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Family practices related to the quality and quantity of smartphone use and early executive-linguistic development

Prácticas en el hogar relacionadas con la calidad y cantidad del uso del smartphone y desarrollo ejecutivo-lingüístico temprano

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ABSTRACT
There is growing interest in understanding how smartphone use may impact early childhood development. In this study, we used a latent variable approach to examine parental practices related to smartphone use and their effects on young children's executive and linguistic development. Specifically, we considered two factors associated with smartphone use: a quantity factor, comprising various measures of exposure, and a quality factor, reflecting how often families engage in strategies that promote contingent interactions and support learning during screen time. We also explored the role of parental education in shaping these practices. Results indicate that greater exposure has detrimental effects on young children's executive functioning and communicative-linguistic performance. Conversely, higher quality use positively influences expressive language skills, which are in turn associated with stronger executive abilities. In addition, maternal education not only has a direct positive effect on children's executive and language development, but also an indirect effect on communicative-linguistic skills by fostering more frequent, high-quality child–adult interactions during screen time. These findings underscore the need to limit smartphone exposure in early childhood while emphasizing the importance of embedding screen use within environments that optimize its developmental value. They also highlight the role of parental education in shaping screen-related practices.

RESUMEN
Existe un interés cada vez mayor por entender cómo el uso de teléfonos inteligentes puede afectar el desarrollo infantil temprano. En este estudio, adoptamos un enfoque de variable latente para examinar las prácticas parentales relacionadas con el uso de estos dispositivos y sus efectos en el desarrollo ejecutivo-lingüístico temprano. Específicamente, consideramos dos factores relacionados con este uso: un factor de cantidad, que comprende varias medidas de exposición a estos dispositivos, y un factor de calidad, que refleja la frecuencia con la que las familias emplean estrategias que promueven interacciones contingentes y que apoyan el aprendizaje durante el tiempo frente a pantallas. Además, exploramos el papel de la educación parental en la configuración de estas prácticas. Los resultados indican que una mayor exposición tiene efectos perjudiciales en el funcionamiento ejecutivo y el desempeño comunicativo-lingüístico de los niños pequeños. Por el contrario, una mayor calidad influye positivamente en las habilidades del lenguaje expresivo que, a su vez, se asocian con mejores habilidades ejecutivas. En este contexto, la educación materna no solo muestra un impacto positivo directo en el desarrollo ejecutivo-lingüístico temprano, sino que también tiene un efecto indirecto en las habilidades comunicativo-lingüísticas a través de una mayor frecuencia de interacciones adulto-niño de alta calidad durante el tiempo frente a pantallas. Estos hallazgos apuntan a la necesidad de minimizar la exposición a estos dispositivos en estas edades, al tiempo que destacan la importancia de integrar su uso en entornos que optimicen su valor para el desarrollo. También destacan el papel de la educación parental en la configuración de las prácticas implementadas en el hogar relacionadas con las pantallas.

KEYWORDS · PALABRAS CLAVES
Early child development, executive functioning, language, family practices, smartphone use.
Desarrollo infantil temprano, funcionamiento ejecutivo, lenguaje, prácticas familiares, uso del smartphone.

1. Introduction

Research has found a consistent relationship between language development and executive functions (EFS) in children (Bruce et al., 2023; Kaushanskaya et al., 2017). EFs are cognitive skills that help individuals control their behavior, focus attention, manage time effectively, plan and complete tasks, and solve problems efficiently (Starr et al., 2023). Thus, this construct includes skills such as inhibitory control, memory updating, cognitive flexibility, planning and higher-order problem solving skills (Diamond, 2013; Miyake et al., 2000; Starr et al., 2023). Executive functioning has been shown to be linked to language learning processes in early childhood and in children from diverse backgrounds (White et al., 2017). These processes include fast mapping (the ability to quickly learn new words by associating them with their meanings after minimal exposure), extension (applying newly learned words to similar objects or contexts), and bootstrapping (using existing linguistic knowledge, such as syntax or semantics, to infer the meaning of unfamiliar words or grammatical structures).

There are several ways in which the development of linguistic skills can be related to specific EFs. For example, working memory updating is essential for comprehending oral discourse, as new information must replace or integrate with previously held content. Working memory is also crucial for storing newly acquired words and retrieving them from the mental lexicon. Inhibition and cognitive flexibility also play a role. When a word or expression is heard, multiple lexical entries may be activated, and the listener must select the one most appropriate to the context. Furthermore, inhibition has been shown to correlate with vocabulary and morphosyntactic abilities (Ekerim & Selcuk, 2018; Gandolfi & Viterbori, 2020; Ibbotson & Kearvell-White, 2015). This association is often explained by the idea that the ability to suppress irrelevant stimuli is important for focusing on and learning relevant linguistic input from the environment.

Some studies have found that early linguistic skills predict the subsequent development of EFs (Kuhn et al., 2016; Peredo et al., 2015), suggesting that language plays a crucial role in EFs. Some researchers argue that inner speech supports EFs by enabling individuals to verbally guide themselves through tasks; that is, language facilitates self-regulation (Baron & Arbel, 2022).

