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"Um" Fillers Distinguish Children with and without ASD

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Abstract

Two laboratories have reported that children with ASD are less likely than their typical peers to fill pauses with *um* but their use of *uh* is unaffected (Irvine, Eigsti, & Fein, 2016; Gorman et al., 2016). In this brief report, we replicated this finding by comparing the discourse of 7-to-15-year-olds with ASD ($N = 31$) to that of their typically developing same-age peers ($N = 32$). The robustness of this easily documented difference in discourse suggests a potentially useful clinical marker of ASD.

Keywords

Autism Spectrum Disorder; fillers; disfluency; discourse

Spoken language contains frequent pauses and, in English, these pauses are often filled with *uh* or *um*. Arguably, these forms are not mere disfluencies, rather, they are conventional in phonological form, meaning, and use (Clark & Fox Tree, 2002, cf. Corley & Stewart, 2008). Investigations of *um* or *uh* (but not both) have revealed multiple pragmatic discourse functions served by these fillers. For example, listeners take *um* to mean that speakers are having difficulty planning or remembering what they want to say (Fox Tree, 2007) and *uh* to mean that speakers are introducing information that is new to the discourse (Arnold, Fagnano, & Tanenhaus, 2003; Arnold, Tanenhaus, Altmann, & Fagnano, 2004). There is debate over whether fillers might also serve as an indicator of truthfulness. A meta-analysis of 41 studies found that filled pauses, in general, bore no reliable relationship with the truthfulness of the utterances in which they occurred (Sporer & Schwandt, 2006), but more recent work suggests that *um* use is lower during lying than truth telling (Arciuli, Mallard, & Villar, 2010; Villar, Arciuli, & Mallard, 2012). Adults and children with Autism Spectrum Disorders (ASD) produce fewer filled pauses relative to content word repetitions than their typical peers do (Lake, Humphreys, & Cardy, 2011; MacFarlane, Gorman, Ingham, Hill, Papadakis, Kiss, & van Santen, 2017). Given that pragmatic deficit is a core symptom of ASD, this finding lends credence to the hypothesis that *ums* and *uhs* serve pragmatic functions, whatever they may be.

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There is increasing evidence that *uh* and *um* are not interchangeable. Higher *um* use is associated with female sex, higher education and younger age, whereas higher *uh* use is associated with male sex, lower education, and older age, and this is true of all of the (Germanic) languages that have been studied (Wieling et al., 2016). Compared to *uh*, *um* is more likely to occur at the beginning of a prosodic phrase, and more likely to be followed by a longer pause (Clark & Fox Tree, 2002). As such, these forms may serve distinct pragmatic functions (Fox Tree, 2001).

Irvine et al. (2016) collected verbal descriptions of paintings under dual load (tapping a keyboard while talking for 10 seconds) from 64 people ages 8 to 21 years. Some had ASD, some had typical development, and some had histories of ASD but had achieved optimal outcomes. They found that the *uh* rate (total *uh*s relative to total fluent words produced) did not distinguish the groups but *um* rate did. The ASD group had a lower *um* rate than either the typical or optimal outcomes groups. Moreover, *um* rate was negatively correlated with autism severity as measured by the Social Communication Questionnaire but it bore no relationship to chronological age, overall language ability, executive function, or IQ. Given the relation to the severity of social-communicative deficits, the authors conclude that *um* serves a listener-oriented pragmatic function; whereas *uh* may be more speaker-directed.

