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Infant Media Exposure and Toddler Development

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Abstract

Objective—To determine whether duration and content of media exposure in 6-month-old infants are associated with development at age 14 months.

Design—Longitudinal analysis of 259 mother-infant dyads participating in a long-term study related to early child development, from November 23, 2005, through January 14, 2008.

Setting—An urban public hospital.

Participants—Mothers with low socioeconomic status and their infants.

Main Exposure—Duration and content of media exposure at age 6 months.

Main Outcome Measures—Cognitive and language development at age 14 months.

Results—Of 259 infants, 249 (96.1%) were exposed to media at age 6 months, with mean (SD) total exposure of 152.7 (124.5) min/d. In unadjusted and adjusted analyses, duration of media exposure at age 6 months was associated with lower cognitive development at age 14 months (unadjusted: $r=-0.17$, $P<.01$; adjusted: $\beta=-0.15$, $P=.02$) and lower language development ($r=-0.16$, $P<.01$; $\beta=-0.16$, $P<.01$). Of 3 types of content assessed, only 1 (older child/adult-oriented) was associated with lower cognitive and language development at age 14 months. No significant associations were seen with exposure to young child-oriented educational or noneducational content.

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Conclusions—This study is the first, to our knowledge, to have longitudinally assessed associations between media exposure in infancy and subsequent developmental outcomes in children from families with low socioeconomic status in the United States. Findings provide strong evidence in support of the American Academy of Pediatrics recommendations of no media exposure prior to age 2 years, although further research is needed.

Media exposure plays an increasing role in the lives of infants and toddlers,^{1–3} despite the American Academy of Pediatrics recommendation that children younger than 2 years should have no media exposure.^{4,5} In part, the increasing exposure of infants and toddlers to various types of media has resulted from the emergence of media content specifically geared toward infants and toddlers and marketed as educational.^{6,7} Children from families with low socioeconomic status (SES) are likely to be most vulnerable to any adverse effects of media exposure on early child development because they have been documented to have the greatest exposure to media^{8–10} and are at increased risk in general for disparities in early development, school readiness, and educational achievement.¹¹

A substantial body of literature^{12–14} has documented adverse effects of noneducational media in preschool and school-aged children on later outcomes, including cognition, achievement, and behavior. Emerging research strongly suggests the potential for adverse effects of media beginning in infancy.^{10,15} However, many of the studies have been performed with families that are not economically disadvantaged; also, these studies have not been prospective or have not included detailed information regarding content. In particular, to our knowledge, there has been no prior longitudinal study performed in the United States concerning the effect of media exposure on the development of infants from families with low SES.

In this study, we sought to assess whether duration and content of media exposure at age 6 months were related to later developmental outcomes at age 14 months. We had 2 hypotheses: first, that total duration of media exposure in infancy would be adversely related to developmental outcomes, and second, that associations between media exposure and developmental outcomes would vary depending on content, with the greatest adverse effects seen for non-educational content.

METHODS

STUDY DESIGN

We performed a longitudinal analysis of mother-infant dyads participating in the Bellevue Project for Early Language, Literacy, and Education Success, a study assessing the role of primary care interventions in promoting child development through enhanced shared reading and play. Two interventions, the Video Interaction Project^{16,17} and Building Blocks,¹⁸ were studied in the larger project; each was designed to enhance shared reading and play. This analysis included mothers and infants who had been enrolled from November 23, 2005, through January 14, 2008.

STUDY SAMPLE

Enrollment of consecutive eligible mother-infant dyads was performed in the postpartum unit of Bellevue Hospital Center, New York, New York, an urban public hospital serving at-risk families. Inclusion criteria were intention to receive pediatric primary care at our institution for at least 3 years, English or Spanish as the primary language, uncomplicated full-term delivery, no early intervention eligibility, the mother as the primary care-giver, ability to contact the mother, mother's age being at least 18 years, and no significant maternal medical problems, as described previously.¹⁰

We obtained written informed consent from parents before participation. Approval for studies involving human cohort individuals was obtained from the New York University School of Medicine Institutional Review Board and Bellevue Hospital Center Research Committee.

