

A comparative study of language phenotypes in Autism Spectrum Disorder and Specific Language Impairment

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Abstract

Background: Problems with communication and language are among the main characteristics of both Autism Spectrum Disorder (ASD) and Specific Language Impairment (SLI). The main objective of the present study was to analyze whether the two disorders have similar formal language profiles. **Method:** The study involved three groups of 20 students each, divided into ASD, SLI, and Control, of similar ages and IQ. The CELF-4 standardized test was administered to assess their language skills. **Results:** No significant differences in language were found between the SLI and ASD groups, with no effect sizes. Differences were observed between the SLI and ASD groups when they were compared separately with the Control group, with a large effect size. **Conclusions:** There is an overlap in the linguistic profiles of children with SLI and children with ASD. Similarity is thus confirmed in comprehensive and expressive language, as well as in morphosyntactic and lexical-semantic production.

Keywords: Language, autism spectrum disorder, specific language impairment, language phenotypes.

Resumen

Estudio comparativo de los fenotipos lingüísticos en el Trastorno del Espectro Autista y en el Trastorno Específico del Lenguaje. Antecedentes: los problemas de comunicación y lenguaje constituyen una de las características principales tanto del Trastorno del Espectro Autista (TEA) como del Trastorno Específico del Lenguaje (TEL). El objetivo principal del presente estudio ha sido analizar si ambos trastornos presentan perfiles de lenguaje formal similares. **Método:** en el estudio participaron tres grupos de 20 alumnos cada uno, divididos en TEA, TEL y Control, equiparados en las variables edad y CI. A todos los participantes se les administró el test estandarizado CELF-4 para evaluar sus habilidades lingüísticas. **Resultados:** no existen diferencias significativas en lenguaje entre los grupos TEL y TEA, con tamaños del efecto prácticamente nulos. Las diferencias se establecen entre los grupos TEL y TEA cuando se les compara por separado con el grupo Control, obteniéndose un tamaño del efecto grande. **Conclusiones:** se produce un solapamiento en los perfiles lingüísticos entre niños con TEL y TEA. En consecuencia, se confirma la similitud en lenguaje comprensivo y expresivo, así como en la producción morfosintáctica y léxico-semántica.

Palabras clave: lenguaje, Trastorno del Espectro Autista, Trastorno Específico del Lenguaje, fenotipos lingüísticos.

Nowadays, in *The Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5 American Psychiatric Association, 2013), Autism Spectrum Disorder (ASD) is described as a heterogeneous neurodevelopmental disability of broadly varying degrees of severity and manifestations. It is characterized by difficulties in communication and social interaction and by restricted and repetitive behaviors and interests. Formal language impairment does not constitute a core symptom for diagnosis, but a broad set of linguistic difficulties may be manifested in individuals with ASD, ranging from the complete absence of language to difficulties with the lexical-semantic, grammatical, and pragmatic components thereof. Most research to date has focused on this latter component, with difficulties having been observed in

managing the rules of discourse and in keeping to the topic of a conversation and offering new and relevant information (Roberts, Rice, & Tager-Flusberg, 2004; Ying, Carter, & Stephenson, 2018). Some authors employ the term autism spectrum disorder and language impairment (ASD-LI) to refer to a subtype of ASD that presents formal language impairment (Boucher, 2012; Tager-Flusberg, 2006; Williams, Botting, & Boucher, 2008).

Irregular language development is often the first problem to be identified by parents of children who go on to be diagnosed with ASD (Herlihy, Knoch, Vibert, & Fein, 2015; Hudry et al., 2014; Tek, Mesite, Fein, & Naigles, 2014), and approximately 63% of all children diagnosed with ASD have language impairment (Brignell et al., 2018). Of the few studies that have examined formal language deficits in ASD, the work by Kjelgaard and Tager-Flusberg (2001) and Tager-Flusberg (2006; 2015) stands out. These authors' conclusions indicate the presence of a language phenotype similar to that of SLI, that is, involving numerous and serious problems in lexical-semantic and morphosyntactic aspects of language.

SLI, for its part, is defined as a significant disruption in language acquisition and development in the context of appropriate sensory

and neurological development and in the absence of cognitive deficits in the non-verbal sphere (Leonard, 2014). In SLI, a child's first words tend to appear at around 24 months of age, with the autonomous lexicon developing in a slow and limited manner from then onward. Children with SLI also have difficulties accessing the lexicon and commit errors of evocation. Basic syntactic organization is not consolidated until 48 months, and is characterized by the juxtaposition of words, the use of utterances that are dependent on adult production (Serra, Serrat, Solé, Bel, & Aparici, 2002), and the omission of functional or relational words, that is, pronouns, prepositions, and conjunctions (Del Valle, Acosta, & Ramírez, 2018a).

