previous studies have shown that the degree of bilingualism or L2 proficiency has a positive effect on language learners' creativity. Evidence has also suggested that L2 proficiency is related to L2 motivation. Therefore, Study 1 investigated the relationships among L2 motivation, L2 proficiency, and creativity. The mediation role of L2 proficiency in the association between L2 motivation and creativity was further explored subsequently.

Participants

A total of 60 participants, whose first language (L1) was reported to be Mandarin Chinese with English as their second language (L2), were recruited. They were all required to finish a demographic survey, the Student Motivational State Questionnaire, and the Language History Questionnaire through a widely used online survey platform in mainland China (http://www.wjx.cn) on their cell phones. Participants also completed a paper-based test of the Torrance Tests of Creative Thinking (TTCT; [85]). However, due to incomplete information or invalid responses, the data from six participants were discarded. Therefore, the data of 54 participants (23 males, 31 females, mean age: 19.94 ±0.83 years, ranging from 18 to 22 years) were analyzed. Participants were all self-reported to be right-handed and had no history of neurological or psychiatric conditions, or substance abuse. All 54 participants had been informed of the procedures of the test and signed a written form of consent.

Written consent was obtained from all participants, and the study protocol was approved by the Academic Committee of the Ministry of Education Key Laboratory of Modern Teaching Technology at Shaanxi Normal University in China. To ensure participant anonymity and data confidentiality, we implemented robust measures throughout the study. Specifically, no individual participant data will be presented or made publicly available; all results are reported in aggregate form only. Furthermore, to protect data at all stages, original data are stored confidentially, with access strictly controlled and requiring approval from the Academic Committee for any use. In addition to these safeguards, all research team members received comprehensive data privacy training and signed confidentiality agreements.

Instruments

L2 Motivation

The Student Motivational State Questionnaire [33] was used to assess participants' L2 motivation. The questionnaire includes 20 items, rated on a 6-point Likert scale (1 ="definitely not" to 6= "totally true"). It was translated from English to Chinese by an expert in applied linguistics and English language teaching. The internal consistency reliability of the Student Motivational State Questionnaire (Cronbach's α= 0.81) was satisfactory in the current study.

L2 Proficiency

To measure L2 proficiency, participants completed the Language History Questionnaire [57, 58]. This self-assessment tool includes a 7-point scale (1 ="very poor" to 7 = "excellent").

Creativity

Creativity was evaluated using the Verbal Form of the Torrance Tests of Creative Thinking (TTCT; [85]), which is one of the most frequently used assessments of creative abilities [14],Krumm, Aranguren, et al., 2014,[49, 50]. The first four verbal tasks from the TTCT were used in the current study and participants were asked to finish them on paper. The first three tasks required participants to generate questions, causes, and consequences of certain events. The fourth task asked participants to improve a product (i.e., a toy elephant). Creativity scores were calculated based on three components: flexibility (counting the number of different categories of responses), fluency (counting the total number of meaningful and relevant responses), and originality (evaluating the uniqueness of responses). The total TTCT score for each participant was the sum of these three components. Three doctoral

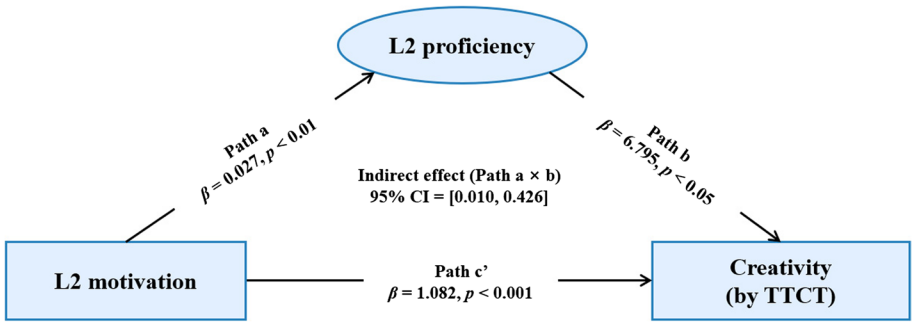

Fig. 1 Mediation Role of L2 Proficiency between L2 Motivation and Creativity in Chinese English Language Learners. Path coefficients displayed are standardized regression coefficients (β). Statistical results are satisfied for a mediation effect: Path a, Path b, Path c', and Path a × b are all significant

candidates specializing in creativity research, who were unaware of the specific goals of the current study, rated the responses (inter-rater reliability: Cronbach's $\alpha = 0.83$).

Procedure

Participants first completed the Student Motivational State Questionnaire and the Language History Questionnaire on their cell phones in a quiet room. Once all participants finished the two questionnaires, they then continue to finish the four tasks of the TTCT. In each TTCT task, they were encouraged to write down all the appropriate and novel responses that they could think of.

Data analysis

Data analysis was performed using SPSS 25 (IBM Corp., Armonk, NY, USA). Descriptive statistics and correlation analyses were conducted to understand the relationships among L2 motivation, L2 proficiency, and creativity. To test the mediation effect, Hayes's [35] SPSS PROCESS macro (v3.5,Model 4) was employed, using a confidence level of 95% and a bootstrapping sample of 5000 resamples to analyze whether L2 proficiency mediated the impact of L2 motivation on creativity (see Fig. 1).

Results

Table 1 shows the descriptive statistics and correlations of the key variables in Study 1. The findings revealed that L2 motivation was positively correlated with both L2 proficiency ($r = 0.38$, $p < 0.01$) and creativity ($r = 0.65$, $p < 0.001$). Moreover, a significant positive relationship was observed between L2 proficiency and creativity ($r = 0.46$, $p < 0.01$).

To further explore the potential mediation effect, a simple mediation analysis was performed (Fig. 1). The results demonstrated that L2 motivation predicted L2 proficiency (Path a: $\beta = 0.027$, $SE = 0.010$, $p < 0.01$) and creativity (Path c': $\beta = 1.082$, $SE = 0.216$, $p < 0.001$). L2 proficiency further predicted creativity (Path b: $\beta = 6.795$, $SE = 3.013$, $p < 0.05$). L2 motivation also had a positive influence on creativity through L2 proficiency (Path a × b: $\beta = 0.184$, $SE = 0.105$, 95% CI = [0.010, 0.426]).

