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Early manifestations of unexpected bilingualism in minimally verbal autism

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Background: Unexpected bilingualism (UB) in autism, in which children speak languages not spoken in their social environment, has been sporadically reported. UB implies that autistic children can acquire languages in a non-socially interactive way. The early minimally verbal period in autism could be critical for non-interactive language acquisition, given the predominance of non-social interests at that time. However, evidence of language acquisition outside social interaction during this period remains limited and restricted to small case studies. **Methods:** Caregivers of 119 autistic, 102 non-autistic clinical, and 75 typically developing (TD) children aged 2–6 years completed a structured questionnaire about their children's language-related interests and use. They were also asked to estimate the relative proportion of each language their children were exposed to in their social environment. UB was operationalized as the use of at least one language not spoken in the child's social environment to name letters and/or numbers. **Results:** Of the autistic group, 53% were considered minimally verbal. A total of 38.7% of autistic children displayed UB, with autistic children being 4.38 times more likely to show UB than TD children ($p < .001$). In contrast, the non-autistic clinical children did not differ significantly from TD children. The presence of UB was not associated with the children's expressive language level. Autistic children were 8.28 times more likely than TD children to use a non-dominant language (here English) ($p < .001$), after controlling for their proportion of social exposure to that language. Non-interactive media were the only sources caregivers reported to explain the presence of UB in autistic children. **Conclusions:** Autistic children, even those who are minimally verbal, are less dependent on their social environment for specific aspects of language development. Non-interactive pathways of language acquisition may have a prominent role in early language development in autism. **Keywords:** Autism; unexpected bilingualism; language; early development; hyperlexia.

Introduction

One of the first clinical signs suggestive of autism is a delay or regression in socio-communicative development, with over 75% of autistic individuals experiencing language delay (Anderson et al., 2007; Gagnon et al., 2021; Norrelgen et al., 2015; Pickles, Anderson, & Lord, 2014; Tager-Flusberg & Kasari, 2013). When oral language emerges, its developmental trajectory is often atypical, marked by a developmental plateau in childhood (World Health Organization, 2024), frequently followed by formulaic speech, delayed echolalia, and pronominal reversal (Howlin, 1981; Luyster, Zane, & Wisman Weil, 2022), and a late language burst (Fountain, Winter, & Bearman, 2012; Pickles et al., 2014).

During the plateau period, the communicative lexicon progresses minimally, with children using at most some words and proto-words for which semantic understanding and generalization are not fully developed (Clarke, 2019; Meilleur & Fombonne, 2009). Even if the plateau encompasses the crucial early years for typical language acquisition, it will lead most autistic children to reach, at various levels, functional expressive language by age 8 (Gagnon et al., 2021; Wodka, Mathy, & Kalb, 2013). Such a plateau is not necessarily predictive of poor language outcomes (Boterberg, Charman, Marschik, Bölte, & Roeyers, 2019; Gagnon et al., 2021; Pickles et al., 2014) and language can recover at ages well beyond typical expectations (e.g., Pickett, Pullara, O'Grady, & Gordon, 2009; Windsor, Doyle, & Siegel, 1994). This suggests that the plateau period is not devoid of linguistic development, even if that development is not readily observable. Coherently, the minimally verbal period does not imply a total absence of vocabulary, but word knowledge is mainly reserved for apparent non-communicative purposes (Charman, Drew, Baird, & Baird, 2003; Lazenby et al., 2016). Despite the considerable delay in communicative language, autistic children often retain an interest in the formal aspects of language. A particularly striking example of this is their early or timely self-directed interest in written language, even among those with significant delays in spoken language (Ostrolenk et al., 2024).

The language plateau in autism often coincides with the period of highest social impairment, and language catch-up is often accompanied by concurrent improvements in social functioning (Fountain et al., 2012). In typically developing (TD) children, the importance of social interaction in the development of communication and language is well

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documented, especially during the early stages of development (Kuhl, Tsao, & Liu, 2003; Mundy & Gomes, 1998; Tomasello, 1988; Tomasello & Farrar, 1986). According to the 'social' hypotheses of autistic language delay, early autistic language impairments are related to limited social drive and/or processing of socially loaded cues required for language acquisition (e.g., Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; Su, Rogers, Estes, & Yoder, 2021; Tang et al., 2023). Autistic children would be limited in interpreting the social context in which language is used (for discussions see: Boucher, 2012; Jaswal & Akhtar, 2018). Consistently, autistic children struggle to correctly interpret gestures such as pointing at an object or following the speaker's gaze or attention in situations that require joint attention. This limitation would consequently shape their language experience (Sterponi, de Kirby, & Shankey, 2015) and therefore their language development. Other 'perceptual' support for this hypothesis involves atypical brain activity during voice processing (Key & D'Ambrose Slaboch, 2021), speech in noise perception (Ruiz Callejo & Boets, 2023), or the absence of social bias in interpreting the perceptual dimension of socially loaded situations (Ristic et al., 2005).

