

RESEARCH REPORT **OPEN ACCESS**

Maternal Child-Directed Speech Toward Children With Infantile Spasm or West Syndrome

Le Normand M.T.^{1,2} | Christelle Gosme^{3,4} | Marluce Leitgel-Gille⁴ | Roberta Simas⁴ | Xavier Jeudon⁴ | Bernard Golse³ | Lisa Ouss^{4,5}

¹Institut Pasteur, Institut de l'Audition, INSERM, Paris, France | ²Laboratoire de Psychopathologie et Processus de Santé, Université de Paris Cité, Boulogne-Billancourt, France | ³Laboratoire de Psychologie Clinique, Psychopathologie, Psychanalyse, Université de Paris Cité, Boulogne-Billancourt, France | ⁴Child and Adolescent Psychiatry Department, Necker-Enfants Malades Hospital, APHP, Paris, France | ⁵Child and Adolescent Psychiatry Liege University, Liege, Belgium

Correspondence: Le Normand M.T. (marie-therese.lenormand@inserm.fr)

Received: 1 September 2025 | **Revised:** 12 February 2026 | **Accepted:** 15 February 2026

Keywords: autism spectrum disorder | epilepsy | infantile spasms | intellectual disability | maternal child-directed speech | West Syndrome

ABSTRACT

Background: Maternal child-directed speech (MCDS) plays a critical role in early language and communicative development, yet little is known about how it adapts to neurodevelopmental conditions such as Infantile Spasms/West Syndrome (WS), particularly when co-occurring with intellectual disability (WID) or autism spectrum disorder (WASD).

Aims: This study investigated how mothers adapt their speech when interacting with children with WS, including those with WID and WASD, compared to age-matched typically developing (TD) children.

Methods and Procedures: Forty-four mother–child dyads participated in standardized free play sessions. MCDS was transcribed and analysed using the Child Language Data Exchange System (CHILDES), focusing on lexical diversity, noun, verb, adjective and pragmatic features (e.g., exclamations, directiveness, questions, attention-directing expressions, mental state references).

Outcomes and Results: Lexical diversity did not differ significantly between groups. However, clear group differences were found in pragmatic use: mothers of children with WS produced more exclamations, attention-directing expressions, and mental state references, suggesting adaptive strategies to sustain engagement. In the WS and TD groups, MCDS features were significantly associated with children's developmental quotients (DQ), a pattern not observed in the WID or WASD subgroups.

Conclusions and Implications: Findings suggest that mothers flexibly adjust their communicative input to children's developmental and interactional needs, with unique adaptations evident in WS. These results underscore the importance of tailoring parent-mediated interventions to support communication in children with complex neurodevelopmental contexts.

WHAT THIS PAPER ADDS

What is already known on this subject

- Maternal child-directed speech (MCDS) varies across neurodevelopmental conditions. Prior research has documented this variability in children with language delay and developmental language disorder (DLD), including those with co-occurring autism spectrum disorder (ASD).

What this paper adds to the existing knowledge

- To date, no studies have examined MCDS in the context of early-onset epilepsy during infancy, such as Infantile Spasms or West Syndrome (WS), leaving a critical gap in the literature. This study demonstrates that MCDS is shaped by (i) the neurological

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDeriv](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2026 The Author(s). *International Journal of Language & Communication Disorders* published by John Wiley & Sons Ltd on behalf of Royal College of Speech and Language Therapists.

impact of WS, including alterations in social responsiveness that may occur independently of intellectual disability or ASD; (ii) the child's developmental abilities; and (iii) communicative features associated with ASD. These findings broaden our understanding of how maternal speech adapts to diverse, early-emerging neurodevelopmental disorders.

What are the potential or actual clinical implications of this work?

- This study highlights the complexity of mother–child communication in the context of WS and co-occurring conditions. The findings underscore the need for tailored clinical interventions that consider both caregiver input and the child's communicative and developmental profile. MCDS may potentially serve both as a sensitive indicator of developmental status and as a modifiable element of early intervention. Personalized approaches that build on the child's communicative strengths while addressing specific challenges may support improved language outcomes and broader cognitive development.

1 | Introduction

1.1 | Maternal Child-Directed Speech (MCDS) to Typically Developing Children

MCDS addressed to typically developing (TD) children has been widely investigated over the past three decades. Previous research has examined multiple language domains. Several studies have focused on lexical input and vocabulary development, highlighting the role of simplified and structured caregiver speech in supporting early word learning (Hayes and Ahrens 1988; Hampson and Nelson 1993; Newport et al. 1977, 1986). Other work has emphasized the pragmatic and interactional functions of MCDS, viewing it as a socially embedded communicative system that supports language learning through affective and contextual cues (Gleitman et al. 1984; Mahdhaoui et al. 2011; Saint-Georges et al. 2013). In addition, a substantial body of research has documented the prosodic and acoustic characteristics of MCDS that enhance infants' attention and engagement (Fernald 1985; Fernald and Kuhl 1987; Braarud and Stormark 2008). Research indicates that the lexical, morphosyntactic, and functional features of MCDS vary according to the child's chronological and developmental age, supporting the idea that mothers naturally adjust their communicative style to match their child's perceived abilities (D'Odorico et al. 1999). MCDS is generally characterized by simpler syntax, shorter utterances, and a higher prevalence of single-word phrases (Brent and Siskind 2001), while also including more questions, directives, and attention-getting expressions (Krupee and Uzgiris 1987; Hoff 2006). As children grow, maternal speech shifts from affect-salient communication—used primarily to maintain interaction—toward more information-salient speech, which conveys meaningful content, likely due to children's increasing engagement with their environment (Bornstein et al. 1992; Henning et al. 2005). Several factors influence early language development, including speech frequency, saliency, and emotional cues, all of which help infants process linguistic input and engage socially (Cooper et al. 1997; Owens 2008; Snow 1972). Language acquisition is an experience-dependent process shaped by interconnected cognitive, social, and motor mechanisms, such as statistical learning, functional specialization, and visual attention (D'Souza et al. 2017). Notably, maternal responsiveness has been linked to vocabulary development, particularly in younger children (Sherrod et al. 1977; Ruffman et al. 2002; Ruffman et al. 2020; Ruffman 2023). By 2 years of age, TD children can comprehend hundreds of words, demonstrating the remarkable efficiency of early language learning (Frank et al.

2019; Braginsky et al. 2019). Overall, research highlights the adaptive nature of MCDS in facilitating language development and supporting the rapid, implicit acquisition of linguistic skills in early childhood.

1.2 | Maternal Child Directed Speech (MCDS) to Children With Late Talking

Although some evidence suggests that MCDS directed toward late-talking children is less synchronized with children's language development than that directed to typically developing (TD) children, findings in this area remain inconsistent. Importantly, late talkers constitute a heterogeneous group, many of whom eventually achieve age-appropriate language skills, in contrast to children with language impairments (LI; also referred to as developmental language disorder, DLD), whose difficulties are more persistent and pervasive. This heterogeneity may partially account for the mixed results reported in the literature.

For instance, Lasky and Klopp (1982) found no significant differences in MCDS across a range of communicative variables when comparing late-talking and non-late-talking children aged 27–45 months, suggesting that caregivers may not systematically alter their input in response to early expressive delays alone. However, other studies have identified qualitative differences in maternal input, particularly when children exhibit broader or more persistent language difficulties. Petersen and Sherrod (1982) reported that MCDS directed toward language-delayed children—matched on linguistic level rather than chronological age—contained fewer interpretations of the child's activities, fewer approvals of verbal behaviour, and fewer semantically contingent utterances, alongside an increased use of semantically unrelated input. These features are especially relevant to children with language impairments, for whom contingent and semantically aligned input is considered critical for supporting language learning.

Similarly, Harris et al. (1986) observed that mothers of late-talking children aged 20–34 months produced fewer references to objects within the child's current focus of attention and used fewer specific object labels, while more frequently initiating verbal interactions without accompanying non-verbal actions. Such patterns may be particularly consequential for children with language impairments, who often rely more heavily on multimodal cues and shared attentional frameworks to support

lexical and pragmatic development. Further evidence indicates that mothers of late-talking children aged 20–30 months tend to adopt a more directive and less responsive interactional style than mothers of TD children, characterized by increased use of directives and fewer questions (Hodapp 2001, 2002; D’Odorico and Jacob 2006; Spiker et al. 2002; Venuti et al. 2012). Although such directiveness may serve as an adaptive scaffolding strategy in response to limited child output, children with language impairments may be particularly vulnerable to reduced conversational reciprocity, as their language-learning difficulties extend beyond delayed onset to include weaknesses in morphosyntax, semantics, and pragmatics. Consequently, MCDS that is less contingent or less responsive may inadvertently constrain opportunities for these children to practice communicative initiation, joint attention, and pragmatic language use.

1.3 | Maternal Child Directed Speech (MCDS) to Children With Autism Spectrum Disorder (ASD)

MCDS plays a crucial role in language development for children with ASD (Swensen 2007; Warren et al. 2012; Bang and Nadig 2015). Research suggests that responsive maternal speech can support long-term language outcomes in children with autism. For instance, Siller and Sigman (2002) found that mothers of children with ASD provided similar amounts of responsive verbal utterances as mothers of typically developing (TD) children, and this responsiveness was significantly associated with improved language skills 10 and 16 years later. However, studies specifically examining MCDS in children with ASD remain limited. Tubul-Lavy et al. (2020) reported that mothers of children with ASD (mean age: 27 months) used a comparable number of content words at the same linguistic level as mothers of TD children but showed distinct differences in word choice. Specifically, they used significantly more concrete nouns and active verbs while rarely incorporating abstract nouns, stative verbs, adjectives, or adverbs. This suggests that MCDS toward children with ASD may be more focused on concrete and action-oriented communication. Additionally, Romeo et al. (2022) found that parental language input predicts expressive language development and is associated with neural oscillatory patterns linked to language acquisition in toddlers at risk for ASD. These findings highlight the importance of MCDS in shaping language development in children with ASD, though further research is needed to understand its specific effects and potential adaptations for enhancing communication outcomes.