Gorman et al. (2016) conducted a parallel study. Their participants were 4-to-8-year olds who had ASD, and same age peers who had specific language impairment (SLI), or typical development. SLI is a neurodevelopmental disorder that compromises language ability—and in that way shares a challenge that is also characteristic of ASD—but people with SLI do not present with restricted, repetitive patterns of behavior or the same deficits in social-communicative reciprocity that characterize ASD. The investigators prepared transcripts of each child's discourse during the play, picture description, story-telling, and conversation associated with the administration of the Autism Diagnostic Observation Survey (ADOS). From these transcripts, they found that *uh* rate (*uh*s relative to total fluent words) did not vary with participant group but *um* rate did. Again, the ASD group used *um* at a lower rate than the typical group. The ASD and SLI groups did not differ in *um* rate (nor did the SLI and typical group differ). When *um* was considered in relation to *uh* (*ums/[ums + uhs]*), the ASD group had lower ratios than both the ASD and SLI groups. Like Irvine et al. (2016), Gorman et al. (2016) found no association between *um* rate and chronological age, overall language ability, executive function, or IQ. There was a trend towards a correlation between scores on the Social Communication Questionnaire and *um-uh* ratio in the ASD group such that those who performed more poorly on social communication had lower ratios than those who performed better. Together, the difference between the ASD and SLI groups in *um-uh* ratio and the pattern of correlations within the ASD group suggest that *um* use reflects social-communicative skill rather than language ability *per se*.

More boys than girls are affected by ASD, and the Irvine et al. (2016) and Gorman et al. (2016) studies reflected that; their ASD samples were 88% and 90% boys, respectively. There is some evidence that low *um* use is specific to boys with ASD. In a third study of 65 children with ASD (49 boys, 16 girls) ages 6 to 17 and 17 typical peers, Parish-Morris, et al. (2017) also reported lower filled pause rates among children with ASD. However, with reasonable power to detect sex differences, they found that the girls with ASD used fewer

*uh*s than the boys but a similar number of *um*s. Thus their *um*-*uh* ratios were higher and not distinguishable from those of the typical peers.

Together, these three studies demonstrate that low *um* rates may distinguish children (or at least boys) with ASD from their typical age-mates, both at younger ages (Gorman et al., 2016) and older ages (Irvine et al., 2016) and in a range of discourse tasks. If this finding is robust, *um* rate may provide a useful clinical marker of ASD. Whereas previous studies have mined the pragmatic deficits associated with ASD to determine the discourse functions of fillers, we might now be able to mine the distinct functions of *um* and *uh* fillers to aid in the identification of ASD.

In the current study, we aimed to replicate the lower rate of *um* usage on the part of children with ASD as reported by Irvine et al. (2016) and Gorman et al. (2016) and confirm the significant association between *um* usage and social-communication ability as reported by Irvine et al. (2016) in an independent sample of children participating in a different discourse activity. Our sample of ASD children was 94% boys, so we did not attempt to replicate Parish-Morris et al. (2017).

Method

Participants

This study involved analysis of discourse samples collected in conjunction with (but subsequently not used in) a project exploring associations between syntax and the lexicon among children with and without ASD (REMOVED FOR BLIND REVIEW). The ASD group comprised 31 children (29 boys); the group of typically developing (TD) peers comprised 32 children (16 boys), all were monolingual English speakers. Participants with ASD had been diagnosed with ASD prior to the study. Participants in the TD group did not have ASD or any other neurodevelopmental disabilities per parent report. In both groups, ages ranged from 7 to 15 years with a mean of 10;9.

All participants had normal hearing acuity and nonverbal intelligence as determined by passing scores on a pure-tone hearing screening (American Speech-Language-Hearing Association, 1990) and standard scores above 80 on the matrices subtest of the Kaufman Brief Intelligence Test-2 (Kaufman & Kaufman, 2004), respectively. An assistant trained in reliable administration for research purposes verified the diagnosis of ASD via scores on Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1999). To further describe the participants, we collected demographic information and administered the Clinical Evaluation of Language Functions (Semel, Wiig, & Secord, 2003), the Expressive Vocabulary Test (Williams, 2007), the Peabody Picture Vocabulary Test-3 (Dunn & Dunn, 1997), and the Social Communication Questionnaire (SCQ, Rutter, Bailey, Berument, Lord, & Pickles, 2003).

