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STUDY

Effects of task emotions and attention control on L2 speech performance across tasks with different cognitive demands

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Abstract
The task-modulated emotion–cognition–performance interaction warrants greater scholarly attention due to its pedagogical potential for effective L2 instruction and learning. However, implications for L2 speaking remain underexplored. This study investigates the effects of tasks with varying cognitive demands on English-as-a-Foreign-Language learners' task emotions (anxiety, enjoyment, and boredom), as well as the separate and combined effects of these emotions and attention control on L2 speech performance across these tasks. Results showed that task demands were effective in affecting task emotions, with the least demanding task eliciting the lowest anxiety and the highest enjoyment. Among these emotions, only task anxiety significantly predicted breakdown fluency. Furthermore, higher attention control capacity was associated with greater syntactic complexity under moderate or high enjoyment, and with higher accuracy under conditions of high boredom, highlighting the interactive role of task emotions and attention control in L2 speech production. These findings hold significant insights for task-based language teaching researchers and L2-speaking practitioners, particularly in informing task design that addresses both learners' emotional needs and cognitive challenges.

Keywords: attention control; cognitive demands; L2 speech performance; picture narrative task; task emotions

1. Introduction

Task-based language teaching, a learner-centered pedagogical approach that integrates both form and meaning, offers learners opportunities to acquire language through activating their developing language system in line with task needs (Cheng & Sun, 2026; Ellis et al., 2020; Luo & Sun, 2025). However, the extent to which learners benefit from these well-designed opportunities can vary considerably, which can be attributed to individual differences (Skehan, 2024; Sun et al., 2025), such as cognitive and affective variables (Li, 2024). Although growing theoretical and empirical evidence highlights the interactive nature of affective and cognitive factors in shaping learners' engagement and performance (Ellis et al., 2020; Li et al., 2024), these two systems are often investigated in isolation, and little research has systematically explored how this interaction varies across tasks with differing demands (Li, 2024). Gaining deeper insights into these cognitive–affective dynamics and their joint effects on task performance could support the development of tailored L2 learning and instruction that addresses both learners' emotional needs and cognitive challenges.

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Of all the skills involved in using a foreign language, speaking is particularly demanding (Sun & Zhang, 2023; Zhang & Sun, 2026). Due to the demands of real-time language processing, L2 speaking places high emotional and cognitive pressure on learners (Zuniga & Simard, 2022). According to control-value theory (Pekrun, 2006), task-specific emotions (i.e., learners' immediate emotional responses during task execution) interact with limited cognitive resources to shape subsequent task performance. This emotion–cognition–performance interplay is further shaped by task demands, which influence both learners' emotional responses and cognitive processing by altering perceived difficulty, cognitive load, and control and value appraisals over the task (Pekrun, 2006). In this context, attention control—the capacity to sustain focus on task-relevant information while resisting distractions from both internal (e.g., task-induced anxiety) and external (e.g., time pressure) sources (Burgoyne et al., 2023; Unsworth et al., 2024) – is essential for successful L2 speech production.

To gain insight into the relationships among task emotions, attention control capacity, and L2 speech performance under tasks with varying cognitive demands, the present study examined (1) the effects of task demands on task emotions (i.e., anxiety, enjoyment, and boredom) and (2) the separate and combined effects of these emotions and attention control on L2 speech performance across three oral tasks with varying demands.

2. Literature review

2.1. L2 speech production, emotions, and attention

Building upon Levelt's (1989) L1 speech production model, Kormos (2006) proposed a modular framework for L2 speech that encompasses four stages: conceptualization, formulation, articulation, and self-monitoring. In this top-down model, the first step is conceptualization, where relevant concepts are activated and discourse content is planned. Subsequently, the lexical, syntactic, and phonological elements of linguistic messages are encoded in formulation, followed by articulation, which physically articulates the encoded message with the laryngeal organs. Self-monitoring operates throughout all stages, ensuring both internal and external speech remain accurate and aligned with the intended preverbal plan.

These cognitively demanding processes, which differ in the degree of automatization among L2 learners, place a considerable burden on limited attentional resources (Kormos, 2000). When combined with real-time processing pressure, this cognitive load renders L2 speaking both cognitively and emotionally taxing. According to control-value theory (Pekrun, 2006), learners' emotions arise from their subconscious control and value appraisals of self-presentation and expected task outcome. These emotions can elicit both physiological responses (e.g., sweating, breathing difficulties, or nausea due to heightened anxiety) (Horwitz et al., 1986) and cognitive effects (e.g., broadening or narrowing attentional focus) (Fredrickson, 2001), which jointly influence subsequent task performance. For example, positive emotions (e.g., enjoyment) may enhance performance by expanding cognitive flexibility and promoting a broader range of thought and actions (MacIntyre & Gregersen, 2012), while negative emotions (e.g., anxiety or boredom) often receive greater processing priority (Yang et al., 2016), diverting attention away from task-relevant information and potentially impairing performance (Meinhardt & Pekrun, 2003). Accordingly, emotions and attention are intricately intertwined, and their interaction shapes L2 speech performance. This dynamic becomes particularly evident under increased task demands, where individual differences in attention control capacity determine how effectively learners manage emotional distractions.

