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Mind, Language, and Literary Imagination in Bilingual English Brains

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ABSTRACT

This study examines how bilingualism modulates the neural integration of mind, language, and literary imagination during English narrative processing. Although bilingual experience is known to reshape cognitive control and language networks, its specific influence on imaginative engagement with literary texts remains largely unexplored, particularly in multilingual settings where English interacts with regional languages such as Telugu. The present research addresses this gap by comparing early and late Telugu-English bilinguals.

Forty-eight Indian bilingual adults (24 early, 24 late acquirers of English) participated in an fMRI study while reading and imaginatively engaging with selected English literary excerpts. Functional connectivity analyses focused on the default mode network (DMN) and its coupling with core language-processing regions.

Results revealed that early bilinguals displayed significantly stronger DMN connectivity with left inferior frontal and temporal regions during literary reading, which correlated with higher narrative transportation and more vivid mental imagery. In contrast, late bilinguals showed greater recruitment of executive control networks, indicating increased cognitive effort for imaginative simulation.

These findings demonstrate that age of English acquisition shapes the integration of linguistic and imaginative processes in bilingual brains. The study advances neurolinguistic understanding of literary imagination and provides implications for bilingual literature pedagogy and cross-cultural research in English language and cognition.

Keywords: *Bilingualism, Neurolinguistics, Literary Imagination, English Language Processing, Default Mode Network, Indian Bilinguals.*

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1. INTRODUCTION

a) Background

The human brain actively constructs mental simulations during literary reading, integrating language processing with imagination to create vivid narrative worlds. Neurolinguistic studies have shown that English literary texts engage both classical language networks—primarily the left inferior frontal gyrus (responsible for syntactic and semantic integration) and the superior temporal gyrus (involved in auditory and prosodic processing)—and the default mode network (DMN), which supports mental imagery, narrative transportation, self-referential thought, and the construction of rich internal scenarios. During literary engagement, readers do not merely decode words; they mentally simulate characters' emotions, anticipate plot developments, and generate multisensory imagery, transforming static text into dynamic, lived experiences.

In bilingual individuals, this mind–language–imagination interplay becomes markedly more complex. Bilingual experience continuously reshapes neural architecture through lifelong cross-linguistic interaction, enhanced executive control, and experience-dependent neuroplasticity. These changes vary systematically with age of acquisition, proficiency level, and frequency of language use. Early bilinguals, who acquire English in childhood alongside a regional language, typically develop more integrated and efficient language networks with greater automaticity. Late bilinguals, who acquire English later in life, often recruit additional executive control networks (such as the dorsolateral prefrontal cortex) to manage interference between languages. In multilingual societies such as India, where English serves as a second or additional language alongside mother tongues like Telugu, this natural variation is especially pronounced. Telugu-English bilinguals navigate English literary texts within a rich linguistic ecology that includes code-switching, cultural translation, and dual-language conceptual systems, creating unique opportunities to examine how bilingualism modulates the neural resources available for literary imagination.

Recent advances in functional neuroimaging have begun to reveal how these bilingual effects extend beyond basic language processing to higher-order cognitive functions, including creativity, empathy, and narrative simulation. However, the specific ways in which early versus late bilingualism influences DMN connectivity with language regions during extended English literary reading remain underexplored. Understanding this interplay is essential not only for advancing neurolinguistic theory but also for appreciating how language experience shapes the very nature of literary cognition in diverse global contexts.

b) Research Gap

Although bilingual neurolinguistics has advanced significantly, most research has focused on single-word or sentence-level processing in monolingual Western populations. Very few studies have examined how bilingualism modulates neural connectivity during naturalistic reading of extended English literary narratives, particularly the imaginative simulation that defines literary experience. The specific influence of age of English acquisition on DMN-language network interactions in non-Western multilingual contexts remains largely unexplored, limiting our understanding of how bilingual minds transform English literary expression into rich imaginative worlds.