The two groups were matched for chronological age and nonverbal intelligence (Table 1). They did not differ significantly on maternal education. As is characteristic of the disorder, the children with ASD scored more poorly on measures of language and social communication. On the SCQ, 29 of the 31 children with ASD met the recommended cut-off

of 12 as a threshold for ASD (Lee, David, Rusyniak, Landa, & Newschaffer, 2007). We did not exclude the two children who did not meet this threshold from the ASD group as we had already verified their independent diagnosis with the ADOS. All participants with TD scored below 12 on the SCQ.

Procedure

To elicit expository discourse, the examiner asked what is your favorite game or sport; why is X your favorite game/sport; How do you play X; and how do you win? (Nippold, Hesketh, Duthie, & Mansfield, 2005). The examiner provided general prompts and as much time as needed for the child to complete the task.

From digital audio files, a research assistant transcribed the discourse according to conventions in the Systematic Analysis of Language Transcripts (Miller & Chapman, 1995). A second assistant independently transcribed 20% of the samples. Inter-transcriber reliability exceeded 90% for utterance boundaries, mazes, morphemes, and *uh* vs. *um* distinctions.

The discourse of the two groups did not differ in volubility as measured by seconds (ASD M = 327, SD = 204, TD M = 279, SD = 126, t = 1.12, df = 61, p = .27), or words (ASD M = 382, SD = 325, TD M = 354, SD = 267, t = 0.37, df = 61, p = .72).

Results

Given non-normal distributions per Kolmogorov-Smirnov Tests, we used nonparametric Mann-Whitney U tests to compare the *um* and *uh* use of the TD and ASD groups. Just as in Irvine et al. (2016) and Gorman et al. (2016), the groups did not differ in *uh* use, but they did differ in *um* use (Table 2). Whether measured as the total number of *um*s, the ratio of *um*s to total fluent words, or the ratio of *um*s to total *um+uh*, the TD group used more *um*s than the ASD group and these were medium to large effects. A cut-off of fewer than two *um*s per every 100 words yielded a sensitivity to ASD of .77, a specificity of .69, a positive likelihood ratio of 2.5 (95% CI 1.4–4.3) and a negative likelihood ratio of .33 (95% CI .17-.65).

Figure 1 presents a comparison of *um* and *uh* use by diagnosis and sex. Given that our sample was not powered to discern both effects, we refrained from going beyond this descriptive analysis. Note that one girl with ASD used *um* frequently and the other did not. Neither used *uh* at all, so their *um/(um+uh)* ratios were 1, equivalent to the upper quartile for the TD girls.

There was no relationship between the SCQ and either the *um*/fluent words ratio, Spearman rank R = −.06, p > .05, or the *um/(um+uh)* ratio, Spearman rank R = .02, p > .05.

Discussion

This study replicated the primary finding of Irvine et al. (2016) and Gorman et al. (2016) in an independent sample of children and extended that finding to expository discourse. Children with ASD filled pauses with *um* at a lower rate than their typical peers. Their rate

of *uh* fillers was unaffected. Given the expository task applied here, a person using fewer than two *um*s per every 100 fluent words is 2.5 times as likely to have ASD as a person who uses more; a person who uses more than two is 1/3 as likely to have ASD as a person who uses less.

For a group of 24 adults with ASD, Irvine et al. (2016) reported a significant correlation of −.45 between the SCQ lifetime severity score and the *um*/fluent words ratio (lower scores on the SCQ equate to more severe ASD symptomology). For a group of 50 children with ASD, Gorman et al. (2016) reported a nonsignificant correlation of −.29 between the SCQ Communication Total Score and the *um/(um+uh)* ratio. In the group of 29 children with ASD examined here, there was no relationship between the SCQ and *um* usage whether measured as *um*/fluent words or *um/(um+uh)*. Although low *um* use is associated with ASD, the evidence that it reflects severity of the social-communication deficits that characterize ASD is inconclusive.