The possible linguistic differences and similarities between ASD and SLI are often discussed when language impairments are addressed (Brignell et al., 2018; Eigsti & Bennetto, 2009; Tager-Flusberg, 2006; Terzi, Marinis, Kotsopoulou, & Francis, 2014; Tomblin, 2011; Tuller et al., 2017). Despite the wide heterogeneity of both impairments, some conclusions have been reached.

On the one hand, research has focused on the structural language deficits in ASD and SLI children, and has demonstrated some similarities between them, meaning that a phenotypic overlap exists (De Fosse et al., 2004; Weismer, 2013; Herbert & Kenet, 2007; Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg, Paul, & Lord, 2005). For example, some children in both groups often omit the morphemes of verb tenses, especially in English, and they show deficits in tasks involving nonword repetition. Although these two deficits have been considered clinical markers of SLI, they also occur in children with ASD (Demouy et al., 2011; Loucas et al., 2008; Roberts et al., 2004; Whitehouse, Barry, & Bishop, 2008). Another similarity is related to lexical and grammatical development. Children in the two groups show similar vocabulary (Demouy et al., 2011; McGregor et al., 2012) and comparable performance in understanding and repeating sentences (Manolitsi & Botting, 2011; Whitehouse et al., 2008). The grammar similarities have been corroborated by Tuller et al. (2017), who also add that both ASD and SLI participants make mistakes with clitic pronouns and complex sentences.

On the other hand, some differences between ASD and SLI have been observed. Some authors point out that ASD participants do better than SLI participants in nonword tasks (Durreleman & Delage, 2016; Riches, Loucas, Baird, Charman, & Simonoff, 2011) and in lexical tasks involving word associations and structures (Lloyd, Pantin, & Botting, 2006; Loucas et al., 2013; Manolitsi & Botting, 2011). Surenik and Friedmann (2018) showed that subjects with ASD perform differently from subjects with SLI in sentence understanding, production, and repetition. Moreover, the morphosyntactic mistakes made by the two groups differ.

Some authors, like Charman (2010) and Williams et al. (2008), remark that although the two groups share similarities in one stage of their development, it remains to be proved that these remain as the children grow up.

Therefore, it is necessary to promote research into the language skills present in both disorders. The main aim of the present study is, precisely, to examine and compare language phenotypes in Spanish-speaking children with a diagnosis of ASD or SLI. We focused on processing analysis, that is, Expressive and Receptive Language as well as Core Language, and on more specific skills related to Language Content and Language Structure.

Consequently, the following hypotheses can be made for this research about children with ASD: (1) they will have more

difficulties with Receptive Language than children with SLI; (2) they will have fewer difficulties with Expressive Language than children with SLI; (3) they will have fewer difficulties with Language Structure than children with SLI; (4) they will have more difficulties with Language Content than children with SLI.

Method

Participants

In this study, 60 children participated, all of whom were enrolled in schools in the Island of Tenerife (Canary Islands, Spain). They were divided into three groups: (1) a group of children with Specific Language Impairment (SLI: $n = 20$, mean age [*range*] = 9.1 years [7.4, 11.5], $SD = 1.5$); (2) a group with Autism Spectrum Disorder (ASD: $n = 20$, mean age [*range*] = 9.5 years [7.0, 11.2], $SD = 1.1$), and (3) a typical development control group (CG: $n = 20$, mean age [*range*] = 8.6 years [7.1, 11.4], $SD = 1.3$). The K-BIT intelligence test was used to evaluate non-verbal IQ (Kaufman & Kaufman, 2000). The means of the three groups (and their SD) were 100.4 (7.3), 98.5 (7.3), and 104.5 (6.9), respectively.

Two of the groups were selected by convenience sampling, given that the students were required to meet specific selection criteria. For the SLI group, an initial screening was carried out in all the schools of the island of Tenerife, in collaboration with school administrators and educational and psychopedagogical guidance counsellors. These counsellors were asked to refer all students showing possible signs of SLI—that is, problems with comprehension or expression in one or more components of language, but especially in morphosyntax and semantics—or students with several years' history of unresolved language difficulties. A total of 65 students were referred in this way, all of whom were put through an exhaustive comprehensive language assessment protocol to confirm the diagnosis, consisting of several standardized tests, including the Peabody test (Dunn, Padilla, Lugo, & Dunn, 1986) and the Auditory Association and Visual Association subtests of the ITPA (Kirk, McCarthy, & Kirk, 2005). In addition, an analysis of language samples was carried out to confirm the diagnosis (Del Valle, Acosta, & Ramírez, 2018a,b). This administration of the evaluation protocol led to the selection of a sample of 20 students with a diagnosis of SLI. A total of 34 students were excluded from the study for presenting simple language delay, that is, a slight chronological lag in development characterized more by phonological than by structural difficulties, and 11 children were excluded for not completing the tests, due to repeated absences or lack of collaboration.

