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M. Collet, M Gagnière, C. Rousseau, M Chapron, M Fiquet, M Certain

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DR. LAURE FIQUET (Orcid ID : 0000-0002-5968-4406)

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Case control study found that primary language disorders were associated to screen exposure at 3.5-6.5 years of age

Impact of childhood screen exposure

1. M Collet, general practitioner, Department of General Medicine, University of Rennes, Rennes, France
2. B Gagnière, epidemiologist, Department of General Medicine, University of Rennes, Rennes, France
3. C Rousseau, statistician, Centre for Clinical Investigation, University of Rennes, Rennes, France
4. A Chapron, general practitioner and lecturer, Centre for Clinical Investigation, Department of General Medicine, University of Rennes, Rennes, France
5. L Fiquet, general practitioner and lecturer, Centre for Clinical Investigation and Department of General Medicine, University of Rennes, Rennes, France
6. C Certain, general practitioner, Department of General Medicine, University of Rennes, Rennes, France

Corresponding author: M Collet, general practitioner, Department of General Medicine, University of Rennes, France. Université de Rennes 1- 2 avenue du Pr Léon Bernard - 35043 Rennes Cedex. Tel: +33 2 23 23 49 68. Email: m.collet.these@gmail.com.

ABSTRACT

Aim

We explored the associations between childhood exposure to screens, including televisions, computers, game consoles, tablets and smartphones, and primary language disorders.

Methods

This multi-centre case-control study comprised 167 children aged 3.5-6.5 years, who were born in 2010-2012 and diagnosed with primary language disorders, and 109 matched controls without language disorders. Questionnaires were completed by their parents who were recruited by 16 family doctors and 27 speech and language therapists in the Ille-et-Vilaine region of France. The data were analysed using a multivariate logistic regression model and presented as adjusted odds ratios (aOR) and 95% confidence intervals (95% CI).

Results

We found that cases (44.3%) and controls (22.0%) exposed to screens in the morning before nursery or primary school were three times more likely to develop primary language disorders (aOR 3.40, 95% CI 1.60-7.23). When this risk was combined with rarely or never discussing screen content with their parents (aOR 2.14, 95% CI 1.01-4.54) they were six times more likely to have language problems (aOR 5.86, 95% CI 1.44-23.95).

Conclusion

Being exposed to screens in the morning before school, and rarely or never discussing screen content with parents, meant children were six times more likely to develop primary language disorders.

KEYWORDS

Children, Primary healthcare, Primary language disorders, Screen content, Screen media

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KEY NOTES

- This study explored the associations between childhood exposure to screens and primary language disorders.
- We studied 167 children aged 3.5-6.5 years and 109 controls by analysing parental questionnaires collected by family doctors and speech and language therapists.
- The combination of screen exposure in the morning before nursery or primary school and rarely or never discussing screen content with parents was associated with a six-fold increased risk of primary language disorders.

INTRODUCTION

Digital media use has increased over the past decade and even young children have access to televisions, computers, game consoles, tablets and smartphones. Studies have shown that when they are using screens, young children do not have the emotional interactions with their caregivers (1,2) that are important for their psychomotor development, especially language development (3). In France, all children are tested with ERTL4, a French Authority for Health validated scale, to evaluate language development when they are four years old (4). Studies have shown that primary language disorders affect 4-6% of French children (4,5).

Many international studies have shown that exposure to screens had a significant impact on children's health (6), including language disorders (7-11), but most of them only took television exposure into account.

The aims of this study were to look for statistical links between childhood exposure to screens, including televisions, computers, game consoles, tablets and smartphones, and the onset of primary language disorders.

