

# Using LENA to Map the Language Learning Environments and Vocal Behavior of Young Children with ASD

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# Acknowledgements

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- Gilkerson, Richards & Xu are LENA Foundation employees



# Background

- Social communication and language development core deficits of ASD
- We know little about naturalistic behavior throughout the day
- Technological advancements allow automatic analysis of day-long recordings



# LENA Overview

- LENA = Language Environment Analysis
- Purpose: To provide scientists, clinicians, and parents with automatically generated information about a child's natural language environment and language development.



# LENA Overview

- Digital Language Processor
- LENA Clothing
- 16 hours of audio data
- Advanced speech identification algorithms
- LENA Developmental Snapshot



# LENA System Measures

- **Adult Word Count**
  - Number of words the child is exposed to
- **Conversational Turns**
  - Number of interactions between child and adult
- **Child Vocalizations**
  - Number of times child vocalizes (talks or babbles)



# Focus

- Comparing language environment of ASD and TD children matched both for chronological age and development age
- Expands on Warren et al (2010). What automated vocal analysis reveals about the vocal production and language learning environment of young children with ASD. Journal of Autism & Developmental Disorders, 40, 555-569.



# LENA Foundation Natural Language Study

- Ongoing data collection effort conducted by non-profit foundation and university collaborators
- Largest natural language database in the world
- Various datasets are being collected





# Typically developing dataset

- Normative study = 329 children 2=48 months of age, recording 1/month for 6 months
- Longitudinal extension = 80 normative children continuing recording 1/month for 3 years
- Participants matched US census on mother's attained education
- Participants completed numerous developmental questionnaires and clinical evaluation at regular intervals.

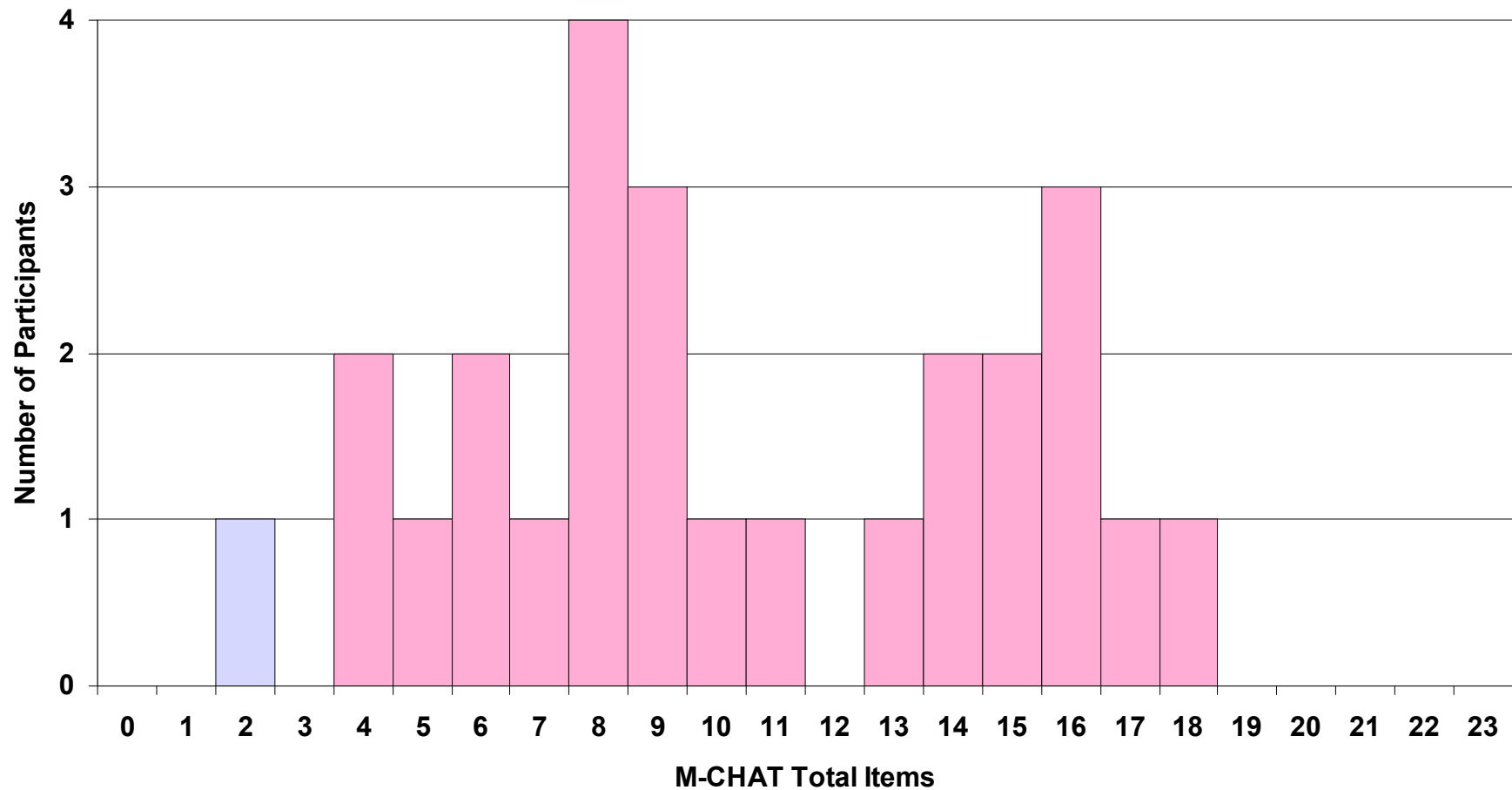


# ASD dataset

- N=26, 16-48 mo.
- Recruited nationwide
- Written documentation of ASD diagnosis by a professional required for participation
- Recorded 1/week for 7 weeks (twice during first week)
- Completed parent questionnaires  
(M-CHAT, SCQ, CSBS, CDI, MacArthur, CBCL/LDS, LENA Developmental Snapshot, BRIEF-P)



