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Article

# Biosensing measurement and psychological mechanism exploration of emotional responses in English learners

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**Abstract:** Emotions have an important role in English language learners (ELL), impacting motivation, engagement, and performance. Understanding how emotions influence ELL performance is critical for creating effective instructional programs. Previous research has explored emotional reactions utilizing self-reports or behavioral observations, but only a small amount of research has used biosensing technology to offer objective, real-time data on emotional states. The purpose of this research is to examine English learners' emotional responses using biosensing measurements to investigate the psychological mechanisms supporting these responses and offer knowledge about how emotions influence language learning. The investigation involved 150 English language learners. Biosensing devices were used to evaluate physiological indicators such as heart rate variability, skin conductivity, and facial expressions while students completed English language tasks. Furthermore, psychological mechanisms were investigated using questionnaires and interviews, yielding qualitative insights into how learners experience and handle their emotions during the learning process. Statistical analysis, such as regression, descriptive, correlation analysis, ANOVA, and chi-square statistics, was used to investigate the association between emotional responses and language learning efficacy. The findings show a strong association between good emotional reactions and better language learning outcomes, whereas negative emotions, such as anxiety, are associated with lower engagement and performance. Finally, this approach emphasizes the relevance of understanding emotional dynamics in language learning and the necessity of developing methods to enhance positive emotional involvement.

**Keywords:** English language learners (ELL); emotional; learning efficacy; psychological mechanisms; biosensing

## 1. Introduction

Emotional responses in English learners play a crucial role in shaping language attainment procedure and overall learning involvement [1]. Emotions, both positive and negative, can significantly affect motivation, engagement, and cognitive processing throughout language learning. Knowledge about such emotions is useful for the educators to establish effective and beneficial learning environments, which might aid language growth and outcome mental health. In English language acquisition, emotion could be linked to the learner's confidence, culture, and learning past experiences [2]. By using 218 unique approaches to analyze electroencephalogram (EEG) data, the 217 Neuro Sky EEG biosensor is able to determine the attention level every second. Additionally, it is anticipated that the automatically determined attention level would assist educators or online learning platforms in giving personalized feedback and improving student performance [3]. Learners who are positive about their achievement have positive communication behaviors, which include active speaking and listening, leading to faster language

acquisition. Anxiety, frustration, and fear of failure are the negative emotions that could interfere with the learning process. English language users can also experience anxiety due to potential errors that they are likely to make when speaking or writing another language [4].

This has implications in the learning process since it turns into avoidance type of behavior like refusing to be called upon to respond to questions or losing self-esteem [5]. One of the main affective variables reported by learners was language anxiety, which is related to low self-esteem. This anxiety can present itself as a concern for grammatical mistakes, communication failure, or social humiliation in students' interactions with their peers. In addition, the effects can regulate learners' cognitive processes, including attention, memory and thinking skills [6]. Learners' positive affect enhances their abilities to pay attention and think, thus aiding language acquisition as compared to negative effect, which hampers focus and learning of new words and grammar patterns [7]. When learners are anxious, may be unable to focus on the activities in class since the feeling of anxiety takes precedence over the learner's cognitive mechanisms for learning. Emotional responses also depend on such learner factors as personality type and level of emotional intelligence [8].

Since more intelligent learners have a better ability to control their emotions, they retain what they learn in class. Whereas the students lack a sufficient number of emotional regulation skills could experience more difficulty than others when it comes to stressors involved in language learning. Teachers can utilize the biosensor-based response as a guide when speaking with other educators, which could decrease the irregularity in psychological assessment [9]. Hence, it is crucial to scientifically assess emotional reactions to learning English and use the results to establish appropriate and favorable learning conditions. Learning complexity involves different aspects such as the emotional factors of a language learning process. Therefore, development of more biosensor-based physiological signal-based emotion recognition systems throughout time the above types of affective variables are recognized, they can be used in teaching learning process to support and meet the needs of students, hence increasing the effectiveness of language acquisition experiences [10].

The purpose of this research is to examine English learners' emotional responses using bio-sensing measurements, investigate the psychological mechanisms supporting these responses, and offer knowledge about how emotions influence language learning.

A list of literature reviews was given in Section 2. In Section 3, the method is explained. Section 4 describes the results and discussion. Conclusion is provided in Section 5.

## 2. Related work

Self-efficacy and emotional control were found to be two possible indicators of English as a Foreign Language (EFL) teachers' psychological wellness, which was examined by Xiyun et al. [11]. It was found that both factors significantly predicted teachers' psychological well-being, with teacher self-efficacy contributing to a larger proportion of the variance. The identification of significant teacher characteristics in forecasting their psychological well-being at work contributes useful information.

Finally, it provided some information that EFL instructors who were less effective and had not learned emotional control techniques were susceptible to exhaustion.

The impact of the sudden implementation of Emergency Remote Teaching (ERT) after the COVID-19 pandemic on the mental health of English learners was evaluated by Resnik and Dewaele [12]. In both in-person and ERT settings, learners expressed more satisfaction than anxiety. However, compared to in-person classes, students' Foreign Language Enjoyment (FLE) was noticeably lower in ERT situations. According to the sub-dimensions, teacher appreciation was the most consistent across contexts, but in the ERT situation, personal FLE and particularly social FLE decreased significantly in the ERT setting.

To support English educators in better handling situations like the COVID-19 epidemic, focused on the difficulties that English teachers and students had when educating and learning online, to overcome these difficulties, and important lessons obtained. The wide variety of informative, socioeconomic, and digital environments reflected a variety of difficulties faced by language instructors and students as well as the solutions it created to solve the difficulties. Although there had been many technical problems, online language learning and teaching had important cognitive and affective component by Tao and Gao [13].

Dryden et al. [14] established the significance of secure learning environments and emotional support for EFL from immigrant background. The spaces could help to immigrant the harmful psychological responses of foreign language anxiety (FLA) by enabling EFL students to authentically share problems, lived experiences, and facial expressions through translanguaging using biosensor. Translanguaging would also serve as an emotionally safe space for reducing the negative emotional responses of FLA.

Richards [15] examined the types of emotions that encountered by educators and students, the reasons behind them and the potential effects it would have on instruction and learning, focused on emotions in teacher development, emotions and the educator, as well as English language students. There were recommendations on how educators and students might cultivate emotional competence, or the capacity to recognize and effectively control emotions in language education and instruction.

Wang [16] investigated the causes of and remedies for teacher ennui and included English language instructors of all ages and genders. Following a thematic evaluation of the collected data, the findings showed that the majority of participants found online delivery to be more boring than in-person delivery. Furthermore, the results demonstrated that the variables and solutions connected to students, tasks, Information Technology (IT), and teachers fit under the macro categories of teacher boredom antecedents and solutions.

Greenier [17] examined the function of psychological well-being (PWB) and emotion control as forecasters of work arrangement using a sample of English language teachers. To determine similarities and differences in the methods that PWB and emotion control could influence work involvement among English teachers, a multi-group structured comparison modelling was conducted.

Fan and Wang [18] examined how emotional control, professional achievement, and EFL teachers' well-being were all related, as the conceptual framework of connections showed, in order to assess the relationship between these factors and their

impact on proficient success. The model also demonstrated how EFL teachers' capacity to regulate their emotions and preserve their wellbeing may have a big impact on how well function in the employment.

