



Neural Correlates of Body-Object Interaction Effects in Word Reading: An fMRI Study*

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ABSTRACT

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The amodal symbolic model and the embodied cognition model offer distinct perspectives on conceptual knowledge or processing. While the amodal symbolic model views concepts as abstract and independent from sensory and motor experiences, the embodied cognition framework posits that concepts are grounded in sensory and motor experiences. This study investigates the neural underpinnings of the Body-Object Interaction (BOI) effect during word reading using functional magnetic resonance imaging (fMRI). Participants read high and low BOI words while their brain activity was monitored. Our findings revealed significant activation in the left inferior frontal gyrus (Broca's area), insula (BA 13), and supramarginal gyrus (BA 40) for high BOI words compared to low BOI words. These results support the embodied cognition model, suggesting that understanding high BOI words involves reactivating sensory and motor experiences associated with the words' referents. The study advances the ongoing debate between the amodal symbolic and embodied cognition models and offers insights into the neural mechanisms of language comprehension, with potential applications in education, therapy, and artificial intelligence.

KEYWORDS

embodied cognition, Body-Object Interaction(BOI), amodal symbolic model, fMRI, word reading, Broca's area

1. Introduction

The amodal symbolic model and the embodied cognition (henceforth, EC) model offer distinct perspectives on conceptual knowledge or processing. The amodal symbolic model views concepts as abstract and independent from sensory and motor experiences (Fodor 1975, Smith 1978, Pylyshyn 1984). Conceptual processing is argued to be centralized in specific brain regions, typically associated with higher-level cognitive functions. These areas operate independently of the sensory and motor systems. In contrast, the EC framework posits that concepts are not stored in an abstract, amodal format (Barsalou 1999, 2008, Pecher and Zwaan 2005, Gibbs 2006, Semin and Smith 2008). Instead, they are grounded in sensory and motor experiences. For example, understanding the word “kick” involves reactivating the sensory and motor experiences associated with kicking. This perspective suggests that understanding concepts is not solely confined to abstract mental representations but is deeply rooted in sensorimotor experiences. Conceptual processing is taken to be distributed across various brain regions, including those involved in sensory and motor functions. These regions work together to create a unified conceptual experience.

One of the ways that embodied cognitive processes can be investigated is using the concept of BOI, which measures the perception of the ease with which a human body can physically interact with a word’s referent. Previous behavioral research has demonstrated that high BOI words (e.g., “belt”) are processed more efficiently than low BOI words (e.g., “sun”) during reading tasks (Siakaluk et al. 2008a, Siakaluk et al. 2008b), as evidenced by shorter gaze durations and fewer regressions in eye-tracking studies (Philips et al. 2012). These findings indicate that sensorimotor information is integral to lexical semantics.

Despite these behavioral insights, the neural mechanisms underlying the BOI effect remain largely unexplored. Identifying the brain regions involved in processing high versus low BOI words could provide a neural basis for the EC theory and reveal how sensorimotor experiences influence language comprehension. Functional magnetic resonance imaging (fMRI), with its ability to capture brain activity in response to specific cognitive tasks, offers a powerful tool to investigate these neural correlates.

In this study, we aim to elucidate the neural underpinnings of the BOI effect during word reading using fMRI. Participants will read high and low BOI words while their brain activity is monitored. By identifying the neural correlates of the BOI effect, this study aims to contribute to a more comprehensive understanding of how embodied experiences shape language comprehension. The findings will provide insights into the broader question of how the brain integrates sensory and motor information with linguistic processes. This research has the potential to inform educational strategies, therapeutic interventions, and artificial intelligence models that seek to mimic human language understanding.

There are two research questions in the current study as follows:

1. How do high BOI words compared to low BOI words influence brain activation patterns, particularly in regions associated with motor planning and sensorimotor integration?
2. Do high BOI words elicit greater activation in the left inferior frontal gyrus, insula, and supramarginal gyrus, as predicted by the EC model?

