

Syntactic transfer in
Artificial Grammar Learning:
A free classification
and set-variance account

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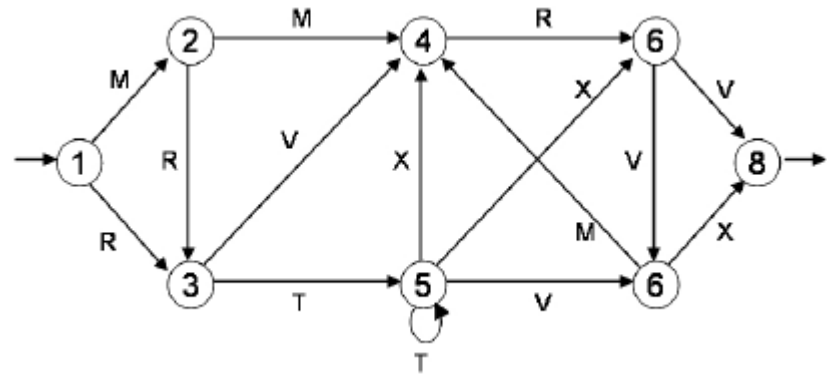
Mike Le Pelley

Artificial grammar learning

- Present letter strings for a “memory test”

XMTRV, XTVMRX ...

- Test on novel *grammatical* and *ungrammatical* (often random) strings.



Theories of AGL

- Abstraction of the grammar
- Chunks (bigrams, trigams)
- Microrules (e.g. mean string length, permissible starting and ending letters)

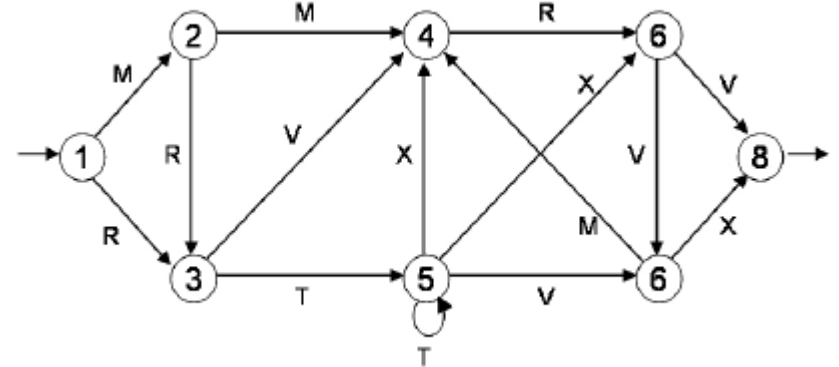
- Detection of *structure* in an abstract sense e.g. set variance.

XMTRV, XTVMRX ...

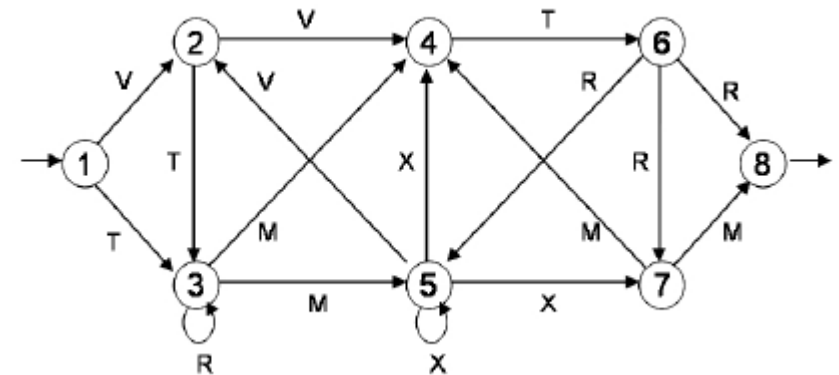
Design

- Train on Grammar A (or NG strings)
- Test on mixed list of: Grammar A, Grammar B, & random strings

Grammar A



Grammar B



Stimuli

- GA & GB share no bigrams or trigrams
- NG strings contain an equal proportion of GA and GB bigrams + trigrams.

