APPLICATION OF COMMUNICATION DEVELOPMENT INVENTORIES IN THE EXAMINATION OF EARLY BIMODAL BILINGUALISM

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Abstract: *Hearing children of deaf adults (CODAs) are bimodal bilinguals who acquire sign language at home and spoken language through hearing contacts. This study presents the first systematic description of the bimodal competence of CODAs in Spain using comparable instruments to evaluate language acquisition. A total of 26 signing-hearing children (aged 8-31 months) with at least one deaf signing parent were assessed every four months (82 CDIs per language) using the Spanish Communication Development Inventory and the Spanish Sign Language adaptation. A repeated measures analysis of variance showed no main effect of language, and a significant effect of age. There was a notable increase in vocabulary from 20 to 23 months in both languages.*

Keywords: *Children of deaf adults (CODA), bimodal, bilingualism, sign language*

INTRODUCTION

Sign language acquisition from birth is a unique developmental pathway that accounts for a relatively small percentage of all sign language users worldwide (Lillo-Martin & Henner, 2020). This group comprises hearing children of deaf adults (CODAs), who grow up immersed in two distinct linguistic and cultural worlds. At home, CODAs acquire sign language as their first or family language, while simultaneously having access to spoken language through extended hearing family members and other interactions. CODAs are defined as bimodal bilingual children because they acquire two languages using two separate modes: visual-manual and auditory-oral systems (Hofmann & Chilla, 2015).

Few studies have focused on bimodal acquisition in CODAs (Hadjikakou et al., 2009; Hofmann & Chilla, 2015; Preston, 1995, 1996; Singleton & Tittle, 2000). The findings on the outcomes of CODAs regarding sign language acquisition are inconclusive: some studies have reported age-appropriate vocabulary acquisition in CODAs, whereas others have reported delayed vocabulary acquisition (Hofmann & Chilla, 2015). Regarding spoken language, evidence suggests that CODAs develop skills similar to those of monolingual children (Capirci et al., 2002), and the amount of vocabulary in the majority language spoken between 15 and 24 months does not differ in both groups (Brackenbury, 2005). In this sense, bimodal bilinguals differ from unimodal bilinguals because, for the latter, the vocabulary measured in one of their languages is generally smaller than that of monolinguals (Byers-Heinlein et al., 2024; Siow et al., 2023). For this reason, measuring the vocabulary of unimodal bilinguals in only one language underestimates their actual lexical mastery, whereas the acquisition of vocabulary in the majority spoken language in bimodal bilinguals is expected to be less affected (Mercure, Bosworth et al., 2025).

Another aspect that differentiates between bimodal and unimodal bilingualism is the use of code-blending (Mercure, Bosworth et al., 2025). Simultaneous production of spoken words and

signs in bimodal bilinguals results in a higher degree of code-blending than in unimodal bilinguals. The effect of this characteristic on the development of two languages in bimodal bilinguals is unclear.

Regarding the asymmetry of linguistic input, i.e., the differences in the quantity, quality, and status of the two languages acquired by a child, both types of bilingualism (unimodal and bimodal) face asymmetries based primarily on the amount of exposure and the status of the language (majority vs minority). However, bimodal bilinguals face additional asymmetric challenges related to the dual modality and the frequency of contact with fluent linguistic models available in sign languages (Rinaldi et al., 2014), which can have a significant impact on their acquisition trajectory. In the earliest stages, CODA toddlers tend to have a higher exposure to sign language than to spoken language due to the amount of time they spend interacting with their signing parents. However, at later stages, increased exposure to spoken language in broader social and educational contexts contribute to an accelerated growth of spoken language, leading to a shift in dominance from signing to speech (Pérez Martín et al., 2014).

In general, language development in CODAs follows early acquisition milestones similar to those observed in monolinguals and unimodal bilinguals (Chen Pichler et al., 2017), with the exception of babbling and early expressive and receptive skills. Rhythmic hand movements, also known as manual babbling, have been observed in CODAs, but not in infants exposed only to spoken language (Petitto et al., 2004). From the ages of 4 to 8 months, CODA infants have demonstrated higher levels of early receptive skills (such as smiling in response to an attempt at communication) compared to unimodal bilinguals (Mercure, St. Clair et al., 2025). In addition, as manual articulation requires lesser fine motor control than speech, and early signs are visually salient and often iconic, sign languages facilitate both perception and production in young children (Casselli & Pyers, 2020, Morgan et al., 2007).