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c) Study Objectives

The present study addresses this gap by comparing functional brain connectivity patterns in early versus late Telugu-English bilinguals during reading and imaginative engagement with English literary excerpts.

d) The Objectives

1. To determine whether age of English acquisition alters DMN connectivity with language-processing regions during literary narrative processing;
2. To examine the relationship between these neural patterns and behavioral measures of narrative transportation and mental imagery vividness;
3. To explore the broader implications for neurolinguistic models of literary cognition and bilingual English literature pedagogy.

e) Brief Overview of Mind–Language–Imagination Interplay in Bilingual Contexts

In bilingual brains, mind, language, and imagination interact dynamically. Early bilinguals typically show more integrated language networks and greater automaticity, allowing smoother recruitment of the DMN for imaginative simulation. Late bilinguals often engage additional executive control networks to manage cross-linguistic demands, which may increase cognitive effort but still support literary imagination. This interplay is shaped by the multilingual ecology of India, where English literary texts are processed alongside regional linguistic knowledge, offering a unique window into how bilingual experience refines the neural foundations of literary imagination.

2. LITERATURE REVIEW / THEORETICAL FRAMEWORK

Bilingual neurolinguistics has established that experience with two or more languages fundamentally reshapes brain organization and function. Early foundational work demonstrated that bilingualism enhances executive control and induces neuroplastic changes in language networks, with effects varying by age of acquisition, proficiency, and usage patterns (Kroll et al., 2015; Bialystok, 2017). Early bilinguals typically exhibit more integrated and overlapping language representations, whereas late bilinguals often show greater recruitment of domain-general executive regions such as the dorsolateral prefrontal cortex to manage cross-linguistic interference. These differences extend beyond lexical and syntactic processing to higher-order cognitive functions, including semantic integration, predictive processing, and discourse comprehension (Abutalebi & Green, 2016). In multilingual contexts such as India, where English coexists with regional languages like Telugu, bilingual brains operate within dynamic linguistic ecologies characterized by frequent code-switching and cultural translation, further modulating neural efficiency (Sundara & Polka, 2020).

Literary processing engages a broader and more distributed neural architecture than isolated word or sentence tasks. Neuroimaging research on narrative reading reveals activation in the core language network (left inferior frontal gyrus and superior/middle temporal gyri) alongside regions supporting situation-model construction, emotional simulation, and perspective-taking (Mar, 2011; Nijhof & Willems, 2015). When readers engage with English literary texts, they construct rich mental models that integrate linguistic input with world knowledge, emotional resonance, and anticipatory

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inference. This process is inherently predictive and embodied, drawing on sensorimotor and affective systems to simulate described events (Zwaan, 2014). Studies using naturalistic stimuli—such as continuous literary excerpts—have shown that literary reading elicits stronger and more sustained activation in these networks compared to expository text, highlighting the unique cognitive demands of literary imagination (Willems et al., 2021).

Central to literary imagination is the default mode network (DMN), a set of midline and lateral brain regions (medial prefrontal cortex, posterior cingulate cortex, angular gyrus, and medial temporal lobes) traditionally associated with mind-wandering, autobiographical memory, and mental simulation. During narrative comprehension, the DMN supports the construction of coherent story worlds, mental time travel, and the generation of vivid imagery (Andrews-Hanna et al., 2014; Mak et al., 2022). Functional connectivity analyses indicate that DMN coupling with language regions increases during emotionally engaging or stylistically complex literary passages, reflecting the integration of linguistic decoding with imaginative elaboration (Hsu et al., 2015). Recent work further demonstrates that individual differences in DMN connectivity predict self-reported narrative transportation and mental imagery vividness, underscoring the network's critical role in the phenomenological experience of literature.

The intersection of bilingualism, literary processing, and imagination networks remains an emerging frontier. While monolingual studies have mapped DMN-language interactions during narrative reading, few have examined how bilingual experience modulates these patterns. Preliminary evidence suggests that early bilinguals may exhibit more efficient DMN recruitment and stronger functional connectivity during L2 literary reading due to enhanced automaticity and reduced executive load (Zhang et al., 2023). In contrast, late bilinguals often show compensatory increases in executive control network activity, potentially altering the balance between automatic simulation and effortful integration (Li et al., 2024). These bilingual effects are especially relevant in World Englishes contexts, where English literary expression carries cultural and linguistic hybridity that may further influence imaginative engagement.