1.4 | Maternal Child Directed Speech (MCDS) Toward Children With Intellectual Disabilities (ID)

MCDS to children with ID exhibits specific modifications that reflect mothers’ adaptations to their child’s developmental abilities. Research has shown that mothers of children with Down syndrome simplify their speech in various ways, including using a lower diversity of vocabulary, shorter utterances, and more telegraphic input compared to mothers of TD children (Zampini et al. 2012; Lorang et al. 2020). However, studies on MCDS toward children with early severe neurodevelopmental disorders remain largely unexplored, leaving uncertainty regarding the potential role of language sample analyses in differential diagnosis. One

area of growing interest is the study of MCDS toward children with early onset epilepsy like West syndrome—classically defined by the triad of infantile spasms, developmental regression or stagnation, and hypsarrhythmia on EEG. WS is an early-onset epileptic encephalopathy typically presenting between 3 and 7 months of age. Spasms occur in brief clusters of flexor, extensor, or mixed axial movements, often on arousal from sleep. Aetiology is heterogeneous, encompassing structural, genetic, metabolic, and acquired causes; symptomatic cases are more common than cryptogenic ones. The condition represents a neurologic emergency, as ongoing spasms and hypsarrhythmia are associated with adverse neurodevelopmental outcomes. First-line treatments include ACTH, high-dose corticosteroids, and vigabatrin (particularly in tuberous sclerosis complex). Prognosis depends largely on the underlying cause, rapidity of diagnosis, and early initiation of appropriate therapy. Given that WS emerges early in development and is associated with a high risk of ASD (7%–25% of cases) and ID or learning disorders (70%–90% of cases) (Strasser et al. 2018), understanding maternal speech patterns in WS with and without co-occurring ASD and ID is crucial. Prior research has shown that early parent-child interactions can serve as predictors of later developmental delays or ASD (Ouss et al. 2014). Additionally, early-onset epilepsy, as seen in WS, has been linked to developmental delays and cognitive-communicative disabilities. Despite these associations, it remains unclear whether MCDS toward children with WS resembles that used by mothers of children with ASD or other forms of ID or is specifically affected by the syndrome itself. Investigating the linguistic characteristics of MCDS toward children with WS may provide valuable insights into how mothers fine-tune their verbal input in response to their child’s unique developmental needs. This research could enhance our understanding of early language development in children with neurodevelopmental disorders and inform more effective intervention strategies for children with autism, ID, or epilepsy-related language impairments.

2 | The Current Study

The primary aim of this study is to examine the characteristics of MCDS to children with Infantile Spasms/WS, both with and without co-occurring intellectual disability (WID) and/or autism spectrum disorder (WASD), in comparison to typically developing (TD) children. A secondary aim is to determine how the presence and severity of ID and/or ASD symptoms shape the linguistic features of MCDS.

Given the limited research on MCDS in the context of WS, we hypothesize that MCDS toward children with WS reflects adaptations to perceived developmental delays. These adaptations may function as compensatory strategies or express maternal concerns regarding the child’s developmental trajectory. Specifically, we expect overall vocabulary diversity in MCDS toward children with WS to be comparable to that directed toward TD children. In contrast, we expect more pronounced differences in pragmatic language use (e.g., interrogatives, exclamations, directives, attention-getting expressions, and mental state references) than in the distribution of lexical content words (e.g., nouns, verbs, adjectives). Such adaptations may be observed both in the range of vocabulary used and in the balance between lexical and pragmatic elements across WS subgroups.

We further propose that these MCDS patterns are shaped by the child's cognitive and communicative profile. This design allows us to disentangle whether maternal adaptations are driven primarily by the presence of epilepsy or by the child's actual developmental abilities.

By examining these patterns, this study seeks to advance understanding of how mothers adjust their language input to support the developmental needs of children with WS, thereby contributing to broader knowledge on adaptive parental communication strategies in neurodevelopmental disorders.

3 | Method

3.1 | Participants

This study included 44 mother-child pairs, all of whom spoke European French as their primary language. The children with Infantile Spasms (for clearer abbreviation, we keep the name West Syndrome, (WS) were divided into three subgroups: (i) WS without ID or ASD (West): 12 children (four boys, eight girls) (ii) WS with Autism Spectrum Disorder (WASD) and Intellectual Disability (ID): eight children (four boys, four girls) (iii) WS with ID but without ASD (WID): 13 children (five boys, eight girls). All children with WS were recruited from the Department of Child Neurology at the Centre for Rare Epilepsy, Necker enfants-malades Hospital, Paris. ASD diagnoses were confirmed using the Autism Diagnostic Interview-Revised (ADI-R; Le Couteur et al. 2003), ICD-10 criteria, and clinician assessments. Intellectual disability (ID) was classified as mild, moderate, or severe based on ICD-10 standards.

The TD group consisted of 11 children (seven boys, four girls), recruited through Maternal and Infant Prevention institutions, paediatric consultations, or by proxy. These children were selected to match the clinical group in age at study onset. None had been diagnosed with a neurodevelopmental disorder by an expert clinician, and all were in good health with typical development and normal hearing.

All participants were native French speakers from middle-to-high socioeconomic backgrounds. Parents provided background information via a demographic questionnaire and gave written informed consent. Neurodevelopmental profiles were assessed using the Brunet-Lézine Revised Developmental Examination, which estimates a developmental quotient (DQ) based on normative data for 3-year-old French toddlers (Josse 1997). Individual participant characteristics are summarized in Table 1.

The TD group showed uniformly high developmental quotients ($DQ \geq 90$) and the highest levels of expressive language, with mean length of utterance (MLU) values consistently above 2.7 and moderate-to-high utterance rates. Children with WS without comorbid diagnoses demonstrated greater variability in both cognitive and language measures, with DQ values ranging from 71 to 105 and MLU values spanning from 1.07 to 3.34, despite the absence of intellectual disability (ID) or autism spectrum disorder (ASD). In contrast, children with WID exhibited markedly reduced developmental and language outcomes. DQ values decreased systematically with increasing

ID severity, ranging from mild to severe, and were accompanied by consistently low MLU values, generally below 2.0, as well as reduced utterance rates. The most pronounced impairments were observed in participants with severe ID, who showed the lowest DQ scores and minimal expressive language output. Children with WASD also demonstrated substantial cognitive and linguistic impairment, with DQ values predominantly below 55 and MLU values clustering around 1.0–1.6. Utterance rates in this group were generally low, and most participants presented with frequent, treatment-resistant seizures. Overall, the Table 1 indicate a graded decline in cognitive and expressive language measures across groups, with the most severe profiles observed in children with comorbid ID or ASD, particularly in the presence of poorly controlled epilepsy.

Group-level descriptive statistics for chronological age, developmental quotient (DQ), mean length of utterance (MLU), and utterance rate are presented in Table 2

Mean chronological age was comparable across groups, with values ranging from 36.0 to 38.6 months. Mean DQ values differed across groups, with higher mean values in the TD ($M = 90$) and WEST ($M = 88.75$) groups and lower mean values in the WID ($M = 42.92$) and WASD ($M = 33.38$) groups; greater variability was observed in the WID and WASD groups. Mean MLU values varied across groups, with mean values of 3.23 for TD, 2.06 for WEST, 1.51 for WID, and 1.26 for WASD. Mean utterance rate values were 0.44 for TD, 0.38 for WEST, 0.31 for WID, and 0.22 for WASD. Overall, the descriptive statistics of participants indicate variation across groups in cognitive and expressive language level, in the context of similar chronological ages.

3.2 | Method

3.2.1 | Description of a Standardized Free Play Procedure

The naturalistic observation was designed to be standardized. A 1 m² mat, placed at the centre of the room, served as the designated play area for a set of standardized toys. During the 15-min free-play session, children were seated initially but remained free to move, explore, and manipulate objects both on and off the mat. Mothers were instructed to play and interact with the child as naturally as possible, as they usually do. To ensure consistency across dyads, all families were provided with the same set of toys: a red ball, a cloth book, nesting cubes, a teddy bear, a giraffe, small cars, and a Fisher-Price house with figurines. These familiar materials were selected to encourage spontaneous play in children, while the limited number of items facilitated comparability across sessions. Recordings were made using Sony video recorders with ECM-T140 external microphones as part of a longitudinal study on language development in children with neurodevelopmental disorders (Figure 1).

3.2.2 | Data Analysis

Transcriptions were completed in accordance with the Codes for the Human Analysis of Transcripts (CHAT) format of the Child Language Data Exchange System (CHILDES) using Com-

TABLE 1 | Participant characteristics.