Despite these seemingly positive outcomes, CODAs are recognised as a heterogeneous group with unique needs for early communicative and linguistic development (Singleton & Tittle, 2000). Their family environment is complex due to various sociolinguistic factors: the majority language presents a greater challenge for deaf parents to learn; sign language is often under-recognised in society; parents may experience insecurities that affect language input (Hofmann & Chilla, 2015); and families may have diverse experiences of integration into deaf and hearing communities (Mercure, St. Clair et al., 2025). This complexity highlights the need for systematic investigation of language acquisition in CODAs using equivalent instruments to evaluate their development in both languages (spoken and sign) to determine the possible early intervention needs of these families.

In this context, the present study aims to provide the first systematic description of the bimodal bilingual language competence of CODAs in Spain using an adaptation of the MacArthur-Bates Communication Development Inventory (CDI) to the Spanish Sign Language (Lengua de Signos Española, LSE).

Based on previous studies on this topic, the following hypothesis was formulated: At each age interval between 8 and 31 months, with assessments carried out at four-month increments, CODAs are expected to show an advantage in expressive vocabulary in sign language relative to spoken language, driven by contextual influences and modality-specific developmental constraints.

METHODS

Participants

The sample comprised 26 native signing children (13 boys and 13 girls) between the ages of 8 and 31 months. The inclusion criteria were hearing children whose home language was LSE, because at least one parent was a signing-deaf adult. In fact, 21 children had parents who were both signing adults. The participants were evaluated at 4-month intervals, providing a total of 82 CDIs in each language - between 1 and 6 CDIs per language and per child. Sex was evenly distributed across different datasets. Table 1 summarises the ages of the participants, along with the number of CDIs completed in each age range and in each language.

Table 1. *Participants and completed CDIs for each age group and each language*

Age in months	8-11	12-15	16-19	20-23	24-27	28-31	Total
Number of CDIs collected per language	9	12	16	15	14	16	82
Mean age of participants Months (Standard deviation)	8.56 (0.73)	12.83 (0.94)	17.63 (1.15)	21.87 (0.99)	25.36 (1.34)	28.93 (1)	

Instruments

The early language development of CODAs was evaluated using two instruments: the CDI adaptation of the LSE (CDI-LSE; Rodríguez-Ortiz et al., 2020; accessible at http://www.fundacioncnse.org/cdi/) and the Spanish spoken language CDI (López-Ornat et al., 2005).

The main differences between both instruments were that, instead of two inventories (for ages 8-15 months and 16-30 months), CDI-LSE contains one unique inventory (for ages 8-36 months), in which several sections were omitted, including vocalisations, interjections, sounds of animals and other things, parts of the body, gestures and actions, and grammar.

Procedure

After the families had agreed to participate and provided authorisation for the collection of data from the children, a researcher who was a native signer visited them and explained how to use the inventory and send the results of their observations.

Parents recorded their children's expressive vocabulary by marking on a list of signs that the children could produce. In most cases, teachers and grandparents collected the spoken-language CDI. All of them received instructions on how to collect the data. The CDI-LSE questionnaire was presented in written form and made available through a website that included videos linking each word in the inventory to its corresponding LSE sign. Each child was assessed every 4 months until the age of 31 months, following the procedure used in previous adaptations of the CDI to sign languages (see Rodríguez-Ortiz et al., 2020). Data was categorised into groups based on the same age intervals reported in previous studies (8-11, 12-15, 16-19, 20-23, 24-27, and 28-31 months).

This study was conducted in accordance with the ethical requirements and principles outlined in the Declaration of Helsinki of 1964. The Ethics Committee for Experimentation of the Universidad de Sevilla approved the recruitment and data collection procedures (03-02-11). Informed consent was obtained from the parents before further data analysis.

