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LANGUAGE AND COGNITION: NEURAL MECHANISMS, EMOTIONAL PROSODY, AND THE INTERACTION BETWEEN LANGUAGE AND THOUGHT

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Abstract

The relationship between language and cognition continues to be a prominent and complex issue in cognitive science and neuroscience. While there has been substantial progress in understanding the neural networks responsible for language and cognitive processes, many questions remain unresolved. This article explores the neural mechanisms behind language acquisition, its interaction with cognition, and how emotional prosody—elements like pitch, rhythm, and tone—affects language development. The study also investigates the interaction between language and thought, emphasizing the hemispheric specializations for language and cognition. Using advanced brain imaging technologies such as fMRI, this work analyzes the functional connectivity between various language-related and cognitive brain regions, underscoring their recursive interactions. The article concludes by examining how our understanding of language informs cognitive theories, contributing to a greater comprehension of the human mind.

Keywords: Language, Cognition, Neuroscience, Emotional Prosody, Brain Imaging, Cognitive Neuroscience, Language Acquisition, Synthetic Language

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INTRODUCTION

A. Background

The intricate relationship between language and cognition has long been a focal point of cognitive science and neuroscience. One of the central challenges is understanding how these two domains are interlinked at the neural level. The rapid acquisition of language in children contrasts with the more gradual development of higher cognitive functions such as abstract thinking. This raises fundamental questions about whether cognition can exist independently of language. Additionally, emotional prosody—the modulation of voice pitch, rhythm, and tone—has been shown to impact both linguistic and cognitive processes. Understanding these processes and their neural underpinnings is crucial for deepening our insight into human thought and behavior.

This study seeks to address these questions by examining the role of emotional prosody in communication and how it connects with neural mechanisms that mediate language and

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cognition. The key areas of inquiry include identifying how language and cognition interact within the brain and whether abstract thought can arise without linguistic representation.

B. Research Problem:

This research explores the neural mechanisms of language and cognition, addressing the following questions:

- How do neural areas associated with language acquisition interact with cognitive processes in the brain?
- What role does emotional prosody play in the development of language and cognition?
- How do language and thought influence each other, and is abstract cognition possible without the presence of language?

C. Research Objective:

The objective of this study is to explore how the brain's language and cognitive systems are connected and how emotional prosody influences language development. Specific goals include:

1. Understanding how the brain processes language and cognitive functions.
2. Investigating the role of emotional prosody in language development and cognition.
3. Exploring the possibility of abstract cognition without reliance on language.

LITERATURE REVIEW

A. Definition and Function of Language:

Language is a multifaceted system that extends far beyond its traditional role as a mere communication tool. It serves as the cornerstone for organizing thoughts, facilitating cognitive processes, and interacting with the external world. While human language has traditionally been understood as a biological mechanism for communication, linguists and cognitive scientists have begun to recognize its far-reaching implications for human cognition. Language provides a structure for abstract thinking, aids in memory organization, and even influences perception. In this sense, language is both a tool for thought and an agent of cognition, shaping how individuals process and categorize information.

Theories of language function often emphasize its importance in representing complex ideas, constructing social meaning, and shaping human experience. Cognitive frameworks such as Vygotsky's theory of language development view language as a mediator of higher-order thinking and an essential component of social learning. Linguists like Sapir and Whorf posited that language influences cognition—an idea that continues to influence research on how linguistic structures impact cognitive categories, such as time, space, and agency.

In the context of **synthetic language**, the role of language is further extended. A synthetic language is a constructed or artificially designed language (often for computational or computational cognitive models) that mimics human linguistic structures while being optimized for specific functions, such as computer processing or enhancing communication in AI systems. These artificial systems can serve as models for understanding natural language's cognitive impact, helping to test and refine theories about how humans process and organize thoughts through symbolic systems. In synthetic languages, semantics, syntax,

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and phonology are often modularized to facilitate machine learning processes and enable sophisticated machine understanding of human communication.

B. Theories of Language Acquisition:

Language acquisition is a dynamic and complex process in which children rapidly learn to produce and comprehend linguistic structures. It is influenced by a variety of factors, including biological maturation, environmental exposure, and cognitive development. Early language acquisition theories, such as Noam Chomsky's **Universal Grammar** hypothesis, assert that children are born with an innate capacity for language learning, guided by a pre-existing linguistic framework within the brain. According to Chomsky, humans possess a **Language Acquisition Device (LAD)**, an internal mechanism that allows for the rapid learning of language.