Code	Group	Gender	SES	CA	DQ	MLU	Utterance rate	ID	ASD	Epilepsy severity
TD01	TD	F	High	43	90+	3.00	0.34	No	No	—
TD02	TD	F	High	30	90+	3.20	0.54	No	No	—
TD03	TD	F	High	48	90+	2.72	0.30	No	No	—
TD04	TD	M	High	36	90+	2.91	0.44	No	No	—
TD05	TD	M	High	38	90+	3.30	0.34	No	No	—
TD06	TD	M	High	40	90+	3.73	0.45	No	No	—
TD07	TD	M	High	29	90+	3.92	0.41	No	No	—
TD08	TD	M	High	36	90+	3.42	0.38	No	No	—
TD09	TD	M	High	30	90+	2.85	0.52	No	No	—
TD10	TD	F	High	36	90+	3.32	0.82	No	No	—
TD11	TD	M	High	30	90+	3.12	0.36	No	No	—
W1	WEST	F	High	36	80	1.90	0.34	No	No	1
W2	WEST	M	High	38	82	1.79	0.26	No	No	1
W3	WEST	F	Middle	39	82	2.65	0.35	No	No	1
W4	WEST	M	High	36	90	2.33	0.40	No	No	1
W5	WEST	F	High	42	93	3.34	0.52	No	No	1
W6	WEST	F	High	40	95	2.04	0.47	No	No	2
W7	WEST	M	Middle	37	98	2.68	0.32	No	No	1
W8	WEST	F	High	38	102	2.06	0.22	No	No	1
W9	WEST	F	High	36	105	1.07	0.51	No	No	1
W10	WEST	M	Middle	37	71	1.58	0.37	No	No	1
W11	WEST	F	Middle	38	79	1.58	0.46	No	No	1
W12	WEST	F	Middle	42	88	1.75	0.36	No	No	1
W13	WID	F	Middle	45	55	1.83	0.25	Mild	No	2
W14	WID	F	Middle	37	57	1.27	0.36	Mild	No	1
W15	WID	M	Middle	38	57	2.32	0.38	Mild	No	1
W16	WID	F	Middle	39	61	1.11	0.33	Mild	No	1
W17	WID	F	Middle	38	68	1.54	0.38	Mild	No	1
W18	WID	M	High	36	69	1.22	0.33	Mild	No	2
W19	WID	M	Middle	37	25	1.30	0.04	Moderate	No	1
W20	WID	M	High	44	31	1.85	0.68	Moderate	No	1
W21	WID	F	High	36	33	1.55	0.37	Moderate	No	1
W22	WID	F	High	37	39	1.50	0.12	Moderate	No	1
W23	WID	M	Middle	35	42	1.82	0.33	Moderate	No	1
W24	WID	F	High	38	9	1.00	0.09	Severe	No	2
W25	WID	F	Middle	42	12	1.33	1.33	Severe	No	2
W26	WASD	M	Middle	37	54	1.00	0.08	Mild	Yes	2
W27	WASD	F	High	37	20	1.62	0.17	Severe	Yes	2
W28	WASD	F	High	36	24	1.20	0.22	Severe	Yes	2
W29	WASD	M	High	39	26	1.31	0.14	Moderate	Yes	2
W30	WASD	M	Middle	36	38	1.00	0.38	Moderate	Yes	1

(Continues)

TABLE 1 | (Continued)

Code	Group	Gender	SES	CA	DQ	MLU	Utterance rate	ID	ASD	Epilepsy severity
W31	WASD	F	High	37	39	1.24	0.44	Moderate	Yes	1
W32	WASD	M	Middle	36	46	1.50	0.14	Moderate	Yes	1
W33	WASD	F	High	45	20	1.23	0.26	Severe	Yes	2

Note: DQ values reported as 90+ indicate performance at or above the upper limit of the test. Epilepsy severity was assessed as following, 1 = controlled seizures with treatment, 2 = resistant seizures despite multiple treatment. Chronological age is reported in months.

Abbreviations: ASD, autism spectrum disorder; DQ, developmental quotient; ID, intellectual disability; MLU, mean length of utterance; SES, socioeconomic status indexed by maternal education.

TABLE 2 | Group means and standard deviations for age, developmental quotient, mean length of utterance, and utterance rate.

Group	n	Age (M)	Age (SD)	DQ (M)	DQ (SD)	MLU (M)	MLU (SD)	Utterance rate (M)	Utterance rate (SD)
TD	11	36.00	6.08	90.00	0.00	3.23	0.37	0.44	0.14
WEST	12	38.25	2.14	88.75	10.28	2.06	0.61	0.38	0.10
WID	13	38.62	3.12	42.92	20.13	1.51	0.37	0.31	0.16
WASD	8	37.88	3.04	33.38	12.75	1.26	0.22	0.22	0.14

Note: Values are means (M) and standard deviations (SD). Chronological age is reported in months. For the TD group, developmental quotient (DQ) values reported as 90+ were conservatively coded as 90 for descriptive purposes.



FIGURE 1 | Standardized free play procedure.

puterized Language Analysis (CLAN) software (MacWhinney, 2000). All maternal utterances were transcribed by a trained research assistant. A second trained research assistant independently reviewed each audio–video file alongside its transcript to identify and correct errors in spelling, segmentation, and coding. Discrepancies were resolved through consensus; any remaining unresolved segments were coded as *unintelligible* after three review passes. Interrater agreement across transcripts was 95%.

3.2.3 | Maternal Speech Measures

To assess similarities and differences in MCDS across groups, both quantitative and qualitative linguistic variables were anal-

ysed. These measures were selected to capture potential adaptations in maternal language as a function of the child's cognitive and communicative abilities.

3.2.3.1 | Vocabulary Diversity (VOC). This measure accounts for the influence of sample size on the traditional type-token ratio (TTR). VOC models the rate at which new lexical items are introduced as sample size increases, providing a more reliable estimate of lexical richness. Non-lexical fillers and unintelligible sounds were excluded from the analysis.

3.2.3.2 | Interrogatives. This variable measured the proportion of interrogative utterances relative to the total number of maternal utterances. Interrogatives were identified based on rising intonation patterns and/or syntactic structures characteristic of questions.

3.2.3.3 | Exclamations (Affect-Salient Speech). Exclamatory utterances were defined as expressions used to maintain interaction and convey affect. This category included emotionally expressive words such as *ah* [ah], *hop* [hop], *voilà* [here], *hé* [hey], and *bravo* [bravo].

3.2.3.4 | Questions. This category included lexical forms used to request or seek information from the child, including *où?* [where?], *quoi?* [what?], *comment?* [how?], *quand?* [when?], and *pourquoi?* [why?].

3.2.3.5 | Directives. Directives were imperative forms used to guide or instruct the child's actions. Examples included *aller* [go], *faire* [do], and *mettre* [put].

3.2.3.6 | Attention-Getting Devices. These were expressions used to attract or maintain the child's attention, such as *attends* ! [wait!], *donne* ! [give!], *viens* ! [come!], and *prends* ! [take!].

3.2.3.7 | Mental State References. Mental state terms reflected the child's internal experiences, including perceptions, desires, intentions, and beliefs. Relevant lexical items included *regarder* [look], *vouloir* [want], *voir* [see], *pouvoir* [can], *falloir* [must], *savoir* [know], and *croire* [believe].

These linguistic features were chosen to provide insight into the ways caregivers adapt their speech in response to the developmental characteristics of their children. All analyses were conducted using standardised coding procedures to ensure reliability and comparability across participants.

4 | Results

4.1 | Descriptive Statistics for all Linguistic Measures by Groups

We analysed MCDS data from 44 mothers interacting with children with WS ($n = 33$) and TD controls ($n = 11$) to examine group differences in linguistic features

As shown in Table 3, the clinical groups generally exhibited greater variability than the TD group across several linguistic measures, as reflected by wider confidence intervals. Variability was particularly pronounced in the WASD group, most notably for percentage of verbs, which showed a substantially wider confidence interval relative to the other groups.

To further examine group differences and the relations between cognitive level and language measures, inferential group comparison and correlational analyses were conducted.

4.2 | Group Comparison

A one-way between-subjects analysis of variance (ANOVA) revealed significant group effects for the percentage of nouns, $F(3, 39) = 2.96, p < 0.05$; exclamations, $F(3, 39) = 2.69, p < 0.05$; and questions, $F(3, 39) = 5.11, p < 0.01$. No significant group differences were found for vocabulary diversity (VOCD), $F(3, 39) = 1.53, p = 0.22$; percentage of verbs, $F(3, 39) = 2.00, p = 0.13$; or percentage of adjectives, $F(3, 39) = 0.96, p = 0.42$.

4.3 | Post Hoc Comparisons

Post hoc comparisons were conducted to further examine group differences in MCDS (see Figure 2). No significant differences were observed among the WASD, WID, and TD groups for vocabulary diversity (VOCD), verb use, or adjective use. Significant differences emerged for other linguistic features. The proportion of nouns was significantly lower in MCDS toward children with WASD than toward TD children, $t = -2.93, p = 0.006$. Exclamations occurred significantly more frequently in MCDS toward

children with WASD than toward TD children, $t = 2.26, p = 0.02$. Group differences were also observed in the use of interrogative forms. Mothers of children with WASD and WID produced fewer questions than mothers of TD children, with significant contrasts for WASD versus TD, $t = -3.11, p = 0.004$; WID versus TD, $t = -2.54, p = .015$; and the combined WS group versus TD, $t = -3.59, p < 0.001$. Together, these findings suggest that while lexical diversity and descriptive language use are relatively consistent across groups, noun use, exclamations, and question-asking vary as a function of the child's neurodevelopmental profile.

4.4 | Correlational Analysis Across Clinical Group

Clear differences emerged in the pattern of associations across clinical groups. Vocabulary diversity was positively associated with the DQ variable in both the West and WID groups, with statistically significant correlations observed in each group ($r = 0.68$ and $r = 0.64$, respectively, $p < 0.05$). In contrast, the WASD group demonstrated a negative association between vocabulary diversity and the DQ variable, which did not reach statistical significance, indicating a qualitatively different pattern of association relative to the other clinical groups. Group-specific contrasts were also evident for morphosyntactic measures. Percentage of verbs was significantly negatively associated with the DQ variable in the WID group ($r = -0.63, p < 0.05$), whereas corresponding associations were weaker and non-significant in the West and WASD groups. For percentage of exclamations, the WASD group showed a strong negative association that approached statistical significance ($r = -0.70, p < 0.10$), a pattern not observed in the West or WID groups.