Based on the EC model, we hypothesize that high BOI words compared to low BOI words will elicit greater activation in brain regions associated with motor planning/execution and sensorimotor integration, such as the left inferior frontal gyrus (Petrides and Pandya 2009, Price 2012) often referred to as Broca’s area (typically encompassing Brodmann Areas 44 and 45), left insula (Dronkers 1996), and left supramarginal gyrus (Hickok

and Poeppel 2007, Binder et al. 2009). The rationale behind this hypothesis is that the EC model suggests that understanding language involves mentally simulating the actions and experiences described by the words. High BOI words, therefore, trigger more simulations in the brain's motor and sensory systems, as if the individual were performing the actions themselves.

An alternative hypothesis based on the amodal symbolic model posits that the activation patterns for high and low BOI words should be largely similar, as both types of words are processed through abstract, amodal representations. Any differences in activation are expected to be minimal and not localized to sensorimotor regions. In other words, the amodal symbolic model does not predict significant activation in sensorimotor regions such as the left inferior frontal gyrus, insula, and supramarginal gyrus (part of the left inferior parietal lobule) when processing high BOI words compared to low BOI words. This is because the model posits that conceptual processing is abstract and not tied to sensory or motor experiences. These predictions contrast with those of the EC model, which emphasizes the involvement of sensorimotor areas in processing high BOI words.

By addressing these research questions and testing these hypotheses, this study aims to provide a clearer understanding of the neural mechanisms underlying the BOI effect and contribute to the ongoing debate between the amodal symbolic and EC models.

2. Previous Studies

One of the earliest investigations into the BOI effect was conducted by Siakaluk et al. (2008a) and Siakaluk et al. (2008b). The researchers employed a standard lexical decision task, a phonological lexical decision task, a semantic categorization task, and a semantic lexical decision task. Their findings indicated that participants were faster and more accurate in responding to high BOI than to low BOI words in all of these tasks, suggesting that sensorimotor information or bodily experience facilitates lexical access.

Eye-tracking technology has provided additional insights into the BOI effect during reading. Philips et al. (2012) investigated the influence of BOI on eye gaze behavior during reading. The study found that words with high BOI (e.g., “cat”) lead to shorter gaze durations and fewer regressions compared to words with low BOI (e.g., “sun”). These results align with the EC perspective, suggesting that sensorimotor experiences are integrated into semantic processing even during natural reading tasks.

Neuropsychological studies have also contributed to understanding the BOI effect and the EC theory. For instance, Hauk et al. (2004) utilized event-related fMRI to demonstrate that action words associated with face, arm, or leg actions (e.g., “lick,” “pick,” or “kick”) activated distinct regions along the motor strip during a passive reading task. These activated regions were either directly adjacent to or overlapped with areas triggered by actual movements of the tongue, fingers, or feet. While this study did not specifically address the BOI effect, it provides direct evidence that sensorimotor information is integral to lexical-semantic processing. Relatedly, in their fMRI study, Raposo et al. (2009) examined neural activation patterns as participants listened to arm- and leg-related verbs presented in three different contexts: isolation (e.g., “kick”), literal sentences (e.g., “kick the ball”), and idiomatic sentences (e.g., “kick the bucket”). The study revealed significant activation in motor regions when action verbs were presented in isolation, and to a lesser extent, in literal sentential contexts. However, when the same verbs were presented in idiomatic contexts, no activation was observed in the motor and premotor cortices. These findings suggest that motor responses to action verbs are context-dependent rather than automatic and invariant.

Additionally, Kemmerer et al. (2008) conducted an fMRI study in which participants' brains were scanned

while they made semantic judgments involving action verbs (e.g., “run”, “jog”, “walk”). According to the EC framework, the researchers hypothesized that action verbs would activate the primary motor and premotor cortices. Their findings confirmed this hypothesis, thereby supporting the EC theory. Also, Fernandino et al. (2013) investigates how Parkinson’s disease (PD) affects both automatic and controlled processing of action verbs. It reveals that PD patients with motor impairments exhibit greater difficulty processing action verbs compared to abstract verbs, particularly in tasks requiring explicit semantic judgments. This supports the hypothesis that the motor system plays a critical role in the semantic processing of action-related words, thereby supporting the EC theory.