A recent review (Shokrkon & Nicoladis, 2022) also examined the role of third variables in explaining the relationship between EFs and language development in early childhood, including biological factors such as brain maturation—particularly the development of the frontal lobes. Contextual factors, such as the nature of adult-child interactions, are also critical in shaping this relationship. For example, engaging children in meaningful conversations not only expands their vocabulary but also enhances their cognitive control and problem-solving abilities (Spruijt et al., 2020).

In recent years, children's screen exposure—that is, the time spent in front of electronic devices with screens (e.g., televisions, computer monitors, laptops, tablets, or smartphones) consuming digital content—has received increasing attention, particularly in relation to its potential impact on child development. Despite recommendations from organizations like the World Health Organization (WHO, 2019) and the American Academy of Pediatrics (AAP, 2016) to limit screen time for young children, studies conducted in several countries show that actual screen exposure far exceeds international guidelines, with children under 5 years of age often spending around 2–3 hours daily on screens (Alroqi et al., 2023; Bhutani et al., 2024; Gomes et al., 2024; Rocha et al., 2023).

Research has consistently shown a negative impact of extensive passive screen exposure on language development (Adelantado-Renau et al., 2019; Bal et al., 2024; Kostyrka-Allchorne et al., 2017; Madigan et al., 2020), as well as on cognitive development and executive functioning (Anderson & Subrahmanyam, 2017; Bal et al., 2024; Oh et al., 2023; Reus & Mosley, 2018; Vanderloo et al., 2022). This aligns with findings from other studies suggesting that high screen use displaces time spent on more beneficial activities, such as child-adult talk/interactions and play, further impacting language development and self-regulation (Brushe et al., 2024; Guellai et al., 2022; Medawar et al., 2023; Nopembri et al., 2023; Sundqvist et al., 2021).

However, a growing body of research suggests that additional factors related to children's screen exposure should be considered, as they may help mitigate its negative effects or even contribute positively to child development. One such factor is context, specifically how children engage with digital content. For instance, a meta-analysis conducted by Madigan et al. (2020) found that co-viewing (watching screens together with a caregiver) was associated with improved language skills in children. In line with this, the quality of interactions during screen time appears to play a crucial role in shaping its impact on cognitive development. Studies have shown that high-quality interactions, characterized by active engagement and conversation during screen viewing, can support language development and cognitive skills, helping to offset some of the negative effects linked to passive screen use (Alroqi et al., 2023; Bal et al., 2024; Tu et al., 2024). Similarly, recent reviews and meta-analyses indicate that supervised exposure to age-appropriate content can be beneficial for children's linguistic and cognitive development, especially when combined with interactive engagement (Guellai et al., 2022; Jing et al., 2023).

Research in this field study has found that socioeconomic and cultural factors also influence screen use and its impact: families with higher socioeconomic status (SES) and higher educational levels are not only more effective at regulating screen time (Fung et al., 2023; Rocha et al., 2023), but also use educational content to support development (Bal et al., 2024).

In summary, the relationship between cognitive-linguistic skills and screen exposure is significantly influenced by both the quantity of screen time and the quality of interactions during that time, with both factors appearing to be shaped by families' SES. Therefore, additional research exploring how these dynamics interact is needed to better understand how to optimize screen use for developmental benefits, particularly during early childhood.

1.1. The present study

This study examines the impact of parental practices related to smartphone use on young children's executive and linguistic development, using a latent variable approach. We hypothesize that families' SES, as indicated by maternal education level, is associated with both the quantity and quality of children's smartphone use. Based on prior research, we expect that children of mothers with lower educational attainment are exposed to screens for longer periods than those whose mothers have higher educational levels. Additionally, we expect that higher maternal educational levels will be associated with more frequent child–adult verbal interactions and greater learning support during screen co-viewing. Finally, we hypothesize that the quantity of screen exposure is negatively related to language

development and executive functioning, whereas the quality of screen exposure is positively related.

2. Methodology

2.1. Participants

The data for this study were drawn from an incidental sample of 207 children between the ages of 3 and 6, along with their families, from various regions of Spain. All participants were Spanish-speaking children born at term, with no history of illness or permanent medical conditions, and no family history of speech or language disorders, learning difficulties, or other neurodevelopmental conditions. Table 1 presents the main demographic and socioeconomic characteristics of the sample.

Table 1

Sociodemographic characteristics of the sample

Variables	***M* (*SD*) [Min – Max] or N (%)**
Child's age (in months)	56.22 (9.76) [36-72]
Child's sex	
Female	117 (56.5)
Male	90 (43.5)
Position in birth order	
First child	114 (55.1)
Other positions	93 (44.9)
Siblings	
No (only child)	75 (36.2)
Yes	132 (63.8)
Entry course	
1st cycle of Early Childhood Education (0-3 years old)	161 (77.8)
2nd cycle of Early Childhood Education (3-6 years old)	46 (22.2)
Socioeconomic status	
With financial difficulties	4 (1.9)
Economic capacity to meet essential needs	19 (9.2)
Economic capacity to save some money	166 (80.2)
High income, no financial worries	18 (8.7)
Maternal education	
Upper or lower secondary (≤12 years)	73 (35.3)
Post-secondary or higher (>12 years)	134 (64.7)
Paternal education[a]	
Upper or lower secondary (≤12 years)	122 (58.9)

Post-secondary or higher (>12 years)	82 (40.2)
Languages spoken by adults in the family with the child	
Only Spanish	141 (68.1)
Spanish plus other language(s)	66 (31.9)
Contact with second language	54 (26.1)
Contact with third language	12 (5.8)
Hours per day that a second language is used with the child	1.50 (4.17) [0-24]
Hours per day that a third language is used with the child	0.08 (0.39) [0-4]

Note. [a]Three families reported the absence of a male parent.

