

Body position and vocabulary learning: An experimental proposal

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Abstract

Nowadays, people across the world spend a large proportion of their waking hours in a seated position. One solution that has been suggested is encouraging people to stand more during the day, for example by using sit-stand desks. These desks can be adjusted to allow users to work either sitting or standing up, and they are becoming increasingly popular around the world. While the health benefits of this approach are becoming more widely recognised, the cognitive consequences of this shift are not as well understood. Some studies have shown that standing can have a positive effect on cognitive functioning. One question that arises, then, is whether standing enhances word learning or at least does not hinder it. To address this question, a study was conducted at UNESP in Bauru, Brazil, as part of the LIVIA-SCALab collaboration within the CAPES-COFECUB project framework.

This methodological chapter outlines the aforementioned study's design, in which adult native speakers of Brazilian Portuguese learnt 27 rare words in their mother tongue, with body position and word presentation systematically manipulated. While the analyses are underway, the authors present their hypothesis, proposing the study as a means of expanding our understanding of how body position influences cognitive processes, particularly word learning. This study could be a first step towards answering this question and may provide valuable insights into theory and practice in education and cognitive science.

Body position in daily life

Nowadays, across the world, people spend a large proportion of their waking time in a seated position, particularly during office work, study hours, commuting and leisure activities when these allow it (Leitzmann, 2023). Such widespread sedentary behavior has been linked to multiple cardio-metabolic health risks such as obesity, deficient blood pressure, high levels of cholesterol, reduced cardiorespiratory fitness (Bull *et al.*, 2020), among other health and psychological issues (e.g., Bonnet & Cheval, 2023; Levine, 2015). This also has been reported to be the case even for children (Saunders *et al.*, 2014). Furthermore, high levels of sedentary time have been associated with reduced brain health, dementia and lower academic performance (Bueno *et al.*, 2022; Lima *et al.*, 2019; Voss *et al.*, 2014).

Sedentary behavior is defined as any waking activity performed while sitting, reclining, or lying with an energy expenditure of ≤ 1.5 metabolic equivalents (METs) (Tremblay *et al.*, 2017, p. 9). Common examples of sedentary behavior include working at a desk, watching television, or travelling

in a motor vehicle. High-income countries, in which desk-based employment is prevalent, tend to exhibit the highest sitting times. Recent analyses estimate that more than 30% of European and U.S. adults sit for up to ten hours per day (Bullock *et al.*, 2017). Middle-income regions, such as Latin America, are also experiencing increasing sedentary behavior, with reports indicating an average of about seven hours of daily sitting (Luis de Moraes Ferrari *et al.*, 2019).

Recommendations clearly state that any reduction in sedentary time can provide measurable health benefits (Bull *et al.*, 2020). Bonnet and Barela (2021) and Bonnet and Cheval (2023) even suggested that people should avoid sitting for more than 8 hours per day. One way to spend more time in the standing position during the day is to use sit-stand desks, both for adults in desk-based jobs and for children and adolescents in schools. Sit-stand desks are, by definition, adjustable desks that can be used either in a sitting or standing position by simply changing the desktop's height.

Implementation of sit-stand desks

Children and adolescents typically spend most of their day in a seated position, especially in classroom settings, where they endure prolonged periods of sitting. There is evidence suggesting that children and adolescents spend more time sitting during school hours than outside of school (Abbott *et al.*, 2013). This is noteworthy because it has been found that sedentary habits start at these young ages (Biddle *et al.*, 2010).

In response to excessive sedentariness among young populations, the implementation of sit-stand desks in schools started all over the world and will move on positively at least until 2030 (*Standing Desks Market Size, Share & Growth Report*,

2030, n.d.). The use of these sit-stand desks is intended to reduce the time spent sitting in schools. Consistently, in their systematic review of school-based interventions measuring sedentary time, Hegarty *et al.* (2016) reported significant decreases in sedentary time following the use of sit-stand desks in schools. Two additional reviews confirmed beneficial effects (Minges *et al.*, 2016; Sherry *et al.*, 2016), showing that sit-stand desks in schools significantly increased energy expenditure and standing time of school learners by 60 minutes. This finding aligns with evidence from adult studies in desk-based jobs showing a reduction of 77 minutes per eight-hour workday when using sit-stand desks (Neuhaus *et al.*, 2014).