No statistically significant associations were identified for percentages of adjectives, nouns, or questions in any group, and correlation magnitudes for these measures were generally small across groups.

Table 4 presents all correlations between children's DQ scores and the six MCDS variables in the three WS subgroups: West, WASD and WID. Consistent with the overall sample, both the WASD and WID subgroups showed significant negative correlations between the percentage of exclamations and DQ, $r = -0.70, p < 0.01$ and $r = -.52, p < 0.01$, respectively. A significant positive correlation between the percentage of adjective use and DQ was found only in the WASD group, $r = 0.82, p < 0.01$. Notably, the WASD subgroup displayed divergent correlation slopes for several MCDS variables—including vocabulary diversity, adjectives, nouns, and verbs—relative to the West and WID groups.

4.5 | General Linear Model

A general linear model was conducted to examine whether MCDS predicted children's DQ scores while controlling for WS subgroups. The overall model was statistically significant, $F(8,23) = 11.91, p < 0.001$, and accounted for a large proportion of the variance in DQ scores, with $R^2 = 0.81$ and adjusted $R^2 = 0.74$. The omnibus test for the group effect was significant, $F(2,23) = 26.15, p < 0.001, \eta^2_p = 0.69$, indicating that children's DQ scores varied substantially across the groups.

TABLE 3 | Descriptive statistics for linguistic measures by group.

Measures	Group	N	Mean	SD	Median	95% CI
Vocabulary diversity	TD	11	41.44	3.61	43.22	[39.02, 43.86]
	West	12	45.80	2.78	48.41	[39.60, 52.00]
	WID	13	42.36	1.85	44.11	[38.33, 46.40]
	WASD	8	36.52	3.30	37.56	[28.72, 44.32]
Percentage of exclamations	TD	11	11.06	0.91	11.07	[10.45, 11.67]
	West	12	11.25	1.32	10.79	[8.31, 14.18]
	WID	13	12.95	1.06	12.23	[10.64, 15.27]
	WASD	8	15.02	1.30	15.65	[11.95, 18.08]
Percentage of nouns	TD	11	16.82	1.55	18.17	[15.90, 17.74]
	West	12	14.20	1.03	13.67	[11.91, 16.49]
	WID	13	14.02	0.81	13.46	[12.25, 15.79]
	WASD	8	11.74	1.04	11.23	[9.28, 14.20]
Percentage of verbs	TD	11	9.68	1.05	10.25	[9.01, 10.35]
	West	12	8.15	0.73	8.68	[6.53, 9.77]
	WID	13	9.96	0.60	9.62	[8.67, 11.26]
	WASD	8	12.96	2.91	10.04	[6.09, 19.83]
Percentage of adjectives	TD	11	3.81	0.31	3.80	[3.60, 4.02]
	West	12	2.49	0.82	1.46	[0.66, 4.32]
	WID	13	2.82	0.50	2.34	[1.73, 3.91]
	WASD	8	3.01	0.59	2.45	[1.63, 4.40]
Percentage of questions	TD	11	3.36	0.54	3.15	[3.00, 3.72]
	West	12	1.75	0.31	1.95	[1.04, 2.45]
	WID	13	1.57	0.26	1.64	[1.01, 2.13]
	WASD	8	1.92	0.28	1.76	[1.27, 2.57]

Abbreviations: CI, confidence interval; TD, typically developing; W, West syndrome without ASD and ID; WASD, West syndrome with Autism Spectrum Disorder and ID; WID, West syndrome with Intellectual Disability.

TABLE 4 | Correlations between children's DQ scores and the six MCDS variables in the three WS subgroups.

MCDS measures	West <i>r</i>	WID <i>r</i>	WASD <i>r</i>
Vocabulary diversity	0.68*	0.64*	-0.56*
Percentage of exclamations	-0.25	-0.52*	-0.70**
Percentage of adjectives	-0.34	-0.10	0.82**
Percentage of nouns	0.25	0.23	-0.16
Percentage of verbs	-0.43	-0.63*	0.35
Percentage of questions	0.04	0.19	0.38

Correlations (*r*) are two-tailed.

**p* < 0.05.

***p* < 0.01. Sample sizes: West = 12, WID = 13, WASD = 8.

After controlling for group, none of the maternal speech predictors were statistically significant. However, the percentage of exclamations, $F(1,23) = 3.37$, $p = 0.079$, $\eta^2_p = 0.13$, and vocabulary diversity, $F(1,23) = 2.46$, $p = 0.13$, $\eta^2_p = 0.10$, showed nonsignificant trends, suggesting potential small-to-moderate

effects. The percentages of nouns, adjectives, verbs, and questions were all nonsignificant predictors ($ps > 0.21$). Relative to the West group, children in the WASD group scored significantly lower on DQ ($b = -45.55$, $SE = 7.75$, $t = -5.88$, $p < 0.001$), as did children in the WID group ($b = -41.07$, $SE = 6.20$, $t = -6.63$, $p < 0.001$). Post hoc

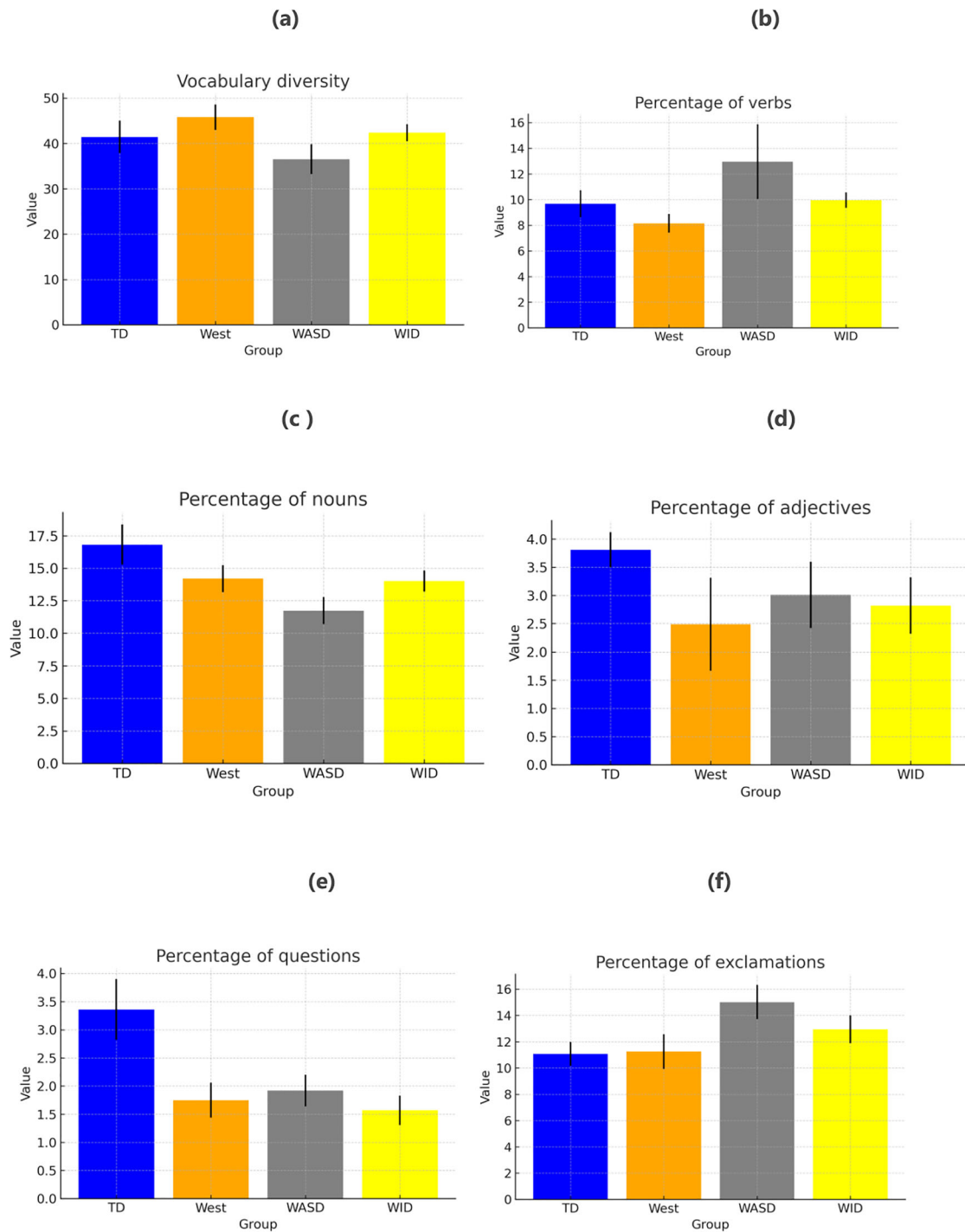


FIGURE 2 | Bar charts illustrating post hoc comparisons of MCDS measures across three subgroups of children with West syndrome (WS) and a typically developing (TD) group. Panel (a) shows vocabulary diversity; panel (b) verbs; panel (c) nouns; panel (d) adjectives; panel (e) questions; and panel (f) exclamations.

comparisons confirmed that both the WASD and WID groups had significantly lower DQ scores than the West group ($p < 0.001$), with large effect sizes ($d = 3.14$ and $d = 2.83$, respectively).

There was no significant difference between the WASD and WID groups ($p = 1.00$). Estimated marginal means showed that children in the West group had the highest DQ scores ($M = 84.70$, $SE = 4.65$, $95\% \text{ CI } [75.07, 94.32]$), followed by the WID group ($M = 43.63$, $SE = 4.07$, $95\% \text{ CI } [35.21, 52.04]$), and the WASD group ($M = 39.15$, $SE = 5.63$, $95\% \text{ CI } [27.50, 50.79]$).