The role of social interaction in autistic children's language development, however, remains ambiguous, with some children depending on it more than others (e.g. Kissine et al., 2019) and some not even benefiting from joint attention for full language development (Kissine, Saint-Denis, & Mottron, 2023). Critically, a substantial fraction of autistic individuals reaches expected language levels despite persistent sociopragmatic difficulties (de Villiers, Fine, Ginsberg, Vaccarella, & Szatmari, 2007; Deliens, Papastamou, Ruytenbeek, Geelhand, & Kissine, 2018). Accordingly, some autistic children may speak languages that are not spoken in their social environment, which is referred to as 'unexpected bilingualism' (UB) (Abd El-Raziq, Meir, & Saiegh-Haddad, 2024; Francis et al., 2024; Kissine et al., 2019; Vulchanova, Talcott, Vulchanov, & Stankova, 2012; Zhukova, Talantseva, An, & Grigorenko, 2023). A language not spoken by their parents may even become their primary or transiently dominant language (e.g., Zhukova et al., 2023).

Our hypothesis, first developed in a theoretical paper (Mottron, Ostrolenk, & Gagnon, 2021), is that autistic children's interest in language is less influenced by interactional aspects and that they may benefit from non-socially interactive exposure during their plateau period (e.g., television and YouTube videos; Francis et al., 2024; Kissine et al., 2019). Consequently, autistic children may demonstrate some mastery of a language that is less or not spoken in their social environment (Kissine, 2021). According to this hypothesis, exposure to non-interactive linguistic material may be sufficient to stimulate children's innate interest in language, allowing them to make minimal use of it at least during the plateau period, which is estimated to occur between the ages of 2 and 6. The implicit processing of non-interactive structured material may converge conceptually with the perceptual interests and special abilities observed in autism, which often have a language-related component (Jacques et al., 2018; Klin, Danovitch, Merz, & Volkmar, 2007; Mottron et al., 2013). One of the most striking examples is hyperlexia, the self-taught learning of decoding skills ahead of reading comprehension, which is largely associated with autism (Nation, 1999; Ostrolenk, Forgeot d'Arc, Jelenic, Samson, & Mottron, 2017; Saldana, Carreiras, & Frith, 2009). In hyperlexia, visual-perceptual interests involve redundant structural units, here letters or numbers (Grigorenko et al., 2002; Ostrolenk et al., 2017). In the most striking form of hyperlexia, a child may read fluently without having developed spoken language (Atkin & Lorch, 2006; Craig & Telfer, 2005; Huttenlocher & Huttenlocher, 1973; Ostrolenk et al., 2017), illustrating an acquisition and usage of written language that is non-interactive.

The circumscribed focus of our hypothesis on the 2-to-6 age range is intended to capture the plateau period, during which language development follows an atypical trajectory in both regressive and non-regressive autistic children. This period extends from the average age of onset of language regression around the end of the second year of life to the period in which significant language catch-up is observed in the majority of autistic children (Baghdadli et al., 2018; Bernabei, Cerquiglini, Cortesi, & D'Ardia, 2007; Fountain et al., 2012; Gagnon et al., 2021; Goldberg et al., 2003; Pickles et al., 2014). It does not preclude the possibility that the most crucial period for language acquisition may occur before the age of 4, a time when typically developing children already use mature grammatical structures (Feldman, 2019; Gervain, 2020), nor does it exclude the possibility that many autistic children may experience earlier language recovery (Bennett et al., 2014; Gagnon et al., 2021; Goldberg et al., 2003). Considering age 6 as the upper limit of a sensitive window for language in autism aims to better match the empirically observed time frame for late explosive language development in autistic 'late bloomers' (Fountain et al., 2012; Gagnon et al., 2021; Pickles et al., 2014, 2022).

