Word Reading and the Tolerance Principle

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Outline

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1. The Tolerance Principle – generalisation and rule-learning
2. Reading
3. Study 1

The Tolerance Principle

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The Tolerance Principle

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The challenge of language acquisition:

- An infinitely productive linguistic system
- Variable and unreliable input
- Rules and exceptions

How do children accomplish this?

- UG
- Statistical learning
- Both? (Yang 2016)

The Tolerance Principle

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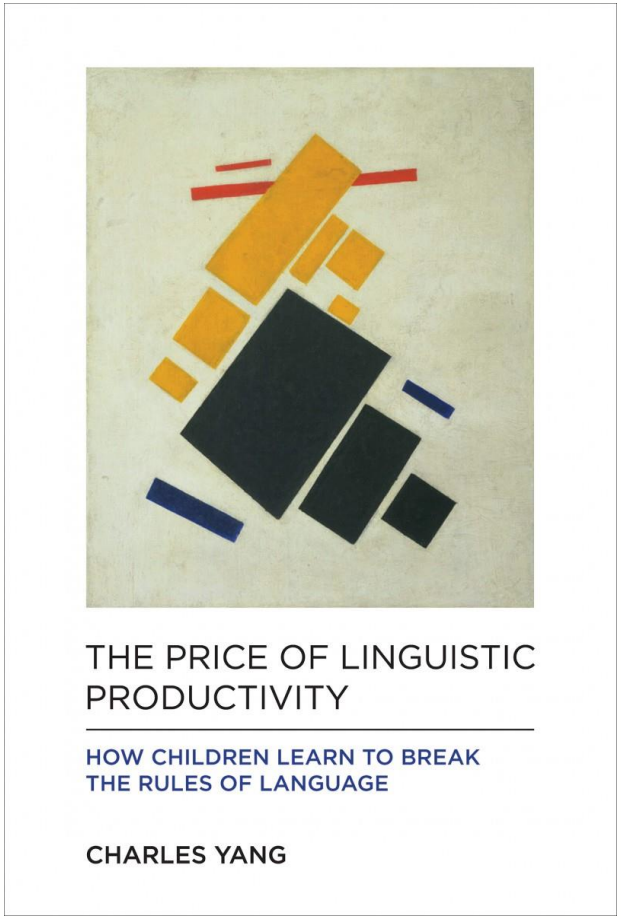
- Charles Yang - morphology
- How do children derive generalisations from linguistic data? E.g. walk-walked, talk-talked
- How do children tease apart exceptions from regularities? E.g. run-ran
- The Tolerance Principle
- The learner postulates a **productive** rule only if it results in a more efficient organisation of language than lexical storage.
- Number of **exceptions** must fall **below a critical threshold**



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Provides an algorithm for the tipping point of computational efficiency between:

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$$e \leq \theta_N \text{ where } \theta_N := \frac{N}{\ln N}$$

For a productive rule to be formed, the number of exceptions must be less than the number of items a rule could apply to divided by the natural log of the number of items.

"Passing the tolerance test"

The Tolerance Principle

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- Subsets also have regularities
- Critical for children to acquire complex structures found in the world's languages (Yang 2016) E.g. German noun plurals

Reading

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- If the TP underlies generalisation in areas of language such as morphology, can it be extended to other areas of language?
- Can the TP aid our understanding of how we read – specifically, how we learn and use spelling-sound consistencies?
- Does the TP underlie the reading acquisition process?

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  - but at what level?

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- Analogy

  r**ough** → t**ough**

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- E.g. TOUSE

  OU ✗

  OUSE ✓

Study 1

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Questions

- How do adults use spelling-sound consistencies in English to pronounce **nonwords**?
- How do they generalise using the "rules" they've already learned from English words?
- Do their pronunciations follow patterns which are predicted by the Tolerance Principle, choosing pronunciations which pass the tolerance test?

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Method

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- 7 conditions:

1. vowel winner, body winner (no conflict) e.g. TRINT
2. vowel winner, body winner (conflict) e.g. SMEAD
3. vowel all fail, body winner e.g. TROWD
4. vowel all fail, body all fail e.g. THILD
5. vowel winner, body all fail e.g. TROOD
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TP has a predicted pronunciation

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Hypotheses

H1: When a **vowel grapheme** has a pronunciation which **passes** the tolerance test**,** this will be the pronunciation used**,** even when there is a conflicting body pronunciation.

