# “Synthetic Grammar Learning” by Pigeons (Columba livia)

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**Abstract:** Pigeons learned to categorize strings of colored characters according to the rules of synthetic grammars. In experiment 1, pigeons characterized strings as grammatical or not with respect to a single synthetic grammar, by pecking either left or right. In experiment 2, pigeons categorized strings as having been generated by one of two different grammars. Responses to grammatical stimuli in experiment 1, and both categories in experiment 2 were accurate at levels greater than chance. Responses to the non-grammatical stimuli from experiment 1 however, were not; a form of the feature-positive effect.


*Figure 1*: Example stimulus display

## Introduction:

Initially proposed as tool for modeling syntax, synthetic grammars have become a powerful tool for investigating both category learning and implicit memory in humans. Herbranson & Shimp (2003) recently demonstrated that pigeons are also capable of accurately classifying letter strings based on whether or not they conform to the rules of a synthetic grammar. Their pigeons however, displayed an asymmetry, in that they accurately categorized grammatical character strings, but performed at chance on similarly structured letter strings that violated the grammar. Failure to learn the non-grammatical category could be due to the lack of a strong “family resemblance” or category structure, and argues that pigeons were truly learning something about the grammar, rather than memorizing individual exemplars. The present research attempts to abolish the asymmetry by replacing the non-grammatical stimuli with stimuli generated by a different, structured grammar.

## Method:

10 male white carneaux pigeons (Columba livia) were maintained at 80% of free-feeding weight. Sessions took place daily in operant chambers equipped with CRT video monitors. On each of 62 daily trials, a bird viewed a character string from 3 to 8 letters in length, presented in text mode and responded by pecking an illuminated square to the left or right of the stimulus (see figure 1). Left responses were reinforced in the presence of stimuli from one category and right responses were reinforced in the presence of stimuli from the other category.

## Results:

Experiment 1: Birds were trained to classify two categories of character strings: grammatical strings generated from the grammar shown in figure 2, and distortions of strings generated from the same grammar (either one or two letters were changed such that it resulted in a non-grammatical string). Following training, pigeons were tested on previously unseen transfer stimuli. Figure 3 shows accuracy of responding during the last 10 days of training. Figure 4 shows accuracy during transfer, indicating that acquired knowledge of the grammar was not limited to previously encountered exemplars. * indicates $p < .05$.

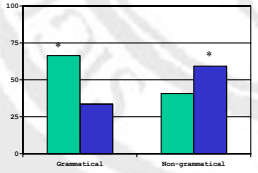


*Figure 3*: Training Performance

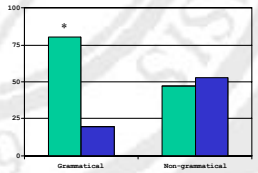


*Figure 4*: Transfer Performance

Experiment 2: Pigeons learned to categorize stimuli as generated from grammar 1 (the same as in experiment 1) and grammar 2 (from Reber, 1967). Figure 5 shows accuracy data from the last 10 days of training. Figure 6 shows transfer performance on previously unseen strings. * indicates $p < .05$.

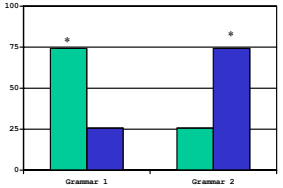


*Figure 4*: Training

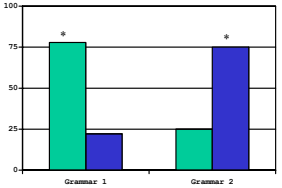


*Figure 5*: Transfer

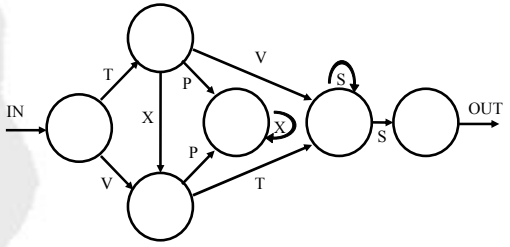


*Figure 2:* Synthetic Grammar used in experiments 1 and 2.

## Discussion:

These data reinforce the notion that pigeons can learn the complex structure of a synthetic grammar. Furthermore, it suggests that the ability to learn synthetic grammars relies on family resemblance, like many other forms of visual categorization. In experiment 1, pigeons failed to learn only the non-grammatical category, which displayed a less cohesive family resemblance. Birds in experiment 2 showed no such asymmetry. Note that this result is not necessarily expected, since experiment 2 require a pigeons to learn more; optimal performance is based on knowledge of two grammars, rather than one.

## References:

Herbranson, W.T. & Shimp, C.P. (2003). “Artificial grammar learning in pigeons: A preliminary analysis. *Learning & Behavior, 31*, 98-106.

Reber, A.S. (1967). Implicit learning of artificial grammars. *Journal of Verbal Learning and Verbal Behavior, 6*, 855-863.