# Comparison of Nervousness Levels in Interpersonal and ChatGPT-based Learning for Cambodian Language Acquisition

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**Abstract.** In recent years, learning support tools that use generative artificial intelligence (AI) technologies have garnered significant attention as a means of providing personalized learning experiences. When learning a new language, psychological burdens such as the "fear of making mistakes" and "anxiety in interpersonal communication" have been identified as major obstacles to effective learning. This study evaluates differences in anxiety levels between interpersonal and generative AI-based learning by measuring brain activity using electroencephalography. The results indicate that interpersonal learning tends to induce higher levels of anxiety, particularly during the initial stages, even though this anxiety diminishes with repeated sessions. In contrast, ChatGPT-based learning tends to suppress anxiety, even in the early stages. These results suggest that ChatGPT is an effective tool for reducing anxiety in second language acquisition. In particular, the experimental results demonstrate that ChatGPT can serve as a means for learners who feel anxious about interpersonal learning to continue their studies in a more relaxed state.

**Keywords:** Generative AI · ChatGPT · Second Language Learning · Khmer Language · Nervousness Level.

## 1 Introduction

With the widespread adoption of online learning tools, second language acquisition methods have undergone significant transformation. In particular, learning support tools that leverage generative artificial intelligence (AI) technologies have attracted considerable attention as a means of providing personalized

learning experiences. These technological advancements have enabled learners to study anytime and anywhere, making such tools particularly promising in regions and for languages where educational resources are limited.

However, when focusing on less commonly studied languages such as Khmer (Cambodian), a lack of sufficient teaching materials and structured educational environments remains a major challenge. In addition, psychological burdens, such as fear of making mistakes and anxiety in interpersonal communication, have been identified as obstacles to effective language learning. In face-to-face learning environments, the pressure of directly interacting with teachers or peers can negatively impact learning efficiency and continuity.

In contrast, online learning tools powered by generative AI offer a learning environment free from direct human interaction, potentially alleviating psychological stress. However, empirical research examining the extent to which these tools affect learning efficiency and psychological factors is still limited. In addition, there is a lack of systematic studies comparing levels of anxiety and learning outcomes between interpersonal learning and online learning platforms.

This study bridges this gap by experimentally comparing generative AI-based learning tools (specifically, ChatGPT) and interpersonal learning. Focusing on the context of Khmer language acquisition, this study measures learner anxiety levels and explores both the potential benefits and limitations of generative AI-based online learning.

## 2 Previous work

### 2.1 Second Language Learning Anxiety

Anxiety in second language learning has been extensively studied as a psychological barrier that impedes learners' progress [1]. Spielberger defined anxiety as "subjective tension and worry caused by autonomic nervous system activation," which positions it as a crucial factor in the context of language learning. Based on this theory, Bailey investigated the effects of interpersonal anxiety in classroom settings and found that elevated anxiety levels typically hinder learning performance. In East Asian educational contexts, frequent instances of classroom silence are observed, which are attributed to learners' interpersonal anxiety.

In addition, Motoda [2] categorized second language anxiety into "in-class anxiety" and "out-of-class anxiety" and analyzed their respective characteristics in detail. His findings revealed that in-class anxiety primarily stems from direct interactions with others, whereas out-of-class anxiety is primarily associated with adaptation to environments in which the target language is spoken. In addition, Harumi suggested that silence in the classrooms of Japanese learners of English may not merely indicate shyness or a lack of motivation but rather function as a psychological defense mechanism aimed at reducing anxiety. These studies collectively highlight the direct impact of anxiety on learners' academic performance and the importance of addressing emotional and psychological factors in second language education.

### 2.2 Advantages and Challenges of Online Learning

The rapid spread of COVID-19 has prompted educational institutions worldwide to adopt online learning at an unprecedented pace. This shift has facilitated the widespread implementation of educational formats distinct from conventional face-to-face instruction, thereby accelerating the digital transformation of education. Sugino [3] investigated the challenges faced by educational institutions and the insights gained from students' perspectives during this transition. The significance of this study lies in its systematic analysis of the effectiveness and limitations of online learning, not merely as a temporary solution but as a sustainable modality of education for the future.