To test our hypothesis, we documented cases of unexpected bilingualism in children during the autistic plateau period, that is, instances where the children used languages that were not present in their social environment to name letters or numbers. We also assessed the differential influence of languages spoken in the child's environment on their use in autistic compared to TD children, and documented their exposure to some non-interactive language sources to explore the potential origins of unexpected bilingualism. The languages that children used for numbers and letters were compared

between three distinct groups: autistic children, non-autistic clinical children, and TD children of less than 7 years old. We focused on letters and numbers because their knowledge typically begins before age three in Western societies and is usually mastered by school age in TD children (Griffin, Burns, & Snow, 1998, p. 61). Numbers and letters are a common area of interest for autistic children (Ostrolenk et al., 2024; Ostrolenk, Boisvert, & Mottron, 2025). Among those who eventually develop literacy skills, this interest is not delayed compared to TD children, which increases the likelihood that letters and numbers will be included in the limited expressive vocabulary of minimally verbal autistic children (Newman et al., 2007; Ostrolenk et al., 2024). Studying the language used to name letters and numbers provides a systematic way to measure language use in minimally verbal autistic children, even outside of a communicative context.

Methods

Population

Participants were recruited from the CIUSSS-NIM Autism Assessment Clinic, which handles exclusively the assessment of children referred for an autism diagnosis within a circumscribed geographic area of Montreal, Canada, except for children showing detectable neurogenetic signs and those getting private assessments. Approximately 13,500 births per year are recorded in this area. The caregivers of all the 701 children under the age of seven referred for an autism diagnostic assessment at the clinic between 2018 and 2021 were contacted (see Ostrolenk et al., 2024). Additionally, we recruited 76 typically developing children from daycares within the same geographical area. A total of 341 caregivers, who had known the child since at least the age of one and who were fluent in French, consented to answer a questionnaire over the phone about their child's interests and language abilities. The quality of the caregiver's responses was rated by the evaluator immediately after the interview on a scale from 1 to 5. All participants with an interview quality score greater than 2/5 were included, regardless of the diagnosis received, except those with no reported language use or incomplete language data (36 autistic children, 8 non-autistic clinical children, 1 TD child excluded). The final sample included 119 autistic children (28 females, 91 males, mean age 53 months); 102 non-autistic clinical children (22 females, 80 males, mean age 61 months) and 75 TD children (35 females, 40 males, mean age 48 months [Table 1]). The non-autistic clinical group consists of children who were initially referred for an autism assessment but ultimately received a diagnosis of speech/language disorder (25%), ADHD (22%), or other alternative diagnoses (see Appendix S1, Table S1).

Table 1 Demographic information and expressive language level

	Autistic group	Clinical group	Typically developing group
N	119	102	75
Sex, *n* (%)			
Female	28 (24%)	22 (22%)	35 (47%)
Male	91 (76%)	80 (78%)	40 (53%)
Age, months			
Mean	53	61	48
SD	11	13	16
Range	31–80	30–83	26–83
Language level, *n* (%)			
Limited to letters and numbers	9 (8%)	0 (0%)	0 (0%)
Stereotyped language	3 (3%)	1 (1%)	0 (0%)
Isolated words	50 (42%)	4 (4%)	2 (3%)
Three words sentences	18 (15%)	26 (25%)	3 (4%)
Sentences with conjugated verb	39 (33%)	71 (70%)	70 (93%)

Ethics approval and consent to participate

This research project was approved by the CIUSSS-NIM Research Ethics Committee (study number 2019-1793). Informed consent was obtained for all participants.

Autism assessment process

The diagnostic assessment was conducted by one of 13 child psychiatrists or pediatricians from the assessment clinic. It included a detailed psychiatric assessment, with a multidisciplinary team involved when necessary. The Autism Diagnostic Observation Schedule (ADOS-2; Lord et al., 2012) was used in most cases, except in instances where the diagnosis was extremely obvious during the clinical interview (4 autistic children and 30 non-autistic clinical children). Most of the clinicians involved had more than 10 years of experience in conducting autism assessments. DSM-5 criteria (American Psychiatric Association, 2013) were used to assign the diagnoses of autism spectrum disorder or an alternative diagnosis.

Measures

As described in more detail elsewhere (Ostrolenk et al., 2024), phone interviews were conducted according to a structured questionnaire, the QIMET (in French, *Questionnaire sur l'intérêt pour le matériel écrit chez les tout-petits*), documenting children's interest in letters and numbers, associated behaviors and skills, oral language level and relevant qualitative information provided by caregivers (Ostrolenk et al., 2024). The children's expressive language level was determined based on the caregiver's selections from the following options to the item 'The child produces verbally': repetitive language or delayed echolalia (categorized here as stereotyped language), only isolated words, non-echolalic sentences of at least three words, and sentences with conjugated verbs. Children whose caregivers did not report any expressive language, but still mentioned their child naming letters and numbers, were classified as having language 'limited to letters and numbers'.