# Sample Characteristics M-CHAT





# Chronological Age Matching

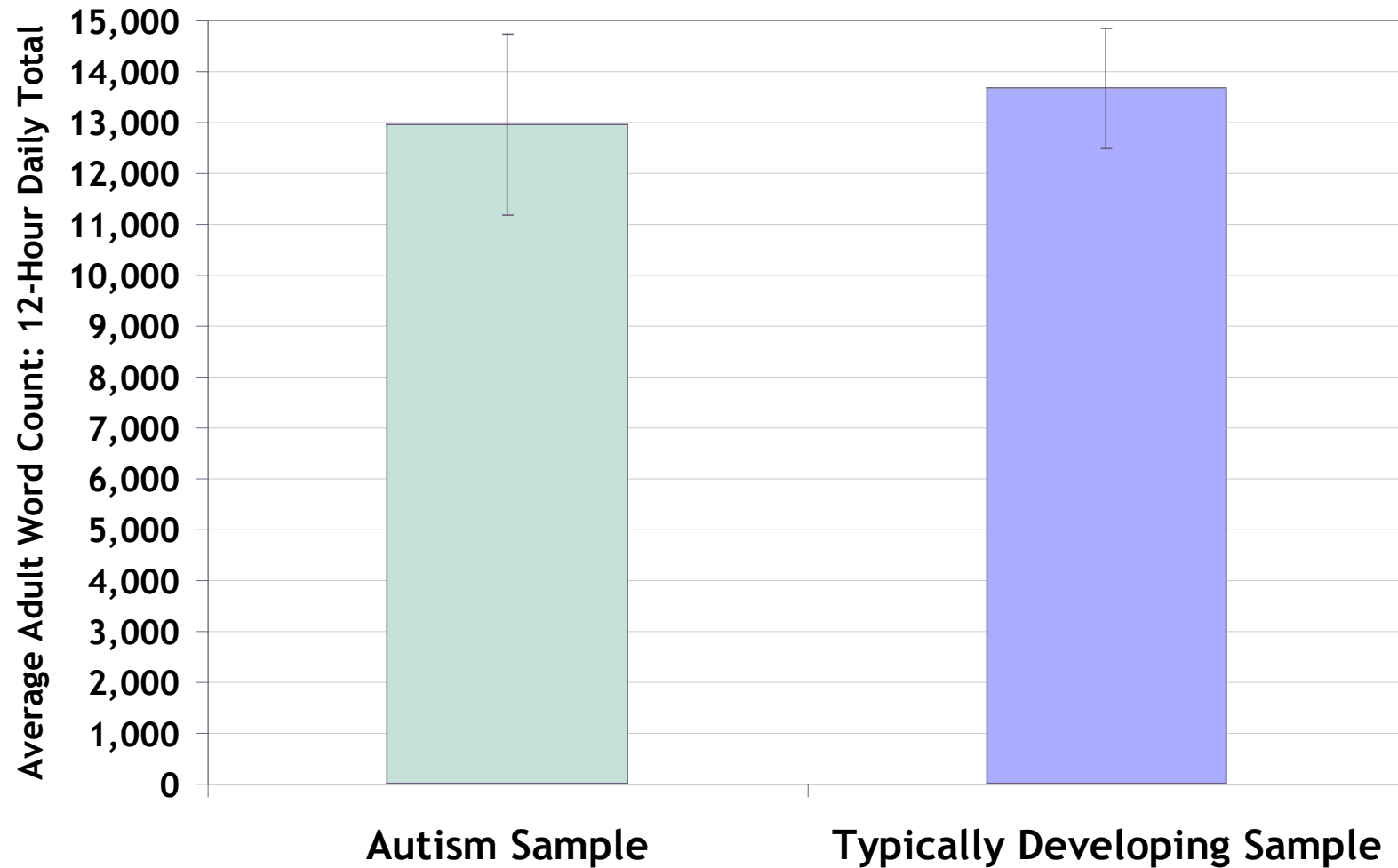
- 3:1 match for chronological age
- Also matched on gender and SES
- Limited TD recordings to 3 per participant to match time span of ASD recordings
- ASD: N=26; # recordings = 204
- TD: N=78, # recordings = 234



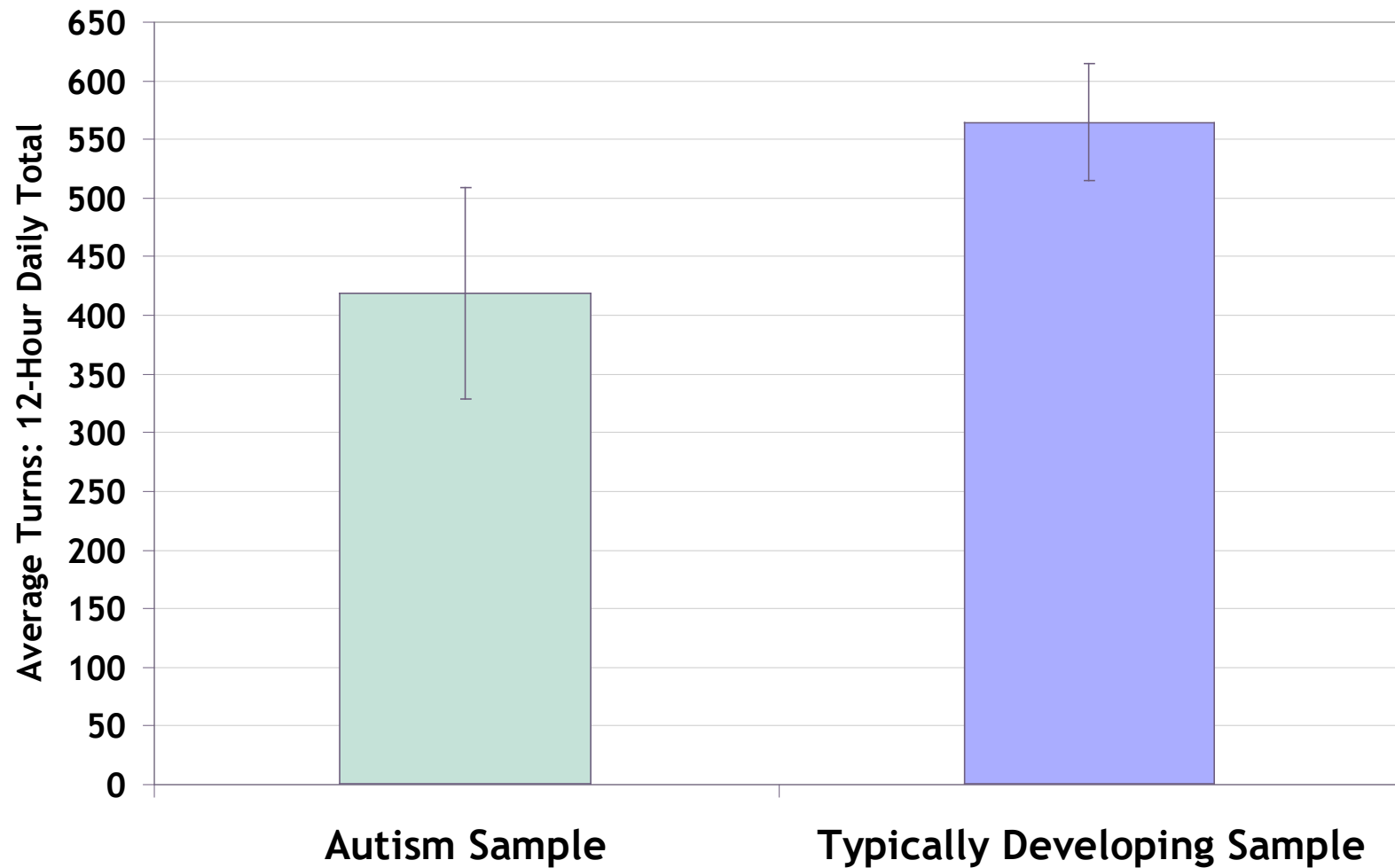
# Chronological Match Characteristics

	<u>ASD</u> <u>Sample</u>	<u>TD</u> <u>Sample</u>	<u>Total</u> <u>Sample</u>
# Participants	26	78	104
# Male	22	66	88
Chronological Age	33m	30m	31m
# Recordings	204	234	438
Recording Hours	2,448	2,808	5,256
Recording Span	7 wks	9 wks	8 wks