Validation and Robustness

To ensure validation and robustness of results, the following calculations and analyses were performed:

First, to assess the normality of data distributions, Shapiro–Wilk tests were conducted for L2 motivation, L2 proficiency, and creativity scores. The Shapiro–Wilk test results for all three variables (L2 motivation: $p = 0.091$; L2 proficiency: $p = 0.057$; creativity: $p = 0.176$) indicated non-significant deviations from normality. Therefore, based on these test results, the data for L2 motivation, L2 proficiency, and creativity met the assumption of normal distribution, justifying the use of parametric statistical analyses for subsequent analyses.

Second, to ensure the robustness of our mediation analysis in Study 1, we included age and gender as covariates in the model. These demographic variables were

Table 1 Descriptive Statistics (Means and Standard Deviations) and Pearson Correlations for L2 Motivation, L2 Proficiency, and Creativity in Study 1

Variables	*M* ± *SD*	1. L2 motivation	2. L2 proficiency	3. Creativity
1. L2 motivation	73.93 ± 8.63	1	0.38**	0.65***
2. L2 proficiency	4.26 ± 0.62	0.38**	1	0.46**
3. Creativity	70.98 ± 16.95	0.65***	0.46**	1

Significance levels: **$p < 0.01$, ***$p < 0.001$ (2-tailed).

controlled for because they could potentially influence the relationships between L2 motivation, L2 proficiency, and creativity. After adjusting for age (direct effect: $\beta = 1.094$, $SE = 0.219$, $p < 0.001$; indirect effect: $\beta = 0.181$, $SE = 0.106$, 95% CI = [0.008, 0.415]) and gender (direct effect: $\beta = 1.098$, $SE = 0.219$, $p < 0.001$; indirect effect: $\beta = 0.184$, $SE = 0.105$, 95% CI = [0.008, 0.416]), the simple mediation model (L2 motivation → L2 proficiency → creativity) remained significant. It was confirmed that the mediation pathway is not confounded by these demographic factors. This strengthens the validity of our findings.

Third, to check the robustness and validation of our model (shown in Fig. 1), we tested an alternative model in which the order of L2 proficiency and creativity was reversed. Specifically, we examined whether creativity mediates the relationship between L2 motivation and L2 proficiency (i.e., L2 motivation → creativity → L2 proficiency). Using the same analytical approach as in our original analysis (i.e., PROCESS Model 4), we found that the indirect effect of L2 motivation on L2 proficiency through creativity was not significant (indirect effect: $\beta = 0.010$, 95% CI = [− 0.013, 0.034]). This result indicates that creativity does not serve as a mediator between L2 motivation and L2 proficiency. It provides further support for the validity of our original mediation model, which posits that L2 motivation influences creativity through the mediator of L2 proficiency.

Interim Discussion

The findings from Study 1 indicate a clear positive relationship between L2 motivation and L2 proficiency, as well as between L2 proficiency and creativity among bilinguals. The results also highlighted that L2 proficiency played a mediation role in the association between L2 motivation and creativity. These findings support the first hypothesis (H1) that L2 proficiency mediates the relationship between L2 motivation and creativity. Given that reflection is closely linked to both L2 acquisition and creativity in the literature, it is pertinent to test whether reflection also plays a mediating role. Therefore, Study 2 will focus on this potential relationship and test the second hypothesis (H2).

Study 2

While Study 1 explored the mediation role of L2 proficiency, Study 2, based on a different and larger sample, extended this line of research by further investigating how reflection would interact with the variables in Study 1. Previous studies have indicated that reflection is related to both L2 acquisition and creativity. Therefore, reflection would be another possible mediator among the variables in Study 1. It is presumed as the second hypothesis (H2) which would be tested in Study 2.

Participants

A total of 232 participants, whose first language (L1) was reported to be Mandarin Chinese with English as their second language (L2), were recruited from another university in China. None of them participated in Study 1. Participants in Study 2 were asked to complete a demographic survey, the Student Motivational State Questionnaire, the Language History Questionnaire, the Rumination-Reflection Questionnaire, and the Runco Ideational Behavior Scale (RIBS) through a widely used online survey platform (http://www.wjx.cn) on their cell phones. Fourteen participants'data were excluded due to incomplete responses or invalid information. Therefore, the data of 218 participants (61 males, 157 females; mean age = 18.11 ± 0.73 years, ranging from 16 to 21 years) were analyzed. All participants were right-handed and self-reported no history of psychiatric or neurological conditions, or substance use.

Written consent was obtained from all participants, and the study protocol was approved by the Academic Committee of the Ministry of Education Key Laboratory of Modern Teaching Technology at Shaanxi Normal University in China. To ensure participant anonymity and data confidentiality, we implemented robust measures throughout the study. Specifically, no individual participant data will be presented or made publicly available. All results are reported in aggregate form only. Furthermore, to protect data at all stages, original data are stored confidentially, with access strictly controlled and requiring approval from the Academic Committee for any use. In addition to these safeguards, all research team members received comprehensive data privacy training and signed confidentiality agreements.

Instruments

L2 Motivation and L2 Proficiency

The Student Motivational State Questionnaire [33] and the Language History Questionnaire [57, 58] used in Study 1 were also used in Study 2. The internal consistency reliability of the Student Motivational State Questionnaire (Cronbach's $\alpha = 0.85$) for Study 2 was satisfactory.

Reflection

The reflection subscale of the Rumination-Reflection Questionnaire [87] was used to assess participants' reflections. The reflection subscale contains 12 items rated on a 5-point scale (1 = "strongly disagree" to 5 = "strongly agree"). The items were translated from English to Chinese by an expert who specialized in psychology studies. This scale had satisfactory internal consistency reliability (Cronbach's $\alpha = 0.82$) in the current study.

