

Psycholinguistic Analysis of Language Processing in Multilingual Societies

Hafsa Rahman*1, Ghulam Yasin2

¹ University of Malakand, KPK Pakistan.

Corresponding Author: hafsarahman844@zohomail.com

² Department of Computer Science, University of Makran Panjgur. yasinarmar38@gmail.com

DOI: <https://doi.org/10.63163/jpehss.v4i1.1171>

Abstract

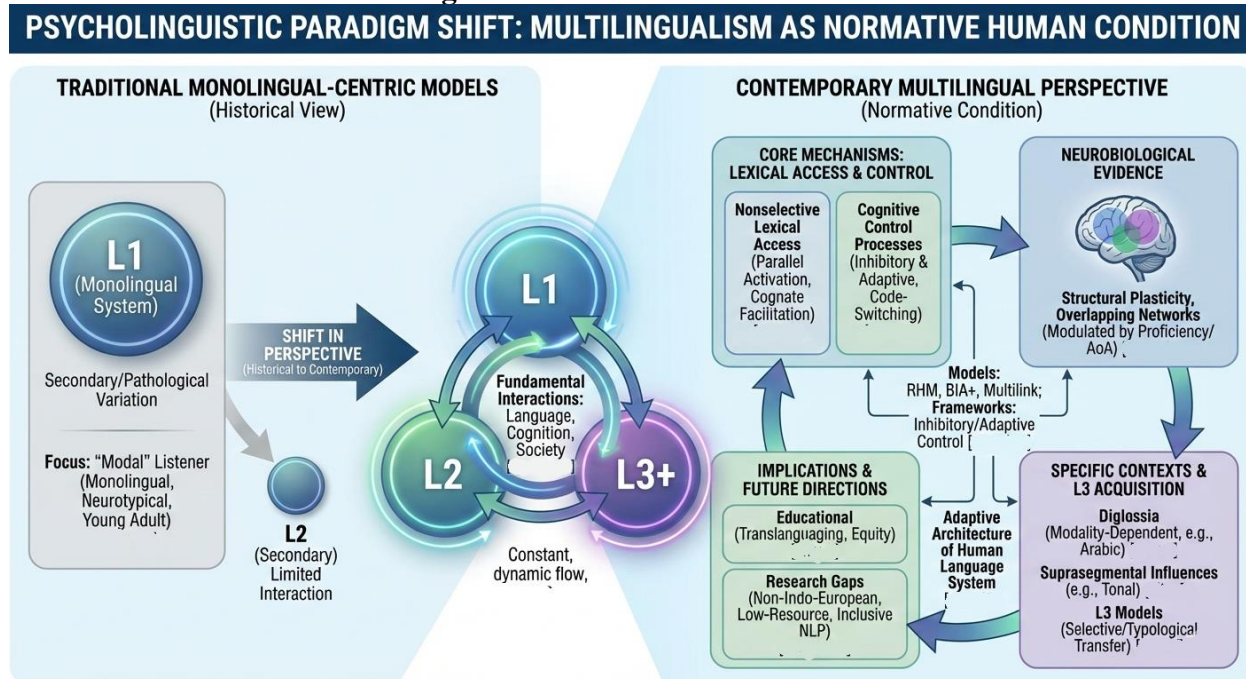
This paper provides a comprehensive psycholinguistic analysis of language processing in multilingual societies, shifting from monolingual-centric models to viewing multilingualism as the normative human condition. It examines core mechanisms including nonselective lexical access across languages, evidenced by cognate facilitation and parallel activation in models such as the Revised Hierarchical Model (RHM), BIA+, and Multilink. Cognitive control processes, particularly inhibitory control and adaptive mechanisms in code-switching contexts, are explored through frameworks like the Inhibitory Control model and Adaptive Control Hypothesis. Neurobiological evidence highlights structural plasticity, overlapping neural networks modulated by proficiency and age of acquisition, and modality-dependent processing in diglossic environments such as Arabic. Additional topics include suprasegmental (tonal) cross-linguistic influences and models of third language (L3) acquisition emphasizing selective or typological transfer. The discussion extends to educational implications, supporting multilingual pedagogies and translanguaging to promote equity and cognitive benefits. Despite advances, persistent gaps remain in research on non-Indo-European languages and low-resource contexts, underscoring the need for inclusive, globally representative studies and equitable NLP development. Overall, multilingualism reveals fundamental interactions between language, cognition, and society, offering critical insights into the adaptive architecture of the human language system.