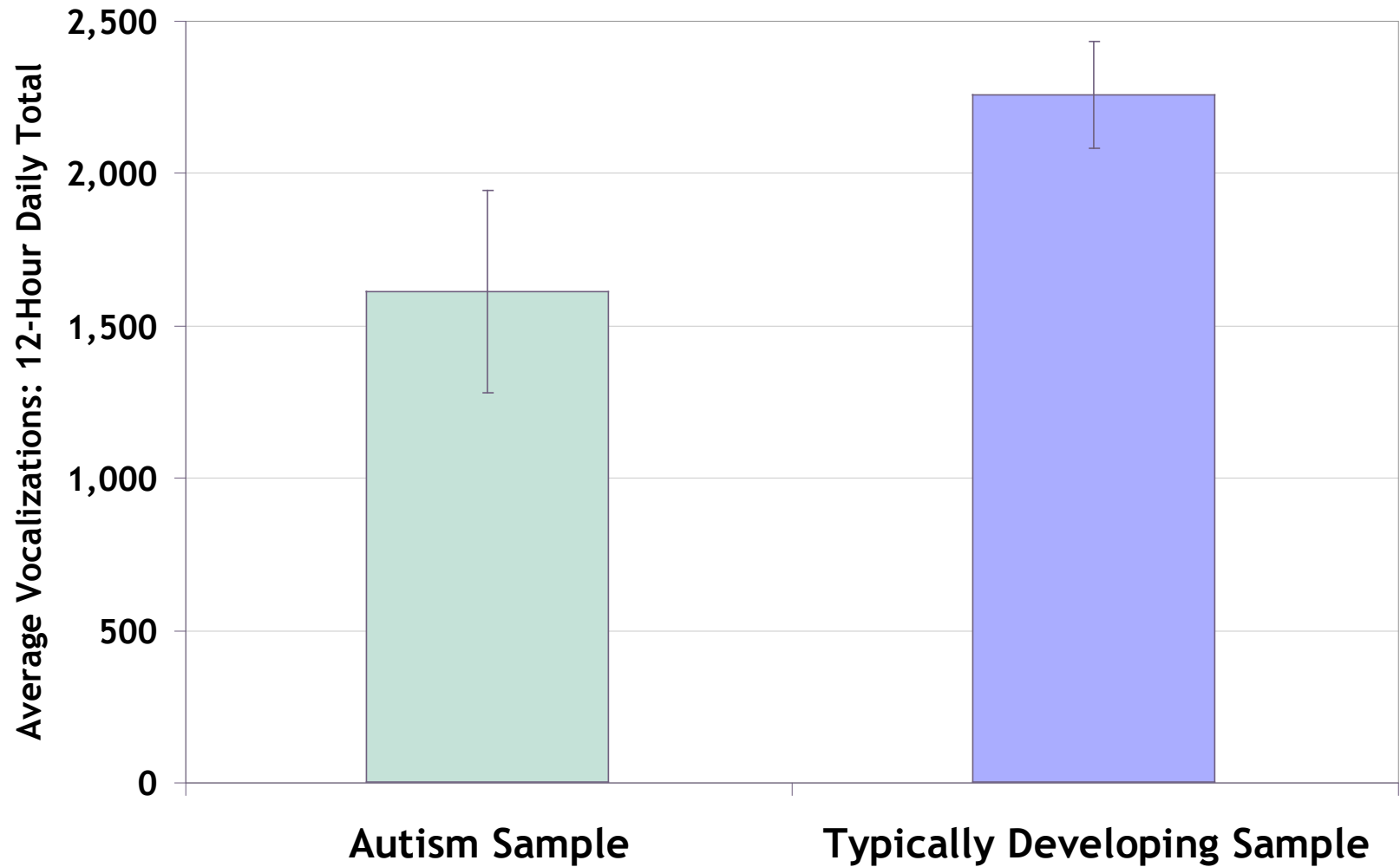
# CA Match - Adult Word Count



# CA Match - Conversational Turns

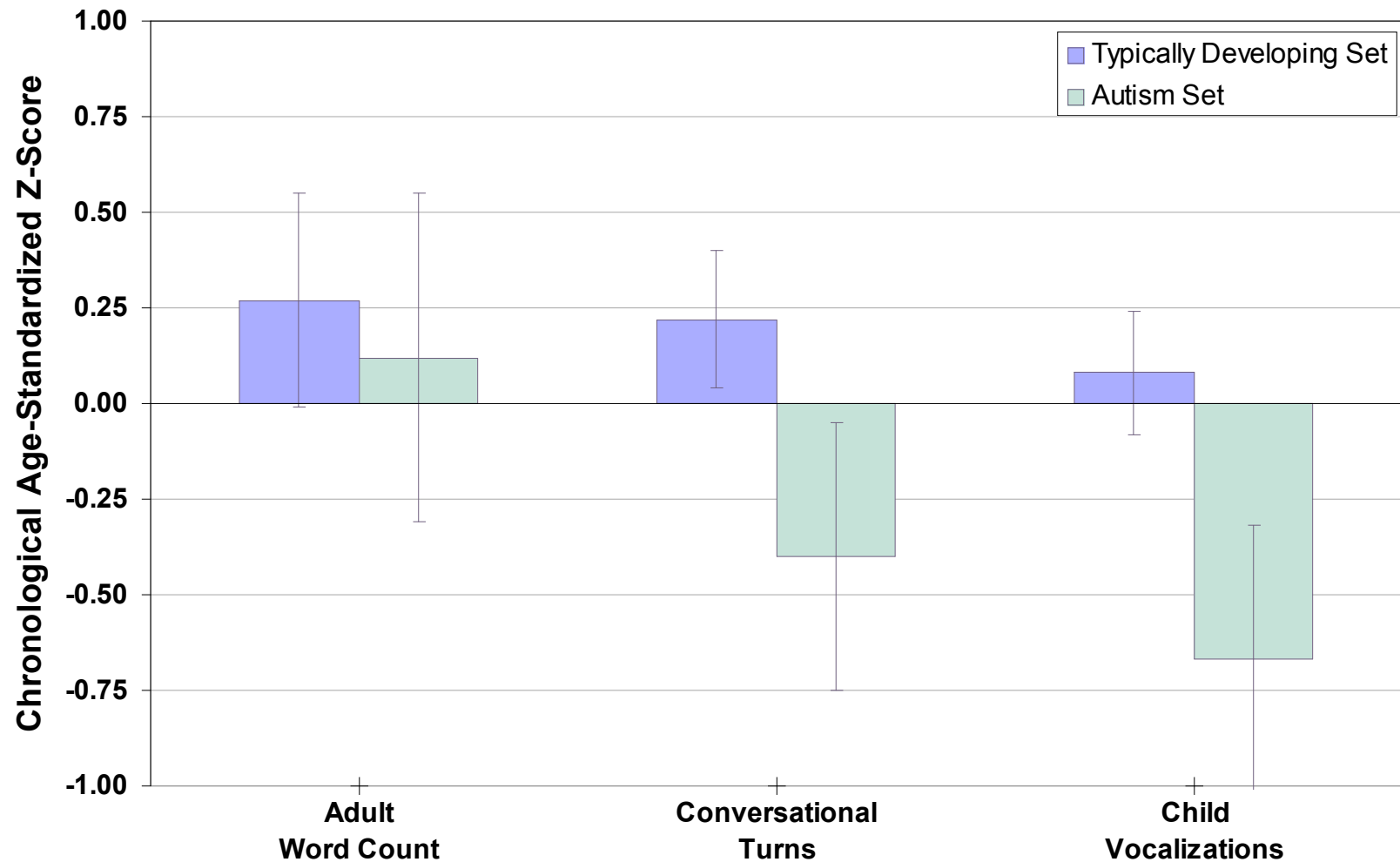


# CA Match – Child Vocalizations





# Chrono Age Match – Summary





# Implications: The Language Learning Environment of Children with Autism

- Cumulative Impact of Adult Word Count
  - Children with autism hear 1,000 fewer adult words a day: 7,000 fewer per week; over 1 million fewer across three years
- Cumulative Impact of Child Vocalizations
  - Children with autism produce 700 fewer vocalizations a day: 4,900 fewer per week; 765,000 fewer across three years
- Cumulative Impact of Conversational Turns