STUDY VARIABLES AND ASSESSMENTS

The independent variables were total duration and content of media exposure at age 6 months. The dependent variables were cognitive and language development at age 14 months. We also assessed potential confounders, including home environmental factors, and family sociodemographic characteristics.

MEDIA EXPOSURE

We assessed electronic media exposure in the home with a widely used method, namely, a 24-hour recall diary based on an interview with the mother.^{19–21} We asked the mother to provide information about all electronic media (television, videos/DVDs, movies, and games) to which the infant had been exposed on the most recent typical day, including name and duration (in minutes) of each program. We asked the mother to include all programs for which the infant was present and awake, from the infant's awakening in the morning until going to sleep for the night. Information from the diary was then used to calculate our 2 study variables:

1. Total duration of exposure (in minutes): We calculated total daily duration by adding together the duration of each exposure for the child during the 24-hour period.
2. Content of exposure (in minutes): We assessed program content using information obtained from industry rating systems and a consumer media Web site (TV Parental Guidelines,²² TV Guide,²³ and the Motion Picture Association of America).²⁴ Media content was categorized while masked to outcomes, using a classification system developed by some of us^{10,21}:

Educational young child–oriented programs consisted primarily of those with educational content intended for children 2 to 6 years old, including live action and animated programs (eg, *Sesame Street* and *Blue's Clues*). In addition, media marketed as infant-directed and educational (eg, *Baby Einstein* and *Brainy Baby*) was also included in this category; however, there was a limited number of exposures to this type of media.

Noneducational young child–oriented programs consisted of those without educational content intended for children 2 to 6 years old. Examples include action cartoons such as *Sponge-Bob SquarePants* that are intended for young children and contain little or no violence.

Older child/adult–oriented programs consisted of those considered appropriate for school-aged children (7 years and older) and teenagers but not for younger children on the basis of violence and other such content. Examples of older child–oriented programs include *Xiaolin Showdown*. Adult-oriented programs consisted of those not oriented toward children but adults, of genres including news, sports, game, talk, variety, soap opera, drama, and comedy. Examples include *Good Morning America* (talk show), *La Fea Más Bella* (soap opera), and *Law & Order* (drama).

Unknown programs consisted of those we were unable to categorize owing to incomplete information.

COGNITIVE AND LANGUAGE DEVELOPMENT

We assessed cognitive development at age 14 months using the Bayley Scales of Infant and Toddler Development, 3rd edition (Bayley-III), Cognitive Scale.²⁵ We assessed language development using the Preschool Language Scale-4 (PLS-4). The PLS-4 consists of a total score and 2 subscales: auditory comprehension and expressive communication.²⁶

CONTROL VARIABLES

We collected sociodemographic data from maternal interviews conducted during the postpartum period, including mother's educational level, age, primary language spoken, ethnicity, country of origin, and marital status, and child's sex and position in the birth order. We also assessed maternal depressive symptoms using the Patient Health Questionnaire-9.²⁷ To define the presence of symptoms, a cutoff score of 5 was used, corresponding to mild depression. We assessed the cognitive home environment using StimQ (<http://pediatrics.med.nyu.edu/patient-care/for-healthcare-providers/stimq-cognitive-home-environment>), an office-based questionnaire that is reliable and valid in families with low SES and correlates with the Home Observation for Measurement of the Environment inventory.²⁸

STATISTICAL ANALYSIS

Associations between media exposure at age 6 months and cognitive and language development at age 14 months were analyzed. In unadjusted analyses, we used Pearson correlations. In adjusted analyses, we used multiple linear regressions adjusting for all control variables and exposure status with respect to the primary care interventions being carried out within the larger study. Separate multiple regressions were performed for total duration of media exposure and for each category of content. To assess the independent effect of each category of content, additional regressions were performed, including all 3 content categories in a single model, while adjusting for the same control variables. In each of these models, β (standardized regression coefficients) and B (unstandardized regression coefficients) were calculated. Because the distribution of media exposure was significantly different than normal (Kolmogorov-Smirnov $Z=2.8$, $P<.001$) with positive skew (skewness=2.3, SE=0.1; Figure 1), analyses of media duration and content were performed using log transformations; these transformations were performed adding a constant of 1 to each value to account for values of 0.²⁹ This analytic approach was also consistent with theoretical concerns because effects of media exposure are likely to be nonlinear. This has been found in a number of studies of negative effects of exposure³⁰⁻³² and of learning in relation to educational exposure.³³