Among various emotions, anxiety, enjoyment, and boredom are the three most commonly experienced and influential affective states in foreign language learning (Li & Han, 2022). Recently, these emotions have been conceptualized as a "three-body problem" (Dewaele et al., 2023b), highlighting their dynamic interdependence and sensitivity to the alignment between task challenge and learners' L2 skills (Csikszentmihalyi, 1975). Specifically, boredom tends to emerge when tasks are either too easy or overwhelmingly difficult; enjoyment arises when task demands are well matched to

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learners' skills; and anxiety is triggered when challenges significantly exceed learners' perceived abilities. Incorporating all three emotions into a single study thus provides a nuanced, three-dimensional perspective on their distinct antecedents and consequences (Dewaele et al., 2023b; Li & Han, 2022). Growing evidence on the effects of task-specific emotions on L2-speaking performance aligns with control-value theory, indicating that task enjoyment tends to facilitate L2 speech performance (Aubrey, 2022; Shangguan et al., 2025), whereas task anxiety (Shangguan et al., 2025) and boredom (Shirvan et al., 2024) are generally detrimental. However, these emotions have often been examined in isolation or primarily through the lens of the anxiety–enjoyment dichotomy, with boredom in particular receiving limited attention (Li et al., 2023). Furthermore, much of this evidence involving task-specific emotions stems from small-scale idiodynamic studies, limiting the generalizability of findings and underscoring the need for more robust, larger-sample quantitative research.

Although limited, existing evidence suggests that the interaction between emotions and attention control capacity plays a significant role in L2 speech performance. For example, L2 speakers with higher levels of foreign language anxiety (FLA) tend to produce more self-repairs than their less anxious peers, and this relationship is moderated by attentional shift capacity (Zuniga & Simard, 2022). Similarly, Simard et al. (2023) identified a specific link between attentional shift ability, FLA, and L2 speech fluency. Despite these valuable contributions, this line of research has several limitations. First, the focus has been primarily on anxiety, with little attention given to the roles of enjoyment and boredom. Second, most studies have examined general trait emotions, overlooking task-specific emotions, which are more closely related to performance during language tasks (Li et al., 2024). In addition, L2 proficiency—a factor known to influence emotional responses, cognitive processing, and task outcomes—was not statistically controlled, which may affect the robustness and generalizability of the findings (Li, 2022; Li & Sun, 2026).

2.2. Task demands, task emotions, attention, and L2 speech performance

Mounting research has confirmed the significant effect of task demands on specific stages of L2 speech production, yet the findings remain inconsistent. For example, Kormos and Trebits (2012) found that task demands significantly affected accuracy, but not syntactic complexity or fluency. In contrast, Chen (2019) reported notable effects on syntactic complexity and fluency, with minimal impact on accuracy. Furthermore, while Chen (2019) observed enhanced fluency under tasks with higher formulation demands, Préfontaine and Kormos (2015) found that such tasks resulted in a slower articulation rate. These discrepancies may be attributable to learners' individual differences, particularly in cognitive traits and affective responses to varying task demands (Li & Sun, 2026; Sun et al., 2025). As highlighted in control-value theory (Pekrun, 2006), individuals' emotional responses to task demands shape how emotions and cognitive resources interact, ultimately influencing performance in distinct ways. Therefore, further investigations are needed to better understand how task demands interact with learners' cognitive and emotional characteristics in shaping L2 speech performance.

Accumulating research has examined learners' task-specific emotional responses to varying task demands; however, findings remain inconclusive (e.g., Donate, 2018; Kormos & Préfontaine, 2017; Mora et al., 2024; Révész, 2011; Xing et al., 2024). These inconsistencies may stem from differences in emotional measurement or in how task complexity was operationalized. For example, Donate (2018) independently assessed task-specific anxiety during and after a monologue speaking task and found that anxiety had a stronger negative impact on performance in a complex task than in a simpler one. In contrast, Révész's (2011) study used a post-task questionnaire to measure anxiety experienced in group discussion and reported a nonsignificant effect of L2 anxiety in either complex or simple task conditions. These mixed results and the predominant focus on task anxiety highlight the need for further research that includes a broader range of emotions and carefully considers the manipulation of task demands.

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Although growing evidence in L2 writing suggests that emotional and cognitive variables interact differently depending on task demands (Li et al., 2024), such task-modulated emotion–cognition–performance interactions remain underexplored in L2 speaking. To our knowledge, such a line of inquiry in L2 speaking is limited to Xing et al. (2024), who examined the interplay between task emotions (i.e., anxiety and enjoyment), working memory, and L2 speech performance across tasks of varying complexity. Their findings revealed no significant effect of task demands on either task anxiety or enjoyment. However, the interaction between emotional and cognitive variables differed by task demands. In the simple task, enjoyment was positively associated with fluency, anxiety was negatively associated with fluency, and working memory was positively associated with syntactic complexity. In contrast, in the complex task, neither anxiety nor working memory showed significant correlations with performance, while enjoyment continued to positively predict fluency.

