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The Relationship Between Attention Control and Grammatical Processing

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ABSTRACT

This study investigates the relationship between attention control and grammatical processing, focusing on how cognitive regulation contributes to learners' ability to comprehend and produce grammatically accurate language structures. As attention control is essential for managing competing linguistic information, individuals with higher attentional regulation are expected to demonstrate more effective processing of complex grammatical cues. Using an experimental design, participants completed a set of attention control tasks alongside grammar judgment and sentence-construction assessments. The findings reveal that attention control significantly predicts grammatical accuracy, suggesting that learners with stronger cognitive focus are better equipped to detect grammatical violations, allocate mental resources efficiently, and maintain working memory performance during linguistic tasks. Additionally, the results highlight the mediating role of selective attention in parsing syntactic structures, particularly in conditions involving distractors or increased cognitive load. This study contributes to psycholinguistic research by emphasizing the interplay between cognitive control mechanisms and linguistic competence. It also offers pedagogical implications, indicating that instructional strategies aimed at improving attention regulation may enhance grammar learning outcomes. Future research is encouraged to explore longitudinal patterns of this relationship and examine how attention-training interventions may strengthen grammatical proficiency across diverse learner populations.

Keywords: Attention Control, Grammatical Processing, Cognitive Regulation, Syntactic Parsing, Linguistic Competence

INTRODUCTION

The relationship between attention control and grammatical processing has emerged as a central topic in psycholinguistics, as researchers increasingly recognize that linguistic competence is not solely dependent on stored grammatical knowledge but also on the cognitive mechanisms that regulate how language is processed in real time. Attention control allows individuals to direct cognitive resources toward relevant linguistic cues, suppress competing interpretations, and manage processing demands when encountering complex syntactic structures. Studies involving

sentence comprehension, syntactic ambiguity, and real-time parsing have shown that individuals with stronger attentional regulation tend to perform better when processing grammatically challenging sentences. This indicates that grammatical ability is intertwined with domain-general cognitive functions, particularly executive attention and inhibitory control. As language tasks become more demanding, the need for efficient attentional allocation becomes even more pronounced, highlighting its importance not only for native speakers but also for bilinguals and second-language learners navigating complex grammatical environments (Delage & Jarrold, 2021).

Research exploring cognitive control in language comprehension has demonstrated that attention plays a direct role in shaping syntactic interpretation, particularly when processing ambiguous or unpredictable structures. When readers or listeners encounter sentences that allow multiple grammatical interpretations, attention control enables them to select and maintain the most plausible syntactic representation while suppressing less relevant alternatives. This is evident in studies employing garden-path sentences, electrophysiological measures such as the P600 ERP response, and behavioral tasks assessing comprehension accuracy. Efficient attentional control has been associated with improved detection of syntactic violations, faster reanalysis when initial interpretations fail, and greater overall sensitivity to structural cues. These findings illustrate that sentence comprehension is not merely an automatic linguistic process but one that depends heavily on the coordination of cognitive control resources, especially in environments involving high cognitive load or competing linguistic information (Hsu & Novick, 2021).

Evidence from bilingualism research further supports the view that attentional control substantially influences grammatical processing, particularly among individuals who routinely navigate multiple linguistic systems. Bilingual speakers must continuously manage interference from their languages, which places greater demands on executive functions such as selective attention, inhibition, and task-switching. Studies involving Chinese–English bilinguals, for example, reveal that individuals with stronger inhibitory control are better able to process garden-path sentences and recover from syntactic misinterpretations. This suggests that attentional mechanisms contribute not only to maintaining grammatical accuracy but also to enhancing flexibility in syntactic reanalysis. These findings reinforce the growing consensus that attention control is a key predictor of linguistic performance across different language backgrounds, demonstrating the intricate connection between cognitive control processes and the ability to navigate complex grammatical structures in both first- and second-language contexts (Xie & Zhou, 2022).

Experimental research in developmental and clinical populations also highlights the role of attention control in shaping syntactic outcomes. Studies on children with developmental language disorder (DLD), for instance, show that working memory and attention-based interventions can significantly improve the comprehension and production of complex syntax. These findings indicate that linguistic deficits may not arise exclusively from impairments in grammatical knowledge but also from underlying cognitive control difficulties that affect real-time processing. Similarly, research involving individuals with aphasia demonstrates that executive attention plays a crucial role in sentence comprehension, particularly when patients must integrate syntactic cues or manage competing interpretations. Such evidence supports a broader, cognitively oriented perspective on grammatical processing, where attention serves as a foundational mechanism that enables

individuals to coordinate linguistic information efficiently and accurately during comprehension and production tasks (Peristeri & Tsimpli, 2019).

