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Screen Time in 36-month-olds at Increased Likelihood for ASD and ADHD

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Highlights

- 36-month-old children with elevated ADHD symptoms had the most screen time.
- Higher screen time was associated with lower receptive/expressive language scores.
- Screen time was associated with behavioral phenotype, not family history of ASD/ADHD.
- Screen time reduction strategies and behavioral management support may benefit families of young children.

Abstract

We examined the relationship between video-based media viewing (screen time), behavioral outcomes, and language development in 120 36-month-old children with a family history of Autism Spectrum Disorder (ASD) or Attention-Deficit/Hyperactivity Disorder (ADHD) or no family history of either condition. Participants were classified into one of three diagnostic groups: ASD (n=20), ADHD Concerns (children with elevated ADHD symptoms; n=14), or Comparison (n=86). Children in the ADHD Concerns group spent more time viewing screen media than Comparison children. Increased screen time was associated with lower receptive and expressive language scores across groups. Future longitudinal studies are needed to determine the direction of effects and causality.

Keywords: ASD, ADHD, Screen Time, Preschool Children, Language Development

Screen Time in 36-month-olds at Increased Likelihood for ASD and ADHD

1. Introduction

The amount of time children spend viewing electronic media (hereafter referred to as “screen time”) has increased dramatically in the last two decades (Chen & Adler, 2019) despite research demonstrating significant associations with a variety of negative developmental outcomes (Hinkley et al., 2014; Lin, Cherng, Chen, Chen, & Yang, 2015; Tomopoulos et al., 2010). The latest recommendations issued by the American Academy of Pediatrics (AAP) suggest no independent screen time for children younger than age 2 and no more than 1 hour per day for children 2 to 5 years of age (AAP Council on Communications and Media, 2016). Preschoolers who engage in screen time more than 2 hours per day demonstrate increased emotion dysregulation and diminished prosocial behavior (Domingues-Montanari, 2017; Stiglic & Viner, 2019), elevated inattention and hyperactivity (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Landhuis, Poulton, Welch, & Hancox, 2007; Wu et al., 2017), and lower language (Byeon & Hong, 2015; Duch et al., 2013; Hutton et al., 2019; Zimmerman,Christakis, & Meltzoff, 2007) among a range of other negative associations relevant to child health and well being.

Longitudinal studies in community samples suggest that increased screen time may contribute to delayed developmental milestones, increased inattention, and lower language skills over time (Madigan, Browne, Racine, Mori, & Tough , 2019; Tamana et al., 2019; Tomopoulos et al., 2010). These

associations may be especially relevant to subgroups of children at increased risk for developmental delays and/or behavioral difficulties, such as those with a family history of Autism Spectrum Disorder (ASD) or Attention-Deficit/ Hyperactivity Disorder (ADHD).

Children with a first-degree relative diagnosed with ASD and/or ADHD are at increased likelihood for receiving these diagnoses themselves (Miller et al., 2019; Ozonoff et al., 2011) and are also more likely to experience other behavioral challenges or subthreshold symptoms of either disorder (Clifford et al., 2013; Messinger et al., 2013; Miller et al., 2018; Toth, Dawson, Meltzoff, Greenson, & Fein, 2007). Children diagnosed with ASD and ADHD have been shown to view greater amounts of screen media than typically developing children (Ceranoglu, 2018; Lingineni et al., 2012; Slobodin, Heffler, & Davidovitch, 2019), putting them at greater risk for the negative effects of increased screen time documented in the literature. Children with developmental delays and/or behavior problems may be the most vulnerable to the negative effects of excess screen time due to the developmentally beneficial interactions that screen time may replace (American College of Pediatricians, 2016; Pempek, Kirkorian, & Anderson, 2014; Roseberry, Hirsh-Pasek, & Golinkoff, 2014).

To our knowledge, screen time has not previously been examined in young children with a family history of ASD or ADHD, despite the demonstrated associations between screen time, language development, and these diagnoses. This study examines the relationship between screen

time, diagnostic status, and language development in 36-month-old children more likely to exhibit atypical development due to a family history of ASD or ADHD. Based on the previous literature, we hypothesized that 36-month-old children diagnosed with ASD and those with elevated ADHD symptoms would engage in more screen time than comparison children. In addition, we hypothesized a negative association between screen time and language development.