Xing et al.'s (2024) study has several limitations. First, the manipulation of task complexity was limited, as both the complex and simple tasks used the same picture set and differed only in the sequence of image presentation. Second, the study did not address the combined effects of task-specific emotions and cognitive abilities across tasks with varying demands, leaving the dynamic interaction between affective and cognitive variables underexamined. Moreover, much of the existing research on task complexity has focused on manipulating a single dimension—either resource-directing or resource-dispersing (Robinson, 2005)—without considering how task demands may affect different stages of speech production. Building on Skehan's (2009) and Levelt's (1989) models, future research should move beyond examining overall task demands to undertake more fine-grained analyses of how task design shapes the conceptualization and formulation stages of speech production. Such an approach could yield a more comprehensive understanding of how task characteristics interact with learners' affective and cognitive resources to influence L2 performance.

2.3. Research questions

To bridge the aforementioned gaps, the present study explores the effects of task demands on task emotions (anxiety, enjoyment, and boredom) and investigates the effects of task emotions, attention control capacity, as well as their synergistic effects on L2 speech performance across tasks with differing demands at both conceptualization and formulation stages. The research questions (RQs) are as follows:

RQ 1: To what extent do task demands affect task emotions (anxiety, enjoyment, and boredom)?

RQ 2: To what extent do task emotions (anxiety, enjoyment, and boredom) and attention control capacity, separately and together, influence learners' L2 speech performance across tasks with varying demands?

3. Methodology

3.1. Participants

Participants were 79 Chinese English-as-a-Foreign-Language learners with an average of 21.19 years (min = 18; max = 29). Among them, 24 were male and 55 were female. They were students from two universities in China from various majors, and 94.94% of them have passed the Chinese College English Band 4 (CET-4), indicating an intermediate to upper-intermediate level of English proficiency. Only one participant reported prior residence in an English-speaking country, with a duration of approximately 4 months.

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3.2. Instruments

Six measurement instruments were used to collect data: A sociodemographic questionnaire, a LexTALE lexical decision test, the Attention Control Test, three-picture narration tasks differing in demands, and a comprehensive task emotion scale.

Sociodemographic questionnaire. The questionnaire collects background information such as name, gender, age, major, language use, and CET-4 grades.

LexTALE lexical decision test. This test is a standard "Yes/No" lexical decision task used to assess L2 proficiency in advanced English learners (Lemhöfer & Broersma, 2012). Participants need to determine whether each of the 60 presented English words is a real word or a nonword.

Attention Control Test. This study adopted Burgoyne et al.'s (2023) Attention Control Test to measure individual differences in attention control. The test includes the Stroop Squared task, the Simon Squared task, and the Flanker Squared task. According to Burgoyne et al. (2023), these tasks demonstrate excellent trial-level internal consistency (split-half reliabilities of .93, .97, and .94), good temporal stability across repeated sessions ($r = .46–.75$), moderate intercorrelations (average $r \approx .50$), and loadings on a single latent factor representing attentional control. In our dataset, the three tasks were moderately intercorrelated (average $r = .46$) and were therefore treated as indicators of the same construct. See Supplementary File 1 for the correlation matrix for these three squared tests. The resulting composite reliability, assessed using Cronbach's α, was 0.71, indicating acceptable internal consistency. For each test, participants complete a 30-s practice phase followed by a 90-s test phase.

Three-picture narration tasks. Three-picture narration tasks with varying cognitive demands on conceptualization and formulation have been designed: Task A, with low demands on conceptualization and formulation; Task B, with moderate demands on conceptualization but high demands on formulation; and Task C, with high demands on conceptualization but moderate demands on formulation. The manipulation of task demands was informed by Skehan's (2009) framework, which situates task complexity within the conceptualization and formulation stages of speech production, and is consistent with previous empirical designs (e.g., Kormos & Préfontaine, 2017; Kormos & Trebits, 2012). The conceptualization demands were manipulated based on the level of abstractness or concreteness of the information, specifically whether the presented pictures exhibited a clear storyline. Similarly, the formulation demands were manipulated through the negotiability of lexis retrieval, specifically whether the task provided linguistic support or allowed flexibility between conceptualization and formulation.

Task A presents six sequential pictures accompanied by a familiar fable, The Crow and the Pitcher, along with an English reference text. The familiar content and linguistic support minimize cognitive demands at both the conceptualization and formulation stages. Task B also uses a coherent six-picture sequence but without reference to the text, requiring participants to rely solely on their L2 resources, thereby imposing moderate conceptual and high formulation demands. Task C provides six unrelated pictures, requiring participants to construct a coherent narrative, which places high demands on conceptualization and moderate demands on formulation due to the flexibility in tailoring their storyline design to their available linguistic knowledge. For all three tasks, participants are required to narrate a coherent story based on the pictures and produce at least three sentences for each picture after 1 min of preparation. See Supplementary File 2 for the tasks.

To ensure the tasks appropriately varied in cognitive demands, the design was first scrutinized by four L2-speaking professionals and pilot-tested before the main study. Participants also completed a post-task questionnaire, which included a one-item scale measuring overall perceived task difficulty and an open-ended question about their perceptions of the task demands. Results indicated that participants perceived Task C as the most demanding, followed by Task B and Task A, reflecting the assumed hierarchy of conceptualization demands. This pattern is consistent with previous studies (Chen, 2019). Their qualitative responses further confirmed the intended manipulation: Task C was described as having the highest conceptualization demands, Task B as having the highest formulation demands, and Task A as low in both conceptualization and formulation demands.

