Opposing Contributions of Letters and Bigrams in Word Recognition?

Mary L. Still Alison L. Morris

Iowa State University

Letter Position Coding

Recent research in visual word recognition has focused on how letter order is coded during word recognition. Much of this work is based on priming paradigms with the assumption that presentation of two similar items will lead to facilitation or interference in comparison to presentation of two dissimilar items.

Evidence for Relative Letter Position Coding

Partial Word Priming (Peressotti & Grainger, 1999)

	Prime	Target
Facilitation	B L C N	B A L C O N
No Facilitation	N L C B	B A L C O N

Subset/Superset Priming (Bowers, Davis, & Hanley, 2005)

	Semantic Categorization	Target
Interference	Is the target an animal?	D R A M A
Interference	Is the target an animal?	S E E P

Accounting for Letter Position Findings

Several word recognition models can accommodate relative position priming effects, but they have different explanations. Here we test the basic assumptions of these models. What are the units involved in word recognition that are responsible for orthographic similarity?

Single Letters	Bigrams
SOLAR (Davis, 1999)	Open-Bigram (Grainger & van Heuven, 2003)
Overlap Model (Gomez et al., 2008)	SERIOL (Whitney, 2001)

All imply that orthographic similarity depends on relative letter order

Conditions

Prime type	4-letter prime	bigrams	let. pos	let. id
Mirror anagram	elba	0	0	4
Bigram anagram	bael	3/6 or 4/6	0	4
Neighbor	ible	3/6	3	3

4-letter target = *ABLE* 5-letter target = *PERCH*

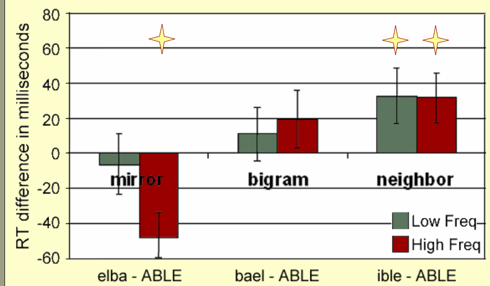
Prime type	5-letter prime	bigrams	let. pos	let. id
Mirror anagram	hcrep	0	1	5
Bigram anagram	rphec	4/9	0	5
Neighbor	persh	5/9 or 6/9	4	4

Procedure: Lexical Decision

→ bael → ABLE

500 ms 35 or 100 ms Until response

Experiment 1: 35ms Primes

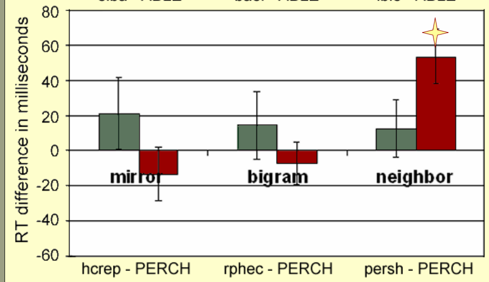


4-Letter *t*-tests

H Freq Mirror
t_1 (59) = 3.3, p < .01
t_2 (22) = 3.2, p < .01

L Freq Neighbor
t_1 (59) = -2.1, p = .04
t_2 (22) = -2.7, p = .01

H Freq Neighbor
t_1 (59) = -2.2, p = .03
t_2 (22) = -2.1, p = .05



5-Letter *t*-tests

H Freq Neighbor
t_1 (59) = -3.4, p < .01
t_2 (17) = -2.9, p = .01

• Stimulus characteristics

126 lexical decision trials: 42 nonword targets, 84 word targets
Word Targets: 42 low frequency (*M* = 8), 42 high frequency (*M* = 394)
All items had low neighborhood densities (*M* = 2)

• Two items, one high frequency (*thus*) and one low frequency (*newt*), were excluded from all analyses due to excessive error rates

References

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Gomez, P., Ratcliff, R., Perea, M. (2008). The overlap model: A model of letter position coding. *Psychological Review, 115,* 577-600.

Grainger, J. & van Heuven, W. J. B. (2003). Modeling letter position coding in printed word perception. In P. Bonin (Ed.), *The Mental Lexicon.* New York: Nova Science Publishers (pp. 1-24).

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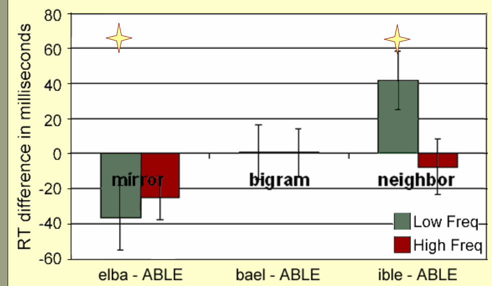
Whitney, C. (2001). How the brain encodes the order of letters in a printed word: The SERIOL model and selective literature review. *Psychonomic Bulletin and Review, 8,* 221-243.

http://www.psychology.iastate.edu/~almorris/MorrisLab/Presentations.htm

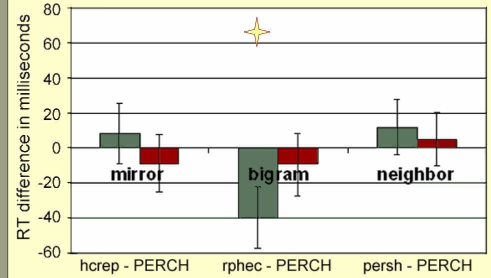
Experiment 2: 100ms Primes



4-Letter *t*-tests

L Freq Mirror
t_1 (71) = 2.4, p = .02
t_2 (22) = 3.0, p < .01

L Freq Neighbor
t_1 (71) = -2.5, p = .02
t_2 (22) = -2.1, p = .04



5-Letter *t*-tests

L Freq Bigram
t_1 (71) = 2.2, p = .03
t_2 (17) = 1.8, p = .08

Results and Conclusions

Interference for mirror anagrams

- Interference is obtained when the prime and target share all letter identities, but share no letters in the same relative position
- Mirror anagrams are orthographically similar
- How does *elba* interfere with processing of *able*?
- Difficult to explain with current theories of word recognition

Bigrams *and* letter identity may determine orthographic similarity

- Mirror anagram interference disappears with 5-letter words perhaps because the prime and target share the same middle letter
- Neighbor primes result in facilitation; is this due to shared bigrams?

What are the contributions of letter identity and relative letter position (bigrams) in word recognition?

1. Offsetting effects? Shared letter id in the wrong position leads to interference, but shared bigrams lead to facilitation
2. Different time courses? Letter identity alone is used early in word recognition, while the influence of bigrams is seen later
3. Two coding systems? One system for very coarse coding (letter identities) and another system for relative position coding (e.g., bigrams)

Mirror anagram results have been replicated using 6-letter items (*thgink – KNIGHT*) and word primes (*paws – SWAP*; Morris & Still, 2008)