Overall, these findings suggest that sit-stand desks effectively encourage and lead to a reduction in sitting time. However, their widespread use raises important questions about how body position might impact cognitive processes and performance, both for adults in the workplace and for children in educational settings.

Body position and cognitive tasks

The effects of standing desks on health start to be established but far less is known about the cognitive consequences of this shift (For reviews see Sherry *et al.*, 2016; Silva *et al.*, 2025). More precisely, although studies show that sit-stand desks are an effective way of addressing health issues, further research is needed to establish whether posture affects cognitive aspects such as attention, perception and memory processes, which ultimately shape learning outcomes in educational contexts, for example. Some studies suggest that standing enhances cognitive control and selective attention (Rosenbaum *et al.*, 2017; Smith *et*

al., 2019), whereas others report no significant effects (Caron *et al.*, 2022; Straub *et al.*, 2022). Additional findings further suggest that posture influences task performance differently, with sitting proving most effective for arithmetic tasks and standing for cognitive control (Abou Khalil *et al.*, 2024). In their study, Rosenbaum *et al.* (2017) investigated young adults performing a Stroop task either when standing or when sitting. In the Stroop task, participants are shown mismatched words and colors (e.g., the word “red” printed in blue ink) and are asked to inhibit the conflicting information when demanded to say the color of the ink, for example. In experimental studies, the Stroop effect is widely used to test cognitive control. The authors found a significant difference in performance between sitting and standing body positions; participants completed the task faster when standing compared to sitting. Similarly, Smith *et al.* (2019) observed significantly increased focus and reduced errors in task-switching and search visual paradigms when participants were standing. These findings led to the conclusion that standing could significantly enhance selective attention and, consequently, cognitive performance. Some explanations for this phenomenon have centered on the physical effort required by standing. This body position is thought to induce a state of increased arousal, supported by heightened alertness or even a fight-or-flight-like response, which may enhance cognitive functioning (Smith *et al.*, 2019).

This is in line with a further study by Mehta *et al.* (2015) who found that high school students using sit-stand desks exhibited improvements in executive function, working memory, and increased prefrontal cortical activation measured via functional near-infrared spectroscopy (fNIRS). The authors took these results as initial evidence that sit-stand desks may influence frontal brain function, which is closely tied to learning.

Furthermore, in students with attention difficulties, there is some evidence that non-sedentary positions positively influence in-seat behavior (i.e., how students remain physically engaged in their seating), academic engagement, and attention (Rollo *et al.*, 2019).

At the same time, other published studies did not show any significant effect – neither positive nor negative – of body position on cognitive task performance. For example, Caron *et al.* (2022) used the Stroop task, task-switching and the visual search tasks paradigms but found no meaningful effects of body position on performance. Moreover, in their meta-analysis, Straub *et al.* (2022) found no evidence that body position influenced performance in the Stroop task, even when applying more sensitive analyses to control for individual differences. In school context, Dornhecker *et al.* (2015) also reported no significant differences in academic engagement between classrooms using sit-stand desks and those using traditional seated desks.

All in all, no study to date has reported negative effects of sit-stand desks on academic outcomes. Thus, consistent with other reviews (Sherry *et al.*, 2016; Straub *et al.*, 2022), dynamic sit to stand interventions appear to be a simple and feasible health strategy in educational settings, given that they can reduce sedentary time without deteriorating student learning. Indeed, Straub *et al.* (2022) emphasized that if the effects of body position on cognition were consistently beneficial, possible applications could be considered, among others, in educational contexts. For example, postural strategies that facilitate focus on specific elements of information may enhance learning conditions in classrooms. Considering that standing reduces sedentary behavior and can increase engagement during learning without adverse consequences (Dornhecker *et al.*, 2015; Sherry *et al.*, 2020), it is worthwhile continuing to investigate whether body

position influences not only attentional or arithmetic tasks but also more fundamental processes such as learning.