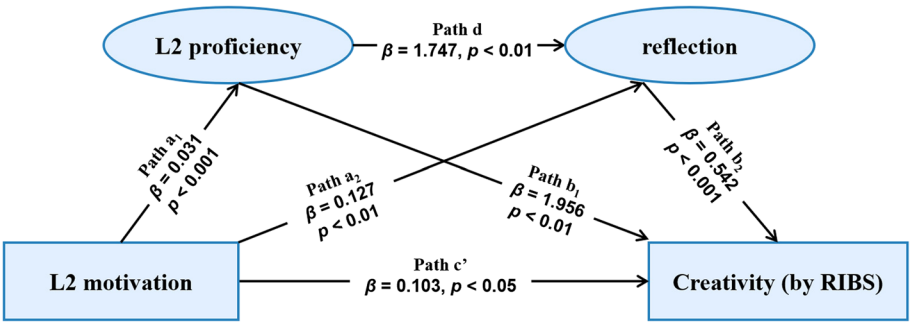

Fig. 2 Serial Mediation Roles of L2 Proficiency and Reflection between L2 Motivation and Creativity in Chinese English Language Learners. Path coefficients displayed are standardized regression coefficients (β). Statistical results are satisfied for a serial mediation effect: Path a_1, Path b_1, Path a_2, Path b_2, Path c', Path d, Path $a_1 \times b_1$, Path $a_2 \times b_2$, and Path $a_1 \times d \times b_2$ are all significant

Creativity

The Runco Ideational Behavior Scale (RIBS; [67]) was used to assess participants' individual creativity. This scale measures creative ideation in daily life and is widely used in creativity research. The scale contains 23 items rated on a 5-point scale (1 = "never" to 5 = "very often"). The sum of points of these 23 items is used to indicate the performance of creativity. The scale was translated from English to Chinese by an expert who specialized in creativity studies. The internal consistency reliability of the RIBS was found to be satisfactory (Cronbach's α = 0.84) in the current study.

Procedure

Participants finished the Language History Questionnaire, the Student Motivational State Questionnaire, the reflection subscale from the Rumination-Reflection Questionnaire, and the RIBS. Participants were not told the purposes of the questionnaires and were required to mark the choice that best fits their situations.

Data analysis

Descriptive statistics and correlation analyses were carried out using SPSS 25 (IBM Corp., Armonk, NY, USA). Serial mediation analysis was performed using Hayes's [35] SPSS PROCESS macro (v3.5,Model 6). A confidence level of 95% was set, and 5000 bootstrap samples were used to test hypothesis (H2) of whether both L2 proficiency and reflection were playing mediation roles in the relationship between L2 motivation and bilinguals' creativity (see Fig. 2).

Results

Table 2 shows the means, standard deviations, and correlations of the key variables for Study 2. L2 motivation was in a positive correlation with L2 proficiency (r = 0.50, p < 0.001), reflection (r = 0.33, p < 0.01), and creativity (r = 0.37, p < 0.001). L2 proficiency was positively correlated with reflection (r = 0.31, p < 0.001) and creativity (r = 0.38, p < 0.001). Reflection was associated with creativity (r = 0.52, p < 0.001).

To explore the potential mediating roles of L2 proficiency and reflection, a serial mediation analysis was conducted (Fig. 2). The results showed that L2 motivation predicted L2 proficiency (Path a_1: β = 0.031, SE = 0.004, p < 0.001), reflection (Path a_2: β = 0.127, SE = 0.040, p < 0.01), and creativity (Path c': β = 0.103, SE = 0.047, p < 0.05). L2 proficiency further predicted reflection (Path d: β = 1.747, SE = 0.652, p < 0.01) and creativity (Path b_1: β = 1.956, SE = 0.746, p < 0.01). Reflection predicted creativity (Path b_2: β = 0.542, SE = 0.077, p < 0.001). The results further suggested that L2 motivation had a positive influence on creativity through L2 proficiency (Path $a_1 \times b_1$: β = 0.061, SE = 0.023, 95% CI = [0.020, 0.107])

Table 2 Descriptive Statistics (Means and Standard Deviations) and Pearson Correlations for L2 motivation, L2 proficiency, reflection, and creativity in Study 2

Variables	*M* ± *SD*	1. L2 motivation	2. L2 proficiency	3. Reflection	4. Creativity
1. L2 motivation	73.11 ± 12.92	1	0.50***	0.33**	0.37***
2. L2 proficiency	3.84 ± 0.80	0.50***	1	0.31***	0.38***
3. Reflection	44.45 ± 7.14	0.33**	0.31***	1	0.52***
4. Creativity	73.75 ± 9.16	0.37***	0.38***	0.52***	1

Significance levels: **p < 0.01, ***p < 0.001 (2-tailed).

and reflection (Path $a_2 \times b_2$: $\beta = 0.069$, $SE = 0.028$, 95% CI = [0.018, 0.131]) respectively. The positive influence of L2 motivation on creativity was significant through L2 proficiency and reflection in sequence (Path $a_1 \times d \times b_2$: $\beta = 0.029$, $SE = 0.012$, 95% CI = [0.007, 0.054]).

Validation and Robustness

To ensure validation and robustness of results, the following calculations and analyses were performed:

First, to assess the normality of data distributions, Shapiro–Wilk tests were conducted for L2 motivation, L2 proficiency, reflection, and creativity scores. The Shapiro–Wilk test results for all four variables (L2 motivation: $p = 0.223$; L2 proficiency: $p = 0.061$; reflection $p = 0.095$; creativity: $p = 0.192$) indicated non-significant deviations from normality. Therefore, based on these test results, the data for L2 motivation, L2 proficiency, reflection, and creativity met the assumption of normal distribution, justifying the use of parametric statistical analyses for subsequent analyses.

Second, to ensure the robustness of serial mediation analysis in Study 2, we included age and gender as covariates in the model. These variables were included to account for any potential influence on the relationships among L2 motivation, L2 proficiency, reflection, and creativity. After controlling for age (direct effect: $\beta = 0.105$, $SE = 0.047$, $p < 0.05$; total indirect effect: $\beta = 0.158$, $SE = 0.034$, 95% CI = [0.095, 0.228]) and gender (direct effect: $\beta = 0.108$, $SE = 0.047$, $p < 0.05$; total indirect effect: $\beta = 0.158$, $SE = 0.035$, 95% CI = [0.092, 0.232]), the serial indirect effect of L2 motivation on creativity through L2 proficiency and reflection remained significant. This demonstrates that the sequential mediation pathway is robust and not affected by these demographic factors, further supporting the reliability of our conclusions.

