

CogALex VI - 2020

**The Workshop on the Cognitive Aspects of the Lexicon**

**Proceedings of the Workshop**

December 12, 2020  
Barcelona, Spain (Online)

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ISBN: 978-1-952148-39-2

## Introduction

Supporting us in many tasks (thinking, searching, memorizing, categorizing, communicating) words are a key aspect of natural language and human cognition. Yet they are large in number, and complex in form, hence the question, how are they learned, accessed and used? These are typical questions addressed in this kind of workshop that looks at words from a cognitive perspective.

More specifically we are interested in the creation, use and enhancements of lexical resources (representation, organization of the data, etc.). What are their limitations, and how can they be overcome? What are the users' and the engineers' needs (computational aspects)?

Given these goals, the CogALex workshop series, which this year has reached the sixth edition, has become a venue to discuss these issues from multiple viewpoints: linguistics (lexicography, computational- or corpus linguistics), neuro- or psycholinguistics (tip-of-the-tongue problem, word associations), network-related sciences (vector-based approaches, graph theory, small-world problem).

Also, just like in previous workshops (CogALex IV and V) we proposed a 'shared task'. This year the goal was to provide a common benchmark for testing lexical representations for the automatic identification of lexical semantic relations (synonymy, antonymy, hypernymy) in various languages (English, Chinese, etc.). Discovering whether words are semantically related or not – and, if so which kind of relation holds between them – is an important task both in language (writing, production of coherent discourse) and cognition (thinking, categorization). Semantic relations also play a central role in the organization of words in the lexicon and their subsequent retrieval (word access, navigation).

We received 25 submissions of which we accepted 7 for oral presentation, 6 as posters, and 3 as shared task papers (which means, we had overall an acceptance rate of about 65%, and 32% for oral presentations). We were pleasantly surprised to see that a growing number of authors combine work done in linguistics and psychology. Actually, the most highly rated paper came from two teams favorably complementing each other in this respect, which shows that it is possible to work together, and to produce excellent results which may benefit not only the respective teams but also the rest of the community. We hope that such results encourage other researchers or research teams to build on the strengths of other disciplines.

Obviously, none of the results here presented would be possible without the dedication of the authors and the efforts of the reviewers, who have considerably contributed to helping the authors to improve their work. We would like to thank both of them.

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### **Best Paper Award:**

Markus J. Hofmann, Lara Müller, Andre Rölke, Ralph Radach and Chris Biemann.  
*Individual corpora predict fast memory retrieval during reading*

### **Keynote Talk**

Vito Pirrelli (ILC, Pisa, Italy)

*Emerging words in a vanishing lexicon: prospects of interdisciplinary convergence*

In the wake of the 'cognitive revolution' (Miller 2003), scholars believed in a parsimonious form of direct correspondence between grammar rules, their organization and processing principles on one hand, and psychological and even neurological processes on the other. Grammatical rules and syntactic structures were claimed to have psycholinguistic reality, i.e. to be mentally represented, and speakers were believed to use the representations offered by linguists (e.g., Clahsen 2006, Jackendoff 1997, Levelt et al. 1999, Marslen-Wilson and Tyler 1998, Miller and Chomsky 1963). This straightforward assumption has been shared and popularized by Steven Pinker (Pinker 1999, Prasada and Pinker, 1993).