Keywords: multilingualism, psycholinguistics, lexical access, cognitive control, code-switching, inhibitory control, diglossia, language acquisition, neural plasticity, bilingual advantage

1. Introduction

The study of how the human mind and brain accommodate multiple linguistic systems has undergone a profound paradigm shift over the last several decades (Bourguignon, 2023). Historically, psycholinguistic research was centered on the "modal" listener typically defined as a monolingual, neurotypical, and young adult viewing any deviation from this standard as a secondary or even "pathological" variation (Ibrahim, 2024). Contemporary perspectives, however, have redefined multilingualism as a fundamental lens through which the intrinsic dynamics between language, cognition, and their neural underpinnings are fully understood (Kroll et al., 2010). In an increasingly globalized world, the active use of two or more languages is perhaps the most common characterization of human communication, necessitating an expert-level synthesis of how these complex systems interact, compete, and reorganize the cognitive architecture of the speaker (Filippi et al., 2025).

Figure 1. The Psycholinguistic Paradigm Shift: Transitioning from Monolingual-Centric Models to a Normative Multilingual Framework.



2. Theoretical Architecture of the Multilingual Lexical System

A central preoccupation of psycholinguistic inquiry is the organization and access of words within the mental lexicon. For multilingual individuals, this inquiry expands to whether languages are stored in functionally independent modules or within a single, integrated network (Kroll & Stewart, 1994). A significant body of experimental evidence, utilizing paradigms such as lexical decision, picture naming, and eye-tracking, suggests that multilingual speakers simultaneously activate all their known languages when processing any single one (Fridman & Meir, 2025). This phenomenon, known as nonselective lexical access, implies that the "non-target" language is never fully dormant but instead provides a constant background of activation that must be managed by the cognitive system (Dijkstra & van Heuven, 2002).

The theoretical debate regarding the structure of this system has been traditionally dominated by the tension between the Revised Hierarchical Model (RHM) and localist-connectionist models such as the Bilingual Interactive Activation plus (BIA plus) (Ashraf, 2024). The RHM, proposed by Kroll and Stewart in 1994, was initially designed to explain developmental asymmetries in translation performance (Ferreira & Schwieter, 2023). It posits that in the early stages of second language (L2) acquisition, lexical forms are mapped to meaning through the first language (L1) translation equivalent a process termed lexical mediation (del Maschio et al., 2022). Over time, as L2 proficiency increases, the direct link between L2 forms and their conceptual representations strengthens, allowing for more efficient, direct concept mediation (Lu et al., 2023).

Table 1. Comparison of Major Lexical Processing Models

Model Feature	Revised Hierarchical Model (RHM)	BIA plus Model	Multilink Model
Primary Domain	Word Production and Translation (Dijkstra et al., 2019)	Word Recognition (Dijkstra & van Heuven, 2002)	Integrated Recognition & Production (Dijkstra et al., 2019)

Lexical Access Mechanism	Proficiency-dependent serial mediation (Kroll & Stewart, 1994)	Nonselective parallel activation (Dijkstra & van Heuven, 2002)	Nonselective parallel activation (Dijkstra et al., 2019)
Lexical Representation	Shared conceptual level (Kroll et al., 2010)	Integrated with language tags (Dijkstra & van Heuven, 2002)	Connectionist RHM architecture (Dijkstra et al., 2019)
Developmental Sensitivity	Accounts for acquisition history (Kroll & Stewart, 1994)	Models steady-state instances (Dijkstra & van Heuven, 2002)	Considers relative L2-proficiency (Dijkstra et al., 2019)
Asymmetry Explanation	Link strength asymmetry (Kroll & Stewart, 1994)	Relative frequency (Dijkstra & van Heuven, 2002)	Translation costs and similarity (Dijkstra et al., 2019)

The cognate facilitation effect provides further empirical weight to the integrated lexicon hypothesis. Cognate's words sharing both form and meaning across languages are consistently processed faster than non-cognates (Lijewska, 2020). This facilitation suggests that activation from both linguistic systems converges on a common semantic representation, effectively lowering the threshold for word recognition (Muylle et al., 2022). Interestingly, this effect is modulated by the degree of orthographic and phonological similarity, with identical cognates eliciting the greatest facilitation (Arana et al., 2022). However, the influence of phonological overlap can be complex; while it often assists recognition, some studies have noted inhibitory effects in specific cross-linguistic contexts, suggesting that phonological competition can sometimes hinder access (Young, 2025).