  - Children with autism engage in about 150 fewer turns a day: 1,050 fewer per week; 164,000 fewer across three years



# Developmental Age Matching

- 2:1 match on developmental age (CDI)
- Also matched on Gender and SES
- Limited TD recordings to 3 per participant to match time span of ASD recordings
- ASD: N=26; # recordings = 204
- TD: N=52, # recordings = 146



# Child Development Inventory (CDI)

## ■ General Development Scale

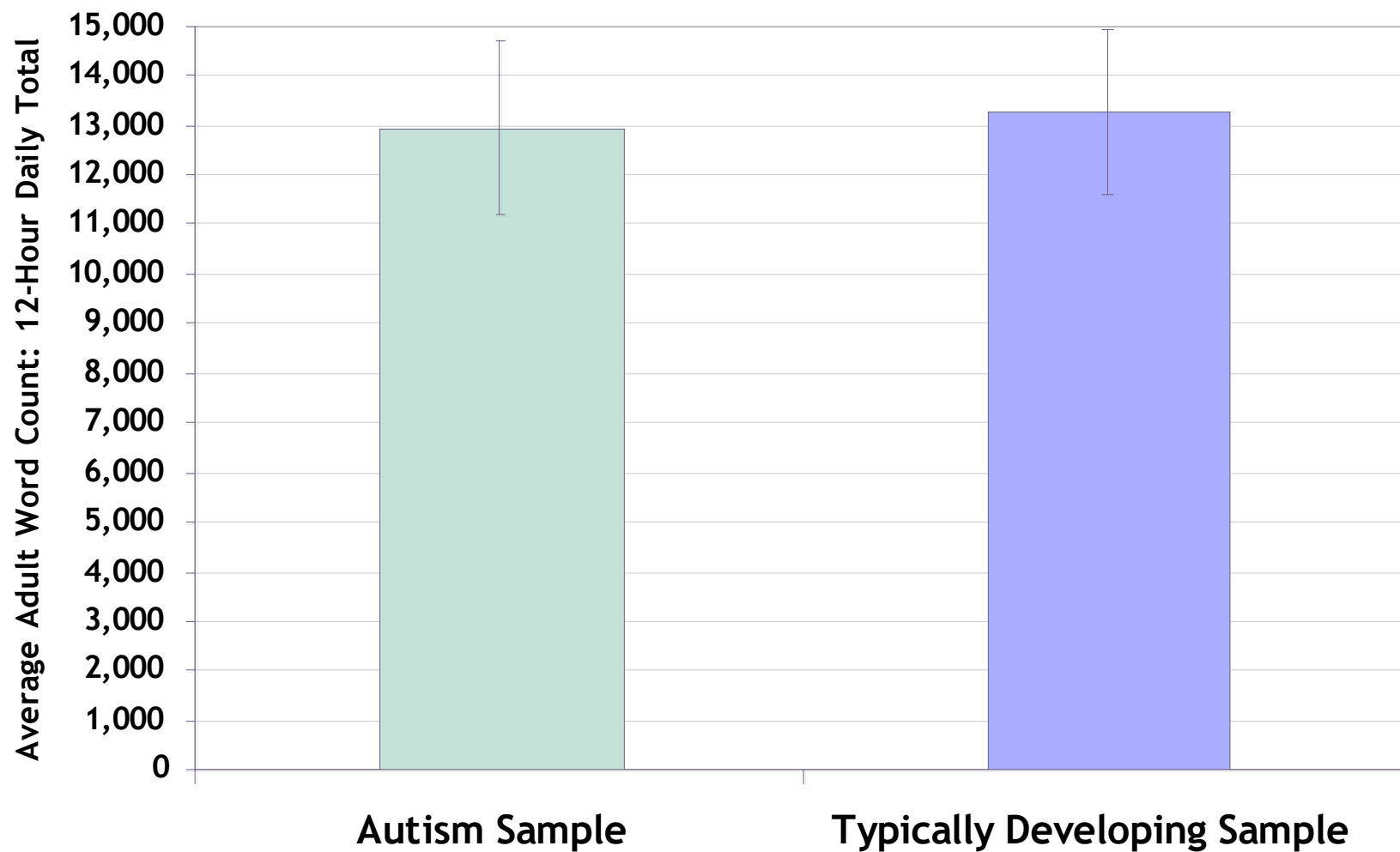
- Social Development
- Self Help
- Gross Motor / Fine Motor
- Expressive Language
- Receptive Language
- Letters and Numbers
- Possible Problems