What about language learning?

If standing or other non-sedentary body positions have beneficial effects on cognition in general, could they also enhance the learning of new vocabulary, or at least not hinder it? This question is particularly important because language learning is a core component of education. It is also timely, given the growing implementation of sit-stand desk in schools worldwide, with studies being conducted in several high-income countries (e.g., Australia, Canada, North Europe, USA) to evaluate their impact.

Vocabulary is widely recognized as a cornerstone of language learning and literacy development. It underpins reading comprehension, supports the acquisition of additional vocabulary and enriches communication in both oral and written modalities (Beck *et al.*, 2013; Cain *et al.*, 2001; Perfetti & Stafura, 2014). A robust vocabulary has also been associated with broader academic success, as it facilitates the comprehension of increasingly complex texts encountered in middle and high school (Castles *et al.*, 2018). Consequently, exploring how vocabulary is acquired, and whether body positions such as sitting or standing modulate this process is of high educational relevance.

How do we learn words?

Children typically learn new words incrementally, first grasping approximate meanings and then refining these through additional encounters in varied contexts (Carey, 2010; Nation,

2017). In adults the process is not completely different as we keep learning words during all our lives (Brysaert *et al.*, 2016). Word learning involves then both the initial mapping of form to meaning and the gradual integration of new lexical items into the learner's mental lexicon (Davis & Gaskell, 2009). Research in psycholinguistics has demonstrated that repeated exposure, attention allocation, and memory consolidation mechanisms all contribute to such process (Clay *et al.*, 2007; Wagner *et al.*, 2007).

Experimental paradigms have often focused on controlled word-learning tasks, where learners are presented with novel words under different instructional or environmental conditions. Such paradigms have facilitated the identification of variables that have been demonstrated to be significant for word learning, including frequency of exposure, semantic richness and contextual support. Across studies, outcomes are typically measured using recognition or recall tasks, which provide indices of how effectively new vocabulary has been encoded and retrieved (Frishkoff *et al.*, 2008). Of importance here is that word learning is not an independent process, it draws on attention, working memory, and long-term memory. Thus, any factor that influences these processes, such as body position, might reasonably be expected to affect vocabulary acquisition.

The role of context

Context provides semantic information that helps learners infer meaning, strengthens associations with prior knowledge, and encourages deeper processing, all of which enhance long-term retention (Nation, 2017). A number of experimental studies have explicitly compared context-rich versus context-poor learning conditions both in mother tongue (Nation & Snowling, 1998; Wang *et al.*, 2011) and second language learning (Elgort, 2011;

Webb, 2008). In their study, Webb (2008) investigated incidental vocabulary learning among Japanese learners of English and found that target words presented in meaningful sentence contexts were recalled and recognized more successfully than those provided in word lists. Similarly, Elgort (2011) demonstrated that context facilitates the transition from initial form-meaning mapping to integration into the mental lexicon, allowing learners to use new words productively rather than merely recognizing them.

On one hand, Nation and Snowling (1998) found that contextual facilitation was particularly beneficial for children with dyslexia, as they rely on contextual cues to compensate for poor decoding skills. On the other hand, poor comprehenders benefit less from context than typical readers. Which suggests that a good level of reading is necessary to benefit from context. Similarly, Wang *et al.* (2011) showed that context facilitated learning of irregular novel words, indicating that contextual information is especially valuable when decoding alone is insufficient for normal readers. More recently, Norman *et al.* (2023) examined how contextual diversity affects word learning. Participants studied eight pseudowords in either diverse contexts (sentences on different topics) or non-diverse contexts (sentences on the same topic). Although diversity did not influence word form recognition, transfer differed by condition. Non-diverse contexts enhanced performance in familiar settings, while diverse contexts supported better generalization to new, unfamiliar contexts. These findings point to diverse contexts as a factor to promote flexible, decontextualized representations meaning that rich context has a key role in supporting robust vocabulary acquisition.