Research into the developmental aspects of the BOI effect has shown that it is present in children as well. In Wellsby and Pexman (2014), the BOI effect on children’s naming behavior was evaluated using a composite measure derived from their response latency and accuracy data. The findings indicated that younger children (aged 6 to 8 years) did not exhibit a BOI effect, whereas older children (aged 8 to 10 years) demonstrated a facilitatory BOI effect in which high BOI words were named more quickly and accurately than low BOI words. Wellsby and Pexman suggested that for older children, high BOI words triggered more enriched semantic representations due to prior sensorimotor experiences. These enriched representations, coupled with the older children’s relatively more advanced reading systems, resulted in the facilitatory BOI effect. This suggests that the integration of sensorimotor information into lexical semantics occurs early in development and may play a role in language acquisition. Relatedly, James and Maouene (2009) examined neural activation patterns in children during verb and adjective processing using fMRI. Children aged 4 to 6 passively listened to lists of verbs and adjectives while their neural activation was monitored. The results revealed distinct processing mechanisms for verbs and adjectives; verbs activated motor systems in the frontal cortex during auditory perception, whereas adjectives did not. This finding suggests that in the developing brain, there is a connection between sensorimotor experiences and language processing, as action-related words stimulate the corresponding motor areas of the brain.

Several theoretical models have been proposed to explain the BOI effect within the framework of EC. The dual coding theory (Paivio 1991) provides a robust framework for understanding the BOI effect by emphasizing the role of dual representations in cognitive processing. High BOI words benefit from being encoded in both verbal and non-verbal systems, leading to enhanced memory, faster recognition, and more efficient processing. This dual coding not only explains the BOI effect but also highlights the importance of integrating sensorimotor and linguistic information in cognitive tasks. Future research can further explore the mechanisms of dual coding and its implications for various domains of cognitive science. Additionally, the perceptual symbol systems theory (Barsalou 1999) posits that perceptual and motor experiences are stored as sensorimotor simulations, which are reactivated during language processing. Specifically, the perceptual symbol systems theory offers a compelling account of the BOI effect by grounding cognitive processes in perceptual and motor experiences. High BOI words benefit from richer, more vivid simulations, leading to more efficient processing. This framework not only elucidates the mechanisms behind the BOI effect but also provides a broader understanding of how embodied experiences shape cognitive functions.

The body of research on the BOI effect underscores the importance of sensorimotor information in lexical processing. Studies employing lexical decision tasks and eye-tracking have consistently shown that high BOI words are processed more efficiently than low BOI words. This effect is evident across different age groups and cognitive tasks, supporting the EC theory.

This literature review highlights the robust evidence for the BOI effect within the framework of EC and its implications for understanding the interplay between sensorimotor experiences and cognitive processes. The next

section outlines the methodology of the current fMRI experiment, which compares neural responses with high BOI words and low BOI words.

3. Methodology

3.1 Participants

Fifteen right-handed undergraduate students (ages 20-25; 7 females, 8 males) participated in the study. All participants were native English speakers with normal or corrected-to-normal vision and no history of neurological or psychiatric disorders. Participants provided informed consent and were compensated for their time. This study was approved by the Institutional Review Board at Kyung Hee University. All participants were right-handed according to the Edinburgh Handedness Inventory (Oldfield 1971).