Third, to check the robustness and validation of our model (shown in Fig. 2), we tested an alternative model in which the order of L2 proficiency and reflection was reversed. Specifically, we examined whether reflection and L2 proficiency serially mediate the relationship between L2 motivation and creativity (i.e., L2 motivation → reflection → L2 proficiency → creativity). Using the same analytical approach as in our original analysis (i.e., PROCESS Model 6), we found that the indirect effects of L2 motivation on creativity through reflection and L2 proficiency were not significant (indirect effect: $\beta = 0.007$, 95% CI = [− 0.001, 0.016]). This result indicates that the alternative model is invalid and provides further support for the validity of our original serial mediation model, which posits that L2 motivation influences creativity through the sequential mediators of L2 proficiency and reflection.

Interim Discussion

In Study 2, the results of Study 1 were replicated on a different and larger sample using a different measure of creativity (i.e., the RIBS). Study 2 showed that L2 proficiency mediated the association between L2 motivation and creativity. We further found that reflection was in positive correlations with L2 motivation, L2 proficiency, and creativity. It came to the conclusion that reflection served as another mediator among these variables. L2 proficiency and reflection played serial mediation roles in the association between L2 motivation and creativity. Therefore, Study 2 not only supported the conclusion of Study 1 on another test sample, but it also supported the second hypothesis (H2).

General Discussion

The two substudies investigated the relationship between L2 motivation and creativity among bilinguals. In Study 1, we found that L2 motivation was positively linked to both L2 proficiency and creativity. Simple mediation analysis demonstrated that L2 proficiency played a mediating role in the relationship between L2 motivation and creativity. These results provided sufficient evidence to support the first hypothesis (H1). Study 2 expanded upon these findings by using a larger and independent sample and a different creativity assessment (i.e., the RIBS). The results of Study 2 further revealed that reflection was in positive correlations with L2 motivation, L2 proficiency, and creativity. Serial mediation analysis found that L2 proficiency and reflection played serial mediation roles in the association between L2 motivation and creativity. These results supported the second hypothesis (H2). These findings align with the principles of SCT and Amabile's Componential Theory of Creativity, providing a theoretical lens through which to understand these relationships. Although our study was consistent with a substantial body of research, it primarily focused on divergent thinking as a key aspect of creativity in bilinguals [45, 53]. It is important to consider the broader landscape of creativity, which crucially includes convergent thinking as well [32, 78].

Study 1 supported the findings of previous studies. First, Study 1 showed that L2 motivation was in positive correlation with L2 proficiency. This finding was in accordance with the results of previous studies. Apart from the primary role of cognitive ability in L2 acquisition, previous studies have also shown that language learners' emotive and affective factors also played significant roles in language learning [21, 28]. From a SCT perspective, this highlights the importance of motivational factors in driving learning outcomes. L2 motivation is a crucial factor that influences the process of L2 acquisition [19]. As previous studies have pointed out, language

learners with high motivation are found to have high L2 proficiency and low motivation comes with low L2 proficiency [30, 47, 99]. The socio-educational model explains that the motivational effect results in the attained proficiency, which ultimately produces additive or subtractive bilingualism [27]. The positive role of L2 motivation on L2 proficiency was further tested from an opposite approach. Studies have already found the negative effects of demotivation on L2 learners' language achievement [29, 47]. The high demotivation is frequently associated with the low L2 proficiency [93].

Second, the results from Study 1 also indicated a significant positive relationship between L2 proficiency and creativity, consistent with findings from prior research. Studies have shown that bilinguals tend to have an advantage in creativity compared to monolinguals [45, 53, 89] and that L2 proficiency plays a critical role [53, 77]. This finding of the current study is also supported by previous studies using various creativity test paradigms, such as the Uses of Objects Test [39], the Insight Problem-solving Task [15, 44], the Torrance Test of Creative Thinking [13], and the Chain Free Association Task [96]. Studies have suggested language proficiency predicts bilinguals' cognitive capacities [8, 70]. In the domain of creative cognition, studies have established a positive association between L2 proficiency and performance in creativity [53, 64, 65, 70, 98]. Comparative studies have also shown that bilingual individuals outperform monolinguals in creativity and that balanced bilinguals perform better than unbalanced bilinguals [53, 77]. This aligns with Amabile's Componential Theory, where L2 proficiency can be seen as a domain-relevant skill contributing to creativity. While much of the existing research on bilingualism and creativity, and our Study 1, has demonstrably linked L2 proficiency to enhanced divergent thinking, the impact on convergent thinking remains less explored. However, it is reasonable to infer that the enhanced cognitive control and executive functions often observed in bilinguals [9, 12]. These cognitive abilities contribute to divergent flexibility and positively influence convergent creative problem-solving. For example, bilinguals'potentially superior ability to inhibit irrelevant information and focus attention [36] might be advantageous in tasks requiring focused analytical reasoning and the selection of optimal solutions, core components of convergent creativity [32].

Study 1 also extended the results of previous studies. The results of Study 1 have shown a positive association between L2 motivation and creativity. The literature has suggested that a lot of factors influence bilinguals' creative cognition, such as the age of L2 acquisition [42], cross-cultural experience [76], the length of exposure to L2 cultural settings [42], mood [41], and the language of testing [41]. Such evidence suggests that language-related factors may play an important role in bilinguals' creativity. Following this line of research, we have extended previous studies by finding that L2 motivation is associated with bilinguals' creativity. Moreover, we conducted a simple mediation analysis to explore the relationships among L2 motivation, L2 proficiency, and creativity. The mediation analysis conducted in Study 1 showed that L2 proficiency serves as a mediating factor between L2 motivation and creativity, implying that L2 motivation enhances creativity not only directly but also through the improvement of L2 proficiency. This mediation pathway is theoretically consistent with both SCT and Amabile's model. It suggests a process where motivation drives skill development (i.e., L2 proficiency), which in turn unlocks creative potential. Considering both divergent and convergent aspects of creativity, it is plausible to hypothesize that this mediation pathway may positively influence both the generation of novel ideas (i.e., divergent thinking) and the refinement and selection of the most effective ideas (i.e., convergent thinking).