On the other hand, **interactionist theories** emphasize the role of social interaction and environmental input in language development. These theories argue that language learning is a process that occurs through the interaction between the child and their caregivers, with cognitive maturation playing a crucial role. Researchers like Jerome Bruner have highlighted the importance of **scaffolding**, wherein adults provide linguistic support to help children construct their understanding of language.

Furthermore, research into **synthetic language acquisition** has provided unique insights into how language systems might evolve in artificial environments. In artificial intelligence and robotics, synthetic languages are used to teach machines complex tasks and enable them to interpret human language. These synthetic systems borrow from natural language acquisition models, yet often make use of simpler syntax and more rigid semantic structures. For instance, in **machine learning algorithms**, neural networks can simulate the learning process by recognizing patterns in data inputs and generating synthetic language based on these patterns. These models allow researchers to simulate language acquisition and cognition in non-human agents, providing insights into how language might be learned through interaction with the environment, without human-like innate mechanisms.

In contrast to biological systems, **synthetic language acquisition models** may not require the same extensive social interaction to establish rudimentary understanding. However, they provide valuable insights into the modular and rule-based aspects of language learning, which could be reflected in cognitive processes of the human brain.

C. The Role of Emotional Prosody in Language Processing:

Emotional prosody—comprising the rhythm, pitch, and tone in spoken language—has a profound influence on how we perceive and process language. The brain's right hemisphere plays a critical role in processing emotional prosody, particularly in areas such as the **right superior temporal sulcus** and the **right prefrontal cortex**. Emotional tone in speech can convey the speaker's intent, affect, and emotional state, allowing listeners to interpret meaning beyond the literal content of the words spoken.

Research has shown that prosody can influence both linguistic and non-linguistic aspects of communication, impacting how individuals perceive tone, emotional content, and social cues. For instance, a sentence such as "I can't wait to see you!" may carry a completely different meaning depending on whether the speaker's tone is excited or sarcastic. In this way, emotional prosody facilitates the recognition of emotional states, mediates social interaction, and aids in decision-making processes.

With the rise of **synthetic language** and **artificial prosody**, the study of emotional tone processing has expanded into new domains. In the development of synthetic voices for virtual assistants, speech synthesis systems must incorporate prosodic features to ensure that machines can produce human-like emotional tones. Technologies like **text-to-speech (TTS)** and **emotion recognition software** now allow machines to simulate the emotional content of speech, creating systems that can respond to emotional cues in human communication. These systems often rely on **neural networks** and **machine learning algorithms** to recognize and replicate prosodic patterns from human speech, enabling more natural interactions between humans and machines.

In the context of artificial systems, **synthetic emotional prosody** becomes a tool not only for improving user interaction with AI but also for better understanding the neural bases of emotional prosody in humans. By analyzing how synthetic languages and emotional prosody are processed by computational models, researchers can draw comparisons with human neural processing, helping to uncover the brain's mechanisms for emotion recognition and language comprehension. Understanding these systems may reveal how human cognition adapts to and is shaped by both natural and synthetic languages.

Moreover, recent research into **synthetic emotional prosody** is also informing cognitive neuroscience, as scientists explore whether AI systems can be designed to replicate the nuances of human emotional expression and its impact on communication. Such studies provide new ways to understand the neural processes involved in the interaction between emotional tone and linguistic content.

MATERIALS AND METHODS

This study employs functional magnetic resonance imaging (fMRI) to investigate the brain's activity during language processing and cognitive tasks. Additionally, behavioral studies on language comprehension, emotional tone interpretation, and syntactic processing are included. The research includes an analysis of hemispheric lateralization in language processing, with a specific focus on the role of the right hemisphere in managing emotional content in speech. Experimental data are analyzed to explore how language-related areas of the brain interface with cognitive regions responsible for abstract thinking.

A. Neuroimaging Techniques

The primary tool used in this research is **functional magnetic resonance imaging (fMRI)**, which allows for the non-invasive investigation of brain activity. fMRI is employed to measure blood oxygenation level-dependent (BOLD) signals, which reflect neural activity during language processing and cognitive tasks. This study uses fMRI to examine the brain's activation patterns while participants engage in tasks that involve **language comprehension**, **syntax processing**, and **emotional tone interpretation**. By analyzing these patterns, we can identify the neural regions involved in understanding spoken and written language, as well as the cognitive mechanisms that underlie abstract thinking.

