Published in final edited form as:

Pediatr Neurol. 2018 February ; 79: 53–58. doi:10.1016/j.pediatrneurol.2017.09.017.

Comparison of Spontaneously Elicited Language Patterns in Specific Language Impairment and High Functioning Autism

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Abstract

Objective—To characterize differences in the use of language in children with specific language impairment (SLI) and high functioning autism (HFA) by analyzing verbal responses on standardized tests. The overall goal was to provide clinicians with additional tools with which to aid in distinguishing the 2 neurodevelopmental disorders.

Study Design—This study included 16 children with SLI, 28 children with HFA, and 52 typically developing participants between the ages of 6 and 14. Groups were matched for age, and SLI and HFA groups were matched on Verbal and Performance IQ. Responses from standardized tests were examined for response length, grammatical errors, filler words, perseverations, revisions (repeated attempts to begin or continue a sentence), off topic attention shifts (lapses in attention to the task), and rambling. Data were analyzed using parametric and non-parametric methods.

Results—SLI responses were longer and contained more filler words than did those of the other two groups, while HFA responses exhibited more grammatical errors, off topic attention shifts, and rambling. SLI and HFA responses showed higher rates of perseveration compared to controls. There were no significant differences in revisions among the 3 groups.

Conclusions—Differences in language patterns of participants with SLI and HFA may be useful to the clinician in helping to differentiate isolated language impairment from high functioning autism. The results also support the conclusion that the 2 conditions are separable and each exhibits a different pattern of language dysfunction.

Key words not in article title

Autism spectrum disorder; specific language impairment; developmental language disorder; language disorders

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Conflict of Interest: The authors have indicated they have no potential conflicts of interest to disclose.

Initial Manuscript Draft: Megan Craig wrote the first draft of the manuscript. No honorarium, grant, or other form of payment was given to anyone to produce the manuscript.

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Introduction

Specific language impairment (SLI) and autism spectrum disorder (ASD) are two neurodevelopmental disorders that at times may share some commonalities, making it difficult to determine an accurate diagnosis. Direct comparisons of the two groups have demonstrated some overlap in communicative and social domains, with the suggestion that autism and SLI might share etiological factors.¹ Widely accepted tests used to diagnose ASD may also categorize children with SLI as being on the autism spectrum, adding to the conundrum regarding accurate diagnosis. Yet clinicians are frequently tasked with determining whether a child with language delay falls into the category of SLI or ASD. Additional methods of differentiating between the two conditions would be useful clinically.

SLI is a neurodevelopmental disorder characterized by a delay in language development that cannot be explained by a specific cause, such as hearing loss, environmental deprivation, autism, or another developmental disorder.² Children affected by SLI struggle to maintain conversations, learn new words, and conjugate verbs to match the subject and tense.² ASD, in contrast, may cause a range of symptoms including repetitive movements and behaviors, difficulty relating to others and adjusting to routines, and impaired communication, e.g. very limited speech and fixation on select topics.³ Though the definitions of SLI and ASD appear to be discrete, it has been proposed that the disorders lie on a “continuum of pathology”,¹ possibly with shared etiological factors. This view is supported by the presence of some overlap in the symptoms and risk factors associated with these conditions.^{1,4}

The current study was designed to examine potential phenotypic differences between children diagnosed with SLI and high functioning autism (HFA) using commonly administered neuropsychological tests and analyzing language patterns of children with these conditions. The hypothesis was that children with SLI and HFA would have differences in their use of language that could be identified on commonly used tests and that would help to differentiate the 2 conditions.

Patients and Methods

Subjects were children between the ages of 6 and 14 years in one of three groups: SLI (n = 16; 10 male; 6 female), HFA (n = 28; 18 male; 10 female), and typically developing (n = 52; 23 male; 29 female). Children were recruited by contacting schools, speech language pathologists, and autism societies. Additionally, ads seeking participants were placed in pediatricians' offices and in parent magazines. This study was approved by the UCSD Human Research Protections Program. Parental consent was obtained, and child assent was obtained from participants aged seven or above. Data were collected as part of a larger study of language and learning in children with neurodevelopmental disorders.

