

Associations between Media Viewing and Language Development in Children Under Age 2 Years

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Objective To test the association of media exposure with language development in children under age 2 years.

Study design A total of 1008 parents of children age 2 to 24 months, identified by birth certificates, were surveyed by telephone in February 2006. Questions were asked about child and parent demographics, child-parent interactions, and child's viewing of several content types of television and DVDs/videos. Parents were also asked to complete the short form of the MacArthur-Bates Communicative Development Inventory (CDI). The associations between normed CDI scores and media exposure were evaluated using multivariate regression, controlling for parent and child demographics and parent-child interactions.

Results Among infants (age 8 to 16 months), each hour per day of viewing baby DVDs/videos was associated with a 16.99-point decrement in CDI score in a fully adjusted model (95% confidence interval = -26.20 to -7.77). Among toddlers (age 17 to 24 months), there were no significant associations between any type of media exposure and CDI scores. Amount of parental viewing with the child was not significantly associated with CDI scores in either infants or toddlers.

Conclusions Further research is required to determine the reasons for an association between early viewing of baby DVDs/videos and poor language development. (*J Pediatr* 2007;151:364-8)

Several high-quality educational television shows, including *Blue's Clues*, *Sesame Street*, *Barney*, and others, have proven educational value when viewed appropriately by children age 2-1/2 to 5 years.¹ In contrast, no commercial television programs or videos have demonstrated a benefit for children under age 2 years,² and heavy television viewing between age 0 and 3 years has been associated with subsequent development of problems with attention³ and impaired reading and mathematical proficiency.⁴ The American Academy of Pediatrics has recommended no screen time for children under age 2.^{5,6}

Notwithstanding the paucity of evidence for cognitive development benefits of early viewing of DVDs or videos, claims have been made for such benefits.² Approximately 3/4 of the 100 top-selling infant videos on Amazon.com in 2005 made educational claims, both explicit and specific.² For example, one product targeted at 0- to 2-year-olds claimed that the video will "teach your child about language and logic, patterns and sequencing, analyzing details and more."²

This study reports the association of early viewing with language development in a cross-sectional sample of children age 8 to 24 months old, adjusting for likely confounders related to parental socioeconomic status and child-parent interactions.

METHODS

Data

The data were collected through a telephone survey conducted in February 2006. Households were identified by retrospective extraction from birth certificates in the states of Washington and Minnesota. These states were chosen because they are representative of their respective regions, and because birth certificates are public data in these states. Phone numbers are recorded on birth certificates in Washington and were obtained from a commercial phone number-matching firm for Minnesota.

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|-----|-------------------------------------|----|---------------------|
| CDI | Communicative Development Inventory | CI | Confidence interval |
|-----|-------------------------------------|----|---------------------|

Parents gave their oral consent to participate in the survey. All study procedures were approved by the University of Washington's Institutional Review Board.

To be eligible for the study, parents had to speak English fluently and have a working phone number. Only 1 child per household was eligible for the study. Children with significant disabilities (eg, deafness, blindness, severe mental retardation) were excluded. Up to 8 callbacks were made per phone number at various times of the day and the week. As described elsewhere, the sample had relatively higher incomes and higher education than the population from which it was recruited.⁷

Survey Instrument

Parents who consented to participate were asked detailed questions of their children's time use. Included were questions about time spent interacting with adults in several capacities (eg, being read to, listening to stories, listening to music). The parents were asked whether their child ever watched television or DVDs/videos. Those who answered yes to these questions were asked to report the typical amount of viewing in each of 6 content types. These content types were identified a priori, based on previous work^{8,9} and included children's educational programs on television (eg, *Sesame Street*, *Blue's Clues*, *Arthur*), children's educational programs on DVD/video (eg, *Sesame Street* on DVD), children's non-educational television shows (eg, *Sponge Bob Squarepants*, *Bob the Builder*, shows on the Cartoon Network), children's movies (eg, *The Little Mermaid*, *Toy Story*) on DVD/video, baby DVDs/videos (eg, *Baby Einstein*, *Brainy Baby*), and adult television (eg, *The Simpsons*, *Oprah*, sports programming). Parents were provided with these categories and examples and were asked to report their child's viewing by category for a typical weekday and a typical weekend day. The questions were worded to specifically include only foreground viewing (ie, time when the child's main activity was watching television) and to exclude background viewing (ie, times when the television was on but the child was not watching it as a primary activity).