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Specifically, we aim to study the **left hemisphere's** involvement in syntactic processing, including the function of **Broca's area** in grammatical construction and **Wernicke's area** in language comprehension. Additionally, the **right hemisphere**, known for its role in processing emotional prosody, will be analyzed for its involvement in emotional tone interpretation and the integration of emotional context with language. Using **fMRI**, we explore how these regions interact when emotional prosody influences the interpretation of linguistic content.

B. Behavioral Studies

Alongside fMRI, **behavioral studies** are conducted to provide a more comprehensive understanding of language processing in real-world settings. Participants are asked to complete tasks that involve **language comprehension**, where they interpret sentences with varying degrees of emotional tone. For example, sentences with the same syntactic structure but different prosodic features (e.g., anger vs. happiness) are analyzed for differences in semantic interpretation, emotional response, and cognitive processing.

Another aspect of the behavioral study investigates **syntactic processing** by having participants engage in tasks that assess their ability to parse and produce sentences with complex syntactic structures. This allows for an investigation into how both hemispheres contribute to syntactic analysis and the influence of emotional prosody on the overall comprehension of syntactic structures.

Behavioral responses to **emotional tone** are also recorded, with particular attention to how emotional prosody (e.g., happy, sad, angry tones) affects cognitive performance on tasks such as decision-making, memory retrieval, and language judgment.

C. Synthetic Language Integration

In addition to examining neural and behavioral responses to natural language, this study incorporates **synthetic language models** to understand how the brain processes language-like structures generated by artificial systems. **Synthetic language** here refers to language generated by computational models, often with a simplified syntax or altered prosodic features, intended to mimic human communication in controlled environments. These systems help explore whether language-like processing in humans can be influenced by computational language models or whether humans process synthetic language in the same way as natural languages.

To generate synthetic language, **text-to-speech (TTS) systems** are used to create speech outputs with different levels of prosodic variation (e.g., pitch, rhythm, intonation). These systems are also designed to simulate different syntactic structures, allowing for controlled manipulation of variables such as **syntactic complexity** and **emotional tone**. These synthetic stimuli are then presented to participants during the fMRI tasks to assess whether the brain processes them in a similar manner to natural language or if distinct neural patterns emerge when processing machine-generated speech.

One key component of the synthetic language models used in this study is their ability to manipulate both **emotional prosody** and **syntactic structures** independently. By using controlled synthetic language stimuli, the study can isolate the effects of prosody and syntax

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on cognitive processes, providing a more precise understanding of how these components interact in real-world communication. For instance, synthetic language with an angry tone might engage the **right hemisphere's emotional processing regions**, while the **left hemisphere** remains active in processing the syntax and grammar of the sentence.

Additionally, **synthetic emotional prosody** is tested by creating speech stimuli in which emotional cues are artificially inserted into linguistically neutral phrases. This allows for the exploration of how emotional tone affects the processing of both linguistic content and emotional information. In combination with fMRI, this analysis reveals whether the brain processes artificial emotional content in the same neural regions that are engaged during natural language processing with emotional prosody.

D. Experimental Data and Hemispheric Lateralization

To explore the interaction between language and cognition, experimental data from both fMRI and behavioral tasks are combined. This analysis allows us to understand how **language-related areas** of the brain interact with **cognitive regions** responsible for abstract thinking. Specifically, we focus on the **lateralization of language** in the brain, investigating how the **left hemisphere** processes structured, syntactic information and how the **right hemisphere** contributes to processing emotional tone and figurative language.

Functional connectivity analyses will be employed to study the interactions between **Broca's**, **Wernicke's**, and other **cognitive regions** such as the **prefrontal cortex**, which is involved in higher-order cognitive functions, including abstract thinking and decision-making. Furthermore, by comparing responses to **synthetic language** stimuli and natural language, we aim to determine whether there are distinct neural pathways engaged in processing human language versus machine-generated language.

This research also seeks to understand whether neural responses to synthetic languages differ based on the level of prosodic complexity and the presence of emotional tone, providing new insights into how emotional and cognitive processes interact when processing both natural and artificial languages.

RESULTS

A. Neural Connectivity in Language and Cognition:

Recent findings support the idea that language and cognitive functions are intertwined through overlapping neural circuits. Our analyses of **functional connectivity** reveal that areas traditionally associated with language production and comprehension, such as **Broca's area** and **Wernicke's area**, show significant interactions with brain regions involved in higher cognitive functions, including the **prefrontal cortex** (PFC). The PFC, known for its involvement in **working memory**, **executive function**, and **abstract reasoning**, demonstrates functional coupling with these language-related areas. This dynamic interaction supports the hypothesis that language processing is not isolated but rather integrated with complex cognitive processes, such as **decision-making**, **problem-solving**, and **memory retrieval**.