4.6 | Qualitative Group Differences in MCDS

Figure 3 illustrates group differences in MCDS based on the percentage of occurrences of 24 target words distributed across five linguistically and socially meaningful categories: exclamations/affect-salient words, directives, questions, attention-getting devices, and references to mental states.

Statistical analyses revealed significant group differences in four of the five categories. Mothers of children with WS produced

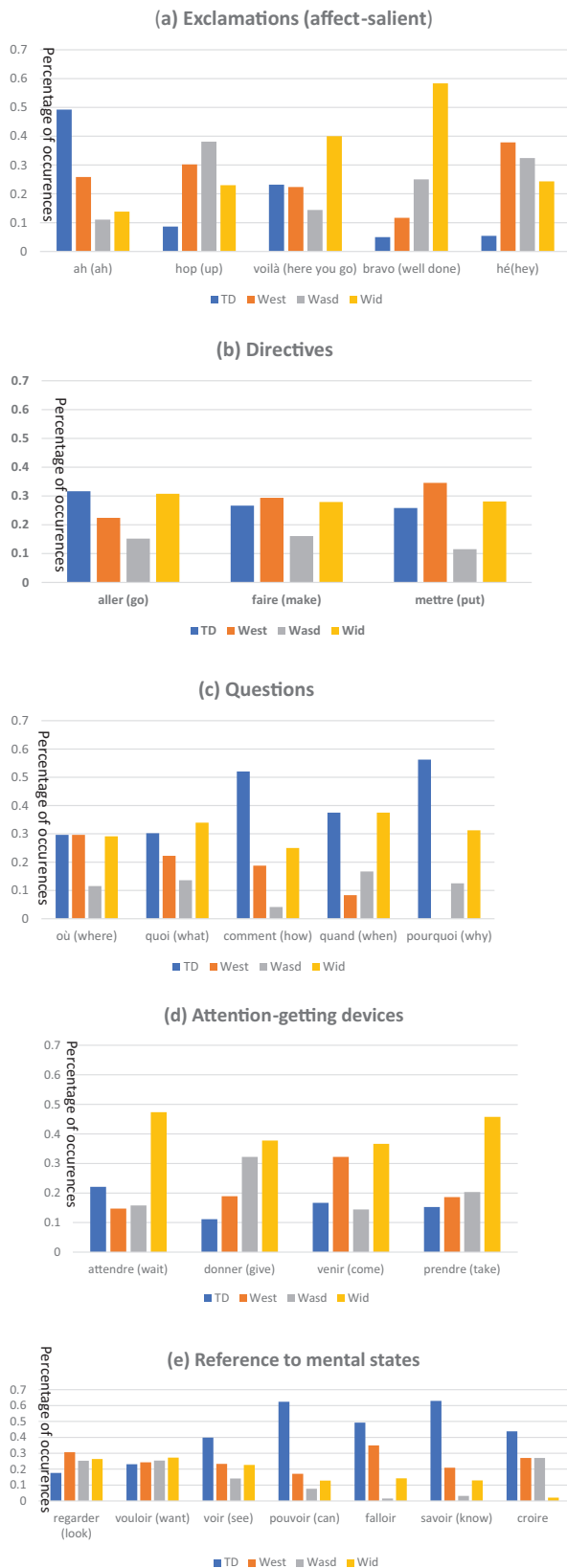


FIGURE 3 | Percentage of occurrences of MCDS toward WS subgroups and age-matched TD children.

significantly more exclamations ($\chi^2 = 149.19$, $p < 0.001$), questions ($\chi^2 = 58.28$, $p < 0.001$), attention-getting devices ($\chi^2 = 23.08$, $p < 0.006$), and references to mental states ($\chi^2 = 79.09$, $p < 0.001$) compared to mothers of TD children.

In contrast, no significant group difference was found for directives ($\chi^2 = 4.89$, $p = 0.56$), indicating that the use of commands or instructions was comparable across groups. This suggests that despite differences in other communicative strategies, both groups maintain similar levels of goal-oriented or behaviour-guiding speech, possibly reflecting shared norms around structuring children's activities or maintaining compliance during interaction.

5 | Discussion

This corpus study examined how MCDS adapts to the communicative and developmental profiles of children with West Syndrome (WS), including subgroups with co-occurring autism spectrum disorder (WASD) or intellectual disability (WID), compared with typically developing (TD) peers. Four main findings emerged, each offering insights into the ways mothers adjust their language input.

First, analyses revealed that while overall vocabulary diversity (VOCd) did not differ significantly across groups, mothers of children with WASD tended to use a narrower vocabulary set compared to both TD children and other WS subgroups. Although this trend did not reach significance, it suggests a more constrained lexical environment, potentially reflecting adaptations to the child's perceived or actual linguistic limitations. Importantly, significant group differences were observed in specific lexical categories. Mothers of children with WASD used more exclamations but fewer nouns, while both WASD and WID groups showed reduced use of questions compared with TD interactions. This shift toward affectively salient (exclamatory) rather than referential (nouns, questions) input likely reflects adjustments to the reduced social reciprocity and joint attention challenges typical of ASD and ID. Interestingly, verb use was somewhat higher in the WASD group, though highly variable, hinting at mothers' attempts to emphasize action-based engagement. These affect-salient expressions may serve to increase engagement or emotional salience in interactions with children who present with reduced social responsivity—characteristics commonly observed in ASD (McDuffie and Yoder 2010 ; Paul et al. 2008). Conversely, mothers of children in the WASD group used significantly fewer nouns compared to those of TD children. This reduction in referential language may reflect a decrease in object-labelling or joint attention scaffolding behaviours, which are typically limited in children with ASD (Tager-Flusberg et al. 2005). Taken together, these findings suggest that MCDS is qualitatively shaped by the child's neurodevelopmental profile, with mothers relying more on emotional expressiveness and less on referential scaffolding when interacting with children with ASD or ID.

In accordance with extensive evidence on adaptive caregiver communication, our findings suggest that mothers actively adjust their interactional strategies in ways that reflect both shared and diagnosis-specific characteristics of their children's neurodevelopmental profiles.

Rather than functioning as static providers of linguistic input, mothers act as sensitive calibrators who continually reshape the emotional, referential, and temporal contours of their communication to match their child's attentional patterns, communicative availability, and developmental competencies (Bornstein et al. 2008; Tamis-LeMonda et al. 2001; Warren et al. 2007; Guralnick, 2008; Guralnick et al. 2008). These adaptive processes are consistent with broader models of responsive caregiving and maternal attunement, which emphasize that parental scaffolding, linguistic input, and emotional modulation are dynamically shaped by the child's cues (Landry et al. 2006; Rogoff 2003). The nature of these adaptations differed in theoretically meaningful ways between the ASD and ID groups, illustrating how the affordances and constraints of each neurodevelopmental profile guide maternal communicative choices. Mothers of children with ASD—who often exhibit reduced joint attention, attenuated responsiveness to verbal prompts, and difficulty sustaining shared reference—tended to rely more heavily on affective signalling and emotional expressiveness, a pattern echoing evidence that emotionally salient cues can serve as compensatory routes to engagement when referential scaffolding is less effective (Siller and Sigman 2002; De Falco et al. 2011a, 2011b, 2011; De Falco, Venuti, et al. 2011; Edmunds et al. 2019; Green et al. 2015; Adamson et al. 2019). In contrast, mothers of children with ID, who typically display broader cognitive delays but comparatively preserved social reciprocity, more often integrated emotional attunement with structured verbal scaffolding, consistent with findings that verbal guidance and predictable linguistic routines remain effective supports for this population (Dieterich et al. 2006; Rowe and Snow 2020; Lowe, Erickson, et al. 2021; Lowe, Weisleder, et al. 2021; Venuti et al. 2009). Together, these diagnosis-specific patterns reinforce conceptual frameworks emphasizing child-driven adaptation (Smith, Mirenda, et al. 2023; Smith, Jones, et al. 2023) and underscore that maternal communication is strategically calibrated to the socio-communicative demands of the interaction rather than uniformly applied.

These interpretive insights also carry significant implications for parent-mediated intervention and clinical practice. If mothers naturally recalibrate their communicative strategies to align with the affordances of their child's developmental profile, evidence-informed intervention should leverage—not replace—these intuitive patterns. For children with ASD, coaching may focus on helping parents capitalize on emotionally expressive strategies to establish engagement in contexts where joint attention and shared referential focus are limited, while also providing embedded opportunities to gradually scaffold coordinated attention when readiness cues emerge (Kasari et al. 2010; Shire and Kasari 2016; Green et al. 2010). For children with ID, parent coaching may more effectively emphasize the combined use of affective attunement with graduated, structured linguistic scaffolding, building on these children's relatively stronger social reciprocity to support language, cognitive, and play development (Yoder and Warren 2002; Spiker et al. 2002; Haebig et al. 2013). More broadly, the present findings reinforce the value of individualized, developmentally informed guidance within early intervention frameworks, highlighting the importance of tailoring communication strategies to each child's socio-communicative strengths and vulnerabilities. Such tailoring aligns with principles of responsive caregiving and ecological validity (Mahoney et al. 1998; Sussman 2012) and may

ultimately enhance the efficacy, generalization, and sustainability of parent-implemented communication supports across home and community contexts.

Third, subgroup analyses reinforced this interpretation. High frequencies of exclamations were again linked to lower developmental outcomes, especially in children with pronounced cognitive or behavioural challenges. For children with WID, greater use of descriptive or referential language appeared more beneficial than reliance on affective expressions, highlighting the developmental value of lexical elaboration. By contrast, in WASD, mothers' speech reflected a qualitatively distinct pattern characterized by heightened emotionality but reduced referential scaffolding. These subgroup-specific adaptations underscore the heterogeneity within WS and suggest that the developmental utility of particular speech features depends on the child's cognitive and communicative profile. Tailored parental communication strategies may therefore be necessary to address the unique needs of different subgroups.