The parents also were asked a series of demographic questions, including how many other children lived in the household, whether both parents lived in the household, and questions about maternal and paternal education and about household income. The parents were asked to report the child's ethnicity (Hispanic or non-Hispanic) and race (in several categories, including mixed race). Parents were asked to report whether the child was in a nonparental care arrangement (ie, daycare) and, if so, for how many hours per week. The child's age was available from the birth certificate.

Variables

OUTCOME. The outcome in these analyses is the child's normed score on the short-form Communicative Development Inventory (CDI), a standard instrument for measuring children's language development.¹⁰ This instrument was de-

veloped by psycholinguists to measure the relationship between children's language and experimental tests of neural, cognitive, and social development.¹¹ The CDI provides a reliable, valid, and broadly-adopted measure of linguistic and communicative development, with excellent internal and test-retest reliability.¹⁰ The short form has been shown to have good psychometric properties.¹⁰ The scores adequately separate children's abilities at age 8 to 24 months.¹⁰ Cronbach's alpha is 0.97 for level 1 (age 8 to 16 months) and 0.99 for level 2 (age 17 to 23 months). Correlation between the short forms and the long forms of the CDI varies between 0.74 and 0.93.¹⁰ We transformed raw scores into percentile norms using previously published age-sex national norms.¹²

PREDICTORS. The primary predictors for this analysis are the amounts of media viewing by content type. The original 6 content categories were reduced to 4 by consolidating educational content on TV and on DVD/video and consolidating children's movies on DVD/video with children's noneducational TV. The 4 resulting content categories were children's educational, children's noneducational, baby DVDs/videos, and grownup TV. Average daily viewing was used in all analyses, calculated as twice the reported weekend viewing plus 5 times the reported weekday viewing, divided by 7.

A dummy variable was included indicating whether the parent watched with the child "usually" or "always" versus less often. To control for possible selection effects for those who never watched either television or DVDs/videos, a dummy variable was included indicating whether the child watched any media.

COVARIATES. In addition to race/ethnicity and age as described earlier, the parents provided information about household income and maternal and paternal education in categories. Where paternal education was missing, it was imputed with the modal value. The parents were asked to report whether the child was in a nonparental care arrangement (ie, daycare) and, if so, for how many hours per week.

Parental interaction with their children was tracked in 3 areas: reading, storytelling, and music. For each of these areas, the parents were asked how often they did the activity with their child: never, once a month, a few times a month, once a week, a few times a week, once a day, or more than once a day. For the purposes of analysis, these answers were dichotomized as once a day or more frequently versus a few times a week or less frequently. This dichotomization preserved most of the information from the full responses in a parsimonious manner that simplified the interpretation of results. Because parents engaged their children in music less often than in the other activities, the music variable was dichotomized at several times a week or more versus less frequently.

The demographic control variables were chosen because they are known to be associated with both television viewing and with language acquisition. The parental interaction variables were included to control for the possibility of confounding by this important environmental influence.

Table I. Sample descriptive statistics

| Variable | Age 8 to 16 months | | Age 17 to 24 months | |
|---|--------------------|-------|---------------------|-------|
| | Mean or % | SD | Mean or % | SD |
| Normed score on the short-form CDI* | 61.17 | 27.19 | 49.28 | 29.92 |
| Parental Interactions | | | | |
| Reading at least once daily | 74% | | 85% | |
| Storytelling at least once daily | 71% | | 72% | |
| Music listening at least several times weekly | 82% | | 87% | |
| Children's media watching time (hours/day) | | | | |
| Baby DVDs/videos | 0.15 | 0.35 | 0.16 | 0.43 |
| Children's educational shows | 0.31 | 0.70 | 0.70 | 0.96 |
| Movies and children's noneducational TV | 0.16 | 0.49 | 0.39 | 0.75 |
| Grownup TV | 0.10 | 0.31 | 0.15 | 0.41 |
| Parental viewing with child | | | | |
| Rarely or about half the time (referent) | 21% | | 37% | |
| Usually or always | 34% | | 44% | |
| N/A: no media viewing | 44% | | 19% | |
| n | 384 | | 345 | |

SD, standard deviation.

*The 8- to 16-month-olds were assessed with the level 1 (infant) instrument; the 17- to 24-month-olds, with the level 2 (toddler) instrument (Form B).

Analyses

Linear regression was performed to test the association between media time and language development. Separate regressions were performed for those children age 8 to 16 months who completed the level 1 (infant) short CDI and those age 17 to 24 months who completed the level 2 (toddler) short CDI. For infants (level 1), we used the normed receptive language scores, a measure of how many words that the child understands. For toddlers (level 2), we used the normed expressive language scores, a measure of how many words the child says. All variables were entered simultaneously into the regression.