RESULTS

In order to verify our hypothesis (the advantage of expressive vocabulary in sign language over spoken language at each age interval), Table 2 shows the number of signs and words produced in each age group. However, as the number of signs and spoken words was not the same when comparing both inventories, we selected only those signs and spoken words that were common to both inventories. This resulted in 477 signs for the 8- to 15-month interval and 415 signs for the remaining intervals. Subsequently, we calculated the percentage of signs and spoken words relative to the total number of common items. These percentages of common items are shown in Table 3.

One participant obtained very low scores in both sign language (4.26%) and spoken language (1.32%) in the 28- to 31-month interval (the only recorded interval for this participant). For this reason, he was eliminated from the analysis (and from Tables 2 and 3), but the results of the analysis did not change with or without this participant.

A factorial repeated-measures ANOVA was conducted with *language* as the within-subject factor and *age interval* as the between-subject factor (six age intervals: 8-11, 12-15, 16-19, 20-23, 24-27, and 28-31 months). Contrary to our hypothesis, there was no significant main effect of language on vocabulary ($F(1, 74) = 3.65$, $p = .060$). There was a significant main effect of age interval ($F(5, 74) = 29.92$, $p < .001$, partial $\eta^2 = .67$), but the interaction

between language and age interval was not significant ($F(5, 74) = 0.23$, $p = .950$). Post-hoc contrasts indicated that vocabulary percentages did not differ among the 8-11, 12-15, and 16- to 19-month intervals. However, all three intervals showed significantly lower vocabulary percentages than the 24-27 and 28- to 30-month intervals ($p < .005$). Vocabulary percentages in the 8-11 and 12- to 15-month intervals were also significantly lower than those in the 20- to 23-month interval ($p < .005$), and vocabulary in the 20- to 23-month interval was lower than in the 28- to 30-month interval. Similar patterns were observed when each language was analysed independently. Overall, vocabulary in both languages showed a marked increase, starting at 20 to 23 months. Beyond this main result, a more detailed examination of the data in Tables 2 and 3 revealed substantial heterogeneity in the development of both languages, and this heterogeneity increased with the child's age.

Table 2. *Number of children studied and mean (SD) number of signs and spoken words across the six age groups.*

		Sign language		Spoken language	
Months	*n*	*Mean*	*SD*	*Mean*	*SD*
8-11	9	1.11	1.54	1.56	2.01
12-15	12	15.58	13.66	7.17	7.41
16-19	16	62.81	35.48	56.69	85.93
20-23	15	134.87	98.10	134.07	130.57
24-27	14	201.50	123.39	224.36	149.70
28-31	15	284.27	162.05	249.87	133.62

Note: *SD*, standard deviation

Table 3. *Percentage of signs and spoken words relative to those shared by both inventories across the six age groups*

	Sign language		**Spoken language**	
Months	*Mean*	*SD*	*Mean*	*SD*
8-11	.40	.62	.20	.40
12-15	10.62	8.05	1.59	2.20
16-19	14.36	7.57	10.33	16.48
20-23	30.44	17.62	23.65	20.66
24-27	43.33	23.42	42.52	25.70
28-31	55.78	29.34	48.14	24.17

Note: A comparison of the signs and spoken words that were common to both inventories resulted in 477 signs for the 8- to 15-month interval and 415 signs for the remaining intervals. *SD*, standard deviation.

DISCUSSION AND CONCLUSIONS

This study describes the early bimodal bilingual development of hearing children of deaf adults (CODAs) in Spain. It characterises the developmental trajectories of children navigating two distinct linguistic modalities using comparable instruments for Spanish Sign Language (LSE) and spoken Spanish.

Contrary to our initial hypothesis, according to which, CODAs were expected to show an early advantage in expressive sign vocabulary due to contextual exposure and modality-related constraints, the results indicate that bimodal bilinguals develop both languages along a relatively balanced trajectory for most of the early developmental period assessed (between 8 and 31 months, evaluated at four-month intervals). The results revealed no significant main effect of language on vocabulary across the age range (8-31 months). Instead, both languages developed along a largely balanced trajectory, with no interaction between language and age interval. This suggests that, based on an assessment with equivalent tools, CODAs do not exhibit a systematic expressive advantage for sign language during early development.