Sugino's study identified several key advantages of online learning as perceived by students. Chief among these is the ability to study at one's own pace, a benefit particularly valuable for learners who require repeated review to deepen their understanding. The availability of recorded lectures allows students to revisit complex content multiple times, thereby enhancing their knowledge retention. Additional benefits include time and spatial flexibility, such as the elimination of commuting and the ability to attend classes from home. These advantages are particularly meaningful for students with busy schedules or those who would otherwise need to travel long distances. In addition, during the pandemic, online learning was extensively appreciated for providing a safe learning environment and minimizing the risk of infection.

However, several challenges associated with online learning have also been identified. The feeling of isolation stemming from the inability to meet teachers and peers has been cited as the most significant drawback. Although face-to-face instruction fosters learning through interpersonal interactions, online environments typically restrict such opportunities, potentially reducing learners' motivation. Students also frequently report difficulties in maintaining concentration and staying motivated, highlighting the self-regulated nature of online learning. Additional concerns include the difficulty of asking questions or making comments during class and the lack of immediate feedback from instructors, which can hinder the learning process in an online setting.

## 3 Proposed Method

This study investigated differences in anxiety levels experienced during second language learning in face-to-face settings versus interactions with ChatGPT through brainwave activity measurements. Specifically, electroencephalography (EEG) data were collected using the wearable EEG device FocusCalm in conjunction with the brainwave monitoring application GoodBrain. FocusCalm is a headband-style wearable device that records brain activity, and it communicates with the GoodBrain application via Bluetooth to enable real-time EEG measurements.

To evaluate anxiety, this study focuses on the $\beta$ (beta) wave component of EEG signals. Beta waves are generally associated with concentration and nervousness levels, with higher beta wave activity typically indicating a higher state

of tension or arousal. In this study, the learning experiment was conducted over approximately one month. Each participant engaged in 10 learning sessions: five sessions in a face-to-face learning environment and five sessions using ChatGPT. The content of the lessons remained consistent under both conditions, allowing for a direct comparison of anxiety-related changes attributable to the different learning environments.

## 4 Experiment

### 4.1 Overview of Experiment

This study investigated the differences in anxiety levels between interpersonal learning and ChatGPT-based learning in the context of second language acquisition. The experiment was conducted with a university student who had no prior experience in learning the Khmer language. Although two students initially participated, data from one participant were excluded due to failure in EEG data recording. The participant engaged in both interpersonal learning and ChatGPT-based learning sessions during which changes in anxiety levels under each learning condition were measured. In the interpersonal learning sessions, the participant interacted with a teacher in a face-to-face dialog-based format. In the ChatGPT-based learning sessions, the participant engaged in conversational learning through interactions with ChatGPT. Over one month, the participant completed five interpersonal sessions and five ChatGPT-based sessions, totaling 10 learning sessions.

### 4.2 Experimental Procedure

In each learning session, the participant engaged in conversational practice depending on the learning condition. Under the interpersonal learning condition, the participant practiced speaking with a Khmer language instructor located in Cambodia via a real-time online conferencing system. Under the ChatGPT-based learning condition, the participant interacted directly with ChatGPT in a dialog-based format to proceed with the learning tasks. The content of the conversational practice for each session is summarized in Table 2. Five conversational sessions were conducted under each condition. All learning sessions were standardized to a 30-min duration.

### 4.3 Implementation of ChatGPT-Based Learning

During the ChatGPT-based learning sessions, the voice conversation feature of the ChatGPT smartphone application was used, enabling spoken dialogue instead of text-based input. The sessions used the GPT-4o version. Each session began with specific instructions, followed by conversation-based learning, as detailed in the table below.