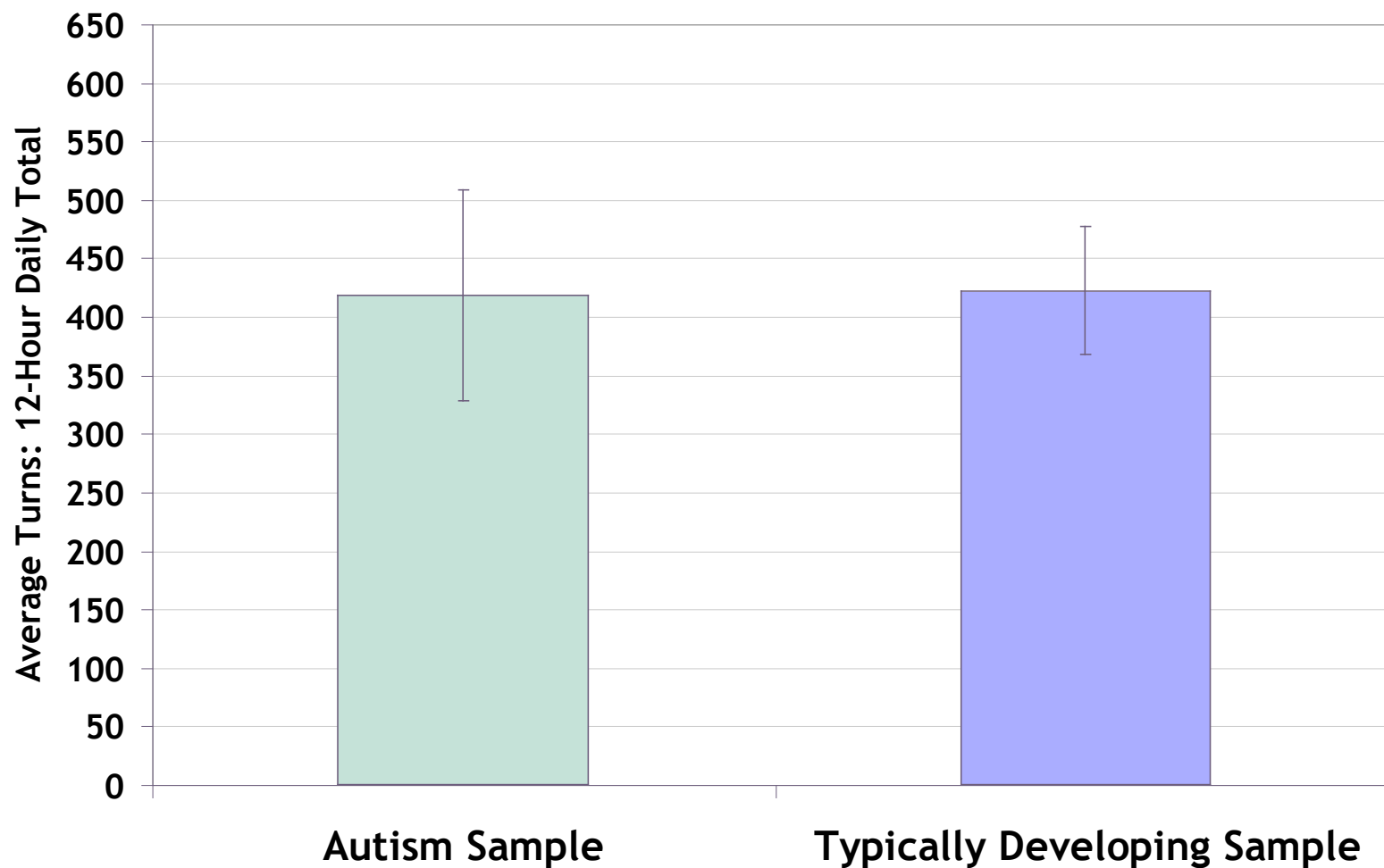
# Developmental Match Characteristics

	<u>ASD</u> <u>Sample</u>	<u>TD</u> <u>Sample</u>	<u>Total</u> <u>Sample</u>
# Participants	26	52	78
# Male	22	44	66
General Dev Age	19m	20m	20m
# Recordings	204	146	350
Recording Hours	2,448	1,752	4,200
Recording Span	7 wks	6 wks	6 wks

