Automatic detection of idiosyncratic word use in Autism Spectrum Disorders

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Background

Neologisms
- ADI-R: "non-words".
- Volden & Lord (1991): "words that are not included in the standard lexicon of adult native language speakers".
- Lord (1996): "use of made-up non-words as if they were words".

4. Stereotyped/Idiosyncratic Use of Words or Phrases.
Coding for this item includes delayed echolalia or other highly repetitive utterances with consistent intonation patterns, as well as the use of words or phrases that are inappropriately formal. These words or phrases can be intended meaningfully and can be appropriate to conversation at some level. The focus of the item is on the stereotyped or idiosyncratic quality of the phrasing, unusual use of words or formation of utterances, and/or their arbitrary association with a particular meaning. Neologisms should be coded here, as well as clear evidence of a pronoun error *across person* (e.g., *you* or *he/she* to mean *I*). Score relative to the participant's expressive language level.

ADOS Manual, Module 3

Idiosyncratic Word Use
- Kanner (1946): "peculiar and out of place in ordinary conversation".
- ADI-R: "obviously peculiar" words.
- Volden & Lord (1991): "standard, familiar words or phrases [used] in idiosyncratic, but meaningful ways".

Motivation & Objectives

Problem
Definitions of neologism and idiosyncratic words or phrases, as presented in ADOS manual, are vague and over-inclusive: "repetitive", "inappropriately formal", "unusual use of words or formation of utterances", "idiosyncratic", "neologisms". Broad definition may lead to errors in clinical judgment about autism-peculiar language.

Objective
Determine whether significant differences between TD and ASD groups can be obtained by measuring neologism and unusual word use with 1) manual methods based on specific criteria, and 2) automated methods based on natural language processing (NLP) techniques.

Data

	TD	ASD
# subjects	17	20
age	6.24 (1.38)	6.38 (1.25)
NVIQ	125.71 (11.63)	108.9 (16.41)
# sentences	420 (144.26)	363.05 (163.39)

ADOS activities transcribed with modified SALT annotation:
- Make-Believe Play
- Joint Interactive Play
- Description of a Picture
- Telling a Story From a Book
- Conversation and Reporting

Method

Automated Methods
Use word frequencies tabulated from the Wall Street Journal (WSJ) training set of the Penn Treebank (40,000 sentences, 1 million words).

Neologisms: Words from a transcript that do not appear in the WSJ (known as *out-of-vocabulary words*, or **OOVs**) are *potential* neologisms.

1. Raw OOV rate: number of OOVs used divided by the number of total words used.
2. OOV type rate: number of unique OOVs used by a child divided by the number of unique words used.

Unusual Words: Words from a transcript that appear very rarely in the WSJ may be considered unusual.

1. Low frequency words: percentage of words used by a child with WSJ frequency <= 100.
2. Mid-frequency words: percentage of words used with WSJ frequency > 100, <= 10,000.
3. High frequency words: percentage of words used with WSJ frequency > 10,000

Manual Methods
Use extracted WSJ OOVs and Amazon Mechanical Turk, a web-based interface in which untrained "workers" read transcripts and identify any strange or unusual words.

Neologisms: Detailed examination of WSJ OOVs by trained linguist in order to exclude existing words, non-words subsequently explained by the child, and non-words whose meaning can be extrapolated from productive morphological processes (e.g., adding *-er* or *-ish* to an existing word).

Unusual Words
1. Raw Mechanical Turk data: Percentage of sentences containing words identified as strange or unusual by untrained Mechanical Turk workers.
2. Mechanical Turk data + detailed linguistic examination à la Volden & Lord (1991): Review sentences identified by workers, and determine whether the word has a:
   - non-developmental syntax or morphology error
   - developmental syntax or morphology error
   - semantic error: a non-word or inappropriate word