**Table 1.** Contents of each learning session

| Session | Learning Content |
|---|---|
| 1st | Basic vocabulary and greetings |
| 2nd | Simple self-introduction |
| 3rd | Dialogue involving questions and responses |
| 4th | Sentence construction |
| 5th | Practical conversation |

**Table 2.** Specific instruction to give to ChatGPT

| Session | Specific Instructions |
|---|---|
| 1st | "Explain basic vocabulary and greeting expressions in Cambodian (Khmer) for beginners, while providing explanations in Japanese and including pronunciation guides." |
| 2nd | "Present example sentences in Japanese with their Cambodian (Khmer) translations to help learners practice simple self-introductions in Cambodian. Additionally, provide practice exercises for reinforcement." |
| 3rd | "Present simple questions in Cambodian (Khmer), followed by example responses in the same language. Structure the interaction to allow learners to effectively imitate the dialogues." |
| 4th | "Generate practice tasks where learners convert information provided in Japanese into Cambodian (Khmer) sentences, including sample problems to support the learning process." |
| 5th | "Perform role-playing conversations in Cambodian (Khmer) that simulate everyday situations, encouraging learners to engage in natural, context-based dialogue." |

### 4.4 Data Collection Method

EEG data were collected using a consumer-grade brainwave device, FocusCalm. The device was paired with the brainwave monitoring application GoodBrain, which was installed on a tablet or smartphone, to facilitate data acquisition. During data collection, the experimenter operated the tablet with great care to avoid any influence on the participant's learning experience. EEG measurements were performed at three specific time intervals within each session: 0–5 min, 15–20 min, and 25–30 min. Importantly, the data were recorded in real time without interrupting the learning activities, thereby ensuring a natural and continuous learning environment during EEG acquisition.


**Fig. 1.** Simple EEG （FocusCalm）

## 5 Experimental Results

### 5.1 Post-Experiment $\beta$ Wave Activity

The EEG data collected from the participant across the three time intervals are presented in Table 3.

The average $\beta$ wave values in each session are presented in Table 4. These values are not simple averages of the three time intervals listed in Table 3 but rather represent the mean of the raw EEG data recorded continuously during the three time periods within each session. For analysis and to simplify interpretation while avoiding excessive multiple comparisons, the session-level average data in Table 4, rather than the segmented data in Table 3, are used in subsequent sections.

The data in Table 4 are visualized in Figure 2. This figure shows a comparative line graph illustrating the changes in average $\beta$ wave activity for each session under both interpersonal and ChatGPT-based learning conditions. As shown in Figure 2, the average $\beta$ wave value during the first interpersonal session was the highest among all sessions. In the second interpersonal session, the value was lower than that in the first session. The third session exhibited an even lower value than the first and second sessions. This downward trend continued in the fourth and fifth sessions, with the fifth session recording the lowest average $\beta$ wave value observed under the interpersonal condition. These results suggest a clear trend of decreasing $\beta$ wave activity as the number of interpersonal learning sessions increased, indicating a gradual reduction in anxiety over time.

In contrast, the ChatGPT-based sessions exhibited a relatively stable pattern. The first session exhibited a moderate level of $\beta$ wave activity. The second

**Table 3.** Average $\beta$ wave values by time interval for each session

| Time Interval | Interpersonal | ChatGPT-based |
|---|---|---|
| Session 1 (0–5 min) | 0.0556 | 0.0304 |
| Session 1 (15–20 min) | 0.0522 | 0.0364 |
| Session 1 (25–30 min) | 0.0561 | 0.0401 |
| Session 2 (0–5 min) | 0.0508 | 0.0394 |
| Session 2 (15–20 min) | 0.0420 | 0.0369 |
| Session 2 (25–30 min) | 0.0511 | 0.0361 |
| Session 3 (0–5 min) | 0.0363 | 0.0325 |
| Session 3 (15–20 min) | 0.0381 | 0.0282 |
| Session 3 (25–30 min) | 0.0404 | 0.0313 |
| Session 4 (0–5 min) | 0.0334 | 0.0281 |
| Session 4 (15–20 min) | 0.0343 | 0.0348 |
| Session 4 (25–30 min) | 0.0340 | 0.0427 |
| Session 5 (0–5 min) | 0.0331 | 0.0480 |
| Session 5 (15–20 min) | 0.0319 | 0.0435 |
| Session 5 (25–30 min) | 0.0350 | 0.0432 |

session exhibited a slight increase compared with the first session. The third session exhibited the lowest value among the ChatGPT sessions. The fourth session exhibited approximately the same $\beta$ wave activity as the third session, whereas the fifth session exhibited the highest value under the ChatGPT-based learning condition. Overall, the $\beta$ wave activity in the ChatGPT-based sessions remained relatively consistent, with a slight upward shift in the final session.