METHODS

Study participants

This multi-centre case-control study included children born between 1 January 2010 and 31 December 2012 and studied them when they were aged between 3.5 - 6.5. It was conducted in 24 towns in the Ille-et-Vilaine department surrounding the tertiary care hospital

affiliated to the University of Rennes, France. This age range corresponds to the detection period of language disorders (4). Cases were included if they had been diagnosed with a primary language disorder by a speech and language therapist. This included all primary language disorders, from simple speech and language delay to developmental dysphasia. The control children had been followed by a family doctor and did not need speech therapy. Participants were excluded if they matched one of the criteria for secondary language disorders (4,5), such as: a language disorder due to prematurity because they were born before 37 weeks of gestation, a congenital disease, a neurological disorder, a psychiatric disorder or hearing problems. They were also excluded if neither of their parents spoke French at home.

The family doctors were selected if they worked with speech and language therapists who were based in the same towns or health centres. Half of the family doctors who were approached (16/32) agreed to take part along with the majority of the speech and language therapists (27/28). We received 117 parental questionnaires from the family doctors and 200 from the speech and language therapists. We had to exclude eight controls and 33 cases because they matched one of the criteria for secondary language disorders. This meant that from July to October 2016, we were able to include 167 children with a primary language disorder and 109 controls without any language disorder in this French primary healthcare study. (Figure 1)

The research process

A parental questionnaire was created to collect information on the child, its family, speech monitoring, medical monitoring and screen access. The screen access part of the questionnaire gathered information about screen types, multi-screen exposure, what screens the child owned or had access to, first screen exposure, time of exposure, duration of exposure and parental guidance.

The questionnaire was edited after feedback from a sample of 32 people and this resulted in a shorter questionnaire that was easier for the general population to understand.

The same questionnaire was used for both groups. Information on potential confounders found in the literature (8,9,11-13) were collected and these were: the child's age and sex, the family situation, the parents' ages, the parents' levels of education and their socio-economic status.

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This parental questionnaire was systematically offered by health professionals to parents consulting them if their child's date of birth corresponded to the inclusion criteria. All the questionnaires were completed during the healthcare visits. Each questionnaire was accompanied by a letter about the study and only one questionnaire was completed for each family. A code number was assigned to each anonymous questionnaire for the analyses. Parents gave their oral consent to participate in the survey. Ethical approval for the study was obtained from the Research Ethics Committee of the University Hospital.

Data analyses

Variables were described and compared in both groups. A statistically significant difference was established for any p value of <0.05.

The Student's t-test or the Mann-Whitney test was used to compare the quantitative variables and a chi-square test or a Fisher's exact test was used for the qualitative variables (Table 1).

Any socio-demographic variables that showed a statistically significant difference between both groups, and which could influence language delay, were selected as confounding factors (Table 1).

The initial analysis was based on a logistic regression model adjusted for confounding factors in order to identify risk factors for primary language disorders (Table 2). From this first analysis, variables with a p value of less than 0.20 were included in a multivariate model and a step-by-step selection was performed, so that the independent risk factors could be adjusted (Table 3). These models were used to estimate the adjusted odds ratios (aOR) and their 95% confidence intervals (CI).

RESULTS

Population characteristics

The mean age of the children was five years of age (Table 1) and all of them were already attending nursery or primary school. In France formal compulsory education starts at the age of six, but nearly all French parents send their children to nursery school from the age of three. The groups differed by sex (p = 0.007). The male-to-female ratio of the children with a

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primary language disorder was 2.41:1, compared to 1.02:1 in the control group. There was a statistically significant difference between the two groups with regard to their rank among their siblings ($p = 0.0015$), their family situation ($p = 0.02$), their parents' levels of education ($p < 0.001$) and their socio-economic status ($p = 0.005$). These socio-demographic variables, which can affect a child's language development, were selected as confounding factors and enabled us to produce adjusted results.

Exposure to screens

In this study, 94.2% of children in both groups had access to television, half (53.5%) had access to a tablet and a third had access to a computer (32.4%), a game console (34.9%) or a smartphone (30.2%).