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Table 1. Summary of complexity, accuracy, and fluency measures

Constructs	Types	Measures	
Complexity	Lexical complexity	Lexical sophistication	No. of sophisticated lexical words/No. of lexical words
	Syntactic complexity	Mean length of ASU	No. of total words/No. of ASU
Accuracy	Accuracy	The ratio of error-free ASU	No. of error-free ASU/No. of ASU
Fluency	Speed fluency	Articulation rate	No. of syllables (pruned)/Phonation time
	Breakdown fluency	Mean length of silent pause	silent duration time/No. of silent pauses
	Repair fluency	Repair rate	No. of disfluency markers/Total speaking time

The comprehensive task emotion scale. This 14-item scale measures task-specific anxiety (4 items), enjoyment (4 items), and boredom (4 items) on a 9-point Likert scale. The items were developed based on (1) representative proxies of each emotion in L2 speaking (e.g., anxiety: worry about disfluency; enjoyment: engagement, sense of achievement; and boredom: disengagement, mind-wandering), and (2) established emotion scales in L2 research (e.g., anxiety: Botes et al., 2022; enjoyment: Li et al., 2018; and boredom: Li et al., 2023). An example item is "This speaking task makes my mind begin to wander." Exploratory factor analysis supported the construct validity of the scale (Kaiser–Meyer–Olkin [KMO] = 0.86; Bartlett's test $p < .001$), with model fit indices indicating a good fit (root mean square residual [RMSR] = 0.02; root mean square error of approximation [RMSEA] = 0.03; Tucker–Lewis index [TLI] = 0.987; Bayesian information criterion [BIC] = −135.65). Internal consistency was good across subscales ($\alpha = 0.891$ for anxiety, 0.903 for enjoyment, and 0.794 for boredom). See Supplementary File 3 for item details.

3.3. Data collection and analysis

Participants first completed a sociodemographic questionnaire (5min), followed by the Attention Control Test (10min) and the LexTALE lexical decision test (10min). Subsequently, they proceeded to complete three-picture narration tasks (5min) in a counterbalanced order to minimize the order effects. Upon finishing each speaking task, participants filled out the comprehensive task emotion scale (3min). They then had a 5-min rest before commencing the next task. The experiment was conducted in a separate room.

Emotions were operationalized as the mean scores of their respective scales. Participants' L2 proficiency was assessed using the final score of the LexTALE lexical decision test. Attention control capacity was indexed by subtracting the total number of incorrect responses from the total number of correct responses across all three attention control tasks. L2-speaking task performance was evaluated using representative measures of complexity, accuracy, and fluency. The specific metrics for each dimension are presented in Table 1. All recordings were first transcribed verbatim, and a combination of manual analysis and automated tools was used. Syntactic complexity and accuracy were coded manually, while lexical complexity was assessed using an automated processing tool developed by Lu (2012). Fluency was analyzed using Praat software and verified through manual checks. The AS-unit (analysis of speech unit) was adopted as the basic unit of analysis. An AS-unit (ASU) is defined as an independent clause or subclausal unit together with any associated subordinate clauses and has been shown to be particularly suitable for the analysis of spoken language (Foster et al., 2000).

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Statistical analysis was conducted in *R* software (version 4.4.2). To address RQ1, three linear mixed-effects models were constructed to examine the effects of task demands on each task emotion, with L2 proficiency as a covariate and participants included as a random effect. If an effect was found, post hoc tests were conducted for further investigation, with Tukey's HSD correction for multiple comparisons.

To address RQ2, a Bayesian multivariate multilevel model was constructed to simultaneously estimate six outcome variables representing key dimensions of L2 speech performance—namely, complexity, accuracy, and fluency. The model included task demands, attention control capacity, and task emotions (task anxiety, task enjoyment, and task boredom) as fixed effects, with L2 proficiency (LexTALE) added as a control covariate. Random intercepts for participants were specified to account for within-subject variability. Crucially, the model incorporated two-way interaction terms between attention control capacity and each task emotion to examine whether the predictive effect of task emotions on L2 speech performance depended on participants' attention control capacity. The full model formula was as follows: L2 speech performance ~ Task demands + Attention control capacity × (Task anxiety + Task enjoyment + Task boredom) + LexTALE + (1 | Participant).

Bayesian multivariate multilevel modeling was adopted due to its capacity to jointly estimate multiple possible interrelated outcome variables, its robustness with small sample sizes, and its flexibility in handling hierarchical data structures and complex interaction effects (Hox, 2019). This modeling framework is particularly well-suited to the current study, which investigates the nuanced interplay between cognitive and emotional predictors across multiple dimensions of L2 speech performance. By estimating all outcome variables simultaneously, the model accounts for potential correlations among dependent variables and enhances estimation efficiency.

