It Hurts Less the Second Time Around:

ERPs show anaphor resolution facilitated by valence of antecedent

Liam Clegg[1], Abigail Swain[1], Eric C. Fields[1], Nate Delaney-Busch[1], Daphne Holt[1,2,3], Gina Kuperberg[1,2,3]

[1] Department of Psychology, Tufts University; [2] MGH/MIT/HMS Athinoula A. Martinos Center for Biomedical Imaging; [3] Department of Psychiatry, Massachusetts General Hospital

Introduction

Language is often used to convey emotional states, reactions and feelings. The emotional content of words influences their storage, salience and accessibility – all factors known to influence online language processing. Despite this, there has been very little psycholinguistic work examining the impact of emotional words on the mechanisms of discourse comprehension.

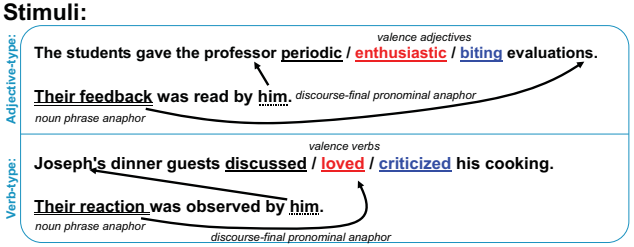
Our Questions

1. Are emotional words encountered in a neutral context associated with increased lexico-semantic processing? If so, this would predict an increased N400 effect to emotional (versus neutral) words within sentences, even when these are matched on cloze, frequency and other factors known to influence lexico-semantic processing [1, 2].

2. Does the emotional salience of a word lead to its being easier to link referentially to a subsequent neutral anaphor, even across clause boundaries? If so, this would predict a reduced anterior negativity effect (reflecting reduced working memory costs engaged in referential linking, [3]) to neutral anaphors following emotional (versus neutral) antecedents.

Design

Stimuli:

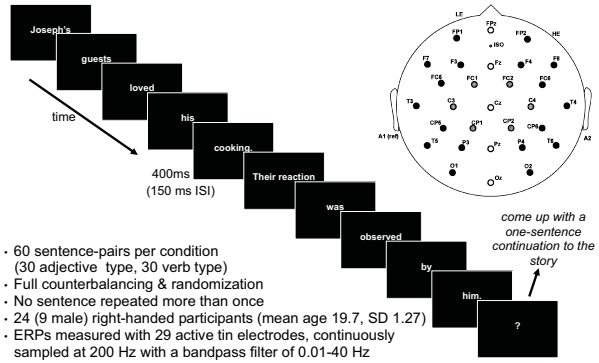


Stimuli Characteristics:

	Neutral	Positive	Negative
Number	180	180	180
Frequency (valence word; HAL)‡	8,802 [13,527]	9,159 [15,183]	6,490 [13,584]
LSA (between valence word and next content word in sentence 1)	0.128 [0.124]	0.144 [0.124]	0.121 [0.105]
Valence ratings of valence words*	4.05 [0.546]	5.55 [0.601]	2.21 [0.535]
Arousal ratings of valence words^	2.85 [0.674]	4.50 [0.879]	4.53 [0.949]
Valence ratings of whole scenario*	4.23 [0.473]	5.26 [0.522]	2.48 [0.542]
Cloze probability of valence words	0.56% [3.13%]	0.69% [2.62%]	0.12% [0.93%]

Means are shown with standard deviations in brackets.
‡ Some valence words did not exist in the HAL database and these were represented as null values in our calculations.
*Items were rated on a seven point scale from 1 (very negative) to 7 (very positive)
^Items were rated on a seven point scale from 1 (least arousing) to 7 (most arousing)

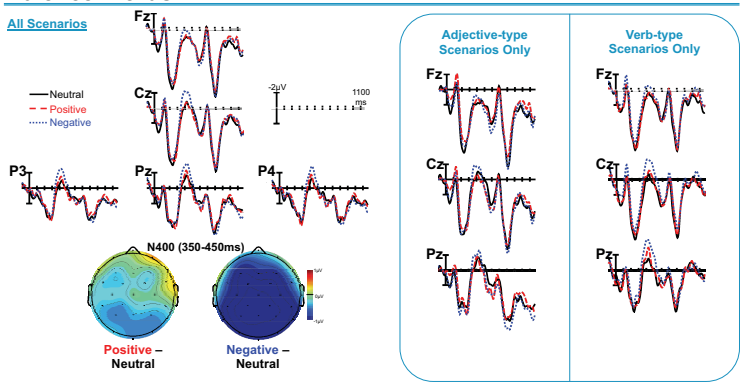
Presentation & Recording:



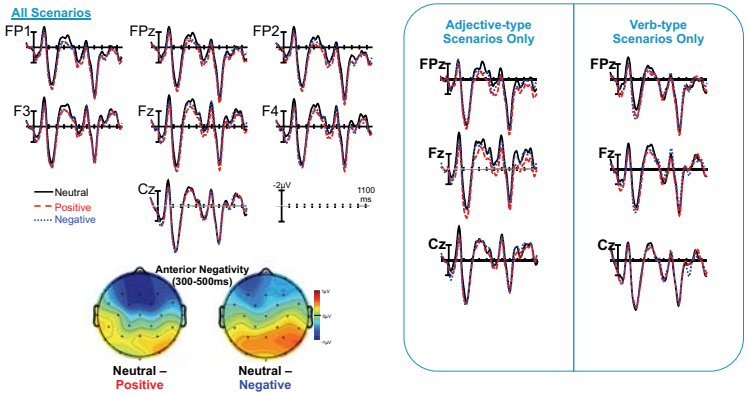
- 60 sentence-pairs per condition (30 adjective type, 30 verb type)
- Full counterbalancing & randomization
- No sentence repeated more than once
- 24 (9 male) right-handed participants (mean age 19.7, SD 1.27)
- ERPs measured with 29 active tin electrodes, continuously sampled at 200 Hz with a bandpass filter of 0.01-40 Hz

Results

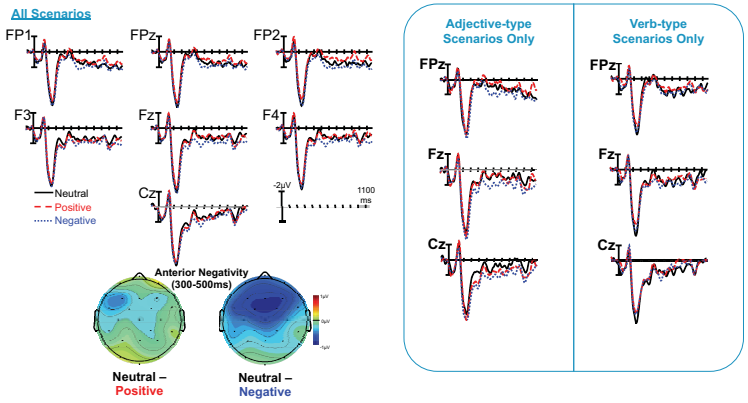
Valence Words



Noun Phrase Anaphor



Discourse-final Pronomial Anaphors



Conclusions

Effects on valence words

(a) The clear N400 effect to negative (vs. neutral) words replicates previous findings [1, 2]. The smaller N400 effect to positive vs. neutral *verbs* partially replicates previous findings [1]. Both may reflect *increased lexico-semantic processing* of emotional words following a neutral context.

- ? Direct reflection of mismatch of emotional expectancy at an amodal lexico-semantic level of representation
- ? Direct reflection of increased arousal-related neural activity (before, after, or at the same time as the valence word is fully decoded for meaning)
- ? Indirect reflection of increased arousal-related neural activity (feedforward to amodal lexico-semantic representations, leading to 'enhanced' lexico-semantic analysis).

(b) The increased positivity effect to emotional (vs. neutral) *adjectives* partially replicates previous findings [1]. It may reflect prolonged analysis driven by arousal associated with negative and positive words.

Effects on neutral NP anaphors

(a) The reduced anterior negativity effect to neutral NP anaphors in emotional (vs neutral) discourse, may reflect reduced WM costs in resolving these anaphors. The emotional salience (both positive and negative) of the antecedents may increase their accessibility for subsequent anaphor resolution, even across clause boundaries.

(b) The reduced anterior negativity effect to neutral discourse-final pronomial anaphors in negative (vs neutral) discourse may again reflect reduced WM costs in resolving the anaphors. The introduction of negatively-valenced words in a discourse context may increase the salience of other potential antecedents, reducing the cost of subsequent anaphor resolution, even when these anaphors appear many words downstream from their antecedents.

References

1. Holt, D.J., Lynn, S.K. & Kuperberg, G.R. Neurophysiological correlates of comprehending emotional meaning in context. *Journal of Cognitive Neuroscience* 21, 2245-2262 (2009).
2. Van Berkum, J.J.A., Holleman, B., Nieuwland, M., Otten, M. & Murre, J. Right or wrong? The brain's fast response to morally objectionable statements. *Psychological Science* 20, 1092-1099 (2009).
3. Van Berkum, J.J.A., Brown, C.M. & Hagoort, P. Early referential context effects in sentence processing: evidence from event-related brain potentials. *Journal of Memory and Language* 41, 147-182 (1999).

Acknowledgements:
This work was supported by NIMH (R01 MH071635) and NARSAD (with the Sidney Baer Trust).