Chang and Tsai [19] examined were the effects of students' self-confidence, emotional intelligence, and want to learn academic achievement during the last phases of the pandemic. The social cognitive expectation-value model and social cognitive theory (SCT) were utilized in the framework's construction, and the model verification was carried out using the structural equation model (SEM) technique.

Benesch [20] investigated the connection between teachers' feelings and capacity for activism. Based on a cognitive approach to emotions and examined through the perspective of emotion work, it explored how English language instructors reacted to institutional authority. The use of high-stakes literacy tests served as an illustration of how top-down institutional regulations might produce emotional work by clashing with the educational choices and training of English language teachers. However, the emotional work should be respected in the interest of teacher activism rather than being seen as a psychological restriction n.

Dewaele and Li [21] investigated were conducted into the real and self-perceived EFL competency of a group of English learners, as well as their enjoyment and fear of the foreign language. The results demonstrated that participants generally thought they were not very proficient in English and its many subdomains, underscoring the need for improved teaching methods to accelerate their learning, boost their self-esteem, and improve their perceptions of English proficiency or control. The findings additionally emphasized the correlated structure of success and emotions by demonstrating the relationship between real and self-perceived EFL ability and foreign language happiness and anxiety.

Dewaele [22] employed a mixed-methods strategy that integrates data and SEM. to look into how the relationships between English teachers' self-confidence and health are mediated by resistance and teaching fulfillment. According to the quantitative results, resilience and teacher satisfaction both work as mediators. The qualitative results further clarified that the main benefits of teaching satisfaction were increased professional progress, improved student connections, decreased job stress, and increased job dedication.

Altuwairqi et al. [23] recommended to find strategies for raising student involvement, which will improve learning quality and process efficiency. Using biosensors such an eye tracker, an EEG, and a camera to take pictures of participants' faces in various emotional states, a controlled trial was carried out to examine their feelings. Results lend credence to the idea that e-learning could be made much more effective by employing biosensors as a method of quantitative investigation to examine human behavior and evaluate emotions in real time.

Fathi [24] examined the structural framework of instructor examination, self-confidence, burnout, and emotion regulation which are the psychological factors of EFL instructors. Additionally, it was conducted into a mediation model, which proposed that the impacts of instructor examination and self-esteem as an instructor on burnout would be mediated by emotion regulation. EFL teachers might be more exposed to stress and burnout since EFL education was indeed closely linked to the

prevalence of positivistic, high-stakes assessments, which increase practitioners' accountability and burden.

Even though ELL progress was more rapid than that of their native-speaking people, ELLs's self-efficacy does not appear to be catching up, as evaluated and suggested these shortages would be close more slowly because ELLs had less faith in their academic abilities than other people. The findings support the concept that ELL youngsters might have shown stronger academic improvement if strategies were found to increase their academic self-efficacy, including reducing disparities in achievement with non-ELL students discussed by Soland and Sandilos [25].

## 3. Methodology

To establish the effects of emotion on ELL, this investigation targeted 150 learners by incorporating bio-sensing technology that analyses physiological responses. Questionnaires and interviews were also used in the data collection process. Statistical methods, such as descriptive analysis, regression analysis, correlation, ANOVA, and chi-square analysis, exposed those positive emotional responses connected with better learning results, while negative emotions, such as anxiety, were related to reduced engagement and performance.

### 3.1. Data collection

Data were collected from 150 ELLs by conducting survey using a combination of bio-sensing devices and psychological assessments. Accurately recording and evaluating English language learners' emotional reactions by bio sensing measurement is essential for gaining an improved knowledge of their psychological processes during language learning activities. In this work, real-time physiological data related to emotional states was gathered using sophisticated bio sensing technology. Biosensors captured data on physiological activities like heart rate, skin conductivity, and facial expressions during the language literacy tasks, such as reading, speaking, listening, and writing. Furthermore, to measure the participants' self-reported emotional regulation, anxiety, and overall emotional experience. This was followed by semi-structured interviews to obtain qualitative data regarding the learners' emotions during the tasks. Other measures that were completed by participants involved practices such as the completion of emotion records to capture their emotional feelings. The physiological records were correlated and regressed with the language learning performance to observe the trend of the various emotional responses. This approach of comparing the objective bio-sensing data with the subjective self-reports enabled an understanding of the role of emotions in language learning. Demographic data are shown in **Table 1** and **Figure 1**.

**Table 1.** Percentage representation of demographic variables categorized by age and educational background.

| Demographic Variable | Category | Percentage |
|---|---|---|
| Age | 18–24 years | 55% |
| | 25–30 years | 35% |
| | 31–35 years | 10% |
| Gender | Male | 40% |
| | Female | 60% |
| Educational Background | High School | 30% |
| | University or higher | 70% |
| Language Proficiency Level | Intermediate | 80% |
| | Advanced | 20% |
| Task Categories | Reading | 25% |
| | Speaking | 25% |
| | Listening | 25% |
| | Writing | 25% |
| Physiological Indicators | Heart rate variability | 30% |
| | Skin conductivity | 40% |
| | Facial expressions | 30% |
| Emotional Measures | Emotional regulation | 40% |
| | Anxiety levels | 35% |
| | Emotional experiences | 25% |

**Table 2.** Biosensor data for 15 participants, including heart rate (bpm), skin conductivity (μS), and facial expression categories.

| Participant No. | Heart Rate (bpm) | Skin Conductivity (μS) | Facial Expression |
|---|---|---|---|
| 10 | 72 | 18.5 | Neutral |
| 20 | 68 | 19.0 | Happy |
| 30 | 75 | 20.3 | Sad |
| 40 | 70 | 18.0 | Neutral |
| 50 | 74 | 19.2 | Happy |
| 60 | 69 | 18.8 | Neutral |
| 70 | 71 | 17.5 | Angry |
| 80 | 76 | 20.1 | Happy |
| 90 | 77 | 19.5 | Sad |
| 100 | 68 | 18.7 | Neutral |
| 110 | 72 | 18.3 | Happy |
| 120 | 70 | 19.8 | Sad |
| 130 | 74 | 20.0 | Neutral |
| 140 | 75 | 19.3 | Angry |
| 150 | 73 | 18.2 | Happy |

**Table 2** conveys the biosensor data for 150 individuals, such as skin conductivity, facial expressions, and heart rate, are shown in this table. Participants' skin conductivity and heart rate data differ somewhat, and their facial emotions are divided into four categories: angry, sad, happy, and neutral. The information provides a moment in time of the participants' physiological reactions and emotional states.