H2: When a **vowel grapheme** does **not** have a pronunciation which passes the tolerance test**,** but the **body** does**,** this will be the most common pronunciation used.

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Results

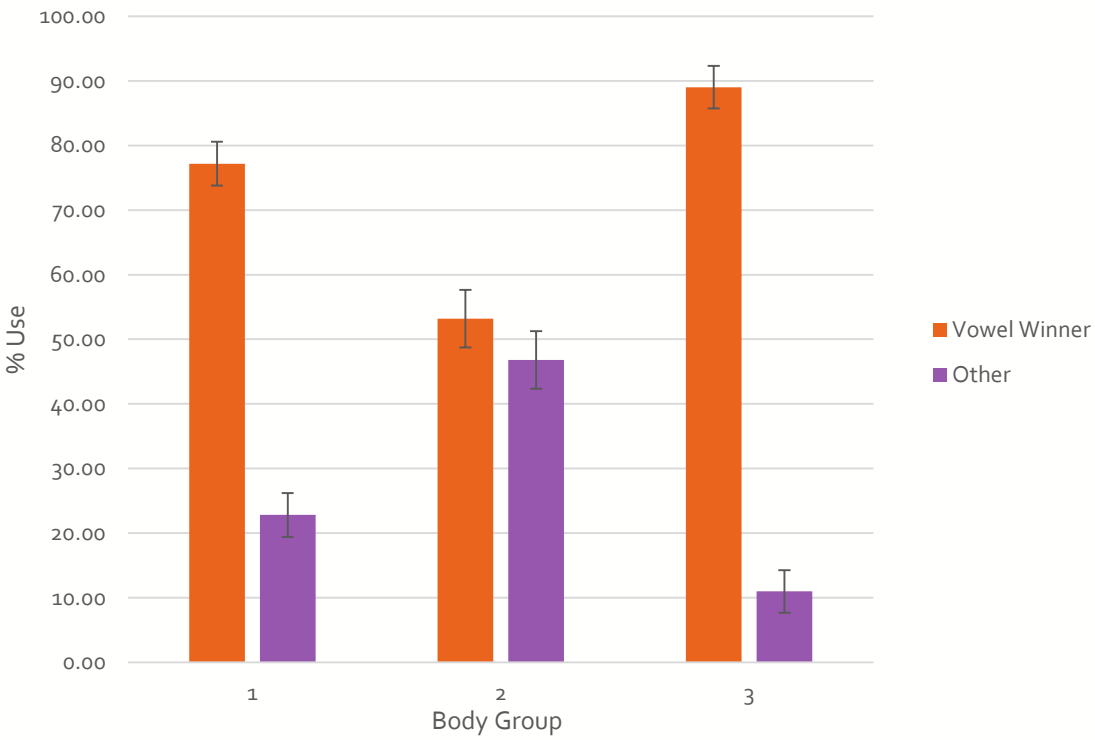
H1: Vowel use in conditions with a vowel winner

$\chi^2(2, n = 2509) = 180.60)$, $p<.001$

BG1: $t(59) = 8.006$, $p<.001$

BG2: $t(14) = 11.822$, $p<.001$

BG3: $t(29) = 1.010$, $p = .321$



Vowel Pronunciation for Body Groups 1, 2 and 3.
Error bars represent standard errors.