Children in both groups were exposed to screens for the first time at a mean age of 15.7 ± 12.4 months and 83.3% had been exposed before the age of two years ($p = 0.43$). During a typical nursery or primary school week, 44.3% of the cases and 22.0% of the controls were exposed to screens in the morning before school ($p < 0.001$) and the average exposure was 20 minutes long in both groups. Cases were also more likely to be exposed to screens during lunch and dinner at home and before going to bed on a typical school week. Cases spent an average of 87.7 ± 54 minutes per day in front of a screen versus 55.8 ± 52.2 minutes per day for controls ($p < 0.001$), with a mean time of exposure for both group of 74.7 ± 55 minutes. In both groups, children were alone in front of the screen 40.0% of the time. Possession of screens was similar in both groups, with 5.1% of the children having a television in their room, 15.0% their own game console, 16.1% their own tablet and 0.7% a computer in their room. None had their own smartphone.

With regard to the parents' behaviour, 31.5% of the cases and 14.8% of the controls, said that they rarely or never talked about screen content with their children ($p = 0.002$). In addition, 17.4% of the cases and 7.3% of the control group said that they rarely or never found time to engage in activities unrelated to screen-based activity with their children ($p = 0.017$). But only 1.8% of parents reported that they rarely communicated with their child in both groups. We found

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that 44.8% of the cases' families and 25.0% of the controls' families said that they had the television on in the background when their children were around (p = 0.001).

Multivariate analyses

In the first analysis (Table 2), exposure to screens in the morning before school (aOR 3.42) and the duration of weekly screen exposure (aOR 1.09), were significantly related to primary language disorders. Rarely or never discussing screen content with children was not significant (aOR 1.99 and 95% CI 0.96 to 4.13) in this analysis.

The second analysis (Table 3) showed the impact of each individual risk factor on the primary language disorder, while controlling for the other risk factors. Exposure to screens in the morning before nursery or primary school, was still significantly related to primary language disorders (aOR 3.40 and 95% CI 1.60 to 7.23). Once it was analysed independently of the other variables, rarely or never discussing screen content with children was significantly related to primary language disorders (aOR 2.14 and 95% CI 1.01 to 4.54). However the duration of weekly screen exposure was no longer statistically significant.

A composite variable was derived from these two significant variables. The purpose of this last analysis was to evaluate the additional effect of the risks. A child who was exposed to screens in the morning before school, and who rarely or never discussed screen content with their parents, was about six times more likely to develop primary language disorders (aOR 5.86 and 95% CI 1.44 to 23.95) compared to a child who did not show these two features.

DISCUSSION

This study looked at how primary language disorders in children aged 3.5-6.5 years could be associated with exposure to televisions, computers, game consoles, tablets and smartphones. The findings were significant, as they showed that children who were exposed to screens before they started their day at nursery or primary school, and who rarely or never discussed screen content with their parents, were six times more likely to have language problems.

In this study 83.3% of the children were exposed to screens before the age of two, which confirmed data in previous studies (6,7,14,15). There have been very few reports in the French

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literature concerning the rate of exposure to digital screens at this age. The children in our study mostly had access to televisions (94.2%), which reflected the general French population (16). Half of the children in our sample had access to a tablet, which also reflected the general French population (16). In our study 5.1% of the children had a television in their room and other French literature has quoted various rates for this including 0.9% of children under three (17) and 17% of one to six years olds (18). While one French study (18) found that 34% for seven to 12 year olds owned a tablet, our study found that it was just 16.1%, but the children in our sample were younger.

Three studies have established associations between early screen exposure and the risk of language disorders (7,8,19). Our study didn't corroborate these results, but the children in our sample were exposed to screens for the first time between 15-16 months old, which was much later than these international studies, which were carried out on children who were first exposed to screens at 7-9 months. This could be explained by a cultural difference. Moreover, the first exposure, and especially that of the cases, might have been overestimated due to memory bias or the parents' fear of social judgment.