The only robust developmental pattern identified was the significant effect of age, with vocabulary in both languages showing a marked increase from the 20- to 23-month interval onwards. Before this point (from 8-19 months), vocabulary size in both LSE and spoken Spanish remained relatively low and statistically comparable. The sharp increase observed from the 20- to 23-month interval aligns with developmental expectations reported for both deaf children exposed to LSE (Rodríguez-Ortiz et al., 2020) and hearing children acquiring spoken language (Chen Pichler et al., 2017), suggesting that bimodal bilingualism does not delay the onset of accelerated lexical growth.

The absence of a language-specific advantage supports the idea that early bimodal bilingualism can have a "positive effect": acquiring a signed and a spoken language simultaneously does not impede vocabulary development in either modality (Mercure, St. Clair et al., 2025). Unlike uni-

modal bilinguals, who often show smaller vocabularies in each language relative to monolinguals, the CODAs in our sample displayed comparable growth in LSE and spoken Spanish across age intervals. This balance may reflect the complementary nature of visual-manual and auditory-oral systems, which reduce competition for articulatory and perceptual resources.

Although spoken-language exposure is expected to increase as children expand their social networks, we did not observe spoken vocabulary surpassing sign vocabulary in the older age intervals measured (24-30 months). A plausible methodological explanation is that, in many families, spoken-language CDIs were completed by hearing relatives or teachers with only partial knowledge of the child's spoken production, potentially underestimating spoken vocabulary. This reporting bias should be considered a limitation.

A second limitation concerns sample size. Although small samples are common in CODA research, they could lead to a reduction in statistical power and constrain the generalisability of findings.

Finally, substantial individual variability was detected in expressive vocabulary across both languages. This heterogeneity underscores the importance of examining individual developmental pathways and considering factors such as gender, number of siblings, presence of signing relatives, kindergarten attendance, parental education, and who completes the CDI (e.g., relatives or teachers). Some children within this heterogeneous group may require early intervention and support for language development, as illustrated by one participant in the present study.

The most direct implications of our findings highlight the importance of reassuring deaf parents that using sign language at home with their hearing children provides a solid foundation for language development and that it does not delay spoken language acquisition.

Future research should combine parental reports with direct vocabulary assessments to obtain a more comprehensive picture of bimodal language development. In addition, longitudinal follow-ups beyond 31 months are needed to establish if, and when, a shift toward spoken-language dominance emerges as children enter a formal education system.

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REFERENCES

Byers-Heinlein, K., Gonzalez-Barrero, A. M., Schott, E., & Killam, H. (2023). Sometimes larger, sometimes smaller: Measuring vocabulary in monolingual and bilingual infants and toddlers. *First Language*, *44*(1), 74-95. https://doi.org/10.1177/01427237231204167

Brackenbury, T. (2005). Incidental Word Learning in a Hearing Child of Deaf Adults. *Journal of Deaf Studies and Deaf Education*, *11*(1), 76-93. https://doi.org/10.1093/deafed/enj018

Capirci, O., Iverson, J. M., Montanari, S. & Volterra, V. (2002). Gestural, Signed and Spoken Modalities in early Language Development: The Role of Linguistic Input. *Bilingualism: Language and Cognition, 5* (1), 25–37. https://doi.org/10.1017/S1366728902000123

Caselli, N. K., & Pyers, J. E. (2020). Degree and not type of iconicity affects sign language vocabulary acquisition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 46*(1), 127–139. https://doi.org/10.1037/xlm0000713

Chen Pichler, D., Kuntze, M., Lillo-Martin, D., Quadros, R.M., & Stumpf, M.R. (2017). *Sign Language Acquisition by Deaf and Hearing Children: A Bilingual Introductory Digital Course*. Gallaudet Univ. Press

Hadjikakou, K., Christodoulou, D., Hadjidemetri, E., Konidari, M., & Nicolaou, N. (2009). The Experiences of Cypriot Hearing Adults with Deaf Parents in Family, School, and Society. *Journal of Deaf Studies and Deaf Education, 14*(4), 486–502. https://doi.org/10.1093/deafed/enp011