According to the Declarative/Procedural model (Pinker and Ullman 2002), the distinction drawn by linguists between regular and irregular morphology is not just a matter of classificatory convenience, but is motivated by the way linguistic information is processed in the human brain. Different cortical and subcortical areas are recruited to process and retrieve word forms like *walked* and *sang*. The former is decomposed into its sublexical constituents (*walk* and *-ed*), while the latter is stored as a whole. Likewise, the classical organization of the language architecture into two sharply compartmentalized modules, namely a word-based lexicon and a rule-based grammar, was viewed as reflecting the neuro-functional divide between a long-term store of static units (or knowledge of "what") and a procedural system (or knowledge of "how") (Ullman 2002). Accordingly, the irreducible building blocks of language competence are stored in and accessed from a redundancy-free mental lexicon. Rules, in turn, are responsible for the assembly and disassembly of these blocks when complex structures (e.g. morphologically complex words, phrases or sentences) are processed in production or recognition. Despite this seemingly clear division of labour, researchers disagreed considerably on matters of detail. Some of them assume that full words are the minimal building blocks in the mental lexicon (Butterworth 1983, Manelis and Tharp 1977), others claim that only sublexical units are stored (Taft 1979, 2004, Taft and Forster 1975), yet others propose a combination of the two (Baayen 1992, Frauenfelder and Schreuder 1992, Caramazza, Laudanna and Romani 1988, Laudanna and Burani 1985). Nonetheless, the largely dominant view was that storage and computation are distinct processes, subserved by different brain areas, in line with what Harald Baayen (2007) humorously dubbed the 'pocket calculator metaphor'.

This general picture was challenged by the 'connectionist revolution' (Medler 1998, Pirrelli et al. 2020). Multi-layered perceptrons proved to be able to process both regularly and irregularly inflected words with a unique underlying mechanism (Rumelhart and McClelland 1986). Accordingly, morphological structure was not modelled as an all-or-nothing issue. Rather, it was an emergent property of the dynamic self-organization of subsymbolic, distributed representations, contingent on the processing history of input forms. In fact, artificial neural networks appear to mark an even more radical departure from traditional language processing architectures. First, in neural networks, lexical representations are not given but learned. Thus, aspects of how they are acquired and eventually represented are not taken for granted, but lie at the core of connectionist modelling. Secondly, and most importantly, lexical representations and processing routines are not assigned to different components, but they both rest on the same level of weighted connections.

On the one hand, storage implies processing. Network nodes that have been repeatedly activated in processing an input word are the same units representing this word in long-term memory. On the other hand, processing implies storage. The online processing of an input word consists in the short-term re-activation of processing routines that were successfully triggered by the same word in the past. Ultimately, processing and storage only designate two different points in time (i.e. immediate response to stimulus, and response consolidation) of the same underlying learning dynamics.

McClelland and Rumelhart (1986) published their pioneering book on Parallel Distributed Processing 35 years ago. Strange as it may seem, the theoretical consequences of this radical shift of paradigm have not been fully appreciated. In my talk, I will try to reappraise their contribution by showing how it can deal with issues like word representation and processing. In doing so, I will consider evidence from several interrelated lines of research. The first one revolves around evidence from human word processing and lexical acquisition, suggesting that a lot of lexical information is inextricably related to processing. The second line of research focuses on recent advances in the neurobiology of human memory and its tight connection with language processing. Last but not least, I will consider neurobiologically inspired computer models of the language architecture.

Drawing on an analogy with recent developments in discriminative learning and morphological theory (Baayen et al. 2011, Blevins 2016, Ramsar and Gitcho 2007, Ramsar and Yarlett 2007), I will suggest that speakers' knowledge about words is the resulting state of a dynamic, self-organizing process. According to this view, words are abstractions emerging from interrelated patterns of sensory experience, communicative and social interaction and psychological and neurobiological mechanisms (Elman 2009). The information associated with them is hardly ever stable, time-independent or context-independent. Their content is continuously updated and reshaped as a function of the moment (when), the reason (why) and the frequency (how often) of its access and processing. Such flowing activation state is reminiscent of the wave/particle duality in quantum physics (Libben 2016) or the inherently adaptive, self-organising behaviour of biological dynamic systems (Beckner et al. 2009). Hence, if we look for particles (i.e. individual word representations) we may not be able to find them. It all depends on the task or the context.

This discussion leads to an apparently paradoxical state of affairs. We know that the linguists' view of the lexicon as a redundancy-free container of word representations fails to capture our current understanding of how words are accessed, used and processed. Can then we talk about the reality of words in any non-metaphorical or non-epiphenomenal sense? I believe that we can. After all, speakers have lexical knowledge. However, the mental reality of words resides in the collective behaviour of nodes and connections in a lexical network engaged in a particular word processing task. It cannot be deduced from any individual and stable representation. As the context or task changes, also the pattern of these connections will change, and so our perception of individual representations.

