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The Impact of Adjacent-Letter Flanking Bigrams on Lexical Decision Performance

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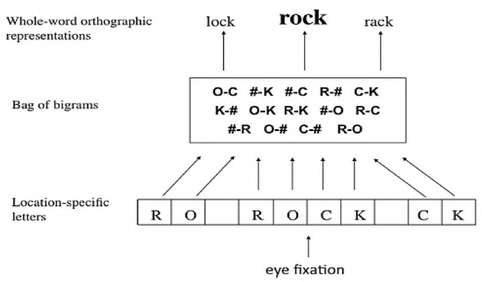
Introduction

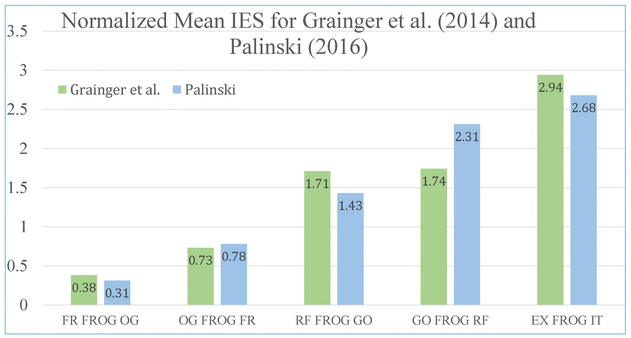
- Many researchers have proposed that information is processed in a hierarchal system. Grainger and Van Heaven (2003) included a level in which activation of letter pairs is a step in the path to activation of a word representation in the mental lexicon. This level includes both adjacent and nonadjacent bigrams. (See Fig. 1)

Figure 1



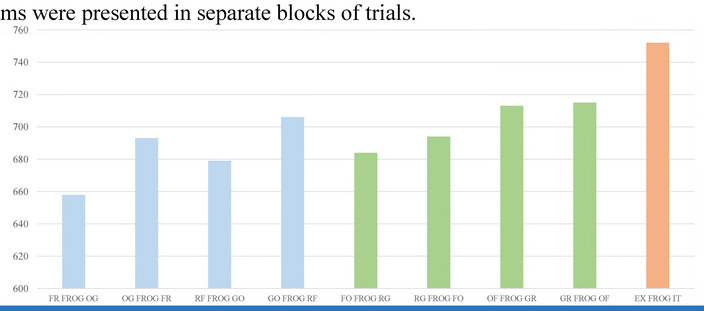
- In 2014 Grainger, Mathôt, & Vitu conducted a lexical decision experiment in which letter strings were presented with flanking bigrams that contained pairs of adjacent letters from the target string or letters not in the target string.
- Grainger et al. reported that, for words, responding was more efficient when the flanking bigrams contained letters from the target string than when they did not. They also reported that when flanking bigrams contained letters from the target string, only letter order, not relative flanker position, affected performance. (See Fig. 2, green bars)

Figure 2



- In 2016 Palinski replicated these results (see Fig. 2, blue bars) and conducted a second experiment that included targets flanked by adjacent letter and non-adjacent letter bigrams.
- Although, for nonadjacent letter bigrams, the pattern of performance over conditions was like that in Grainger et al. and Palinski Experiment 1 (Fig. 3, green bars), for adjacent-letter bigrams, the pattern was different (Fig. 3, blue bars). Location of bigram letters relative to their locations in the target affected performance.
- Araya, Russo, & Smith (2017) replicated Palinksi's experiment and obtained similar results—specifically, an effect of location for adjacent-letter flankers.
- We conducted an experiment in which adjacent letter and non-adjacent letter bigrams were presented in separate blocks of trials.

Figure 3



Method

- 53 CSU students recruited through CSU Sona Systems were granted credit for their participation.
- 180 four-letter words and 180 four-letter pseudo-words (letter strings that resemble actual words –FROP for example) were used as targets in a lexical decision task. Each target was flanked by a pair of bigrams.
- There were nine flanking bigram conditions.

Figure 4

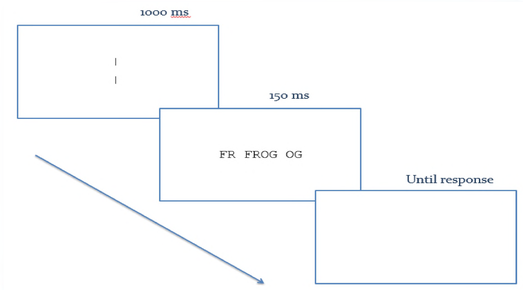
		Letter Order	
		Same	Switched
Relative Flanker Position	Nearer	FR FROG OG FO FROG RG	RF FROG GO OF FROG GR
	Farther	OG FROG FR RG FROG FR	GO FROG RF GR FROG OF

Adjacent letter bigrams are shown in blue and nonadjacent letter bigrams are shown in green.

