

# Linguistic And Non-Linguistic Semantic Processing In Individuals With Autism Spectrum Disorders: An ERP Study

Emily Coderre<sup>1</sup>, Mariya Chernenok<sup>1</sup>, Barry Gordon<sup>1,2</sup>, & Kerry Ledoux<sup>1</sup>

<sup>1</sup>Cognitive Neurology/Neuropsychology, Department of Neurology,  
The Johns Hopkins University School of Medicine, Baltimore, MD

<sup>2</sup>Department of Cognitive Science, The Johns Hopkins University, Baltimore, MD

## Introduction

### Language deficits in autism

- Autism spectrum disorders (ASDs) are characterized by widespread language impairments [1].
- Language deficits may stem from difficulties with *semantic integration*: the ability to integrate the meanings of pieces of information and arrive at a holistic understanding [2].

### The N400 and semantic processing

- The N400 event-related potential (ERP) is thought to index semantic processing.
- N400 amplitude is reduced when stimuli are easier to integrate semantically with their preceding context compared to stimuli that are difficult to integrate [3].

### Semantic processing in individuals with ASD

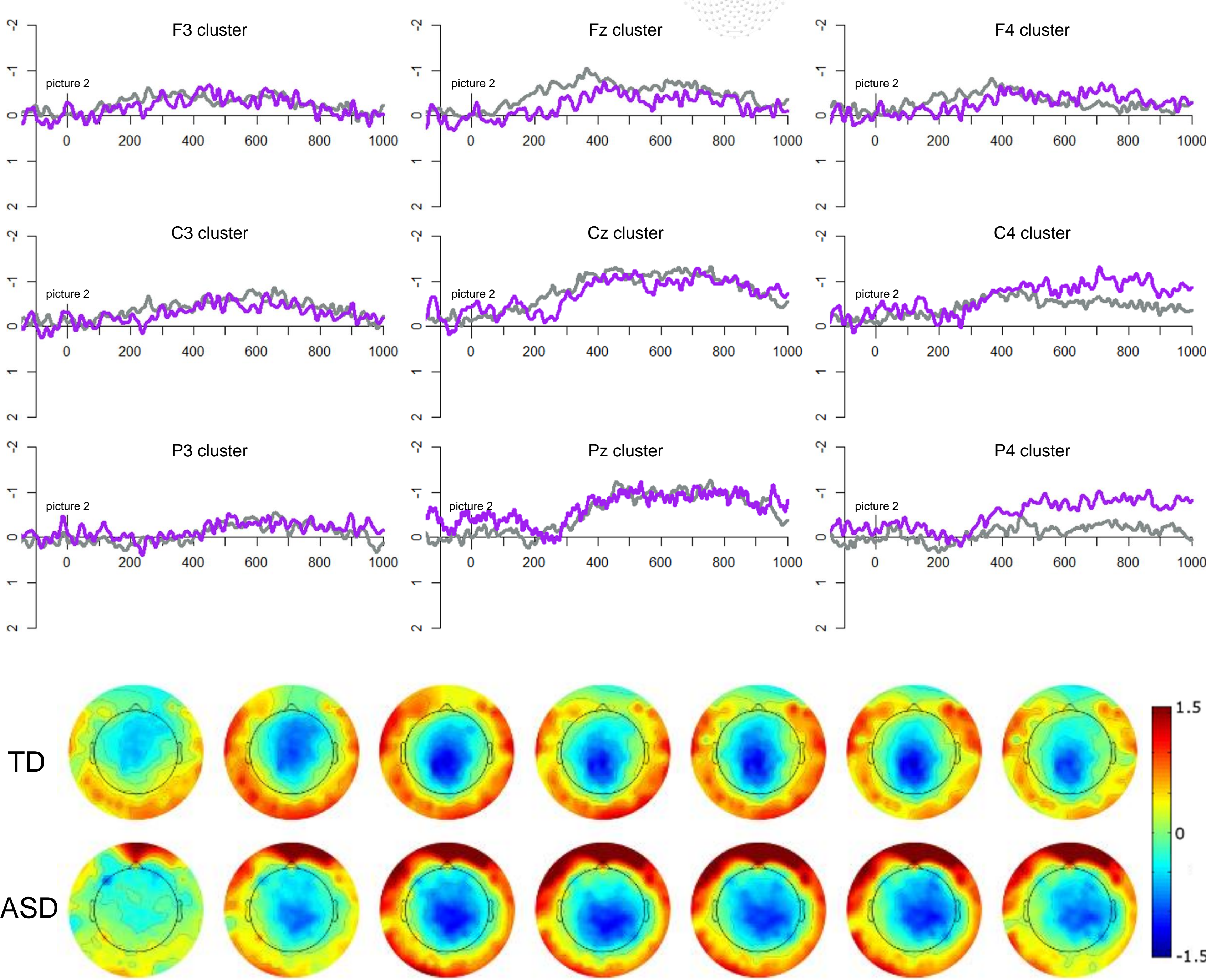
- In individuals with ASD, the *N400 effect* (i.e., the modulation of N400 amplitude by semantic relatedness) in response to linguistic stimuli is reduced or absent compared to typically-developing (TD) individuals [4,5], suggesting impaired semantic integration during language processing.
- However, visuo-semantic processing of non-verbal stimuli is not impaired [4,6].
- This could suggest semantic processing impairments only for language, but such a modality-specific deficit has not been satisfactorily established.