SLI and HFA subjects were group-matched for age and intelligence quotient (IQ). Typically developing controls were included to allow for association of language patterns with characteristics unique to SLI or HFA, and not to the pediatric population as a whole. Children classified as HFA had a nonverbal IQ in the normal range, scored in the autistic range on the Autism Diagnostic Observation Schedule (ADOS),⁵ and were able to

understand instructions and cooperate with testing. Those with SLI had normal non-verbal intelligence, scored in the non-autistic range on the ADOS, and had previously scored at least 1.5 standard deviations below the mean on the Clinical Evaluation of Language Fundamentals 4 (CELF-4) on earlier testing,⁶ even though for some participants their current scores obtained at the time of this study as reported in Table 1 was higher (most likely due to therapeutic interventions). Previous language tests were acquired from school psychologists and/or speech/language pathologists who had tested the children for diagnostic, treatment, or academic purposes. The ADOS was administered by a person who had received formal training on ADOS administration. Language and intelligence tests were administered by trained psychometrists under the supervision of a neuropsychologist. All testing for the current study was completed within a 3-month period. Exclusion criteria for all groups included a history of a condition that might have caused brain damage, including meningitis, hypoxic brain injury, or severe traumatic brain injury. Additionally, participants with known genetic disorders and those who did not identify English as their first and primary language were excluded.

All participants completed the CELF-4 and Wechsler Abbreviated Scale of Intelligence (WASI).⁷ Video recordings were made (with consent) of the testing sessions so that the responses could be transcribed and analyzed at a later date. To elicit free-speech responses to structured questions, five prompts were selected from each of the following subtests: the CELF-4 Formulated Sentences subtest, the WASI Vocabulary subtest, and the WASI Similarities subtest. The Formulated Sentences subtest required participants to construct a sentence using a given word or phrase to describe a picture. The prompts “longest”, “quickly”, “unless”, “until”, and “as soon as” were selected. In the Vocabulary subtest, participants provided a definition of a given word; this study examined responses to the prompts “number”, “lunch”, “alligator”, “dance”, and “famous”. The Similarities subtest required participants to identify similarities between two words, specifically “shirt-jacket”, “bowl-plate”, “smooth-rough”, “shoulder-ankle”, and “steam-cloud” in this study. The specific prompts were chosen based on our observation that most of the children were able to provide responses to those words or word groups. Because there was a relatively large age range, not all prompts were able to be completed by all subjects. Also, responses with missing videos were excluded. However, these constituted a very low percentage of all participants. The final number of participants per task were: 16 participants with SLI (Formulated Sentences, n = 16; Vocabulary, n = 16; Similarities, n = 15), 28 participants with HFA (Formulated Sentences, n = 26; Vocabulary, n = 26; Similarities, n = 25), and 52 typically developing participants (Formulated Sentences, n = 52; Vocabulary, n = 52; Similarities, n = 51).

Videotaped recordings of the testing sessions were used to transcribe participants’ responses. All transcriptions were completed by one examiner (MC). Responses were evaluated for response length, grammatical errors, and filler words; these data were later re-checked by the same rater for within-rater reliability and reproducibility. Filler words included conjunctions used to connect complete sentences, including “and” or “or”, as well as placeholder words used to stall for time, such as “like” and “um”. Grammatical errors and filler words were normalized to response length in words and expressed as a decimal value reflecting their proportion in the response as a whole. Responses were assessed for presence or absence of

perseveration, revision, off topic attention shift, and rambling in each response as a whole. Revisions were defined as repeated attempts to begin or continue a sentence, e.g. “An alligator could, an alligator wants, an alligator likes to swim.” Off topic attention shifts described lapses in attention to the task, e.g. “What’s on the floor?”

Data were analyzed using IBM SPSS Statistical Software program. Scores for each of the parameters included were analyzed between groups using ANOVA, independent samples T-tests, or chi-square analyses. *p* values of less than 0.05 were a priori considered significant.

Results

Baseline group characteristics for overall performance on standardized tests administered at the time of the current study differed among groups in that SLI and HFA participants scored lower than typically developing controls on all measures. Inclusion criteria specified that SLI participants were required to have a previous score of 1.5 standard deviations below the mean on a standardized language test, though scores obtained during the current testing period were at times higher than the cutoff, possibly due to interventions (which every child in the study had received). Importantly, there were no significant differences between SLI and HFA on IQ or language measures. There were no significant differences in age or gender distribution among the three groups (see Table 1).

Response Length

SLI participants had longer response lengths overall than did either of the other two groups. In the Vocabulary subtest, SLI responses were longer than HFA ($p = 0.006$) and typically developing ($p = 0.002$) responses. Both SLI and HFA responses were longer than typically developing responses in the Formulated Sentences subtest ($p = 0.03$, $p = 0.007$).