All independent and dependent variables were standardized before model estimation to improve sampling efficiency and facilitate the interpretation of regression coefficients on a common scale. Weakly informative priors were specified for all parameters, based on the scale of the standardized variables. These priors served to regularize estimates and prevent overfitting while minimizing undue influence on the posterior distributions. Prior predictive checks were conducted to evaluate the plausibility of the specified priors in light of the observed data. Model fit was evaluated through posterior predictive checks, which compared the observed data to data simulated from the posterior predictive distribution. Convergence diagnostics were also examined, including trace plots, the potential scale reduction factor (R-hat), and effective sample size (ESS) statistics. All diagnostics indicated adequate model convergence and fit.

4. Results

4.1. The effects of task demands on task emotions (RQ1)

As shown in Table 2, task demands had a significant effect on both task anxiety and task enjoyment, whereas their effect on task boredom was not statistically significant.

The post hoc pairwise comparisons are shown in Table 3. As for task anxiety, significant differences were found between Task A and Task B ($p < .001$), and between Task A and Task C ($p < .001$), while no significant difference was noted between Task B and Task C ($p = .171$), which indicated that participants experienced the lowest anxiety in Task A, with similar levels of anxiety reported in Task B and Task C. Despite no statistically significant difference, task anxiety was higher in Task C than in Task B.

Regarding task enjoyment, participants reported significantly higher enjoyment in Task A compared to Task B ($p = .038$). No significant differences were observed between Task A and Task C ($p = .428$) or between Task B and Task C ($p = .437$). These results suggest that Task A was the most enjoyable, whereas Task B was the least enjoyable. Although the difference between Task B and Task C was not statistically significant, enjoyment tended to be higher in Task C than in Task B.

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Table 2. The results of linear mixed-effects models

Response	Effect	Estimate	*SE*	*t*	*p*	Marginal R^2	Conditional R^2
Task anxiety	(Intercept)	7.465	0.977	7.642	<.001***	.181	.666
	Task B	1.244	0.181	6.887	<.001***		
	Task C	1.570	0.181	8.692	<.001***		
	LexTALE	−0.043	0.015	−2.843	.006**		
Task enjoyment	(Intercept)	3.532	0.893	3.956	<.001***	.065	.475
	Task B	−0.516	0.208	−2.476	.014*		
	Task C	−0.259	0.208	−1.245	.215		
	LexTALE	0.036	0.014	2.629	.010*		
Task boredom	(Intercept)	3.869	0.771	5.016	<.001***	.023	.644
	Task B	0.165	0.132	1.244	.215		
	Task C	−0.013	0.132	−0.096	.924		
	LexTALE	−0.017	0.012	−1.456	.15		

Note: Task A had both low conceptualization and formulation demands; Task B had moderate conceptualization and high formulation demands; and Task C had high conceptualization and moderate formulation demands. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3. Post hoc pairwise comparisons

Emotions	Comparison	Estimate	*SE*	*z*	*p*
Task anxiety	Task A–Task B	−1.244	0.181	−6.887	<.001***
	Task A–Task C	−1.570	0.181	−8.692	<.001***
	Task B–Task C	−0.326	0.181	−1.805	.168
Task enjoyment	Task A–Task B	0.516	0.208	2.476	.035*
	Task A–Task C	0.260	0.208	1.245	.426
	Task B–Task C	−0.256	0.208	−1.230	.435
Task boredom	Task A–Task B	−0.165	0.132	−1.244	.427
	Task A–Task C	0.013	0.132	0.096	.995
	Task B–Task C	0.177	0.132	1.340	.373

Note: Task A had both low conceptualization and formulation demands; Task B had moderate conceptualization and high formulation demands; and Task C had high conceptualization and moderate formulation demands. * $p < .05$. ** $p < .01$. *** $p < .001$.

In terms of task boredom, no significant differences were found across any task comparisons. Nevertheless, the descriptive pattern indicated that participants experienced the highest boredom in Task B, followed by Task C, and the lowest boredom in Task A.

4.2. The separate and joint effects of task emotions and attention control capacity on L2 speech performance (RQ2)

The results of the Bayesian multivariate multilevel modeling indicated satisfactory model convergence and fit. All potential scale reduction factors (R-hat) were approximately 1.00, and all ESSs exceeded 400, suggesting that the Markov chains converged properly and that the posterior estimates were stable. In interpreting the results, a 95% credible interval (CrI) that did not include zero was

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Table 4. Results of the Bayesian multivariate multilevel modeling

Response	Fixed effects	Estimate	Est. error	95% CrI	R-hat	Bulk ESS	Tail ESS
Lexical complexity	LexTALE	0.262	0.062	[0.141, 0.384]	1.000	21,476.756	9631.507
	Task B	0.852	0.128	[0.598, 1.102]	1.000	20,690.285	9129.006
	Task C	1.121	0.132	[0.860, 1.377]	1.000	19,116.980	10,373.706
Syntactic complexity	LexTALE	0.231	0.083	[0.067, 0.394]	1.000	12,925.184	9155.441
	Task B	−0.435	0.132	[−0.696, −0.176]	1.000	17,173.440	10,504.144
	ACC	0.172	0.082	[0.011, 0.337]	1.001	13,157.878	10,284.984
	ACC × TE	0.251	0.095	[0.064, 0.439]	1.000	11,367.918	10,175.278
Accuracy	Task B	−0.408	0.128	[−0.663, −0.161]	1.000	14,923.471	9696.225
	ACC × TB	0.281	0.093	[0.100, 0.463]	1.000	13,684.548	10,483.562
Speed fluency	LexTALE	0.183	0.087	[0.012, 0.354]	1.000	7568.070	8508.244
	Task B	−0.911	0.099	[−1.103, −0.715]	1.000	15,080.038	10,278.679
	Task C	−0.788	0.106	[−0.996, −0.578]	1.000	12,894.292	9837.950
Breakdown fluency	LexTALE	−0.183	0.092	[−0.363, −0.001]	1.001	6368.844	8291.198
	Task B	0.267	0.093	[0.084, 0.450]	1.000	15,707.441	10,062.702
	Task C	0.335	0.101	[0.135, 0.534]	1.000	12,561.947	10,674.693
	TA	0.228	0.077	[0.076, 0.376]	1.001	8569.418	9239.678

