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Interoceptive–Affective Calibration in Second-Language Classrooms: A Conceptual Framework for Understanding Speaking Performance

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Abstract: Students 'ability to demonstrate second-language knowledge in a classroom does not always match what they can retrieve during private study. Speaking tasks are especially sensitive to social evaluation, time pressure, uncertainty, and the learner's interpretation of bodily arousal. Although research has separately examined stress and memory, foreign-language anxiety, working memory, and interoception, these strands are not yet routinely integrated into classroom-level models of moment-to-moment speaking performance. This conceptual article proposes an interoceptive–affective calibration framework: a model in which learners interpret internal bodily signals (such as changes in heart rate, breathing, muscle tension, and visceral sensation), appraise the situation, and allocate attention between communicative goals and self-monitoring. The framework does not assume that bodily arousal is inherently harmful. Instead, it proposes that performance depends partly on whether arousal is interpreted as manageable activation or as evidence of threat, and on whether learners can redirect attention toward meaning and retrieval. The article synthesises relevant work on stress and memory, second-language anxiety, cognitive load, emotion regulation, and interoceptive awareness. It identifies a research opportunity at the intersection of these fields and outlines testable hypotheses, feasible classroom measures, and ethical considerations. The proposed model is intended to guide empirical investigation rather than to present untested mechanisms as established facts.

Keywords: educational neuroscience; interoception; second-language learning; foreign-language anxiety; speaking performance; working memory; emotion regulation

1. Introduction

A familiar classroom event illustrates a persistent problem for language educators. A learner may understand a grammar point, recognise vocabulary in a reading task, and produce accurate sentences while practising alone, yet struggle to retrieve familiar words when asked to speak in front of peers. Such a difference is often described as a lack of confidence or insufficient preparation. These explanations may be relevant, but they do not fully account for the rapid interaction between bodily arousal, emotional appraisal, attention, memory retrieval, and the social demands of speaking.

Second-language (L2) communication is cognitively demanding. A speaker must formulate an intention, retrieve lexical and grammatical information, organise speech, monitor output, and respond to an interlocutor in real time. When the task also involves public evaluation, the learner may allocate additional attention to possible mistakes, negative judgement, or visible signs of nervousness. Resources that could otherwise support formulation and retrieval may consequently be diverted toward self-monitoring.

Educational neuroscience has established that stress can influence learning and memory in ways that depend on its timing and context. Stress around learning may sometimes strengthen memory formation, whereas stress at retrieval can impair access to previously learned information (Vogel & Schwabe, 2016). In L2 contexts, anxiety and cognitive load are also related, although the relationship is variable and does not establish a single causal pathway (Yi et al., 2026). Neuroimaging work has further suggested that anxiety and proficiency are associated with differences in neural activity during L2 communication, but such findings should not be translated into simple classroom diagnostic claims.

A potentially useful, but insufficiently integrated, perspective is interoception: the perception and interpretation of signals arising from within the body. A learner may notice a racing heart, shallow

breathing, warmth, or muscular tension before speaking. The physiological change itself does not determine the learning outcome. Its meaning to the learner—danger, embarrassment, readiness, or ordinary activation—may shape attention and behaviour. Recent synthesis work on school-aged populations identifies interoception as relevant to self-regulation and emotional functioning while noting fragmented definitions, measurement approaches, and limited direct evidence from educational settings (Interoceptive Awareness in School-Aged Children and Youth, 2026).

This article develops a conceptual bridge between interoceptive awareness and L2 speaking. Its contribution is not the claim that interoception has never been studied, nor that a new neural mechanism has been discovered. Rather, it proposes a classroom-focused framework and a research agenda for examining how bodily-signal awareness and appraisal may interact with anxiety, cognitive load, and lexical retrieval during communicative tasks.

2. Scope and conceptual approach

The article is a theory-building narrative synthesis, not a systematic review or meta-analysis. It draws on established research areas relevant to the proposed framework: stress and memory, foreign-language anxiety, working memory and cognitive load, emotion regulation, embodied cognition, and interoceptive awareness. The sources were selected for their conceptual relevance to the proposed relationships and their potential to inform classroom research. No claim is made that every relevant study has been identified, that a formal database search was exhaustive, or that the framework has been empirically validated.

The unit of analysis is the speaking episode: a bounded classroom event in which a learner is expected to produce spoken L2 output. The framework is intended primarily for adolescent and adult language learners, although developmental differences should be considered before applying it to younger children. It focuses on ordinary educational stressors—such as being called on, timed speaking, peer observation, and corrective feedback—not clinical anxiety or diagnosis.