2. Method

2.1 Overview of Procedures

This study is a cross-sectional analysis of data at the 36-month time point from a prospective longitudinal investigation of children at increased familial risk for ASD and ADHD. The research was conducted under the approval of the university's Institutional Review Board and informed consent was obtained for all participants. Clinical assessments were conducted by Masters- or Ph.D.-level examiners trained to reliability on all measures and unaware of familial risk group, previous test results, or diagnoses.

2.2 Participants

2.2.1 Recruitment Groups: The sample included 120 36-month-old children with increased likelihood to develop either ASD (n = 62) or ADHD (n = 30) based on the diagnostic status of an older sibling (ASD or ADHD) or parent (ADHD), or with no family history of either disorder (n = 28) in first, second, or third degree relatives. Participants were recruited between 6 and 18 months of age (M = 7.45 months, SD = 2.37). To verify recruitment group

status, proband diagnoses of ASD were confirmed via diagnostic reports from a clinician and a score above the diagnostic cut-off for ASD on the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2; Lord et al., 2012). Proband diagnoses of ADHD were confirmed via diagnostic reports from a clinician or documentation of treatment for ADHD. When medical records were not available for sibling probands, an evaluation was performed by the study team to confirm diagnosis. When medical records were not available for parent probands (Familial ADHD group only), eligibility was established by self-report of prior ADHD diagnosis and *T*-scores of $\geq$ 65 on the ADHD Index of the Conners Adult ADHD Rating Scale (CAARS; Conners, Erhardt, & Sparrow, 1999) as rated by the partner/spouse. Exclusion criteria for the higher-likelihood groups (Familial ASD and Familial ADHD) included diagnosis of a genetic disorder in the proband and birth before 32 weeks gestation in the participating child.

The primary inclusion criterion for children in the lower-likelihood group (No Familial ASD/ADHD) was status as a younger sibling of a child with typical development. Exclusion criteria for this group included birth before 37 weeks gestation; developmental, learning, or genetic conditions in any older sibling; and ASD or ADHD in a first-, second-, or third-degree relative.

2.2.2 Outcome Groups: Study participants were classified into one of three groups based on a standardized diagnostic evaluation conducted at 36 months of age. The ASD group (n = 20) met Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (*DSM-5;* American Psychiatric

Association, 2013) criteria for ASD and obtained a score over the ASD cutoff on the ADOS-2. The ADHD Concerns group (n = 14) included children who exhibited developmentally atypical levels of inattention and/or hyperactivity-impulsivity. Though the median age of ADHD diagnosis is 7 years of age (Visser, et al., 2014), symptoms of the disorder are believed to emerge earlier in development, indicating elevated risk for later diagnosis (Curchack-Licktin, Chacko, & Halperin, 2014; Miller et al., 2018). Following the approach taken by Hatch et al. (2020), children in this group had a clinical best estimate outcome of "ADHD Concerns" based on examiner observation during the evaluation, 4 or more *DSM-5* symptoms of ADHD in either the inattentive or hyperactive domain *or* 5 or more *DSM-5* symptoms across both domains, *and* at least one symptom endorsed by 2 or more raters based on the ADHD-RS (parent and teacher report) or a *DSM-5* checklist (examiner). Children rated by examiners as having elevated ADHD symptoms in *addition* to an ASD diagnosis (n = 6) were included in the ASD group based on their primary diagnosis of ASD. The Comparison group (n = 86) included all other participants from all recruitment groups who did not meet criteria for ASD or ADHD Concerns.

2.3 Measures

2.3.1 Screen Time. Parents completed a questionnaire indicating the number of hours their child spent watching television programs, movies, and streaming media content on any device on a typical recent weekday and weekend day (rating scale: 0, < 1, 1, 2, 3, or $\geq$ 4 hours per day). Responses

of less than 1 hour and 4 or more hours were coded as 0.5 and 4 respectively. Following prior work (Madigan et al., 2019; Zimmerman et al., 2007), a weighted daily average was used as the primary variable for analysis, calculated by multiplying the weekday response by 5, the weekend response by 2, and dividing the sum of these by 7. This resulted in a possible range for the screen time variable of 0 to 4 hours per day.