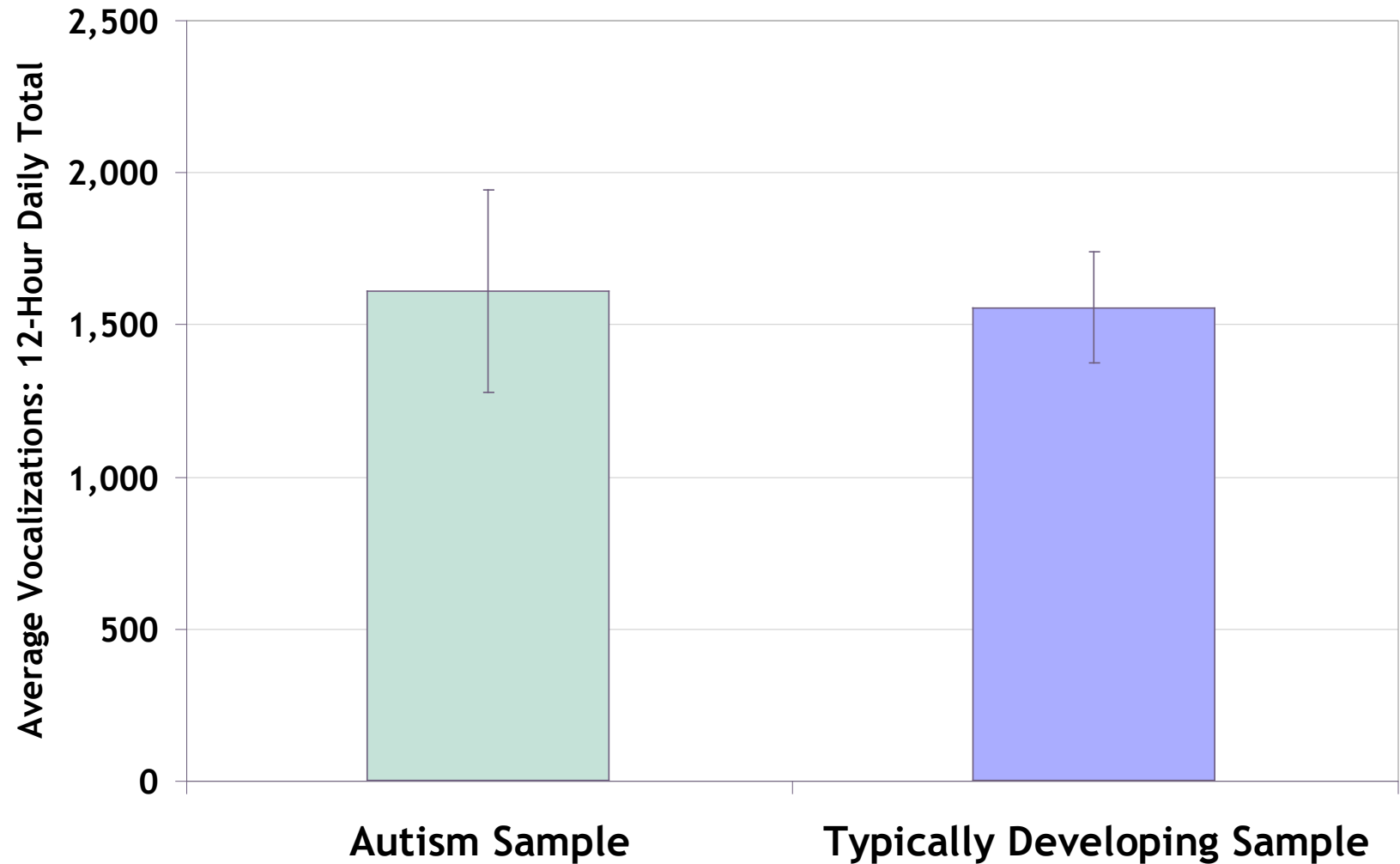
# DA Match - Adult Word Count



# DA Match - Conversational Turns

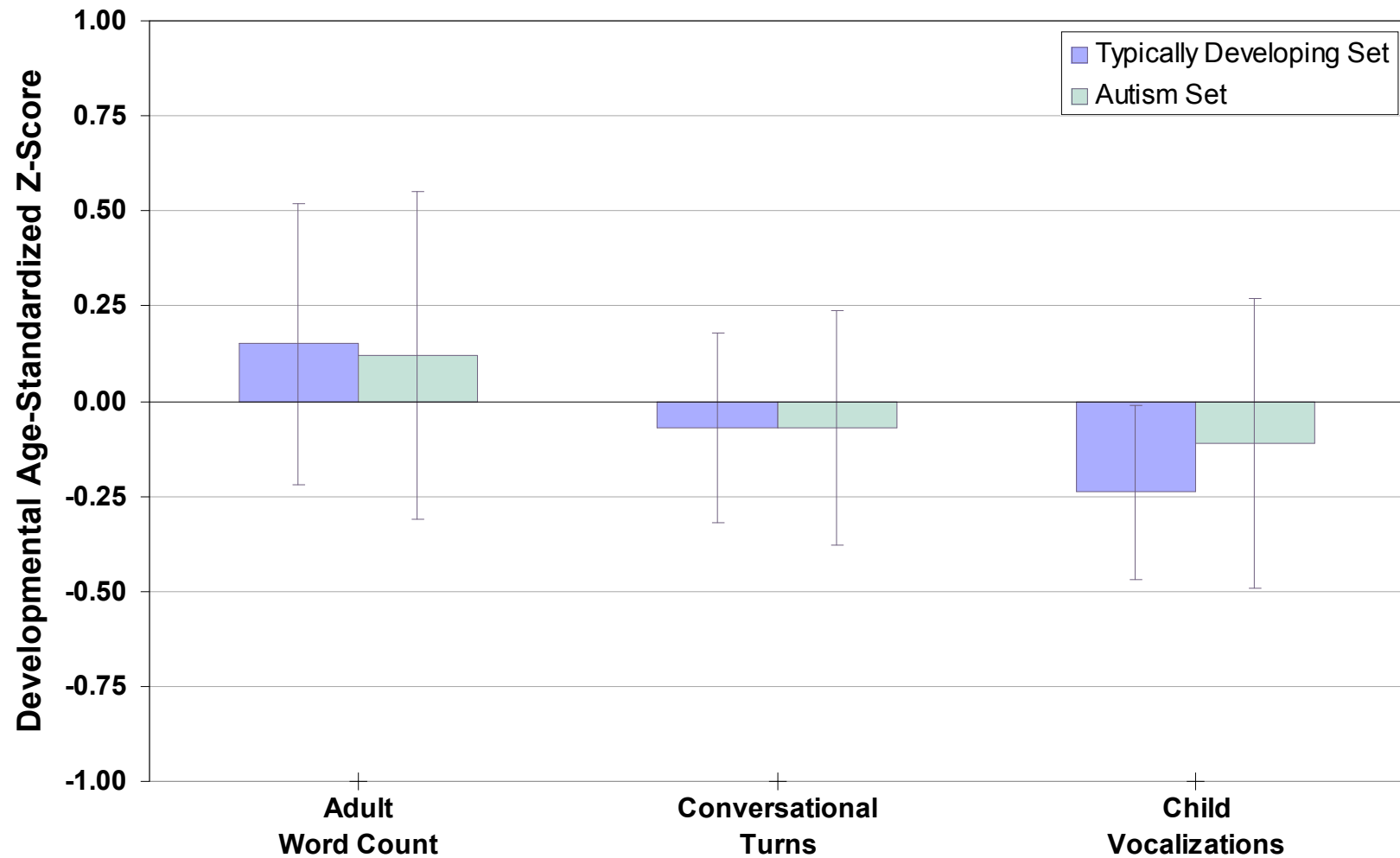


# DA Match – Child Vocalizations





# Dev Age Match – Summary





# Child Vocalization Types

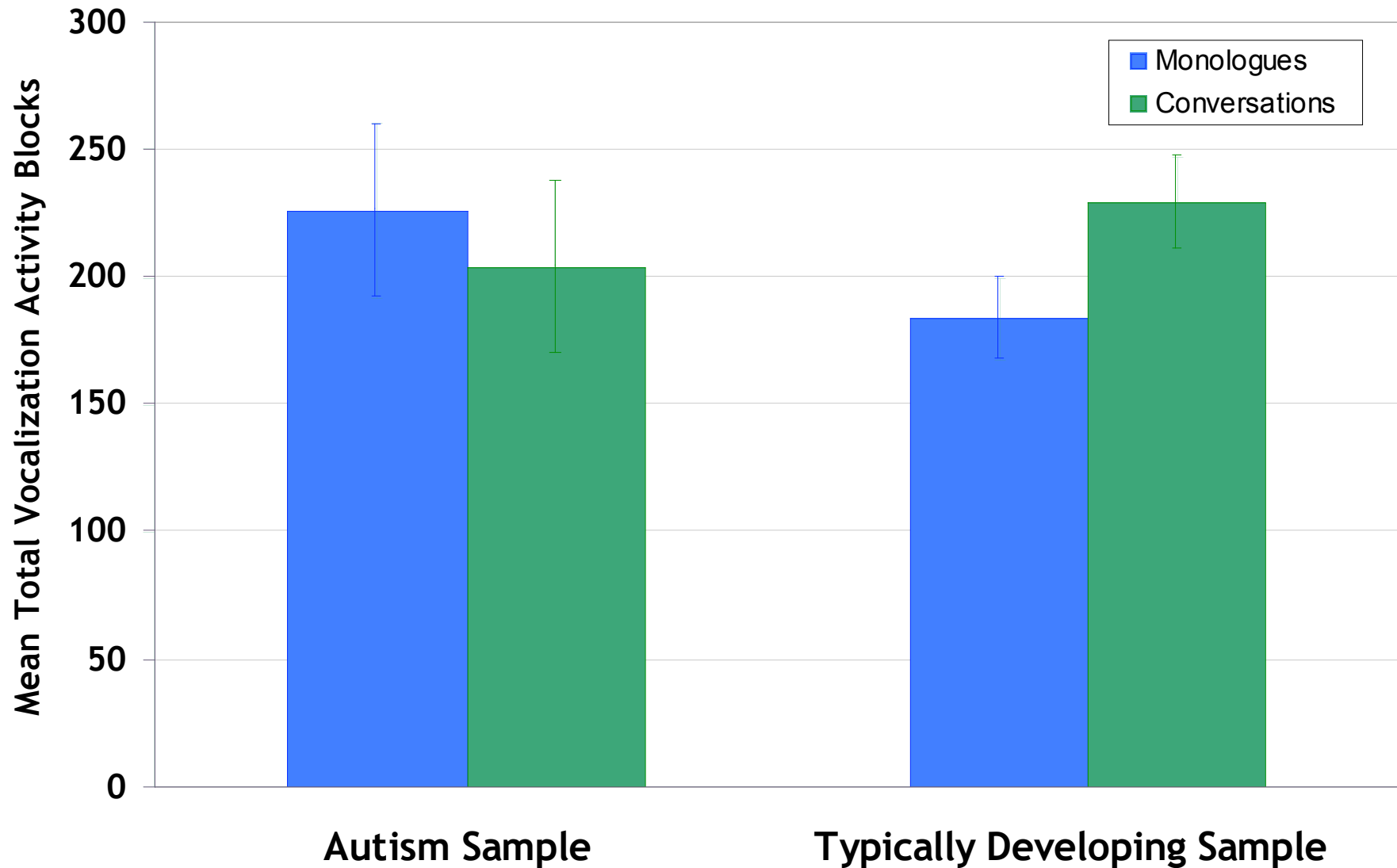