### The current study

- We established whether semantic processing deficits in individuals with ASD are restricted to the linguistic domain.
- Compared within-modality semantic priming of linguistic stimuli (written words) and non-linguistic stimuli (pictures) in adults with ASD and TD adults.

## Results: Pictures

### TD vs. ASD: Unrelated-related difference waves



## Discussion

### Non-linguistic semantic processing

- Both groups showed an N400 effect for picture pairs.
- Suggests non-linguistic semantic processing is not impaired in individuals with ASD.

### Linguistic semantic processing

- Both groups showed an N400 effect for words from 400-800 ms, indicating successful semantic processing of language.
- However, there were group differences in the timing and topography of the N400 effect.
- N300 component**
  - An N300 occurred from 300-500 ms over frontal scalp for the TD group but not the ASD group.
  - The N300 is proposed to reflect expectancy processes in semantic priming [7].
- N400RP (right-lateralized N400) component**
  - An N400RP occurred from 400-700 ms over parietal scalp for the ASD group but not the TD group.
  - The N400RP is proposed to reflect a semantic matching strategy [7].
- This suggests an expectancy-based strategy for the TD group (N300), but a more controlled post-lexical integration strategy for the ASD group (N400RP).

## Hypotheses

- Reduced or absent N400 effect for words in ASD group compared to TD group, reflecting impaired semantic processing of language.
- No group differences in N400 effect magnitude for pictures, reflecting intact non-linguistic semantic processing in individuals with ASD.