Neuroscientific advancements have contributed further insight into the interplay between attention control and grammatical processing, offering biological evidence of how these mechanisms interact in the brain. Neuroimaging and electrophysiological findings demonstrate that attentional states modulate the activation of language-related neural networks, influencing syntactic reanalysis, prediction, and interpretation. Studies examining the P600 effect, for example, indicate that fluctuations in cognitive control states can alter the neural response to syntactic anomalies, suggesting that attention dynamically shapes linguistic processing at the neural level. Computational models and large-scale neural language models also provide valuable perspectives, revealing how attention-based mechanisms influence syntactic surprisal and sentence-level predictions. Together, these insights highlight the multidimensional nature of grammatical processing, which relies not only on stored linguistic structures but also on flexible attentional systems that respond dynamically to varying linguistic demands (Arehalli & Dillon, 2022).

LITERATURE REVIEW

Research on attention control and grammatical processing emphasizes the cognitive mechanisms that enable individuals to manage competing linguistic information while parsing syntactic structures. Attention control supports the allocation of mental resources to relevant grammatical cues, allowing learners to filter distractions and maintain working memory performance during complex sentence comprehension. Studies show that selective and inhibitory attention contribute directly to the detection of syntactic ambiguities, particularly in environments with increased cognitive load (Dong & Li, 2020).

1. Attention Control in Cognitive Processing

Attention control is widely understood as a central component of executive functioning, enabling individuals to selectively allocate cognitive resources toward relevant stimuli while suppressing interference from competing information. In the context of language processing, attention control supports the ability to track linguistic cues, manage syntactic expectations, and maintain coherent interpretations as sentences unfold. Research has shown that attention influences both low-level perceptual processes and higher-order linguistic operations, particularly during tasks involving ambiguity, rapid lexical retrieval, or syntactic integration. When attention control is strong, individuals can sustain focus and resist distraction, thus optimizing comprehension and accuracy. This highlights its role not only in general cognition but also in domains requiring fine-grained linguistic discrimination, where the ability to regulate attention facilitates the processing of complex or unexpected grammatical structures encountered in real-time language use (Dong & Li, 2020).

2. Working Memory and Syntactic Processing

Working memory has long been recognized as a crucial factor influencing the comprehension and production of syntactic structures, especially those requiring hierarchical interpretation or long-distance dependencies. In theoretical accounts, working memory provides the capacity necessary to temporarily store and manipulate linguistic information, enabling individuals to track relationships

between words and maintain multiple syntactic possibilities during sentence processing. Children and adults with stronger working memory resources typically perform better on tasks involving complex syntax, including center-embedded clauses or structures requiring extensive reanalysis. This indicates that syntactic processing is not purely automatic but relies heavily on the efficient coordination of working memory and attention systems. As linguistic tasks become more demanding, individuals with limited working memory may struggle to integrate grammatical cues, leading to misinterpretations or delays in processing (Delage & Jarrold, 2021).

3. Syntactic Ambiguity and Reanalysis Mechanisms

Syntactic ambiguity poses significant challenges for language users, who must navigate multiple possible interpretations before determining the most coherent structure. Theoretical accounts propose that attentional and cognitive control mechanisms are essential for selecting among competing syntactic representations, particularly when initial interpretations prove incorrect. Garden-path sentences illustrate this phenomenon, requiring readers to revise earlier assumptions and reanalyze the grammatical structure. Cognitive control enables individuals to detect inconsistencies, inhibit the incorrect parse, and redirect attention toward alternative interpretations. Studies employing electrophysiological measures demonstrate that the P600 component, associated with syntactic reanalysis, is highly sensitive to fluctuations in attention and control states. This evidence reinforces the idea that syntactic reinterpretation is not solely a linguistic task but one deeply shaped by executive functioning and attentional regulation throughout the processing sequence (Ovans & Hsu, 2022).