Future Considerations

The female sex in general (Wieling et al., 2016) and girls with ASD in particular (Parish-Morris et al., 2016) appear to use *uh* less than males. As concluded by Parish-Morris et al. (2016), this tendency serves to mask low *um* usage in girls with ASD, especially when *um* usage is determined as the ratio of *um/(um+uh)*. The two girls with ASD in the current study never used *uh* so their *um/(um+uh)* ratios were 1. This high ratio did indeed mask low *um* usage in one of the girls. Future examinations of filler use among girls with ASD should consider using *um* relative to total fluent words, rather than *um* relative to *uh*, as it might prove to be a more sensitive measure of girls' deficits in pragmatic discourse performance. That said, it was the *um/(um+uh)* ratio, not the *um*/fluent words ratio, that differentiated the ASD and SLI groups in Gorman et al. (2016).

The verbal task used to elicit discourse merits consideration as well. In our data set, the overall number of filled pauses was noticeably lower for both *um* and *uh* in both ASD and TD groups than in the Irvine et al. (2016) data set. We attribute this to task difference. Fillers are more frequent when discourse is difficult (Arnold, Hudson-Kam, & Tanenhaus, 2007; Bortfeld, Leon, Bloom, Schober, & Brennan 2001), and the time-constrained, high-load picture description task in Irvine et al. was likely more challenging than the untimed, no-load favorite game or sport description elicited here. Cognitive load was also offered as an explanation for the variation in filler use across discourse activities reported in Gorman et al. (2016). Those activities, arranged from most to least use of *um*, were conversation, picture description, play, and story-telling. Those wanting to use *um* rate as a variable should plan the discourse activity with care to ensure maximum sensitivity to between-group differences.

Conclusions

The current study had two primary limitations. The relatively small sample of children with ASD meant that the study was underpowered to test potential relationships between *um* use and the participants' performance on tests of cognition, language, and autism symptomology. The few female participants in the ASD group prevented conclusions about sex differences in *um* usage among individuals with ASD. The contribution of the current

study is that it replicated the main finding of Irvine et al. (2016) and Gorman et al. (2016): a low rate of pauses filled with *um* differentiates children with ASD from their typical age-mates across a variety of discourse tasks. Low *um* use is a robust pattern and one that is relatively quick and easy to document, requiring discourse samples of only minutes in length. Although the sensitivity and specificity of this measure are not adequate to support its use as a sole index of ASD, the likelihood ratios are promising. As such, presentation of a low *um* rate in the presence of a typical *uh* rate holds potential as a clinical marker of ASD.