## ■ Conversations

- Blocks of vocalizations including both key child and adult segments bounded by 5 seconds or longer of silence or sounds not consisting of human vocalization

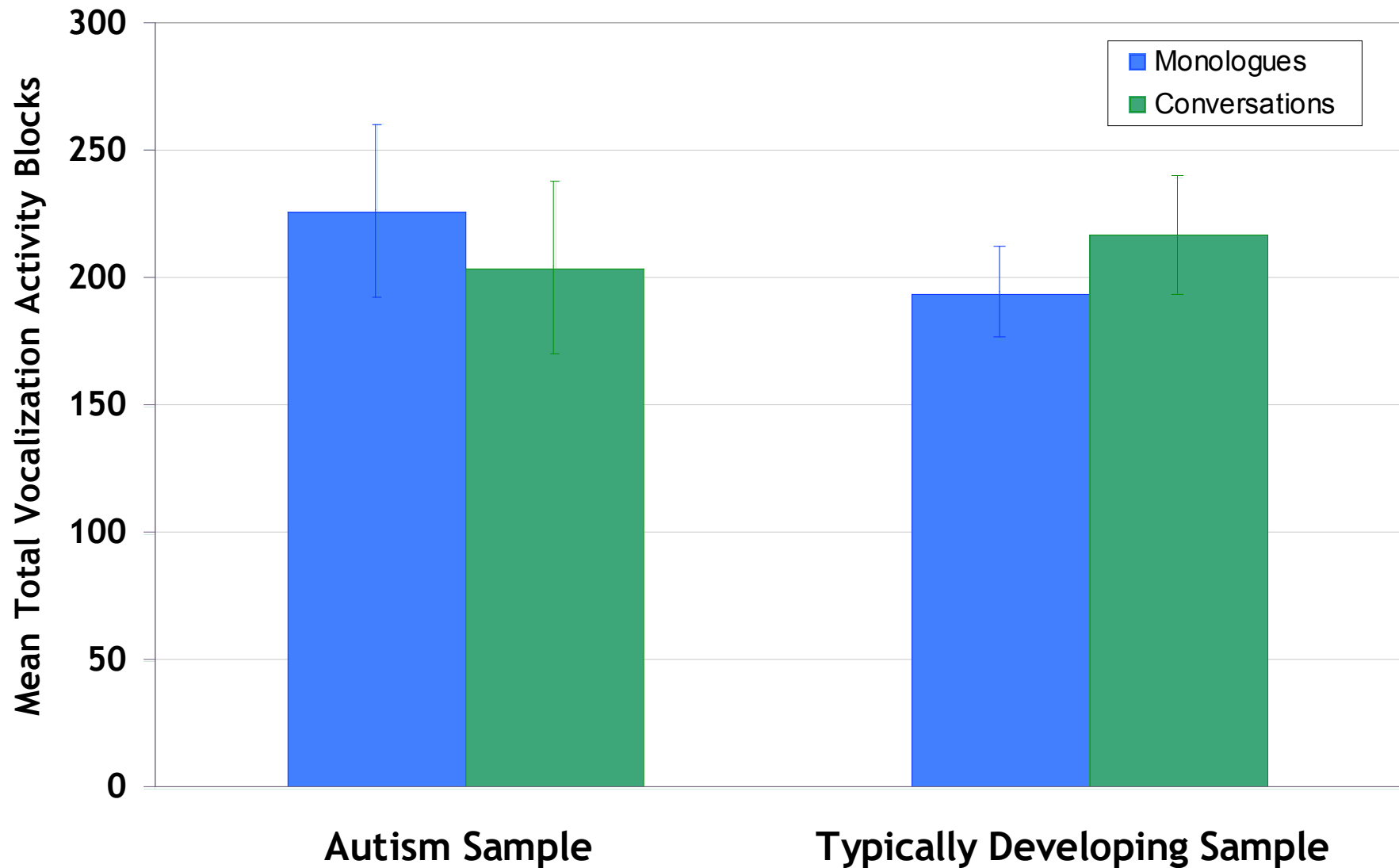
## ■ Monologues

- Blocks including key child vocalizations only with no adult vocalizations within +/- 5 seconds