Study 2 replicated the results of Study 1 on another larger sample using a different measure of creativity. It also verified the mediation role of L2 proficiency in the association between L2 motivation and creativity. Our results remain consistent across different creativity measures. In Study 1, creativity was evaluated using the performance-based TTCT, while Study 2 utilized the self-reported RIBS, yet both studies confirmed significant mediation effects involving L2 proficiency. Additional checks, including controlling for age and gender and testing alternative model specifications, further support the stability and reliability of these results.

In Study 2, we expanded on Study 1 by exploring how bilinguals' reflection influences creativity, aligning with prior research that connects reflection to creativity. We found participants' reflection was related to creativity. This result is in accordance with studies in creativity. The positive roles of reflection have been confirmed not only in individual creativity [31, 34, 90] but also in team creativity [62, 75]. On the one hand, creativity refers to the ability to generate ideas that are both novel and useful [79]. Frequently, in order to concentrate on a single point and generate a creative solution, the individual has to complete a thorough and deep analysis of all the information based on what is known and extensively explore every possible approach and reasoning [31]. On the other hand, self-reflection enables people to evaluate the value and accuracy of their thinking and offers structure, meaning, and continuity in life [73]. Therefore, self-reflection contributes to people's thinking flexibility, broadens their perspectives, and stimulates novel ideas [34, 83].

Evidence also shows that individuals with high levels of self-reflection would learn from the past and look for breakthroughs in problem-solving [37]. In the domain of team creativity, reflection is one key component of reflexivity [75, 91]. The positive roles of team reflexivity on creative performance have been well established by empirical studies [11, 84]. Members in teams with high reflexivity would collect information, consider past experiences, and reflect on them during their tasks [71]. During this process, team members would build upon diverse opinions for problem-solving or task execution and improve their objectives and solutions that are conducive to team creativity. Based on shared understanding and accumulated knowledge, team reflexivity also contributes to team creativity by combining and extending the cognitive abilities of different team members [74]. Moreover, evidence has shown team reflexivity benefits team creativity by optimizing the team's focus and strategy for problem-solving [51, 60]. These findings on reflection and creativity are consistent with both SCT's emphasis on self-regulation and Amabile's Componential Theory, where reflection aligns with creativity-relevant processes. It is important to note that reflection is not solely tied to divergent thinking. Effective reflection also critically supports convergent thinking by enabling individuals to critically evaluate generated ideas, identify the most viable solutions, and refine their approaches [17, 72]. Therefore, while reflection can broaden idea generation, it may also enhance focused analysis and convergent cognition within bilingual creativity.

Study 2 advanced prior research by revealing correlations between L2 motivation, L2 proficiency, and reflection. First, it has been found that L2 motivation and L2 proficiency were correlated with reflection. To the best of our knowledge, there has been no direct research supporting this finding. However, there have been extensive studies investigating the relationships between metalinguistic reflection and L2 acquisition. These studies could be indirect evidence supporting our results. When L2 learners are producing language, they are engaged in metalinguistic reflection on knowledge of the target language and its uses [80]. The follow-up studies have concluded that metalinguistic reflection is a major source of L2 acquisition while L2 learners are comprehending and producing language [81]. Several studies have also confirmed the close relationship between metalinguistic reflection and L2 acquisition [24]. Further research has found that the level of L2 proficiency is one of the two major determinants of the amount of metalinguistic reflection generated by L2 learners [52, 92]. Reflection tested in Study 2 is relatively domain-general and measures participants' disposition by answering a dozen questions. In this sense, we have extended the results of previous studies in metalinguistic reflection to the more domain-general reflection. It is possible that during the long process of L2 acquisition, participants' thinking styles could be changed and their metalinguistic reflection might be transferred to the domain-general reflection. Therefore, the present research found that both L2 motivation and L2 proficiency were in positive associations with reflection. This potential transfer from metalinguistic to domain-general reflection aligns with broader cognitive development principles within SCT.

Moreover, Study 2 extended the results of previous studies by verifying and analyzing the mediation roles of reflection. Though previous studies had already shown that both bilingualism and reflection would be beneficial to creativity, there was no direct study exploring the relationships among those variables. In the current study, we found that reflection mediated the relationship between L2 motivation and creativity, suggesting that L2 motivation influences creativity through reflection. Furthermore, it has been verified that L2 proficiency was correlated with reflection. Further serial mediation analysis indicated that L2 proficiency and reflection served as serial mediators in the association between L2 motivation and creativity. This result further suggests that L2 motivation influenced creativity through L2 proficiency and reflection successively. This serial mediation model provides a more detailed account of the mechanisms, as conceptualized by our theoretical framework, through which L2 motivation impacts bilingual creativity.

Limitations

While this research offers important insights into the cognitive mechanisms underlying bilingual creativity, it is not without limitations. First, the current research is a cross-section design and covers only young and healthy bilingual participants. The concrete causal relationships among the variables could not be established. There should be longitudinal studies to explore the causal relationships among L2 motivation, L2 proficiency, reflection, and creativity. Second, there should be further exploration of the relationships among L2 motivation, L2 proficiency, and reflection. As numerous factors would influence language motivation and proficiency, it remains unknown whether there are other possible mediators and moderators (e.g., cultural exposure, working memory capacity) in the models we proposed. The theory explaining the cognitive mechanisms of bilinguals' creativity should also be explored. Finally, further studies are encouraged to explore the impact of bilingualism on both convergent and divergent thinking, as the combination of

both cognitive abilities would better represent an individual's creativity. Amabile's theory, in particular, emphasizes the interplay of both divergent and convergent thinking. This would reveal a comprehensive picture of a bilingual advantage in creativity.

Conclusion

In summary, the present study explored the cognitive mechanisms underlying bilingual creativity, guided by Socio-Cognitive Theory and Amabile's Componential Theory, focusing on the roles of L2 motivation, proficiency, and reflection. The findings demonstrate that L2 motivation significantly influences creativity, both directly and indirectly through L2 proficiency and reflection. Study 1 showed that L2 proficiency mediates the relationship between motivation and creativity, while Study 2 revealed that reflection, along with proficiency, acts as a serial mediator. These results emphasize the importance of L2 motivation in fostering creativity, suggesting that motivated language learners are more likely to achieve higher proficiency, engage in reflection, and enhance their creative performance.