2.2. Measures and instruments

2.2.1. Child's expressive communicative and linguistic skills

The Expressive Language Parent Report from the Merrill-Palmer-Revised Scales (Roid & Sampers, 2011) adapted for the Spanish population, was used to assess children's communicative-linguistic development. This instrument includes 26 items in the form of questions regarding the child's communication and language, which are grouped into three dimensions: word combination and narrative skills (7 items), semantics and morphology (10 items), and use of language and extralinguistic elements (9 items).

Participating families rated each of the 26 items using a 3-point Likert scale, according to how frequently they observed the assessed communicative-linguistic behaviors in their child at home during the time of data collection: (1) never or almost never, (2) rarely, or (3) frequently. The raw score for each dimension was calculated by multiplying the number of responses for the never or almost never option by 1, the rarely option by 2, and the frequently option by 3, and then summing these three values.

For the current sample, score reliability was good across the three dimensions: word combination and narrative skills (ordinal alpha: .83; omega: .82), semantics and morphology (ordinal alpha: .85; omega: .86), and use of language and extralinguistic elements (ordinal alpha: .72; omega: .72).

In this study, the raw score on each of these measures was used as an indicator of the latent variable *expressive communicative-linguistic skills*.

2.2.2. Child's everyday executive functioning

The child's core executive skills were assessed using 3-6 years version of the ATENTO Family Questionnaire (Sánchez-Sánchez & Solar, 2024). ATENTO is a set of questionnaires designed to assess the presence of EF difficulties, as well as potential symptoms of attention deficit hyperactivity disorder (ADHD) and other related issues in children and adolescents aged 3 to 18 years. To accomplish this, the ATENTO questionnaires include statements that describe behaviors commonly associated with EF difficulties and other related problems that may be observed in children and adolescents in their daily lives.

Participating families were asked to indicate how frequently their child exhibited these behaviors over the past 6 months using a 5-point Likert scale: (1) never or almost never, (2) rarely, (3) sometimes, (4) often, or (5) always or almost always. The following scales were used in this study: attentional control (12 items), working memory (10 items), flexibility (8 items), planning and organization (8 items), and temporal processing (5 items). Raw scores were calculated by averaging the scores of the items corresponding to each scale.

Score reliability was high across all scales in the current sample: attentional control (ordinal alpha: .94; omega: .94), working memory (ordinal alpha: .89; omega: .89), flexibility (ordinal alpha: .82; omega: .82), planning and organization (ordinal alpha: .87; omega: .87), and temporal processing (ordinal alpha: .79; omega: .79).

In this study, the raw score on each scale was used as an indicator of the latent variable *everyday executive skills*.

2.2.3. Child's smartphone exposure

Several measures were used to assess children's exposure to smartphones. Each is described below:

- Child's smartphone usage frequency per week

  Parents were asked to estimate how often their child uses a smartphone each week, using a 6-point Likert scale: (1) never, (2) occasionally (less than once per week), (3) once per week, (4) several times per week, (5) every day, or (6) more than once per day.

- Child's daily smartphone usage time

  Parents also reported the average amount of time their child typically spends on a smartphone each day, specifying the duration in hours and minutes.

- Percentage of time the child spends alone with a smartphone

  The information regarding the child's exposure to this type of device was completed with a question that sought to find out how this use occurs. To do so, parents were asked to indicate the approximate percentage of time their child spends alone in front of a smartphone by selecting one of the following five values: 0%, 25%, 50%, 75%, or 100% of the time.

2.2.4. Parental behavior during child's exposure to screens

The quality of screen time was assessed by asking parents to report how frequently they implement a set of five parenting strategies that foster contingent interaction and support their child's learning during co-viewing of digital content, using a five-point Likert scale: (1) not yet, (2) rarely, (3) sometimes, (4) often, or (5) very often. Specifically, the following parental behaviors were considered: discussing the content (or related topics) with the child, answering the child's questions about content (or related topics), exploring the child's understanding through questions, paying attention to the child's interest through

his/her behavior, and clarifying words/concepts. In this study, the reliability of the scores from this questionnaire was also good (ordinal alpha: .85; omega: .86).

2.3. Procedure

This study is part of a broader research project on emergent literacy (PID2021-123962NA-I00), which received approval from the Institutional Ethics Committee of the National University of Distance Education (UNED).

Participating families were invited by both pre-service and in-service teachers. Data were collected through an online survey completed by parents after they provided voluntary and informed consent.

3. Analyses and results

3.1. Analyses

First, the distribution of the variables was assessed using skewness and kurtosis tests. Descriptive statistics were then used to summarize the data. Continuous variables were expressed as means (*M*), standard deviations (*SD*), and minimum and maximum (Min-Max) values, while frequencies and percentages were used for nominal and ordinal variables. Student's *t*-tests and Mann-Whitney *U*-tests were conducted to explore differences associated the child's sex and parental education, with effect sizes being reported in terms of Cohen's *d* value and rank biserial correlation coefficient (r_{rb}), respectively. Spearman's correlations coefficients (ρ) were computed to examine bivariate associations between continuous and ordinal variables. Finally, multivariate interrelationships among study variables were analyzed using structural equation modeling (SEM).