Further evidence comes from studies of reading and listening comprehension, in which context helps learners infer meanings

of unfamiliar words and reinforces retention (Hulme *et al.*, 2022; Van Den Broek *et al.*, 2022). In these studies, context seems to facilitate word retention by reducing memory load and guiding learners toward more efficient encoding strategies.

An experimental proposition

If context supports vocabulary acquisition by enhancing attention and memory processes, body position may interact with this effect. The standing position has been associated with heightened alertness and selective attention in some tasks (Rosenbaum *et al.*, 2017; Smith *et al.*, 2019). Given that vocabulary learning depends on both attention and memory consolidation, it is plausible to hypothesize that body position might modulate the benefits of context. Specifically, the standing position could amplify the advantages of meaningful context, leading to improved recall and recognition compared to the sitting position.

At present, however, no study has directly examined how body position affects vocabulary learning. The central question remains: are the benefits of meaningful context preserved, amplified, or diminished when learners are standing rather than sitting?

To address this gap, a study was conducted at UNESP in Bauru, Brazil as part of the LIVIA – SCALab collaboration within the framework of the CAPES–COFECUB project. We wondered whether body position modulates the effects of context on word learning. Based on the evidence at hand, we expected that learners acquire words more effectively when standing and when presented within meaningful context, compared to when sitting and presented with unmeaningful context. This hypothesis lies on two bodies of evidence. First, studies suggesting that

standing may enhance alertness and certain cognitive functions, and second, research showing that meaningful context facilitates vocabulary acquisition. Together, these literatures raise the possibility that body position and context may both complementarily support word learning.

Design

The experiment employed a 2x2 factorial design, with two independent variables: body position (sitting vs. standing) and word presentation (with meaningful context vs. with unmeaningful context). This design allowed for the examination of main effects of body position and context, as well as their interaction.

Participants

The study recruited eighteen adult native speakers of Brazilian Portuguese. All participants were adults (M age = 21.5; SD = 2.8), with normal or corrected-to-normal vision and no reported language or reading disorders. They provided informed consent in accordance with ethical standards of UNESP.

Materials

Stimuli were drawn from LexPorBR, a lexical database of Brazilian Portuguese (Estivalet & Meunier, 2015). The targets were 27 words selected based on frequency (M = 0.10; SD =0.19), word length (M =10.07; SD =0.26), and semantic properties (i.e., not belonging to a single semantic category). Each target word was embedded in six sentences, three providing a meaningful context and three other offering no supporting semantic

information. Two stimulus lists were created to counterbalance context presentation. In list A, half of the target words appeared in meaningful contexts and the other half in non-meaningful contexts; in list B, this assignment was reversed. Sentence order was randomized for all participants. Thus, participants were exposed to both context conditions and both body position conditions (sitting and standing). Specifically, participants assigned to List A or List B completed the task in both positions, ensuring that each context type was experienced under both postural conditions.

Apparatus

Stimuli were presented on a computer screen connected to a Tobii eye-tracking system. The system recorded gaze behavior allowing for measurement of fixation and saccade metrics. Participants either sat in a standard chair or stood in front of the screen, with table and lighting adjustments made to ensure comparable visual conditions across positions.

Procedures

At the beginning of the session, participants were provided with detailed instructions in Portuguese, explaining the task and ensuring comprehension. After that, they were positioned in front of the screen on which stimuli were presented. Following the first calibration of the eye tracker, the sentences with the embedded target words were presented for the exposition phase. Depending on the condition, the sentences either provided sufficient context to infer the words' meanings or did not. Each participant performed the tasks in both sitting and standing positions in a counterbalanced order.