3. Cognitive Control and the Mechanics of Language Inhibition

Given the parallel activation of multiple languages, the multilingual mind must employ sophisticated control mechanisms to ensure that the intended language is selected while interference from non-target languages is suppressed (Green, 1998). This challenge is often conceptualized as a form of "mental juggling," where the speaker must keep both languages active while avoiding errors in production (Jansen et al., 2022). The Inhibitory Control (IC) model remains a cornerstone for understanding this process (Gahramanova, 2024).

The IC model, proposed by Green in 1998, suggests that language selection is achieved through the top-down inhibition of non-target lexical candidates. This inhibition is reactive; it is recruited when conflict is detected between competing language systems (Lee et al., 2025). One of the most prominent pieces of evidence for this mechanism is the observation of asymmetric switch costs (Franc, 2025). When unbalanced bilinguals switch between their languages, they often take longer to switch back to their dominant L1 from their weaker L2 than the reverse. The IC model explains this by positing that to produce the weaker L2, the speaker must powerfully inhibit the dominant L1 (Alharbi, 2022).

Table 2. Taxonomy of Cognitive Control Processes in Multilingualism

Control Type	Definition and Mechanism	Psycholinguistic Manifestation	Neural Correlates
Inhibitory Control	Reactive suppression (Green, 1998; Misra et al., 2012)	Asymmetric switch costs (Green & Wei, 2014; Alexander, 2025)	Left caudate, Basal ganglia (Abutalebi & Green, 2007)
Conflict Monitoring	Detection of competing signals (Braver, 2012; Abutalebi et al., 2012)	Reduced Simon effect (Green, 1998)	Anterior Cingulate Cortex (ACC)

			(Abutalebi et al., 2012)
Goal Maintenance	Proactive sustainment (Braver, 2012)	Faster reaction times (Braver, 2012)	Dorsolateral PFC (De Groot, 2011)
Task Disengagement	Cessation of current schema (Braver, 2012)	N2 component in ERP (Filippi et al., 2015; Misra et al., 2012)	Inferior Parietal areas (Abutalebi & Green, 2007)

4. Adaptive Control and the Psycholinguistics of Code-Switching

Code-switching the fluid alternation between languages within a single discourse is not merely a product of language deficiency but a sophisticated cognitive and sociolinguistic strategy (Ng & Yang, 2022). The Adaptive Control Hypothesis (ACH) proposes that the cognitive mechanisms recruited by bilinguals are highly dependent on their interactional environment (Lai et al., 2022). The ACH identifies three distinct contexts: "single-language," "dual-language," and "dense code-switching". The cognitive demands vary across these settings; dual-language contexts tax interference suppression heavily, whereas dense code-switching relies on "cooperative" schemas where both languages are highly integrated, potentially reducing the need for explicit inhibition (Braver, 2012). Expanding on these dynamics, the Language Entropy Approach suggests that the unpredictability of language use in high-entropy environments promotes more efficient proactive control (Gullifer & Titone, 2021).

5. Neurobiology and Structural Plasticity in the Multilingual Brain

Advances in neuroimaging have established that the multilingual brain exhibits a remarkable degree of structural plasticity. Studies utilizing Diffusion Tensor Imaging (DTI) have shown differences in white matter tracts between bilingual and monolingual children, indicating that managing multiple languages physically alters internal communication networks (Pliatsikas, 2020).

Functionally, multilingual individuals process all their languages within a largely overlapping network in the perisylvian cortex of the left hemisphere. However, the specific activation patterns are modulated by variables such as age of language acquisition (AoA) and proficiency (Połczyńska et al., 2020). As proficiency in a later-learned language increases, activation patterns tend to become more efficient and "native-like," showing a reduction in the recruitment of extra brain areas (Martín-Fernández et al., 2012).

6. Diglossia and the Cognitive Architecture of Arabic

A nuanced area of research concerns diglossic societies, such as the Arabic-speaking world, where two distinct varieties of the same language serve different social functions (Asadi & Abu-Rabia, 2021). Spoken Arabic (SA) is acquired as the native variety, while Literary Arabic (LA) is learned through formal education for literacy (Ibrahim, 2024).