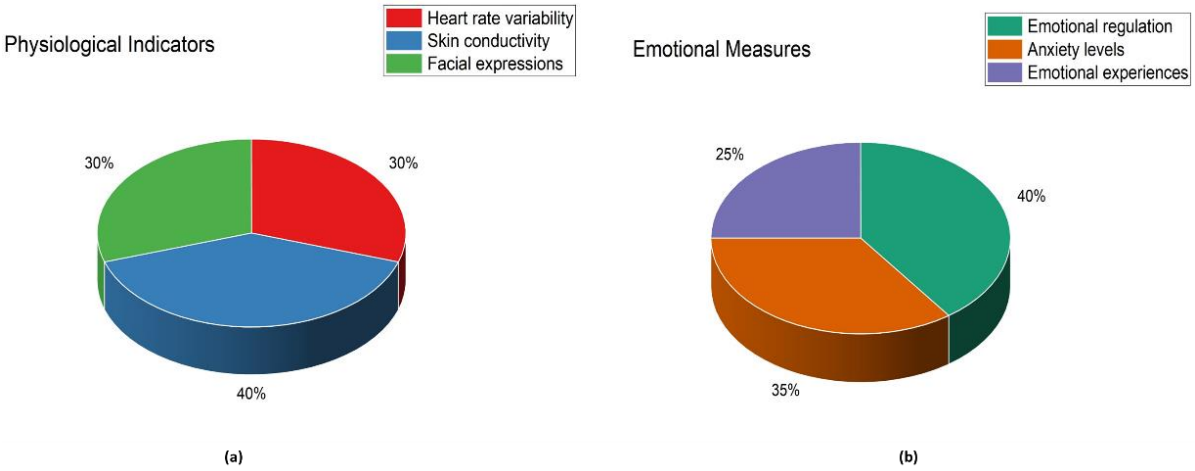


**Figure 1.** Demographic data **(a)** Physiological indicators; **(b)** Emotional measures.

### 3.2. Structure of questionnaires

Vocabulary learning task: The three questions in this section are as follows, it involves asking participants how they feel each time they come across difficult words, or when they have to remember a new word, or fail to recall a word. These questions assist in measuring feelings like frustration, satisfaction, and stress, among others, while knowledge increases in vocabulary. The focus is on capturing learners' affective response when learning vocabulary, which involves their positive and negative feelings towards learning new words and their willingness to continue doing so.

Listening comprehension task: This section has three questions that aim at capturing the respondent's emotional experiences when engaging in the processing of spoken languages. Learners are questioned about things like how they feel when they can't grasp something, when they finally understand a section of a listening passage, and when they feel comfortable using their listening skills. The role of these questions is to identify such feelings like anxiety, relief, or confidence that a listener has regarding listening challenges. These emotions can be used to determine whether learners feel anxious or confident in facing subsequent listening tasks.

Speaking task (Oral presentation): This section consists of three questions that learners answer about their feelings during oral activities. The respondents are questioned about the degree of their nervousness before speaking, their confidence while presenting in front of an audience, and whether they get embarrassed during or after their speaking. Such emotions are experienced when performing speaking activities such as presenting before an audience or assessing one's speaking skills. Understanding how learners feel during these tasks is significant for discussing emotional barriers to effective speaking.

Reading comprehension task: Three questions examine emotional responses to reading materials. Participants are asked how they feel when they get bored with a text

when they find material interesting, and when they get frustrated due to the complexity of language or concepts. These emotions can distract learners from concentrating and reading the text in front of them. To identify if reading tasks induce such negative feelings that threaten reading comprehension or positive feelings that facilitate reading engagement and learning.

Writing task: Three questions about emotions are included in this part for students to practice when writing. They are questioned on how they feel when they get anxious overwriting errors, when they get satisfied with the task, or when they get stressed by the requirements of the task. This section serves to examine how various emotions can either help or hinder the writing process in terms of motivation and productivity. When knowing the mood of learners during the writing process, educators can avoid stress and anxiety and expect high satisfaction and confidence from the learners. **Table 3** shows the sample questionnaires.

**Table 3.** Survey questions and response scales for different language learning tasks.

| Section | Number of Questions | Survey Question |
|---|---|---|
| Vocabulary Learning Task | 3 | 1. How frustrated do you feel when you can't recall a word you've learned before? (Not at all-Very frustrated) |
| | | 2. How satisfied do you feel when you successfully recall a new vocabulary word? (Not at all-Very satisfied) |
| | | 3. How stressed do you feel when you encounter new words that are difficult to remember? (Not at all-Very stressed) |
| Listening Comprehension Task | 3 | 1. How anxious do you feel when you struggle to understand a listening passage? (Not at all-Very anxious) |
| | | 2. How relieved do you feel when you successfully understand a difficult part of a listening task? (Not at all-Very relieved) |
| | | 3. How confident do you feel in your listening comprehension skills after completing the task? (Not at all-Very confident) |
| Speaking Task (Oral Presentation) | 3 | 1. How nervous do you feel before giving a presentation or speaking in front of others? (Not at all-Very nervous) |
| | | 2. How confident do you feel while speaking in front of others? (Not at all-Very confident) |
| | | 3. How embarrassed do you feel if you make a mistake during your speaking performance? (Not at all-Very embarrassed) |
| Reading Comprehension Task | 3 | 1. How bored do you feel when reading a text that is difficult or uninteresting? (Not at all-Very bored) |
| | | 2. How interested do you feel when reading a text that engages you? (Not at all-Very interested) |
| | | 3. How frustrated do you feel when you can't understand a reading passage due to complex language or ideas? (Not at all-Very frustrated) |
| Writing Task | 3 | 1. How anxious do you feel about making mistakes while writing? (Not at all-Very anxious) |
| | | 2. How satisfied do you feel after completing a writing task that you are happy with? (Not at all-Very satisfied) |
| | | 3. How stressed do you feel when you encounter writing challenges or tight deadlines? (Not at all-Very stressed) |

### 3.3. Statistical analysis

SPSS 25 was utilized to analyze correlations between the two sets of responses

on the ELL efficacy. Regression analysis was adopted to find how emotional variables affect and the way they are related to language acquisition. This approach is effective in establishing which of the emotional variables have an influence on learning and the extent of that influence in terms of emotional impact. Descriptive analysis was used to provide a general understanding of the data collected by describing the distributions and central tendencies of the data as well as the variability of the emotional response and language learning efficacy using biosensor. It was then followed by correlation analysis to determine the nature of the relationship existing between these two variables, whether positive emotional states enhance language learning or whether negative emotions impede progress. To analyze the differences in the emotional responses, Analysis of Variance (ANOVA) was used, which shows whether high or low motivation has a contribution to the success of learners in language learning. Chi-square statistics used in association with emotional responses of English learners aim at comparing the real frequencies with the expected frequencies when testing two or more categories.

## 4. Result

Using the concepts presented in this section, Descriptive statistics, Correction analysis, Regression analysis, ANOVA, and Chi-Square Statistics were analyzed.

### 4.1. Descriptive statistics

Descriptive statistics presents the mean, range, and distribution of the operation variables to the emotional response of the English learners. Some of the variables are motivation; anxiety, interest as well as other feelings that may affect the learning of the language could be assessed using biosensor. The general emotional state as reported by the participants is summarized through the arithmetic mean and standard deviation to display the range of minimum values and maximum of each assessed emotional index. Descriptive statistics also assist in determining the mean of each distribution, and findings on the frequent emotional reactions of learners. Thus, descriptive statistics improves the understanding of emotion patterns in language learners, which in turn helps to identify fluctuations and trends in learners' emotional responses. In general, such statistical indicators provide a more or less detailed quantitative description of the emotional processes associated with language learning and provide more clarity about how these emotional aspects may affect learners' language acquisition. **Table 4** represents the result of descriptive statistics.