Receptive language was estimated from the item: 'When you give him/her verbal instructions without supporting gestures (for example, "put this paper in the trash" or "take off your shoes"), is he/she able to follow them?'. If the caregiver responded 'sometimes' or 'most of the time', the child was considered able to understand instructions involving a verb.

Caregivers were asked to estimate the relative proportions of languages spoken or heard in social contexts at home and at daycare/school (e.g., home: 50% French and 50% English; daycare: 90% French and 10% Creole). The final estimate for each language was calculated by averaging the percentages of exposure to each language at home and daycare/school (in the

previous example, 70% French, 25% English, and 5% Creole). Only exposure in the home environment was considered if a child did not attend school or daycare.

Four items from the QIMET were used to assess the languages used by children for numbers and letters: 'Languages in which the child sings the alphabet', 'Languages in which the child names the letters he/she recognizes', 'Languages in which the child counts out loud', and 'Languages in which the child names the numbers he/she recognizes'. 'Unexpected bilingualism' (UB) was coded as a categorical variable when, for at least one of the four items, the reported language was not identified by the caregiver as part of the languages spoken in the child's social environment, either at home or in daycare/school.

The socially non-interactive language sources of passive exposure were derived from the questionnaire's items documenting the games and leisure activities in which the children engaged, as reported by their caregivers. The four sources were: tablets, computers, televisions, and mobile phones.

To document the origins of the child's unexpected language use, parents were asked to answer open-ended questions, such as: 'Does your child have abilities that sometimes surprise you (e.g., memory, calculations, music, spelling or grammar, puzzles, use of applications, motor skills, sense of direction, etc.)?' and 'Are there any other interesting things about your child's interests that you would like to mention? Anecdotes, details, comments…'.

Analyses

Statistical analyses were performed using R software version 4.4.1 (R Core Team, 2024) (see Appendix S2 for specific packages). Chi-squared test analyses were used to compare the frequency of UB and the non-interactive language sources across groups (Autistic, Non-autistic clinical, and TD). Fisher's exact test was used to compare the frequencies of expressive language levels according to the presence or absence of unexpected bilingualism within each group. The Bonferroni correction was used for pairwise comparisons.

Logistic regression analysis was used to assess the effect of the diagnosis on the odds of manifesting unexpected bilingualism, while controlling for the children's age. The TD group was used as the reference group. The same analysis, including sex as a covariate, was also performed as a sensitivity analysis (see Appendix S1, Table S2).

The effect of exposure to a language in the social environment on its use by the child was assessed using a logistic regression model. This analysis was restricted to English, which was the most common non-dominant language to which children in our sample were socially exposed. The same analysis could not be applied to French, the dominant language in our sample, since over 95% of our sample used it, making the results lack sufficient variability for meaningful statistical analysis. Diagnosis was included as an interaction term with the percentage of exposure to English in the child's social environment, as we make the hypothesis that social language exposure has a different effect on autistic children compared to TD children. Therefore, the analysis assesses the influence of both diagnosis and social exposure to English on its use while controlling for age:

$$\begin{aligned}\log\left(\frac{P(\text{English}=1)}{1-P(\text{English}=1)}\right) = {} & \beta_0 + \beta_1 \cdot \text{Diagnosis} \\ & + \beta_2 \cdot \text{English\_Exposure} \\ & + \beta_3 \cdot \text{Age} \\ & + \beta_4 \cdot (\text{Diagnosis} \\ & \times \text{English\_Exposure})\end{aligned}$$

This analysis was restricted to TD and autistic children, as interpretation would be more complex for the group of non-autistic clinical children, many of whom have language disorders. Additionally, the heterogeneity of diagnoses within this group would have further limited the interpretation of the results. The same analysis, including sex as a covariate, was also performed as a sensitivity analysis (see Appendix S1, Table S3).

Results

Demographic information and expressive language levels

Autistic children's expressive language level was markedly more limited compared to clinical and TD children. Fifty-three percent of autistic children did not use sentences, compared to only 5% of clinical children and 3% of TD children (Table 1). Despite these expressive limitations, 92% of autistic children consistently followed verbal commands, communicating in full sentences from their caregivers. This included 67% of those whose expressive language was restricted to letters and numbers, indicating a better understanding of language than what is observable through their expressive abilities.

