Language Before Surgery: Lexical Diversity in Children with Posterior Fossa Tumors

Posterior fossa tumors (PFTs) are the most common pediatric brain tumors[1]. Following tumor resection, some children can experience transient mutism or reduced speech, collectively named postoperative speech impairments[2] (POSI). Regardless of POSI, patients can report persistent language impairments[1], including word-finding difficulties (WFDs)[1,3,4]. Picture-naming tasks revealed WFDs in some patients both pre and postoperatively[3,4]. However, WFDs also appear in spontaneous speech, where increased repetitions and general word use may reduce lexical diversity (LD), offering a more ecologically valid assessment, especially in young children less suited for picture-naming tasks. While reduced LD[5] and general all-purpose verbs[6] have been documented in postoperative spontaneous speech of children with PFTs, preoperative analyses are scarce[1], despite evidence that preoperative language impairments increase the risk of POSI[7]. Younger age at resection is another POSI risk factor[2], yet younger patients are rarely studied.

In preparation for planned research on language impairments in infants and toddlers with PFTs, we analyzed preoperative LD in spontaneous speech from older patients (3–17 years; N = 61, 15 later developed POSI) and 71 controls, hypothesizing the lowest LD in patients who developed postoperative POSI. LD was measured using the traditional type-token ratio (TTR) and three alternative indices designed to minimize sample size effects[8]: moving average TTR, hypergeometric distribution D, and measure of textual LD. These respectively capture incremental TTR calculations, the probability of unique word occurrences, and TTR stability across text[9, 10].

Results showed that patients did not differ in preoperative LD from the controls in any of the measures. Moreover, no significant group or individual differences were found between POSI and non-POSI patients. These findings contrast with previously reported reduced postoperative LD[5] and impaired pre/postoperative picture-naming[3,4]. One possible explanation is that, despite the ecological validity of spontaneous speech, WFDs may remain masked in unconstrained contexts, highlighting the need for specific elicitation tasks.

Keywords: posterior fossa, brain tumor, children, word-finding difficulties, lexical diversity

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Additional Material

Participants

	N	Age M(SD)	% of males
POSI	15	9;1(3;6)	60%
nonPOSI	46	9;5(3;5)	63%
Controls	71	8;11(3;9)	63%

Participants were tested in their native language (either English, Dutch, or Italian). Patient data was collected through the European Study on Cerebellar Mutism Syndrome database. Control data was available from previous studies or from an online repository. POSI, nonPOSI, and control groups were matched for age and sex.

Table 1 Linear models with Helmert contrast coding and post hoc Benjamini-Hochberg procedure

	TTR			**HD-D**			**MTLD**			**MATTR**		
Predictors	*Est.*	*CI*	*Adj. p*	*Est.*	*CI*	*Adj. p*	*Est.*	*CI*	*Adj. p*	*Est.*	*CI*	*Adj. p*
(Intercept)	0.633	0.594 – 0.671	**<0.001**	21.50	19.713 – 23.294	**<0.001**	18.708	13.725 – 23.691	**<0.001**	0.896	0.883 – 0.910	**<0.001**
Patients vs Controls	-0.001	-0.011 – 0.009	0.868	-0.080	-0.544 – 0.383	0.854	-0.501	-1.792 – 0.791	0.575	0.002	-0.001 – 0.006	0.278
POSI vs nonPOSI	0.010	-0.012 – 0.033	0.577	-0.737	-1.780 – 0.306	0.271	-1.279	-4.181 – 1.624	0.539	-0.000	-0.008 – 0.007	0.944
Age (months)	0.000	-0.000 – 0.000	0.868	0.021	0.004 – 0.039	**0.041**	0.063	0.013 – 0.112	**0.033**	0.000	0.000 – 0.000	**0.046**
Italian	0.052	0.022 – 0.083	**0.004**	1.826	0.425 – 3.227	**0.028**	12.926	9.028 – 16.825	**<0.001**	0.018	0.008 – 0.028	**0.003**
Dutch	-0.001	-0.035 – 0.034	0.976	0.596	-0.996 – 2.188	0.575	1.612	-2.818 – 6.043	0.575	0.009	-0.003 – 0.020	0.271
Tot. n° token	-0.001	-0.001 – -0.001	**<0.001**	0.028	0.016 – 0.039	**<0.001**	0.031	-0.001 – 0.063	0.113	0.000	0.000 – 0.000	**0.009**
Observations		132			132			132			132	
R^2 / R^2 adjusted		0.515 / 0.492			0.396 / 0.367			0.379 / 0.349			0.295 / 0.261	

TTR = type-token ratio; *HD-D* = hypergeometric distribution D; *MTLD* = measure of textual lexical diversity; *MATTR* = moving average type-token ratio; *POSI* = patients who later developed postoperative speech impairments (i.e., mutism or reduced speech), *nonPOSI* = patients who did not develop postoperative speech impairments