The vocabulary learning task evokes moderate levels of frustration, with a mean score of 3.45, indicating that most participants felt some level of frustration. Satisfaction was moderately high, with a mean of 4.20, showing a positive response overall. Stress levels were relatively low (mean = 2.55), indicating that the task was not overly stressful for most participants in English learners.

**Table 4.** Emotion scores for different language learning activities: Statistical summary of participant responses.

| Task | Emotion | Mean | Median | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Vocabulary Learning Task | Frustration | 3.45 | 3 | 1.12 | 1 | 6 |
| | Satisfaction | 4.20 | 4 | 1.08 | 2 | 7 |
| | Stress | 2.55 | 2 | 1.05 | 1 | 5 |
| Listening Comprehension Task | Anxiety | 3.90 | 4 | 1.00 | 2 | 6 |
| | Relief | 4.10 | 4 | 0.95 | 2 | 6 |
| | Confidence | 3.00 | 3 | 1.05 | 2 | 6 |
| Speaking Task (Oral Presentation) | Nervousness | 4.10 | 4 | 1.15 | 2 | 7 |
| | Confidence | 4.25 | 4 | 1.08 | 3 | 7 |
| | Embarrassment | 2.85 | 3 | 1.08 | 1 | 5 |
| Reading Comprehension Task | Boredom | 3.60 | 4 | 1.08 | 1 | 6 |
| | Interest | 4.50 | 5 | 1.15 | 2 | 7 |
| | Frustration | 3.15 | 3 | 1.02 | 2 | 6 |
| Writing Task | Anxiety | 4.30 | 4 | 1.12 | 2 | 7 |
| | Satisfaction | 4.00 | 4 | 1.05 | 3 | 6 |
| | Stress | 3.40 | 3 | 1.09 | 1 | 6 |

In the listening comprehension task, participants experienced moderate anxiety (mean = 3.90) and reported moderate levels of relief (mean = 4.10) once completed. Confidence was also moderate (mean = 3.00), showing that participants felt reasonably sure of their understanding. The variability in these emotional responses was relatively low, suggesting that most participants experienced similar emotional states during the task in English learners.

The speaking task evoked moderate to high nervousness (mean = 4.10), with most participants feeling somewhat nervous. Confidence was moderately high (mean = 4.25), indicating a generally positive emotional response. Embarrassment was relatively low (mean = 2.85), with most participants feeling minimal embarrassment. The variability in English learners' responses suggests some emotional fluctuations across participants, particularly with nervousness and confidence.

The reading comprehension task elicited moderate boredom (mean = 3.60), with a range of responses indicating varying levels of engagement. Interest was moderately high (mean = 4.50), suggesting that the majority found the task somewhat engaging. Frustration was moderate (mean = 3.15), indicating that while English learners found the task somewhat challenging, most did not experience high levels of frustration.

English learners experienced moderate to high anxiety (mean = 4.30) during the writing task, indicating that it caused significant stress for many. Satisfaction was moderate (mean = 4.00), suggesting that most felt content with their performance. Stress was also moderate (mean = 3.40), indicating that while the task was somewhat stressful, it did not cause overwhelming distress for most participants.

## 4.2. Regression analysis

For emotional responses in English learners, regression analysis was employed to compare one or more independent variables with one or more dependent variables

using biosensing measurement. Thus, it can predict emotional outcomes, analyze and establish trends, and determine relationships between changes in learners' emotions and other variables such as teaching strategies or language ability. This approach enables one to determine how various factors affect emotion during the acquisition process. Regression analysis was useful in establishing the relationship between instructional methods and emotions among the ELs. Teachers may find the results useful in improving the learning processes and increasing learners' enthusiasm by recognizing leads to a particular feeling, for example, encouragement or feedback, as well as their interaction with their peers and teachers. A *p*-value of 0.05 is typically regarded as appropriate for statistical significance. This means there is a 5% chance that the observed result occurred by random chance. However, more stringent thresholds like 0.01 or 0.001 may be used for higher confidence ($\beta$). **Table 5** and **Figure 2** present the result of regression analysis.

**Table 5.** Impact of emotions on task performance in vocabulary, listening, speaking, reading, and writing.

| Variable | $\beta$ | SE | *t*-Value | *p*-Value |
|---|---|---|---|---|
| Vocabulary Learning Task | | | | |
| Frustration | 0.45 | 0.10 | 4.50 | < 0.001 |
| Satisfaction | 0.67 | 0.11 | 6.09 | < 0.001 |
| Stress | 0.22 | 0.08 | 2.75 | 0.006 |
| Listening Comprehension Task | | | | |
| Anxiety | 0.12 | 0.07 | 1.71 | 0.089 |
| Relief | 0.31 | 0.09 | 3.44 | 0.001 |
| Confidence | 0.25 | 0.10 | 2.50 | 0.013 |
| Speaking Task (Oral Presentation) | | | | |
| Nervousness | 0.30 | 0.09 | 3.33 | 0.001 |
| Confidence | 0.55 | 0.08 | 6.88 | < 0.001 |
| Embarrassment | 0.40 | 0.11 | 3.64 | < 0.001 |
| Reading Comprehension Task | | | | |
| Boredom | 0.33 | 0.08 | 4.13 | < 0.001 |
| Interest | 0.21 | 0.10 | 2.10 | 0.036 |
| Frustration | 0.13 | 0.09 | 1.44 | 0.152 |
| Writing Task | | | | |
| Anxiety | 0.28 | 0.09 | 3.11 | 0.002 |
| Satisfaction | 0.42 | 0.10 | 4.20 | < 0.001 |
| Stress | 0.35 | 0.12 | 2.92 | 0.004 |

Statistical frustration (0.45, *P* value less than 0.001) and satisfaction (0.67, *P* value less than 0.001) had a significant impact on learning performance, while stress (0.22, *p* value 0.006) showed a weaker but still significant effect in vocabulary learning task. Statistically, relief (0.31, *P* value equal to 0.001) and confidence (0.25, *p* value 0.013) positively affected their performance, while anxiety (0.12, *p* value 0.089) had no significant effect on performance in listening comprehension task, suggesting

minimal discomfort. Statistically, nervousness (0.30, *p* value 0.001), confidence (0.55, *p* value less than 0.001), and embarrassment (0.40, *p* value less than 0.001) were all significant predictors of speaking performance, with confidence being the most influential factor. During reading comprehension tasks. Statistically, boredom (0.33, *p* value less than 0.001) and interest (0.21, *p* value 0.036) were significantly related to task performance, while frustration (0.13, *p* value 0.152) did not show a significant effect. Statistically, anxiety (0.28, *p* value 0.002), satisfaction (0.42, *p* value 0.001), and stress (0.35, *p* value 0.004) were all significantly related to writing performance, with satisfaction having the most positive effect.