Note: ACC = attention control capacity; TA = task anxiety; TE = task enjoyment; TB = task boredom; Task A had both low conceptualization and formulation demands; Task B had moderate conceptualization and high formulation demands; and Task C had high conceptualization and moderate formulation demands.

taken as evidence of a significant effect, consistent with established conventions in Bayesian inference. Statistically significant results are reported in Table 4, with the complete results available in Supplementary File 4.

In terms of the separate effects, the results showed that task emotions and attention control significantly influenced L2 speech performance. Specifically, task anxiety had a significant positive effect on breakdown fluency (Estimate = 0.228, 95% CrI = [0.076, 0.376]), suggesting that learners experiencing higher levels of anxiety during speaking tasks tended to produce more silent pauses in their speech. Furthermore, attention control capacity was found to exert a significant positive effect on syntactic complexity (Estimate = 0.172, 95% CrI = [0.011, 0.337]). This suggests that learners with greater attention control tended to produce syntactically more complex utterances compared to those with lower attention control.

In terms of the interaction (or joint) effect between task emotions and attention control capacity, as presented in Table 4, two significant interaction effects were observed. First, attention control significantly interacted with task enjoyment in predicting syntactic complexity (Estimate = 0.251, 95% CrI = [0.064, 0.439]) and with task boredom in predicting accuracy (Estimate = 0.281, 95% CrI = [0.1, 0.463]). To further interpret these interactions, simple slope analyses were conducted. For clarity and to highlight meaningful patterns, only statistically significant results are displayed in solid colored lines in interaction plots.

Regarding syntactic complexity, as shown in Figure 1, attention control capacity significantly predicted syntactic complexity at mean and high levels of task enjoyment. At the mean level of enjoyment, greater attention control was associated with increased syntactic complexity (95% CrI = [0.004, 0.326]), and this effect was even more pronounced under high enjoyment conditions

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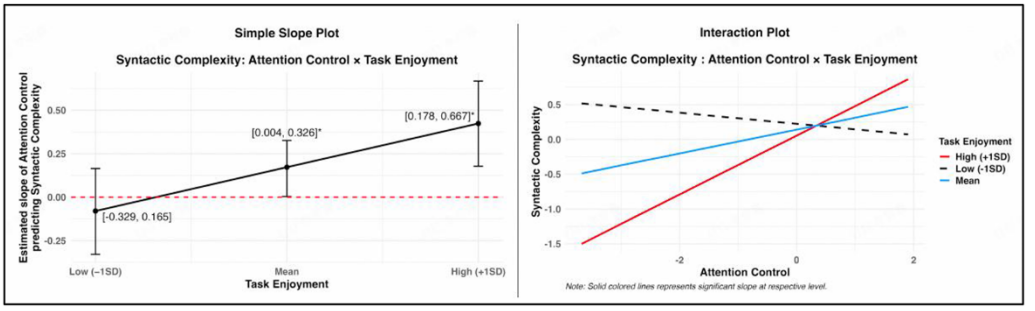


Figure 1. Simple slope plot and interaction plot of attention control capacity × task enjoyment on syntactic complexity.

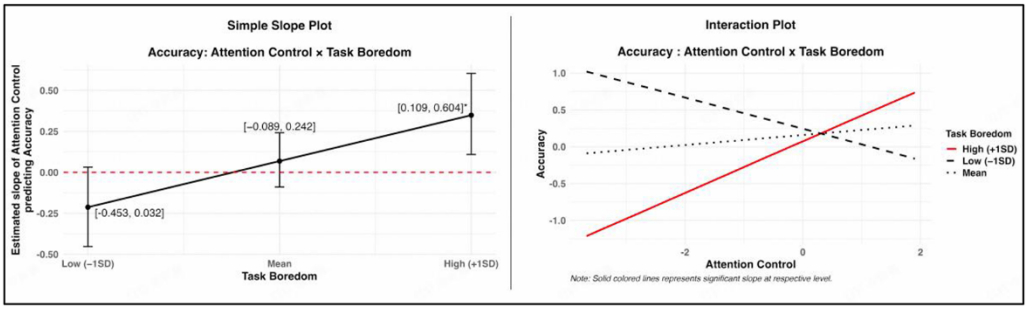


Figure 2. Simple slope plot and interaction plots of attention control capacity × task boredom on accuracy.