Many studies have shown that the duration of exposure to screens has been linked to the risk of language disorders (8-11,20). This result wasn't verified by our study, but our sample age was not the same as we included children aged between 3.5 and 6.5 years, while the average age in other studies was around two years of age. Moreover, the average daily screen time of our sample was lower than in other studies (9,21). These discrepancies could have been due to a cultural difference as most of the other studies were American. In France, exposure to screens for children under six is rarely evaluated. The latest French study that did evaluate this rate (22) found that the children aged 3-11 were exposed to television for 45 minutes per day and to interactive screens for 30 minutes per day. These match the 75 minutes per day of screen time that we found in our sample. Including subjects over the summer months, when children spend more time engaged in outdoor activities, may also have led to us underestimating true exposure. Unlike others, our study took into account the variable exposure to screens in the morning before school.

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The variable exposure to screens in the morning before school remained statistically linked to primary language disorders, independent of other variables (Table 3). The average exposure to screens in the morning was 20 minutes long for children in both groups. We could say that the very fact that they were exposed to screens in the morning, rather than the duration of that exposure, favoured the appearance of language disorders. This could be explained by the fact that being exposed to screens in the morning was an exhausting activity that made the child less able to acquire knowledge and learn for the rest of the day. Indeed, Lillard and Peterson (23) concluded that exposing four-year-olds children to fast-paced television cartoons had an immediate negative impact on their executive functions. These programmes with rapidly presented events are the ones that are most watched by children. Christakis et al (24) reported that being exposed to screens before the age of three was associated with attentional problems at the age of seven. This link between television exposure and attentional problems have been found in other studies (25) and could have been explained by Harlé and Desmurget's study (26). They reported that when children were paying close attention to a screen, they responded to a primary attention reflex, which is not a deliberate intention of commitment. The latter allowed children to carry out necessary tasks for learning, while the former one excited and exhausted them.

The fact that parents did not discuss screen content with their children has already been shown to have harmful consequences (27). Studies have shown that when children under the age of two were left alone in front of a screen they did not learn anything from the screen content (3,28,29). Not discussing screen content with their child could increase the child's risks of viewing inappropriate content. Most children between three and 12 years old have been exposed to television content that was not suitable for their ages. Even age appropriate, content may not have been adapted to the child personality.

The analysis of the composite variable, despite the loss of power generated by the increased number of categories, showed a cumulative effect for both exposures. Indeed, the two principal risk factors were individually significant and their combination made them even more important, as they increased the risk by approximately six-fold.

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Strengths and limitations of the study

This study had a number of limitations. The initial speech and language assessment of each child was not collected and this could have been a classification bias. Collecting the data with a parental questionnaire might have introduced bias because of its nature. Indeed, this method was sensitive to memory bias and the fear of social judgment about screen exposure. We also recognise that our adjustments could have been incomplete as we only chose to include confounding factors that had been validated by several studies. As mentioned above, we carried out the study in the summer months and this could have meant children played outside.
The low participation rate of family doctors relative to speech and language therapists may have led to a selection bias in our study. Indeed, we recruited cases and controls in the same cities, but in nine cities we had no control answers. However, we performed a sensitivity study to remove these nine cities from the analysis and this had no impact on the results, so the unbalanced nature of the participation was not critical in the final analysis.

The strengths of this case-control study include the fact that it confirmed other publication results (7-11) about the association between primary language disorders and screen exposure. The low rate of primary language disorder allowed us to interpret the odds ratios in this study as relative risks (30). The fact that the study was multicentric provided us with diverse representativeness, including urban, rural and semi-urban areas. The large number of subjects included provided a wide variety of behavior towards screen exposure. The male-to-female ratio of the cases was 2.41:1, but this was consistent with what has been elsewhere found in the literature (8,13). The case group also included more blended families, which have rarely been analysed in other studies

The multivariate analyses were adjusted on the sociodemographic variables, which were confounding factors in the study, in order to make the groups comparable and to limit confusion biases. As shown in Table 2, there were 11 statistically significant unadjusted variables compared to two significant variables after adjustment. The adjusted results, which were less biased, have provided more robust study results.

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CONCLUSION

Our study showed that children who were exposed to screens in the morning before primary or nursery school, and who rarely or never discussed the content they watched with their parents, were about six times more likely to develop primary language disorders than children who did not display these two features. Cohort studies that took into account the two significant variables mentioned would provide further insight regarding language disorders and screen exposure. Screen exposure in children is a major public health issue and health professionals working with children have an important health prevention role to play by informing parents about the risks. In addition, there is a lack of international consensus about exposure to screens and this needs to be addressed.