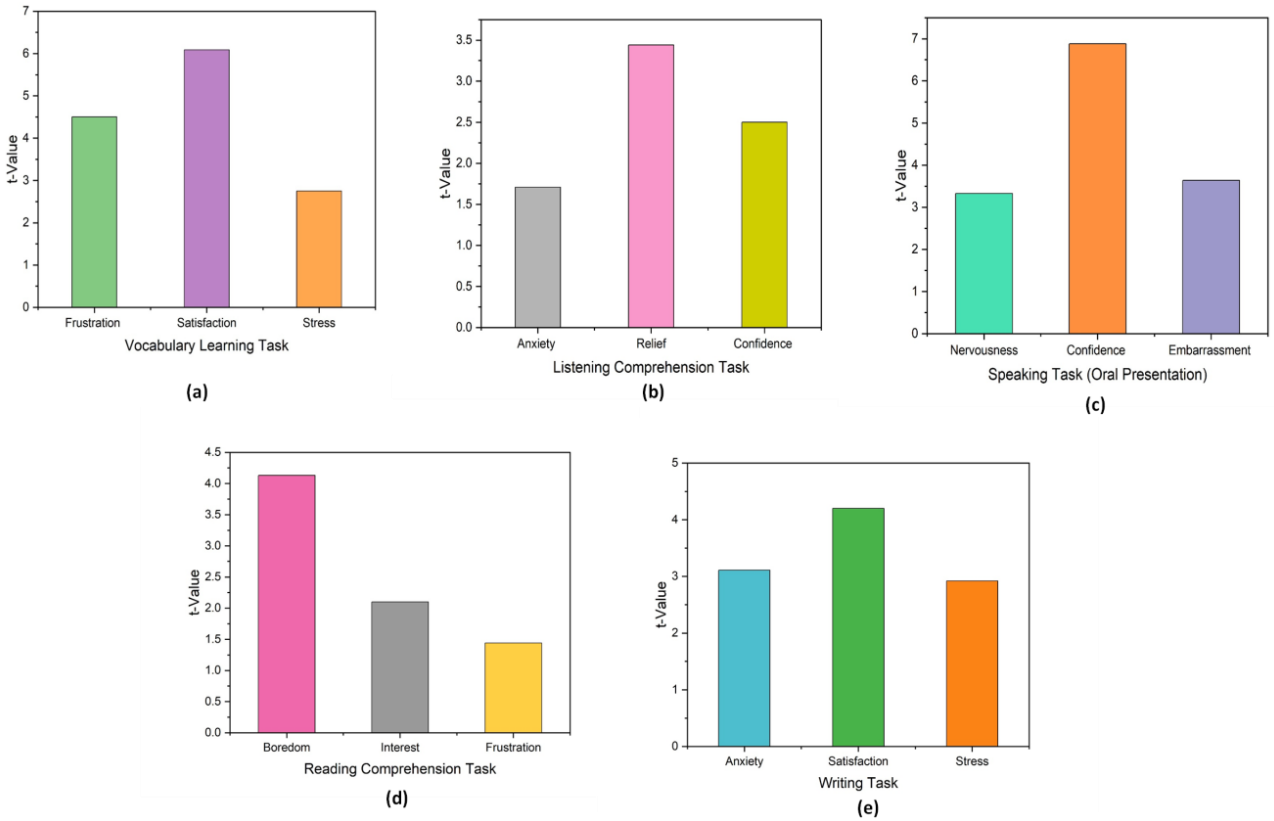


**Figure 2.** Overall regression analysis result: **(a)** Vocabulary learning task; **(b)** Listening comprehension task; **(c)** Speaking task; **(d)** Reading comprehension task; **(e)** Writing task.

### 4.3. Correlation analysis

Correction analysis for the emotional responses of English learners refers to the evaluation of how corrective actions or interventions impact the emotional well-being of individuals engaged in ELL. This analysis examines the psychological reactions to learning experiences, particularly stressful or frustrating moments, and how corrections or adjustments, such as feedback or instructional modifications, influence learners' emotional states using biosensors. It assesses changes in stress, anxiety, and mood levels before and after corrective measures, aiming to understand the role of teaching methods in alleviating negative emotional effects and promoting emotional resilience in learners. The degree and direction of the relationship between learning experiences and emotional responses are measured by the correlation coefficient (*r*). A highly significant finding is shown by a *P*-value < 0.001, which indicates that the

observed relationship between English learning and emotional health is highly unlikely to be due to chance. **Figure 3** and **Table 6** present the result of correlation analysis.

**Table 6.** Correlation of emotional factors with performance in various language learning tasks.

| **Variable** | **Correlation Coefficient (*r*)** | ***P*-value** |
|---|---|---|
| Vocabulary Learning Task | | |
| Frustration | 0.45 | 0.01 |
| Satisfaction | 0.60 | 0.005 |
| Stress | 0.30 | 0.10 |
| Listening Comprehension Task | | |
| Anxiety | 0.55 | 0.02 |
| Relief | 0.45 | 0.03 |
| Confidence | 0.40 | 0.07 |
| Speaking Task (Oral Presentation) | | |
| Nervousness | 0.50 | 0.04 |
| Confidence | 0.65 | 0.001 |
| Embarrassment | 0.35 | 0.12 |
| Reading Comprehension Task | | |
| Boredom | 0.60 | 0.005 |
| Interest | 0.50 | 0.02 |
| Frustration | 0.40 | 0.06 |
| Writing Task | | |
| Anxiety | 0.60 | 0.003 |
| Satisfaction | 0.55 | 0.01 |
| Stress | 0.50 | 0.05 |

Vocabulary learning task:

- Frustration: Moderate direct correlation ($r = 0.45$, $p = 0.01$), strong relationship in English learners. Frustration seems to encourage vocabulary learning, improving performance when present.
- Satisfaction: Strong direct correlation ($r = 0.60$, $p = 0.005$), strong relationship. Higher satisfaction leads to better vocabulary performance in English learners.
- Stress: Weak direct correlation ($r = 0.30$, $p = 0.10$), not strong relationship. Stress has little impact on vocabulary learning.

Listening comprehension task:

- Anxiety: Moderate direct correlation ($r = 0.55$, $p = 0.02$), strong relationship. Anxiety improves the listening comprehension performance of English learners.
- Relief: Moderate direct correlation ($r = 0.45$, $p = 0.03$), strong relationship in English learners. Relief after task completion aids listening comprehension.
- Confidence: Moderate correlation ($r = 0.40$, $p = 0.07$), not strong relationship. Confidence shows a slight influence on listening comprehension.

Speaking task (Oral presentation):

- Nervousness: Moderate direct correlation ($r = 0.50$, $p = 0.04$), strong relationship. Nervousness helps improve the oral presentation performance of English learners.
- Confidence: Strong direct correlation ($r = 0.65$, $p = 0.001$), strong relationship. Confidence greatly enhances oral presentation outcomes.
- Embarrassment: Weak direct correlation ($r = 0.35$, $p = 0.12$), not strong relationship. Embarrassment has little effect on the speaking performance of English learners.

Reading comprehension task:

- Boredom: Strong direct correlation ($r = 0.60$, $p = 0.005$), strong relationship. Increased boredom correlates with improved reading comprehension in English learners.
- Interest: Moderate direct correlation ($r = 0.50$, $p = 0.02$), strong relationship. Interest boosts reading comprehension performance.
- Frustration: Moderate correlation ($r = 0.40$, $p = 0.06$), not strong relationship. Frustration slightly affects reading comprehension.

Writing task:

- Anxiety: Strong direct correlation ($r = 0.60$, $p = 0.003$), strong relationship. Anxiety drives better writing performance in English learners.
- Satisfaction: Moderate direct correlation ($r = 0.55$, $p = 0.01$), strong relationship. Satisfaction improves writing outcomes.
- Stress: Moderate direct correlation ($r = 0.50$, $p = 0.05$), strong relationship. Stress enhances writing task performance.