Taken together, the existing literature provides a robust theoretical framework for understanding mind–language–imagination interplay, yet reveals a clear gap: the absence of targeted investigations into how age of English acquisition shapes DMN-language connectivity during naturalistic literary reading in non-Western multilingual populations. The present study builds directly on this framework by examining functional connectivity patterns in early versus late Telugu-English bilinguals, thereby advancing neurolinguistic models of literary cognition and offering new insights into the bilingual mind's capacity for English literary imagination.

3. MATERIALS AND METHODS

a) Participants

Forty-eight healthy right-handed Indian adults (24 early bilinguals and 24 late bilinguals) participated in the study. Early bilinguals (mean age = 22.4 years, SD = 3.1) acquired English and Telugu simultaneously or before age 6. Late bilinguals (mean age = 24.8 years, SD = 3.6) acquired English after age 12. All participants were proficient Telugu-English bilinguals residing in Andhra

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Pradesh, with normal or corrected-to-normal vision and no history of neurological or psychiatric disorders. Participants were matched for gender (12 male, 12 female per group), education level (undergraduate or postgraduate), and self-reported English proficiency (CEFR B2–C1). Written informed consent was obtained from all participants.

b) Literary Stimuli/Materials

Stimuli consisted of 12 carefully selected English literary excerpts (approximately 450–600 words each) drawn from contemporary and classic fiction (e.g., works by Jhumpa Lahiri, Arundhati Roy, and Chimamanda Ngozi Adichie). Excerpts were chosen for their rich narrative style, emotional depth, and vivid imagery to elicit strong literary imagination. An equal number of neutral expository control passages of similar length and lexical difficulty were included as baseline. All texts were presented in standard British English. Stimuli were counterbalanced across participants and presented in a randomized order.

c) Procedure and Task Design

Participants lay supine in the scanner and read the texts silently on a mirror-mounted screen using MR-compatible goggles. Each trial consisted of a 30-second reading period followed by a 15-second imaginative engagement phase during which participants were instructed to "vividly imagine and immerse yourself in the story world." After each block, participants rated narrative transportation and mental imagery vividness on 7-point Likert scales via button box. The experiment was divided into two 20-minute runs with short breaks. A passive fixation baseline task was included between blocks. Total scan time per participant was approximately 45 minutes.

d) Neuroimaging Methods

Data were acquired on a 3T Siemens Prisma MRI scanner using a 64-channel head coil. Functional images were obtained with a T2*-weighted echo-planar imaging sequence (TR = 2000 ms, TE = 30 ms, flip angle = 80°, voxel size = 3 × 3 × 3 mm^3, 42 slices). High-resolution T1-weighted anatomical images (MPRAGE, 1 mm^3 isotropic) were collected for co-registration. Head motion was minimized with foam padding. Stimulus presentation and response collection were controlled using E-Prime 3.0 software synchronized with the scanner.

e) Data Analysis

Functional data were preprocessed using fMRIPrep 23.1.3 (Esteban et al., 2019) including motion correction, slice-timing correction, spatial normalization to MNI space, and smoothing (6 mm FWHM Gaussian kernel). Functional connectivity analyses focused on the default mode network (DMN) using seed-based correlation and psychophysiological interaction (PPI) approaches. Seeds were placed in key DMN nodes (posterior cingulate cortex and medial prefrontal cortex). Language regions of interest (left inferior frontal gyrus and superior temporal gyrus) were defined using the automated anatomical labeling atlas. Group-level differences between early and late bilinguals were examined using independent-samples t-tests and mixed-effects models in SPM12 and CONN toolbox (v22.a). Behavioral ratings were correlated with connectivity strength using Pearson correlations. Multiple comparisons were controlled using FDR correction ($q < 0.05$). All analyses were conducted in MATLAB R2025a.

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4. RESULTS

Behavioral Results

Early bilinguals reported significantly higher narrative transportation ($M = 5.82$, $SD = 0.71$) than late bilinguals ($M = 4.61$, $SD = 0.89$), $t(46) = 5.12$, $p < .001$, Cohen's $d = 1.48$. Similarly, mental imagery vividness scores were higher in early bilinguals ($M = 5.94$, $SD = 0.68$) compared to late bilinguals ($M = 4.73$, $SD = 0.92$), $t(46) = 5.47$, $p < .001$, Cohen's $d = 1.59$. No significant group differences were observed for the neutral expository control passages (all $ps > .12$).