## 6 Analysis

In this section, statistical analyses are performed based on the experimental results. The primary objective is to investigate trends in changes in tension levels, which are represented by $\beta$ wave activity, during interpersonal learning and ChatGPT-based learning. In addition, comparative analysis is performed to evaluate the effects of each learning modality on anxiety levels. Through this analysis, we explore how each instructional method influences learners' psychological responses during second language acquisition.

**Table 4.** Average $\beta$ wave values per session

| Session | Interpersonal | ChatGPT-based |
|---|---|---|
| Session 1 | 0.0546 | 0.0356 |
| Session 2 | 0.0479 | 0.0375 |
| Session 3 | 0.0382 | 0.0307 |
| Session 4 | 0.0339 | 0.0352 |
| Session 5 | 0.0333 | 0.0449 |

### 6.1 Changes in Anxiety Levels During Interpersonal and ChatGPT-based Learning

To begin the analysis, we separately examined whether tension levels (as indicated by $\beta$ wave activity) changed statistically across repeated sessions under each learning condition: interpersonal and ChatGPT-based. Visual inspection of the raw $\beta$ wave data suggested that the distributions followed a normal distribution. Pairwise comparisons were performed between all five sessions (Session 1–5); thus, it was necessary to apply a correction for multiple comparisons. Therefore, we employed Tukey's honestly significant difference (HSD) test, a parametric multiple comparison method, to assess the statistical significance of differences across session means.

The results of the Tukey HSD test for the interpersonal and ChatGPT-based learning sessions are presented in Tables 5 and 6, respectively.

**Table 5.** Tukey HSD test results for interpersonal learning sessions

| Comparison | $p$-value | Significance |
|---|---|---|
| Interpersonal 1 vs. 2 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 1 vs. 3 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 1 vs. 4 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 1 vs. 5 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 2 vs. 3 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 2 vs. 4 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 2 vs. 5 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 3 vs. 4 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 3 vs. 5 | 9.653E-007 | Significant ($p \leq 0.001$) |
| Interpersonal 4 vs. 5 | 0.5496 | Not significant ($p > 0.05$) |

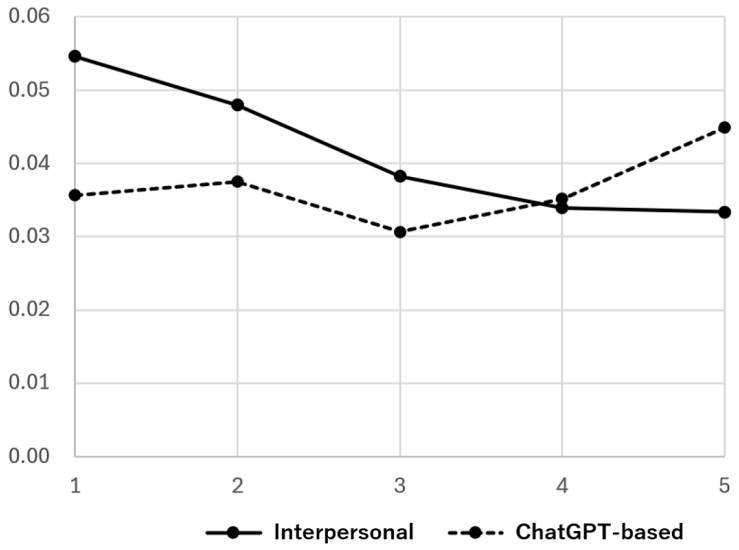


**Fig. 2.** Changes in $\beta$ wave activity during interpersonal and ChatGPT-based learning sessions

With regard to interpersonal learning, as shown in Table 5, there was no statistically significant difference in $\beta$ wave activity between Sessions 4 and 5. However, all other session pairs exhibited significant differences. These results suggest that the anxiety levels decreased significantly with repeated exposure to the interpersonal learning environment and began to stabilize in the fourth session. During Sessions 1–3, the participant may have experienced heightened psychological stress as part of the adaptation process to a new language environment, resulting in elevated $\beta$ wave activity. As the number of learning sessions increased, the participant appeared to become more accustomed to the setting, resulting in a measurable reduction in anxiety. The absence of a significant difference between Sessions 4 and 5 implies that approximately four interpersonal sessions are sufficient for learners to reach a state of emotional stability, where anxiety no longer continues to decline and instead levels off.