(95% CrI = [0.178, 0.667]). However, under low task enjoyment, the predictive effect of attention control was not statistically significant (95% CrI = [−0.329, 0.165]).

Regarding accuracy, as depicted in Figure 2, attention control positively predicted speech accuracy (95% CrI = [0.102, 0.604]) under high boredom. In contrast, at low and mean levels of boredom, the relationship between attention control and accuracy was not statistically significant (low: 95% CrI = [−0.453, 0.032]; and mean: 95% CrI = [−0.089, 0.242]).

5. Discussion

5.1. Task demands were effective in affecting task emotions

Results revealed that task demands significantly influenced both the types and intensity of emotions experienced during task execution. Specifically, the least demanding task elicited the lowest levels of anxiety and the highest levels of enjoyment, suggesting that tasks with lower cognitive or linguistic demands may facilitate a more positive emotional experience.

With respect to task anxiety, the nonsignificant differences observed between Task B and Task C are consistent with previous studies (Mora et al., 2024; Révész, 2011; Xing et al., 2024), yet they diverge from the findings of others (Donate, 2018; Kormos & Préfontaine, 2017). This inconsistency may stem from L2 learners' ability to mitigate the negative effects of anxiety (Révész, 2011), the sequencing of task implementation (Mora et al., 2024), and the stimuli used to control task demands (Xing et al., 2024). In this study, the absence of a significant difference in anxiety between Task B and Task C may be partly explained by procedural requirements, which can amplify the cognitive load of a task (Robinson & Gilabert, 2007). Although the instruction to produce at least three sentences for each picture applied to all tasks, in Task B, this requirement, combined with a relatively clear storyline, may

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have placed additional demands on conceptualization and consequently heightened learners' anxiety. This overlapping effect may have reduced the expected differences in anxiety between the two tasks.

As for task enjoyment, the absence of significant differences between Task B and Task C aligns with previous findings (Kormos & Préfontaine, 2017; Xing et al., 2024). One plausible explanation lies in the creativity embedded in task design, which has been recognized as a key source of enjoyment in L2 learning (Pawlak et al., 2020). Although participants perceived Task C as overall more demanding, the creative challenge of constructing a story from unrelated pictures appeared to stimulate their interest and foster greater enjoyment (Kormos & Préfontaine, 2017). The relative flexibility afforded in the formulation stage may also have contributed to this positive experience. By contrast, Task B, with its predetermined storyline and heavier formulation demands, may have been perceived as more rigid, thereby restricting learners' opportunities for creative expression and ultimately limiting their enjoyment.

Regarding task boredom, no significant differences were observed across the three tasks. One possible explanation is the nature of picture-based narrative tasks, which are likely to engage learners' imagination and may therefore mitigate the emergence of boredom, and the real-time cognitive demands of speech production could have helped sustain learners' attentional involvement throughout task performance. In addition, boredom is often associated with a mismatch between task demands and learners' abilities, either when demands are too low to sustain interest or too high to be manageable (Pekrun, 2006). Given the relatively advanced L2 proficiency of participants in the present study, it is plausible that they were able to cope with the cognitive and linguistic requirements of all three tasks, thereby sustaining engagement and reducing the likelihood of boredom.

5.2. Respective effects of task emotions and attention control capacity on L2 speech performance

As for task emotions, only task anxiety was found to significantly affect breakdown fluency, indicating that participants who experienced higher task anxiety tended to produce longer silent pauses during speech production. This negative effect of anxiety on L2 speech performance is consistent with prior research (Robinson, 2007). Fluent speech heavily relies on the efficient and smooth translation of the content of macroplanning into linguistic output, requiring a high degree of automatic retrieval of linguistic information from the speakers' existing L2 knowledge (Felker et al., 2019). However, when anxiety interferes with cognitive processing of knowledge representations, it increases cognitive pressure and self-monitoring consciousness, which often causes participants to fixate on potential mistakes and second-guess their linguistic choice (MacIntyre & Gardner, 1994). In addition, the anxiety-induced physiological responses, such as sweating, increased heart rate, and physical tension (Croft et al., 2004), can consume additional attentional resources that would otherwise be allocated to language production (MacIntyre & Gregersen, 2012). The narrowed cognitive bandwidth and additional attention consumption brought by higher anxiety disrupt what may otherwise be a smooth and coherent flow of speech.

In contrast, task enjoyment and task boredom did not show significant independent effects on task performance, suggesting that positive or low-arousal emotions alone may be insufficient to drive measurable changes in L2 output. Although all three emotions have been shown to correlate with foreign language performance individually, when examined simultaneously within the same model, anxiety consistently emerges as the most influential predictor (Dewaele et al., 2023b; Li & Han, 2022). For instance, Dewaele et al. (2023b) employed dominance analysis to examine the effects of FLA, enjoyment, and boredom on academic achievement and found that anxiety was the strongest predictor. Similarly, Dewaele et al. (2023a) reported that structural equation modeling revealed significant negative effects of anxiety on performance, whereas enjoyment and boredom showed no direct predictive power. Notably, unlike prior studies that focused on trait emotions, the present study provides task-specific evidence highlighting the predominant role of anxiety in L2 performance. Moreover,

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the relationship between emotions and performance is likely more complex than a simple linear effect. L2 performance may be influenced by nonlinear or spiraling dynamics (Dewaele et al., 2023b; Fredrickson & Joiner, 2002), in which positive emotions partially offset the negative effects of anxiety (Garland et al., 2010), leading to more balanced emotional states during task execution. Such dynamics may help explain why task emotions had a weak impact in the present study.