Table 3. Modality-Dependent Processing of Arabic Varieties

Modality	Status of Spoken Arabic (SA)	Status of Literary Arabic (LA)	Primary Evidence
Auditory	Dominant (L1) (Ibrahim, 2024)	Non-dominant (L2-like) (Ibrahim, 2024)	Faster RTs and semantic priming for SA (Ibrahim, 2024)
Visual (Written)	Non-dominant (L2-like) (Ibrahim, 2024)	Dominant (L1) (Ibrahim, 2024)	Faster recognition of LA words (Ibrahim, 2024)

Cognitive Load	Lower in speech; higher in reading (Ibrahim, 2024)	Higher in speech; lower in reading (Ibrahim, 2024)	Visual familiarity and frequency effects (Ibrahim, 2024)
-----------------------	--	--	--

Evidence suggests that the cognitive representation of these varieties is modality-dependent. In the auditory modality, SA functions as the dominant L1, showing robust facilitation. In contrast, in the visual modality, the status is inverted; LA functions as the dominant variety due to its exclusive use in literacy (Zheng et al., 2025). This "bidialectalism" impacts the developmental trajectory of literacy acquisition, requiring children to manage the phonological distance between their dialect and the literary language (Fridman & Meir, 2025).

7. Suprasegmental Processing and Tonal Influence

The interaction between a multilingual's languages extends to suprasegmental features like lexical tone. In tonal languages like Mandarin, pitch contours are crucial for differentiating meaning (Garrido-Pozú, 2024). Psycholinguistic research has demonstrated that Mandarin-English bilinguals continue to use pitch information to constrain lexical access even when speaking English, a non-tonal language. Experiments using the picture-word interference paradigm have shown that cross-language homophones with a rising tone facilitate naming in English more than those with a falling tone an effect absent in English monolinguals (Khatin-Zadeh et al., 2021).

8. Models of Sequential Multilingualism and L3 Acquisition

As research moves to third language (L3) acquisition, models emerge to explain the dynamics of sequential multilingualism. A primary debate is whether linguistic transfer is "wholesale" (entire grammar) or "selective" (property by property) (Slabakova, 2017).

Table 4. Theoretical Models of Third Language (L3) Acquisition

Model of L3 Acquisition	Transfer Mechanism	Key Drivers of Transfer	Facilitative or Inhibitory?
Typological Primacy Model (TPM)	Wholesale (entire grammar) (Slabakova, 2017)	Perceived structural proximity (Slabakova, 2017)	Viewed as primarily facilitative (Slabakova, 2017)
Scalpel Model	Selective (property-by-property) (Slabakova, 2017)	Complexity, frequency, and use (Slabakova, 2017)	Can be both (Slabakova, 2017)
Cumulative Enhancement Model (CEM)	Selective and additive (Slabakova, 2017)	Prior L1 and L2 experience (Flynn et al., 2004)	Argues transfer is only facilitative (Slabakova, 2017)
Linguistic Proximity Model (LPM)	Selective (Slabakova, 2017)	Similarity of specific properties (Slabakova, 2017)	Can be both (Slabakova, 2017)

9. Societal Impacts and Educational Equity

The psycholinguistic profile of the multilingual learner has significant implications for education policy. Evidence overwhelmingly supports multilingual education programs. Research on children in urban environments reveals that achieving high proficiency in both languages enhances academic performance, particularly in complex cognitive tasks (Lijewska, 2020). Furthermore, multilingualism has been found to mitigate the negative effects of low socioeconomic status on

academic achievement. Strategic translanguaging in classrooms drawing on all of a learner's linguistic resources enhances comprehension and engagement (Lai et al., 2022).

10. Future Directions: Addressing Global Research Gaps

Despite the proliferation of research, a "resource asymmetry" remains in psycholinguistic literature and technology. Majority studies focus on Indo-European languages, while over 7,000 languages remain underrepresented (García & Wei, 2022). Developing NLP tools for low-resource languages is essential for digital equity. Current AI models often exhibit US-centric cultural biases due to the prevalence of Western training data (Ferreira & Schwieter, 2023). Countering the "Matthew Effect" requires digital revitalization and community partnerships to arrive at a more universal and inclusive understanding of the human language capacity (Ibrahim, 2024).

