

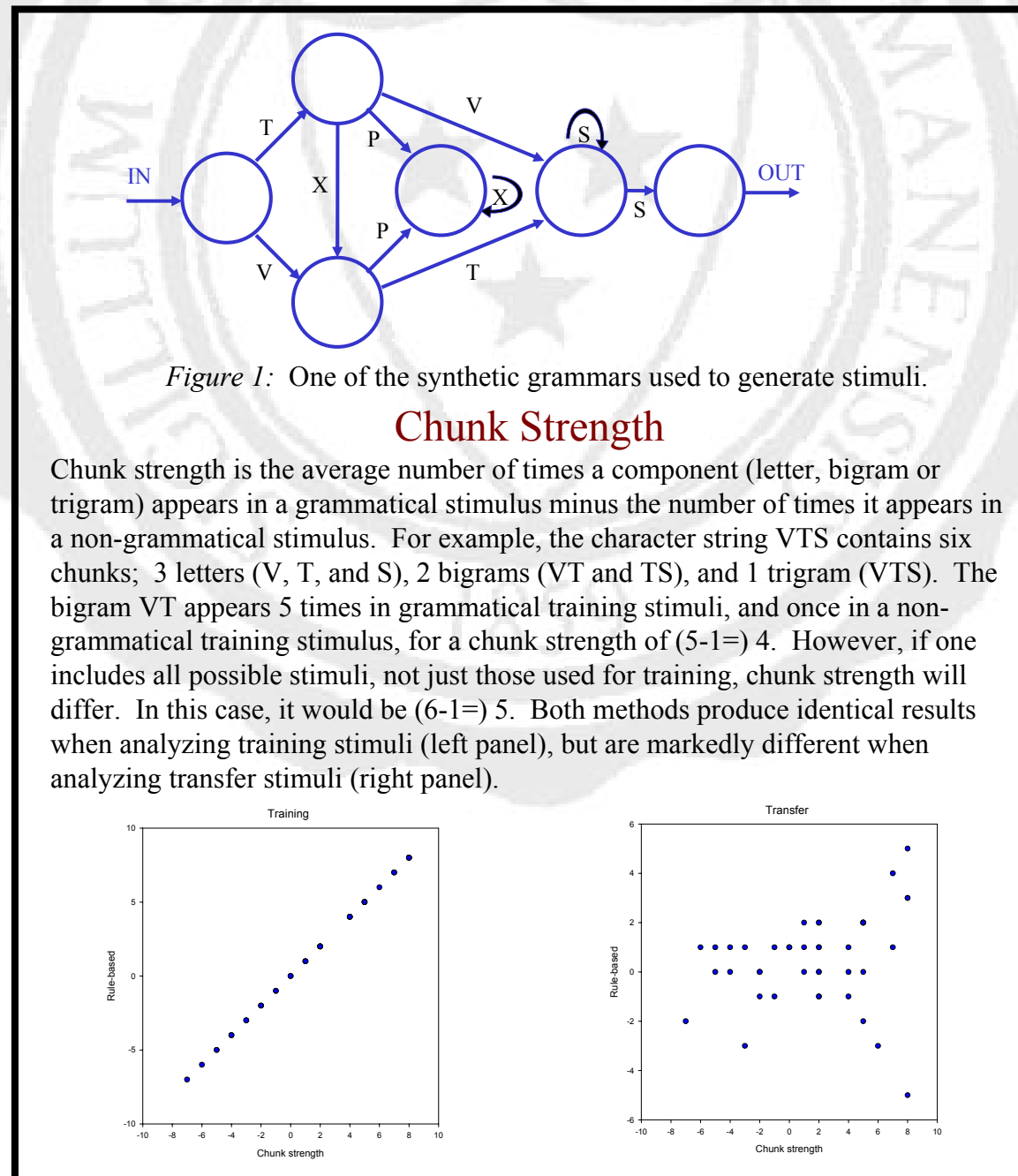
Comparing Chunk-Strength and Rule-Based Accounts of Synthetic Grammar Learning in Pigeons (*Columba livia*)

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Abstract: Pigeons learned to categorize strings of colored alphanumeric characters according to the rules of synthetic grammars. After reaching an accuracy criterion on a set of training stimuli, pigeons accurately classified novel transfer stimuli generated from the same rules. Accurate performance during training is consistent with each of two possible models: one based on simple chunk-strength, and one based on the abstract rules of the grammar. However, performance during transfer more strongly supports the rule-based account.

Introduction: Synthetic grammars have become a powerful tool for investigating category learning in humans and, more recently, pigeons (Herbranson & Shimp, 2003). There is disagreement however, over how synthetic grammars are learned. While accurate categorization of novel transfer stimuli makes a simple memorization strategy implausible, two other models have been proposed that can each account for most of the human data. One of these is that accurate responding is based on an implicit understanding of the abstract rules of the grammar (Reber, 1967). A second possibility is that acquired associations between string fragments and grammatical status (“chunk-strength”) are sufficient to account for performance (Servan-Schreiber & Anderson, 1990). While the issue has not yet been reconciled, it is possible to pit the two explanations against one another. Chunk-strength assumes that associations are learned during training, and is calculated only from previously encountered stimuli. In contrast, a rule-based account is not defined exclusively by previously encountered stimuli. According to this possibility, an accurate predictor of performance would be one that includes every possible stimulus that is consistent with the rules, not just those presented during training.

Method: 6 male white carneau pigeons (*Columba livia*) were maintained at 80% of free-feeding weight. Sessions took place daily in operant chambers equipped with 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. Left responses were reinforced in the presence of stimuli generated from an artificial grammar (see figure 1) and right responses were reinforced in the presence of stimuli that violated the rules of the grammar. Following acquisition of the categories, pigeons were presented with novel, never before seen stimuli to assess transfer.



Results: Birds accurately categorized 66% of stimuli over the final 10 days of training. The 95% confidence interval for correct categorizations was $61% < \mu < 69%$. Novel transfer stimuli were also accurately categorized at a rate of 60%, with a 95% confidence interval of $56% < \mu < 64%$. (Chance accuracy would be 50% in each case.) To compare chunk-strength and rule-based accounts of learning, two definitions of chunk-strength were used to predict pigeons' responses during transfer. One used only training stimuli (chunk-strength) while one used all possible stimuli (rule-based; see center panel for definitions of each). The rule-based account reliably produced a more optimal estimate of slope ($F(1,5)=10.17, p<.05$), intercept ($F(1,5)=10.44, p<.05$), and r^2 ($F(1,5)=19.67, p<.01$) for predictions of responses to novel transfer stimuli.

Discussion: These data reinforce the notion that pigeons' visual categorization abilities are both complex and powerful. Furthermore, it suggests that pigeons can extract rules about a category that go beyond the specific stimuli or components of stimuli encountered during training. In the case of synthetic grammar learning, accurate categorization is better explained in terms of global rules than in terms of local associations between components. A comparable analysis has not yet been done with a human population, but such a comparison would be an important contribution to comparative psychology.

References:

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