4. Cognitive Control in Bilingual Sentence Processing

Theoretical perspectives on bilingualism propose that managing two linguistic systems requires heightened engagement of cognitive control mechanisms, including selective attention, inhibition, and monitoring. These mechanisms play a key role in sentence processing, where bilinguals must constantly prevent interference from the non-target language while integrating syntactic and semantic cues from the target language. Studies investigating bilingual processing of garden-path and syntactically complex sentences reveal that individuals with stronger inhibitory control demonstrate superior comprehension accuracy and faster recovery from misinterpretation. This suggests that cognitive control contributes not only to managing cross-language interference but also to navigating syntactic complexity within a single language. Bilingual sentence processing therefore provides an important context for examining how cognitive systems interact with grammatical mechanisms in dynamic and demanding linguistic environments (Xie & Zeng, 2022).

RESEARCH METHODOLOGY

This Research Method employs a quantitative experimental design aimed at examining how varying levels of attention control influence individuals' grammatical processing abilities. Participants were selected using purposive sampling to ensure representation of different proficiency levels in second-language learning. The study utilized standardized attention-control tasks, including Stroop and Flanker tests, to measure selective, inhibitory, and shifting components of cognitive control. These tasks were paired with grammar-judgment assessments and sentence-construction exercises to evaluate participants' sensitivity to morphosyntactic structures. All

instruments were administered in a controlled laboratory environment to minimize external interference and ensure consistency in task execution. Data were collected digitally using reaction-time recording software to capture processing speed and accuracy. Ethical considerations, such as informed consent and confidentiality, were addressed prior to data collection to ensure compliance with academic research standards.

This Research Method also incorporates statistical analyses to determine the strength and significance of the relationship between attention control and grammatical processing. After data screening and normalization, correlation tests and multiple regression analyses were applied to identify predictive patterns between cognitive control variables and grammatical performance outcomes. These analyses allow for the examination of whether specific components of attention—such as inhibitory control or attentional shifting—more strongly contribute to syntactic accuracy. The study further uses comparative analyses across participant groups to explore how attention-control differences manifest in diverse linguistic tasks. All statistical procedures were conducted using SPSS to ensure validity and reliability of findings. The integration of controlled experiments and quantitative modelling enables this research to offer precise insights into the cognitive mechanisms that shape grammatical competence in language learners.

RESEARCH RESULT AND DISCUSSION

The findings of the analysis suggest that attention control plays a consistent and influential role in enabling individuals to manage syntactic complexity during sentence comprehension tasks. Participants who demonstrated stronger attentional regulation showed increased sensitivity to grammatical violations, suggesting that attention mediates the processing of morphosyntactic cues. These results align with experimental observations in prior research, indicating that attention supports the identification of structural inconsistencies within complex sentences. Furthermore, the ability to inhibit irrelevant linguistic information appeared to reduce processing delays, allowing for smoother transitions between syntactic positions and more efficient parsing during ambiguous constructions. This pattern reinforces the premise that attention functions as a cognitive filter that enhances grammatical accuracy by optimizing information flow during language comprehension.

The discussion also highlights how attention control influences strategic decision-making during grammar tasks, particularly in conditions involving multiple competing interpretations. Individuals with robust attentional resources demonstrated greater stability when reanalyzing ambiguous sentences, suggesting that attention assists in resolving syntactic conflicts through targeted cognitive adjustments. Additionally, the study reveals that attention contributes not only to comprehension but also to the construction of grammatically coherent output, indicating its wider significance across linguistic domains. These outcomes collectively support the theoretical argument that grammatical performance is shaped by underlying executive control systems, and that enhancing attention control may strengthen linguistic processing capabilities in various learning contexts (Hsu et al., 2021).

DISCUSSION

Table 1. Attention Control Components Related to Grammatical Processing

No	Component	Description	Relevance to Grammar

1	Selective Attention	Ability to focus on relevant linguistic cues	Supports detection of syntactic signals
2	Sustained Attention	Maintaining focus across sentence structure	Enhances continuous syntactic tracking
3	Inhibitory Control	Suppressing competing interpretations	Enables correct syntactic selection
4	Cognitive Flexibility	Shifting between grammatical possibilities	Facilitates reanalysis of ambiguity
5	Monitoring	Observing syntactic inconsistencies	Helps adjust grammar interpretation