In contrast, the results for ChatGPT-based learning (Table 6) revealed no statistically significant difference in $\beta$ wave activity between Sessions 1 and 4. However, all other pairwise comparisons exhibited significant differences. These results suggest that, unlike the steady decline observed under the interpersonal learning condition, the anxiety levels during ChatGPT-based learning fluctuated over time and ultimately stabilized. Rather than exhibiting a linear decrease, the $\beta$ wave values in the ChatGPT sessions varied within a certain range across sessions. This nonlinear pattern indicates that the participant's anxiety did not progressively diminish with repeated exposure to the AI agent but rather increased and fell intermittently. One possible explanation for this variation is the

**Table 6.** Tukey HSD test results for ChatGPT-based learning sessions

| Comparison | $p$-value | Significance |
|---|---|---|
| ChatGPT 1 vs. 2 | 9.653E-007 | Significant ($p \leq 0.001$) |
| ChatGPT 1 vs. 3 | 9.653E-007 | Significant ($p \leq 0.001$) |
| ChatGPT 1 vs. 4 | 0.8716 | Not significant ($p > 0.05$) |
| ChatGPT 1 vs. 5 | 9.653E-007 | Significant ($p \leq 0.001$) |
| ChatGPT 2 vs. 3 | 9.653E-007 | Significant ($p \leq 0.001$) |
| ChatGPT 2 vs. 4 | 9.653E-007 | Significant ($p \leq 0.001$) |
| ChatGPT 2 vs. 5 | 9.653E-007 | Significant ($p \leq 0.001$) |
| ChatGPT 3 vs. 4 | 9.653E-007 | Significant ($p \leq 0.001$) |
| ChatGPT 3 vs. 5 | 9.653E-007 | Significant ($p \leq 0.001$) |
| ChatGPT 4 vs. 5 | 9.653E-007 | Significant ($p \leq 0.001$) |

participant's psychological response during the process of adapting to conversational interactions with generative AI. These fluctuations reflect a combination of initial curiosity, cognitive load, uncertainty in interpreting AI responses, and evolving perceptions of interaction quality. Therefore, although ChatGPT-based learning may reduce certain types of interpersonal pressure, it introduces its set of psychological dynamics that manifest as variability in anxiety levels.

### 6.2 Comparison Between Interpersonal and ChatGPT-based Learning

Next, we evaluated differences in anxiety levels between interpersonal and ChatGPT-based learning during the initial phase (Sessions 1–3). As shown in Figure 3, independent $t$-tests were conducted for the following pairs: Interpersonal Session 1 vs. ChatGPT Session 1, Interpersonal Session 2 vs. ChatGPT Session 2, and Interpersonal Session 3 vs. ChatGPT Session 3. The results of these comparisons are summarized in Table 7. Given that three separate hypothesis tests were conducted, the Bonferroni correction was used to control the family-wise error rate. Accordingly, the significance level of $\alpha = 0.05$ was adjusted by dividing it by the number of comparisons ($n = 3$), resulting in a corrected threshold of $\alpha = 0.0167$ for determining statistical significance.

As shown in Table 7, significant differences in $\beta$ wave activity were observed between Interpersonal Session 1 and GPT Session 1 and Interpersonal Session 2 and GPT Session 2. In contrast, no significant difference was observed between Interpersonal Session 3 and GPT Session 3. These results indicate that at the early stages of learning (Sessions 1 and 2), anxiety levels were significantly higher under the interpersonal learning condition than under the ChatGPT-based condition. However, in Session 3, this difference was no longer statistically