The current study advances our theoretical understanding of bilingual creativity by elucidating the interplay of motivational, linguistic, and metacognitive factors, providing empirical support for key tenets of Socio-Cognitive Theory and Amabile's Componential Theory in the context of bilingualism. Furthermore, it offers valuable and actionable implications for educators and policymakers, cultivate reflective learning, and explicitly promote creativity in educational settings. By emphasizing the interconnected roles of L2 motivation, proficiency, and reflection, the present research provides a compelling rationale for prioritizing motivational and reflective practices in language education, ultimately aiming to maximize both language acquisition and the flourishing of creative thinking in language learners. Specifically, educators might implement task-based learning to boost motivation and incorporate reflective journals to enhance metacognitive awareness, while policymakers could prioritize teacher training in creativity-focused L2 pedagogy and curriculum design.

Authors' contributions
Yilong Yang designed the study, performed the data analysis, and drafted the manuscript. Yadan Li collected data, reviewed, and revised the manuscript.

Funding
This research was supported and funded by the National Social Science Fund of China (23BYY189).

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study protocol was approved by the Academic Committee of the Ministry of Education Key Laboratory of Modern Teaching Technology at Shaanxi Normal University in China. All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki Declaration. Participants had been informed of the procedures of the test and signed a written form of consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 18 December 2024 Accepted: 7 April 2025
Published online: 15 May 2025

References

1. Amabile TM. A model of creativity and innovation in organizations. Research in Organizational Behavior. 1988;10:123–67.
2. Amabile, T. M. Creativity in context: Update to the social psychology of creativity. Routledge; 2018.
3. Angelovska T. Cross-linguistic awareness of adult L3 learners of English: A focus on metalinguistic reflections and proficiency. Lang Aware. 2018;27(1–2):136–52.
4. Baer, J. Divergent thinking and creativity: A task-specific approach. Routledge; 1993.
5. Bandura, A. Social foundations of thought and action: A social cognitive theory. Prentice-Hall, Inc; 1986.
6. Bandura A. Social cognitive theory: An agentic perspective. Annu Rev Psychol. 2001;52(1):1–26.
7. Berry R. Making the most of metalanguage. Lang Aware. 2005;14(1):3–20.
8. Bialystok E. Levels of bilingualism and levels of linguistic awareness. Dev Psychol. 1988;24(4):560-567.
9. Bialystok E. Cognitive effects of bilingualism: How linguistic experience leads to cognitive change. J Neurolinguistics. 2017;41:173–85. https://doi.org/10.1016/j.jneuroling.2016.06.008.
10. Bialystok E, Craik FIM, Ryan J. Executive control in a modified antisaccade task: Effects of aging and bilingualism. J Exp Psychol Learn Mem Cogn. 2006;32(6):1341-1354.
11. Carter SM, West MA. Reflexivity, effectiveness, and mental health in BBC-TV production teams. Small group research. 1998;29(5):583–601.
12. Costa A, Hernández M, Sebastián-Gallés N. Bilingualism aids conflict resolution: Evidence from the ANT task. Cognition. 2008;106(1):59–86.
13. Cramond, B. The Torrance Tests of Creative Thinking: From design through establishment of predictive validity. In R. F. Subotnik & K. D. Arnold (Eds.), Beyond Terman: Contemporary longitudinal studies of giftedness and talent (pp. 229–254). Ablex Publishing; 1994.
14. Cramond B, Matthews-Morgan J, Bandalos D, Zuo L. A report on the 40-year follow-up of the Torrance Tests of Creative Thinking: Alive and well in the new millennium. Gifted Child Quarterly. 2005;49(4):283–91.
15. Cushen PJ, Wiley J. Aha! Voila! Eureka! Bilingualism and insightful problem solving. Learn Individ Differ. 2011;21(4):458–62.
16. De Guerrero MC. Early stages of L2 inner speech development: what verbal reports suggest 1. Int J Appl Linguist. 2004;14(1):90–112.
17. Dewey, J. How we think: A restatement of the relation of reflective thinking to the educative process. D.C. Heath; 1933.
18. DiCamilla FJ, Antón M. Private speech: A study of language for thought in the collaborative interaction of language learners. Int J Appl Linguist. 2004;14(1):36–69.
19. Dörnyei, Z. The psychology of the language learner: Individual differences in second language acquisition. Routledge; 2005.