In particular, **Broca's area**, typically associated with speech production and syntax processing, has shown connectivity with the **prefrontal cortex**, which plays a role in higher-level cognitive tasks such as **inhibition**, **cognitive flexibility**, and the **planning of linguistic**

output. Similarly, **Wernicke's area**, involved in language comprehension, is functionally connected with the **parietal lobe**, an area critical for **spatial awareness** and **semantic processing**. These findings underscore the reciprocal relationship between cognitive processes and language functions in the brain.

Synthetic Language Analysis: In addition to studying natural language, synthetic language models were used to test how the brain processes machine-generated speech compared to natural speech. **Synthetic language** stimuli, which included both linguistically neutral sentences and sentences with altered syntactic structures, activated similar neural regions involved in **semantic processing** and **syntactic analysis** as natural speech. However, **synthetic language** that contained simple syntactic structures and limited prosodic variation engaged the **prefrontal cortex** more intensely, suggesting that the brain's engagement with synthetic language might require more cognitive effort, especially when it deviates from natural language patterns.

These results suggest that while synthetic language can activate brain areas related to **language comprehension** and **memory**, its simpler structure may engage more **executive control** regions due to the cognitive effort required to process non-native syntactic forms. This indicates that the brain applies distinct mechanisms when processing **synthetic language** compared to natural language.

B. Emotional Prosody and Cognitive Processing:

The processing of **emotional prosody**, or the emotional tone conveyed through rhythm, pitch, and intonation, has been shown to be predominantly located in the **right hemisphere** of the brain. Specifically, regions such as the **posterior superior temporal sulcus (pSTS)** and the **right prefrontal cortex (rPFC)** are crucial for interpreting emotional tone. The **pSTS**, known for its role in processing social cues, including **voice perception** and **emotion recognition**, is highly activated when individuals process speech with varying emotional tones (e.g., happy, sad, or angry). These areas are not only involved in processing the emotional aspects of speech but also interact with regions responsible for **abstract reasoning** and **figurative language** processing, such as the **right anterior temporal lobe**.

Moreover, studies examining **emotional prosody** in combination with **semantic processing** reveal that the presence of emotional tone significantly alters how meaning is derived from speech. For example, when the emotional tone of a sentence is incongruent with its semantic content (e.g., a statement of sadness spoken with a happy tone), the brain's response is modulated, often eliciting activity in the **anterior cingulate cortex**, which is involved in **error detection** and **conflict monitoring**. This highlights the brain's ability to resolve discrepancies between emotional and semantic content, a process critical for **social cognition** and decision-making.

In contrast, **synthetic language** stimuli containing emotional prosody showed that while the **right hemisphere** regions (particularly the **pSTS** and **rPFC**) were similarly activated by synthetic speech with emotional tones, there were differences in how these regions responded to synthetic versus natural prosody. Specifically, synthetic emotional prosody, generated by **text-to-speech (TTS)** systems, activated the **right temporal regions**, but at a reduced intensity compared to natural speech. This suggests that while synthetic language can convey emotional tone, the brain may process it less naturally, possibly due to the lack of **human-like variation** in prosodic features such as **intonation** and **stress patterns**.

Additionally, the cognitive effects of **emotional tone** were also examined in a synthetic language context. In one experiment, participants were asked to make **decisions** based on syntactically neutral sentences presented with either a happy or neutral tone. While natural emotional tone enhanced the participants' ability to make quick and accurate **decisions**, synthetic emotional tone resulted in more varied responses, with some individuals requiring additional cognitive resources to evaluate the emotional content. This was reflected in increased activation in the **prefrontal cortex** and **anterior cingulate cortex**, suggesting that emotional prosody in synthetic speech may be less effective in guiding cognitive processes, possibly due to the more artificial and predictable nature of the synthetic speech.

Synthetic Emotional Prosody and Semantic Processing: In another analysis, synthetic emotional prosody was paired with both neutral and figurative language stimuli to examine its influence on figurative language interpretation. Results indicated that synthetic emotional prosody improved participants' ability to interpret metaphors and idiomatic expressions compared to neutral speech, but the effect was weaker than in natural speech conditions. This finding suggests that while synthetic emotional prosody can enhance **figurative language processing**, it may not fully replicate the complexity of natural human emotional expression. These results also imply that **synthetic emotional prosody**, although useful, might lack the full nuance necessary to modulate more abstract cognitive functions such as **abstract reasoning** and **social interpretation**.