RESULTS

STUDY SAMPLE

From November 23, 2005, through January 14, 2008, a total of 516 mother-infant dyads were enrolled, of which 377 infants (73.1%) were evaluated at age 6 months. Of these, 259 (68.7%) also had an evaluation at age 14 months and constitute the sample analyzed in this study. Families assessed and not assessed when infants were aged 14 months showed similar data for media exposure and all sociodemographic characteristics except for maternal primary language spoken. Assessed families were more likely to speak Spanish as the primary language ($P=.001$).

Descriptive data are shown in Table 1. Mean (SD) media exposure was 152.7 (124.5) minutes, with a median of 120.0 minutes. As seen in Figure 1, 15.8% (41 of 259) had less than 60 minutes of exposure, including 3.9% (10 of 259) who had no exposure to media. Of

the total media exposure, 23.0 (38.7) minutes were categorized as young child-oriented educational, 6.6 (19.1) minutes as young child-oriented noneducational, 91.5 (86.8) minutes as older child/adult-oriented, and 31.6 (80.2) minutes as unknown (data are given as mean [SD]).

MEDIA EXPOSURE AND COGNITIVE/LANGUAGE DEVELOPMENT

Total Duration of Media Exposure—Longer daily duration of media exposure at age 6 months predicted lower cognitive development (Bayley-III) and language development (PLS-4 Total Language Score) at age 14 months in unadjusted and adjusted analyses (Table 2). For language subscales, associations were present for auditory comprehension and expressive communication but somewhat stronger for the auditory subscale.

In multiple linear regression analyses adjusting for all potential confounders, statistically significant associations were found for duration of total and older child/adult-oriented media exposure with each of the developmental measures (Table 2 and Table 3). For example, the coefficient for the association between total daily duration of media exposure and PLS-4 Total Language Score was -1.2 ($P=.005$). Because media exposure was log transformed, this finding can be interpreted to mean that a 50.0% increase in media exposure was associated with approximately a 0.5-point decrease in PLS-4 Total Language Score. Similar effects are seen with PLS-4 Total Language Score and older child/adult-oriented content. However, no associations were found for educational young child-oriented or noneducational young child-oriented content.

Figure 2 shows predicted developmental scores for different levels of media exposure based on the multiple linear regression models adjusting for all potential confounders described herein. As shown in Figure 2 regarding predicted cognition scores, infants exposed to 0 minutes of media had an adjusted mean Bayley-III score of 102.1, but those with 60 minutes of exposure had an adjusted mean Bayley-III score of 95.9 (0.4 SD lower). Media exposure beyond 60 minutes was associated with further decrements in Bayley-III score; infants with 360 minutes of exposure had an adjusted mean Bayley-III score of 93.2 (0.59 SD lower than those with 0 minutes). Regarding predicted language scores, infants exposed to 0 minutes of media had an adjusted PLS-4 Total Language Score of 103.0, whereas infants with 60 minutes of exposure had an adjusted mean PLS-4 score of 98.2 (0.32 SD lower than those with 0 minutes of exposure); similarly, infants with 360 minutes of exposure had an adjusted PLS-4 score of 96.0 (0.47 SD lower than those with 0 minutes of exposure).

Content of Media Exposure—Exposure to older child/adult-oriented content at age 6 months predicted lower cognitive (Bayley-III) and language (PLS-4 Total Language) scores at age 14 months (Table 3). As with total duration, associations were present for auditory comprehension and expressive communication but were stronger for the auditory subscale. In these analyses, educational and noneducational media with young child-directed content were not associated with cognitive and language scores.

To determine whether any single content category independently predicted development and would account for the results from other categories, simultaneous regression models including all 3 types of media content (educational, noneducational, and older child/adult-oriented content) were performed, adjusting for all potential confounders. In a model in which cognitive development (Bayley-III score) was the outcome variable, older child/adult-oriented content was an independent predictor ($\beta=-.19$, $P<.01$) after adjusting for educational and noneducational young child-oriented media. In a model in which overall language development (PLS-4 Total Language Score) was the outcome variable, older child/adult-oriented content was an independent predictor ($\beta=-.22$, $P<.001$), whereas a trend

(nonsignificant) was seen for exposure to educational young child-oriented content ($\beta = -.11$, $P = .06$).