Grammatical Errors

Grammatical errors were most prevalent in HFA responses, followed by SLI responses, then typically developing responses. HFA responses exhibited more errors than typically developing responses in all subtests (Formulated Sentences $p < 0.001$, Vocabulary $p = 0.004$, Similarities $p = 0.003$). HFA responses also contained more errors than SLI responses; measures were statistically significant in the Formulated Sentences subtest ($p = 0.001$), and approached statistical significance in the Vocabulary subtest ($p = 0.06$). Grammatical errors in SLI responses were more common than in typically developing responses only for the Formulated Sentences subtest ($p = 0.03$).

Filler Words

SLI responses contained more filler words than did responses from either of the other two groups. Filler words were significantly more frequent in SLI responses than in typically developing responses in the Formulated Sentences ($p = 0.004$) and Similarities ($p = 0.02$) subtests. Filler words were significantly more frequent in SLI responses than in HFA responses in the Vocabulary subtest ($p = 0.009$). Use of filler words in HFA participants was not significantly different from that of typically developing participants in any of the subtests.

Response Characteristics

SLI and HFA participants showed higher rates of perseveration than did controls. SLI and HFA groups perseverated in 24.1% and 23.9% of responses, respectively; in contrast, typical participants perseverated in 17.8% of responses ($p = 0.03$). There were no significant differences in rates of revisions among the three groups.

Off topic attention shifts were significantly more prevalent in HFA responses than in responses from either of the other two groups, occurring in 10.5% of HFA responses, 1.8% of SLI responses, and 2.9% of typically developing responses ($p < 0.001$). Additionally, autistic participants rambled in 6.3% of responses, while SLI and typical participants rambled in 3.6% and 2.5% of responses, respectively ($p = 0.009$) (see Table 2).

Discussion

Using free-speech responses to structured stimuli, this study found clear differences in response type between children with SLI and children with HFA. Children with SLI had significantly longer responses than did those with HFA or typically developing children, at least in part because they tended to rely heavily on filler words such as “like”, “um”, and “and”, but also because their language impairment made it difficult for them to express their thoughts in words, thus prompting more attempts to clarify what they meant to say. However, the content of their speech was on target and responsive to the examiner, despite their word-finding difficulties. Children with HFA, in contrast, had shorter responses (length similar to typically developing responses) but exhibited more grammatical errors than the other groups. The most interesting feature of the HFA response was the much higher rate of off topic attention shifts and rambling than was seen in either of the other groups, whereas the SLI children were comparable to controls (see Table 2). It appears that children with HFA may have intrusions of thoughts about other topics. Because of this, they tend to be very tangential and quickly lose focus on the topic at hand. This may be one of the best differentiating features in free-speech samples between SLI and HFA.

A recent study analyzed the use of filler words “uh” and “um” in children with autism, SLI and typically developing during administration of the ADOS.⁸ Similar to our results, they found that children with autism used fewer filler words than did either of the other 2 groups.⁸ The use of these filler words is thought to serve a communicative purpose, in that individuals may use them when they have difficulty coming up with the right word, and communicate that challenge using a filler.⁹ It also invites the listener to help the speaker by trying to fill in the word that the speaker is searching for. Thus, the results are consistent with the known impairments in social and reciprocal communication that are a core feature of children with autism. These characteristics may also explain the frequent lapses in attention to the task and rambling seen in HFA participants in the current study; the observed lack of focus may indicate a lack of intent to communicate.

The results of the present study are consistent with basic differences in communication ability between SLI and HFA, and add to the evidence for the two conditions being separable rather than part of the same spectrum. Additional arguments for the separability of the 2 conditions come from neuro-imaging studies that show distinct differences in brain

structure between SLI and ASD. Roberts et al. (2014) used diffusion tensor imaging to assess the left arcuate fasciculus of children with these conditions.¹⁰ While both were associated with white matter abnormalities indicated by increased mean diffusivity, ASD was associated with axial diffusivity, whereas SLI was correlated with radial diffusivity.¹⁰ Brain structural asymmetries between SLI, ASD, and ASD-LI have also been described.¹¹ Like typically developing participants, children with ASD exhibited leftward volumetric asymmetry in the frontal cortical language regions, whereas the SLI and ASD-LI groups showed reversed rightward asymmetry.¹¹ Asymmetry, therefore, may be more strongly correlated with language impairment than with ASD, further suggesting distinct etiologies for the two conditions.¹¹

Although non-verbal communication skills were not directly analyzed as part of the current study, the difference in use of filler words between SLI and HFA is one potential indicator of differences in communicative intent between the 2 groups. Previous work has found that children with SLI rely more heavily on gestures to convey meaning than typically developing peers, possibly to compensate for their language delay.¹² In contrast, children affected by ASD tend to show delays in gestural communication, gesturing less frequently and with less variety than typically developing peers.¹³

It is important to recognize that, although the inclusion criteria specified that SLI participants have a previous score of 1.5 standard deviations below the mean on a standardized language test, scores obtained during the current study were in some cases above the cutoff, most likely due to therapeutic interventions provided to the child. However, all had a language score consistent with inclusion criteria at a previous testing point.