Attention control capacity was found to significantly influence syntactic complexity, indicating that participants with higher attention control capacity were better able to produce syntactically complex speech. This can be explained by the role of attention control capacity in efficiently allocating cognitive resources (Burgoyne et al., 2023), facilitating the planning and encoding of complex syntactic structures without compromising real-time processing. In contrast, attention control capacity did not significantly affect other aspects of L2 speech, such as lexical complexity, accuracy, or fluency. This finding aligns with previous research suggesting that working memory, another key cognitive resource, typically has a limited influence on L2-speaking performance (Cho, 2018; Xing et al., 2024). The interaction between attention control capacity and task emotions observed indicates that its impact appears to be contingent upon the emotional context of the task. This observation corroborates prior work highlighting that the effects of attention control are particularly noticeable in high-interference contexts where goal-relevant information is at risk of being overshadowed by distractions (Unsworth et al., 2024).

5.3. The interaction patterns of task emotions, attention control capacity, and L2 speech performance across tasks with varying demands

Two interaction effects between task emotions and attention control on L2 task performance were observed across tasks. When experiencing moderate or high task enjoyment, participants with higher attention control capacity produced more syntactically complex speech, highlighting the interplay between affective and cognitive processes in language production. According to Fredrickson's broaden-and-build theory (Fredrickson, 2001), positive emotions broaden attentional scope and enhance cognitive flexibility, enabling learners to consider a wider range of ideas and linguistic structures. When coupled with high attention control, this broadened attentional capacity allows learners to allocate cognitive resources efficiently across competing demands (Chiew, 2021), such as lexical retrieval and syntactic encoding. These findings suggest that positive affective states and executive control interact to create an optimal cognitive environment for syntactic elaboration in L2 speech.

Second, under high task boredom, participants with higher attention control capacity produced more accurate speech compared to those with lower attention control capacity. High task boredom is associated with reduced interest, lapses in concentration, and general disengagement during task execution (Li et al., 2023), which can compromise careful linguistic encoding and lead to errors. Learners with stronger attention control are better able to regulate their attention, maintain task goals, and suppress distractions, thereby preventing errors and ensuring that morphosyntactic and lexical encoding processes are executed more precisely (Herd et al., 2014). In this way, attention control specifically supports accuracy by allowing learners to preserve attentional resources for careful monitoring of linguistic form, even when motivation and engagement are low. These interaction effects across tasks suggest that higher attention control capacity not only amplifies the benefits of positive emotions, such as enjoyment, but also buffers against the detrimental effects of negative emotions like boredom, highlighting its pivotal role in shaping L2 task performance across diverse tasks.

6. Conclusion

The current study investigated how task demands affect commonly experienced task emotions (anxiety, enjoyment, and boredom) and explored the separate and combined effects of these emotions and attention control capacity on L2 speech performance across tasks with varying demands. Results

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showed that task demands were effective in affecting task emotions, with the least demanding task eliciting the lowest anxiety and highest enjoyment. Among these emotions, only task anxiety significantly predicted breakdown fluency. Furthermore, higher attention control capacity was associated with greater syntactic complexity under moderate or high enjoyment, and with higher accuracy under conditions of high boredom, highlighting the interactive role of task emotions and attention control in L2 speech production.

This study has implications for future teaching, learning, and research. First, task emotions deserve greater attention due to their immediate and situation-specific impact. Their malleability allows instructors to implement interventions more effectively by adjusting the environments (Li & Sun, 2026). By continuously improving their task emotional experiences, educators could enhance L2 learners' engagement and motivation, thereby contributing to sustained involvement in the learning process over the long term. Moreover, regarding task emotions' pervasive and prominent effects on task performance, instructors can consider equipping L2 learners with the necessary emotion regulation strategies. Second, since attention control capacity marked its significance under conditions of high interference, it is beneficial for educators to organize such training to enhance students' attention control capacity to better inhibit emotion-evoked distractions. Furthermore, since this intricate interplay between task emotions and attention control interacts with task demands, the synergistic effects of individual differences and task characteristics call for more exploration to enable L2 learners to fully leverage the learning opportunities offered by well-designed tasks.

While the current study's findings provide venues for future research, limitations of the study should be acknowledged. First, the focus on learners with intermediate to high L2 proficiency may limit the generalizability of the findings. Second, L2 proficiency was assessed using the LexTALE test, whose construct validity has been questioned (Puig-Mayenco et al., 2023). Future studies may consider other measures to better capture proficiency, such as the Elicited Imitation Task. Additionally, this study did not include measures of L2 speech performance related to content, such as coherence. Future studies could incorporate measures that assess both the form and content of L2 speech performance. Moreover, the quantitative methodology also presents limitations, and future research could employ qualitative methods, such as the idiodynamic method, to offer a closer insight into this interaction.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0261444826101311.

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