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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 48(0)

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Publication Date

2026

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Peer reviewed

New approaches to lexical ambiguity: theory, methods, models, and measures

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Keywords: lexical ambiguity; word meaning; lexical semantics;
word learning; free association; word embeddings

Overview

Lexical semantics sits at the core of cognitive science, yet word meaning is not static: it is shaped by ambiguity, contextual constraints, and learning history (Rodd, 2020; Piantadosi et al., 2012; Trott & Bergen, 2023). A central challenge is to connect experimental evidence of how meanings are learned, accessed, and selected in real time, with computational accounts that scale to the lexicon and capture how senses emerge from language use (Haro & Ferre, 2018; Beekhuizen et al., 2021). This symposium brings together diverse researchers from the Global North and South who use complementary experimental paradigms and computational approaches to study meaning in context, including pupillometry, large-scale word association graphs, contextual embedding models of developmental change, and large language-model analyses of experimental stimulus variability. Together, the talks bridge computational and experimental perspectives on word meaning processing and word sense learning, offering converging insights into how lexical knowledge is represented, updated, and deployed across timescales. In so doing, it pushes back against classic, relatively siloed approaches to studying lexical semantics, highlighting how an interdisciplinary approach to these issues truly is more than the sum of its parts.

Pupil size tracks contextual modulation in lexical ambiguity resolution

Julieta Laurino and Laura Kaczer

Reading or listening to a word often involves seemingly effortless access to its meaning. Yet most words are lexically ambiguous, requiring the language system to select a contextually appropriate interpretation (Rodd et al., 2002). Contextual cues are therefore critical for resolving ambiguity during comprehension. In this talk, I focus on the role of global semantic context, defined as temporally sustained thematic information presented prior to the target

word. Across a series of experiments (Laurino & Kaczer, 2025), we ask whether global context reduces cognitive effort during word processing and whether this effect scales with the degree of lexical ambiguity. Cognitive effort was indexed using pupillometry across two complementary paradigms: a word-association task and a semantic relatedness task. We found that global context reliably biased meaning selection toward context-consistent interpretations and facilitated behavioral performance. Crucially, these behavioral benefits were accompanied by systematic reductions in pupil dilation, indicating reduced cognitive effort during word-meaning processing. Contextual facilitation was strongest for highly ambiguous words, revealing a tight interaction between lexical ambiguity and contextual support. In addition, we found evidence that context provided in a second language facilitates lexical processing in the first language in bilingual speakers. Together, these findings highlight global semantic context as a key organizing force in lexical ambiguity resolution and position pupillometry as a sensitive tool for tracking context–meaning interactions.

Automatic quantification of lexical ambiguity using large-scale word association data

*Ignacio Iglesias, Blair C. Armstrong, Julieta Laurino,
Laura Kaczer and Álvaro Cabana*

Most words in a language are lexically ambiguous, being associated with multiple meanings that differ in frequency and relatedness. Although ambiguity is a fundamental property of language, existing measures face major limitations. Dictionary-based classifications and subjective ratings of meaning number and frequency often fail to capture its graded nature and are also difficult to scale to the full lexicon. Here we introduce a novel, automated framework to quantify lexical ambiguity using word association data from the Small World of Words (SWOW) project (De Deyne et al., 2019; Cabana et al., 2024). We apply community detection to association graphs to estimate

both the number and distribution of semantic communities for each word, allowing us to derive graded representations of meaning frequency and relatedness. We validate these metrics by comparing them to previously published subjective norms and by showing that they predict lexical decision performance in both English and Rioplatense Spanish. Our results also reveal cross-linguistic differences in lexical ambiguity—Spanish is overall less ambiguous than English—which we hypothesize may reflect typological differences between the languages. This framework offers a scalable, automated, and language-independent approach for quantifying multiple facets of lexical ambiguity, and provides new tools for computational and psycholinguistic models of semantic processing.