## Methods

### Participants

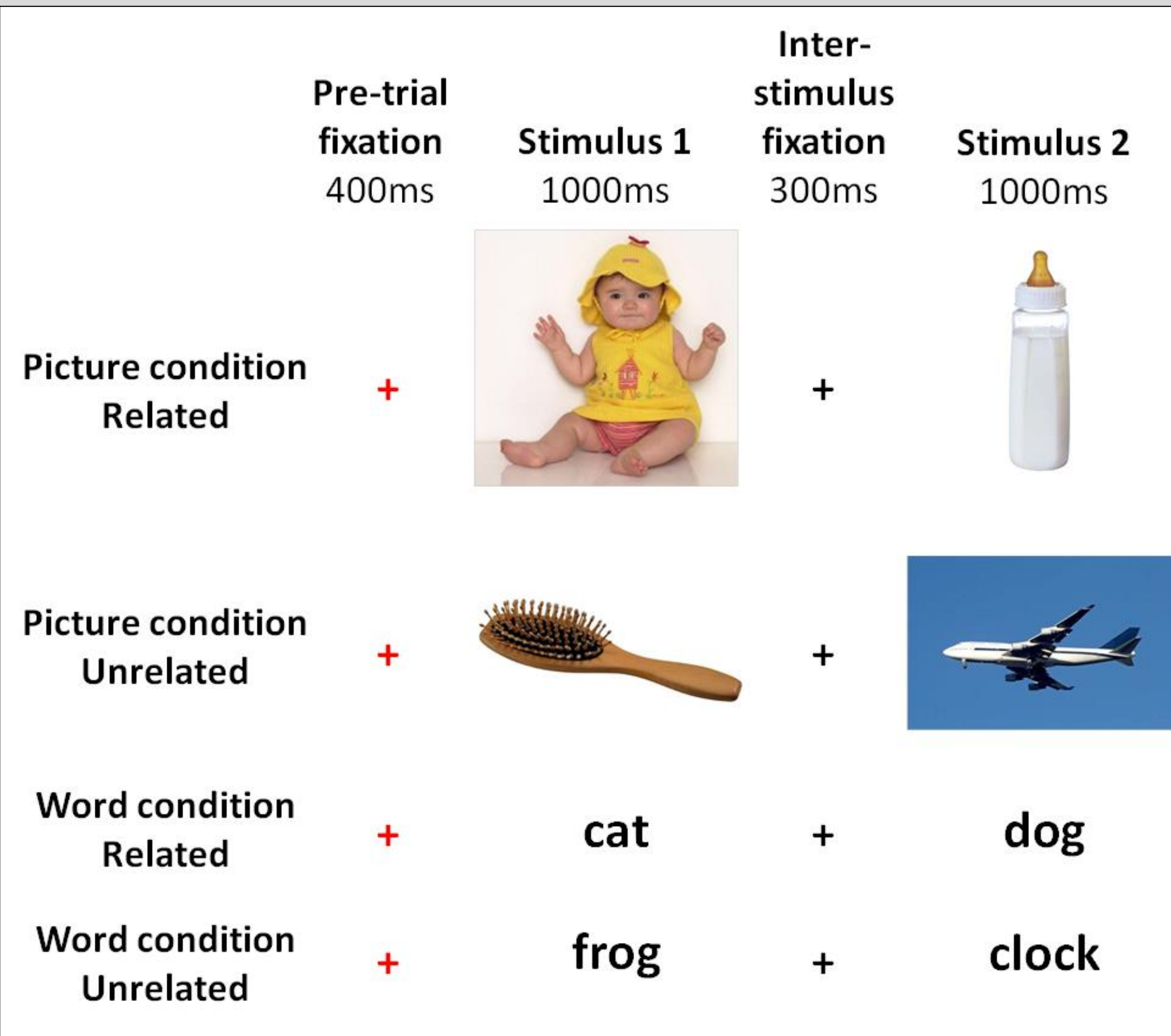
- 20 ASD; mean age 33 years (range 18-68); 17 male, 3 female; 18 Caucasian, 1 Hispanic, 1 mixed race
- 20 TD; mean age 34 years (range 19-69); 17 male, 3 female; 17 Caucasian, 1 Asian, 2 African American
- All right-handed native English speakers
- Groups matched on age ( $p = 0.83$ )
- Lower receptive vocabulary (PPVT) and verbal/non-verbal IQ (K-BIT) in ASD group than TD group (all  $p$ 's  $< 0.05$ )

### Stimuli and Procedure

- 100 word pairs: 50 related, 50 unrelated
- 100 picture pairs: 50 related, 50 unrelated
- Word/picture block order counterbalanced
- Participants judged whether stimuli were related or unrelated

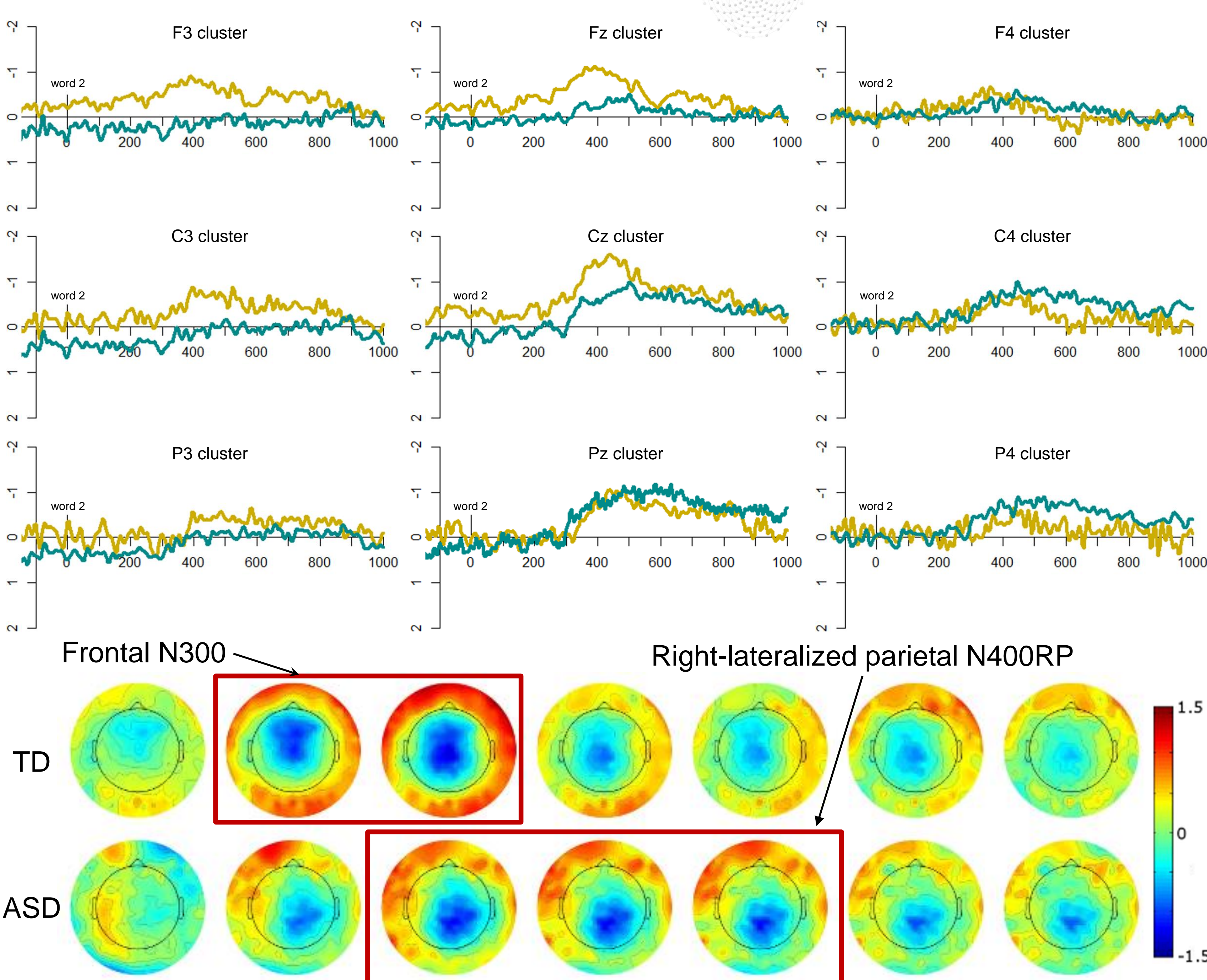
### EEG Data Acquisition and Preprocessing