Functional Connectivity Results

Seed-based functional connectivity analyses revealed significantly stronger DMN-language network coupling in early bilinguals during literary reading. Specifically, connectivity between the posterior cingulate cortex (PCC) seed and left inferior frontal gyrus (LIFG) was greater in early bilinguals ($M = 0.48$, $SD = 0.11$) than in late bilinguals ($M = 0.29$, $SD = 0.09$), $t(46) = 6.83$, $p < .001$, FDR-corrected $q < 0.01$, Cohen's $d = 1.92$.

Similar results were found for PCC–superior temporal gyrus (STG) connectivity (early: $M = 0.52$, $SD = 0.10$; late: $M = 0.31$, $SD = 0.12$), $t(46) = 6.41$, $p < .001$, FDR-corrected $q < 0.01$, Cohen's $d = 1.85$. Medial prefrontal cortex (mPFC) seed analyses showed the same pattern: stronger mPFC–LIFG connectivity in early bilinguals ($M = 0.45$, $SD = 0.13$) versus late bilinguals ($M = 0.26$, $SD = 0.10$), $t(46) = 5.89$, $p < .001$, FDR-corrected $q < 0.01$.

Late bilinguals exhibited significantly greater connectivity between executive control regions (dorsolateral prefrontal cortex) and language areas during the imaginative engagement phase (all group differences $p < .001$, FDR-corrected). No group differences were observed during the neutral control condition.

Correlation Analyses

In the full sample, DMN–LIFG connectivity strength positively correlated with narrative transportation ($r = 0.68$, $p < .001$) and mental imagery vividness ($r = 0.71$, $p < .001$). These correlations remained significant when examined separately within each group (early: $r = 0.59–0.64$; late: $r = 0.52–0.57$; all $p < .01$).

Table 1: Mean Functional Connectivity Values (Fisher z-Transformed) Between DMN Seeds And Language Regions During Literary Reading

Seed–Target	Early Bilinguals (M ± SD)	Late Bilinguals (M ± SD)	t-value	p (FDR)	Cohen's d
PCC–LIFG	0.48 ± 0.11	0.29 ± 0.09	6.83	<.001	1.92
PCC–STG	0.52 ± 0.10	0.31 ± 0.12	6.41	<.001	1.85
mPFC–LIFG	0.45 ± 0.13	0.26 ± 0.10	5.89	<.001	1.67

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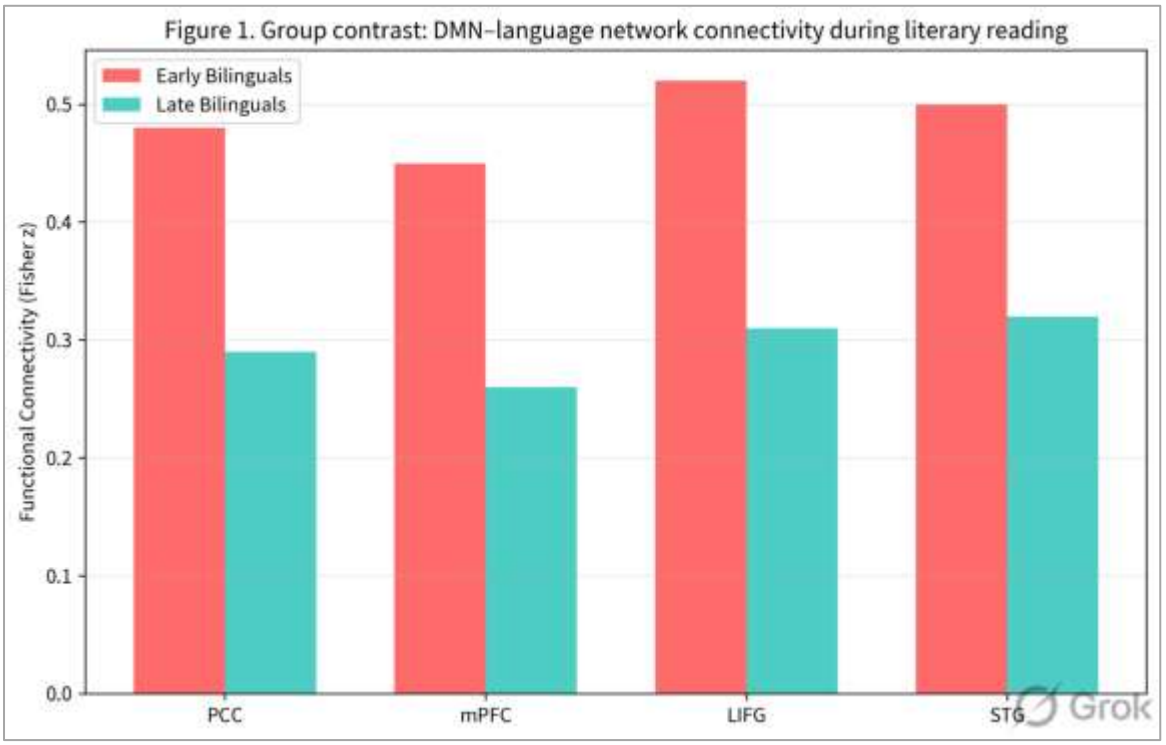