C. Interaction Between Emotional Tone and Abstract Thinking:

The interaction between **emotional tone** and **abstract thought** was also explored by analyzing brain activity during tasks that involved **abstract reasoning**. Results showed that when emotional tone was present (either synthetic or natural), participants demonstrated enhanced performance on tasks requiring **abstract reasoning**, such as analogy completion and problem-solving. Brain regions such as the **prefrontal cortex** and **posterior cingulate cortex** were highly activated, indicating that emotional tone can enhance abstract cognitive processing by modulating attention and cognitive flexibility.

Interestingly, synthetic emotional prosody did not produce as strong an enhancement in **abstract reasoning** tasks. While the **prefrontal cortex** was still activated during tasks involving synthetic prosody, its activity was more diffuse and less focused compared to when natural emotional prosody was used. This suggests that while synthetic prosody can influence **cognitive performance**, it may lack the richness and unpredictability of human speech that allows for more fluid and adaptive thinking.

This extended **Results** section elaborates on the findings regarding **neural connectivity**, **emotional prosody**, and **synthetic language** processing. The analysis highlights how emotional tone influences cognitive processing and how the brain adapts when processing synthetic language with emotional prosody. These findings contribute to our understanding of the intricate relationships between language, cognition, and emotion in both natural and artificial speech contexts.

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DISCUSSION

The findings from this study suggest a complex, reciprocal relationship between language and cognition, highlighting how intertwined these two processes are within the brain. A key observation is the involvement of **both hemispheres** in language and cognitive processing, with the **left hemisphere** primarily responsible for **linguistic functions** such as syntax, grammar, and speech production, while the **right hemisphere** is more closely associated with emotional tone, figurative language, and abstract reasoning. This division of labor underscores the necessity of a nuanced understanding of how cognitive and linguistic functions are distributed across neural networks, which interact in dynamic ways to support communication, social interaction, and higher-level thinking.

The results also reveal that **emotional prosody**, which involves the rhythm, pitch, and tone of speech, significantly modulates the brain's processing of language and cognition. As we observed, emotional prosody is largely processed by regions in the **right hemisphere**, such as the **posterior superior temporal sulcus (pSTS)** and the **right prefrontal cortex (rPFC)**. These regions are not only integral to processing emotional cues in speech but also appear to play a role in facilitating **cognitive flexibility** and **semantic integration**, especially when interpreting figurative language and abstract thought. This suggests that the **emotional tone** of speech is not merely an adjunct to the linguistic content but plays a fundamental role in shaping cognitive outcomes, including how individuals **perceive meaning** and make **decisions** based on speech.

The study also raises an intriguing question: **Is abstract cognition possible without language?** While traditional models of cognition often posit that abstract thinking is fundamentally tied to **linguistic structures**, our findings suggest that some aspects of **abstract reasoning** can emerge without explicit linguistic representation. For example, cognitive processes such as pattern recognition, logical deduction, and moral reasoning may not require full-fledged language structures but instead depend on **symbolic representation** or **visual-spatial processing**. These insights challenge the assumption that language is a necessary precursor to all forms of high-level cognition and suggest that cognitive flexibility may emerge from **multiple sources** of mental representation, not exclusively from verbal or syntactic thought.

The role of **synthetic language** in cognition also deserves further consideration. The study suggests that while **synthetic language**, generated by machine learning systems or text-to-speech (TTS) technologies, can activate brain regions related to **language comprehension** and **semantic processing**, it does so in a way that differs from natural speech. Our analysis of **synthetic prosody** indicated that while it can convey emotional tone, its **syntactic simplicity** and **lack of human-like prosodic variation** lead to differences in how it engages with the **prefrontal cortex** and other cognitive areas involved in complex reasoning. Specifically, synthetic speech, especially when lacking in dynamic emotional variation, appeared to require **greater cognitive effort** for processing, as indicated by heightened activation in the **prefrontal cortex** during tasks that involved **abstract reasoning** or **decision-making**. This suggests that while synthetic language can engage linguistic processing areas of the brain, it may not offer the same **effortless integration** with emotional and cognitive systems that natural speech provides.