There were several limitations to the current study. The age range of subjects tested was rather large, but because of the modest number of subjects we could not adequately assess age as a potential factor in language output. Also, some of the children with SLI no longer met stringent criteria for the diagnosis, and this may have lessened the ability to identify differences in language performance among the groups. Further, the autism group was limited to children with high functioning autism who had normal intellectual functioning, and it is not feasible to generalize to the group of broader autism spectrum disorders. Despite these limitations, the information provided in this study is likely to be important for clinicians working with both SLI and HFA children, as well as diagnosticians who are attempting to make an accurate diagnosis. The differential use of filler words (much greater in SLI children), longer response length in SLI children, and the excessive off-topic and tangential responses observed in the HFA children, may provide clinicians with an additional tool with which to differentiate the 2 conditions using commonly administered standardized tests, which many of these children receive as part of psycho-educational testing or as part of their individualized educational program (IEP). These data could provide clinicians with an additional level of assessment with which to correctly identify children with either SLI or HFA, and be able to guide families to the most appropriate interventions.

Acknowledgments

Funding Source: Supported by the National Institutes of Health (P50 NS22343 to DT) and the UC San Diego School of Medicine research fellowship to MC.

This work was supported by NIH P50 NS22343 (D. Trauner, PI) and the UC San Diego School of Medicine research fellowship. We thank the children and their families, whose participation was vital to the completion of this research.

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Figure 1 A–C.

Summary of language features of SLI, HFA, and typically developing participants. * = HFA or SLI compared with typically developing (* $p < 0.05$, ** $p < 0.001$), + = SLI compared with HFA (+ $p < 0.05$)

Figure 2. Language characteristics of SLI, HFA, and typically developing participants. * $p < 0.05$, ** $p < 0.001$

Table 1

Participant Characteristics

	SLI (n = 16; 6 female)	HFA (n = 28; 10 female)	TD (n = 52; 29 female)	Group Comparisons			
				p	95% CI		
						SLI/HFA	SLI/TD
Age (years)	10.6 (2.1)	10.1 (1.8)	9.7 (2.2)	SLI = HFA = TD, p > 0.05	-8.86 – 20.07	-4.25 – 25.67	-6.53 – 16.74
Verbal IQ	98.1 (14.4)	97.4 (19.3)	114.5 (9.8)	SLI = HFA < TD, p < 0.001	-10.53 – 11.87	-22.73 – (-10.14)	-25.01 – (-9.21)
Performance IQ	93.3 (15.9)	94.8 (19.7)	105.5 (12.2)	SLI vs. TD, p = 0.002; HFA vs. TD, p = 0.012	-13.13 – 10.18	-19.71 – (-4.74)	-19.03 – (-2.48)
CELF Core	83.3 (16.2)	83.9 (25.9)	106.7 (9.7)	SLI = HFA < TD, p < 0.001	-13.41 – 12.19	-32.41 – (-14.55)	-33.21 – (-12.54)
CELF Receptive	85.6 (14.9)	87.7 (24.7)	105.5 (11.4)	SLI vs. TD, p < 0.001; HFA vs. TD, p = 0.001	-14.20 – 9.90	-26.91 – (-12.86)	-27.75 – (-7.73)
CELF Expressive	85.1 (18.2)	85.1 (25.1)	107.4 (9.8)	SLI = HFA < TD, p < 0.001	-14.48 – 14.46	-32.29 – (-12.35)	-32.38 – (-12.25)

Specific Language Impairment (SLI), High Functioning Autism (HFA), typically developing (TD), standard deviation (SD), intelligence quotient (IQ), Clinical Evaluation of Language Fundamentals (CELF), 95% confidence interval of the difference (95% CI)