Hofmann, K. & Chilla, S. (2015). Bimodal bilingual language development of hearing children of deaf parents *European Journal of Special Needs Education, 30*(1), 30–46, http://dx.doi.org/10.1080/08856257.2014.943563

Lillo-Martin, D. & Henner, J. (2021). Acquisition of Sign Languages. *Annual Review Linguistics, 7*, 395–419. https://doi.org/10.1146/annurev-linguistics-043020-092357

López-Ornat, S., Gallego, C., Gallo, P., Karousou, A., Mariscal, S., & Martínez, M. (2005). *Inventarios de Desarrollo Comunicativo MacArthur: Manual Técnico y Cuadernillo.* Ediciones TEA.

Mercure, E., Bosworth, R., & Gliga, T. (2025). Diverse language experiences in deaf infants and in hearing infants with deaf parents: 25 years of improved understanding and recognition. *Infant Behavior and Development*, *80*, 102103. https://doi.org/10.1016/j.infbeh.2025.102103

Mercure, E., St. Clair, V., Goldberg, L., Coulson-Thaker, K. & MacSweeney, M. (2025). From early communication to bimodal vocabulary acquisition: A longitudinal study of hearing children with deaf mothers from infancy to school-age years. *Bilingualism: Language and Cognition 1–15*. https://doi.org/10.1017/S1366728925100308

Morgan, G., Barrett-Jones, S. & Stoneham, H. (2007). The first signs of language: Phonological development in British sign language. *Applied Psycholinguistics, 28*(1), pp. 3-22. https://doi.org/10.1017/s0142716407070014

Pérez Martín, M., Valmaseda Balanzategui, M., de la Fuente Martín, B., Montero, I., & Mostaert, S. (2014). Desarrollo del vocabulario temprano en niños con implante coclear escolarizados en centros con bilingüismo oral-signado. *Revista de Logopedia, Foniatría Y Audiología*, *34*(2), 85-97. https://doi.org/10.1016/j.rlfa.2013.07.008

Petitto, L. A., Holowka, S., Sergio, L. E., Levy, B., & Ostry, D. J. (2004). Baby hands that move to the rhythm of language: Hearing babies acquiring sign languages babble silently on the hands. *Cognition, 93*(1), 43–73. https://doi.org/10.1016/j.cognition.2003.10.007

Preston, P. (1995). Mother Father Deaf: The Heritage of Difference. *Social Science & Medicine, 40*(11), 1461–1467. https://doi.org/10.1016/0277-9536(94)00357-y

Preston, P. (1996). Chameleon voices: Interpreting for deaf parents. *Social Science & Medicine*, *42*(12), 1681-1690. https://doi.org/10.1016/0277-9536(95)00299-5

Rinaldi, P., Caselli, M. C.,Di Renzo,A., Gulli, T., & Volterra,V. (2014). Sign vocabulary in deaf toddlers exposed to sign language since birth. *Journal of Deaf Studies and Deaf Education, 19*, 303–318. https://doi.org/10.1093/deafed/enu007

Rodríguez-Ortiz, I. R., Pérez, M., Valmaseda, M., Cantillo, C., Díez, M. A., Montero, I., Moreno-Pérez, F. J., Pardo-Guijarro, M. J., & Saldaña, D. (2020). A Spanish Sign Language (LSE) adaptation of the Communicative Development Inventories. *Journal of Deaf Studies and Deaf Education, 25*(1), 105-114. https://doi.org/10.1093/deafed/enz033

Singleton, J. L., & M. D. Tittle. 2000. Deaf Parents and Their Hearing Children. *Journal of Deaf Studies and Deaf Education, 5* (3), 221–236. https://doi.org/10.1093/deafed/5.3.221

Siow, S., Gillen, N. A., Lepădatu, I., & Plunkett, K. (2023). Double it up: Vocabulary size comparisons between UK bilingual and monolingual toddlers. *Infancy*, *28*(6), 1030-1051. https://doi.org/10.1111/infa.12562