Most prior studies of screen time have examined time spent watching television and/or videos and these activities account for the preponderance of screen time in young children (Chen et al., 2019; Rideout, 2017). To facilitate comparison with previous research, a question regarding other screen media use (including interactive educational content, playing video games, browsing the internet, or using social media) was not included in the calculation of screen time for analyses. The amount of time spent on these heterogeneous activities did not differ between outcome groups (*p*s > 0.80) and, consistent with prior research at this age (Rideout, 2017), comprised a low proportion (0.22) of total screen media use in our sample.

2.3.2 Mullen Scales of Early Learning (MSEL; Mullen, 1995). This standardized developmental test for children birth to 68 months has high internal consistency (median 0.91) and test–retest reliability (median 0.84). The Expressive and Receptive Language subscale *T*-scores ($M = 50$, $SD = 10$) were used in the current analyses to assess language development.

2.3.3 Autism Diagnostic Observation Schedule, Second Edition (ADOS-2). This semi-structured play-based interaction and observation, was

administered to all participants to assess symptoms, determine outcome classification, and confirm proband ASD diagnosis. Following ADOS-2 guidelines, the Module 1 protocol was administered to children with language development at the pre-verbal or single word level (n = 18) and Module 2 was administered to children with phrase speech (n = 102).

2.3.4 Attention-Deficit/Hyperactivity Disorder Rating Scale – Preschool Version (ADHD-RS). The ADHD-RS, a measure demonstrating excellent reliability and validity (McGoey, DuPaul, Haley, & Shelton, 2007), was used to collect parent-reported ADHD symptoms for outcome group classification. Whenever possible, an additional rater familiar with the child (e.g., daycare provider, preschool teacher) also completed the rating scale (n = 75).

2.4 Analytic Plan

Analysis of variance (ANOVA), followed by planned comparisons between groups, was employed to examine the effects of outcome group on screen time. Regression analyses were employed to examine concurrent associations between screen time and receptive and expressive language. To control for potential effects of relevant outcome and demographic factors, outcome groups (i.e., ASD or ADHD Concerns) were dummy-coded and added to the models, as well as sex and maternal education. Interaction terms (i.e., screen time with outcome groups, sex, and maternal education) were tested, but none were significant and therefore not retained in final models. Variables were entered into the regression models simultaneously.

3. Results

The effect of family history of diagnosis (i.e., recruitment group) on screen time was not significant, $F(2, 115) = 1.57$, $p = 0.21$, and therefore recruitment group was not included in subsequent analyses.

Maternal education was significantly correlated with screen time, $F(1, 115) = 14.13$, $p < 0.001$), so it was included in the ANOVAs as a covariate. There was a significant effect of outcome group on screen time, $F(2, 115) = 4.28$, $p = 0.002$, after adjusting for maternal education. Post hoc analyses, using Bonferroni adjustment for multiple comparisons, indicated that this main effect was due to significantly greater mean hours of screen time in the ADHD Concerns group (adjusted $M = 2.18$, Standard Error (SE) = 0.23) than the Comparison group (adjusted $M = 1.54$, $SE = 0.09$), $p = 0.03$. There were no significant differences (ps > 0.20) in screen time between the ASD group and either the Comparison group or the ADHD Concerns group.

Model parameters for the regression analyses are presented in Table 2. Screen time was significantly associated with language scores (receptive: $\beta = -0.31$, $SE = 0.99$, $p < 0.001$; expressive: $\beta = -0.26$, $SE = 0.95$, $p = 0.002$), after accounting for outcome, sex, and maternal education. As expected, ASD status was associated with lower language performance (receptive: $\beta = -0.49$, $SE = 2.31$, $p < 0.001$; expressive: $\beta = -0.52$, $SE = 2.22$, $p < 0.001$) compared to the Comparison group. Male sex was associated with lower expressive language scores ($\beta = -0.16$, $SE = 1.56$, $p = 0.03$). There was no association between sex and receptive language scores ($\beta = -0.13$, $SE =$

1.62, $p = 0.07$). There was no effect of ADHD Concerns outcome or maternal education on receptive or expressive language performance.