Discovering regularity and mechanisms of sense acquisition through time

Jiangtian Li, Blair C. Armstrong, and Yang Xu

Prior work in developmental psychology and in the cognitive sciences typically focuses on word acquisition without specifying how different senses within a word emerge through time. To shed light on word sense acquisition, we propose a novel framework grounded in the use theory of meaning and state-of-the-art computational methodologies of contextual word embedding to characterize how children learn the different senses of a word over time. Our framework discovers word senses by forming semantic clusters through natural language use and enables a scalable analysis of 1,270 words from approximately 4 million utterances produced by children (19 - 144 months) and their caretakers (MacWhinney, 2000). The psychological validity of these senses was assessed using dictionaries, a pre-registered experiment examining human judgments of semantic similarity, and evaluation using a large language model. We utilized this framework to test three hypotheses motivated by historical language evolution (Xu et al., 2017; Ramiro et al., 2018). First, we hypothesized that concrete senses of a word tend to emerge earlier than more abstract senses. Second, we proposed that word senses grow incrementally in semantic space through the developmental course. Third, we proposed that algorithms of semantic chaining—how words spawn new senses by extending from existing senses—predict the emerging order of word senses. We found support for all three hypotheses. Our work offers a converging view on the cognitive principles and mechanisms across timescales in the ontogeny and phylogeny of word sense emergence.

Quantifying variability in stimuli in word learning experiments: Insights from large language models

Rebecca Norman, J.S.H. Taylor and Jennifer Rodd

Word learning studies provide important evidence concerning the role of contextual diversity on word learning, but performance is often relatively low and highly variable across items. We used BERT (Devlin et al., 2019) to understand how properties of the training sentences used by

Norman et al., (2023) influenced learning. Each training sentence was presented to BERT with the to-be-learned pseudoword masked (e.g., “Enough proof had [MASK] so the jury could make a fair judgement”) and its top five predictions for the masked target recorded (e.g., “emerged”, “arrived”, etc.). We extracted the similarities between predictions across the training set and how strongly the sentences constrained a specific meaning. We then compared this to human word association data to investigate how these properties influenced learning. Learning performance was better for stimuli where BERT’s predictions across the training set for an item were highly similar in meaning, indicating that word meanings are easier to extract from sentences that promote consistent meanings. In addition, learning was better when training sentences were strongly constraining, at least for items learned in the high-diversity condition. This work highlights how integrating computational models with established paradigms for studying the learning of new words and their meanings can both improve the quality and consistency of stimuli and facilitate the identification of the varied factors that shape learning efficacy.

References

- Cabana, Á., Zugarramurdi, C., Valle-Lisboa, J. C., & De Deyne, S. (2024). The "Small World of Words" free association norms for Rioplatense Spanish. *Behavior research methods*, 56(2), 968-985.
- De Deyne, S., Navarro, D. J., Perfors, A., Brysbaert, M., & Storms, G. (2019). The “Small World of Words” English word association norms for over 12,000 cue words. *Behavior research methods*, 51(3), 987-1006.
- Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2019, June). Bert: Pre-training of deep bidirectional transformers for language understanding. In *Proc. NACL* (pp. 4171-4186).
- Laurino, J., & Kaczer, L. (2025). Pupil size tracks the effects of global context and semantic ambiguity on word-meaning processing. *Journal of Cognition*, 8(1), 42.
- MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk, volume I: Transcription format and programs* (3rd ed.). Psychology Press.
- Norman, R., Hulme, R. C., Sarantopoulos, C., Chandran, V., Shen, H., Rodd, J. M., ... & Taylor, J. H. (2023). Contextual diversity during word learning through reading benefits generalisation of learned meanings to new contexts. *Quarterly Journal of Experimental Psychology*, 76(7), 1658-1671.
- Ramiro, C., Srinivasan, M., Malt, B. C., & Xu, Y. (2018). Algorithms in the historical emergence of word senses. *Proceedings of the National Academy of Sciences*, 115(10), 2323-2328.
- Rodd, J. M., Gaskell, G., & Marslen-Wilson, W. (2002). Making sense of semantic ambiguity: Semantic competition in lexical access. *Journal of Memory and Language*, 46(2), 245-266. <https://doi.org/10.1006/jmla.2001.2810>
- Xu, Y., Malt, B. C., & Srinivasan, M. (2017). Evolution of word meanings through metaphorical mapping: Systematicity over the past millennium. *Cognitive Psychology*, 96, 41-53.