Results: Neologisms and OOVs

Wall Street Journal Out-of-Vocabulary Words (WSJ OOVs)
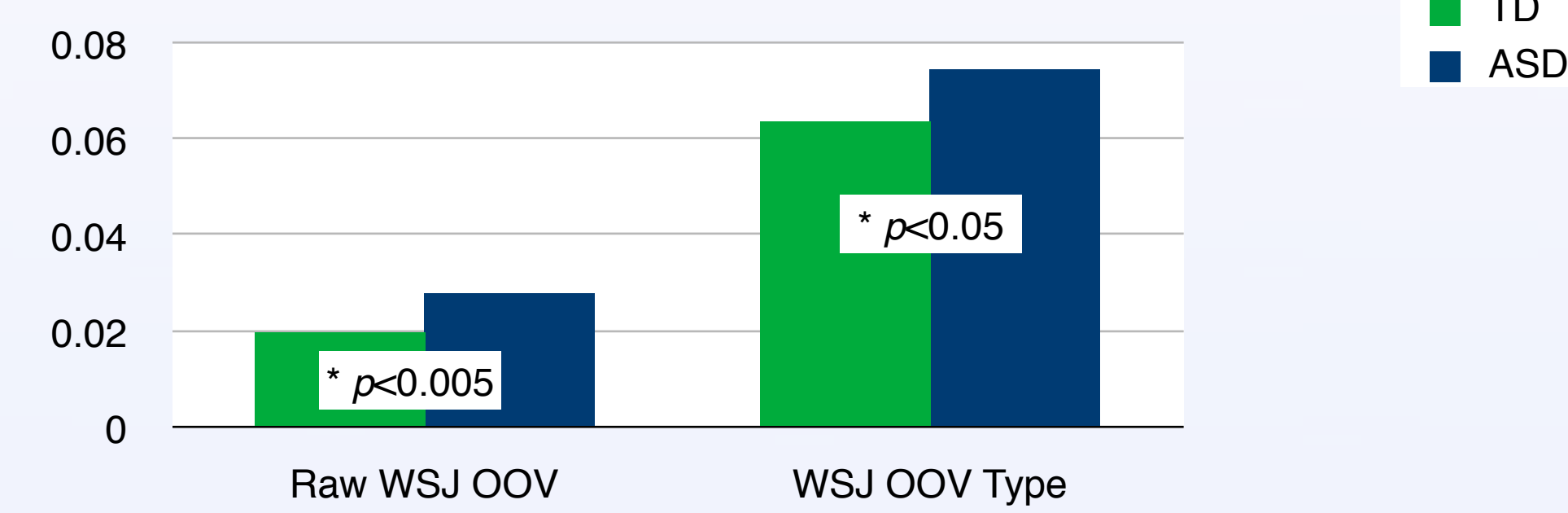
WSJ OOVs Manually Categorized as Neologisms