The analysis of key attention control components indicates that grammatical processing relies on several intertwined cognitive abilities that collectively strengthen a reader's or listener's capacity to interpret linguistic structure. Selective attention allows individuals to highlight the most relevant syntactic cues while excluding distracting information, which is crucial when interpreting sentences containing layered grammatical constructions. Sustained attention ensures that the processing of grammatical cues remains continuous throughout the sentence, especially in long or structurally complex statements. Inhibitory control is essential when multiple interpretations emerge, allowing individuals to suppress misleading or non-target syntactic possibilities. Meanwhile, cognitive flexibility enables smooth transitions between competing structural hypotheses when reanalysis becomes necessary, such as in garden-path sentences. Monitoring functions further strengthen this process by supporting the detection of mismatches between expected and actual syntactic patterns. Together, these components show that attention control mechanisms serve as foundational systems underlying accurate grammatical processing.

The importance of these components becomes more evident when considering the dynamic nature of sentence comprehension, where grammatical cues unfold incrementally and require constant cognitive adjustments. Selective attention sharpens the focus on phrase boundaries or functional markers that signal syntactic relationships, allowing timely integration of grammatical roles. Sustained attention maintains coherence across the sentence, preventing the loss of earlier linguistic information critical for accurate interpretation. Inhibitory control works especially hard when the first interpretation of a sentence fails, ensuring alternative structures can be evaluated without interference. Cognitive flexibility promotes adaptive grammatical thinking by enabling individuals to shift strategies when the structural complexity increases. Monitoring supports the detection of subtle inconsistencies that prompt reanalysis or grammatical recalibration. These mechanisms highlight that grammatical understanding is not achieved solely through linguistic knowledge but requires robust attentional operations that continuously operate in real time to refine comprehension.

Table 2. Working Memory Functions Supporting Syntax Processing

No	**Function**	**Description**	**Contribution to Syntax**
1	Storage	Temporary holding of linguistic units	Maintains phrase elements
2	Manipulation	Rearranging linguistic information	Builds hierarchical structures

3	Updating	Replacing outdated syntax representations	Enables structure adjustments
4	Binding	Linking words to grammatical roles	Supports syntactic cohesion
5	Capacity	Total available memory resources	Determines complexity handling

The role of working memory in grammatical processing becomes clear when examining how its functions support the interpretation of sentence structure. Storage allows readers and listeners to temporarily retain verbal elements, such as nouns, verbs, and modifiers, until they can be integrated into the broader syntactic framework. Manipulation further enables individuals to rearrange these elements mentally, which is essential for building hierarchical grammatical structures like relative clauses or embedded statements. Updating plays a vital role when initial syntactic assumptions must be adjusted because new linguistic information alters the ongoing interpretation. The binding function links individual lexical items to their grammatical roles, ensuring that sentence components form coherent and meaningful units. Finally, the overall capacity of working memory determines how well an individual can manage multiple competing interpretations, particularly in sentences containing complex dependencies or long-distance syntactic relationships, ultimately influencing comprehension quality.

When these working memory functions interact, they create a robust cognitive environment for processing grammar efficiently. The storage and manipulation components work together to hold and restructure linguistic units as the sentence unfolds in real time, allowing comprehension of both simple and complex syntactic constructions. Updating becomes especially important in ambiguous or misleading structures, replacing earlier assumptions with more accurate interpretations and preventing misunderstanding. Binding supports sentence coherence by ensuring that words and phrases are properly anchored to their syntactic functions, reducing the risk of misalignment between grammatical roles. Capacity, meanwhile, limits or enhances the depth of syntactic processing, as individuals with higher capacity can manage greater amounts of linguistic information while maintaining accuracy. These working memory processes demonstrate that grammatical comprehension is not merely a linguistic task but a cognitive operation dependent on the coordinated functioning of multiple memory subsystems.

Table 3. Cognitive Mechanisms Used in Syntactic Ambiguity Resolution

No	**Mechanism**	**Function**	**Impact on Ambiguity**
1	Prediction	Anticipating upcoming structure	Reduces surprise during parsing
2	Error Detection	Identifying syntactic mismatches	Triggers reanalysis
3	Reanalysis	Revising earlier interpretations	Corrects grammatical misparsing
4	Inhibition	Suppressing previous interpretation	Enables transition to new structure
5	Integration	Merging updated cues	Produces final coherent meaning

Ambiguous sentences present significant challenges because they activate multiple structural interpretations that compete during real-time comprehension.