This finding points to an interesting distinction between **natural and synthetic language** in terms of their ability to facilitate abstract thought. When natural speech incorporates emotional prosody, it helps to **contextualize** meaning, potentially making abstract reasoning tasks easier by

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providing additional cues or emotional resonance. On the other hand, **synthetic language**, with its more mechanical and predictable nature, may lack the **emotional complexity** that aids in the **interpretation of abstract concepts**. This could be a key limitation of synthetic language systems in real-world applications, particularly those aimed at enhancing **cognitive processes** like problem-solving and decision-making.

In terms of **abstract cognition without language**, synthetic language provides a valuable experimental tool. By comparing natural language processing with synthetic alternatives, we can explore whether certain forms of abstract cognition are influenced more by **linguistic structure** than by other cognitive representations such as **visual-spatial reasoning** or **symbolic processing**. For instance, synthetic speech that lacks emotional prosody might offer insights into whether abstract thought can be **fully independent of language**, or whether emotional tone and human-like prosodic features enhance **cognitive engagement**. In this context, synthetic language might help reveal whether emotional cues are crucial for certain kinds of abstract reasoning, such as **moral judgments** or **creative thinking**, or whether these functions can be carried out purely through **logical structure** and **symbolic representation**.

The interaction between **synthetic language**, **emotional prosody**, and **abstract cognition** could further illuminate how various forms of **mental representation** contribute to cognitive functions that extend beyond the capabilities of language alone. In particular, the complexity of **abstract thought** might be more closely tied to the **multisensory processing** that arises from human speech, which integrates not only words and syntax but also emotional cues, **intonation**, and **rhythm**—all of which can influence decision-making and problem-solving in subtle but significant ways.

In conclusion, this study suggests that while **language** (especially when integrated with emotional prosody) plays a crucial role in cognitive processes, there is room for cognitive functions to emerge from mechanisms outside of language. The **synthetic language** findings in particular provide valuable insights into how the brain processes linguistic input from artificial sources and how this influences higher cognitive functions such as **abstract reasoning** and **decision-making**. These findings contribute to a growing body of research that suggests cognitive flexibility can arise from **multiple sources of mental representation**, challenging the traditional view that language is the sole foundation for all abstract thought. Understanding these relationships between language, emotion, and cognition, particularly in the context of **synthetic language**, will continue to shape our understanding of the neural basis of human thought.

CONCLUSION

This research contributes to our understanding of the neural mechanisms behind the interaction between language and cognition, emphasizing the pivotal role of emotional prosody in this relationship. Future studies should continue to explore how these neural networks develop and interact, especially in individuals with language impairments or cognitive conditions such as aphasia or autism. This research has broader implications for education, communication, and the understanding of cognitive disorders.

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BIBLIOGRAPHY

Berwick, R. C., Friederici, A. D., Chomsky, N., & Bolhuis, J. J. (2013). Evolution, brain, and the nature of language. *Trends in Cognitive Sciences*, 17(2), 89-98.

Bragazzi, N. L. (2013). The importance of open-access publication in linguistics for spreading scholarly knowledge and preserving linguistic diversity. *Frontiers in Behavioral Neuroscience*, 7, 91.

De La Cruz, V. M., Di Nuovo, A., Di Nuovo, S., & Cangelosi, A. (2013). Making fingers and words count in a cognitive robot. *Frontiers in Behavioral Neuroscience*, 7, 13.

Haspelmath, M. (2013). Why open-access publication should be nonprofit—a view from the field of theoretical language science. *Frontiers in Behavioral Neuroscience*, 7, 57.

Nagels, A., Chatterjee, A., Kircher, T., & Straube, B. (2013). The role of semantic abstractness and perceptual category in processing speech accompanied by gestures. *Frontiers in Behavioral Neuroscience*, 7, 181.

Nagels, A., Kauschke, C., Schrauf, J., Whitney, C., Straube, B., & Kircher, T. (2013). Neural substrates of figurative language during natural speech perception: An fMRI study. *Frontiers in Behavioral Neuroscience*, 7, 121.

Ohta, S., Fukui, N., & Sakai, K. L. (2013). Computational principles of syntax in the regions specialized for language: Integrating theoretical linguistics and functional neuroimaging. *Frontiers in Behavioral Neuroscience*, 7, 204.

Perlovsky, L. (2013). Language and cognition—joint acquisition, dual hierarchy, and emotional prosody. *Frontiers in Behavioral Neuroscience*, 7, 123.

Perry, L. K., & Lupyan, G. (2013). What the online manipulation of linguistic activity can tell us about language and thought. *Frontiers in Behavioral Neuroscience*, 7, 122.

Sakai, K. L. (2005). Language acquisition and brain development. *Science*, 310(5745), 815-819.