Fourth, mothers of children with WS demonstrated both commonalities and differences in their use of questions and mental state references. Although simple "what" and "where" questions were used at similar rates across groups, more abstract forms ("how," "when," and especially "why") were markedly less frequent in WS compared with TD interactions. This "wh-effect" points to a syndrome-specific influence on maternal questioning that is not fully explained by developmental level alone. In the TD group, mothers' use of "wh" questions containing verbs and more complex structures positively predicted the children's comprehension of "wh" questions. In contrast, in the ASD group, frequent use of "wh" questions with "be" as the main verb negatively predicted comprehension. This is consistent with Goodwin et al. (2015) data who examined mothers' use of "wh" questions when interacting with children with ASD versus typically developing (TD) children around the age of 3. They found that (i) mothers of TD children produced a higher overall percentage of "wh" questions, although there were relatively few differences in the types of "wh" questions used compared to mothers of children with ASD and (ii) TD and ASD children appeared to process and benefit from linguistic input differently.

The reference to mental states words showed differences except in "look" and "want" words; these two words may refer to more directive or attention getting devices and highlights the need to pay attention to the context in which these words are used. Likewise, mothers used some mental-state terms (e.g., *look*, *want*) across groups, though these often functioned more as directive or attention-getting devices than as scaffolds for perspective-taking. Qualitative analyses confirmed that in WASD, mothers frequently relied on exclamations and attention-getting speech to compensate for language delays and reduced joint attention, whereas in WID, mothers favoured affect-salient words and directives, consistent with findings from other neurodevelopmental conditions such as Down syndrome. These adaptations suggest that while children with WID may actively engage in communication, they require heightened affective stimulation to sustain participation.

Qualitative analysis reveals a more contrastive profile: mothers simplified CDS, relying on exclamations and attention-getting expressions to compensate for language delays and limited joint

attention in children with ASD. These findings provide insight into how mothers adapt their speech based on the unique characteristics of children with WS and ASD. This supports findings of Tubul-Lavy et al. (2020) and Choi et al. (2020), who found that parents of siblings of children with ASD adjusted their speech to match their 18-month-old infants' communicative abilities.

Regarding WID, a distinct qualitative profile emerged compared to other West categories. Mothers used fewer questions but more exclamations-affect salient words (e.g., *voilà!*, *bravo!*) and attention-getting expressions (e.g., *wait!*, *take!*). These adaptations are in accordance with De Falco et al. (2011) who found that parents of 40-months-old children with Down syndrome used more direct statements, more affect salient speech and asked fewer questions than parents of TD children. These findings suggest that while children with WID actively engage in communication, they require more stimulation and acknowledgment to maintain their participation (Roberts et al. 2019; Swanson 2020). However, Zampini et al. 2020 reported totally opposite findings in 8-month-old infants with various types of sex chromosome trisomies: they showed more directives and questions and less affect salient words in the maternal input addressed to children than in the input addressed to TD children. Their findings suggest that the pattern of MCDS could evolve according to the infant's age, and that the nature of the disease/genetic condition may influence the MCDS. This is consistent with previous research has shown that the experience of raising a child with a severe condition like Infantile Spasms can impact parent-child interactions. For example, Boissel et al. (2020) found that parental anxiety and sadness related to the child's illness affected the child's attachment style at 18 months, regardless of whether the child also had ASD or ID.

Across all findings, mothers of children with WS displayed speech patterns that were more emotionally expressive but less referential and interrogative than those of mothers of TD children. These adaptations may be reflecting maternal efforts to increase engagement, to capture attention and maintain interaction but could inadvertently limit opportunities for language learning when questioning and lexical elaboration are reduced. Importantly, the presence of comorbid ASD or ID shaped distinct communicative profiles, demonstrating that maternal input is finely attuned not only to developmental level but also to diagnostic characteristics.

By situating these findings within the broader literature on parent-mediated interventions, the study underscores the potential of supporting mothers in balancing emotional engagement with cognitively enriching communication strategies. Such interventions may help optimize language-learning opportunities for children with WS and its subgroups, who are at heightened risk for developmental delays.

6 | Conclusion

This study provides the first corpus-based analysis of MCDS toward children with Infantile Spasms, revealing how mothers adapt communication to their child's developmental and diagnostic profile. Mothers of children with comorbid ASD

or ID tended to use more affective but less referential input, highlighting both supportive and limiting adaptations. Despite the small sample, findings underscore the importance of parent-focused interventions that promote a balance between emotional engagement and linguistic scaffolding, with potential to influence developmental trajectories early in life.

Acknowledgements

Open access publication funding provided by COUPERIN CY26.

Ethics Statement

This study was conducted in accordance with the ethical standards from the Department of Child Neurology at the Centre for Rare Epilepsy, Necker enfants-malades Hospital (Paris, France). Ethical approval was obtained from the CNIL (Commission Nationale Informatique et Liberté) approval number: No. 00001072.

Consent

All participants provided informed consent prior to participation.

Conflicts of Interest

The authors declare that there are no conflicts of interest with respect to the authorship, funding, or publication of this study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to ethical and privacy considerations.

References

- Adamson, L. B., R. Bakeman, D. F. Deckner, and M. Ronski. 2019. "Joint Engagement and the Emergence of Language in Children With Autism and Down Syndrome." *Journal of Autism and Developmental Disorders* 49, no. 11: 4284–4299. <https://doi.org/10.1007/s10803-019-04144-1>.
- Bang, J., and A. Nadig. 2015. "Learning Language in Autism: Maternal Linguistic Input Contributes to Later Vocabulary." *Autism Research* 8, no. 2: 214–223. <https://doi.org/10.1002/aur.1440>.
- Boissel, L., G. Le Borgne, L. F. Baldini, et al. 2020. "Attachment Insecurity in Infants With Infantile Spasms: Maternal Anxiety and Sadness, and Infant's Temperament Outweigh Disease Severity." *Epilepsy & Behavior* 113: 107401.
- Bornstein, M. H., C. S. Tamis-LeMonda, C. S. Hahn, and O. M. Haynes. 2008. "Maternal Responsiveness to Young Children at Three Ages: Longitudinal Analysis of a Multidimensional, Modular, and Specific Parenting Construct." *Developmental Psychology* 44, no. 3: 867–874. <https://doi.org/10.1037/0012-1649.44.3.867>.
- Bornstein, M. H., C. S. Tamis-LeMonda, J. Tal, et al. 1992. "Maternal Responsiveness to Infants in Three Societies: The United States, France, and Japan." *Child Development* 63, no. 4: 808. <https://doi.org/10.2307/1131235>.
- Braarud, H. C., and K. M. Stormark. 2008. "Prosodic Modification and Vocal Adjustments in Mothers' Speech During Face-to-Face Interaction With Their Two- to Four-Month-Old Infants: A Double Video Study." *Social Development* 17, no. 4: 1074–1084. <https://doi.org/10.1111/j.1467-9507.2007.00455.x>.
- Braginsky, M., D. Yurovsky, V. A. Marchman, and M. C. Frank. 2019. "Consistency and Variability in Children's Word Learning Across Languages." *Open Mind* 3: 52–67. https://doi.org/10.1162/opmi_a_00026.