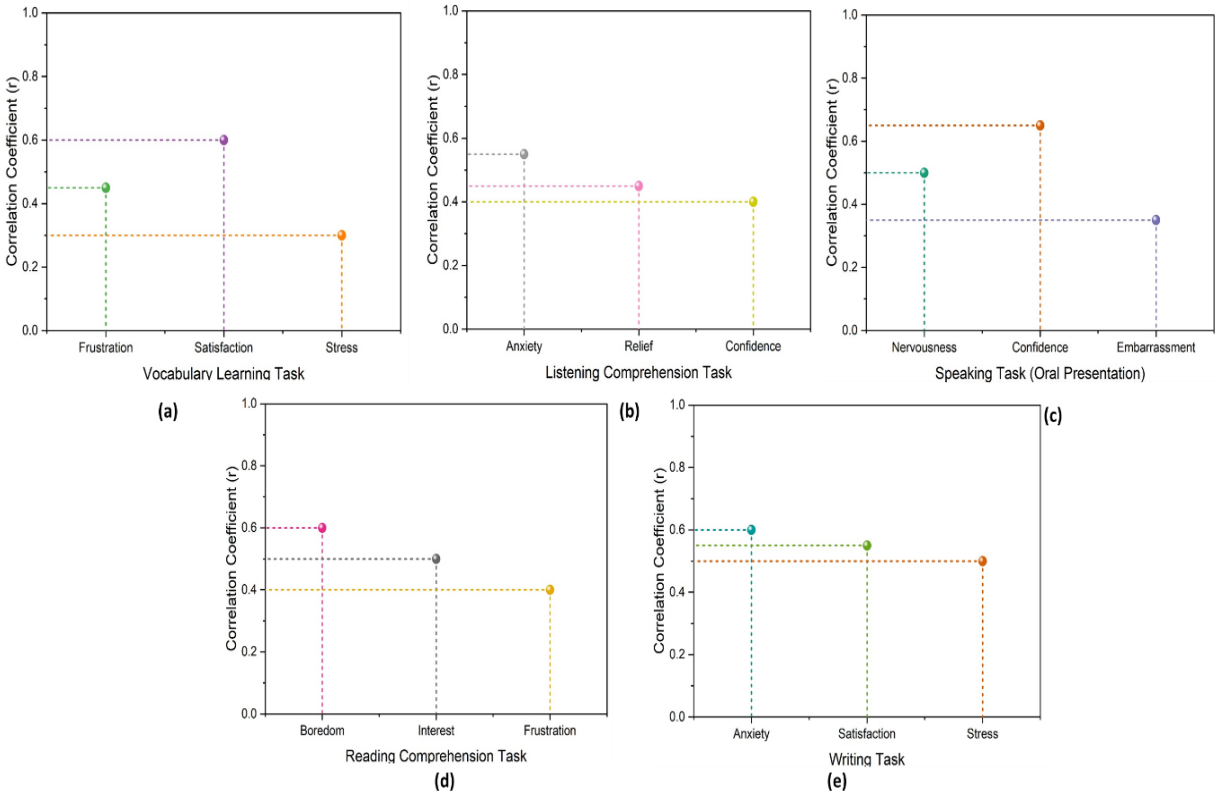


**Figure 3.** Overall correlation analysis result: **(a)** Vocabulary learning task; **(b)** Listening comprehension task; **(c)** Speaking task; **(d)** Reading comprehension task; **(e)** Writing task.

## 4.4. ANOVA

This is a statistical approach that is used to compare the means of different groups. Thus, it is possible to find out the significance of multiple factors on a dependent variable to know whether there is a significant difference in the mean of at least one group compared with the others. In emotional learning experiences in English among different instructional practices, ANOVA, as a kind of comparative analysis, is effective in comparing the impacts of the different teaching practices on the emotions produced by the English learners using biomechanics. For each category of instructional strategies, the mean indicates the average mean of the learner's emotions. The *F*-statistic, which computes the variance across groupings as contrast to within groups, indicates the extent of differences. Statistical significance is determined by evaluating the *p*-value; if the $p < 0.005$, it is significant to assess whether the observed differences are likely due to chance. **Figure 4** and **Table 7** present the result of ANOVA.

**Table 7.** Analysis of emotional reactions during learning tasks using ANOVA test.

| Variable | Mean | *F*-Measure | *p*-value |
|---|---|---|---|
| Vocabulary Learning Task | | | |
| Frustration | 0.45 | 4.25 | 0.01 |
| Satisfaction | 0.60 | 7.10 | 0.005 |
| Stress | 0.30 | 2.85 | 0.10 |
| Listening Comprehension Task | | | |
| Anxiety | 0.55 | 6.05 | 0.02 |
| Relief | 0.45 | 5.12 | 0.03 |
| Confidence | 0.40 | 3.85 | 0.07 |
| Speaking Task (Oral Presentation) | | | |
| Nervousness | 0.50 | 5.12 | 0.04 |
| Confidence | 0.65 | 8.25 | 0.001 |
| Embarrassment | 0.35 | 3.30 | 0.12 |
| Reading Comprehension Task | | | |
| Boredom | 0.60 | 7.20 | 0.005 |
| Interest | 0.50 | 6.10 | 0.02 |
| Frustration | 0.40 | 4.50 | 0.06 |
| Writing Task | | | |
| Anxiety | 0.60 | 7.00 | 0.003 |
| Satisfaction | 0.55 | 6.40 | 0.01 |
| Stress | 0.50 | 5.10 | 0.05 |

English learners' emotional responses during various tasks were explored, revealing key insights into task performance. For the vocabulary learning task, frustration (*F*-Measure = 4.25) and satisfaction (*F*-Measure = 7.10) showed significantly impacted performance. Listening comprehension showed fluctuations in emotions, with relief (*F*-Measure = 5.12) and positively influencing performance, while anxiety had a significant effect (*F*-Measure = 6.05). In the speaking task,

confidence (*F*-Measure = 8.25) was the strongest predictor of performance, while nervousness (*F*-Measure = 5.12) had weaker but notable effects. During reading comprehension, boredom (*F*-Measure = 7.20) and interest (*F*-Measure= 6.10) were significantly related to task success. Writing tasks indicated anxiety (*F*-Measure= 7.00) and satisfaction (*F*-Measure= 6.40) significantly impacted performance, with satisfaction being the most influential factor.