Conclusion

Multilingualism is not a peripheral phenomenon but the default mode of human language use in an interconnected world. This synthesis demonstrates that the multilingual mind operates through dynamic, interactive systems characterized by parallel nonselective activation, sophisticated inhibitory and adaptive control, and experience-dependent neural reorganization. Key models—from the Revised Hierarchical Model and BIA+ to the Adaptive Control Hypothesis—illuminate how speakers efficiently navigate competing linguistic representations, while empirical findings on cognate effects, asymmetric switch costs, diglossic modality shifts (as in Arabic), tonal cross-influences, and L3 transfer highlight the complexity and flexibility of multilingual processing. These insights carry profound implications for education, where leveraging learners' full linguistic repertoires via translanguaging and multilingual programs can enhance cognitive outcomes and mitigate socioeconomic disparities. Nevertheless, the field continues to suffer from a representational imbalance, with disproportionate focus on Indo-European language pairs and Western contexts. Addressing this "resource asymmetry" through expanded research on underrepresented languages, community-driven approaches, and bias-aware AI development is essential for building a truly universal understanding of language processing. By centering multilingualism, psycholinguistics not only better reflects global linguistic diversity but also uncovers core principles of human cognition that remain obscured in monolingual frameworks. Future progress depends on interdisciplinary, inclusive efforts to ensure equitable advances in both theory and application.

References

- Asadi, I. A., & Abu-Rabia, S. (2021). The impact of diglossia on phonological processing. *Reading Psychology, 42*(7), 685–699. <https://doi.org/10.1080/02702711.2020.1864608>
- Braver, T. S. (2012). The variable nature of cognitive control: A dual mechanisms framework. *Trends in Cognitive Sciences, 16*(2), 106–113. <https://doi.org/10.1016/j.tics.2011.12.010>
- Dijkstra, A., & van Heuven, W. J. B. (2002). The architecture of the bilingual word recognition system: From IA to BIA+. *Bilingualism: Language and Cognition, 5*(3), 175–197. <https://doi.org/10.1017/S136672890200301X>
- Dijkstra, A., van Hell, J. G., van Langen, M., & van Heuven, W. J. B. (2019). Multilink: A computational model for bilingual word recognition and word translation. *Bilingualism: Language and Cognition, 22*(4), 657–679. <https://doi.org/10.1017/S136672891800104X>
- Filippi, R., Ceccolini, A., Perry, R. C., & Thomas, M. S. C. (2025). The impact of multilingualism and socio-economic status on academic performance: Evidence from the SCAMP and the national pupil databases. *International Journal of Bilingual Education and Bilingualism, 28*(1), 53–72. <https://doi.org/10.1080/13670050.2024.2397445>

- Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition*, 1(1), 67–81. <https://doi.org/10.1017/S136672899800013X>
- Green, D. W., & Abutalebi, J. (2013). Language control in bilinguals: The adaptive control hypothesis. *Journal of Cognitive Psychology*, 25(5), 515–530. <https://doi.org/10.1080/20445911.2013.796377>
- Gullifer, J. W., & Titone, D. (2021). Characterizing the social contexts of bilingualism using the Language Entropy Questionnaire (LEQ). *Behavior Research Methods*, 53, 1113–1130. <https://doi.org/10.3758/s13428-020-01481-w>
- Ibrahim, R. (2024). Psycholinguistic analysis of language processing in multilingual societies: A process-based approach. *Journal of Applied Psycholinguistics*.
- International Phonetic Association. (2023). Lexical tone effects on pitch processing in bilingual lexical access. *Proceedings of the International Congress of Phonetic Sciences (ICPhS)*, 653.
- Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language*, 33(2), 149–174. <https://doi.org/10.1006/jmla.1994.1008>
- Kroll, J. F., van Hell, J. G., Tokowicz, N., & Green, D. W. (2010). The Revised Hierarchical Model: A critical review and assessment. *Bilingualism: Language and Cognition*, 13(3), 373–381. <https://doi.org/10.1017/S136672891000009X>
- Rystrøm, J., Kirk, H. R., & Hale, S. (2025). *Multilingual! = Multicultural: Evaluating gaps between multilingual capabilities and cultural alignment in LLMs*. arXiv. <https://doi.org/10.48550/arXiv.2502.16534>
- Slabakova, R. (2017). The scalpel model of third language acquisition. *International Journal of Multilingualism*, 14(3), 241–259. <https://doi.org/10.1080/14790718.2017.1321653>
- Bourguignon, N. J. (2023). The emergence of language in the human mind and brain—Insights from the neurobiology of language, thought and action. *Psychological Review*, 130(6), 1544.
- Fridman, C., & Meir, N. (2025). Dynamics of competition and co-activation in trilingual lexical processing: An eye-tracking study. *Bilingualism: Language and Cognition*, 1-16.
- Ashraf, B. (2024). Modeling Lexical Organisation and Access: Bilinguals and Multilinguals. *Balochistan Journal of Linguistics*, 12, 28-28.
- Ferreira, A., & Schwieter, J. W. (Eds.). (2023). *The Routledge handbook of translation, interpreting and bilingualism*. Taylor & Francis.
- del Maschio, N., Abutalebi, J., & Perani, D. (2022). Words, meanings, and the bilingual brain. In *The Routledge Handbook of Semiosis and the Brain* (pp. 190-203). Routledge.
- Lu, C., & Dang, T. N. Y. (2023). Effect of L2 exposure, length of study, and L2 proficiency on EFL learners' receptive knowledge of form–meaning connection and collocations of high-frequency words. *Language Teaching Research*, 13621688231155820.
- Lijewska, A. (2020). Cognate processing effects in bilingual lexical access. *Bilingual lexical ambiguity resolution*, 71-95.
- Muylle, M., Van Assche, E., & Hartsuiker, R. J. (2022). Comparing the cognate effect in spoken and written second language word production. *Bilingualism: Language and cognition*, 25(1), 93-107.
- Arana, S. L., Oliveira, H. M., Fernandes, A. I., Soares, A. P., & Comesaña, M. (2022). The cognate facilitation effect depends on the presence of identical cognates. *Bilingualism: Language and cognition*, 25(4), 660-678.
- Young, K. (2025). *Cognate Facilitation and Processing in English-Speaking Learners of German*. University of Kentucky.