After exposure, participants completed two recall and one reading tasks designed to assess learning outcomes. In the recall tasks, they were asked to orally produce and write the target without any cue. In the reading task, they saw the words in the center of the screen and were required to read them as fast as possible without making any error.

Throughout the entire experiment, gaze behavior toward the words was continuously recorded with calibration conducted at the beginning of each task. Each experimental session lasted approximately 1 hour and 30 minutes per participant. To date, the study has been completed, and all data has been collected and securely stored on an external hard drive. No analyses have yet been conducted.

Planned analyses

Data will be analyzed using Linear Mixed Models (LMMs), through the software Jamovi (The jamovi project, 2024). We will account for both participant- and item-level variability (Baayen *et al.*, 2008). The primary dependent variables related to the learning of vocabulary will include fixation behavior during exposition and the reading task as well as accuracy in the recall and reading tasks. Latency in all the testing tasks will also be considered.

The focus of the analysis is the interaction effect between body position and context. Specifically, analyses will seek to determine whether the benefits of context on word learning are moderated by body position.

Theoretical and practical contributions

Numerous studies have already demonstrated that context plays a decisive role in supporting word learning. Learners are more likely to remember words embedded in meaningful sentences than those presented in isolation (Elgort, 2011; Webb, 2008). This context effect has been consistently observed across modalities, including reading, listening, and incidental learning, and is widely regarded as a cornerstone of effective vocabulary instruction (Beck *et al.*, 2013; Perfetti & Stafura, 2014). Yet the question remains whether this robust effect of context persists in changing body positions. In other words, does standing enhance or interfere with the benefits of meaningful context for word learning? Such a question is relevant since vocabulary acquisition is a foundational component of literacy development and that an increasing number of classrooms worldwide are integrating sit-stand desks.

The present chapter began with a review of the growing literature on body position and cognition, paying particular attention to the educational context. If body position can modulate attention or arousal states, it is plausible that it could also affect the way learners engage with and learn new words. However, within this literature of language learning, the use of sit-stand paradigms in learning domains in schools remains underexplored. The experimental proposition developed here addresses this gap by testing whether body position interacts with context during word learning.

In our study conducted at UNESP in Bauru, Brazil we manipulated both body position (sitting vs. standing) and contextual information during word presentation (meaningful vs. unmeaningful context) while monitoring eye movements through eye-tracking technology. By combining methodologies

from psycholinguistics (contextual information provided during vocabulary acquisition) and cognitive ergonomics (sitting vs. standing), the study aims to open a way at the intersection of language learning and the impact of body position on cognition.

The expected contributions of this work target both theoretical and practical domains. Theoretically, the study is bridging two domains of research: research on body position and cognition, and research on vocabulary learning. The former has largely focused on attention and executive functions, and the latter plays an important role in literacy. Furthermore, a theoretical contribution of this work is the expansion of our understanding of how body positions can shape learning. The integration of our results might provide a novel perspective on how to approach vocabulary teaching. If body position is found to moderate context effects, it would also be a good pathway to continue implementing research with non-sedentary desks in schools. Practically, our study would be valuable by informing classroom practices related to the use of non-sedentary positions for learning. If sit-stand desks were recognized to influence language learning outcomes, educators and policymakers would more strongly support their adoption and design instructional strategies that consider body position. For example, teachers might intentionally schedule vocabulary or reading activities during standing periods, while reserving other tasks for seated conditions, thereby aligning bodily states with cognitive demands.

Conclusion

Our study is seeking to expand our understanding of how body position participates in cognitive processes, more specifically word learning. While much is known about the role

of context during word learning in seated learners, extending this inquiry to different body position will open new perspectives on language learning. Our study described here offers a first step toward answering this question, with the potential to inform both theory and practice in education and cognitive science. If our hypotheses are validated, the findings would suggest that physical body position can modulate language acquisition processes, with potential implications for educational practices. Future studies could expand beyond vocabulary to other aspects of language learning, such as reading comprehension, or bilingual word learning.

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