Exploring Cross-Situational Learning and Mutual Exclusivity

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Introduction

When hearing a novel word for the first time in a situation with referential uncertainty, the word's meaning cannot be inferred immediately. By combining the information from multiple exposures of a word in varying situations, a cross-situational learner can keep track which referent is consistent through these situations, thus inferring the word's meaning. Various experimental studies have shown that adult and child learners can and do use cross-situational learning (XSL) (Gillette, Gleitman, Gleitman, & Lederer, 1999; K. Smith, Smith, & Blythe, 2011). A question is to what extent human learners use XSL in the purest form (i.e. without additional strategies), and to what extent can they deal with referential uncertainty? An additional strategy to reduce referential uncertainty, such as mutual exclusivity (Markman & Wachtel, 1988), may be required. We are interested in exploring what type of learning strategies participants use when they are unconsciously forced to exploit cross-situational information while being allowed to use mutual exclusivity. We explore seven strategies and compare these to the results of an artificial word learning experiment inspired by Gillette et al. (1999).

Method

We selected 12 objects consisting of a mix of photographs of unusual real-world objects and artificial objects, from the set of 120 objects developed by K. Smith et al. (2011). An artificial language consisting of 12 words was created using a script that randomly generates three consonant-vowel pairs. The participants were instructed to try and find word-meaning mappings during 104 training trials, and tested after each trial. During a post-test, all 12 objects were displayed, accompanied by one word. In total, 78 participants (49 females) aged 16-55 (M = 25.03) were recruited. To obtain insights into the strategies participants use, we compared the experimental results with simulations in which various strategies were modeled.

Which one of these objects is ***havora***?

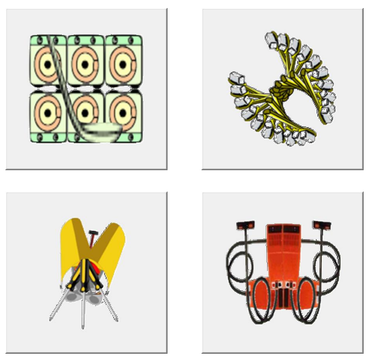


Figure 1a. Training trial

Which one of these objects is ***havora***?

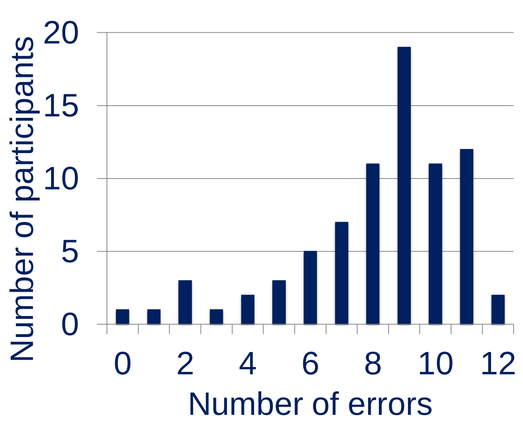
Figure 1b. Post-test trial

Figure 1a & 1b. Examples of displays. Each trial consists of the presentation of an artificial word, a target object, and three filler objects (Figure 1a). Figure 1b displays the twelve stimuli used in the experiment. From left to right and top to bottom: yapono; xiname; puqona; cutuve; hidiko; timilo; cirazu; vapogu; lofoki; havora; lazepo; piwavi.

Conclusion & Discussion

The results show that adult participants learned the set of word-meaning mappings significantly better than a random learner would. However, their performance remained well behind those we observed in all XSL strategies. Furthermore, we observed that the participants performed similar to those strategies that involved mutual exclusivity on the first exposure of each word. Our study confirms that adult participants can learn by using cross-situational information. The results suggest that a random strategy that involves mutual exclusivity as its sole learning mechanism could explain the participants' performance. Nevertheless, we believe further research involving strategies that implement some form of forgetting is required.