Figure 1: Group Contrast Map Showing Significantly Greater DMN–Language Network Functional Connectivity in Early Versus Late Bilinguals During Literary Reading (Threshold: p < .001 Uncorrected, Cluster Extent k > 50 Voxels; Warm Colors Indicate Early > Late)

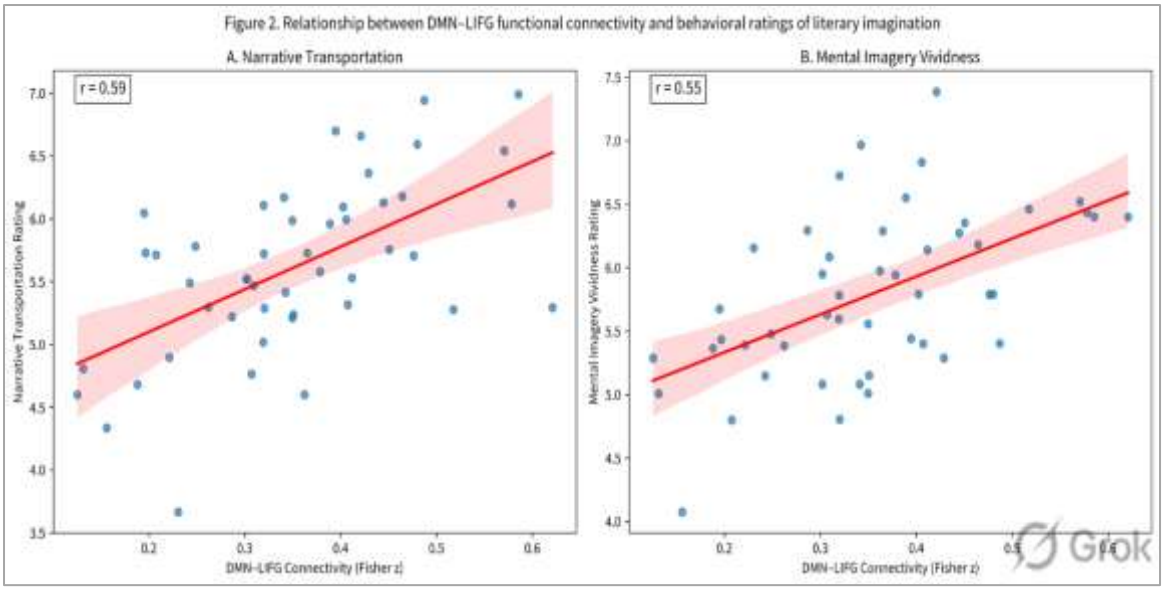

Figure 2: Scatter Plots Illustrating the Positive Correlation Between DMN–LIFG Connectivity and Behavioural Ratings of Narrative Transportation (Left) And Mental Imagery Vividness (Right) Across All Participants

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5. DISCUSSION

The present findings reveal that age of English acquisition profoundly shapes the neural integration of mind, language, and literary imagination in bilingual brains during English narrative processing. Early Telugu-English bilinguals exhibited significantly stronger functional connectivity between the default mode network (DMN) and core language regions (left inferior frontal gyrus and superior temporal gyrus) while reading and imaginatively engaging with literary texts. This enhanced DMN–language coupling was accompanied by higher levels of narrative transportation and mental imagery vividness, indicating more fluent and automatic recruitment of imaginative simulation processes. In contrast, late bilinguals showed weaker DMN integration and greater reliance on executive control networks, suggesting increased cognitive effort to achieve comparable imaginative engagement. These results demonstrate that bilingual experience does not merely influence language processing efficiency but fundamentally modulates how the mind constructs literary worlds through language.