3.2. Material

Forty high BOI and low BOI word pairs were constructed in accordance with the methodology of Phillips et al. (2012), as illustrated in Table 1 (see Appendix for additional examples). High BOI words (e.g., “cat,” “belt”) were characterized by high ratings ($M = 5.63$, $SD = 0.44$) for ease of physical interaction, whereas low BOI words (e.g., “sun,” “case”) received low ratings ($M = 3.33$, $SD = 0.59$), $t(78) = 19.75$, $p < .001$, according to the BOI ratings collected by Tillotson et al. (2008). Additionally, forty non-word fillers were incorporated. The target words were controlled for frequency, imageability, concreteness, and word length to ensure that any observed effects were attributable to BOI. According to Phillips et al. (2012), the high and low BOI word sets did not differ significantly in terms of CELEX normative frequency (Davis 2005), $t(50.35) = 1.10$, $p = .28$; mean normative frequency (Kucera and Francis 1967), $t(78) = 0.57$, $p = .57$; familiarity (Wilson 1988), $t(78) = 0.74$, $p = .47$; concreteness (Wilson 1988), $t(78) = 1.22$, $p = .23$; imageability (Wilson 1988), $t(78) = 0.40$, $p = .69$; bigram frequency (Balota et al. 2007), $t(78) = 0.27$, $p = .79$; and number of orthographic neighbors (Balota et al. 2007), $t(78) = 0.04$, $p = .97$.

Table 1. Experimental Conditions and Example Stimuli

Conditions	Example 1	Example 2
High BOI words	cat	belt
Low BOI words	sun	case

3.3 Procedure

Participants were instructed to determine whether the displayed letter string was an English word or not, by pressing a button as quickly and as accurately as possible using their left hand for a stimulus deemed not to be a word. The reason for instructing them to press the button with their left hand was to prevent confusion in interpreting brain activation in areas such as the motor cortex of the left hemisphere. If the button were pressed with the right hand, it would be difficult to discern whether the activation was due to language processing or the act of pressing the button. This button press was intended to evaluate if subjects paid attention to the task. Since we expected the participants would press keys only for the nonword condition, we excluded the nonword

condition from the fMRI analysis. It is important to note that explicit behavioral responses (accuracy and reaction times) for the high and low BOI word stimuli themselves were not collected, as the primary aim was to investigate neural activity during implicit word reading. The lexical decision task for non-words served as an attentional check. All participants were given a practice session outside the scanner on a subset of the stimuli to familiarize themselves with the task. At the end of the experiment, participants were asked to rate their attentiveness during the task on a scale of 1 (not attentive at all) to 10 (very attentive).

3.4 Paradigm and Stimuli Presentation

As shown in Figure 1, the stimuli were visually presented in blocks of one, two, and three items under the same condition to keep the participants constantly focused on the task. This ‘variable-length block design’ has the advantage of allowing partial sampling of the participant’s performance while maintaining the statistical power of the block design. Presentation and timing of the stimuli were controlled by the E-prime software package (Psychology Software Tools, Inc. 2002). For each condition, 40 words were presented in seven blocks of three words, seven blocks of two words, and five blocks of one word. A dummy block that started the experiment but was not analyzed was included. The reason for presenting more three-word and two-word blocks is due to their higher statistical power. Within a single block, words were presented every three seconds, and the experimental blocks lasted for 3, 6, or 9 seconds. Each block was followed by a 6-second no-stimulus block, indicated by a fixation cross (+). A 6-second no-stimulus block was inserted at the beginning of the experiment, and a 6-second no-stimulus block was presented at the end. The total duration of the experiment was 12 minutes.

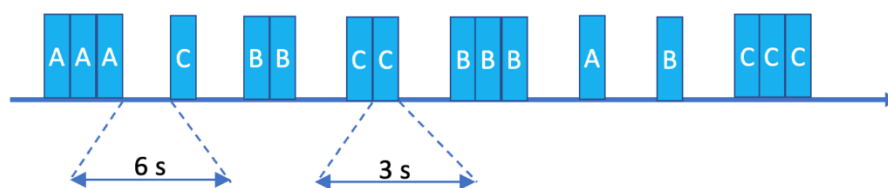


Figure 1. Variable-Length Block Design: Schematic of the Design and Timing Parameters Used in the Experiment