- Brent, M. R., and J. M. Siskind. 2001. "The Role of Exposure to Isolated Words in Early Vocabulary Development." *Cognition* 81, no. 2: B33–B44. [https://doi.org/10.1016/S0010-0277\(01\)00122-6](https://doi.org/10.1016/S0010-0277(01)00122-6).
- Choi, D., L. J. Batterink, A. K. Black, K. A. Paller, and J. F. Werker. 2020. "Prelingual Infants Discover Statistical Word Patterns at Similar Rates as Adults: Evidence From Neural Entrainment." *Psychological Science* 31, no. 9: 1161–1173.
- Cooper, R. P., J. Abraham, S. Berman, and M. Staska. 1997. "The Development of Infants' Preference for Motherese." *Infant Behavior and Development* 20, no. 4: 477–488. [https://doi.org/10.1016/S0163-6383\(97\)90037-0](https://doi.org/10.1016/S0163-6383(97)90037-0).
- D'Odorico, L., and V. Jacob. 2006. "Prosodic and Lexical Aspects of Maternal Linguistic Input to Late-Talking Toddlers." *International Journal of Language & Communication Disorders* 41, no. 3: 293–311. <https://doi.org/10.1080/13682820500342976>.
- D'Odorico, L., V. Jacob, R. Cassibba, and M. Zavagnin. 1999. "The role of conversational format and communicative intention in the development of children's referential skills." *First Language* 19, no. 53: 25–48.
- D'Souza, D., H. D'Souza, and A. Karmiloff-Smith. 2017. "Precursors to Language Development in Typically and Atypically Developing Infants and Toddlers: The Importance of Embracing Complexity." *Journal of Child Language* 44, no. 3: 591–627. <https://doi.org/10.1017/S030500091700006X>.
- De Falco, S., G. Esposito, P. Venuti, and M. H. Bornstein. 2011a. "Mothers and Fathers at Play With Their Children With Down Syndrome: Influence on Child Exploratory and Symbolic Play." *Journal of Applied Research in Intellectual Disabilities* 24, no. 5: 460–470. <https://doi.org/10.1111/j.1468-3148.2010.00623.x>.
- De Falco, S., G. Esposito, P. Venuti, and M. H. Bornstein. 2011b. "Mothers' and Fathers' Verbal Responsiveness in Joint Book Reading With Toddlers at Risk for Autism." *Journal of Child Language* 38, no. 2: 415–441. <https://doi.org/10.1017/S0305000910000215>.
- De Falco, S., P. Venuti, G. Esposito, and M. H. Bornstein. 2011. "Maternal and Paternal Pragmatic Speech Directed to Young Children With Down Syndrome and Typical Development." *Infant Behavior & Development* 34, no. 1: 161–169. <https://doi.org/10.1016/j.infbeh.2010.12.002>.
- Dieterich, S. E., M. A. Assel, P. R. Swank, K. E. Smith, and S. H. Landry. 2006. "The Impact of Early Maternal Verbal Scaffolding on Children's Decoding and Reading Comprehension Outcomes." *Developmental Psychology* 42, no. 6: 937–949. <https://doi.org/10.1037/0012-1649.42.6.937>.
- Edmunds, S. R., S. T. Kover, and W. L. Stone. 2019. "The Relation Between Parent Verbal Responsiveness and Communication Outcomes in Children With or at Risk for Autism Spectrum Disorder: A Systematic Review and Meta-Analysis." *Journal of Autism and Developmental Disorders* 49, no. 2: 469–485. <https://doi.org/10.1007/s10803-018-3746-7>.
- Edmunds, S. R., R. J. Landa, and C. Kasari. 2019. "Early Social Engagement in Infants With Autism Spectrum Disorder: Implications for Intervention." *Journal of Autism and Developmental Disorders* 49, no. 2: 569–582. <https://doi.org/10.1007/s10803-018-3759-y>.
- Fernald, A. 1985. "Four-Month-Old Infants Prefer to Listen to Motherese." *Infant Behavior and Development* 8: 181–195.
- Fernald, A., and P. Kuhl. 1987. "Acoustic Determinants of Infant Preference for Motherese Speech." *Infant Behavior and Development* 10, no. 3: 279–293. [https://doi.org/10.1016/0163-6383\(87\)90017-8](https://doi.org/10.1016/0163-6383(87)90017-8).
- Frank, M. C., M. Braginsky, D. Yurovsky, and V. A. Marchman. 2019. "Wordbank: An Open Repository for Developmental Vocabulary Data." *Journal of Child Language* 44, no. 3: 677–694. <https://doi.org/10.1017/S0305000916000209>.
- Gleitman, L. R., E. L. Newport, and H. Gleitman. 1984. "The Current Status of the Motherese Hypothesis." *Journal of Child Language* 11, no. 1: 43–79. <https://doi.org/10.1017/S0305000900005584>.
- Goodwin, A., D. Fein, and L. Naigles. 2015. "The Role of Maternal Input in the Development of Wh-Question Comprehension in Autism and Typical Development." *Journal of Child Language* 42, no. 1: 32–63. <https://doi.org/10.1017/S0305000913000524>.
- Green, J., T. Charman, H. McConachie, et al. 2010. "Parent-Mediated Communication-Focused Treatment in Children With Autism (PACT): A Randomized Controlled Trial." *Lancet* 375, no. 9732: 2152–2160. [https://doi.org/10.1016/S0140-6736\(10\)60587-9](https://doi.org/10.1016/S0140-6736(10)60587-9).
- Green, J., A. Pickles, G. Pasco, et al. 2015. "Randomised Trial of a Parent-Mediated Intervention for Infants at High Risk for Autism." *Molecular Autism* 6, no. 1: 1–11. <https://doi.org/10.1186/s13229-015-0014-3>.
- Guralnick, M. J. 2008. "International Perspectives on Early Intervention: A Global View." *Infants & Young Children* 17, no. 1: 2. <https://doi.org/10.1097/01.IYC.0000306755.67602.78>.
- Guralnick, M. J., B. Neville, M. A. Hammond, and R. T. Connor. 2008. "Mothers' Social Communicative Adjustments to Young Children With Mild Developmental Delays." *American Journal on Mental Retardation* 113, no. 1: 1. [https://doi.org/10.1352/0895-8017.\(2008\)113\[1:MSCATY\]2.0.CO;2](https://doi.org/10.1352/0895-8017.(2008)113[1:MSCATY]2.0.CO;2).
- Haebig, E., A. McDuffie, and S. E. Weismer. 2013. "The Contribution of Two Dimensions of Parent Input to Child Language Comprehension and Production." *Journal of Speech, Language, and Hearing Research* 56, no. 2: 314–328. [https://doi.org/10.1044/1092-4388\(2012\)11-0345](https://doi.org/10.1044/1092-4388(2012)11-0345).
- Hampson, J., and K. Nelson. 1993. "The Relation of Maternal Language to Variation in Rate and Style of Language Acquisition." *Journal of Child Language* 20, no. 2: 313–342. <https://doi.org/10.1017/S0305000900008308>.
- Harris, M., D. Jones, S. Brookes, and J. Grant. 1986. "Relations Between the Non-Verbal Context of Maternal Speech and Rate of Language Development." *British Journal of Developmental Psychology* 4, no. 3: 261–268. <https://doi.org/10.1111/j.2044-835X.1986.tb01017.x>.
- Hayes, D. P., and M. G. Ahrens. 1988. "Vocabulary Simplification for Children: A Special Case of 'Motherese'?" *Journal of Child Language* 15, no. 2: 395–410. <https://doi.org/10.1017/S0305000900001241>.
- Henning, A., T. Striano, and E. V. M. Lieven. 2005. "Maternal Speech to Infants at 1 and 3 Months of Age." *Infant Behavior and Development* 28, no. 4: 519–536. <https://doi.org/10.1016/j.infbeh.2005.06.001>.
- Hodapp, R. M. 2002. "Parenting Children With Mental Retardation." In *Handbook of Parenting: Children and Parenting*, 355–381. Lawrence Erlbaum Associates Publishers.
- Hodapp, R. M. 2001. "Advancing Finding, Theories, and Methods Concerning Children With Disabilities." *Monographs of the Society for Research in Child Development* 66, no. 3: 115–126. <https://doi.org/10.1111/1540-5834.00159>.
- Hoff, E. 2006. "How Social Contexts Support and Shape Language Development☆." *Developmental Review* 26, no. 1: 55–88. <https://doi.org/10.1016/j.dr.2005.11.002>.
- Josse, D. 1997. Brunet-Lézine révisé. *CPA, Issy les Moulineaux*.
- Kasari, C., A. Gulsrud, C. Wong, S. Kwon, and J. Locke. 2010. "Randomized Controlled Caregiver-Mediated Joint Engagement Intervention for Toddlers With Autism." *Journal of Autism and Developmental Disorders* 40, no. 9: 1045–1056. <https://doi.org/10.1007/s10803-010-0955-5>.
- Kruper, J. C., and I. C. Uğür. 1987. "Fathers' and Mothers' Speech to Young Infants." *Journal of Psycholinguistic Research* 16, no. 6: 597–614. <https://doi.org/10.1007/BF01067087>.
- Landry, S. H., K. E. Smith, and P. R. Swank. 2006. "Responsive Parenting: Establishing Early Foundations for Social, Communication, and Independent Problem-Solving Skills." *Developmental Psychology* 42, no. 4: 627–642. <https://doi.org/10.1037/0012-1649.42.4.627>.
- Lasky, E. Z., and K. Klopp. 1982. "Parent-Child Interactions in Normal and Language-Disordered Children." *Journal of Speech and Hearing Disorders* 47, no. 1: 7–18. <https://doi.org/10.1044/jshd.4701.07>.
- Le Couteur, A., C. Lord, and M. Rutter. 2003. *The Autism Diagnostic Interview-revised (ADI-R)*. Western Psychological Services.