Higher frequency of unexpected bilingualism in autism

While most children use languages spoken in their social environment to refer to letters and numbers, autistic children are significantly more likely to use at least one other language. In our sample, 38.7% of autistic children showed unexpected bilingualism compared to 14.7% of clinical children ($p < .001$) and 12% of TD children ($p < .001$) (see Figure 1). Autistic children had 4.38 times higher odds of unexpected bilingualism than TD children (OR = 4.38, 95% CI [2.06–10.22], $p < .001$); while clinical children showed no significant difference compared to TD children (OR = 1.04, 95% CI [0.42–2.72], $p = .93$). Analyses were adjusted for age (see Appendix S1, Table S2). English was the most frequently used language among all the unexpected languages (Autistic group: 83%; Clinical group: 93%; TD group: 67%) (Table 2).

Independency of unexpected bilingualism and language level

Unexpected bilingualism did not have an overrepresentation at any expressive language level in any group (Table 3). It is neither a skill that disappears with more advanced language abilities nor one that is exclusive to those with more advanced language abilities.

UB: Unexpected bilingualism; use of at least one language not spoken in the social environment; EL: Expected language; exclusive use of languages spoken in the social environment. The p-value refers to the difference in distribution between UB and EL within each group.

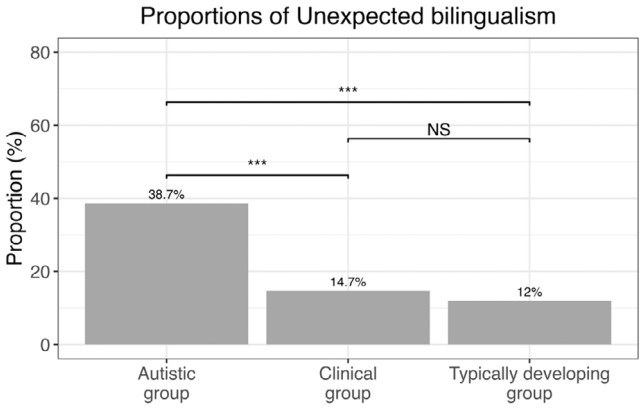

Figure 1 The proportion of autistic, non-autistic, and TD children who used at least one language not spoken in their social environment is higher among autistic children. *$p < .05$; **$p < .01$; ***$p < .001$; NS: Non-significant; Bonferroni correction was applied for pairwise comparisons

Table 2 Unexpected languages used by children

	Autistic group	Clinical group	Typically developing group
Languages, *n*			
English	35	14	6
Spanish	4	1	2
Italian	1	0	1
Portuguese	1	0	0
English; Russian	2	0	0
English; Spanish	1	0	0
Mandarin; German; Spanish	1	0	0
Mandarin; Italian; Portuguese	1	0	0

Lesser influence of social environment for language use in autism

Even when English was not considered 'unexpected' (i.e., was present in the child's social environment and used by the child), autistic children were 8.28 times more likely to use English than TD children, after controlling for the relative proportion of exposure to English in the social environment and the child's age (OR = 8.28, 95% CI [3.65–20.31], $p < .001$). The interaction between diagnosis (TD or Autism) and the relative proportion of social exposure to English indicates that social exposure to English had a lesser influence on English use among autistic children (ß = −0.18, 95% CI [−0.34, −0.05], $p = .02$) (see Appendix S1, Table S3).

Non-social language exposure as a source of language

Caregivers were asked whether their child used any of the following four potential sources of non-interactive language exposure: mobile phones, computers, tablets, or televisions (Table 4). Both mobile phones and tablets were preferred by autistic and clinical children compared to TD children; however, no significant differences were observed between the autistic and clinical groups. Among the 70 children with unexpected bilingualism, the caregivers of 14 of them, all autistic children, offered insights on the source of their children's unexpected language. The reported sources included seven from online videos, five from television, two from tablets, one from a game (type not specified), and one from

Table 4 Prevalence of device usage as potential sources of socially non-interactive language exposure

	Autistic group	Clinical group	Typically developing group	*p*
Device, *n* (%)				
Mobile phone	94 (79%)	75 (74%)	38 (51%)	<.001
	94 (79%)	75 (74%)	–	1
	94 (79%)	–	38 (51%)	<.001
	–	75 (74%)	38 (51%)	.00993
Computer	46 (39%)	41 (40%)	30 (40%)	.969
	46 (39%)	41 (40%)	–	1
	46 (39%)	–	30 (40%)	1
	–	41 (40%)	30 (40%)	1
Tablet	89 (75%)	77 (75%)	39 (52%)	<.001
	89 (75%)	77 (75%)	–	1
	89 (75%)	–	39 (52%)	.006
	–	77 (75%)	39 (52%)	.006
Television	105 (88%)	92 (90%)	69 (92%)	.693
	105 (88%)	92 (90%)	–	1
	105 (88%)	–	69 (92%)	1
	–	92 (90%)	69 (92%)	1

Bonferroni correction was applied for pairwise comparisons.