3.5 Data Acquisition, Preprocessing and Statistical Analysis

Participants were scanned using a 3-T MRI system (Siemens Trio 3T magnet) with a standard 12-channel “matrix” head coil. Functional imaging was performed to measure brain activation through BOLD signals. T2* functional images were obtained using continuous echo planar imaging acquisition [66 slices, matrix size, 110x110; slice thickness, 2.0 mm without slice gaps; voxel size, 2.0x2.0x2.0 mm³; repetition time (TR), 3,000ms; echo time (TE), 23 ms; flip angle, 80°; field of view (FOV), 220 mm]. Structural T1-weighted anatomical volumes were acquired using a spoiled gradient recalled echo (sagittal orientation, slice thickness, 0.8 mm; TR, 3,000ms; TE, 1.87 ms; FOV, 256 mm). The preprocessed imaging data (including physiological motion correction, slice-timing correction, co-registration, realignment to a reference image, segmentation, normalization, and smoothing with a 6-mm FWHM Gaussian filter using SPM12 toolbox) were then analyzed using a voxel-wise GLM analysis.

3.6 Univariate GLM Analysis

After applying a high-pass filter with a cut-off frequency of 128 seconds, the fMRI time series for all voxels in the template space underwent a general linear model (GLM) analysis. The analysis used the hemodynamic response function as a regressor and six motion parameters as nuisance regressors, based on the condition-specific timings. First-level (individual-level) GLM analyses were conducted by performing contrasts for each condition per participant.

At the random-effect level (between-subject level), the parameter estimates for each condition from the first-level analyses were used in a flexible design to perform a repeated-measures analysis of variance (ANOVA) using SPM12. In the second-level analysis, the contrasts of interest were as follows: {High BOI words - Low BOI words} and {Low BOI words - High BOI words}. For this group-level analysis, a voxel-level threshold of $p < 0.005$ and an extent threshold of $k > 200$ voxels were set to meet the cluster-level criterion. Cluster-level correction for multiple comparisons was performed, satisfying a cluster-level corrected threshold of topological FDR(False Discovery Rate) < 0.05 (Chumbley et al. 2010).

As a post hoc analysis, MarsBaR software (Brett et al. 2002) was used to calculate percent signal changes for significantly detected clusters by computing 3mm diameter sphere regions around the cluster peaks.

4. Results

Figure 2 and Table 2 summarize the statistical results for contrasts between conditions. Figure 1 shows the increased activation for the high BOI words compared to the low BOI words at the left inferior frontal gyrus, middle frontal gyrus (BA 9), insula (BA 13), and supramarginal gyrus (BA 40). Participants demonstrated high accuracy (mean accuracy $> 95\%$) on the non-word lexical decision task, confirming their sustained attention and engagement throughout the fMRI experiment. However, we found no activated areas for the low BOI words compared to the high BOI words.

Table 2. Increased Activation Areas for {High BOI words – Low BOI words}

Region	BA	MNI Coordinate x,y,z (mm)	Zmax	Csize	
<i>High BOI words > Low BOI words</i>					
Left	Inferior frontal gyrus	47	-40, 30, -2	6.86	3870
	Middle frontal gyrus	9	-44, 20, 32	9.20	-
	Middle frontal gyrus	9	-38, 12, 30	6.48	-
	Insula	13	-30, -42, 26	4.29	260
	Inferior parietal lobule (supramarginal gyrus)	40	-34, -48, 54	3.87	-
	Inferior parietal lobule (supramarginal gyrus)	40	-34, -50, 42	3.78	-
	<i>Low BOI words > High BOI words</i>				
none					

Note: $p < 0.005$ ($t(14) = 2.88$) and Cluster Size > 200 . [BA: Brodmann Area; Zmax: Maximum Z Values of Clusters; MNI: Montreal Neurological Institute Coordinates; Csize: Cluster Size]