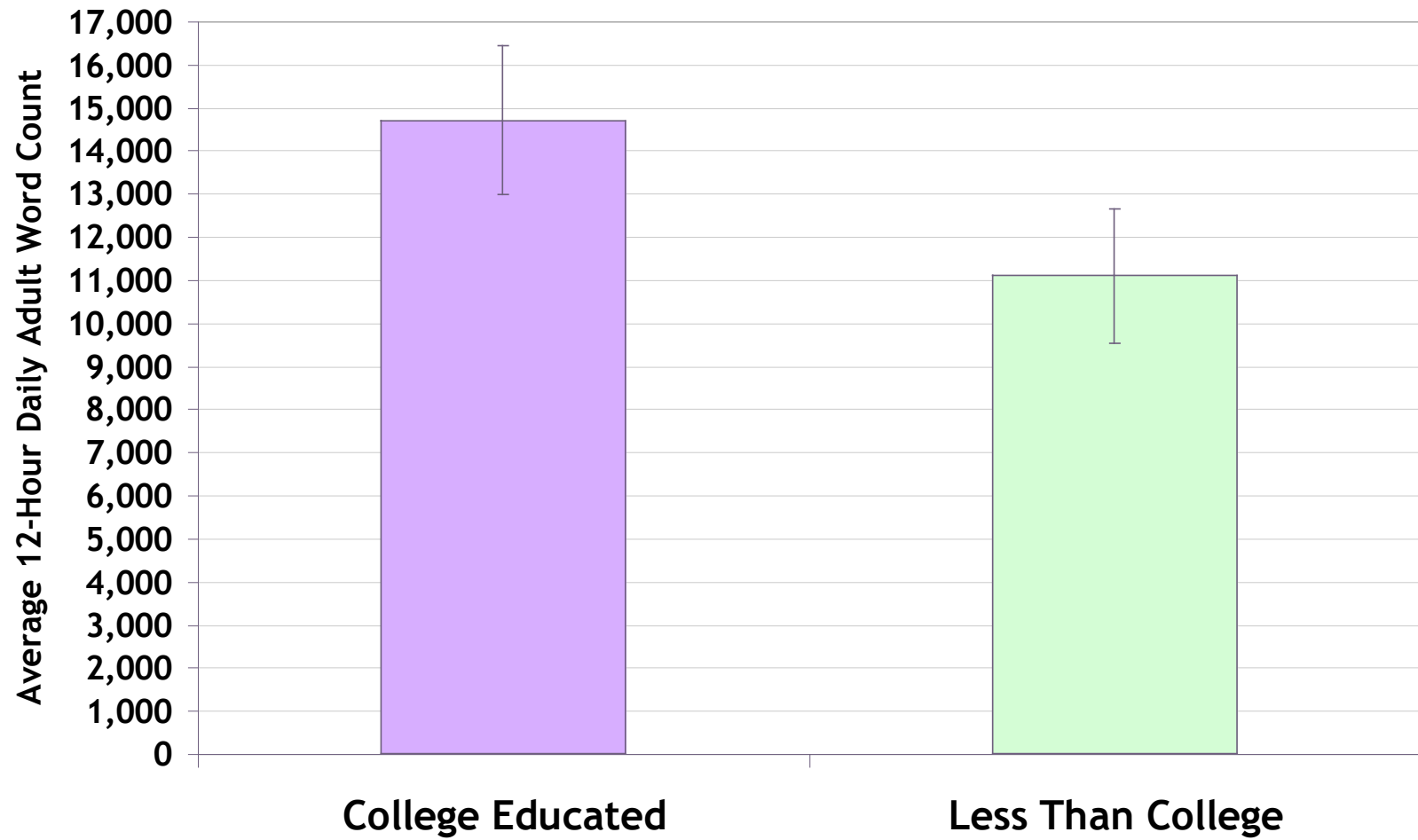
# CA Match – Vocalization Types



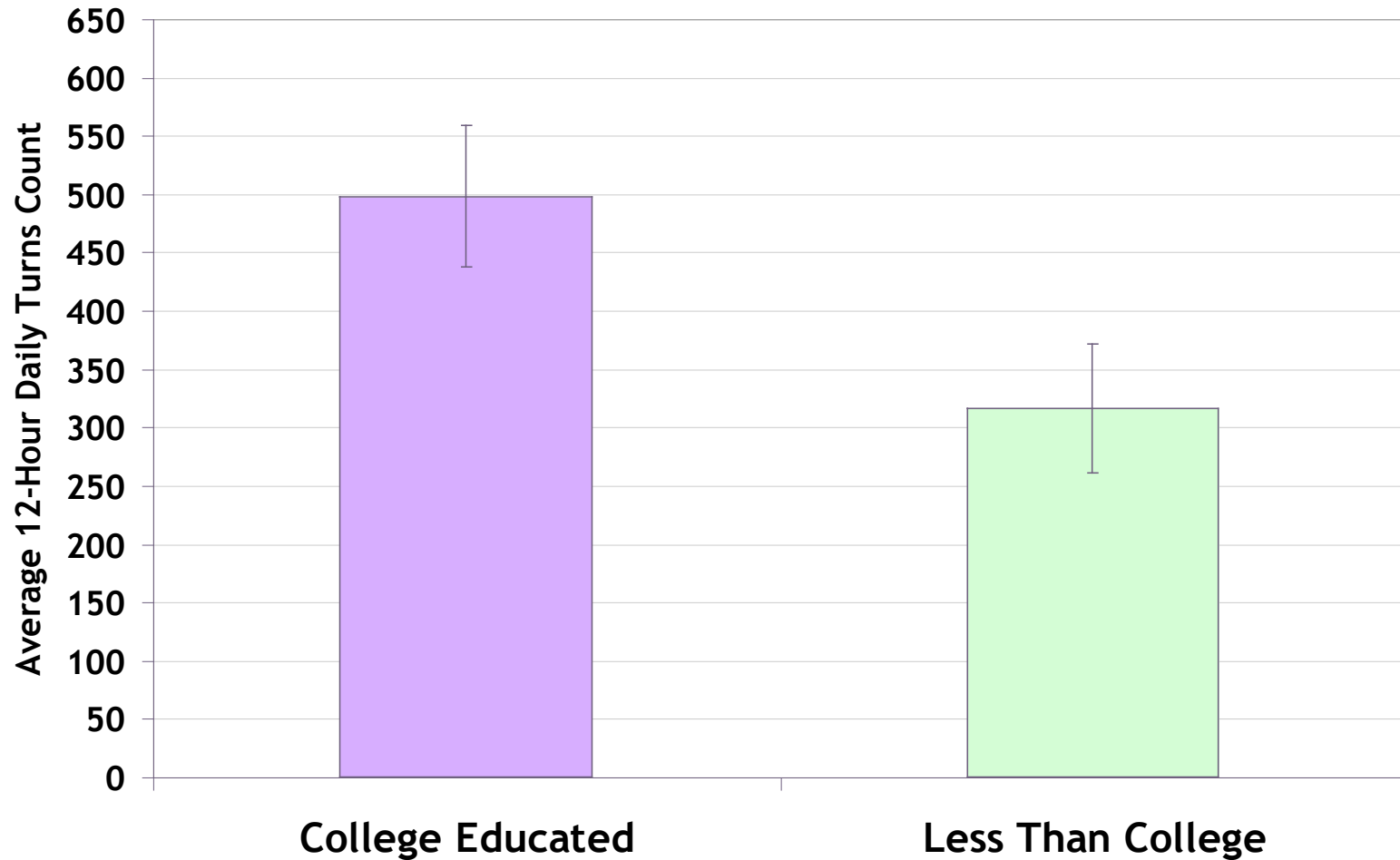
# DA Match – Vocalization Types



# DA Match – Education Differences



# DA Match – Education Differences





# Summary

- Expected performance on both matched sets
  - No difference for adult word exposure
  - Fewer turns for ASD group compared to CA; similar for DA matched TD children
  - Fewer child vocalizations for ASD group compared to CA; similar for DA matched TD children
  - BUT significant difference for ASD group in terms of monologues compared to both CA and DA matched groups
  - Parent education effects hold for CA and DA matched



# Implications

- Children with ASD experience important differences in their language learning environment over time compared to CA matched kids
- When matched for development level, differences go away....suggesting that parents are responding to child DA
- But the presence of high rate of vocal “monologues” may be a unique signature of ASD





# Future Research Directions

- Numerous longitudinal questions
- Specific focus on conversational turn-taking measure as measure of parental responsiveness
- Use of LENA to study intervention fidelity
- Effects of intervention
- Monologues as a screening variable
- Natural history of monologues



# Citation

- Warren et al (2010). What automated vocal analysis reveals about the vocal production and language learning environment of young children with autism. Journal of Autism and Developmental Disabilities, 40, 555-569.