

The Nature and Interaction of Word-Learning Mechanisms Determine How Meanings are Represented

Judith Köhne and Matthew W. Crocker
Saarland University
contact: koehne@coli.uni-saarland.de

People overcome the challenge of word learning in different ways. While there is some agreement regarding the importance of mechanisms such as *cross-situational word learning* (CSWL, Yu & Smith, 2007) and word learning based on the sentence context (sentence-level constraint learning, SLCL, e.g. *syntactic bootstrapping*, Landau & Gleitman, 1985), there is a lack of studies examining the exact interplay of these different ways of word learning. Moreover, there are few investigations of how different learning mechanisms may impact upon the way words are mentally represented and retained. One notable exception is the study by Vouloumanos (2008), which presented evidence for the hypothesis that CSWL proceeds probabilistically and in parallel (see also Yurovsky, Fricker, Yu, & Smith, 2010).

We investigated the nature and interaction of the two word-learning mechanisms – CSWL and SLCL – within a novel two-day experimental paradigm, teaching German adults a semi-natural language (modified Indonesian). Participants were first familiarized with a set of verbs (e.g., *mankemema*, ‘iron’): Actions were simultaneously depicted and named, participants were explicitly asked to memorize these mappings. To those participants who perfectly learned all verbs, 96 noun-learning trials were presented: Spoken SVO sentences, embedding 16 novel object nouns (e.g. *si bintang*, ‘the shorts’), were paired with scenes including potential referents. Nouns had two possible meanings (= referents). One co-occurred with the noun in 83% of the noun’s presentations, the other in 50%. That means that CSWL supported the 83% referent the most. Nouns followed either a restrictive verb (such as *eat*, Condition R) or a non-restrictive verb (Condition N). Restrictive verbs (together with the visual context and learner’s world knowledge), that is, SLCL, also supported the 83% meaning (Ex.1). Nouns were tested forced-choice directly following training and one day after: Either, the 83% object, the 50% object, and two distractors (17%) were selectable (Type 1); or, the 50% object, a category associate (17%) of the 83% object, and two distractors (17%) were depicted (Type 2).

We found that learning rates (83%-object choices in Type 1) were clearly above chance (25%) in both conditions (N: 60%, R: 84%). Moreover, learners were more likely to select the 83% referent in Condition R than N and more likely to select the 50% candidate in Condition N than R. Importantly, in Test Type 2, the 50% referent was preferred over the distractors in Condition N but not in Condition R. In Condition R, on the contrary, there was a clear preference to choose the category associate of the 83% referent. Results from the vocabulary test on Day 2 additionally reveal that learning rates in both conditions were still clearly above chance and only significantly worse than on Day 1 for Condition N.

These results suggest that SLCL (Condition R) completely blocks learner's sensitivity to low-frequency co-occurrence frequencies (83% vs. 50% and 50% vs. 17%), which is not the case for pure CSWL learning. In contrast, SLCL increased learners' sensitivity to category membership. This pattern confirms that while CSWL leads to parallel and probabilistic learning, SLCL is more deterministic and category-based. Finally, while both mechanisms give rise to long-term learning, SLCL learning appears more stable.

(Ex.1)



R: Si laki tambamema si bintang. ‘The man irons the BINTANG.’

N: Si laki tambamema si bintang. ‘The man takes the BINTANG.’

[shorts: 83%, apple: 50%, cheese: 17%, ananas: 17%]

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