The children in the ASD group all had a formal diagnosis of ASD, based on scores obtained in the ADOS-2 (Lord & Rutter, 2012). The Autism Diagnostic Observation Schedule (ADOS-2) is a semi-structured, standardized assessment of social interaction, communication, play, and imaginative use of materials for use in testing individuals suspected of having autism spectrum disorder. For the students in this study, the diagnosis of ASD was made by a board-certified psychiatrist experienced in evaluating ASD and comorbid psychiatric disorders belonging to the local association of Parents of People with Autism of Tenerife (APANATE). It is important to point out that all the students in question have received a diagnosis of ASD but have developed language skills and, therefore, are higher up in the spectrum. They are to be understood

as individuals with high-functioning autism who, despite having acquired oral language, present language difficulties.

The Control group was selected by means of discretionary sampling to ensure the three groups were as similar as possible in other variables that could influence the results. A total of 20 students with typical development were selected from among the classmates of the children with SLI. The students in this group did not have any language difficulties and were being schooled within the usual parameters.

The final sample therefore consisted of 60 students from different social backgrounds, from both public and private schools as well as rural and urban areas.

Instruments

CELF-4 standardized test (Semel, Wiig, & Secord, 2006). This is a language assessment test with scales for Spanish speakers in the United States. It evaluates the processes of language comprehension and expression in general, by means of tasks involving the structuring and formulation of sentences, concepts and directions, structure and kinds of words, and remembering sentences. The average reliability coefficients for the CELF-4 Spanish index scores range from .90 to .96. The structure of the test was validated by several confirmatory analyses (by age group) to check the hierarchical structure of the model. All showed an appropriate goodness of fit.

Procedure

Compliance with ethical standards was positively assessed by the Institutional Review Board of the authors' University. The children's legal guardians were also asked to provide informed written consent for their child's participation.

All participants completed the CELF-4 standardized test to assess their language skills. First, the central measures were considered: (a) Core Language, which includes Concepts and Directions, Recalling Sentences, Formulated Sentences, Word Associations (total); (b) Receptive Language, which includes Concepts and Directions and Word Associations (receptive); and (c) Expressive Language, which includes Recalling Sentences,

Formulated Sentences, and Word Associations (expressive). Second, Language Content measures were taken, consisting of Concepts and Directions, Word Associations (total), and Expressive Vocabulary. Finally, Language Structure was measured, which was made up of Concepts and Directions, Recalling Sentences, and Formulated Sentences.

Data analysis

The analyses carried out before the study examined the normality of the variables used in the design. In addition, analyses of variance (ANOVAs) were performed to verify that the three groups were equal in the variables age and IQ. Finally, the data were analyzed using univariate ANOVAs for each dependent variable studied (subtests of CELF-4). Orthogonal contrasts were performed as *post-hoc* comparisons in those evaluations that showed significant differences, to identify which groups showed differences. All analyses were carried out with the program SPSS v25.

Results

In the first place, normality of the variables age ($z = 0.08$; $df = 60$; $p = .174$) and non-verbal IQ ($z = 0.10$; $df = 60$; $p = .200$) were verified by the Kolgomorov-Smirnov test. In addition, univariate ANOVAs were performed for age ($F(2;57) = 2.5$; $p = .092$; $\eta^2 = .08$), and non-verbal IQ ($F(2;57) = 3.1$; $p = .055$; $\eta^2 = .10$). Both confirmed that there were no significant differences between the groups.

From this point on, the analyses carried out were intended to verify the scores obtained by each of the study groups in the different subtests of CELF-4, as discussed in the previous section. A detailed description of the results can be seen in Table 1.

A very large similarity can be seen between the SLI and ASD groups, with clear differences observed when both are compared with the Control group, since the latter always obtains higher scores.

Once the differences in the average scores obtained by the different groups had been studied, a contrast study was made between them. Table 2 shows this more clearly.