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ABBREVIATIONS aOR, adjusted odds ratio; CI, confidence intervals

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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FIGURE AND TABLES

Flow chart (Figure 1)

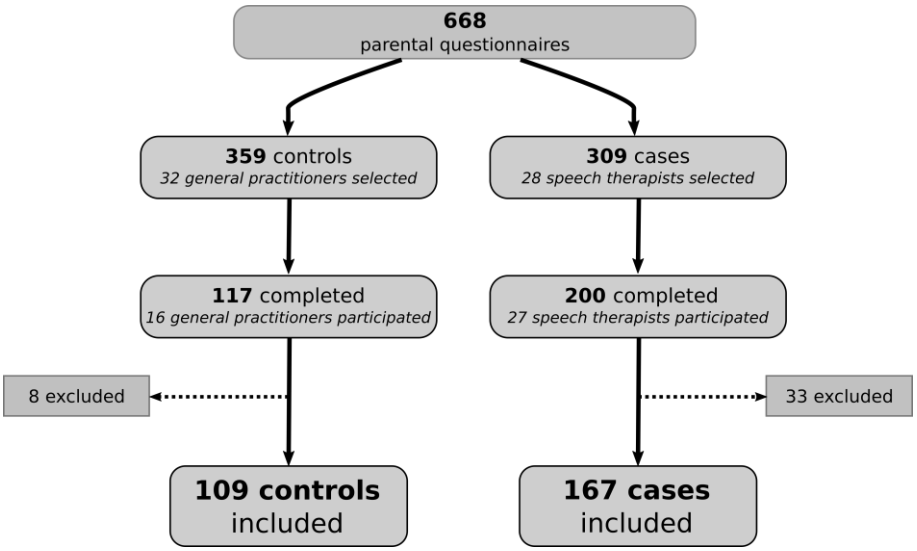

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Table 1: Characteristics of cases and controls

Variables	Total sample (n=276)	Control (n=109)	Case (n=167)	p value
Age	276	109	167	0.0070
(mean ± SD)	5.2 ± 0.8	5.0 ± 0.8	5.3 ± 0.7	(S)
< 4 years old	17 (6.2%)	13 (11.9%)	4 (2.4%)	0.0010 (χ^2)
4-5 years old	100 (36.2%)	46 (42.2%)	54 (32.3%)	
5-6 years old	102 (37.0%)	30 (27.5%)	72 (43.1%)	
≥ 6 years old	57 (20.7%)	20 (18.3%)	37 (22.2%)	
Sex	276	109	167	0.0007
F	103 (37.3%)	54 (49.5%)	49 (29.3%)	(χ^2)
M	173 (62.7%)	55 (50.5%)	118 (70.7%)	
Older siblings	276	109	167	0.0015 (χ^2)
No	127 (46.0%)	63 (57.8%)	64 (38.3%)	
Yes	149 (54.0%)	46 (42.2%)	103 (61.7%)	
Family situation	275	108	167	0.0203
Both parents living together	225 (81.8%)	93 (86.1%)	132 (79.0%)	(χ^2)
One parent alone with their children	30 (10.9%)	13 (12.0%)	17 (10.2%)	
Stepfamily	20 (7.3%)	2 (1.9%)	18 (10.8%)	
Father study lever	247	101	146	< 0.0001
No French High School Diploma (FHSD)	104 (42.1%)	26 (25.7%)	78 (53.4%)	(χ^2)
FHSD +0 year, +1 or +2 years	76 (30.8%)	35 (34.7%)	41 (28.1%)	
> 2 years after FHSD	67 (27.1%)	40 (39.6%)	27 (18.5%)	
Mother study level	250	99	151	< 0.0001
No French High School Diploma (FHSD)	75 (30.0%)	16 (16.2%)	59 (39.1%)	(χ^2)
FHSD +0 year, +1 or +2 years	91 (36.4%)	31 (31.3%)	60 (39.7%)	
> 2 years after FHSD	84 (33.6%)	52 (52.5%)	32 (21.2%)	

n: number
SD: standard deviation
S: Student's t-test
χ^2: Chi-square test
FHSD: French high school diploma

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Table 2: First analysis, logistic regression model for each variable of interest, before and after adjustment.