Table 3 Frequency of unexpected bilingualism according to the level of expressive language

	Autistic group		Clinical group		Typically developing group	
Language level, *n*	UB	EL	UB	EL	UB	EL
Limited to letters and numbers	4	5	0	0	0	0
Stereotyped language	0	3	0	1	0	0
Isolated words	22	28	1	3	0	2
Three words sentences	7	11	7	19	0	3
Sentences with conjugated verb	13	26	7	64	9	61
p-value	.61		.10		1.0	

nursery rhymes (specific origin not specified). Among other notable mentions, one autistic child insisted on having subtitles added to television shows.

Non-interactive media appeared to be the only source guiding focus and interest in language for some autistic children. As an example, among these 14 children, two exclusively used a language not spoken in their social environment. The identified sources of their languages were television and online videos. One of these children even refused to watch cartoons in French, preferring English, despite being raised in a bilingual French and Arabic-speaking environment.

Relevant clinical observations

Only caregivers of autistic children reported that their child used more than one language not spoken in their social environment. Among these, two children spoke English and some words of Russian, one spoke English and some words of Spanish, one spoke some words of Mandarin, German, and Spanish, and one spoke some words of Mandarin, Italian, and Portuguese (Table 2). Unexpected bilingualism also occurred in children with significantly limited receptive language abilities. Six out of 10 autistic children with limited receptive language abilities (i.e., those who did not consistently follow verbal commands from their caregivers) exhibited unexpected bilingualism. Three autistic children did not use any language spoken in their social environment; instead, they used only English, which we still classified as UB.

Discussion

This study compares the languages used by autistic children under the age of 7 years old with those of their clinical or TD peers, focusing on a common domain of interest in autism: letters and numbers (Ostrolenk et al., 2017, 2024, 2025). The study reports a high prevalence of early 'unexpected bilingualism' among autistic children, including those who are minimally verbal. It also shows a reduced influence of the language spoken in the social environment on its usage among autistic children, suggesting that non-interactive sources of exposure may carry greater importance in the early language development of some autistic children compared to their TD peers.

Higher frequency of unexpected bilingualism in autism, independent of language level

Even though most autistic children were minimally verbal, they had more than four times higher odds of showing unexpected bilingualism compared to TD children. This phenomenon is independent of language level, meaning it is not more prevalent among autistic children with either lower or higher language abilities. Although not exclusive to autism, UB, in relation to letters and numbers, is significantly associated with autism and is observed in more than one-third of autistic children. This frequency is much higher than that usually associated with autistic savant abilities or hyperlexia in the context of autism (Ostrolenk et al., 2017). These results, however, may not be informative with regard to the two extreme language developmental phenotypes in autism that were not represented in this study: individuals with no verbal language and those with a more subtle presentation of autism and age-appropriate language development, who are typically diagnosed later.

Lesser influence of social environment for language use in autism

While some autistic children only used languages that were not spoken in their social environment, the vast majority (95%) of both autistic and non-autistic children used some elements of the dominant language spoken in their social environment. However, the use of a socially spoken language does not necessarily imply that it was acquired through social interaction; its primary source may in fact be non-interactive (Beccaria, Gagliardi, & Kissine, 2024). A dimensional assessment of the influence of exposure to social/interactive language on the language used for letters and numbers showed that this influence is reduced in autistic children. This suggests that the role of non-interactive sources of language may generally be underestimated in the acquisition of socially non-dominant or dominant languages. UB could represent the most salient expression of a broader phenomenon of non-interactive language development in autism.

It remains difficult to determine whether UB primarily results from a child actively seeking out exposure to a non-social or less socially spoken language, or from passive exposure enabled by an environment rich in materials in a language other than the child's primary language. While most in our sample are exposed to English by default, given its widespread accessibility in Quebec, some autistic children appear to actively seek out exposure to an alternative language (e.g., by requesting to watch cartoons only in a language other than that spoken by their parents). This may reflect a self-reinforcing learning process whereby the more a child is exposed to a language through an effective modality (whether non-interactive oral language, written language, or a combination of both), the more likely they are to continue seeking it out.

