Picture naming in American Sign Language: an electrophysiological study of the effects of iconicity

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Introduction

- Signs in American Sign Language (ASL) vary in iconicity (the strength of the resemblance between form and meaning). Prior research indicates that iconic signs are retrieved faster in picture-naming tasks than non-iconic signs.[1]
- Iconicity can be analyzed as a structured mapping (alignment) between features of form and meaning.[2]

Present Study

- To examine possible effects of iconicity on the temporal neural dynamics of lexical retrieval, we asked deaf ASL signers to name pictures that targeted iconic or non-iconic signs.
  - Iconicity Predictions: The activation of iconic signs for production will result in larger N400 amplitudes due to the overlap between conceptual and visual/sensorimotor linguistic features.
- To explore effects of structured iconicity, visually salient features of the to-be-named picture were either aligned with iconic features of the sign or there was no visual alignment between the picture and the sign (see Methods)[3].
  - Alignment Predictions: The activation of iconic signs with aligned pictures will result in smaller N400 amplitudes because the visual alignment between the picture and the form of the sign can prime retrieval of the linguistic form compared to iconic signs with non-aligned pictures.

Methods

Participants:
- 23 Deaf individuals, mean age = 35
- Native/Early Signers: 11 early, 12 native

Picture Naming Task:
- Name the presented pictures in ASL
  - Lift hand from spacebar to produce sign.
  - Return hand to spacebar to begin next trial
- ERPs time-locked to picture, reaction times measured to spacebar release.

Stimuli:
- Two conditions
  - Iconicity: whether or not the produced sign is iconic (resembles what it means).
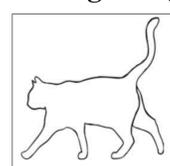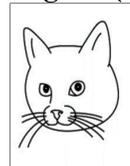 - Alignment: whether or not the presented picture aligns with the visual features of the sign being produced.

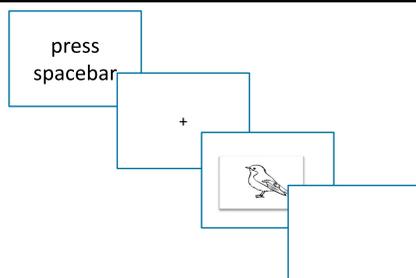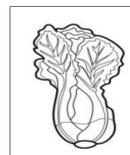Iconic (88 total)   Aligned (44)   Non-aligned (44)   Sign

"Cat"

Non-iconic (88 total)   Non-Iconic (1)   Non-Iconic (2)   Sign

"Lettuce"
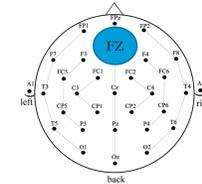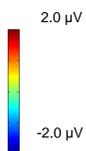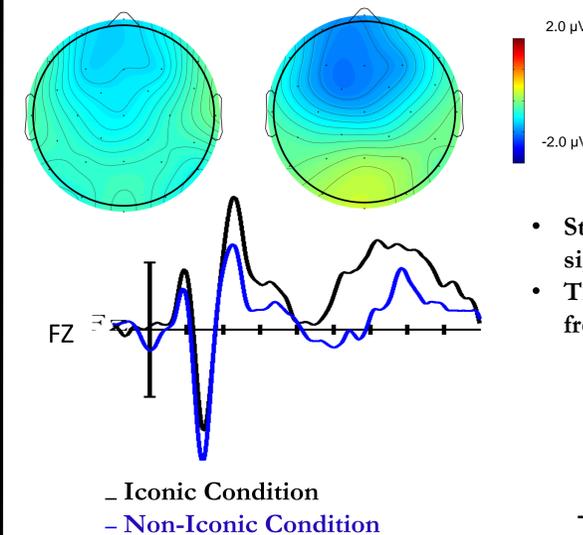
Results