| GA | GB | NG ₁ | NG ₂ |
|----------|---------|-----------------|-----------------|
| MMRV | TMXMTR | MRRXVTX | MTXR XV |
| MMRVX | TMXTRXM | MTMTVM | MVRV |
| MRTTVX | TMXXM | MXMRT | MVXRTMV |
| MRTTXRV | TMXXMTR | MXRT | MXVXT |
| MRTTXVX | TRMTR | RTMVR | RMTTVT |
| MRTVMRV | TRMTRM | RVMVT | RRVXM |
| MRTVX | TRMXM | RXRV | RRXR V |
| MRTXR VX | TRMXXTR | RXVXRR | RVTVXTR |
| MRVRV | TRRMTR | TRTRTX | TMMTV |
| MRVRVX | TRRMXM | TTMVTXR | TMRX |
| RTTVMRV | VTMTR | TVMVVTX | TMVRVMX |
| RTTVX | VTMTRM | TVVMX | TTRTXT |
| RTTXRVX | VTMXM | VMRXVV | VRMVR |
| RTTXV | VTMXTR | VMTXT | VRVTRT |
| RTTXVX | VTMXTRM | VRMTVMT | VTTM |
| RTVMRV | VTMXXM | VRRMTX | VXXTVT |
| RTVMRVX | VTRRMTR | XMRMXVR | XRRTMXV |
| RTXVX | VTMVVTR | XMTXTVR | XTVRXXXR |
| RTXR VX | VVTR | XR XVVRM | XVRTMTM |
| RTXVMRV | VVTRM | XVTVTR | XXTRVXR |

Set similarity

$${}_a S_b = \frac{COM}{N_a} \cdot \frac{COM}{N_b}$$

| A. Pearce (letters) | | | | B. Pearce (bigrams) | | | | | |
|---------------------|------|------|-----------------|---------------------|-----------------|------|------|-----------------|-----------------|
| | GA | GB | NG ₁ | NG ₂ | | GA | GB | NG ₁ | NG ₂ |
| GA | .226 | .032 | .055 | .059 | GA | .164 | 0 | .006 | .008 |
| GB | | .211 | .058 | .056 | GB | | .160 | .010 | .007 |
| NG ₁ | | | .150 | .053 | NG ₁ | | | .107 | .008 |
| NG ₂ | | | | .142 | NG ₂ | | | | .102 |

- GA & GB have lower set variance than NG
- GA is more similar to NG than to GB.

So...

- Similarity predicts negative transfer (ie. NG more likely than G to be called grammatical at test).
- Set variance predicts positive transfer