4. Discussion

This study found that 36-month-old children with elevated ADHD symptoms spent significantly more time viewing screen media than the Comparison group. This is consistent with prior research demonstrating that older children meeting full criteria for ADHD engage in greater amounts of screen time (Ceranoglu, 2018) and suggests that this association exists much earlier in development, even when symptoms of ADHD are just emerging.

Counter to our hypothesis, screen time for children diagnosed with ASD did not differ from the Comparison group. Although several previous studies have reported increased screen time in children with ASD (for review see Slobodin et al., 2019), a recent nationally representative epidemiological study comparing screen time in a large group of children with ASD (n = 1393) to those without ASD (n = 64,163) found no group differences (Montes, 2016), consistent with our findings.

There were no differences in screen time based on recruitment group, indicating that screen time is associated with behavioral phenotypes and not with likelihood for diagnosis based on family history.

Consistent with our hypothesis, screen time was associated with lower language abilities across all groups, with both receptive and expressive language scores decreasing with increased screen time. Even when

controlling for the expected effects of outcome group, children with the highest amount of screen time demonstrated the lowest language development. This finding is particularly relevant to our sample, which is already at high risk for a variety of delays, including language (Marrus et al., 2018; Mueller & Tomblin, 2012).

Although participants were part of a larger longitudinal study, the variable of interest to the present analyses was collected at only a single time point and thus directionality of effects cannot be established. Both ASD and ADHD are disorders with multifactorial etiologies and high heritability (Faraone et al., 2005; Rommelse, Franke, Geurts, Hartman, & Buitelaar, 2010; Tick, Bolton, Happé, Rutter, & Rijsdijk, 2016), but neither is solely genetically determined and there is a great search for environmental factors that may increase risk. It is possible that increased screen time may have a negative impact on behavior and developmental progress, even if it is not causal to an underlying disorder. Children with challenging behaviors, such as those with increased inattention and hyperactivity, may be given greater access to screen media by parents to help manage their behaviors (Radesky, Silverstein, Zuckerman, & Christakis, 2014; Thompson, Adair, & Bentley, 2013). However, these children may be more vulnerable to the loss of real-world learning opportunities incurred as viewing time increases and may supplant developmentally beneficial interactions, potentially further exacerbating behavioral difficulty. Children in high-risk groups may be differentially susceptible to a variety of negative environmental effects on

development (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007), including screen time. Additional study of the impact of screen time on children exhibiting developmental delay and/or behavioral problems is needed.

This study is the first to examine relationships among screen time, behavioral outcomes, and language in a preschool-aged sample of children at increased risk of developmental and/or behavioral challenges. Though most previous studies of screen time have included larger community samples, the majority have relied solely on parent report for outcome measures. A strength of the current study is our data collection methods, which include diagnostic and language assessments conducted by expert examiners unaware of risk status or previous testing.

Our study has several limitations. In keeping with most studies of child media habits, screen time data was collected via parent estimates and may not accurately capture, and likely underestimates, the amount of screen media viewed by children per day. Data regarding the screen media content (e.g., educational vs. entertainment) was not collected, and therefore we were unable to examine whether relationships with screen time varied by type of content. The results in our sample of children at increased likelihood for ASD and ADHD may not be generalizable to other groups at risk for behavioral difficulties or developmental delay. Because these data were collected at a single time point, the current analyses cannot address the direction of effects and causality. Longitudinal examination of screen time

and developmental outcomes is necessary to better understand the mechanism of the associations and also evaluate diagnostic status in the ADHD concerns group at later ages. Although children in the ADHD Concerns group exhibited elevated symptoms of ADHD, given the young age of our sample, most did not yet meet *DSM-5* diagnostic criteria. The sample in this study is being followed longitudinally into later childhood, which will help address some of these limitations.