Table 1
ANOVA for each subtest and central scales of the CELF-4

Subtests and central scales	SG		AG		CG		ANOVA	
	M	SD	M	SD	M	DT	F(2;57)	η^2
Concepts and Directions	-0.3	0.6	-0.5	1.3	0.7	0.5	11.3***	.29
Recalling Sentences	-0.4	0.8	-0.3	1.1	0.7	0.5	11.1***	.28
Formulated Sentences	-0.2	0.9	-0.6	1.0	0.8	0.6	15.8***	.36
Word Classes: receptive	-0.5	0.9	-0.3	1.2	0.7	0.3	11.1***	.28
Word Classes: expressive	-0.5	0.8	-0.3	1.1	0.8	0.3	15.9***	.36
Word Classes: total	-0.5	0.8	-0.3	1.1	0.8	0.3	16.2***	.36
Expressive Vocabulary	-0.2	0.8	-0.5	1.0	0.7	0.8	8.3***	.23
Core Language	-0.4	0.7	-0.5	1.1	0.9	0.3	19.1***	.40
Receptive Language	-0.4	0.6	-0.5	1.2	0.8	0.4	15.6***	.36
Expressive Language	-0.4	0.7	-0.5	1.1	0.9	0.3	19.5***	.41

Note: SG = Specific Language Impairment Group (n = 20); AG = Autism Spectrum Disorder Group (n = 20); CG = Control Group (n = 20).
*** p ≤ .001

Table 2
Orthogonal contrast for each subtest and central scales of the CELF-4

Subtests and central scales	SG vs AG		SG vs CG		AG vs CG	
	F(1;58)	η^2	F(1;58)	η^2	F(1;58)	η^2
Concepts and Directions	0.3	.01	12.5***	.18	18.8***	.25
Recalling Sentences	0.1	.00	16.8***	.22	13.9***	.19
Formulated Sentences	1.1	.02	13.6***	.19	28.2***	.33
Word Associations: receptive	0.3	.01	18.3***	.24	12.3***	.18
Word Associations: expressive	0.5	.01	26.1***	.31	16.1***	.22
Word Associations: total	0.5	.01	26.7***	.32	16.5***	.22
Expressive Vocabulary	0.8	.01	7.6**	.12	15.4***	.21
Core Language	0.0	.00	23.4***	.29	26.6***	.31
Receptive Language	0.1	.00	18.5***	.24	23.3***	.29
Expressive Language	0.1	.00	22.7***	.28	28.1***	.33

Note: SG = Specific Language Impairment Group ($n = 20$); AG = Autism Spectrum Disorder Group ($n = 20$); CG = Control Group ($n = 20$)
** $p < .01$; *** $p < .001$

As can be seen, there are no significant differences between the SLI and ASD groups, with effect sizes of practically zero, meaning that the first hypothesis formulated in the present study could be rejected. Moreover, we found similar results for the other hypotheses, that is, no significant differences between the SLI and ASD groups, with effect sizes of practically zero, meaning that none of the hypotheses formulated in the present study could be confirmed. Differences are observed between the SLI and Control group, in all the variables studied, with large data on the effect size. In the same way, there are significant differences between the ASD and Control group, also in all the variables, with a large effect size.

Discussion

For many years, there has been talk of a possible relation between SLI and ASD in terms of behavioral phenotypes. As indicated by Mendoza (2016), topics of special interest here include comorbidity, shared genetic bases, and overlapping symptoms. It is this latter aspect that constitutes the main aim of the present study. The basis for our thinking is that, by definition, all children diagnosed with ASD will show significant communication difficulties (American Psychiatric Association, 2013). This fact has inspired research into the socio-communicative, pragmatic, and discursive aspects of the disorder. However, a sizeable subgroup of children with ASD also have additional difficulties with formal aspects of language, similar to those observed in profiles of children with SLI: phonological difficulties, moderate vocabulary problems, and more serious deficits in semantic and morphosyntactic components of language (Kjelgaard & Tager-Flusberg, 2001). It is surprising to note that despite the presence of these deficits, very little research has been done in the past few decades to examine structural language profiles in children with ASD.

In the case of SLI, the situation is completely different. While in recent years there has been some debate about the use of the term "specific," there is no doubt that SLI is a disorder characterized by clear language difficulties, mainly of a grammatical and lexical-semantic nature (Leonard, 2014). While these characteristics

would appear to be inherent to SLI, we shall see how they can be shared by other neurodevelopmental disorders such as ASD.

Our first hypothesis addresses a significant aspect of the debate on the language phenotypes of the two disorders. It has often been claimed that problems with receptive language represent one of the strongest differentiators between ASD and SLI (Lloyd et al., 2006). However, there has not been much research into comprehension. Our contribution to this debate, using the CELF-4, shows that there are no significant differences between two groups in this aspect, given that similar profiles were observed for comprehension in both groups. Performance was similar across both groups in conceptual tasks such as those involving inclusion/exclusion, location, sequence, condition, and time, and in tasks where participants must associate two words from among three or four words presented orally. Differences appeared only when comparing each of the two groups with the typical development (control) group. This means that our first hypothesis could not be confirmed.