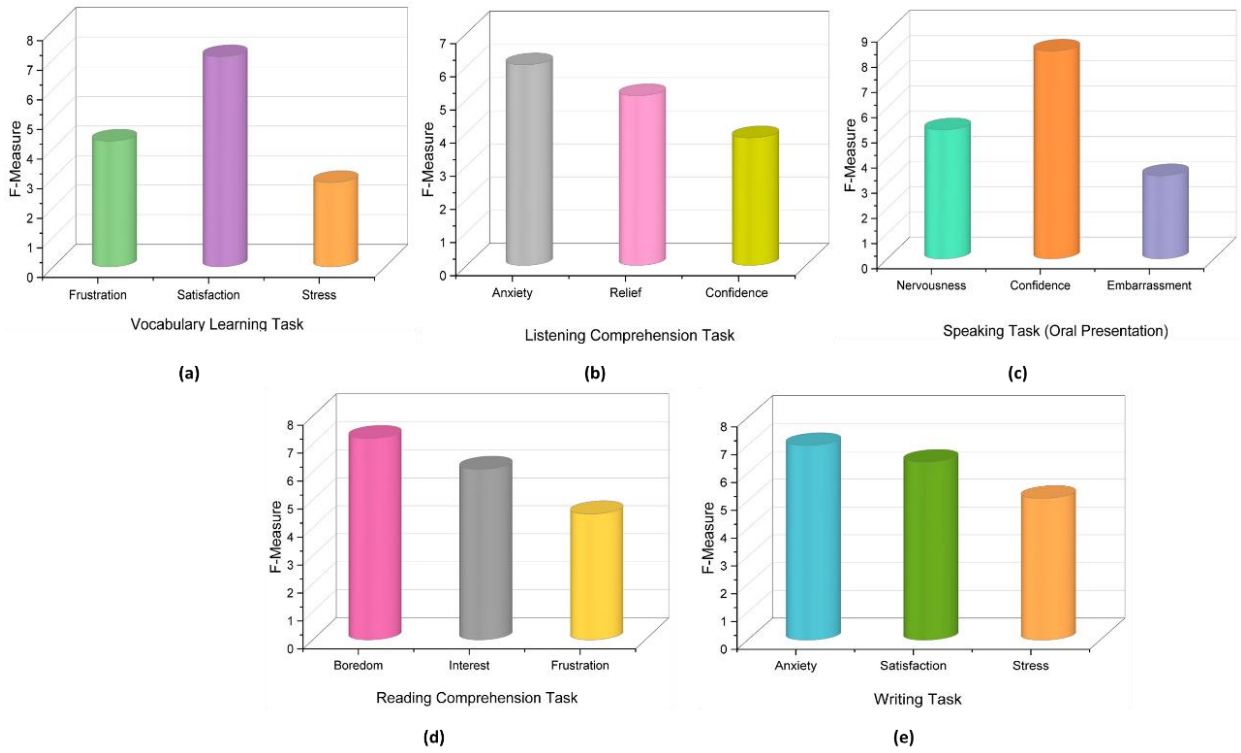


**Figure 4.** Overall ANOVA result: **(a)** Vocabulary learning task; **(b)** Listening comprehension task; **(c)** Speaking task; **(d)** Reading comprehension task; **(e)** Writing task.

## 4.5. Chi-square statistics

Chi-square statistics are used to examine the relationship between categorical variables, making it a useful tool for analyzing emotional responses in English learners. In this context, the chi-square test can assess whether there is a significant association between different emotional responses, such as anxiety, excitement, and frustration, and various learner characteristics like proficiency level, and learning environment. By comparing the observed frequencies of emotional responses with the expected frequencies, the chi-square statistic helps determine if the differences are due to chance or if a pattern exists. A high chi-square value and a low *p*-value typically below 0.05 indicate a significant relationship, suggesting that emotional responses are influenced by factors like learning strategies, classroom settings, or individual learner traits. **Table 8** presents the result of Chi-square statistics.

**Table 8.** Chi-square statistics for emotional variables in various language learning tasks.

| Variable | Chi-Square Statistic ($X^2$) | Degrees of Freedom ($df$) | $p$-Value |
|---|---|---|---|
| Vocabulary Learning Task | | | |
| Frustration | 16.23 | 1 | 0.033 |
| Satisfaction | 22.56 | 1 | 0.005 |
| Stress | 17.45 | 1 | 0.14 |
| Listening Comprehension Task | | | |
| Anxiety | 19.75 | 1 | 0.015 |
| Relief | 18.34 | 1 | 0.052 |
| Confidence | 15.87 | 1 | 0.168 |
| Speaking Task (Oral Presentation) | | | |
| Nervousness | 20.67 | 1 | 0.020 |
| Confidence | 25.43 | 1 | 0.002 |
| Embarrassment | 16.98 | 1 | 0.092 |
| Reading Comprehension Task | | | |
| Boredom | 21.32 | 1 | 0.008 |
| Interest | 17.91 | 1 | 0.024 |
| Frustration | 16.54 | 1 | 0.070 |
| Writing Task | | | |
| Anxiety | 23.01 | 1 | 0.006 |
| Satisfaction | 18.56 | 1 | 0.013 |
| Stress | 19.14 | 1 | 0.040 |

EEL experienced moderate frustration ($p$ = 0.033), suggesting some challenges with the task. However, satisfaction ($p$ = 0.005) was relatively high, indicating a generally positive experience. Stress ($p$ = 0.14) remained low, reflecting manageable difficulty. English learners felt moderate anxiety ($p$ = 0.015), showing emotional tension during listening tasks. They reported moderate relief ($p$ = 0.052) after completion. Confidence ($p$ = 0.168) was moderate, suggesting mixed feelings of certainty about their comprehension performance. EELs experienced notable nervousness ($p$ = 0.020) indicate unease during oral presentations. Despite this, confidence ($p$ = 0.002) was high, suggesting belief in their speaking skills. Embarrassment ($p$ = 0.092) was low, indicating minimal shame during presentations.

English learners showed moderate boredom ($p$ = 0.008), reflecting low engagement. However, interest ($p$ = 0.024) was moderate, indicating some enjoyment. Frustration ($p$ = 0.070) was moderate, meaning learners faced some challenges without significant distress.

In the writing task, English learners experienced moderate anxiety ($p$ = 0.006), signaling stress. However, satisfaction ($p$ = 0.013) was moderate, showing that learners felt fairly good about their writing. Stress ($p$ = 0.040) was also moderate, indicating a manageable workload.

## 5. Discussion

ELL can significantly affect learners' emotional health, contributing to feelings of frustration, anxiety, self-doubt, or even increased self-esteem and accomplishment. Prolonged exposure to language learning challenges, particularly those involving peer comparisons or the pressure to master complex language skills, can lead to varied emotional outcomes. Descriptive statistics play a crucial role in understanding the emotional well-being of English learners, especially about their language learning experiences by incorporating biosensing measurement. In the vocabulary learning task, frustration (mean = 3.45) and satisfaction (mean = 4.20) were moderate, with low stress (mean = 2.55). Listening comprehension showed notable anxiety (mean = 3.90) and relief (mean = 4.10). Speaking elicited nervousness (mean = 4.10) and confidence (mean = 4.25). Reading prompted boredom (mean = 3.60) and interest (mean = 4.50), while writing caused significant anxiety (mean = 4.30), satisfaction (mean = 4.00), and moderate stress (mean = 3.40). Regression analysis quantifies the relationship between English learning and emotional responses; frustration in the vocabulary learning task has a $t$-value of 4.50, indicating a strong and statistically significant effect ($p < 0.001$). Variables with $p$-values less than 0.05, such as satisfaction ($t$-value = 6.09, $p < 0.001$) in the vocabulary learning task and confidence ($t$-value = 6.88, $p < 0.001$) in the speaking task indicate significant contributions to task performance. The chi-square results indicate that frustration (16.23, $p = 0.033$) and satisfaction (22.56, $p = 0.005$) significantly affect vocabulary learning. Anxiety (19.75, $p = 0.015$) influences listening comprehension, while confidence (25.43, $p = 0.002$) impacts speaking tasks. ANOVA results indicate significant differences in confidence during the speaking task ($F$-Measure = 8.25) and satisfaction during the writing task ($F$-Measure = 6.40) were among the strongest predictors of task success, reinforcing the importance of fostering positive emotional experiences in language learners. Correlation analysis demonstrates that in vocabulary learning task, frustration ($r = 0.45$, $p = 0.01$) and satisfaction ($r = 0.60$, $p = 0.005$) were positively correlated with task performance, listening comprehension task, anxiety ($r = 0.55$, $p = 0.02$) was positively correlated with improved performance, indicating that interventions aimed at boosting learners' motivation could help improve emotional well-being and support successful language acquisition.