In the Different-letter condition, bigrams contained letters not in the target (e.g., EX FROG IT).

- In eight conditions, the flanking letters were the same as those in the target. These conditions consisted of flanking bigrams whose letters were adjacent vs. nonadjacent in the target, ordered as in the target vs. switched, and relatively near to vs. relatively far from their locations in the target. In one condition, the flanking letters differed from those in the target. (See Fig. 4)
- Adjacent letter and nonadjacent letter bigrams were presented in separate blocks of trials.
- On each trial, participants saw the target with the flankers on a computer screen for 150ms and were to press one button if the target was a word and the other button if the target was a pseudo-word. (See Fig. 5)
- Inverse efficiency scores (IES) were used as the response measure. For each participant, for each flanker condition, IES was calculated by dividing mean response time by proportion correct.

Figure 5



Acknowledgments

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References

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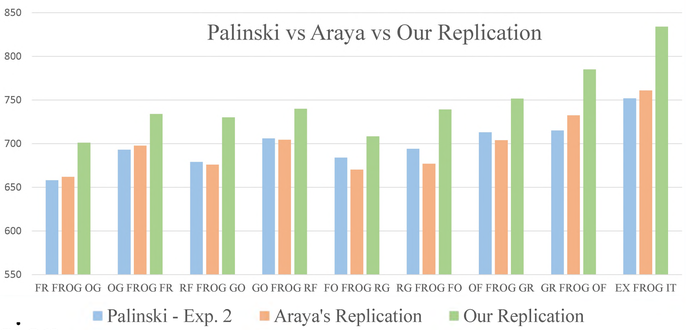
- Palinski, A. M. (2016). *Investigating the role of open bigrams in visual word perception.* Unpublished master's thesis, Cleveland State University.
- Araya, L.G., Russo, N.M., & Smith, A.F. (2017, September)
    - Poster originally presented at the Undergraduate Summer Research Poster session, Cleveland State University

Results

- We found very similar results to those collected by Palinski and Araya et al. (See Fig. 6)
- There was no significant difference found when comparing performance for adjacent letter bigrams and nonadjacent letter bigrams (but a consistent pattern of more efficient performance was found for adjacent letter bigrams in Palinski's experiment as well as the two replications).
- For adjacent-letter flanking conditions:
    - On average, performance was more efficient when flankers contained letters ordered as in the target than when letter order was switched. (IES was lower for FR_OG and OG_FR than for RF_GO and GO_RF)
    - On average, performance was more efficient when flankers contained letters near their original position rather than farther away. (IES was lower for FR_OG and RF_GO than for OG_FR and GO_RF)
- For nonadjacent-letter flanking conditions:
    - On average, performance was more efficient when flankers contained letters ordered as in the target than when letter order was switched. (IES was lower for FO_RG and RG_FO than for OF_GR and GR_OF)
    - On average, performance was more efficient when flankers contained letters near their original position rather than farther away. (IES was lower for FO_RG and OF_GR than for RG_FO and GR_OF)
- For both adjacent and nonadjacent flankers, no significant interaction of letter order and location.

Figure 6



Discussion

- In Grainger's original experiment and Palinski's first experiment (using only adjacent letter flankers) there was no impact of bigram proximity on performance. But in Palinski's 2nd experiment (where she introduced nonadjacent flankers), Araya's Replication, and our replication, proximity had a significant impact on performance.
    - We do not know why this is, but it seems that when both adjacent and nonadjacent bigrams are introduced in an experiment proximity has an impact on performance for adjacent letter bigrams.
- Although performance with adjacent and nonadjacent-letter bigrams did not differ significantly, there is a consistent pattern in the adjacent flankers performance that is different than the pattern for nonadjacent flankers.
- We also observed that when comparing IES within adjacent and nonadjacent flanker conditions the condition where the bigrams (when put together to create a four-letter string) more closely resembled the target word tended to have more efficient performances
    - A good scale of how similar the four-letter string created by combining bigrams is to the target word is determining the minimum number of steps needed to turn that four-letter string into the target word.
    - For example, the bigram pair FR_OG (which has the better performances) requires no steps to recreate the target word when combined into a four-letter string, while RF_GO would requires at least 2 steps (rearranging R and F then G and O) to recreate the target word.