Our second hypothesis was also not confirmed. Once again, there was overlap in expressive language use between the two groups, ASD and SLI. This was observed in their similar performance in tasks involving the recall and formulation of sentences that increased in length and complexity (simple, compound, and complex), and explaining why different words go together in categories such as sports, music, home, clothing, food, vehicles, or animals. Differences appeared only when comparing each of the two groups with the typical development (control) group.

These results agree with those obtained by Kjelgaard and Tager-Flusberg (2001). These authors concluded that the profiles of expressive and receptive language in subjects with ASD who have language structure problems resemble the linguistic profile that defines SLI. The only difference found is related to those phonological deficiencies which are present in SLI but do not appear in ASD (Tager-Flusberg et al., 2005).

Analyzing the data from the present study, it once again becomes clear that there is overlap in the morphosyntactic profiles of the two disorders, meaning that the third hypothesis could not be confirmed, either. This was seen in the recall and formulation of sentences, where the results were the same in the two groups, with differences only appearing when each was compared with the Control group. Therefore, we were able to verify the limitations of both disorders with respect to sentence processing and knowledge of the rules of grammar, as well as problems with auditory memory (when only the first or last words are remembered). In addition, we observed restrictions in the use of conjunctions to form compound sentences. Other investigations offer different results. Some researchers show that grammatical problems are quite similar in ASD and SLI (Williams et al., 2008), while other studies suggest that only subjects with SLI have morphological problems, such as the use of the infinitive instead of verb tenses. Moreover, a recent study carried out by Surenik and Friedmann (2018) showed that both groups, ASD and SLI, made different morphosyntactic mistakes, such as organizing the structure of the sentences or omitting part of them.

The fourth hypothesis also could not be confirmed, given that similar profiles were obtained for the two disorders in the lexical-semantic area as well, specifically with respect to concepts and directions, total word associations, and expressive vocabulary (ability to name illustrations of people, objects, and actions). These results are in line with the findings of Tager-Flusberg (2006).

It would appear that the richness and rigidity of learned word associations leads, in both cases, to denotative but not connotative use of words; that is to say, words are used as proper nouns with a single reference instead of as a rich and generalizable network of associations and meanings, implying that there is a fundamental obstacle to the acquisition of conceptual knowledge. Indeed, poor development of linguistic depth is a sign of the inability to establish classifications, categorizations, associations, and definitions (Axpe, Acosta, Moreno, & Ramírez, 2017). Once again, results are contradictory in this linguistic aspect. Thus, it has been found that there are similarities as regards lexical skills (Demouy et al., 2011; McGregor et al., 2012), but that ASD participants obtain better results in lexical depth, word associations, and structures (Lloyd et al., 2006; Loucas et al., 2013; Manolitsi & Botting, 2011).

Recent evidence of linguistic, neurobiological, and genetic markers has sparked a renewed interest in studying the links between SLI and ASD (Williams et al., 2008). At the linguistic level, it would appear that there is similarly low performance in repetition of pseudowords and errors in verbal inflections (Kjelgaard & Tager-Flusberg, 2001; Roberts et al., 2004). In molecular genetics, some studies have linked the gene CNTNAP2 of the region 7q35 with both SLI and ASD (Bakkaloglu et al., 2008). Therefore, there is an interplay in the language profiles that seems unlikely to have occurred by chance and suggests some degree of overlap in the genetic factors that contribute to each condition (Bishop, 2014; Tager-Flusberg, 2016).

Finally, it is important to point out some limitations in this research. First, the possible heterogeneity of both groups has not been considered. Second, as it is a cross-sectional study, the evolution of the subjects of the sample is not shown. As shown by Williams et al. (2008), the linguistic profiles of ASD and SLI overlap at the early developmental ages, showing similar problems regarding language expression and understanding. However, as ASD and SLI subjects grow up, some similarities are kept but other differences between them appear. For example, phonological and morphosyntactic problems are mitigated in the ASD group as children grow up, but this does not happen in SLI. Also, idiosyncratic expressions like echolalia and pronoun reversal appear in ASD, but not in SLI. Lastly, the sample is made up of only male children, therefore gender differences are not studied. In any case, it should be pointed out that including girls in the sample might have influenced the results, as girls' language tends to be much more advanced than boys' in pragmatic, lexical, and morphosyntactic tasks (Sturrock, Yau, Freed, & Adams, 2019), and in narratives (Conlon et al., 2019).

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