RESULTS

Table I reports the parental interactions and the television and video/DVD viewing values for the sample, along with the mean and standard deviation of the normed CDI scores for each group. As the table shows, the mean was close to that of the national sample among the 17- to 24-month-olds. For the 8- to 16-month-olds, the mean CDI score of 61 in this sample was higher than expected compared with national norms.

Table II reports results of the regression of the normed CDI scores on parental interaction variables and media exposure. These estimates were also adjusted for sex, age, num-

ber of siblings, premature birth, hours per week in daycare, whether both parents are present, maternal and paternal education, parental income, child race/ethnicity, and state of birth (Minnesota or Washington).

Reading once a day as opposed to less frequently was associated with percentile increases in the normed CDI score of 7.07 in the 8- to 16-month-olds and 11.72 in the 17- to 24-month-olds (95% confidence interval [CI] = 0.53 to 13.60 and 1.86 to 21.59, respectively). Telling stories at least once a day as opposed to less frequently was associated with increases in normed CDI scores of 6.47 points (95% CI = 0.23 to 12.71) in the younger children and 7.13 points (95% CI = -0.11 to 14.37) in the older children, albeit with a trend toward significance only in the older children. The effect of listening to music with children was not significant.

Each hour per day of viewing baby DVDs/videos was associated with a 16.99-point lower CDI normed score in the children age 8 to 16 months (95% CI = -26.20 to -7.77). There were no other significant associations of media exposure with CDI scores. The amount of parental viewing with children was not associated with higher CDI scores.

DISCUSSION

This analysis reveals a large negative association between viewing of baby DVDs/videos and vocabulary acquisition in children age 8 to 16 months. The 17-point difference associated in the analysis with each hour of baby DVD/video watching corresponds to a difference of about 6 to 8 words for a typical child out of the 90 included on the CDI. There are 3 possible reasons for this association. First, because many baby DVDs/videos are heavily advertised as promoting cognitive, language, and brain development,² it is possible that parents who are concerned about their child's language development turn to baby videos for help. If this is indeed the case, then it would be fair to say that the poor language development causes greater viewing of baby DVDs/videos.

A second possible explanation for the association between baby DVD/video viewing and vocabulary is that of residual confounding; that is, other variables (not measured in our data) could lead to both high baby DVD/video watching and slow language development. One possible example to illustrate this would arise if those parents who have their children watch a heavy dose of baby DVDs/videos are those who are less motivated to actively promote their children's language development. We partially controlled for this possibility with the parent-interaction variables, but we cannot capture the quality of these interactions, which surely varies. A second possible source of residual confounding would exist if parents who are inattentive, distracted, or simply pressed for time are more likely to rely on baby DVDs/videos as a babysitter. Such parents also might be less likely to know how many words their children know. Although we attempted to adjust for many social and demographic factors that might confound the observed association, it is possible that this adjustment was incomplete.

Table II. Regressions of CDI language scores (normed) on parental interaction and media variables

| Variable | Age 8 to 16 months | | Age 17 to 24 months | |
|---|--------------------|----------------|---------------------|---------------|
| | Coefficient | [95% CI] | Coefficient | [95% CI] |
| Parental interactions | | | | |
| Reading at least once daily | 7.07* | [0.53,13.60] | 11.72* | [1.86,21.59] |
| Storytelling at least once daily | 6.47* | [0.23,12.71] | 7.13† | [-0.11,14.37] |
| Music listening at least several times weekly | 5.36 | [-1.92,12.64] | 7.2 | [-2.10,16.50] |
| Children's media watching time (hours/day) | | | | |
| Baby DVDs/videos | -16.99** | [-26.20,-7.77] | 3.66 | [-4.45,11.77] |
| Children's educational shows | 1.72 | [-4.42,7.87] | 2.21 | [-1.74,6.15] |
| Movies and children's noneducational TV | 6.6 | [-1.81,15.02] | 2.03 | [-2.78,6.83] |
| Grownup TV | -1.42 | [-11.57,8.73] | 2.38 | [-5.68,10.45] |
| Parental viewing with child | | | | |
| Rarely or about half the time (referent) | | | | |
| Usually or always | 5.57 | [-2.10,13.23] | 0.39 | [-6.74,7.52] |
| N/A: no media viewing | -7.70† | [-15.49,0.08] | 2.65 | [-7.29,12.60] |
| r^2 | | 0.17 | | 0.18 |
| n | | 384 | | 345 |

Results also adjusted for sex, age, number of siblings, premature birth, premature birth by age interaction, hours per week in daycare, whether both parents are present, maternal and paternal education, parental income, child race/ethnicity, and the state of birth (Minnesota or Washington).