3. Theoretical foundations

3.1 Stress, memory, and retrieval

Stress is not a uniform cognitive state. Its effects vary according to intensity, duration, controllability, individual history, and the phase of learning under consideration. Research reviewed by Vogel and Schwabe (2016) highlights an important distinction for educators: stress can have different consequences during encoding and during retrieval. A stressful event near learning may sometimes enhance consolidation, while stress experienced when a learner must retrieve information can undermine performance. This distinction cautions against assuming that a student who performs poorly during a pressured speaking task has not learned the material.

The relationship between stress, working memory, and academic performance is also mediated by interacting neuroendocrine and cognitive processes. Almarzouki (2024) reviews evidence linking stress with working-memory performance and discusses the involvement of brain systems that support goal maintenance and memory. For classroom practice, the defensible implication is modest: unnecessary threat and excessive task demands may make it harder for learners to use what they know. It would be an overstatement to infer a learner's hormonal state or neural functioning from visible nervousness.

3.2 L2 anxiety and cognitive load

Speaking in another language can involve both intrinsic linguistic demands and additional demands created by the social situation. Learners may need to search for words, monitor grammar, plan pronunciation, and interpret a partner's response while also worrying about mistakes. Yi et al. (2026), in a systematic review and meta-analysis, report a positive association between cognitive load and foreign-language anxiety across the studies they examined, while emphasising heterogeneity and limitations in the available evidence. The association is important, but it does not show that anxiety always causes load or that reducing anxiety alone will improve language learning.

The distinction between task demand and threat appraisal is central. A challenging task can be productive when learners understand its purpose and believe that success is attainable. The same task may become disruptive when its demands are unclear, time is insufficient, or errors carry disproportionate social consequences. Therefore, classroom research should measure task difficulty and perceived threat separately rather than treating them as interchangeable.

3.3 Interoception and emotional regulation

Interoception refers broadly to the sensing and interpretation of internal bodily states. It is not identical to emotional awareness, mindfulness, or physiological arousal. A person may experience a bodily change without accurately identifying its source; conversely, a person may label an experience as anxiety even when the underlying bodily activation is modest. The interpretation of internal signals is shaped by attention, prior experience, context, and expectations.

A 2026 integrative review of interoceptive awareness in school-aged children and youth describes links with emotional regulation, executive functioning, and school-related functioning, while emphasising that definitions and measures remain inconsistent and that direct educational evidence is limited. This supports further investigation, not immediate adoption of interoception training as a proven teaching intervention. In L2 classrooms, the key research question is whether learners 'awareness and interpretation of bodily sensations help explain why similar speaking demands produce different outcomes across individuals and situations.

3.4 Emotion, embodiment, and the classroom

Emotion and cognition interact throughout learning. Reviews of educational neuroscience describe how emotional processes can influence attention, memory, and motivation (Li & Gow, 2020). Embodied-cognition research similarly argues that cognition is shaped by bodily activity and interaction with the environment. Castro-Alonso et al. (2024) identify several research avenues through which embodiment may inform learning and instruction, including gesture and action-based representations. These literatures suggest that learning should not be understood as an isolated process occurring independently of the learner's body and social environment.

However, the present framework does not equate interoception with embodied learning, nor does it imply that movement or breathing exercises automatically improve language outcomes. Instead, it treats bodily signals as one source of information that may influence how a learner interprets a speaking situation and distributes attention.

4. Proposed framework: interoceptive–affective calibration

The proposed framework describes five interacting stages within a speaking episode. They are analytical components rather than a rigid sequence; in real classrooms, several may operate simultaneously and recursively.

4.1 Task and social context

The learner encounters a task with particular linguistic demands and social features. Relevant variables include preparation time, topic familiarity, audience size, whether the learner is called on unexpectedly, the visibility of assessment, peer relationships, teacher response, and the consequences attached to errors. These features influence both actual task demand and perceived threat.

4.2 Bodily-signal detection

The learner may notice internal changes such as a faster heartbeat, altered breathing, dry mouth, warmth, or muscular tension. The framework distinguishes signal intensity from signal awareness: a learner may experience strong activation but pay little attention to it, or may closely monitor relatively small sensations. Classroom studies should avoid treating self-reported bodily awareness as a direct measure of autonomic activity.