The overall fit of the model under consideration was assessed using a combination of indices, including a chi-square to degrees of freedom ratio (χ^2/df) lower than 2, Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) values close to .95 or above, as well as Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) values close to .06 or below (Brown, 2015).

Univariate and bivariate statistical analyses were performed using IBM SPSS 30 for Windows. SEM was conducted with Mplus 7, using the maximum likelihood with robust standard errors (MLR) estimator. The alpha value was set at .05, and all *p*-values were two-tailed.

3.2. Descriptive and bivariate statistics

Tables 2a, 2b, 3a, and 3b present the descriptive statistics for the outcome measures, both for the full sample and disaggregated by the child's sex and parental education.

No statistically significant differences were found based on the child's sex or paternal education in either expressive or executive skills (all $p>.140$). However, both skill domains varied according to maternal education. Specifically, children whose mothers had a higher

education grade received significantly higher ratings in all expressive communicative-linguistic skills, including word combination and narrative skills (Z=-2.167, p=.030, r_{rb}=.14), semantics and morphology (Z=-4.245, p<.001, r_{rb}=.27), and use of language and extralinguistic elements (Z=-3.416, p<.001, r_{rb}=.18).

Similar results were found in relation to the core executive skills studied: children whose mothers had lower educational levels had greater difficulties in attentional control ($t_{(205)}$=3.000, p=.003, d=.44), working memory ($t_{(121.443)}$=3.230, p<.001, d=.50), planning and organization ($t_{(205)}$=2.517, p=.013, d=.37), and temporal processing ($t_{(124.730)}$=2.549, p=.012, d=.39), although not in flexibility (p=.212).

In relation to smartphone exposure (Tables 4a, 4b, 5a, and 5b), no statistically significant differences were found based on the child's sex or the parental education, either in the frequency per week or in the proportion of time the child spends alone using it (all p>.150). The differences were observed in the amount of time spent per day, and only when maternal education was considered: children whose mothers had a higher education degree spent significantly fewer minutes per day on average than children whose mothers had lower educational levels (Z=-3.324, p<.001, r_{rb}=.23).

Table 2a

Children's performance level in expressive communicative-linguistic skills for full sample and by child's sex

		Total sample (*N*=207)	**Child's sex**	
			Female (*n*=117)	**Male** (*n*=90)
Word combination & narrative skills	*M*	20.38	20.46	20.28
	SD	1.63	1.61	1.67
	Min - Max	8 - 21	8 - 21	11 - 21
Semantics & morphology	*M*	27.97	28.15	27.74
	SD	2.87	2.57	3.22
	Min - Max	14 - 30	14 - 30	16 - 30
Use of language & extralinguistic elements	*M*	25.52	25.62	25.39
	SD	2.00	1.99	2.01
	Min - Max	14 - 27	14 - 27	18 - 27

Table 2b

Children's performance level in expressive communicative-linguistic skills by parental education

		Maternal education		Paternal education	
		≤12 years (*n*=73)	**>12 years** (*n*=134)	**≤12 years** (*n*=122)	**>12 years** (*n*=82)
Word combination & narrative skills	*M*	20.07	20.55	20.26	20.54
	SD	2.06	1.32	1.91	1.14
	Min - Max	8 - 21	11 - 21	8 - 21	15 - 21
Semantics & morphology	*M*	26.92	28.54	27.90	28.07
	SD	3.43	2.34	3.21	2.34
	Min - Max	14 - 30	16 - 30	14 - 30	19 - 30
Use of language & extralinguistic elements	*M*	25.03	25.79	25.56	25.49
	SD	2.15	1.86	2.11	1.87
	Min - Max	14 - 27	18 - 27	14 - 27	18 - 27

Table 3a

Children's performance level in executive skills for full sample and by child's sex

		Total sample (*N*=207)	Child's sex	
			Female (*n*=117)	**Male** (*n*=90)
Attentional control	*M*	1.88	1.86	1.90
	SD	0.65	0.61	0.71
	Min - Max	1.00 - 3.92	1.00 - 3.83	1.00 - 3.92
Working memory	*M*	1.49	1.48	1.52
	SD	0.50	0.47	0.53
	Min - Max	1.00 - 3.00	1.00 - 3.00	1.00 - 2.70
Flexibility	*M*	2.06	2.04	2.09
	SD	0.58	0.59	0.57
	Min - Max	1.00 - 3.88	1.13 - 3.88	1.00 - 3.75
Planning and organization	*M*	1.79	1.79	1.79
	SD	0.60	0.60	0.59
	Min - Max	1.00 - 4.00	1.00 - 4.00	1.00 - 3.25
Temporal processing	*M*	2.05	2.04	2.06
	SD	0.69	0.65	0.74
	Min - Max	1.00 - 4.40	1.00 - 4.00	1.00 - 4.40