Non-interactive language exposure as a source of language acquisition

In line with our hypothesis, highly structurally redundant and repetitive non-interactive language materials may provide more effective language

exposure to support early language acquisition (Mottron et al., 2013, 2021). In the absence of a bias toward social interaction to guide and enable the benefits of exposure to interactive language (Mottron & Gagnon, 2023), autistic children may benefit more from non-interactive linguistic material in their environment that matches their perceptual preferences (Jacques et al., 2018; Kissine et al., 2023; Mottron & Gagnon, 2023). Examples of such materials include written language, subtitled videos, and nursery rhymes on platforms such as YouTube. While the benefits of non-interactive media exposure for language development are often considered limited to vocabulary and sometimes even potentially detrimental for typically developing children (Gowenlock, Norbury, & Rodd, 2024), such input may be particularly beneficial for autistic individuals (El Shemy, Jaccheri, Giannakos, & Vulchanova, 2025).

While parental language is the first source of language exposure in the child's first years, non-interactive sources seem to transiently and successfully compete with it during the early years for autistic children. Like their clinical peers, autistic children show higher usage of mobile phones and tablets than TD children. The benefits of this type of exposure for the acquisition of UB were explicitly reported by caregivers of autistic children. The role of social interaction in language development for autistic children remains controversial (e.g. Kissine, 2021). While higher levels of joint attention are sometimes predictive of later language development, the relationship is complex and not always necessary (Kissine et al., 2023). Moreover, joint attention often does not have the same preferential value in the organization of perception or the mapping of language onto the environment in autism (Akechi et al., 2011; Baron-Cohen, Baldwin, & Crowson, 1997; Parish-Morris, Hennon, Hirsh-Pasek, Golinkoff, & Tager-Flusberg, 2007; Preissler & Carey, 2005).

According to caregivers, the unexpected languages used by these children often originate from media that allow for repeated, controlled, and non-interactive exposure to language. This is consistent with previous findings (Francis et al., 2024; Kissine et al., 2019; Vulchanova et al., 2012). Non-interactive sources offer linguistic input through the visual modality (e.g., written text, toy letters), aligning more closely with autistic perceptual strengths (Mottron, 2017; Smith, 2011; Smith & Tsimpli, 1995) and permitting integration via mappings at the grapheme–phoneme interface (e.g., naming letters) (Mottron et al., 2013; Ostrolenk et al., 2017, 2024; Ostrolenk, Courchesne, & Mottron, 2023).

Why letters?

This study shows that the minimally verbal plateau period is not devoid of familiarity with formal language material, which is often used independently of its communicative function. Exposure to structured, non-interactive linguistic material in the early years may be sufficient to support autistic children's intuitive interest in language, which is consistent with theories that emphasize the innate mechanisms underlying language acquisition (Kissine, 2021). According to the statistical learning model of language acquisition, when toddlers are exposed to material that shares the structural properties of language, they tend to recognize its inherent regularities. This implicit ability is often impaired in children with developmental language disorder but appears to be preserved in autistic children (Foti, De Crescenzo, Vivanti, Menghini, & Vicari, 2015; Haebig, Saffran, & Ellis Weismer, 2017; Obeid, Brooks, Powers, Gillespie-Lynch, & Lum, 2016). In a statistical learning task, autistic children with unexpected bilingualism showed a relative strength in learning structural dependencies compared to both autistic children without UB and non-autistic children (Dumont, Belenger, Destrebecqz, & Kissine, 2025).

Statistical learning skills are not only applied to oral language (e.g., Bettoni et al., 2020; Ellis, Gonzalez, & Deák, 2014; Shafto, Conway, Field, & Houston, 2012; Smith & Yu, 2013). Visual stimuli can also be processed through statistical learning and are likely to contribute to typical language development to some extent, at least in the early stages of language acquisition (for a review, see Abreu, Postarnak, Vulchanov, Baggio, & Vulchanova, 2023). The strength of the visual modality in autistic perception (Mottron, Dawson, Soulières, Hubert, & Burack, 2006), combined with the reliance on non-socially interactive material, suggests that visual processing may be most beneficial for language acquisition in autistic individuals.