4.3 Appraisal and interpretation

The learner interprets the situation and bodily signals. The same sensation may be appraised as evidence of danger (for example, "I am going to fail") or as manageable activation ("I am alert because this matters"). Such appraisals may be influenced by previous classroom experiences, perceived competence, cultural expectations about public error, and the teacher's feedback practices. The framework proposes appraisal as a potential moderator, not as a proven single cause of performance.

4.4 Allocation of attention and working-memory resources

Following appraisal, attention may be directed toward the communicative message, the language needed to express it, the listener's response, or internal monitoring of possible mistakes and bodily sensations. When self-focused monitoring becomes excessive, fewer resources may remain available for planning and lexical retrieval. This is a testable cognitive explanation; it should not be interpreted as a direct observation of working-memory capacity in an individual learner.

4.5 Observable speaking behaviour and learning

The episode may result in fluent participation, delayed responses, shorter utterances, avoidance, repair, or successful communication despite noticeable nervousness. Immediate performance should be distinguished from learning. A learner may perform poorly under pressure yet retain the material, or may speak fluently without durable acquisition. Delayed retrieval and transfer tasks are therefore needed to establish whether an instructional approach changes learning rather than merely short-term performance.

5. Propositions and testable hypotheses

The framework generates the following hypotheses for empirical testing. They are proposals, not findings.

- H1. Higher perceived social-evaluative threat during an L2 speaking task will be associated with greater self-reported cognitive load and reduced immediate lexical retrieval accuracy, after accounting for baseline proficiency and task difficulty.
- H2. The association between bodily arousal and speaking performance will be moderated by appraisal: arousal interpreted as manageable activation will be less strongly associated with performance disruption than arousal interpreted as threat.
- H3. Greater attention to bodily sensations will not necessarily predict better performance. Its relationship with speaking outcomes will depend on whether awareness supports regulation or intensifies self-focused monitoring.
- H4. Predictable task structure, adequate planning time, and feedback that treats errors as information will reduce perceived threat and improve participation, particularly for learners who report high speaking anxiety.
- H5. Changes in immediate speaking performance will not always correspond to changes in delayed retention. Studies should test both outcomes rather than using fluency during a single lesson as the sole indicator of learning.

6. A feasible research programme

6.1 Study design

An initial study could use a within-participant design with adult or university-level L2 learners. Each participant completes comparable speaking tasks under two or more classroom conditions: a low-evaluation condition (private recording or paired rehearsal) and a moderate-evaluation condition (short live response to a small group). Conditions should be counterbalanced, task topics matched for familiarity and linguistic demand, and participation voluntary. The study should not deliberately induce severe distress.

6.2 Measures

A practical measurement package could include: (a) a brief state-anxiety measure immediately before and after each task; (b) perceived cognitive-load ratings; (c) a short interoceptive-attention and

appraisal questionnaire tailored to the task, with its limitations reported; (d) blinded scoring of lexical diversity, retrieval latency, accuracy, speech rate, and repair; and (e) a delayed vocabulary or phrase-retrieval task several days later. If resources permit, non-invasive heart-rate or heart-rate-variability recording may provide complementary physiological information. Such measures are not direct readouts of anxiety and should never be used to label individual students.

6.3 Analysis

Multilevel models would be appropriate if learners complete repeated tasks, because observations are nested within individuals. Analyses should account for baseline proficiency, task difficulty, preparation time, and relevant learner characteristics. Researchers could test whether appraisal moderates the relationship between arousal indicators and performance, and whether cognitive-load ratings statistically mediate part of the association between threat and retrieval. Mediation in observational or short-term experimental designs must be interpreted cautiously; temporal ordering and alternative explanations need to be addressed.

6.4 Classroom-based intervention study

A subsequent study could compare usual speaking-task procedures with a structured preparation routine. The routine might include a clear task goal, a short planning interval, optional silent rehearsal, a neutral reminder that errors are part of practice, and a brief post-task reflection focused on the message communicated. The intervention should not instruct students to suppress bodily sensations or promise that a breathing technique will eliminate anxiety. The key outcomes would be participation, perceived threat, speaking performance, and delayed retention. Researchers should preregister hypotheses and analysis plans where feasible.

7. Implications for teaching practice

The framework offers several low-risk design principles, while recognising that their effectiveness requires evaluation.