- Lorang, E., S. Hartley, and A. Sterling. 2020. "Physiological Arousal and Observed Behaviour in Parent-Child Interactions Involving Young Children With Down Syndrome." *Journal of Intellectual Disability Research* 64, no. 6: 426-433. <https://doi.org/10.1111/jir.12714>.
- Lowe, J. R., S. J. Erickson, P. C. MacLean, and R. Schrader. 2021. "Maternal Verbal Scaffolding and Child Language Development: A Longitudinal Examination in At-Risk Populations." *Frontiers in Psychology* 12: 672243. <https://doi.org/10.3389/fpsyg.2021.672243>.
- Lowe, R., A. Weisleder, and A. Fernald. 2021. "Social Influences on Early Language Learning: The Role of Emergent Caregiver-Child Interactions." *Child Development Perspectives* 15, no. 2: 102-108. <https://doi.org/10.1111/cdep.12401>.
- MacWhinney, B. 2000. *The Childes Project. 1: Transcription Format and Programs*. Erlbaum.
- Mahdhaoui, A., M. Chetouani, R. S. Cassel, et al. 2011. "Computerized Home Video Detection for Motherese May Help to Study Impaired Interaction Between Infants Who Become Autistic and Their Parents." *International Journal of Methods in Psychiatric Research* 20, no. 1: 1-62. <https://doi.org/10.1002/mpr.332>.
- Mahoney, G., G. Boyce, R. R. Fewell, D. Spiker, and C. A. Wheeden. 1998. "The Relationship of Parent-Child Interaction to the Effectiveness of Early Intervention Services for Children With Developmental Disabilities." *Topics in Early Childhood Special Education* 18, no. 1: 5-17. <https://doi.org/10.1177/027112149801800104>.
- McDuffie, A., and P. Yoder. 2010. "Types of Parent Verbal Responsiveness That Predict Language in Young Children With Autism Spectrum Disorder." *Journal of Speech, Language, and Hearing Research: JSLHR* 53, no. 4: 1026-1039. [https://doi.org/10.1044/1092-4388\(2009/09-0023\)](https://doi.org/10.1044/1092-4388(2009/09-0023)).
- Newport, E., H. Gleitman, and L. Gleitman. 1977. "Mother, I'd Rather Do It Myself: Some Effects and Non-Effects of Maternal Speech Style." In: *Talking to Children*, edited by C. E. Snow, and C. A. Ferguson, 109-149. Cambridge University Press.
- Newport, E. L., H. Gleitman, and L. R. Gleitman. 1986. "The input for language learning." In: *Language learning and conceptual change*, edited by W. Demopoulos, and A. Marras, 1-19. Cambridge University Press.
- Ouss, L., C. Saint-Georges, L. Robel, et al. 2014. "Infant's Engagement and Emotion as Predictors of Autism or Intellectual Disability in West Syndrome." *European Child & Adolescent Psychiatry* 23, no. 3: 143-149. <https://doi.org/10.1007/s00787-013-0430-x>.
- Owens, R. E. 2008. *Language Development: An Introduction*, 7. ed., international ed. Pearson.
- Paul, R., K. Chawarska, and F. Volkmar. 2008. "Differentiating ASD From DLL in Toddlers." *Perspectives on Language Learning and Education* 15: 101-111. <https://doi.org/10.1044/llc15.3.101>.
- Petersen, G. A., and K. B. Sherrod. 1982. "Relationship of Maternal Language to Language Development and Language Delay of Children." *American Journal of Mental Deficiency* 86, no. 4: 391-398.
- Roberts, M. Y., P. R. Curtis, B. J. Sone, and L. H. Hampton. 2019. "Association of Parent Training With Child Language Development: A Systematic Review and Meta-analysis." *JAMA Pediatrics* 173, no. 7: 671. <https://doi.org/10.1001/jamapediatrics.2019.1197>.
- Rogoff, B. 2003. *The Cultural Nature of human Development*. Oxford University Press.
- Romeo, R. R., B. Choi, L. J. Gabard-Durnam, et al. 2022. "Parental Language Input Predicts Neurooscillatory Patterns Associated With Language Development in Toddlers at Risk of Autism." *Journal of Autism and Developmental Disorders* 52, no. 6: 2717-2731. <https://doi.org/10.1007/s10803-021-05024-6>.
- Rowe, M. L., and C. E. Snow. 2020. "Analyzing Input Quality Along Three Dimensions: Interactive, Linguistic, and Conceptual." *Journal of Child Language* 47, no. 1: 5-21. <https://doi.org/10.1017/S0305000919000655>.
- Ruffman, T. 2023. "Belief It or Not: How Children Construct a Theory of Mind." *Child Development Perspectives* 17, no. 2: 106-112. <https://doi.org/10.1111/cdep.12483>.
- Ruffman, T., B. Lorimer, S. Vanier, D. Scarf, K. Du, and M. Taumoepeau. 2020. "Use of a Head Camera to Examine Maternal Input and Its Relation to 10- to 26-Month-Olds' acquisition of Mental and Non-Mental State Vocabulary." *Journal of Child Language* 47, no. 6: 1228-1243. <https://doi.org/10.1017/S0305000920000240>.
- Ruffman, T., L. Slade, and E. Crowe. 2002. "The Relation Between Children's and Mothers' Mental State Language and Theory-of-Mind Understanding." *Child Development* 73, no. 3: 734-751. <https://doi.org/10.1111/1467-8624.00435>.
- Saint-Georges, C., M. Chetouani, R. Cassel, et al. 2013. "Motherese in Interaction: At the Cross-Road of Emotion and Cognition? (A systematic review)." *PLOS ONE* 8, no. 10: e78103. <https://doi.org/10.1371/journal.pone.0078103>.
- Sherrod, K. B., S. Friedman, S. Crawley, D. Drake, and J. Devieux. 1977. "Maternal Language to Prelinguistic Infants: Syntactic Aspects." *Child Development* 48, no. 4: 1662.
- Shire, S. Y., and C. Kasari. 2016. "Train-the-Trainer Effectiveness Trials of the JASPER Intervention for Children With Autism Spectrum Disorder." *Journal of Child Psychology and Psychiatry* 57, no. 6: 722-730. <https://doi.org/10.1111/jcpp.12509>.
- Siller, M., and M. Sigman. 2002. "The Behaviors of Parents of Children With Autism Predict the Subsequent Development of Their Children's Communication." *Journal of Autism and Developmental Disorders* 32, no. 2: 77-89. <https://doi.org/10.1023/A:1014884404276>.
- Smith, J., P. Mirenda, and A. Zaidman-Zait. 2023. "Parental Imitations and Expansions of Child Language in Autism and Typical Development: Associations With Child Communication Outcomes." *Journal of Autism and Developmental Disorders* 53, no. 4: 1552-1567. <https://doi.org/10.1007/s10803-022-05820-9>.
- Smith, K. A., E. J. H. Jones, and M. H. Johnson. 2023. "Parent-Child Social Interaction as a Driver of Early Neurocognitive Development." *Developmental Review* 68: 101046. <https://doi.org/10.1016/j.dr.2023.101046>.
- Snow, C. E. 1972b. "Mothers' Speech to Children Learning Language." *Child Development* 43, no. 2: 549. <https://doi.org/10.2307/1127555>.
- Spiker, D., G. C. Boyce, and L. K. Boyce. 2002. "Parent-Child Interactions When Young Children Have disabilities." In *International Review of Research in Mental Retardation*. Vol. 25, 35-70. Elsevier. [https://doi.org/10.1016/S0074-7750\(02\)80005-2](https://doi.org/10.1016/S0074-7750(02)80005-2).
- Strasser, L., M. Downes, J. Kung, J. H. Cross, and M. De Haan. 2018. "Prevalence and Risk Factors for Autism Spectrum Disorder in Epilepsy: A Systematic Review and Meta-Analysis." *Developmental Medicine & Child Neurology* 60, no. 1: 19-29.
- Sussman, F. 2012. *More Than Words: Helping Parents Promote Communication and Social Skills in Children With Autism Spectrum Disorder*. The Hanen Centre.
- Swanson, M. R. 2020. "The Role of Caregiver Speech in Supporting Language Development in Infants and Toddlers With Autism Spectrum Disorder." *Development and Psychopathology* 32, no. 4: 1230-1239.
- Swensen, L. D., Exploring the Effects of Maternal Input on the Language of Children With Autism 2007. *Doctoral Dissertations*. AAI3286870. <https://digitalcommons.lib.uconn.edu/dissertations/AAI3286870>.
- Tager-Flusberg, H., R. Paul, and C. Lord. 2005. "Language and Communication in Autism." In *Handbook of Autism and Pervasive Developmental Disorders: Diagnosis, Development, Neurobiology, and Behavior*, edited by F. R. Volkmar, R. Paul, A. Klin, and D. Cohen, 3rd ed., 335-364. John Wiley & Sons, Inc.
- Tamis-LeMonda, C. S., M. H. Bornstein, and L. Baumwell. 2001. "Maternal Responsiveness and Children's Achievement of Language Milestones." *Child Development* 72, no. 3: 748-767. <https://doi.org/10.1111/1467-8624.00313>.

- Tubul-Lavy, G., A. Jokel, O. Leon-Attia, and L. V. Gabis. 2020. "Content Words in Child-Directed Speech of Mothers Toward Children With Autism Spectrum Disorder." *American Journal of Speech-Language Pathology* 29, no. 3: 1434–1447. https://doi.org/10.1044/2020_AJSLP-19-00170.
- Venuti, P., S. De Falco, G. Esposito, and M. H. Bornstein. 2009. "Mother-Child Play: Children With Down Syndrome and Typical Development." *American Journal on Intellectual and Developmental Disabilities* 114, no. 4: 274–288. <https://doi.org/10.1352/1944-7558-114.4.274>.
- Venuti, P., S. De Falco, G. Esposito, M. Zaninelli, and M. H. Bornstein. 2012. "Maternal Functional Speech to Children: A Comparison of Autism Spectrum Disorder, Down Syndrome, and Typical Development." *Research in Developmental Disabilities* 33, no. 2: 506–517. <https://doi.org/10.1016/j.ridd.2011.10.018>.
- Warren, S. F., N. C. Brady, A. Sterling, K. Fleming, and J. Marquis. 2007. "Maternal Responsivity Predicts Language Development in Young Children With Fragile X Syndrome." *American Journal on Mental Retardation* 112, no. 5: 356–368. [https://doi.org/10.1352/0895-8017\(2007\)112\[0356:MRPLDI\]2.0.CO;2](https://doi.org/10.1352/0895-8017(2007)112[0356:MRPLDI]2.0.CO;2).
- Warren, Z. E., J. H. Foss-Feig, E. E. Malesa, et al. 2012. "Neurocognitive and Behavioral Outcomes of Younger Siblings of Children With Autism Spectrum Disorder at Age Five." *Journal of Autism and Developmental Disorders* 42, no. 3: 409–418. <https://doi.org/10.1007/s10803-011-1263-4>.
- Yoder, P. J., and S. F. Warren. 2002. "Effects of Prelinguistic Milieu Teaching and Parent Responsivity Education on Dyads Involving Children With Intellectual Disabilities." *Journal of Speech, Language, and Hearing Research* 45, no. 6: 1158–1174. [https://doi.org/10.1044/1092-4388\(2002/094\)](https://doi.org/10.1044/1092-4388(2002/094)).
- Zampini, L., M. Fasolo, and L. D'Odorico. 2012. "Characteristics of Maternal Input to Children With Down Syndrome: A Comparison With Vocabulary Size and Chronological Age-Matched Groups." *First Language* 32, no. 3: 324–342. <https://doi.org/10.1177/0142723711410780>.
- Zampini, L., C. Ferrante, G. Silibello, et al. 2020. "Maternal Input to Children With Sex Chromosome Trisomies." *International Journal of Language & Communication Disorders* 55, no. 5: 724–733. <https://doi.org/10.1111/1460-6984.12557>.