|	
TD	subtractions, cactuses, drowneding, gamey, snipper, calerpitter, wowing, noku, anchococa
ASD	fasted, bine, cumbolai, caraholic, boding, weevie, como-saido, introduceded, canflorsid, atened, essoed
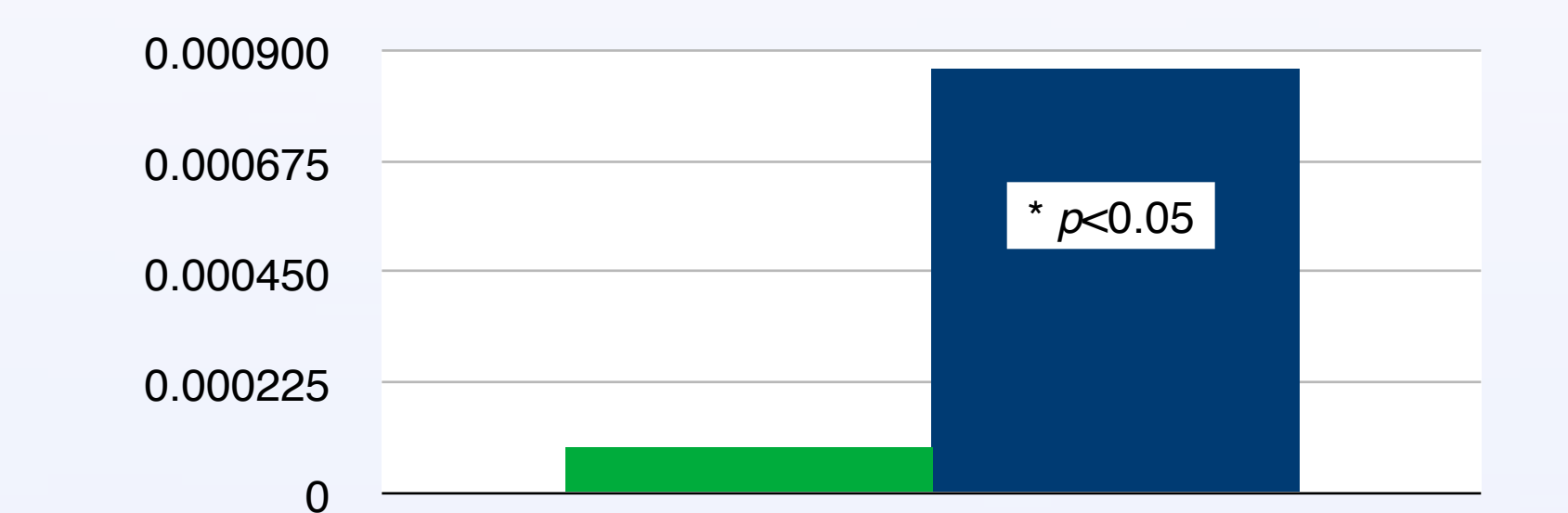
TD	snipper, noku, anchococa
ASD	bine, cumbolai, boding, como-saido, canflorsid, atened, essoed