- Jansen, S., Higuera del Moral, S., Barzen, J. S., Reimann, P., & Opolka, M. (2022). Deconstructing the “Bilingual Advantage”: The Social Embeddedness and Heuristic Fallacies of Scientific Metaphors. In *Demystifying Bilingualism: How Metaphor Guides Research towards Mythification* (pp. 255-305). Cham: Springer International Publishing.
- Gahramanova, A. (2024). The role of code-switching in Azerbaijani EFL classrooms (Master's thesis, Khazar University (Azerbaijan)).
- Lee, Y. W., Rebuschat, P., & Casaponsa, A. (2025). Top-down and bottom-up bilingual speech production: The effects of language context on inhibitory control. *Bilingualism: Language and Cognition*, 1-13.
- Franc, M. (2025). The role of L2 proficiency on inhibitory control in L1 Croatian speakers of L2 English (Doctoral dissertation, Sveučilište u Zagrebu, Sveučilište u Zagrebu, Filozofski fakultet, Odsjek za anglistiku).
- Alharbi, M. (2022). Lexical access by different script adult bilinguals; Evidence from masked primed picture naming and phoneme monitoring tasks (Doctoral dissertation, Cardiff University).
- Ng, G., & Yang, H. (2022). Code-Switching patterns differentially shape cognitive control: Testing the predictions of the adaptive control hypothesis. *Bilingualism: Language and Cognition*, 25(3), 521-535.
- Lai, G., & O'Brien, B. A. (2020). Examining language switching and cognitive control through the adaptive control hypothesis. *Frontiers in Psychology*, 11, 1171.
- Pliatsikas, C. (2020). Understanding structural plasticity in the bilingual brain: The Dynamic Restructuring Model. *Bilingualism: Language and Cognition*, 23(2), 459-471.
- Połączyńska, M. M., & Bookheimer, S. Y. (2020). Factors modifying the amount of neuroanatomical overlap between languages in bilinguals—A systematic review of neurosurgical language mapping studies. *Brain Sciences*, 10(12), 983.
- Martín-Fernández, J., Gabarrós, A., & Fernandez-Coello, A. (2022). Intraoperative brain mapping in multilingual patients: what do we know and where are we going?. *Brain Sciences*, 12(5), 560.
- Zheng, Y., Zhang, J., Yang, Y., & Xu, M. (2025). Neural representation of sensorimotor features in language-motor areas during auditory and visual perception. *Communications Biology*, 8(1), 41.
- Garrido-Pozú, J. J. (2024). Cross-linguistic effects of form overlap in aural recognition of Spanish–English cognates. *Bilingualism: Language and Cognition*, 27(5), 914-926.
- Khatin-Zadeh, O., Eskandari, Z., Cervera-Torres, S., Ruiz Fernández, S., Farzi, R., & Marmolejo-Ramos, F. (2021). The strong versions of embodied cognition: Three challenges faced.