Table 3b

Children's performance level in executive skills by parental education

		Maternal education		Paternal education	
		≤12 years (*n*=73)	**>12 years** (*n*=134)	**≤12 years** (*n*=122)	**>12 years** (*n*=82)
Attentional control	*M*	2.06	1.78	1.88	1.86
	SD	0.66	0.63	0.62	0.70
	Min - Max	1.00 - 3.83	1.00 - 3.92	1.00 - 3.92	1.00 - 3.83
Working memory	*M*	1.65	1.41	1.52	1.48
	SD	0.56	0.44	0.51	0.48
	Min - Max	1.00 - 3.00	1.00 - 2.60	1.00 - 2.90	1.00 - 3.00
Flexibility	*M*	2.13	2.02	2.01	2.13
	SD	0.55	0.60	0.53	0.65
	Min - Max	1.13 - 3.75	1.00 - 3.88	1.00 - 3.75	1.13 - 3.88
Planning and organization	*M*	1.93	1.71	1.78	1.81
	SD	0.57	0.60	0.56	0.65
	Min - Max	1.00 - 3.25	1.00 - 4.00	1.00 - 3.25	1.00 - 4.00
Temporal processing	*M*	2.23	1.96	2.11	1.99
	SD	0.77	0.63	0.73	0.62
	Min - Max	1.00 - 4.40	1.00 - 3.60	1.00 - 4.40	1.00 - 3.60

Table 4a

Children's smartphone usage frequency per week for full sample and by child's sex

	Total sample (*N*=207)	**Child's sex**	
		Female (*n*=117)	**Male** (*n*=90)
Never	54 (26.1)	32 (27.4)	22 (24.4)
Occasionally	67 (32.4)	40 (34.2)	27 (30.0)
Once a week	19 (9.2)	12 (10.3)	7 (7.8)
Several times a week	54 (26.1)	28 (23.9)	26 (28.9)
Every day	11 (5.3)	4 (3.4)	7 (7.8)
More than once a day	2 (1.0)	1 (0.9)	1 (1.1)

Table 4b

Children's smartphone usage frequency per week by parental education

	Maternal education		Paternal education	
	≤12 years	**>12 years**	**≤12 years**	**>12 years**
	(*n*=73)	(*n*=134)	(*n*=122)	(*n*=82)
Never	19 (26.0)	35 (26.1)	35 (28.7)	19 (23.2)
Occasionally	17 (23.3)	50 (37.3)	33 (27.0)	33 (40.2)
Once a week	6 (8.2)	13 (9.7)	12 (9.8)	7 (8.5)
Several times a week	26 (35.6)	28 (20.9)	33 (27.0)	19 (23.2)
Every day	5 (6.8)	6 (4.5)	8 (6.6)	3 (3.7)
More than once a day	0 (0.0)	2 (1.5)	1 (0.8)	1 (1.2)

Table 5a

Children's daily smartphone usage time and percentage of that time unsupervised for full sample and by child's sex

		Total sample (*N*=207)	Child's sex	
			Female (*n*=117)	**Male** (*n*=90)
Child's daily smartphone usage time	*M*	19.88	20.55	19.02
	SD	40.95	43.67	37.35
	Min - Max	0 - 300	0 - 300	0 - 300
Percentage of time the child spends alone on the smartphone	*M*	15.46	15.17	15.83
	SD	28.67	27.65	30.09
	Min - Max	0 - 100	0 - 100	0 - 100

Table 5b

Children's daily smartphone usage time and percentage of that time unsupervised by parental education

		Maternal education		Paternal education	
		≤12 years	**>12 years**	**≤12 years**	**>12 years**
		(*n*=73)	(*n*=134)	(*n*=122)	(*n*=82)
Child's daily smartphone usage time	*M*	29.55	14.62	20.91	17.93
	SD	46.08	37.00	41.28	41.17
	Min - Max	0 - 300	0 - 300	0 - 300	0 - 300
Percentage of time the child spends alone on the smartphone	*M*	19.86	13.06	14.34	16.46
	SD	33.32	25.60	27.26	29.72
	Min - Max	0 - 100	0 - 100	0 - 100	0 - 100

In relation to parental behavior during children's screen exposure (Tables 6a and 6b), no statistically significant differences based on the child's sex were found in the parental strategies used during co-viewing of digital content, at least in relation to those considered in this study (all p>.260). Regarding parental education, families with higher education levels reported answering their child's content-related questions during screen time more often than the ones with less educated parents (mothers: Z=-2.947, p=.003, r_{rb}=.31; fathers: Z=-2.336, p=.019, r_{rb}=.15). Furthermore, families with mothers with a higher education degree also reported a significantly higher frequency of behaviors related to exploring their child's understanding, as well as observing their child's behavior to assess his/her level of interest, than families with mothers with lower educational levels (Z=-2.550, p=.011, r_{rb}=.21 and Z=-3.029, p=.002, r_{rb}=.21, respectively). Differences associated with maternal education were also found, although marginally significant, in the frequency with which families reported that they implemented behaviors such as discussing with their child the content viewed (or related topics) or clarifying words/concepts unknown to the child (Z=-1.775, p=.076, r_{rb}=.21 and Z=-1.717, p=.086, r_{rb}=.11, respectively).