Compliance with Ethical Standards

This study was funded by NIH-NIDCD 2 R01 DC003698 together with an augmentation award from Autism Speaks. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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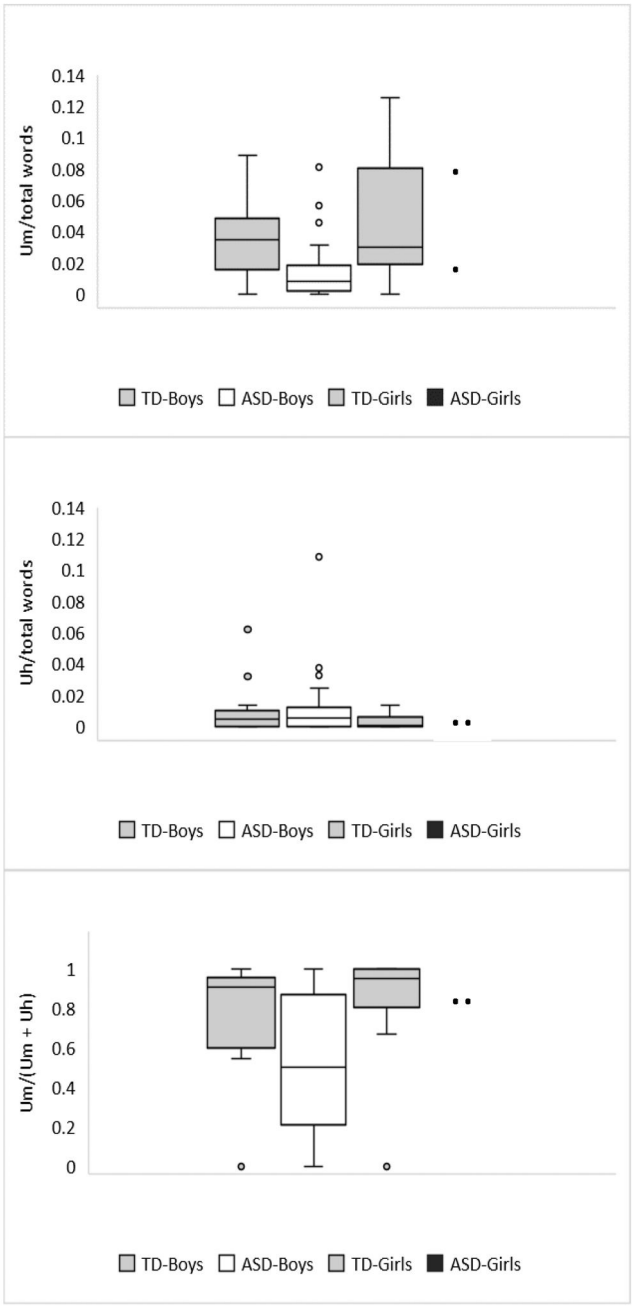

Figure 1.

Comparison of filler use by sex and diagnostic category expressed as *Mdn*, −/+ quartile, and outliers. The scores of the two girls with ASD are plotted individually.

Table 1

Demographic Information and Test Scores for the ASD and TD Groups

	TD (*N* = 32)	ASD (*N* = 31)			
Measure	***Median* (−/+ *quartile*)**	***Median* (−/+ *quartile*)**	***U***	***p***	***r***
Age in Months	129(106, 147)	132(105, 151)	454.5	0.57	.07
Years Maternal Education	16(14,17)	16(15,18)	406.5	0.29	.16
KBIT Matrices SS	111 (106, 122)	113(100, 117)	462.5	0.64	.06
CELF Core SS	116(112,120)	100(84,114)	242.5	0.0005	.44
EVTSS	112(106, 120)	96(84,116)	286.5	.01	.36
PPVT-3 SS	120(112,126)	111(99,119)	326.5	.02	.29
SCQ	2(1,5)	22 (16, 28)	18.5	< 0.001	.83
ADOS Algorithm					
Communication		4 (3, 6)			
Social Interaction		9(7,11)			
Imagination		1(1,2)			
Stereotyped		4 (3, 5)			

Note. KBIT = Kaufman Brief Intelligence Scale, SS = Standard Score, CELF = Clinical Evaluation of Language Functions, EVT = Expressive Vocabulary Test, PPVT= Peabody Picture Vocabulary Test-3, SCQ = Social Communication Questionnaire, ADOS = Autism Diagnostic Observation Survey.

Table 2

Um and Uh Use by the TD and ASD Groups

	TD (*N* = 32)	ASD (*N* = 31)			
Measure	***Mdn* (−/+ *quartile*)**	***Mdn* (−/+ *quartile*)**	***U***	***p***	***r***
Total *urns*	7.5 (5.5, 14.5)	3.0(1.0,6.0)	225.0	.0002	.47
Total *uhs*	1 (0.0, 2.0)	1 (0.0, 4.0)	397.0	.17	.17
ums/fluent words	.03 (.02, .06)	.009 (.002, .02)	241.0	.0005	.44
Uhs/fluent words	.002 (0.0, .007)	.005 (0.0, .02)	407.5	.22	.15
Ums/(ums + uhs)	.92 (.78, 1.0)	.70 (.33, 1.0)	263.0	.009	.34