COMMENT

This study is the first, to our knowledge, to have longitudinally assessed associations between media exposure in infancy and subsequent developmental outcomes in children from US families with low SES. Regarding our first hypothesis, total duration of media exposure at age 6 months predicted lower cognitive and language development at age 14 months. More important, children with 60 minutes of media exposure had approximately one-third SD lower developmental scores in both domains compared with those who had no exposure. Although children with the longest durations of media exposure had adjusted developmental scores in the normal range, the differences found are likely to be important at the population level.^{34,35} Regarding our second hypothesis, exposure to media with older child/adult-oriented content at age 6 months was associated with adverse developmental outcomes at age 14 months. In contrast, significant associations in either direction were not found for exposure to educational and noneducational young child-oriented content. Taken together, our findings provide strong evidence in support of the American Academy of Pediatrics recommendations of no media exposure prior to age 2 years. In demonstrating adverse effects of older child/adult-oriented media, these findings suggest that even media likely not focused on by very young children^{36,37} may have adverse effects, possibly owing to interference with interactions and play.^{38,39} In demonstrating lack of benefit related to educational media exposure in infancy, these findings contradict industry claims⁴⁰ and provide further support for these recommendations.

In documenting adverse associations between overall media exposure in infancy and development at age 14 months, this study has provided an important addition to the existing literature. Two studies performed in Thailand have investigated the effect of media exposure in infancy on the development of toddlers from families with low SES, with only 1 finding positive results. Chonchaiya and Pruksananonda⁴¹ performed a case-control study that found that children exposed to 2 hours or more of television daily prior to age 12 months were 6 times more likely to have language delay. Ruangdaraganon et al⁴² performed a longitudinal study that did not find associations between media exposure and development; however, only 8% of the sample had developmental delay, limiting the authors' power to find associations. In addition, 3 longitudinal studies of associations between media and development in US populations that are not economically disadvantaged have been published. In an analysis of National Longitudinal Study of Youth data, Zimmerman and Christakis¹³ found that average viewing prior to age 3 years was negatively associated with cognitive outcomes at age 6 years. In a US longitudinal analysis of predominantly white, Mid-western families with relatively high levels of education and income, cumulative prior media exposure was associated with reduced vocabulary at 30 months.⁴³ However, in a longitudinal analysis of families in Massachusetts with similar sociodemographic characteristics who are not economically disadvantaged, no associations were found between media exposure prior to age 2 years and language development at 36 months.⁴⁴ Our study, the first to longitudinally study effects of media exposure on development in the United States, suggests real possibility for harm in the vulnerable population of families with low SES.

A strength of our present study was the use of detailed media diaries to quantify duration based on content. Based on these diaries, exposure in infancy to older child/adult-oriented content not appropriate for young children was specifically associated with adverse developmental outcomes. Previous studies in older children have shown adverse effects in association with developmentally inappropriate content, including associations between

media violence exposure in elementary school and aggressive behavior¹² and associations between older child/adult-oriented media content and externalizing behaviors²¹ in older toddlers. Our present findings extend these associations to very young infants.

Regarding educational content, we found limited associations (positive or negative) with developmental outcomes. Our single finding, a nonsignificant trend, suggested the possibility of an adverse association between educational media exposure and overall language development after adjusting for exposure to other content. Although exposure to educational content at the age of school entry has been shown to have potentially beneficial effects,^{20,45} two prior studies of infants and toddlers from families that are not economically disadvantaged have suggested the possibility of adverse effects. In a cross-sectional study, Zimmerman et al⁴⁶ found exposure to educational DVDs for infants such as *Baby Einstein* to be associated with decreased concurrent vocabulary in 8- to 16-month-old children. In a longitudinal study, Linebarger and Walker⁴³ found that exposure beginning in infancy to some educational programs (*Teletubbies*, *Sesame Street*, and *Barney and Friends*) was associated with reduced later vocabulary at age 30 months, whereas other programs (*Dora the Explorer*, *Blue's Clues*, and *Dragon Tales*) were associated with enhanced vocabulary. In contrast, experimental studies^{36,47-50} have consistently shown reduced learning from video compared with live models, which may be owing to formal characteristics that elicit attention but are difficult for infants to understand.⁵¹ In finding lack of positive effects resulting from exposure to educational content, our study does not support development of even educational media for infants.