Table 6a

Parental behaviors during child's exposure to screens for full sample and by child's sex

		Total sample (*N*=207)	Child's sex	
			Female (*n*=117)	Male (*n*=90)
Discuss the content with the child	Not yet	4 (1.9)	3 (2.6)	1 (1.1)
	Rarely	18 (8.7)	6 (5.1)	12 (13.3)
	Sometimes	67 (32.4)	44 (37.6)	23 (25.6)
	Often	71 (34.3)	35 (29.9)	36 (40.0)
	Very often	47 (22.7)	29 (24.8)	18 (20.0)
Answer child's questions	Not yet	1 (0.5)	1 (0.9)	0 (0.0)
	Rarely	5 (2.4)	2 (1.7)	3 (3.3)
	Sometimes	18 (8.7)	12 (10.3)	6 (6.7)
	Often	77 (37.2)	43 (36.8)	34 (37.8)
	Very often	106 (51.2)	59 (50.4)	47 (52.2)
Explore child's understanding	Not yet	1 (0.5)	1 (0.9)	0 (0.0)
	Rarely	26 (12.6)	11 (9.4)	15 (16.7)
	Sometimes	75 (36.2)	43 (36.8)	32 (35.6)
	Often	61 (29.5)	37 (31.6)	24 (26.7)
	Very often	44 (21.3)	25 (21.4)	19 (21.1)
Observe child's interest	Not yet	1 (0.5)	1 (0.9)	0 (0.0)
	Rarely	9 (4.3)	5 (4.3)	4 (4.4)
	Sometimes	47 (22.7)	22 (18.8)	25 (27.8)
	Often	87 (42.0)	51 (43.6)	36 (40.0)
	Very often	63 (30.4)	38 (32.5)	25 (27.8)
Clarify words and/or concepts	Not yet	1 (0.5)	1 (0.9)	0 (0.0)
	Rarely	7 (3.4)	4 (3.4)	3 (3.3)
	Sometimes	36 (17.4)	21 (17.9)	15 (16.7)
	Often	82 (39.6)	43 (36.8)	39 (43.3)
	Very often	81 (39.1)	48 (41.0)	33 (36.7)

Table 7 reports bivariate correlations among the observed study variables. As expected, the highest correlations were primarily found between indicators of each latent variable, supporting both convergent and discriminant validity. There was no relationship between the measures related to quantity and those associated with quality. Exposure measures were generally linked to poorer executive-linguistic skills. Conversely, parental strategies

implemented during screen time had a stronger effect on linguistic performance than on executive functioning, although their significant correlations with working memory indicate some benefit of these practices at the executive level as well.

Table 6b

Parental behaviors during child's exposure to screens by parental education

		Maternal education		Paternal education	
		≤12 years	>12 years	≤12 years	>12 years
		(*n*=73)	(*n*=134)	(*n*=122)	(*n*=82)
Discuss the content with the child	Not yet	1 (1.4)	3 (2.2)	2 (1.6)	2 (2.4)
	Rarely	12 (16.4)	6 (4.5)	13 (10.7)	5 (6.1)
	Sometimes	24 (32.9)	43 (32.1)	39 (32.0)	26 (31.7)
	Often	21 (28.8)	50 (37.3)	41 (33.6)	30 (36.6)
	Very often	15 (20.5)	32 (23.9)	27 (22.1)	19 (23.2)
Answer child's questions	Not yet	0 (0.0)	1 (0.7)	0 (0.0)	1 (1.2)
	Rarely	4 (5.5)	1 (0.7)	5 (4.1)	0 (0.0)
	Sometimes	9 (12.3)	9 (6.7)	12 (9.8)	5 (6.1)
	Often	32 (43.8)	45 (33.6)	50 (41.0)	26 (31.7)
	Very often	28 (38.4)	78 (58.2)	55 (45.1)	50 (61.0)
Explore child's understanding	Not yet	0 (0.0)	1 (0.7)	0 (0.0)	1 (1.2)
	Rarely	17 (23.3)	9 (6.7)	19 (15.6)	7 (8.5)
	Sometimes	24 (32.9)	51 (38.1)	42 (34.4)	32 (39.0)
	Often	22 (30.1)	39 (29.1)	36 (29.5)	24 (29.3)
	Very often	10 (13.7)	34 (25.4)	25 (20.5)	18 (22.0)
Observe child's interest	Not yet	0 (0.0)	1 (0.7)	1 (0.8)	0 (0.0)
	Rarely	7 (9.6)	2 (1.5)	6 (4.9)	3 (3.7)
	Sometimes	20 (27.4)	27 (20.1)	27 (22.1)	20 (24.4)
	Often	32 (43.8)	55 (41.0)	54 (44.3)	31 (37.8)
	Very often	14 (19.2)	49 (36.6)	34 (27.9)	28 (34.1)
Clarify words and/or concepts	Not yet	0 (0.0)	1 (0.7)	1 (0.8)	0 (0.0)
	Rarely	4 (5.5)	3 (2.2)	3 (2.5)	4 (4.9)
	Sometimes	16 (21.9)	20 (14.9)	20 (16.4)	14 (17.1)
	Often	29 (39.7)	53 (39.6)	50 (41.0)	32 (39.0)
	Very often	24 (32.9)	57 (42.5)	48 (39.3)	32 (39.0)