- Make the purpose and success criteria of speaking tasks explicit. Uncertainty about what is expected can add avoidable cognitive and emotional demands.
- Provide a short planning opportunity before public production, especially when the task requires unfamiliar vocabulary or complex ideas.
- Use graduated participation: private rehearsal, pair work, small-group exchange, and then whole-class speaking. This is an option for scaffolding, not a requirement that every learner follow the same progression.
- Respond to errors in ways that preserve communicative purpose. Selective correction and delayed feedback may be preferable when immediate interruption would derail a learner's attempt to communicate.
- Offer choice where practical, such as selecting between two topics or choosing whether to speak first or after a partner. Choice may increase perceived control, but should not become a means of avoiding all challenging practice.
- Invite brief, non-clinical reflection: "What helped you communicate?" or "At what point did you lose your train of thought?" Avoid asking learners to disclose private health information or diagnose their own nervous systems.

8. Limitations and cautions

First, the framework is conceptual and has not been empirically validated. Its proposed links should be treated as hypotheses. Second, interoception is a multidimensional construct, and self-report instruments may measure beliefs about bodily awareness rather than the accuracy of internal-signal perception. Third, physiological indicators such as heart rate are influenced by movement, sleep, caffeine, illness, and many other factors; they cannot independently identify anxiety or cognitive load. Fourth, L2 speaking performance is shaped by proficiency, vocabulary knowledge, task familiarity, motivation,

identity, classroom relationships, and sociocultural expectations. The framework does not replace these explanations.

Fifth, the evidence base spans different ages, tasks, and research settings. Findings from laboratory stress paradigms cannot be transferred directly to ordinary language lessons. Sixth, an emphasis on bodily awareness could unintentionally increase self-monitoring in some learners. Teachers should not require students to track their heart rate, disclose anxiety, or participate in mindfulness or breathing activities. Any intervention should be optional, culturally responsive, and evaluated for unintended effects.

Finally, the framework does not support neuro-reductionism. Teachers cannot infer neural activity, hormone levels, or a student's interoceptive accuracy from posture, silence, eye contact, or speaking speed. Neuroscience can inform hypotheses about learning, but educational decisions should remain grounded in observable learning needs and ethically collected evidence.

9. Conclusion

Differences between what L2 learners know and what they can produce under classroom pressure remain an important challenge for language education. Research on stress and memory, foreign-language anxiety, cognitive load, emotion regulation, and interoception offers complementary insights, but these areas are not always brought together at the level of the speaking episode. This article has proposed an interoceptive–affective calibration framework to examine how classroom conditions, bodily-signal awareness, appraisal, and attentional allocation may jointly shape speaking performance and retrieval.

The framework's value lies in its testability. It encourages researchers to distinguish bodily arousal from its interpretation, immediate performance from durable learning, and task difficulty from social threat. Carefully designed classroom studies could determine whether these distinctions improve explanations of L2 speaking and whether low-risk changes to task structure support learners' participation. Until such evidence is available, the framework should be treated as a research agenda rather than a validated intervention.

References

1. Almarzouki, A. F. (2024). Stress, working memory, and academic performance: A neuroscience perspective. International Journal on the Biology of Stress, 27(1). https://doi.org/10.1080/10253890.2024.2364333
2. Castro-Alonso, J. C., Ayres, P., Zhang, S., de Koning, B. B., & Paas, F. (2024). Research avenues supporting embodied cognition in learning and instruction. Educational Psychology Review, 36, Article 10. https://doi.org/10.1007/s10648-024-09847-4
3. Interoceptive awareness in school-aged children and youth: A systematic integrative review and implications for school health. (2026). Journal of School Health, 96(9), e70227. https://doi.org/10.1111/josh.70227
4. Li, L., & Gow, A. D. I. (2020). The role of positive emotions in education: A neuroscience perspective. Mind, Brain, and Education, 14(3), 220–234. https://doi.org/10.1111/mbe.12244
5. Thomas, M. S. C. (2019). Annual research review: Educational neuroscience: Progress and prospects. Journal of Child Psychology and Psychiatry, 60(4), 477–492. https://doi.org/10.1111/jcpp.12973
6. Vogel, S., & Schwabe, L. (2016). Learning and memory under stress: Implications for the classroom. npj Science of Learning, 1, Article 16011. https://doi.org/10.1038/npjscilearn.2016.11
7. Yi, H., Tang, W., Chen, Q., & Wang, Z. (2026). Cognitive load and foreign-language anxiety in second-language learning: A systematic review and meta-analysis. Journal of Intelligence, 14(9), Article 228. https://doi.org/10.3390/jintelligence14090228