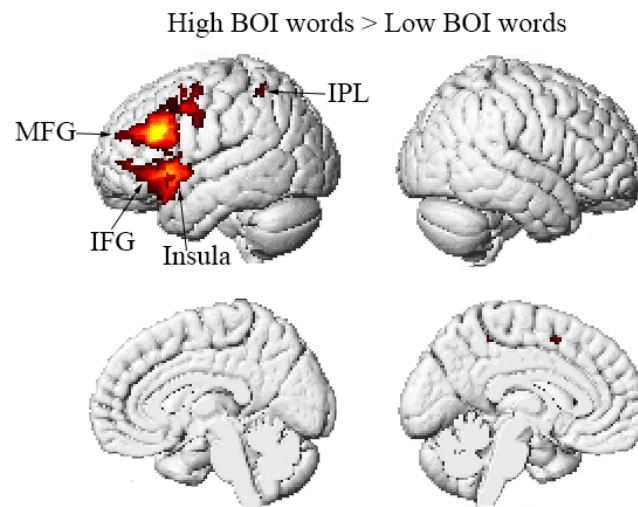


Figure 2. Activation Maps for the {High BOI Words – Low BOI Words} Contrast. IFG: Inferior Frontal Gyrus, IPL: Inferior Parietal Lobule, MFG: Middle Frontal Gyrus

5. Discussion

The present study aimed to elucidate the neural underpinnings of the BOI effect during word reading using fMRI. We hypothesized that high BOI words, compared to low BOI words, would elicit greater activation in brain regions associated with motor planning, execution, and sensorimotor integration, such as the left inferior frontal gyrus (Broca's area), the left insula (BA 13), and the left supramarginal gyrus (BA 40). Our study also predicted that the EC framework would be supported, postulating that high BOI words would activate these sensorimotor-related regions more robustly than low BOI words.

Consistent with the predictions of the present study, the results revealed significant activation in the left inferior frontal gyrus, left insula (BA 13), and left supramarginal gyrus (BA 40) for high BOI words compared to low BOI words. These findings align with the predictions of the EC model, suggesting that understanding high BOI words involves reactivating sensory and motor experiences associated with the words' referents.

The activation in the left inferior frontal gyrus (Broca's area) highlights its role not only in the coordination of the motor aspects of speech articulation (Price 2012) and the planning and execution of complex motor actions (Petrides and Pandya 2009) during language production but also in integrating semantic and motor information during language comprehension (Hauk et al. 2004, Pulvermüller 2005, Willems et al. 2010). This supports the notion that understanding high BOI words involves simulating the actions and experiences described by the words, requiring the engagement of motor planning and sensorimotor regions, thereby confirming the prediction of the EC model. This mental simulation can be conceptualized as a form of embodied imagery, requiring the engagement of motor planning and sensorimotor regions.

The activation of the left insula is consistent with its role in interoception (Critchley et al. 2004), emotional processing (Phan et al. 2002), and coordination of the motor aspects of speech (Dronkers 1996). This finding indicates that high BOI words may evoke more vivid and emotionally charged simulations, engaging the insula

to integrate these sensory and motor experiences.

The activation in the left supramarginal gyrus supports its involvement in phonological processing (Price 2012, Hickok and Poeppel 2007), semantic processing (Binder et al. 2009), spatial awareness (Corbetta and Shulman 2002), tool use (Johnson-Frey 2004) and motor planning (Buxbaum et al. 2005). This region's engagement suggests that high BOI words require the integration of phonological, semantic, sensory and motor information, facilitating more efficient processing.

However, the significant activity elicited by the high BOI condition in the left middle frontal gyrus (BA 9), which is not directly associated with sensory-motor areas, can be attributed to this region's involvement in higher-order cognitive functions. These higher-order functions encompass working memory, which includes the temporary storage and manipulation of information necessary for complex cognitive tasks (D'Esposito et al. 1995), and cognitive control, which involves regulating thought processes and actions in accordance with goals and intentions (Miller and Cohen 2001). The activation observed in this region suggests that processing high BOI words may require greater cognitive resources for integrating sensory and motor information with linguistic content.