Some other things we controlled for

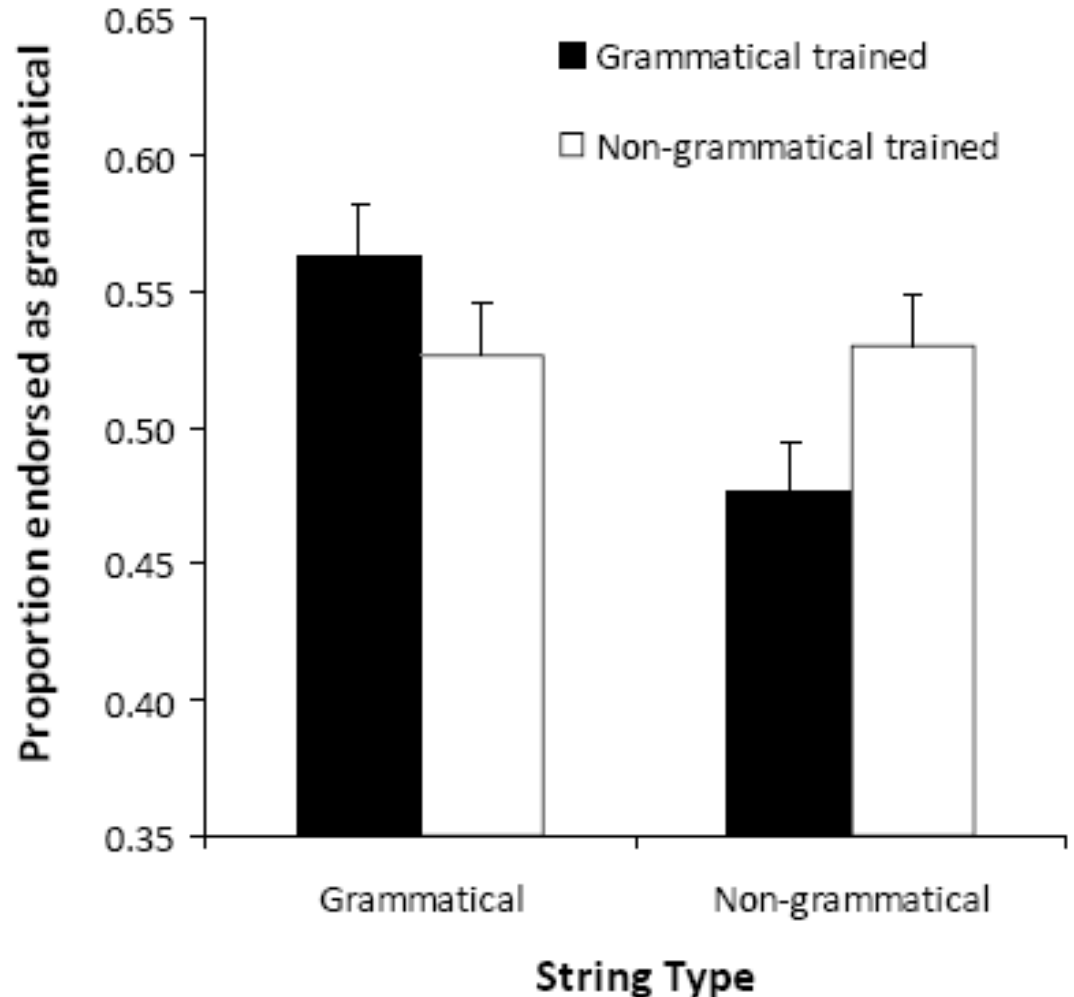
| Set | Length | Repetitions | % Unique Letters |
|-----------------|-------------|-------------|------------------|
| GA | 5.85 (1.04) | .50 (0.51) | 0.72 (0.11) |
| GB | 5.85 (0.88) | .50 (0.51) | 0.66 (0.11) |
| NG ₁ | 5.84 (1.02) | .45 (0.51) | 0.65 (0.10) |
| NG ₂ | 5.80 (1.11) | .50 (0.51) | 0.67 (0.14) |

Procedure

1. “Memorise these strings”
2. Sequentially reveal training strings (1 per 5s) until all 20 are presented.
3. 10 “key training” trials.
4. 80 test trials : 2 blocks of the 40 test strings.
5. Revealed sequentially, each string requires a G or NG response. Response appears on screen.
6. 3 second time-out.

Results

- 3 people excluded for failing the key training!
- d' significantly greater for GT than NGT
- β close to 1 and did not differ.



Free classification?

Two possibilities considered:

1. NGT participants respond randomly.
2. NGT and GT participants are equally good at free classifying test strings into their two groups but - without experience of grammaticality in the training phase – NGT cannot assign the labels G and NG with above-chance accuracy.

$$d'_{\text{abs}}$$

- Inspired by our previous work on free classification (Wills & McLaren, 1998; Haslam et al., 2007).

$$d'_{\text{abs}} = | z(\text{hits}) - z(\text{false alarms}) |$$

- Since minimum of d'_{abs} is 0, chance > 0
- Chance therefore determined by Monte Carlo of an unbiased random responder.

$$d'_{\text{abs}}$$

- Chance: 0.227 ; 95th percentile 0.286.
- GT: $d'_{\text{abs}} = 0.33$
- NGT: $d'_{\text{abs}} = 0.30$
- Do not differ significantly.

Conclusion

- Participants can free classify during the test phase, and the form of training phase does not significantly affect their ability to do so.
- What participants get from the GT training is a sense that the set of items we're calling grammatical have a low set variance.

Implication

- Symbolic transfer
- E.g. Altmann, Dienes & Goode (1995), training and test have same finite-state grammar but are instantiated with different symbols in different modalities (e.g. training – tones; test – letters). Significant transfer.
- Generally considered to be evidence for abstraction.
- Perhaps it is an appreciation of set variance that underlies performance?