Language sciences address different Marr's (1982) levels of understanding of a complex cognitive system. Theoretical linguistics addresses Marr's level one (i.e. what speakers do when they use language), while psycholinguistics is mostly concerned with level two (i.e. how speakers use language), and neurolinguistics with level three (i.e. where in the brain language processes take place). Due to the dominant focus of theoretical linguistics on the basic units of language and the principles of their combination, linguists have laid nearly exclusive emphasis on representation issues. Conversely, psycholinguists and neurolinguists have mainly been concerned with behavioural and physiological evidence of the human processor. As suggested by Anderson (1972), inter-level mapping rarely implies the extrapolation to level Y of properties holding at level X. It is thus not surprising that moving from Marr's level one to another level is often a matter of discovering new laws and concepts, and requires a creative shift from quantitative to qualitative differentiation. Decade-long developments in recurrent neural networks have proved instrumental

in shedding light on the psychological nature of classical linguistic categories and basic units (Elman 2009, Marzi and Pirrelli 2015). Ultimately, they appear to lend support to Poggio's (2010) claim that (language) learning is key to the appropriate methodological unification of Marr's epistemological levels: units in language crucially depend on the way they are acquired, organized and used by the speakers. From this perspective, any attempt to put all these units directly into the speaker's mind is dubious, if not futile.

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# Conference Program

**14:00–14:10 Introduction**

**14:10–15:10 Keynote Talk**

*Emerging Words in a Vanishing Lexicon: Prospects of Interdisciplinary Convergence*

Vito Pirrelli

**15:10–15:30 Break**

**15:30–16:30 Session 1: Oral Presentations**

*Individual corpora predict fast memory retrieval during reading*

Markus J. Hofmann, Lara Müller, Andre Rölke, Ralph Radach and Chris Biemann

*Investigating Rich Feature Sources for Conceptual Representation Encoding*

Lu Cao, Yulong Chen, Dandan Huang and Yue Zhang

*General patterns and language variation: Word frequencies across English, German, and Chinese*

Annika Tjuka

*Less is Better: A cognitively inspired unsupervised model for language segmentation*

Jinbiao Yang, Stefan L. Frank and Antal van den Bosch

## No Day Set (continued)

### 16:30–16:50 Poster Booster and Shared Task Introduction

*The CogALex Shared Task on Monolingual and Multilingual Identification of Semantic Relations*

Rong Xiang, Emmanuele Chersoni, Luca Iacoponi and Enrico Santus

### 16:50–17:50 Poster Session

*Extracting meaning by idiomaticity: Description of the HSemID system at CogALex VI (2020)*

Jean-Pierre Colson

*CogALex-VI Shared Task: Transrelation - A Robust Multilingual Language Model for Multilingual Relation Identification*

Lennart Wachowiak, Christian Lang, Barbara Heinisch and Dagmar Gromann

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*Definition Extraction Feature Analysis: From Canonical to Naturally-Occurring Definitions*

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*Speech Disfluencies occur at Higher Perplexities*

Priyanka Sen

*Bilingual Lexical Access and Cognate Idiom Comprehension*

Eve Fleisig

*Schwa-deletion in German noun-noun compounds*

Tom S Juzek and Jana Haeussler

*Translating Collocations: The Need for Task-driven Word Associations*

Oi Yee Kwong

**No Day Set (continued)**

**17:50–18:00 Break**

**18:00–18:45 Session 2: Oral Presentations**

*Characterizing Dynamic Word Meaning Representations in the Brain*

Nora Aguirre-Celis and Risto Miikkulainen

*Contextualized Word Embeddings Encode Aspects of Human-Like Word Sense Knowledge*

Sathvik Nair, Mahesh Srinivasan and Stephan Meylan

*Automatic Word Association Norms (AWAN)*

Jorge Reyes-Magaña, Gerardo Sierra Martínez, Gemma Bel-Enguix and Helena Gomez-Adorno

**18:45–19:00 Closing Remarks**

