

Blocking in linguistic associative learning

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1. Introduction

The present study uses an artificial language learning (ALL) experiment to examine blocking phenomena consistent with the Rescorla-Wagner (RW) model [1]. The RW model suggests that when a subject is exposed to a compound cue (AB), any changes in associative strength for the component cues are dependent on the total associative strength of the compound cue. This model predicts that if a subject first forms a strong association between cue A and a given pattern, then during subsequent exposure to the compound cue AB, association of the pattern with cue B will be severely limited. We seek to replicate this pattern in language, using cues to the morphological category of plural. We predict that if a subject is first exposed to words containing a single cue to plurality (eg. medial n/nn), and subsequently exposed to words containing two cues to plurality (eg. medial n/nn, final l/l), learning of the second cue will be limited. We compare these subjects to a control set where each cue is presented in isolation, expecting that the control group will learn the second cue significantly better than the test group.

2. Methodology

The experiment is implemented as an online word-learning game using a modified adaptive tracking paradigm [2]. The task was performed by 160 native speakers of American English, recruited on Amazon Mechanical Turk (AMT).

The artificial language consists of pairs of written words referring to pairs of images (singular or plural), following the patterns shown in Table 1.

Table 1. *Word patterns and sample words.*

Pattern	Singular (<i>example</i>)	Plural (<i>example</i>)
1	C-anop (<i>vanop</i>)	C-annop (<i>vannop</i>)
2	C-apol (<i>bapol</i>)	C-apoll (<i>bapoll</i>)
1+2	C-anol (<i>kanol</i>)	C-annoll (<i>kannoll</i>)

The experiment consists of a training phase followed by a test phase. In the training phase, participants are exposed to the language in a forced-choice task with feedback. During this phase, there are two successive blocks of stimuli. Each image is displayed with two possible word choices (correct singular and correct plural). Participants must choose the correct answer before progressing to the next image.

In the test phase, participants are exposed to previously encountered and novel stimuli, and no feedback is provided. In this phase, there are four possible responses for each image in order to allow for selection of a word consistent with Cue 1, Cue 2, both, or neither. 24 word-image pairs occur in the training phase, and 56 (24 seen + 32 novel) in test.

The experiment has two across-subject conditions. In the *co-occurrence* condition, the first block of training stimuli includes only Cue 1 (Pattern 1), while the second block consists of words where Cues 1 and 2 co-occur (Pattern 1+2). In the *stand-alone* condition, the first block of stimuli displays only Cue 1 (Pattern 1), while the second block of stimuli displays only Cue 2 (Pattern 2). The test phase for both conditions includes stimuli of all three types (1, 2, 1+2) to test generalization to novel word patterns.

3. Results

We fit a logistic mixed-effects regression model on the test data, with the outcome variable of whether Cue 2 was correctly identified. Predictors included across-subject condition (co-occurrence or stand-alone), plurality, gender, age, presence in training and word type. There was a very large main effect of plurality, with singular stimuli correct much more frequently than plural stimuli ($z=24.92$, $p<.001$). Because results for singular and plural stimuli patterned quite differently, we subsequently fit models for singular and plural stimuli separately, keeping the other predictors constant.

For singular stimuli, there was a main effect of word pattern, with words of Pattern 1+2 correct more often ($z=2.236$, $p<.05$). There was no significant effect for across-subject condition. For plural stimuli, there were main effects of across-subject condition, gender, presence in training, and word pattern. Males performed significantly better than females ($z=2.898$, $p<.005$), words seen in training were more often correct ($z=2.035$, $p<.05$), and words of Pattern 2 were more often correct than those of Pattern 1+2 ($z=2.443$, $p<.05$). There was also a significant interaction between gender and presence in training. As we hypothesized, participants in the stand-alone condition performed significantly better on Cue 2 than those in the co-occurrence condition ($z=2.139$, $p<.05$), demonstrating blocking of the redundant cue, consistent with predictions made by the Rescorla-Wagner model [1].

4. References

- [1] Rescorla, R.A. and Wagner, A.R., "A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement", in A. Black and W. F. Prokasy [Eds], *Classical Conditioning II*. New York: Appleton-Century-Crofts, 1972.
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