** $P < .01$; * $P < .05$; † $P < .1$.

Finally, it is possible that heavy viewing of baby DVDs/videos has a deleterious effect on early language development. The first 3 years of life are characterized by rapid brain development, and environmental factors are known to influence how the brain develops.¹³⁻¹⁵ It is plausible that extensive exposure to an absorbing but not developmentally constructive stimulus could affect brain development and language acquisition. Heavy viewing of baby DVDs/videos may constitute such an environmental influence. If so, there are several potential causal mechanisms through which such an effect might occur. The viewing of baby DVDs/videos might crowd out interaction time with adult caregivers in ways not measured here. For example, we did not measure the time parents spend directly talking to their infants, or the nature and quality of this verbal input, which are known to be important factors in early language development.¹⁶⁻¹⁹ Baby DVDs/videos contain limited language and display a certain combination of formal features (short scenes and flashy screen images), which might not promote vocabulary learning or might lead to habits of mind that actually impede it.²⁰ Whether these formal features are systematically different than those of the other content types represented here has not been formally studied.

Whatever the reason for the association between baby video viewing and slower early vocabulary growth, 3 points are worth bearing in mind. First, the effect size is large. Although reading every day as opposed to less often is associated with about a 7-point increase in the normed CDI score, watching 1 hour per day of baby DVDs/videos as opposed to none is associated with about a 17-point decrease. Although most children watch considerably less than 1 hour per day, in our sample, 17% of children age 8 to 16 months who watched any baby DVDs/videos watched 1 hour or more per day. Second, there is a dose-response relationship; increased viewing of

baby DVDs/videos is associated with slower vocabulary in a linear way. We separately tested a model in which we included a dummy variable indicating whether the child watched any baby DVDs/videos to control for this potential content-specific selection. That analysis revealed no effect of the indicator of watching any baby DVDs/videos, although the coefficient on the number of hours remained large and significant.

Third, the effect is specific to baby DVDs/videos and specific to children age 8 to 16 months. No other form of media exposure that we measured, and none for children age 17 to 24 months, is associated with either better or worse language outcomes. This fact must be carefully considered when drawing inferences about the associations. Baby DVDs/videos may be different than the other types of content explored. Our casual observation suggests that they typically have little dialogue, short scenes, disconnected images, and a variety of visually salient but linguistically indescribable events (eg, lava lamp images and oddly twirling images). In contrast, children's educational shows (the largest category of viewing at this age) are carefully crafted, and many are exhaustively tested to make sure that they meet the developmental needs of preschoolers. Although the content and formal features are not optimized for children under age 2 years, those children still may be able to understand large portions of the shows' cognitive and linguistic content. In contrast, baby DVDs/videos are designed with only an approximate sense of developmental needs, based on no formal research.²

Vocabulary growth is a good measure of cognitive development in this age range, because it is easily observed and is one of the major developmental tasks of the age. However, it is only partially predictive of future cognitive outcomes. The fact that in these data an association is observed only for the younger children suggests that the association may disappear

by the time the children become toddlers. As such, the impact of baby DVDs/videos on development may be transient.

The analysis presented here is not a direct test of the developmental impact of viewing baby DVDs/videos. We did not test through experimental manipulation whether viewing baby DVDs/videos has a positive or negative impact on vocabulary acquisition. Given the paucity of any evidence around this issue, however, this was a compelling place to start. Nonetheless, our study has several major limitations. First, the study's correlational nature precludes drawing causal inferences. Second, we used only 1 developmental measure—language development, as defined by vocabulary. Finally, the sample is not representative of the general population. Although the variables on which the sample is not representative (income and education) are controlled in this analysis, there may be other family or child attributes that were unobserved and that affected selection into the sample, the exposure, and the outcome.

Despite these limitations, however, our study has several strengths. It is the first formal analysis to test associations between types of media exposure and any developmental outcome in children this young and to test associations between viewing baby DVDs/videos specifically and any developmental measure. This contribution is important, given widespread marketing claims of developmental benefits for such DVDs/videos.² Parents rank potential “educational” and “brain development” benefits as among their top reasons for allowing their babies to watch television and DVDs/videos.⁷ The analysis also controls for a number of variables known to potentially confound the relationship between media exposure and development. Although no study can do so exhaustively, this study's inclusion of time spent in several forms of parent-child interaction is a strength.