20. Ellis R. Modelling learning difficulty and second language proficiency: The differential contributions of implicit and explicit knowledge. Appl Linguis. 2006;27(3):431–63.
21. Ellis, R. The study of second language acquisition. Oxford University; 1994.
22. Eng C-J, Pai H-C. Determinants of nursing competence of nursing students in Taiwan: The role of self-reflection and insight. Nurse Educ Today. 2015;35(3):450–5.
23. Eng KH, Pai F-Y. Reflective practice in distance education: A qualitative case study. International Review of Research in Open and Distributed Learning. 2015;16(1):128–48.
24. Fortune A. Learners' use of metalanguage in collaborative form-focused L2 output tasks. Lang Aware. 2005;14(1):21–38.
25. Francis WS, Strobach EN. The bilingual L2 advantage in recognition memory. Psychon Bull Rev. 2013;20:1296–303.
26. Frenck-Mestre C, Vaid J. Activation of number facts in bilinguals. Mem Cognit. 1993;21(6):809–18.
27. Gardner RC. Social psychology and second language learning: The role of attitudes and motivation. Hodder Arnold; 1986.
28. Gass SM, Selinker L. Second Language Acquisition: An Introductory Course. Routledge; 2020.
29. Ghadirzadeh R, Hashtroudi FP, Shokri O. Demotivating Factors for English Language Learning Among University Students. Journal of Social Sciences. 2012;8(2):189–95. https://doi.org/10.3844/jssp.2012.189.195.
30. Ghapanchi Z, Khajavy GH, Asadpour SF. L2 Motivation and Personality as Predictors of the Second Language Proficiency: Role of the Big Five Traits and L2 Motivational Self System. Canadian Social Ence. 2011;7(6):148–55.
31. Ghosh S. Triggering creativity in science and engineering: Reflection as a catalyst. J Intell Rob Syst. 2003;38(3):255–75.
32. Guilford JP. Creativity: Yesterday, today and tomorrow. The Journal of Creative Behavior. 1967;1(1):3–14.
33. Guilloteaux MJ, Dörnyei Z. Motivating language learners: A classroom-oriented investigation of the effects of motivational strategies on student motivation. TESOL Q. 2008;42(1):55–77.
34. Hao N, Ku Y, Liu M, Hu Y, Bodner M, Grabner RH, Fink A. Reflection enhances creativity: Beneficial effects of idea evaluation on idea generation. Brain Cogn. 2016;103:30–7.
35. Hayes, A. F. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach (2nd ed.). The Guilford Press; 2017.
36. Hilchey MD, Klein RM. Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes. Psychonomic bulletin review. 2011;18(4):625–58.
37. Hong Y-C, Choi I. Three dimensions of reflective thinking in solving design problems: A conceptual model. Education Tech Research Dev. 2011;59(5):687–710.
38. Johnson K, Johnson H. Encyclopedic dictionary of applied linguistics: A Handbook for Language Teaching. Blackwell Publishing Ltd; 1998.
39. Karapetsas A, Andreou G. Cognitive development of fluent and nonfluent bilingual speakers assessed with tachistoscopic techniques. Psychol Rep. 1999;84(2):697–700.
40. Kaufman JC, Plucker JA, Baer J. Essentials of creativity assessment. Wiley; 2008.
41. Kharkhurin A, Altarriba J. The effect of mood induction and language of testing on bilingual creativity. Bilingualism: Language & Cognition. 2016;19(05):1079–1094.
42. Kharkhurin AV. The effect of linguistic proficiency, age of second language acquisition, and length of exposure to a new cultural environment on bilinguals' divergent thinking. Bilingualism: Language and Cognition. 2008;11(2):225–243.
43. Kharkhurin AV. The role of bilingualism in creative performance on divergent thinking and invented alien creatures tests. The Journal of Creative Behavior. 2009;43(1):59–71.
44. Kharkhurin AV. The role of selective attention in bilingual creativity. Creat Res J. 2011;24:239–54.
45. Kharkhurin AV. Multilingualism and creativity. Multilingual Matters; 2012.
46. Kim KH. Meta-analyses of the relationship of creative achievement to both IQ and divergent thinking test scores. The Journal of Creative Behavior. 2008;42(2):106–30.
47. Kim T-Y, Kim Y, Kim J-Y. Structural Relationship Between L2 Learning (De)motivation, Resilience, and L2 Proficiency Among Korean College Students. Asia Pac Educ Res. 2017;26(6):397–406. https://doi.org/10.1007/s40299-017-0358-x.
48. Konaka K. The relationship between degree of bilingualism and gender to divergent thinking ability among native Japanese-speaking children in the New York area New York University]. New York; 1997.
49. Krumm G, Aranguren M, Arán Filippetti V, Lemos V. Factor structure of the torrance tests of creative thinking verbal form B in a Spanish-speaking population. The Journal of Creative Behavior. 2014;50(2):150–64.
50. Krumm G, Lemos V, Filippetti VA. Factor structure of the Torrance Tests of Creative Thinking Figural Form B in Spanish-speaking children: Measurement invariance across gender. Creat Res J. 2014;26(1):72–81.
51. Kukenberger MR, Mathieu JE, Ruddy T. A cross-level test of empowerment and process influences on members' informal learning and team commitment. J Manag. 2015;41(3):987–1016.
52. Leeser MJ. Learner proficiency and focus on form during collaborative dialogue. Lang Teach Res. 2004;8(1):55–81.
53. Leikin M. The effect of bilingualism on creativity: Developmental and educational perspectives. Int J Biling. 2013;17(4):431–47.
54. Leikin M, Tovli E. Bilingualism and creativity in early childhood. Creat Res J. 2014;26(4):411–7.
55. Leikin M, Tovli E, Malykh S. Bilingualism and Creative Abilities in Early Childhood. English Linguistics Research. 2014;26(4):54–63.
56. Leung AK-Y, Chiu C-Y. Multicultural experience, idea receptiveness, and creativity. J Cross Cult Psychol. 2010;41(5–6):723–41.
57. Li P, Zhang F, Yu A, Zhao X. Language History Questionnaire (LHQ3): An enhanced tool for assessing multilingual experience. Bilingualism: Language and Cognition. 2019;938–944. https://doi.org/10.1017/S1366728918001153.
58. Li P, Zhang FAN, Tsai E, Puls B. Language history questionnaire (LHQ 2.0): A new dynamic web-based research tool. Bilingualism: Language and Cognition. 201417(3):673–680. https://doi.org/10.1017/S1366728913000606.
59. Liao Y-H, Chen Y-L, Chen H-C, Chang Y-L. Infusing creative pedagogy into an English as a foreign language classroom: Learning performance, creativity, and motivation. Thinking Skills and Creativity. 2018;29:213–23. https://doi.org/10.1016/j.tsc.2018.08.001.
60. Marks MA, Mathieu JE, Zaccaro SJ. A temporally based framework and taxonomy of team processes. Acad Manag Rev. 2001;26(3):356–76.
61. Marron, T. R., & Faust, M. Free association, divergent thinking, and creativity: Cognitive and neural perspectives. In R. E. Jung & O. Vartanian (Eds.), The Cambridge handbook of the neuroscience of creativity (pp. 261–280). Cambridge University Press; 2018).
62. Ollila S. Creativity and innovativeness through reflective project leadership. Creativity and Innovation Management. 2000;9(3):195–200.
63. Peal E, Lambert WE. The relation of bilingualism to intelligence. Psychol Monogr. 1962;76(27):1–23.
64. Ricciardelli LA. Bilingualism and cognitive development in relation to threshold theory. J Psycholinguist Res. 1992;21(4):301–16.
65. Ricciardelli LA. Creativity and bilingualism. The Journal of Creative Behavior. 1992;26(4):242–54.
66. Roehr K. Metalinguistic knowledge and language ability in university-level L2 learners. Appl Linguis. 2007;29(2):173–99.
67. Runco MA, Acar S. Divergent thinking as an indicator of creative potential. Creat Res J. 2012;24(1):66–75.
68. Runco MA, Jaeger GJ. The standard definition of creativity. Creat Res J. 2012;24(1):92–6.
69. Samad AA, Etemadzadeh A, Far HR. Motivation and Language Proficiency: Instrumental and Integrative Aspects. Procedia Social & Behavioral Sciences. 2012;66:432–40.
70. Sampedro A, Peña J. The effect of bilingualism level on creative performance during preadolescent period. The Spanish journal of psychology. 2019;22:E12.
71. Schippers MC, Den Hartog DN, Koopman PL, Van Knippenberg D. The role of transformational leadership in enhancing team reflexivity. Human Relations. 2008;61(11):1593–616.
72. Schön DA. The reflective practitioner: How professionals think in action. Routledge; 1992.