There are 3 potential mechanisms for media-associated adverse effects on very young children's development. First, a number of studies have shown reductions in parent-child interactions in association with increased media, including reduced audible language,¹⁵ conversation,¹⁰ and engagement with the child.³⁸ Other studies have suggested potential displacement of parent-child shared reading and playing together with toys,^{39,52} activities critical to young children's development. Second, exposure to media in very young children has been shown to interfere with children's play activities.³⁹ Third, specific characteristics of media exposure such as rapid scene changes have been hypothesized to have direct, adverse effects on the developing brain.^{7,36} The first of these mechanisms, reduced interactions, is likely to be especially important in families with low SES, in which children are at increased risk of developmental delay in association with less parental language being directed at them.¹¹

Another important finding relates to characterization of media exposure in children from families with low SES. Our findings are consistent with prior population-based studies in infancy, which have shown substantial exposure as early as age 6 months,⁵³ with increased exposure related to low maternal education.⁸ However, our finding that the greatest media exposure for infants from families with low SES is to older child/adult-oriented content contrasts with prior studies showing educational content to make up the majority of exposure in infancy.⁵³ Our findings underscore the increased risks experienced by children from families with low SES related to early development in the context of greater overall exposure to media and exposure to media less likely to have educational content. Even small effect sizes as noted in this study, with a 50.0% increase in media exposure associated with a 0.5-point decrease in PLS-4 total score, are likely to be important regarding families with low SES, who are already at risk.^{34,35}

This study has some limitations. First, although the use of media diaries allowed the collection of detailed information regarding content, we must acknowledge the possibility that data collected via this assessment tool may underestimate quantity of media in the home and only covers 1 typical day.⁵⁴ Second, there was limited exposure to young child-oriented

noneducational media in this sample, which reduced our ability to draw conclusions about its effect. Regarding young child-oriented educational media, most of the exposure was to preschool-oriented educational media, and there was limited exposure to infant-directed media such as *Baby Einstein*, which prevented us from analyzing this exposure separately. Third, lower effects on expressive compared with receptive language tests may reflect limited expressive language at age 14 months; it is possible that greater effects on expressive language might be seen for older children. Fourth, our results apply to exposure in infants from families with low SES, primarily from a Latino immigrant background, and may not be generalizable to children in families with greater economic resources. Finally, our results may be specific for the infant-early toddler period studied, given rapid changes in development and changes in content of exposure over time, with educational television representing a greater proportion of exposure.⁵³

In conclusion, overall exposure and exposure to older child/adult-oriented content were associated with lower levels of cognitive and language development at age 14 months. Findings from this study provide strong support for the American Academy of Pediatrics recommendation of no media exposure before age 2 years. These findings also cast doubt on the potential for benefit from educational programming in infancy. However, more research is needed regarding what would constitute educational programming during early childhood before definite conclusions can be reached. Given the substantial amount of exposure beginning in early infancy in families with low SES, whose children are at greatest risk for adverse developmental outcomes, these findings suggest that media exposure represents a substantial public health problem. Advocacy efforts and public health interventions will be necessary to reduce exposure and optimize developmental outcomes.

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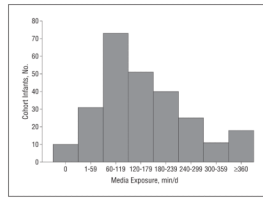


Figure 1.
Total duration of media exposure at age 6 months.

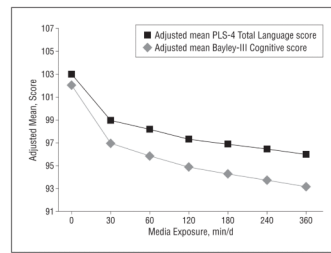


Figure 2. Relationship between total duration of media exposure at age 6 months and predicted development scores at age 14 months. Bayley-III Cognitive indicates Bayley Scales of Infant and Toddler Development, 3rd edition, Cognitive; PLS-4, Preschool Language Scale-4.