Table 7

Spearman's correlations between ordinal and continuous variables of the study

	1	2	3	4	5	6	7	8
1								
2	-.017							
3	-.043	.676***						
4	.049	.486***	.524***					
5	.059	-.092	-.124†	-.002				
6	-.026	-.086	-.114	-.066	.553***			
7	.109	-.011	-.058	-.022	.678***	.356***		
8	-.040	-.059	-.082	.012	.553***	.458***	.547***	
9	.055	-.076	-.083	-.052	.536***	.563***	.538***	.597***
10	.158*	-.087	-.214**	-.054	.106	.090	.185**	.190**
11	.316***	-.122†	-.291***	-.143*	.141*	.167*	.257***	.246***
12	.130†	-.143*	-.232***	-.119†	.302***	.120†	.351***	.301***
13	-.050	.216**	.194**	.166*	.016	-.089	-.012	-.084
14	-.239***	.227***	.196**	.120†	-.176*	-.212**	-.180**	-.228***
15	.003	.136†	.097	.069	-.067	.000	-.148*	-.165*
16	-.130†	.271***	.209**	.169*	-.080	-.133†	-.094	-.154*
17	-.283***	.198**	.129†	.086	-.130†	-.150*	-.120†	-.127†

	9	10	11	12	13	14	15	16	17
1									
2									
3									
4									
5									
6									
7									
8									
9									
10	.130†								
11	.200**	.468***							
12	.194**	.322***	.519***						
13	-.043	-.110	-.203**	-.185**					
14	-.245***	-.272***	-.346***	-.291***	.718***				
15	-.060	-.084	-.143*	-.128†	.643***	.525***			
16	-.137*	-.157*	-.180**	-.187**	.853***	.749***	.631***		
17	-.170*	-.235***	-.292***	-.177*	.524***	.575***	.466***	.557***	

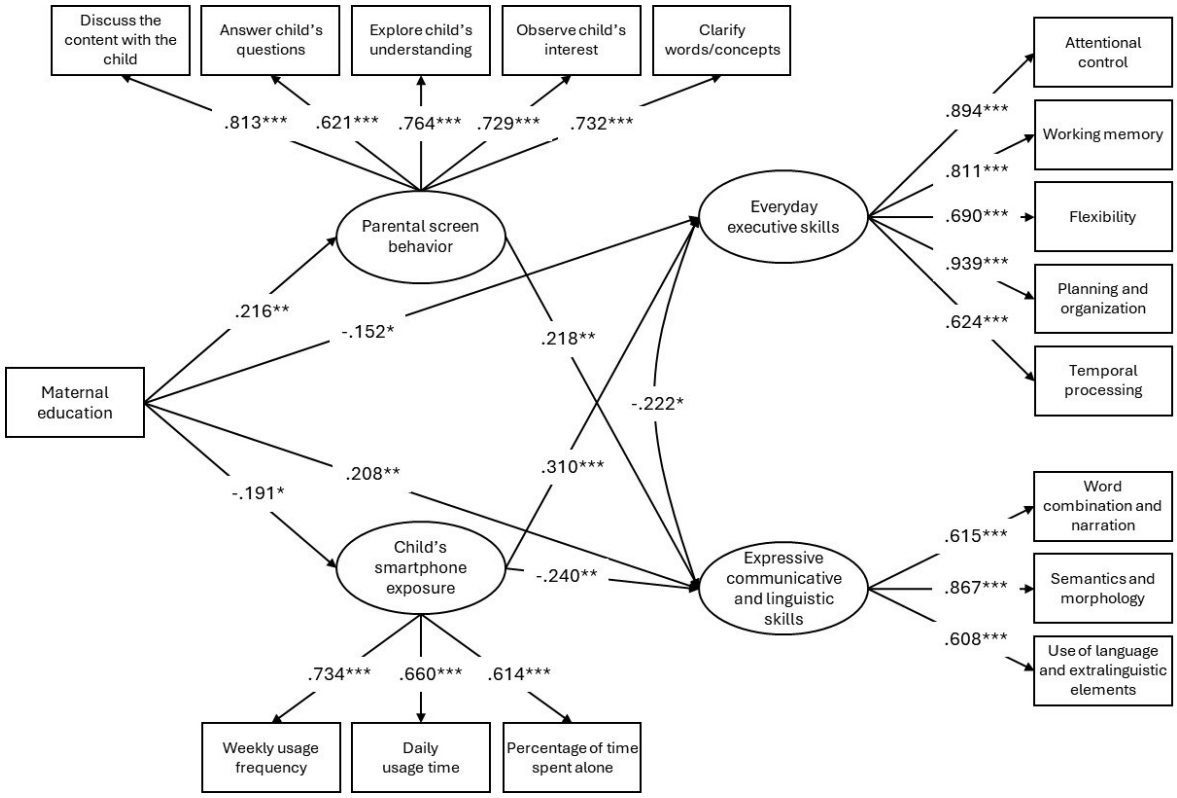
Note. 1: child's age (in months); 2: child's smartphone usage frequency per week; 3: child's daily smartphone usage time (in minutes); 4: percentage of time the child spends alone on the smartphone; 5-9: items from questionnaire on parental behavior during child's exposure to screens; 10: word combination and narrative skills; 11: semantics and morphology; 12: use of language and extralinguistic elements; 13: attentional control; 14: working memory; 15: flexibility; 16: planning and organization; 17: temporal processing. †p<.10; *p<.05; **p<.01; ***p<.001.