Effects of Iconicity

Iconic – Non-Iconic

200 to 400ms   400 to 600ms

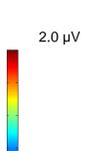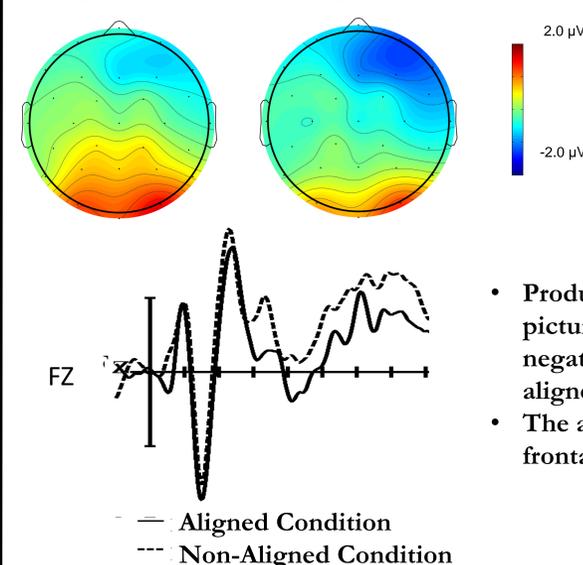2.0 µV / -2.0 µV

FZ

— Iconic Condition
– Non-Iconic Condition

- Starting at 200ms, retrieval of iconic signs differed from non-iconic signs
- These effects took the form of larger frontal negativities to iconic signs
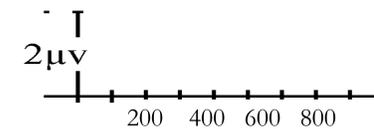
2µv   200 400 600 800

Effects of Alignment

Aligned – Non-Aligned

200 to 400ms   400 to 600ms

2.0 µV / -2.0 µV

FZ

— Aligned Condition
--- Non-Aligned Condition

- Production of signs in the aligned picture condition elicited smaller negativities than signs in the non-aligned picture condition
- The alignment effects had a frontal, right-sided distribution.

LME Analysis

- Models included sign frequency, image prototypicality and image complexity as fixed effects.
- Included electrode site for distribution (x-laterality, y-anteriority. z-depth)
- Behavioral results:
  - Iconic signs were retrieved marginally faster than the non-iconic signs
  - RTs in the aligned picture condition were faster than in the non-aligned picture condition

	Iconic	Non-Iconic	Aligned	Non-Aligned
RT (ms)	815	857	785	845
	p = .06		p = .02 *	

Iconicity results:
- LMEs confirmed a significant interaction with anteriority during the 200-400ms epoch (p <.001) and depth (p=.027)
- During the later epoch (400-600ms), the interaction with anteriority persisted (p = .02)

Alignment results
- During the early epoch, there was a marginal interaction between anteriority and alignment (p = .08)
- Significant interaction with both laterality (p=.017) and anteriority during 400-600ms epoch (p=.001)

Conclusions

- **Iconicity:** More negativity was observed through both the N300 and N400 epochs for naming pictures with iconic signs.
  - Prior picture processing studies have suggested that the N300 might reflect early feature based processes
  - Previous ERP studies have found greater anterior negativity for concrete than abstract words[4]. Greater negativity for concrete words may be due to more extensive activation of sensorimotor information during lexical-semantic processing.[5]
  - Similar to concreteness effects, larger anterior negativity for iconic signs may be linked to greater activation of visual and sensorimotor semantic features, compared to non-iconic signs.
- **Alignment:** Structured alignment of visual features between the picture and sign was associated with a smaller right anterior N400 and an earlier posterior positivity.
  - These effects of alignment could be due to priming of the signs through the visually overlapping features in the picture and sign form, which is also supported by the faster reaction times in the aligned condition.

References
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[2]Emmorey, K. (2014). Iconicity as structure mapping. Phil. Trans. R. Soc. B, 369(1651), 20130301.
[3] Thompson, R. L., Vinson, D. P., & Vigliocco, G. (2009). The link between form and meaning in American Sign Language: Lexical Processing Effects. JEP: Learning, Memory, and Cognition, 35(2), 550.
[4]Barber, H.A., Otten, L.J., Kousta, S., & Vigliocco, G. (2013). Concreteness in word processing: ERP and behavioral effects in a lexical decision task. Brain and Language, 125(1), 47-53.
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