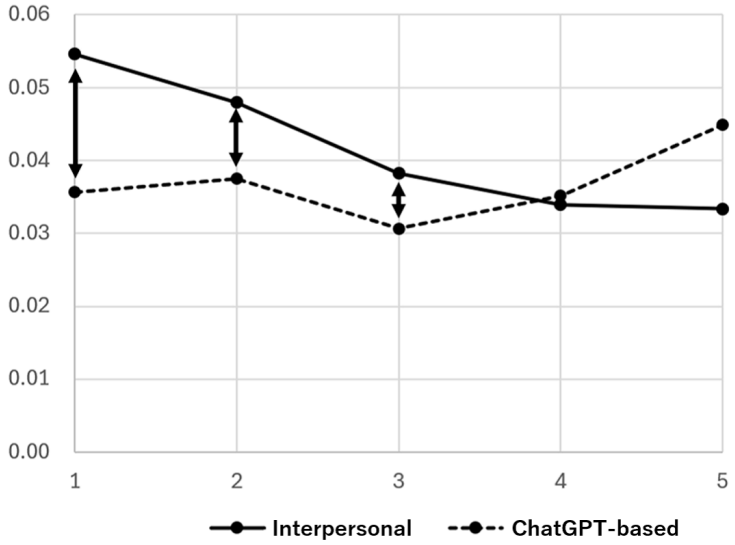


**Fig. 3.** Comparison of $\beta$ wave activity between interpersonal and ChatGPT-based learning during the first three sessions

**Table 7.** Statistical comparison between interpersonal and ChatGPT-based learning

| Comparison | $p$-value | Significance |
|---|---|---|
| Interpersonal 1 vs. GPT 1 | 0.004 | Significant ($p \leq 0.0167$) |
| Interpersonal 2 vs. GPT 2 | 0.012 | Significant ($p \leq 0.0167$) |
| Interpersonal 3 vs. GPT 3 | 0.061 | Not significant ($p > 0.0167$) |

significant, suggesting that the tension experienced in interpersonal learning decreased over time and converged, with more stable anxiety levels observed in ChatGPT-based learning.

These results confirm that anxiety levels are higher under interpersonal learning conditions at the early stages of learning. This is likely due to the psychological burden associated with interacting with a human counterpart, such as the fear of making mistakes or being judged. In contrast, the lower anxiety levels observed in the ChatGPT-based learning sessions can be attributed to the fact that the conversational partner is an AI agent, which may reduce the fear of failure and social evaluation. As the learning sessions progressed, the participant gradually adapted to the interpersonal learning environment, resulting in a decrease in anxiety and the difference in tension levels between the two learning modalities. By Session 3, no statistically significant difference was observed between the two conditions, indicating convergence of anxiety levels over time. An

increase in $\beta$ wave activity was observed in Session 5 under the ChatGPT-based learning condition. This increase in tension may have been caused by external or contextual factors unrelated to the learning method. However, this anomaly was not investigated in detail, because no follow-up survey or qualitative feedback was conducted. Further studies incorporating post-session questionnaires may help clarify such irregularities in future research.

## 7 Conclusion and Future Work

In this study, we evaluated the levels of anxiety experienced during Khmer language learning by comparing interpersonal and ChatGPT-based learning sessions using brainwave ($\beta$ wave) measurements as an objective indicator. The results reveal that interpersonal learning tends to elicit higher anxiety, particularly during the initial stages, whereas ChatGPT-based learning tends to suppress such tension. In addition, a reduction in anxiety was observed across repeated interpersonal sessions, suggesting that learners gradually adapt to human interaction over time. These results suggest that ChatGPT may serve as an effective tool for reducing anxiety in second language learning. In particular, for learners who feel anxious about face-to-face interactions, ChatGPT can offer a more relaxed and sustainable learning environment, particularly during the early phases of language acquisition.

In future work, increasing the number of participants is essential to improve the reliability and generalizability of the results. Incorporating additional physiological indicators, such as heart rate variability, will provide a more comprehensive understanding of the learner's psychological state. In addition, further investigation is required to explore the relationship between anxiety levels and long-term learning outcomes. Understanding whether reduced anxiety translates into better retention or proficiency gains will add valuable insights to the pedagogical implications of AI-assisted language learning. Finally, it is important to explore how the combination of interpersonal and ChatGPT-based learning can be optimized. A hybrid approach may leverage the strengths of both modalities, providing low-anxiety practice opportunities through AI while gradually building confidence for real-world interpersonal communication.

## Research ethics

All experiments were approved by the Research Ethics Committee of Shonan Institute of Technology. The authors also received written informed consent from the participants and their parents or guardians.

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