- EEG recorded at 250 Hz
- EGI GES 300 EEG System
- 256-channel Hydrocel Geodesic Sensor Net
- NetStation 4.3
- Bandpass filtering 0.1-50 Hz
- Motion and eye movement artifacts corrected using ICA



## Results: Words

### TD vs. ASD: Unrelated-related difference waves



## Conclusions

- Intact semantic processing of picture stimuli between groups suggests that individuals with ASD do not have difficulties with non-linguistic semantic processing, as predicted.
- In contrast to previous findings, the ASD group did show an N400 effect in response to linguistic stimuli, suggesting intact semantic processing of language.
- Subtle differences in the timing and topography of the N400 effect suggest different processing strategies between the groups:
  - TD individuals utilize a more expectancy-based strategy.
  - Individuals with ASD employ a more controlled post-lexical integration strategy.
- These differences could be related to the explicit nature of the semantic priming task or to the adult populations we tested.

### References

- Tager-Flusberg, H., Paul, R., & Lord, C. (2005). Language and communication in autism. In F. Volkmar, R. Paul, A. Klin, & D. Cohen (Eds.), *Handbook of Autism and Pervasive Developmental Disorders* (3rd Edition, pp. 335–364). New York: John Wiley & Sons.
- Frith, U. (1989). *Autism: Explaining the enigma*. Oxford: Blackwell.
- Kutas, M., & Federmeier, K.D. (2011). Thirty years and counting: Finding meaning in the N400 component of the event-related brain potential (ERP). *Annual Review of Psychology*, 62, 621–647.
- McCleery, J. P., Ceponiene, R., Burner, K. M., Townsend, J., Kinnear, M., & Schreibman, L. (2010). Neural correlates of verbal and nonverbal semantic integration in children with autism spectrum disorders. *Journal of Child Psychology and Psychiatry*, 51, 277–286.
- Pijnacker, J., Geurts, B., van Lambalgen, M., Buitelaar, J., & Hagoort, P. (2010). Exceptions and anomalies: An ERP study on context sensitivity in autism. *Neuropsychologia*, 48, 2940–2951.
- Kamio, Y., & Toichi, M. (2000). Dual access to semantics in autism: is pictorial access superior to verbal access? *Journal of Child Psychology and Psychiatry*, 41, 859–867.
- Franklin, M. S., Dien, J., Neely, J. H., Huber, E., & Waterson, L. D. (2007). Semantic priming modulates the N400, N300, and N400RP. *Clinical Neurophysiology*, 118(5), 1053–1068.

### ACKNOWLEDGEMENTS

This work was supported by The Therapeutic Cognitive Neuroscience Fund and the Benjamin and Adith Miller Family Endowment on Aging, Alzheimer's, and Autism Research.