73. van Seggelen-Damen, I., & van Dam, K. Self-reflection as a mediator between self-efficacy and well-being. Journal of Managerial Psychology. 2016;31(1):18–33.
74. Shin Y. Positive group affect and team creativity: Mediation of team reflexivity and promotion focus. Small group research. 2014;45(3):337–64.
75. Shin Y, Kim M, Lee S-H. Reflection toward creativity: Team reflexivity as a linking mechanism between team goal orientation and team creative performance. J Bus Psychol. 2017;32(6):655–71.
76. Simonton DK. Foreign influence and national achievement: The impact of open milieus on Japanese civilization. J Pers Soc Psychol. 1997;72(1):86–94.
77. Simonton DK. Bilingualism and creativity. In: Altarriba J, Heredia RR, editors. An Introduction to bilingualism: Principles and processes. Lawrence Erlbaum; 2008. p. 147–66.
78. Sternberg RJ. Handbook of creativity. Cambridge University Press; 1999.
79. Sternberg RJ, Lubart TI. Investing in creativity American psychologist. 1996;51(7):677-688.
80. Swain, M. Focus on form through conscious reflection. In C. Doughty & J. Williams (Eds.), Focus on form in classroom second language acquisition (pp. 64-81). Cambridge University Press; 1998.
81. Swain, M. The output hypothesis: Theory and research. In E. Hinkel (Ed.), Handbook of research in second language teaching and learning . Routledge; 2005:471-483.
82. Swain M, Lapkin S. Talking it through: Two French immersion learners' response to reformulation. Int J Educ Res. 2002;37(3–4):285–304.
83. Tang C. Accessed external knowledge, centrality of intra-team knowledge networks, and R & D employee creativity. R&D Management. 2016;46(S3):992–1005.
84. Tjosvold D, Tang MM, West M. Reflexivity for team innovation in China: The contribution of goal interdependence. Group Org Manag. 2004;29(5):540–59.
85. Torrance EP. Torrance Tests of Creative Thinking. Personnel Press; 1966.
86. Torrance EP. Predictive validity of the Torrance tests of creative thinking. The Journal of Creative Behavior. 1972;6(4):236–62.
87. Trapnell PD, Campbell JD. Private self-consciousness and the five-factor model of personality: distinguishing rumination from reflection. J Pers Soc Psychol. 1999;76(2):284.
88. Vaid J, López BG, Martínez FE. Linking the figurative to the creative: Bilinguals' comprehension of metaphors, jokes, and remote associates. In: Heredia RR, Cieslicka A, editors. Bilingual Figurative Language Processing. Cambridge University Press; 2015. p. 53–86.
89. Van Dijk M, Kroesbergen EH, Blom E, Leseman PPM. Bilingualism and Creativity: Towards a Situated Cognition Approach. Journal of Creative Behavior. 2018;53(2):1–11.
90. Wang Z, Liu D, Cai S. Self-reflection and employee creativity: The mediating role of individual intellectual capital and the moderating role of concern for face. Chinese Management Studies. 2019;13(4):895–917.
91. West MA. Reflexivity, revolution and innovation in work teams. In M. Beyerlein, D. Johnson, & S. Beyerlein (Eds.), Product development teams. JAI Press; 2000:1-29.
92. Williams J. Learner-generated attention to form. Lang Learn. 1999;49(4):583–625.
93. Yadav M, BaniAta H. Factorizing Demotivation, Finding Motivation: A Constructive Approach to Quality Enhancement. Procedia - Social and Behavioral Sciences. 2013;70:120–30. https://doi.org/10.1016/j.sbspro.2013.01.047.
94. Yang Y, Jiang K, Li Y. The Cognitive Mechanisms of the Influence of L2 Proficiency on Bilinguals' Creative Thinking: Serial Mediation Analysis. Foreign Language and Literature. 2021;37(4):125–33.
95. Yang Y, Li Y. The influence of L2 proficiency on creative thinking: the moderating role of executive function. Foreign Language Education. 2019;40(05):44–50.
96. Yang Y, Li Y, Gu J. The neural mechanisms of bilinguals' creativity: A neuroimaging study. J Neurolinguistics. 2025;74:101245. https://doi.org/10.1016/j.jneuroling.2025.101245.
97. Yang Y, Wu S, Duñabeitia JA, Jiang K, Li Y. The Influence of L2 Proficiency on Bilinguals' Creativity: The Key Role of Adaptive Emotion Regulation Strategies During the COVID-19 Pandemic. Front Psychol. 2021;12:695014. https://doi.org/10.3389/fpsyg.2021.695014.
98. Yang Y, Zhang X, Wu S, Li Y. The cognitive mechanisms of bilinguals' creativity: a study of path analysis. Current Psychology; 2025. https://doi.org/10.1007/s12144-025-07559-8.
99. Yu B, Shen H. Predicting roles of linguistic confidence, integrative motivation and second language proficiency on cross-cultural adaptation. Int J Intercult Relat. 2012;36(1):72–82.
100. Zhao X, Lan G, Chen T. Motivational intensity and self-perceived Chinese language proficiency: A moderated mediation model of L2 enjoyment and boredom. *Language teaching research*, *0*(0), 13621688231180465; 2023. https://doi.org/10.1177/13621688231180465.

Publisher's Note