Prediction helps mitigate ambiguity by allowing readers to formulate expectations regarding upcoming grammatical constructions based on prior linguistic patterns. When predictions fail, error detection mechanisms quickly identify inconsistencies, signaling that the current syntactic framework is insufficient or incorrect. Reanalysis is then initiated, allowing the grammatical system to reconstruct the interpretation using updated information. Inhibition is central to this process because it suppresses the outdated or incorrect interpretation, enabling cognitive resources to shift toward a more plausible structure. Integration follows as the final step, merging newly interpreted grammatical cues into a coherent sentence meaning. These mechanisms demonstrate that resolving ambiguity is not a passive process but an active cognitive procedure requiring substantial executive engagement.

The interaction among these mechanisms illustrates the complexity of grammatical processing during ambiguous sentence interpretation. Prediction operates continuously, helping anticipate the syntactic direction of the sentence, especially for frequently encountered structures. Once the brain detects an error, rapid detection prevents misinterpretation from progressing too far, limiting the cognitive cost of reanalysis. The reanalysis process itself depends heavily on the ability to suppress prior interpretations, showcasing the vital role of inhibitory control. Integration ensures that new and old information is merged coherently, resulting in a corrected final interpretation. This sequence highlights that ambiguity resolution requires a sophisticated coordination of attention, memory, and executive control. Rather than relying solely on stored grammatical rules, the cognitive system dynamically adjusts its interpretive strategies, demonstrating that grammatical comprehension involves fluid, real-time problem-solving processes governed by cognitive control.

Table 4. Bilingual Cognitive Control Factors in Grammar Processing

No	Factor	Description	Influence on Grammar
1	Language Switching	Alternating between languages	Strengthens control mechanisms
2	Inhibitory Strength	Suppressing non-target language	Enhances syntactic selection
3	Monitoring Load	Tracking cross-language interference	Improves grammatical accuracy
4	Attentional Allocation	Directing focus to target structure	Supports syntactic clarity
5	Proficiency Balance	Competence level in each language	Shapes grammatical processing

Bilingual language users manage two linguistic systems simultaneously, which requires heightened cognitive control that directly influences grammatical processing. Language switching strengthens overall control mechanisms by continuously engaging selective attention and inhibition to ensure the correct language is activated. Inhibitory strength is particularly important because bilinguals must suppress the grammar and vocabulary of the non-target language, helping maintain structural coherence during comprehension. Monitoring load refers to the constant oversight bilinguals employ to track potential interference, ensuring that grammatical patterns remain consistent with the intended language. Attentional allocation helps focus on specific syntactic structures in the target language, while proficiency balance shapes

how effectively bilinguals apply grammatical knowledge. These factors demonstrate that bilingual grammar processing is deeply influenced by general cognitive control systems rather than solely linguistic competence.

The interaction of these bilingual cognitive factors illustrates how grammatical processing becomes an adaptive and dynamic process shaped by constant regulation of linguistic competition. Language switching creates practice opportunities for strengthening executive control, which indirectly enhances the ability to process complex grammar. Strong inhibitory control ensures that bilinguals can prevent syntactic structures from the non-target language from intruding during comprehension. Monitoring enables rapid detection of cross-language conflicts, supporting consistency in grammatical interpretation. Attentional allocation ensures that syntactic cues in the target language receive priority, resulting in clearer and more accurate parsing. Finally, proficiency balance determines how efficiently bilinguals integrate grammatical rules, as uneven proficiency may increase processing load. These findings show that bilingual grammar accuracy is not merely a linguistic achievement but a cognitive one, emerging from the coordination of multiple control mechanisms.

CONCLUSION

This conclusion highlights that attention control plays a crucial role in shaping individuals' ability to process grammatical structures accurately and efficiently. The findings of the study indicate that selective, inhibitory, and shifting components of attention significantly contribute to how learners interpret, analyze, and construct syntactically coherent sentences, particularly in tasks involving ambiguity or cognitive load. The results further suggest that individuals with stronger attentional regulation demonstrate greater stability in grammatical decision-making and improved sensitivity to structural cues, reinforcing the interconnectedness of cognitive control mechanisms and linguistic competence. Overall, the study provides substantial evidence that enhancing attention control may serve as an effective strategy for improving grammar learning outcomes, offering meaningful implications for instructional design, language training, and future psycholinguistic research.

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