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Results

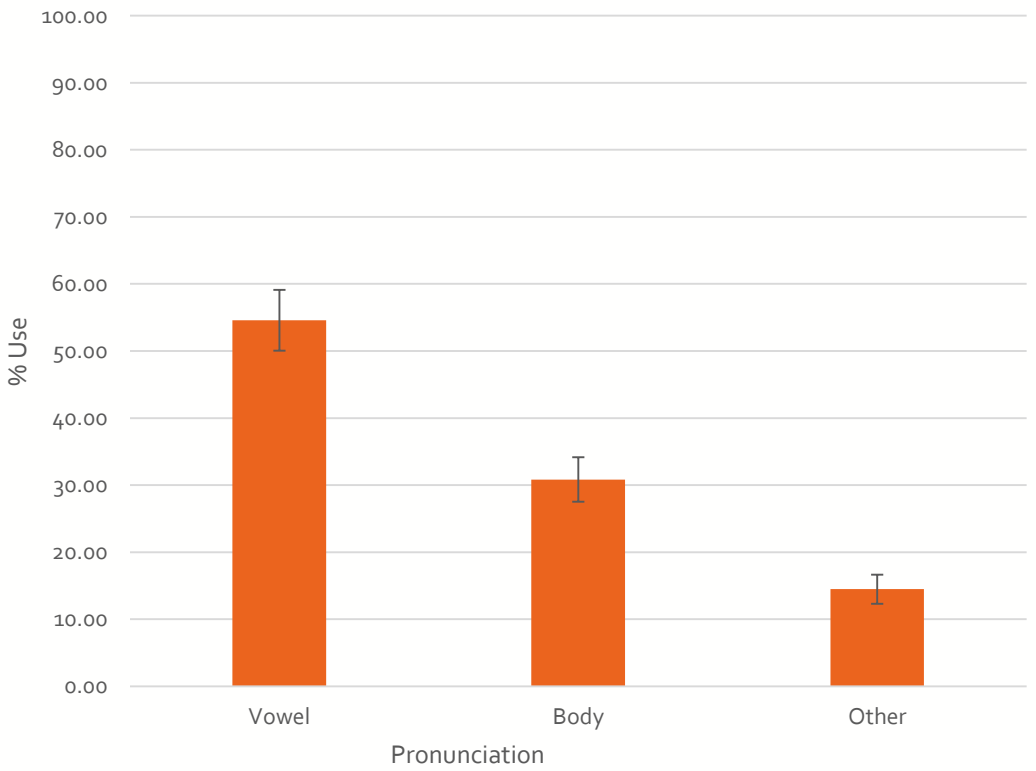
H1: Vowel winner,

Body winner, conflict

F (2, 58) = 22.829, p<.001

Vowel vs body: p = .004

Vowel vs other: p<.001



The percentage of vowel winner, body winner, and other pronunciations of items in body group 2 (vowel winner, body winner, conflict). Error bars represent standard error.

Using arcsine transformed percentages

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Results

H2: Use of body winner in Conditions 2 and 3

$\chi 2(1, n = 1930) = 332.56)$, $p<.001$

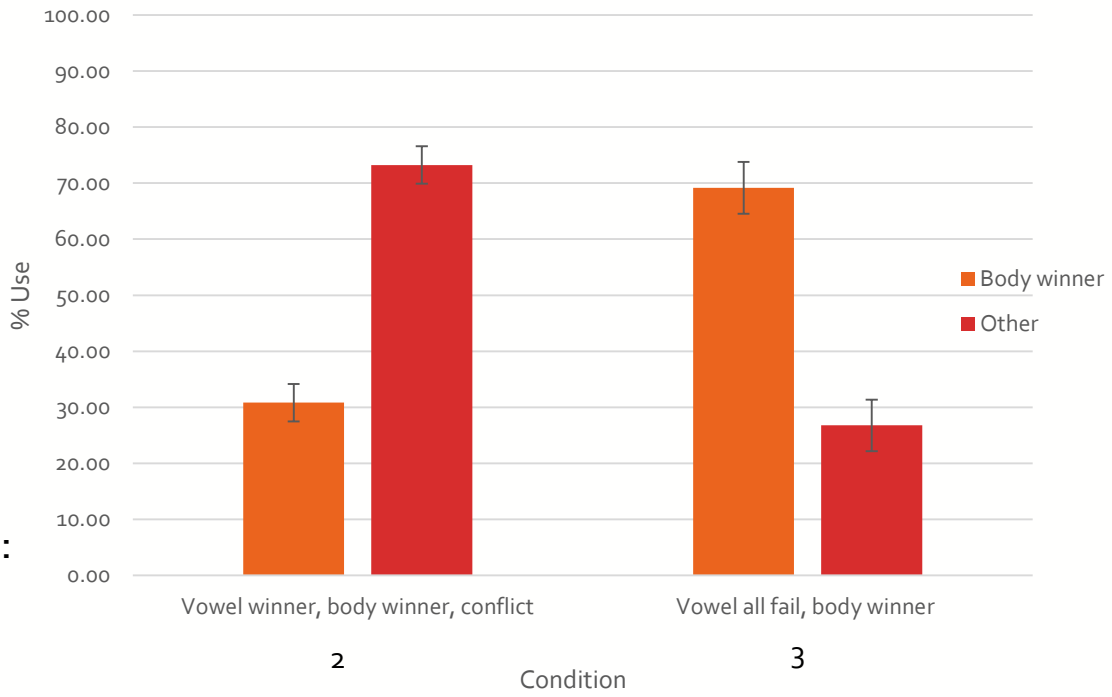
Body use vs. other in condition 2:

$t(29) = -5.75$, $p<.001$

Body use vs. other in condition 3:

$t(50) = 7.76$, $p<.001$

Body use in Cond 2 vs 3: $(t(68.7) = -9.47$, $p<.001$



Average % of body winner pronunciations and all other pronunciations in Condition 2 (vowel winner, body winner, conflict) and 3 (vowel all fail, body winner). Error bars represent standard errors.

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Results

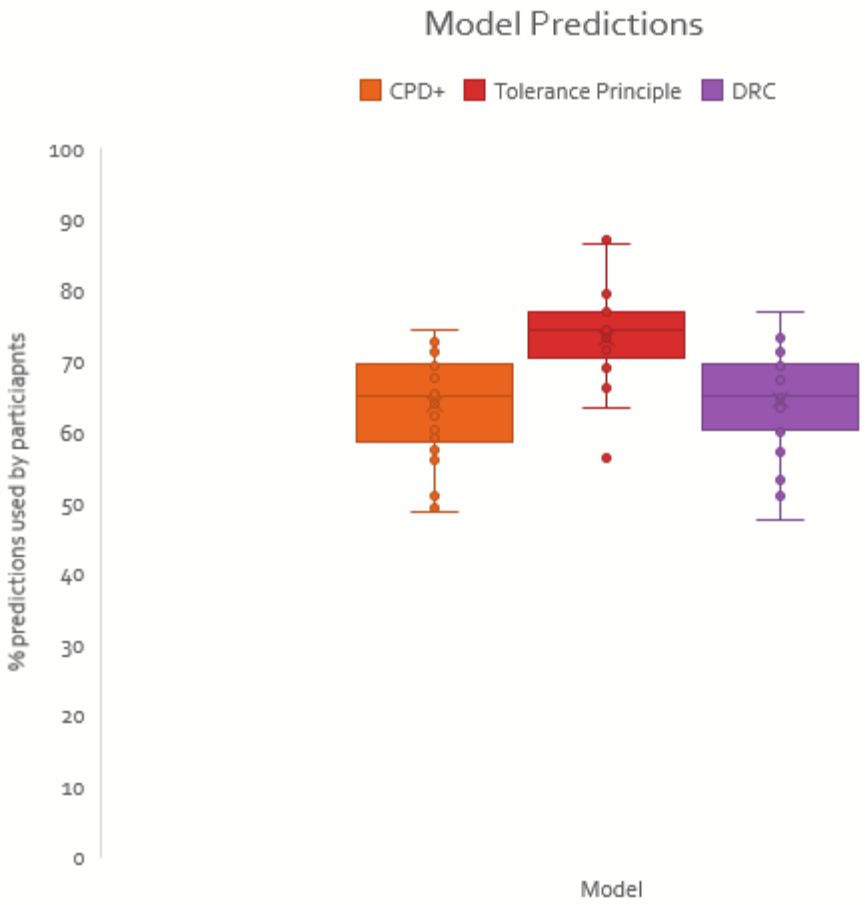
Model Comparison: how often did participants match the model prediction?

$F(2, 71) = 12.42$, $p<.001$,

$MSE = 661.58$, $\eta p^2 = .265$

TP greater than DRC, $p<.001$

TP greater than CDP, $p<.001$



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Conclusions

- Vowel winner use and body winner use in participants' pronunciations support the TP.
- The TP predictions are closer to adults' pronunciations than the predictions of competing models of word reading.
- But there is variation in nonword pronunciations: subject-level variation?

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