5. Conclusion

As hypothesized, higher amounts of screen time were observed in children with ADHD concerns and there was a negative association between screen time and language development in all outcome groups. Counter to our hypothesis, screen time in children with ASD was intermediate to the two other outcome groups and did not differ significantly from either group.

Efforts to increase parental awareness of the potential negative effects of increased screen time on child development are necessary given that, on average, children in the United States exceed the AAP recommended daily amount of screen time by more than double (Rideout, 2017). Our study supports the literature demonstrating an association between increased screen time and diminished language development in young children and extends the findings to include children with below average language development and other delays and/or behavior problems. The findings also demonstrate that young children with elevated symptoms of ADHD may be the most likely to engage in excess screen time in this age group.

Less screen time is consistently associated with more positive outcomes on a variety of measures of development, language, and behavior, although underlying mechanisms are not well understood. Screen time reduction is a simple and benign intervention that may have a positive effect on child development. Providing increased education and guidance to parents including behavioral management support and specific strategies and alternatives to help reduce the use of screen time may benefit families with young children, particularly those with developmental difficulties.

CRediT Author Statement

Monique Moore Hill: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft, Visualization, Project Administration. **Devon Gangi:** Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft. **Meghan Miller:** Conceptualization, Methodology, Resources, Writing – Review & Editing, Supervision, Project Administration, Funding Acquisition**. Sabrina Mohamed Rafi:** Methodology, Investigation, Writing – Review & Editing, Visualization. **Sally Ozonoff:** Conceptualization, Methodology, Resources, Writing – Review & Editing, Supervision, Project Administration, Funding Acquisition.

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Table 1. Sample characteristics by outcome group

	ASD	ADHD Concerns	Comparison
Recruitment Group	*n* (%)	*n* (%)	*n* (%)
Familial ASD	19 (95%)	7 (50%)	36 (41%)
Familial ADHD	1 (5%)	7 (50%)	22 (26%)
No Familial ASD/ADHD	0 (0%)	0 (0%)	28 (32%)
Sex			
Male	13 (65%)	9 (64%)	44 (51%)
Race/Ethnicity[a]			
Non-Hispanic Caucasian	9 (45%)	5 (36%)	46 (54%)
Hispanic	2 (10%)	2 (14%)	8 (9%)
Non-White or Multiracial	9 (45%)	5 (36%)	31 (36%)
Maternal Education[b,d]			
No college degree	9 (45%)	7 (50%)	17 (20%)
College degree or	10 (50%)	7 (50%)	69 (80%)

higher			
Income[c]			
≤ $80,000	7 (35%)	8 (57%)	24 (28%)
> $80,000	12 (60%)	5 (36%)	50 (58%)
Screen Time	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Hours per day	2.03 (0.94)	2.33 (0.94)	1.49 (0.85)
Mullen T-Scores			
Receptive Language	34.65 (13.70)	45.71 (7.89)	51.44 (8.42)
Expressive Language	38.65 (14.90)	50.71 (8.45)	55.65 (7.28)

Note. [a]Missing for 2 in ADHD Concerns group and 1 in Comparison group. [b]Missing for 1 in ASD group. [c]Missing for 1 in ASD group, 1 in ADHD concerns group, and 12 in Comparison group. [d]Maternal education was not significant in the regression analysis.

Table 2. Regression models predicting receptive and expressive language at 36 months from screen time

		Estimate (β)	*SE*	*p*
Receptive Language	Screen Time	-0.31	0.99	< .001
	ASD group	-0.49	2.31	< .001
	ADHD Concerns group	-0.05	2.65	.491
	Sex	-0.13	1.62	.077
	Maternal Education	-0.04	2.02	.641
	Summary	R^2	0.44	
Expressive Language	Screen Time	-0.26	0.95	.002
	ASD group	-0.52	2.22	< .001
	ADHD concerns group	-0.04	2.55	.561
	Sex	-0.16	1.56	.031
	Maternal Education	-0.05	1.95	.531
	Summary	R^2	0.45	

Note: *SE* = standard error.

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