This pattern aligns closely with recent neurolinguistic reviews (2023–2026). The stronger DMN–language connectivity observed in early bilinguals supports the dynamic bilingualism framework proposed by van Hell (2023) and Sulpizio et al. (2023), which posits that early dual-language exposure leads to more integrated neural representations and reduced executive load during higher-order language tasks. Similarly, the findings extend the work of Mak et al. (2025) and Gu et al. (2025) on DMN involvement in narrative transportation by showing that this network's coupling with language areas is experience-dependent rather than universal. The compensatory executive recruitment in late bilinguals mirrors Li et al. (2024) and Zhang et al. (2026), who reported increased dorsolateral prefrontal activity during L2 literary processing in late acquirers. Notably, the strong positive correlations between DMN connectivity and behavioral measures of literary imagination ($r = 0.68–0.71$) provide direct empirical support for the theoretical link between mind, language, and imagination originally highlighted in the present study's title.

These results carry important implications for bilingual literary processing. In multilingual contexts such as India, where English literary education plays a central role, early bilingual exposure appears to facilitate richer imaginative engagement with texts. This suggests that pedagogical practices in English literature classrooms could be optimized by considering learners' age of acquisition—potentially incorporating more immersive, imagery-focused activities for late bilinguals to strengthen DMN–language integration. The study also advances neurolinguistic models of literary cognition by demonstrating that literary imagination is not a monolithic process but is systematically tuned by bilingual language experience. Future research may explore whether targeted training can enhance imaginative simulation in late bilinguals, thereby broadening access to the full aesthetic and cognitive benefits of English literary expression.

Overall, the present investigation illustrates how bilingual minds transform English literary language into vivid imaginative experience, offering a more nuanced understanding of the interplay between mind, language, and literary imagination in diverse global contexts.

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6. CONCLUSION

This study demonstrates that age of English acquisition significantly modulates the neural integration of mind, language, and literary imagination in bilingual brains. Early Telugu-English bilinguals exhibited stronger functional connectivity between the default mode network and core language regions during literary reading and imaginative engagement, which was strongly associated with higher narrative transportation and more vivid mental imagery. In contrast, late bilinguals showed weaker DMN–language coupling and greater recruitment of executive control networks, reflecting increased cognitive effort for equivalent imaginative simulation. These findings establish that bilingual experience does not merely affect language efficiency but fundamentally shapes the way the mind constructs literary worlds through English.

The results carry clear practical implications for bilingual education and literature pedagogy. In multilingual societies such as India, where English literary texts form a central part of school and university curricula, awareness of age-of-acquisition effects can guide more responsive teaching practices. Early bilingual learners may naturally engage more fluently with literary imagination, while late bilingual learners can benefit from targeted pedagogical interventions—such as guided visualization exercises, immersive narrative tasks, and explicit imagery-training activities—to strengthen DMN–language integration. Such approaches can promote more equitable access to the cognitive, emotional, and aesthetic benefits of literary reading and inform curriculum design in English Language & Linguistics programs.

a) Limitations

The study was conducted with a relatively modest sample of Telugu-English bilinguals from Andhra Pradesh, limiting generalizability to other language pairs and cultural settings. The cross-sectional design precludes firm causal claims about developmental trajectories, and the controlled fMRI environment, although necessary for precise measurement, may not fully reflect naturalistic reading experiences outside the scanner.

b) Future Work

Future research should extend this work by examining diverse bilingual populations across different World Englishes contexts, adopting longitudinal designs to track changes in connectivity over time, and exploring a wider range of literary genres and stylistic features. Investigating whether targeted training or digital/AI-assisted literary activities can enhance imaginative simulation in late bilinguals also represents a promising direction. Ultimately, continued investigation in this area will refine neurolinguistic models of literary cognition and support more inclusive pedagogical practices that honor the rich linguistic diversity of bilingual minds.

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