Results: Unusual Words and Word Use

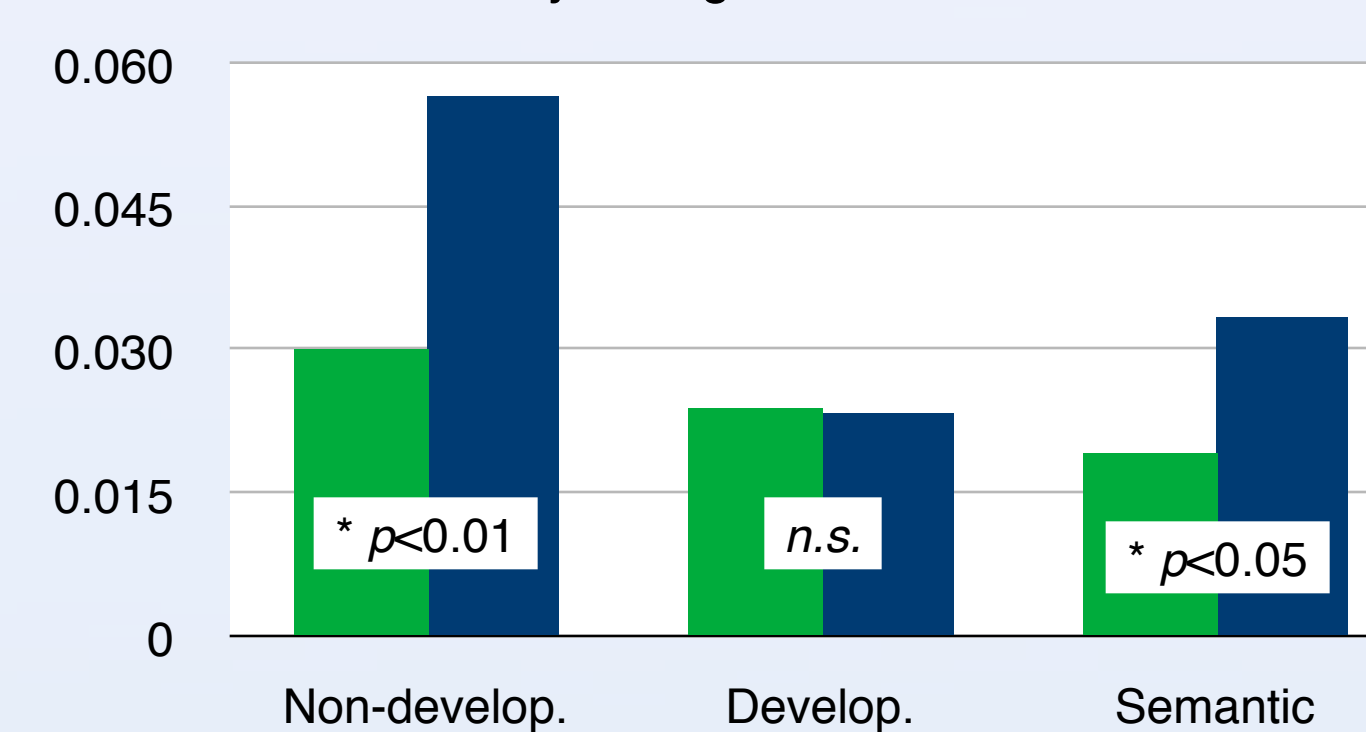
Wall Street Journal Frequency Ranges

Raw Mechanical Turk

Manually Categorized Mechanical Turk
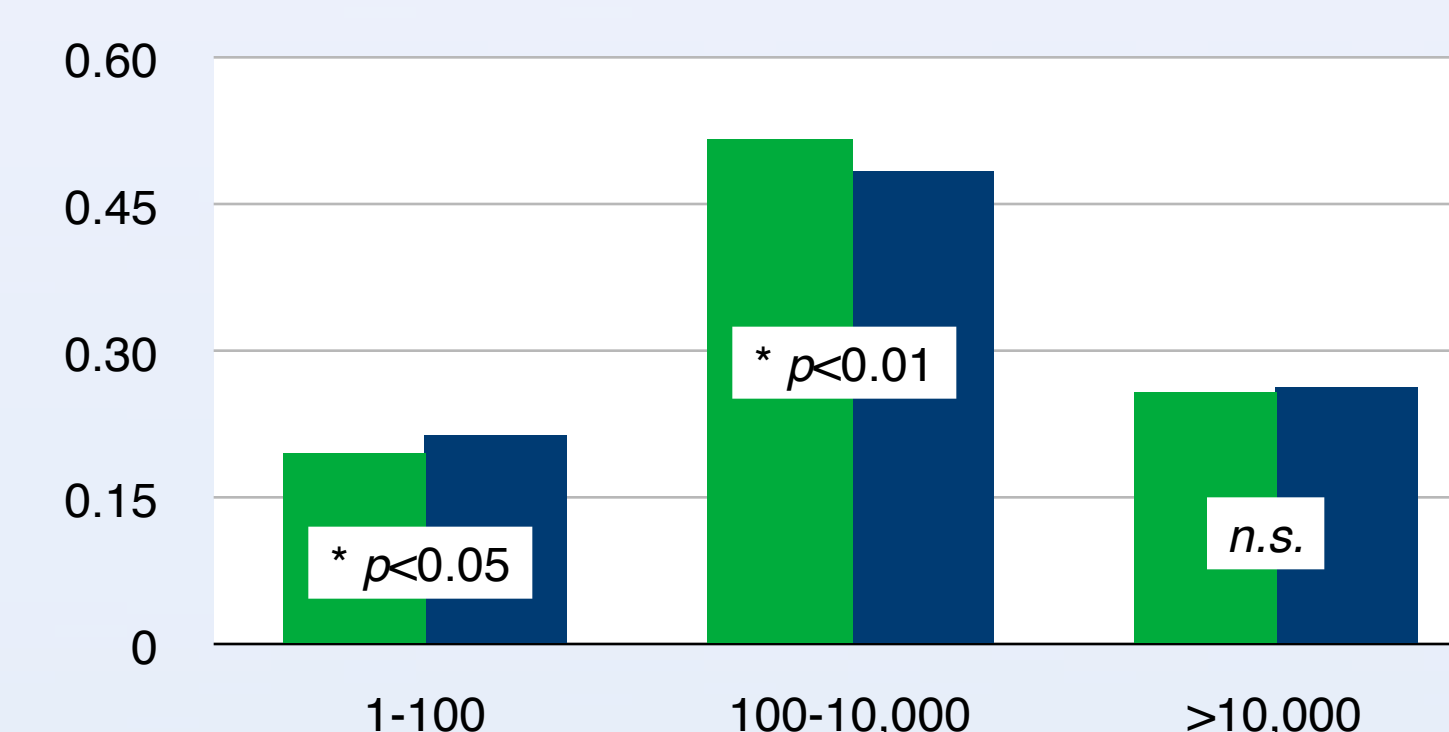
1-100	launch, collection, army, sister, surprised
100-10,000	talks, looking, why, you, well, after
>10,000	a, the, to, of, and, in
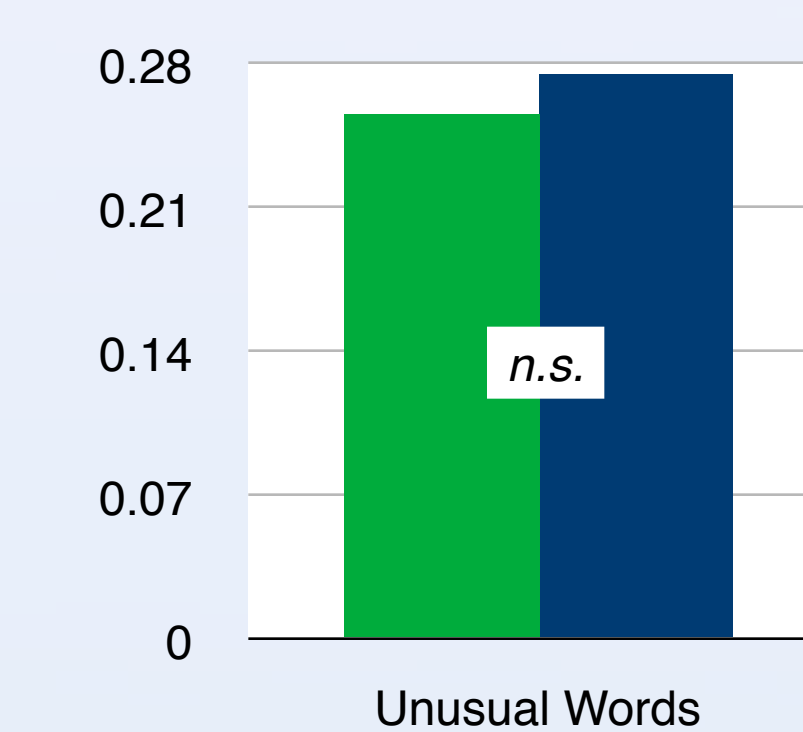
Non-developmental syntax/ morphology errors	Your dog **scared** at me. He locked him **all of out**. Would you like to **be fall** down?
Developmental syntax/ morphology errors	**Her** falls down. He **rans** away. The baby **drinked** it
Semantic errors	Something makes my eyes **poke**. It **smells** like it's falling on your head. All the fish are **leaving** in the air.

Discussion

Conclusions
- Given that OOVs include words that neither are neologisms nor exemplify idiosyncratic word use, the simple coarse measure of OOV rate performed remarkably well.
- NLP-based frequency statistics may capture unusual word usage patterns.
- Defining categories of unusual word use is critical, requires linguistic analysis and clinical expertise.
- Categorization by untrained annotators does not yield group differences revealed by expert annotation.

Future Work
- Explore whether measures of unusual word use can play a role in reducing ASD/DLD diagnostic substitution.
- Further refine definitions/criteria for neologistic and unusual word use to distinguish ASD from DLD.
- Use automated measures, including corpus-based NLP techniques and measures of syntactic complexity, to investigate more subtle differences in ASD vs. DLD word use.
- Combine measures of unusual word use with measures of repetitive language.
- Build algorithms to distinguish underlying causes of unusual word use (e.g., social/communication issues vs. word-retrieval problems), since uncertainty about source of unusual word use can contribute to diagnostic substitution.

References & Acknowledgements

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