Variables	n	OR (95% CI)	aOR (95% CI)	p value
Age of the first exposure to screen	230	*1.00 (0.98 - 1.02)*	1.01 (0.99 - 1.04)	0.2892
Children exposed to screen for the first time before 24 months	230	*1.30 (0.68 - 2.52)*	1.22 (0.52 - 2.87)	0.6515
Number of screens at home ≥ 6	239	***1.66 (1.01 - 2.7)***	1.24 (0.66 - 2.33)	0.4998
Duration of weekly screen time (for 60 mn)	**226**	***1.12 (1.06 - 1.18)***	**1.09 (1.02 - 1.17)**	**0.0142**
Television access	241	*2.74 (0.96 - 7.77)*	0.75 (0.21 - 2.66)	0.6608
Computer access	241	*0.93 (0.55 - 1.56)*	0.80 (0.42 - 1.53)	0.5063
Game console access	241	***1.83 (1.08 - 3.09)***	1.12 (0.57 - 2.18)	0.7408
Tablet access	241	*0.77 (0.47 - 1.25)*	0.84 (0.46 - 1.52)	0.5581
Smartphone access	241	*0.97 (0.57 - 1.64)*	0.94 (0.49 - 1.79)	0.8475
Screen during school weeks	241	***2.37 (1.30 - 4.32)***	1.79 (0.83 - 3.86)	0.1369
Screen when no school	241	*2.08 (0.46 - 9.49)*	3.16 (0.47 - 21.16)	0.2349
Screen during holidays	238	*0.49 (0.13 - 1.85)*	0.38 (0.07 - 2.11)	0.2690
Exposure to screens in the morning before school	**241**	***2.82 (1.63 - 4.87)***	**3.42 (1.64 - 7.14)**	**0.0011**
Screen at lunch	230	***4.45 (1.49 - 13.27)***	2.76 (0.70 - 10.89)	0.1482
Screen in the afternoon	236	*1.10 (0.65 - 1.85)*	0.81 (0.42 - 1.57)	0.5370
Screen at diner	241	***2.48 (1.45 - 4.27)***	1.55 (0.79 - 3.04)	0.2051
Screen in the evening before bedtime	231	***2.05 (1.14 - 3.66)***	1.45 (0.71 - 2.95)	0.3069
Discuss screen content with children (ref: always/often)	**238**	***2.65 (1.42 - 4.94)***	1.99 (0.96 - 4.13)	0.0631
Background television (ref: always/often)	238	***0.41 (0.24 - 0.70)***	0.68 (0.33 - 1.39)	0.2915
Take time for activities with children (ref: always/often)	241	***2.65 (1.16 - 6.05)***	1.73 (0.67 - 4.47)	0.2547
Take time to communicate with children (ref: always/often)	241	*0.98 (0.16 - 5.95)*	0.17 (0.02 - 1.48)	0.1082

OR: unadjusted odds ratios
aOR: adjusted odds ratios
CI: confidence intervals
Ref: reference for the statistical calculation
***Bold covariates** are statistically significant.*
Underlined covariates *had a p <0.20 and then have been included in the second analysis (Table 3)*

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Table 3: Second analysis, multivariate analyses by a descending step-by-step selection of the Table 2.

Variable to explain	n	Variables	aOR (95% CI)	p value
Primary language Disorders	238			
		Exposure to screens in the morning before school	3.40 (1.60 ; 7.23)	0.0015
		Rarely or never discuss the screen content with their child	2.14 (1.01 ; 4.54)	0.0463

aOR: adjusted odds ratios
CI: confidence intervals