Table 2

Language Characteristics

	Group	n	Response Length	Grammatical Errors	Filler Words
			Mean (SE)		
Formulated Sentences	SLI	16	16.2 (1.4)	0.018 (0.004)	0.031 (0.006)
	HFA	26	15.9 (0.9)	0.040 (0.006)	0.019 (0.003)
	TD	52	13.0 (0.5)	0.008 (0.002)	0.013 (0.002)
Vocabulary	SLI	16	39.4 (2.9)	0.030 (0.004)	0.126 (0.009)
	HFA	26	29.7 (2.1)	0.044 (0.006)	0.093 (0.008)
	TD	52	30.4 (1.4)	0.025 (0.003)	0.103 (0.006)
Similarities	SLI	15	17.6 (1.6)	0.029 (0.006)	0.090 (0.011)
	HFA	25	16.2 (1.2)	0.048 (0.010)	0.068 (0.009)
	TD	51	15.3 (0.9)	0.017 (0.003)	0.063 (0.005)

Specific Language Impairment (SLI), High Functioning Autism (HFA), typically developing (TD), standard error (SE)

Table 3

Statistical Significance of Language Characteristics

	Comparison	Response Length		Grammatical Errors		Filler Words	
		p	95% CI	p	95% CI	p	95% CI
Formulated Sentences	SLI/HFA	0.81	-2.78 – 3.56	0.001	-0.04 – (-0.009)	0.06	<0.001 – 0.03
	SLI/TD	0.03	0.31 – 6.13	0.03	0.001 – 0.02	0.004	0.006 – 0.03
	HFA/TD	0.007	0.77 – 4.90	<0.001	0.02 – 0.04	0.17	-0.002 – 0.01
Vocabulary	SLI/HFA	0.006	2.80 – 16.67	0.06	-0.03 – (<0.001)	0.009	0.009–0.06
	SLI/TD	0.002	3.24 – 14.91	0.32	-0.005 – 0.02	0.05	<0.001 – 0.05
	HFA/TD	0.79	-5.51 – 4.20	0.004	-0.006 – 0.03	0.34	-0.03 – 0.01
Similarities	SLI/HFA	0.49	-2.58 – 5.41	0.097	-0.04 – 0.004	0.13	-0.006 – 0.05
	SLI/TD	0.21	-1.36 – 6.08	0.09	-0.002 – 0.02	0.02	0.005 – 0.05
	HFA/TD	0.54	-2.15 – 4.04	0.003	0.01 – 0.05	0.611	-0.01 – 0.02

Specific Language Impairment (SLI), High Functioning Autism (HFA), typically developing (TD), 95% confidence interval of the difference (95% CI)

Table 4

Example Responses

Test	Prompt	Group	Gender	Age	Response
Formulated Sentences	unless	SLI	M	12.3	I have to do my homework um before um if I don't do my homework um I don't know. Um if you want me to play I'll get in trouble unless I do my homework.
		HFA		11.9	Unless the players have forgot one.
		TD		11.4	Unless the boy finishes his homework he may not play baseball.
Vocabulary	lunch	SLI	F	7.1	It's a time of day that you um a kind of meal that you eat every day um and it's um you have it at um a several time like if you're hungry grab a snack or you can ask your mom to make lunch (Q) Um you um it's what you eat um in the afternoon before you take a nap and it's healthy.
		HFA		7.5	Lunch is you could eat some food (Q) Um uh you could eat of some food and somebody and somebody nothing to eat they you usually get friends to share food. Teacher will see it.
		TD		7.6	When you get to eat (Q) Like if you're at school and you go to eat lunch
Similarities	dance	SLI	M	8.3	Dance means like move move in style. (Q) Um um it's like when you move in style like you move um um in ways you create sometimes and that's all. That's all I can define, that's the only way I can define it.
		HFA		7.3	Dance means you are dancing. (Q) Dance means you're uh uh I don't know what to say. (Q) Dance means you uh do some cool moves and dance. Feet, feet, what is the feet? Okay now what is a tech? What is a computer? A computer is something that you work on. Yeah and my dad has a computer that can connect all to satellite.
		TD		7.9	Dance means if music is on you can just like move your body and it is like a exercise.
	steam-cloud	SLI	F	10.5	Steam and cloud? Steam means you could see like it's like smoke. They're both smoke, like they look like smoke.
		HFA		11.5	Well they're like white stuff I believe. Speaking of a cloud that reminds me of I have Mario 10, you know. It's like a video game.
		TD		10.8	Steam and cloud? Um steam can make like fog and so can clouds.

Specific Language Impairment (SLI), High Functioning Autism (HFA), typically developing (TD), male (M), female (F), query (Q)