Results



Strategy	*M*	*SD*	*t*
Participants	0.51	0.11	-
Random from *C*	0.25	0.01	-172.09
Approx XSL	0.94	0.07	23.195
Pure XSL	1.00	0.00	NA
ME	0.94	0.08	18.667
Random from *C* + ME	0.46	0.15	-1.047
Approx XSL + ME	0.97	0.06	26.925
Pure XSL + ME	1.00	0.00	NA

Table 1. All scores differ significantly from the participants score ($p < .001$), except Random form *C* with ME ($p = .316$). NA means *t* could not be computed, because $SD = 0$.

Words	First exposure of each word	Times seen at first exposure	Mean success	Std. error
yapono	11	3	0.26	.050
xiname	8	0	0.65**	.054
puqona	40	14	0.38*	.055
cutuve	13	6	0.17	.042
hidiko	7	3	0.09**	.033
timilo	1	0	0.21	.046
cirazu	4	2	0.08**	.030
vapogu	3	0	0.36	.055
lofoki	5	2	0.21	.046
havora	10	1	0.27	.051
lazepo	2	0	0.38*	.055
piwavi	42	7	0.32	.053

Table 2. The table shows the success rate for all the words at their first exposure. There is a 25% chance level of choosing the correct target. Significant differences from Random from *C* are indicated: *p < .05; **p < .01.

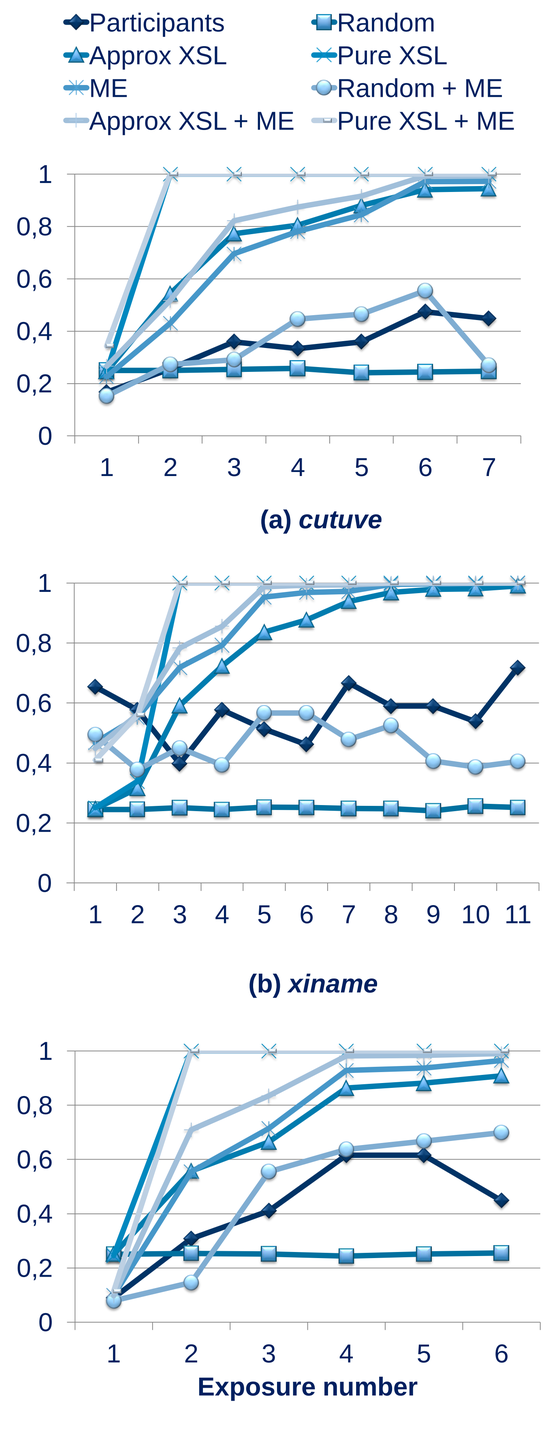


Figure 2a, 2b, & 2c. The success rates of the different strategies for the words (a) *cutuve,* (b) *xiname,* and (c) *hidiko* during subsequent exposures in the experiment.

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