3.3. Structural equation modeling

The fit of the tested model was acceptable: $\chi^2_{(112)}$=182.009, *p*<.001, CFI=.944, TLI=.932, RMSEA=.055 [.040,.069], SRMR=.055. As shown in Figure 1, higher maternal education levels were significantly associated with lower smartphone exposure in children and a higher frequency of responsive, learning-supportive parental behaviors during screen time, as well as better executive-linguistic development in children. In turn, more frequent contingent interactions and responsive parental input during children's digital content viewing were significantly linked to stronger expressive communicative-linguistic skills, although not to children's everyday executive functioning (which is why their effect is ultimately not included in the model). On the other hand, greater smartphone exposure was significantly associated with poorer expressive communicative-linguistic skills and more everyday executive difficulties. Finally, better executive functioning was related to stronger communication and expressive language skills in young children, according to parent reports.

Figure 1

SEM illustrating the relationships between children's executive-linguistic development, parental practices related to smartphone use, and maternal education



Note. Standardized coefficients are depicted. **p*<.05; ***p*<.01; ****p*<.001.

Table 8 presents the indirect effects of maternal education in the proposed model. Maternal education significantly and indirectly predicted children's expressive communicative-linguistic skills through parental screen-time behaviors. However, its indirect

effect on children's executive and expressive skills via children's smartphone exposure was only marginally significant.

Table 8

Indirect effects (standardized estimates) linking maternal education and executive-linguistic development

Indirect effects	Estimate	SE	*p*
Maternal education → Parental screen behavior → Expressive skills	0.047	0.023	.045
Maternal education → Children's smartphone exposure → Expressive skills	0.046	0.026	.079
Maternal education → Children's smartphone exposure → Executive skills	-0.059	0.032	.062

4. Discussion and conclusions

The present study examined the impact of parental practices related to smartphone use on young children's executive and linguistic development, considering both the quantity and quality of screen time.

Consistent with previous research (Adelantado-Renau et al., 2019; Anderson & Subrahmanyam, 2017; Bal et al., 2024; Madigan et al., 2020; Oh et al., 2023; Reus & Mosley, 2018; Vanderloo et al., 2022), our findings suggest that greater exposure to smartphones is associated with poorer executive and linguistic outcomes in young children. However, our results also indicate that high-quality interactions during screen time can help mitigate some of these negative effects. Specifically, when parents actively engage with their children by answering questions, discussing content, and supporting learning, the detrimental impact of screen time is reduced.

This study further highlights the role of maternal education in shaping these outcomes. In line with earlier findings (e.g., Rocha et al., 2023), children of more highly educated mothers were exposed to screens for shorter periods and benefited from more high-quality interactions during screen time. These factors, in turn, contributed to stronger expressive language skills, which were also positively linked to executive functioning. This aligns with research suggesting that socioeconomic factors, including parental education, influence the home learning environment and the quality of linguistic and cognitive stimulation children receive (Bal et al., 2024; Fung et al., 2023).

The findings of this research carry several practical and policy implications. On one hand, efforts should focus on developing programs that equip parents with strategies to limit passive screen use and encourage interactive co-viewing experiences. Supporting parents in discussing content, asking questions, and engaging in meaning-making conversations with their children during screen time may help mitigate the risks associated with smartphone exposure. On the other hand, policymakers should consider revising screen time guidelines to address not only the quantity of exposure but also the quality of interactions during screen use.

Several limitations of this study should be acknowledged, including reliance on parental reports, incidental sampling, and the cross-sectional design. Further research is needed to investigate the long-term effects of smartphone exposure on executive and linguistic skills

beyond early childhood. Additionally, future studies should examine other moderating factors not addressed in the current study, such as access to educational content, parental screen habits, and both digital and verbal skills.

Overall, this study highlights the importance of considering both the quantity and quality of smartphone use in early childhood. While excessive exposure is associated with poorer cognitive and linguistic outcomes, high-quality parental engagement during screen time may act as a protective factor. These findings highlight the need for targeted interventions and policy initiatives that help families optimize screen use for early childhood development.

Author Contributions
Conceptualization: M.T.M.-A., D.d.R., I.C., data curation: M.T.M.-A., formal analysis: M.T.M.-A., I.C., funding acquisition: M.T.M.-A.; investigation: M.T.M.-A., D.d.R., C.T.-S., I.C.; methodology: M.T.M.-A., D.d.R., I.C.; project administration: M.T.M.-A.; resources: M.T.M.-A.; supervision: M.T.M.-A.; visualization: M.T.M.-A., I.C.; writing-original draft preparation: M.T.M.-A., I.C.; writing-review and editing: M.T.M.-A., D.d.R., C.T.-S., I.C.

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Data Availability Statement
The data set used in this study is available at reasonable request to the corresponding author

Ethics approval
Not aplicable

Consent for publication
All authors have consented to the publication of the results obtained by means of the corresponding consent forms.

Conflicts of interest
This study was approved by the Institutional Ethics Committee of the National University of Distance Education.

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