The study's results, together with its strengths and weaknesses, suggest some important directions for future research. One of these would be to follow up the children to see whether the associations identified here have lasting significance. A second line of research could attempt to more precisely identify the particular features of baby DVD/videos that are responsible for these associations. Finally, a randomized trial will ultimately be necessary to permit causal inferences about these associations.

Given the number of children who watch baby DVDs/videos, and the sizable minority who are heavy viewers, we believe that it is feasible, ethical, and important to society to

conduct a large-scale randomized trial in which some families are actively discouraged from allowing their children to watch any baby DVDs/videos. Such a trial would enable us to make firmer statements about the risks and benefits of baby DVDs/videos, and would provide crucial information for parents to help them make their own informed parental choices and decisions based on scientific information.

REFERENCES

1. Anderson DR. Educational television is not an oxymoron. *Ann Am Acad Polit Soc Sci* 1998;557:24-38.
2. Garrison M, Christakis D. *A Teacher in the Living Room? Educational Media for Babies, Toddlers, and Preschoolers*. Menlo Park, CA: Kaiser Family Foundation; 2005.
3. Christakis DA, Zimmerman FJ, DiGiuseppe DL, McCarty CA. Early television exposure and subsequent attentional problems in children. *Pediatrics* 2004;113:708-13.
4. Zimmerman FJ, Christakis DA. Children's television viewing and cognitive outcomes: a longitudinal analysis of national data. *Arch Pediatr Adolesc Med* 2005;159:619-25.
5. American Academy of Pediatrics. Media education. *Pediatrics* 1999;104:341-3.
6. American Academy of Pediatrics, Committee on Public Education. Children, adolescents, and television. *Pediatrics* 2001;107:423-6.
7. Zimmerman FJ, Christakis DA, Meltzoff A. Television and DVD/video viewing in children younger than 2 years. *Arch Pediatr Adolesc Med* 2007;161:473-9.
8. Woodard EH. *Media in the home 2000: the fifth annual survey of parents and children*. Survey series 7:1-41, Annenberg Public Policy Center, University of Pennsylvania; 2000.
9. Weber DS, Singer DG. The media habits of infants and toddlers: findings from a parent survey. *Zero to Three* 2004;25:30-6.
10. Fenson L, Pethick S, Renda C, Cox JL, Dale PS, Reznick JS. Short-form versions of the MacArthur Communicative Development Inventories. *Appl Psychol* 2000;21:95-116.
11. Fenson L, Dale P, Reznick JS, Bates E, Thal D, Pethick S. Variability in early communicative development. *Monogr Soc Res Child Dev* 1994;59:1-190.
12. Dale PS, Fenson L. Lexical development norms for young children. *Behav Res Methods Instrum Comput* 1996;28:125-7.
13. Nelson CA, Bosquet M. Neurobiology of fetal and infant development: implications for infant mental health. In: Zeanah CH, editor. *Handbook of Infant Mental Health*. 2nd ed. New York: Guilford Press; 2000:37-59.
14. Lamb ME, Teti DM, Bornstein MH, Nash A. *Infancy*. In: Lewis M, editor. *Child and Adolescent Psychiatry: A Comprehensive Textbook*. 3rd ed. Philadelphia: Lippincott Williams & Wilkins 2002:293-323.
15. Johnson MH. Functional brain development during infancy. In: Bremner G, Fogel A, editor. *Blackwell Handbook of Infant Development*. Oxford: UK: Blackwell 2001:169-90.
16. Paul R, Miles S. Development of communication. In: Lewis M, editor. *Child and Adolescent Psychiatry: A Comprehensive Textbook*. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2002. p. 332-43.
17. Ritchie WC, Bhatia TK. *Handbook of Child Language Acquisition*. San Diego: Academic Press; 1999.
18. Kuhl PK, Tsao F-M, Liu H-M. Foreign-language experience in infancy: Effects of short-term exposure and social interaction on phonetic learning. *Proc Nat Acad Sci* 2003;100:9096-9101.
19. Kuhl PK. Early language acquisition: cracking the speech code. *Nat Rev Neurosci* 2004;5:831-43.
20. Healy JM. *Endangered Minds: Why Our Children Don't Think and What We Can Do About It*. New York: Simon & Schuster; 1990.