While facing challenges due to a reduced ability to benefit from socio-communicative feedback, non-interactive language acquisition in autism may rely more heavily on exposure to the structural aspects of language (e.g., Dumont et al., 2025) and be aided by its various levels of within-code mapping (e.g., grapheme-phoneme) (Mottron et al., 2013; Mottron & Gagnon, 2023). The present study emphasizes this through anecdotal observations of language production implying a mapping between different modalities (e.g., naming letters aloud), and the case of an unexpectedly bilingual child who insisted on adding subtitles to television cartoons. This could also explain the conceptual overlap between the phenomenon of hyperlexia and UB (Ostrolenk et al., 2023), as well as the preference for screens as a source of language exposure in UB individuals (Francis et al., 2024; Kissine et al., 2019).

Is UB informative for subsequent language development?

The presence of UB in childhood has been reported to either coincide with or be quickly followed by the

use of spoken language at various levels (e.g., Zhukova et al., 2023), and it is sometimes incorporated into socially spoken language (e.g., Kissine et al., 2019). UB may reflect a broader underlying process of non-interactive language development, which could be the primary, or even the only, pathway for some autistic children to initially access language during the critical years for language acquisition. However, its outcomes in terms of functional mastery of the unexpected language and/or the socially spoken languages remain heterogeneous (Dumont, Belenger, Eigsti, & Kissine, 2024).

Limitations

The ways in which core autistic symptomatology associated with the DSM-5-TR Area B, such as insistence on sameness, restricted interests, and perceptual biases, may shape the processing of language-related material and influence subsequent language development were not addressed in the present study and remain to be clarified. These dynamics should be examined further in contexts where passive, non-interactive language exposure is less readily available.

Lower language levels are less represented in non-autistic children, which limits our ability to interpret UB and language levels in TD children. Restricting our definition of UB to letters and numbers in order to explore UB in minimally verbal children may not fully capture the phenomenon in the context of more complex language development. Ethnicity and parental education were not reported, despite their potential relevance to various aspects of language acquisition, but these factors may be similar in the autistic and non-autistic clinical groups drawn from a representative population with identical demographic characteristics. While caregivers' best estimates of the languages spoken in a child's environment rely on parental information and may lack precision, they are widely accepted as valid, particularly in studies with large sample sizes (Mancilla-Martinez, Gámez, Vagh, & Lesaux, 2016; Orena, Byers-Heinlein, & Polka, 2020). Additionally, our measure of receptive language had limited sensitivity and may overestimate the children's receptive language abilities. Finally, although formal IQ assessments and standardized language assessments were not carried out, our results remain conservative. Further studies focusing on non-interactive language exposure through different media are needed, as our results were limited to specific devices and did not control for child age or developmental status.

Conclusion

This study evaluates expressive language use for numbers and letters relative to spoken language in the social environments of autistic, non-autistic clinical, and typically developing children. Focusing on letters and numbers, which are a common early domain of interest for autistic children, provides a way to systematically access the utterances of minimally verbal autistic children, even outside of a communicative context. Autistic children were found to be less dependent on their social environment for their language of use, and more than one-third are unexpectedly bilingual. This phenomenon is observed regardless of their level of language proficiency. Non-interactive language sources appear sufficient for autistic children to achieve at least a minimal level of language proficiency and, in some cases, are the only known source of the language used by autistic children. These findings highlight the critical role of non-interactive language exposure in the differential selection of interventions and language sources considered beneficial for the language development of minimally verbal autistic children.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Table S1. Alternative diagnoses found in the non-autistic clinical group.

Table S2. Effects of diagnoses (autism or other diagnosis) and age on the prediction of unexpected bilingualism.

Table S3. Effects of the level of social exposure to English on its use.

Appendix S2. List of R packages used for the analyses.

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Ethics statement

This research project was approved on 2019-10-01 by the CIUSSS-NIM Research Ethics Committee (*Comité d'éthique de la recherche du CIUSSS du Nord-de-l'Île-de-Montréal*); study reference number 2019-1793. All participants gave informed consent.

Data availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Key points

What's know

- Unexpected bilingualism and its relation to non-interactive language acquisition are documented in autism, but their significance in minimally verbal children during the early stages of language development was unknown.

What's new

- Early 'unexpected bilingualism' (UB) is highly prevalent among autistic children, even those who are minimally verbal.
- The influence of the language spoken in the social environment on the language used is reduced in autistic children.

What's relevant

- Non-interactive sources of language appear to transiently and effectively compete with socially spoken languages during early language acquisition.
- For some autistic children, non-interactive language exposure may be the primary pathway to initially access language.

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