



Get a Grip & Go For Broca

Anthony S. Barnhart¹, Stephen D. Goldinger¹, & Charles A. Perfetti²

¹Arizona State University, ²University of Pittsburgh

Abstract

Recent experiments employing both EMG and fMRI have shown that muscles in the right hand demonstrate increased activation during lexical access and that these effects are augmented when reading handwritten words. An embodied explanation for these increases is that handwritten words are perceived through a motor simulation of the strokes used to generate the items (in a similar fashion to the motor theory of speech perception). In the current study, we extended the previous research on motor activation during lexical access by measuring deviations in grip force during the processing and articulation of high- and low-frequency printed and cursive words. To date, few studies have examined overt motor activities during lexical access, and no studies have examined the motor consequences of a lexical variable such as word frequency. We observed increases in both maximum grip force and squeeze duration for the right hand during the processing of low-frequency, cursive words. In addition, we found that fatigue in hand muscle groups has a detrimental effect on word naming response times, with fatigue in the right hand demonstrating the largest effects.

Motor components of visual language perception.

- Longcamp & colleagues (2003; 2006): Perceiving letters (whether typewritten or handwritten) activates motor areas used to produce them.
- Perception of language (spoken or written) produces covert activation of muscle groups in the right hand (Flebel et al., 2003; Tokimura et al., 1996).

The Gestural Origin of Language

- Arbib (2002): Language evolution from manual gesture.
- Concurrent evolution of manual & oral control led to strong motor associations between effectors.



Motor Theories of Language Perception

- Spoken Language:** Liberman & Mattingly's (1985) motor theory of speech perception. Spoken word recognition through simulation of intended oral gestures.
- Written Language:** Babcock & Freyd's (1988) motor theory of handwriting recognition. Word recognition through simulation of dynamics used to generate the static trace.

Research questions:

- Does lexical access produce differences in overt hand activity?
- Does a variable that affects processing speed also affect level of motor activity?
- Does word script influence motor activity?

Experiment 1: Grip Force & Lexical Access

- Examined hand grip dynamics during the processing of words varying on frequency and script.

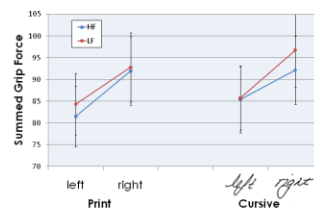
Method

- 72 high- and low-frequency homophone pairs from McRae, Jared, and Seidenberg (1990) generated in print and cursive forms.
- Naming RTs collected with standard voice key; Squeeze data collected by a Vernier Digital Hand Dynamometer.
- Standard word naming task w/ the addition of squeeze; script manipulated within subjects.



Results

Force:



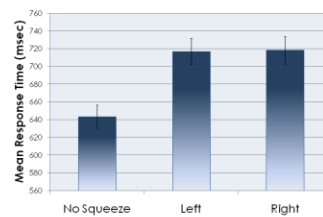
Main Effects:

- Hand***
- Script*
- Frequency**

Interactions:

- Hand X Script X Frequency (marginal; $p = .06$)

Naming Response Times:



Effects:

- Script***
- Frequency***
- Script X Frequency***
- Squeeze***

- RT results could be due to the interaction of motor activity with lexical access or to differences in cognitive effort needed to squeeze while naming.

- Experiment 2 addressed this issue.

Experiment 2: Motor Fatigue & Lexical Access

- If same brain areas are used for lexical access and grasping, fatiguing muscles in the hand should influence naming.

Method

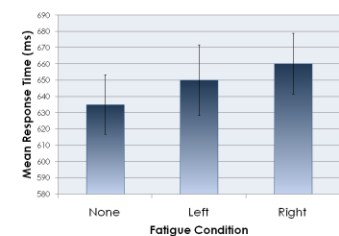
- 384 5-letter words (half high-frequency, half low-frequency) from Coney (2005) generated in print and cursive forms.
- Standard word naming task; script manipulated within subjects; blocked by fatigue.

Fatigue Protocol: Solomon & Robin (1996).

- Assessed maximum grip force for each hand.
- P's asked to maintain grip force above 50% of maximum grip for as long as possible (terminating after dropping below 50% for 2 seconds).

Results

Naming Response Times:



Effects:

- Script***
- Frequency***
- Script X Frequency***
- Fatigue*

Conclusions

- Lexical access affects overt motor activity in both hands, to some extent.
- Fatiguing hand motor areas influences word processing.

Future Directions:

- A lexical decision task with dynamometers could increase sensitivity.

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Please send correspondence to:

Anthony Barnhart

email: Anthony.Barnhart@ASU.edu

webpage: <http://www.public.asu.edu/~abarnhar>

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