Our findings extend previous behavioral research on the BOI effect by providing neural evidence for the EC framework. Earlier studies, such as those by Siakaluk et al. (2008a) and Siakaluk et al. (2008b), demonstrated that high BOI words are processed more efficiently than low BOI words. Our fMRI results corroborate these findings, showing that high BOI words engage brain regions associated with sensorimotor processing, thereby facilitating more rapid and efficient processing.

Neuropsychological studies, such as those by Hauk et al. (2004) and Raposo et al. (2009), have shown that action-related words activate motor areas of the brain. Our study builds on this evidence by demonstrating that high BOI words, which are closely tied to physical interactions, also activate these sensorimotor regions more robustly than low BOI words.

The results of the present study provide strong support for the EC model, which posits that conceptual processing is grounded in sensory and motor experiences. The activation of sensorimotor regions for high BOI words relative to low BOI words suggests that understanding these words involves reactivating the associated physical experiences, supporting the idea that cognitive processes are deeply rooted in bodily interactions.

In contrast, the amodal symbolic model, which predicts minimal differences in activation between high and low BOI words, is not supported by our findings. The lack of significant activation in sensorimotor regions for low BOI words suggests that abstract, amodal representations do not account for the observed neural differences.

The insights from this study have potential applications in various domains. Incorporating physical interactions and sensory experiences in teaching methods could enhance vocabulary acquisition and language comprehension, especially for young learners. For instance, in English language education, pedagogical approaches that actively engage learners' sensorimotor systems, such as Total Physical Response (TPR) or multisensory approaches to vocabulary learning, could leverage the BOI effect to facilitate deeper conceptual understanding and retention of new English words. Rehabilitation programs for language impairments could benefit from strategies that engage sensorimotor systems, such as action-based therapies and multisensory integration techniques. Understanding the neural mechanisms underlying the BOI effect can inform the development of AI models that mimic human language processing, leading to more natural and intuitive human-computer interactions.

While our study provides valuable insights into the neural correlates of the BOI effect, it has some limitations. The sample size was relatively small, which may limit the generalizability of the findings. Despite the small sample size, significant activation patterns were observed, indicating that the study's design was sufficiently

sensitive to detect the specific effects found. Additionally, while our study focused on the neural activation associated with high and low BOI words, future research could explore the temporal dynamics of these activations using techniques such as magnetoencephalography (MEG) or electroencephalography (EEG). Longitudinal studies could also examine how the BOI effect develops over time and its impact on language acquisition and cognitive development. Finally, while this study provided neural evidence for the BOI effect, a limitation is the absence of in-scanner behavioral data (reaction times and accuracy) for the word stimuli themselves. Future research could integrate such behavioral measures within the fMRI paradigm to further triangulate neural and behavioral findings.

6. Conclusion

Our study provides compelling neural evidence for the EC model, demonstrating that high BOI words elicit greater activation in brain regions associated with motor planning and sensorimotor integration. These findings highlight the importance of sensorimotor experiences in language comprehension and contribute to a deeper understanding of the neural mechanisms underlying the BOI effect. By bridging the gap between behavioral and neural evidence, our research advances the ongoing debate between the amodal symbolic and EC models, offering new insights into the interplay between sensory, motor, and linguistic processes.

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Examples in: English

Applicable Languages: English

Appendix

A. 20 sample stimuli of high BOI words and low BOI words

	High BOI words	Low BOI words
1	priest	knight
2	ham	hog
3	mate	gang
4	sword	witch
5	gate	lane
6	cat	sun
7	belt	case
8	goat	herd
9	wheel	coast
10	drill	brain
11	mat	tar
12	silk	lint
13	child	heart
14	cart	loot
15	purse	frost
16	seat	well
17	toy	ash
18	cord	seal
19	thing	place
20	pie	zoo