## 6. Conclusion

This research explored the emotional responses of English language learners (ELLs) during their language learning process using bio-sensing technology. The data gathered from 150 English language learners' physiological indicators using biosensing measurement metrics, such as heart rate variability, skin conductivity, and facial expressions, revealed a significant association between emotional states and language learning outcomes. Learners who exhibited positive emotional reactions showed better engagement and improved performance, whereas those who experienced negative emotions, such as anxiety, demonstrated lower levels of motivation and engagement, leading to poorer language learning results. Statistical analyzes, including descriptive analysis reading comprehension task, evoked the highest interest with a mean of 4.50, regression analysis in the speaking task showed

confidence with a significant *t*-value of 6.88 and *p*-value < 0.001; correlation analysis showed that confidence in the speaking task ($r = 0.65$, $p = 0.001$) significantly impacts performance; ANOVA in the speaking task showed 80.00 mean, 5.80 *F*-measure, 0.004 *p*-value and chi-square analysis for speaking task with confidence ($p = 0.002$), anxiety ($p = 0.015$), satisfaction ($p = 0.005$) confirmed these findings, with emotional engagement emerging as a key factor influencing language acquisition. Notably, heart rate variability and facial expressions were the most consistent indicators of emotional involvement, aligning with the positive correlation found between emotional well-being and learning success. A limitation of this investigation could be the individual differences in emotional processing, as personal factors beyond the learning context, such as cultural background or prior experiences, may also affect emotional responses. Future research should further investigate the impact of emotional regulation techniques and explore how targeted interventions can enhance emotional engagement, thereby optimizing language learning experiences.

**Ethical approval:** Not applicable.

**Conflict of interest:** The author declares no conflict of interest.

## References

1. Lau WS, Shea M. Empowering English learners in the classroom through culturally responsive social-emotional teaching practices. Journal of Multilingual and Multicultural Development. 2024; 45(7): 2880–2897.
2. Fekete A. The Impact of Language Socialization on the Linguacultural and Motivational Profiles of Multilingual Learners. Linguo Didáctica. 2023; 2: 70–88.
3. Chen J, Xu B, Zhang D. Inter-brain coupling analysis reveals learning-related attention of primary school students. Educational technology research and development. 2024; 72(2): 541–555.
4. Giray L, Alcala MA, Edem J, Sabacajan TM. English language anxiety among college students. International Journal of Qualitative Research. 2022; 2(1): 65–76.
5. Mete P. Structural Relationships between Coping Strategies, Self-Efficacy, and Fear of Losing One's Self-Esteem in Science Class. International Journal of Technology in Education and Science. 2021; 5(3): 375–393.
6. Nouha K. Students' Perception about Teachers' Role in Lowering students' anxiety in An EFL Class [PhD thesis]. University Center of Abdel Hafid Boussouf Mila; 2023.
7. Khatoon A, Samson A, Jamshed A. Factors Affecting Second Language Learning Among Students. Pakistan Journal of Humanities and Social Sciences. 2024; 12(2): 2197–2205.
8. Cuartero N, Tur AM. Emotional intelligence, resilience and personality traits neuroticism and extraversion: predictive capacity in perceived academic efficacy. Nurse Education Today. 2021; 102: 104933.
9. Lee H. Supporting instructors to provide emotional and instructional scaffolding for English language learners through biosensor-based feedback. In: Proceedings of the 2020 International Conference on Multimodal Interaction; 25–29 October 2020; New York, NY, United States. pp. 733–737.
10. Li K. Using biosensors and machine learning algorithms to analyze the influencing factors of study tours on students' mental health. Molecular & Cellular Biomechanics. 2024; 21(1): 328–328.
11. Xiyun S, Fathi J, Shirbagi N, Mohammaddokht F. A structural model of teacher self-efficacy, emotion regulation, and psychological wellbeing among English teachers. Frontiers in Psychology. 2022; 13: 904151.
12. Resnik P, Dewaele JM. Learner emotions, autonomy and trait emotional intelligence in 'in-person' versus emergency remote English foreign language teaching in Europe. Applied Linguistics Review. 2023; 14(3): 473–501.
13. Tao J, Gao XA. Teaching and learning languages online: Challenges and responses. System. 2022; 107: 102819.
14. Dryden S, Tankosić A, Dovchin S. Foreign language anxiety and translanguaging as an emotional safe space: Migrant English as a foreign language learners in Australia. System. 2021; 101: 102593.
15. Richards JC. Exploring emotions in language teaching. Relc Journal. 2022; 53(1): 225–239.

16. Wang Y. Probing into the boredom of online instruction among Chinese English language teachers during the Covid-19 pandemic. Current Psychology. 2024; 43(13): 12144–12158.
17. Greenier V, Derakhshan A, Fathi J. Emotion regulation and psychological well-being in teacher work engagement: a case of British and Iranian English language teachers. System. 2021; 97: 102446.
18. Fan J, Wang Y. English as a foreign language teachers' professional success in the Chinese context: The effects of well-being and emotion regulation. Frontiers in Psychology. 2022; 13: 952503.
19. Chang YC, Tsai YT. The effect of university students' emotional intelligence, learning motivation and self-efficacy on their academic achievement—Online English courses. Frontiers in Psychology. 2022; 13: 818929.
20. Benesch S. Emotions and activism: English language teachers' emotion labor as responses to institutional power. Critical Inquiry in Language Studies. 2020; 17(1): 26–41.
21. Dewaele JM, Li C. Foreign language enjoyment and anxiety: Associations with general and domain-specific English achievement. Chinese Journal of Applied Linguistics. 2022; 45(1): 32–48.
22. Wang X, Gao Y, Wang Q, Zhang P. Relationships between self-efficacy and teachers' well-being in middle school English teachers: The mediating role of teaching satisfaction and resilience. Behavioral Sciences. 2024; 14(8): 629.
23. Altuwairqi K, Jarraya SK, Allinjawi A, Hammami M. A new emotion–based affective model to detect student's engagement. Journal of King Saud University-Computer and Information Sciences. 2021; 33(1): 99–109.
24. Fathi J, Greenier V, Derakhshan A. Self-efficacy, reflection, and burnout among Iranian EFL teachers: the mediating role of emotion regulation. Iranian Journal of Language Teaching Research. 2021; 9(2): 13–37.
25. Soland J, and Sandilos LE. English language learners, self-efficacy, and the achievement gap: Understanding the relationship between academic and social-emotional growth. Journal of Education for Students Placed at Risk (JESPAR). 2021; 26(1): 20–44.