Transposed letter effects within an artificial language

Clare Lally, J.S.H Taylor & Kathy Rastle

Royal Holloway, University of London

INTRODUCTION

Successful reading requires not only identification of a word's constituent letters but also analysis of their positions. Evidence from Indo-European languages suggests that letter position is represented flexibly, as readers find non-words with switched (or transposed) letters perceptually similar to their base words (Perea & Lupker, 2003).

jugde **activates** judge

transposed letter non-word **real word**

Mistaking such a non-word for its base word is known as the transposed letter (TL) effect. TL non-words are hard to reject in Indo-European languages, suggesting flexible letter position coding. However, this finding does not arise in Semitic languages like Hebrew, perhaps because these are dense writing systems with many anagrams.

This finding suggests that **flexibility in letter position coding** is not hardwired in the brain, but **influenced by critical aspects of the writing system** (Frost, 2012). We developed a new method using transposed letters to assess the flexibility of letter position coding in artificial languages with varying orthographic density.

Aims of the current experiments:

1. *Can the TL effect be found in trained artificial languages with unfamiliar orthographies?*
2. *Do artificial languages with a dense orthography (more anagrams) elicit more precise letter position coding than languages with a sparse orthography (fewer anagrams)?*

STIMULI

48 participants learned to read aloud 24 words from either a **sparse** or a **dense** orthography.

SPARSE ORTHOGRAPHY
No anagrams
Examples: /metæp/ /pɪvɒb/ /gefʌt/ /sɒpek/

DENSE ORTHOGRAPHY
50% anagrams
Examples: /zesɪf/ /fesɪz/ /tɪdæn/ /dɪtæn/

Target items used for training

Target (trained word) /metæp/

Critical distractors used for test

Transposed letter /mepæt/

Substituted letter /mekæv/

- Substitution controls used familiar trained letters, that were as equally probable as letters in the target and TL condition.
- Critical distractors in which vowels were transposed or substituted were also created.

DESIGN

DAYS 1-4
Behavioural Training
Read Aloud x 9
Discrimination x 3

→

DAY 5
Testing
Visual Lexical Decision Task

Participants learned 24 novel words in an artificial script (target items only) over the course of four days, using reading aloud and multiple choice word discrimination tasks.

On the fifth day, participants completed a **visual lexical decision task**. Targets were trained items, and distractors were untrained items of three types - letter transpositions, letter substitutions, and controls. We compared accuracy in rejecting letter transposition items with letter substitution items. Transposed letter items were expected to be harder to reject, particularly in the sparse orthography, where letter position coding should be relatively flexible.

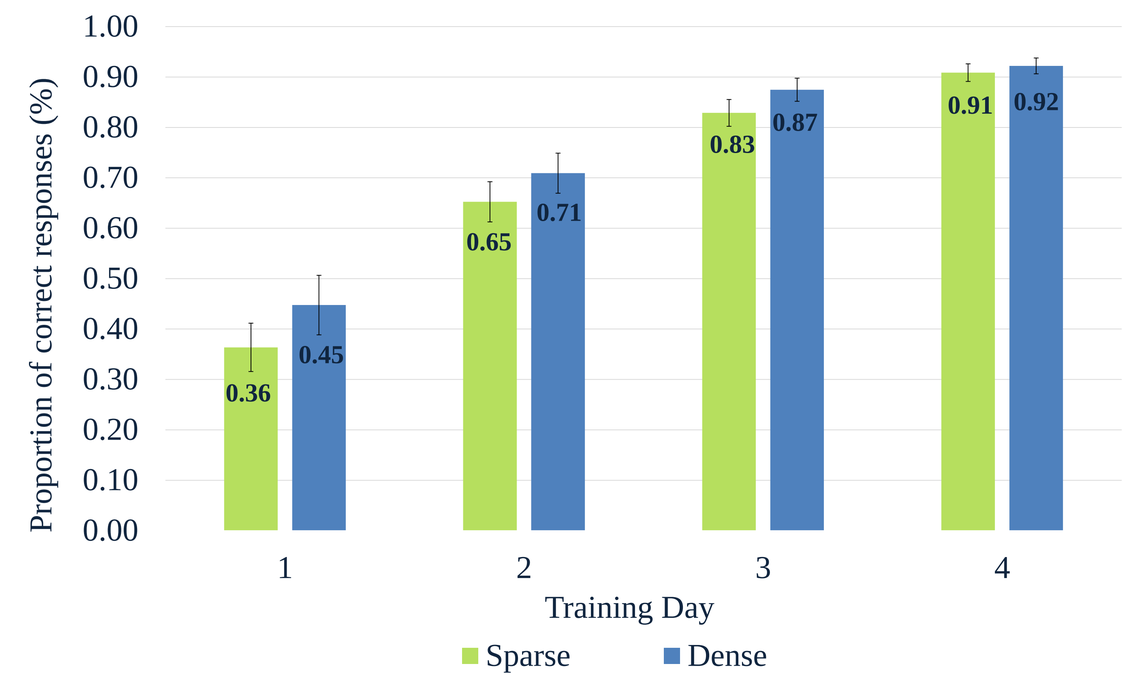
Visual LDT

Is this a word that you have learned?