Table 1Cohort Descriptive Data^a

Characteristic	No. (%)
Mother	
Age, mean (SD), y	27.8 (5.4)
High school graduate	106 (40.9)
Non-US-born	237 (91.5)
Married or living with partner	220 (84.9)
Spanish as primary language	223 (86.1)
Depressive symptoms	62 (23.9)
Child	
Female sex	137 (52.9)
Firstborn	101 (39.0)
Cognitive (Bayley-III) score, mean (SD)	95.5 (11.7)
Total Language (PLS-4) score, mean (SD)	97.0 (8.5)

Abbreviations: Bayley-III, Bayley Scales of Infant and Toddler Development, 3rd edition; PLS-4, Preschool Language Scale-4; US, United States.

^an=259 mother-infant dyads.

Table 2

Duration of Media Exposure at Age 6 Months and Cognitive and Language Development at Age 14 Months

Measure	Total Daily Duration, min				
	Unadjusted		Adjusted ^a		
	r	P Value	β	B (95% CI)	
Bayley-III Cognitive ^b	-.17	.008	-.15	.02	-1.5 (-2.7 to -0.3)
PLS-4					
Total Language ^c	-.16	.009	-.16	.005	-1.2 (-2.0 to -0.4)
Auditory comprehension	-.16	.01	-.14	.02	-1.1 (-2.0 to -0.2)
Expressive communication	-.12	.06	-.13	.02	-1.0 (-1.9 to -0.1)

Abbreviations: Bayley-III Cognitive, Bayley Scales of Infant and Toddler Development, 3rd edition, Cognitive Scale; CI, confidence interval; PLS-4, Preschool Language Scale-4.

^a Adjusted analyses based on multiple regression models including as covariates for child: sex and position in birth order; for mother: age, educational level, country of origin, primary language, marital status, depressive symptoms, and cognitive home environment; and intervention status.

^b n=257 for unadjusted and n=253 for adjusted analyses.

^c n=259 for unadjusted and n=255 for adjusted analyses.

Table 3
Content of Media Exposure at Age 6 Months and Cognitive and Language Development at Age 14 Months

	Content Time (min)				
	Unadjusted	Adjusted ^a			
	r	β ^b	P Value	B (95% CI) ^b	
Educational Young Child–Oriented					
Bayley-III Cognitive ^c	.01	.86	.01	.94	0.03 (−0.7 to 0.8)
PLS-4					
Total Language ^a	−.05	.47	−.06	.33	−0.3 (−0.8 to 0.3)
Auditory comprehension	−.04	.52	−.04	.55	−0.2 (−0.7 to 0.4)
Expressive communication	−.04	.50	−.07	.27	−0.3 (−0.9 to 0.2)
Noneducational Young Child–Oriented					
Bayley-III Cognitive ^c	.03	.56	.04	.49	0.4 (−0.7 to 1.5)
PLS-4					
Total Language ^a	−.03	.62	.003	.96	0.02 (−0.7 to 0.8)
Auditory comprehension	.02	.80	.05	.42	0.4 (−0.5 to 1.2)
Expressive communication	−.07	.23	−.05	.41	−0.3 (−1.2 to 0.5)
Older Child/Adult–Oriented					
Bayley-III Cognitive ^c	−.20	.002	−.18	.006	−1.0 (−1.7 to −0.3)
PLS-4					
Total Language ^a	−.18	.003	−.19	.001	−0.8 (−1.3 to −0.3)
Auditory comprehension	−.18	.005	−.17	.005	−0.8 (−1.3 to −0.2)
Expressive communication	−.13	.04	−.14	.02	−0.6 (−1.1 to −0.1)

Abbreviations: See Table 2.

^a n=259 for unadjusted and n=255 for adjusted analyses.

^b n=259; Adjusted analyses based on multiple regression models including as covariates for child: sex and position in birth order; for mother: educational level, country of origin, primary language, marital status, depressive symptoms, and cognitive home environment; and intervention status.

^c n=257 for unadjusted and n=253 for adjusted analyses.