(metap) TARGET

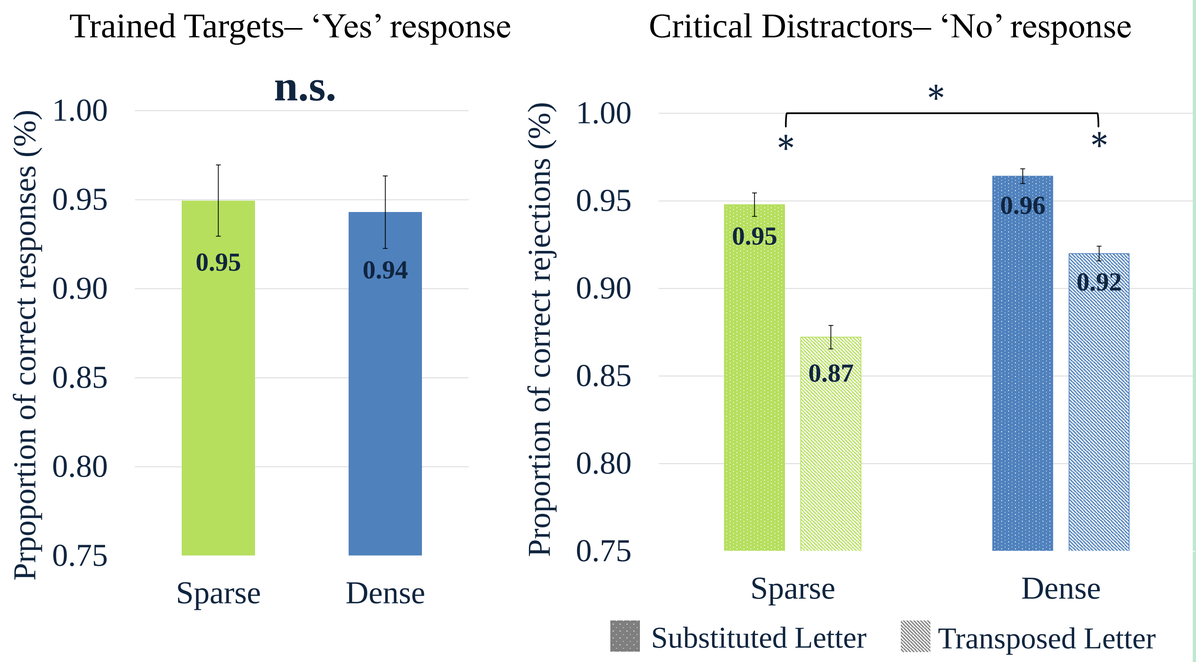
Correct response: YES

READING ALOUD TRAINING TASK



There was a main effect of training day ($p<.001$), with accuracy in performance increasing each day. There was no effect of orthography ($p=.281$) and no interaction between training day and orthography ($p=.826$). This displays that both groups of participants were successful in learning to read in the orthography, and were equally as accurate in terms of performance.

VISUAL LEXICAL DECISION TASK



1 *Can the TL effect be found in trained artificial orthographies?*

✔ **Yes.** The proportion of correct rejections was lower for TL items than substituted letter items ($p<.001$). This was observed in both orthographies.

2 *Does a dense orthography (more anagrams) elicit more precise letter position coding than a sparse orthography (fewer anagrams)?*

✔ **Yes.** When comparing accuracy, the size of the TL effect was significantly larger for the sparse condition than the dense condition ($p<.05$).

Results	TL effect?	Sparse/dense effect?
Visual Lexical Decision Task	✔	✔

CONCLUSIONS

- We have successfully demonstrated that a TL effect is observed in trained artificial languages.
- The results suggest that orthographic density influences the precision of letter position coding. The results indicate that the more dense the orthography, the less flexibility there is in the letter-position coding scheme.
- The research thus far has allowed us to develop a powerful new method that can be used to test how specific linguistic properties influence the development of orthographic representations. Such controlled isolation of aspects of the writing system cannot be achieved using typical cross-linguistic comparisons.

References

Frost, R. (2012) Towards a universal model of reading. *Behavioral and Brain Sciences.* 35, p.263-329.

Perea, M. & Lupker, S.J. (2003) Does jugde activate COURT? Transposed letter similarity effects in masked associative priming. *Memory and Cognition.* 31(6), pp. 829-841.

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