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Just a talking book? Word learning from watching baby videos

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This study examined the relationship between viewing an infant DVD and expressive and receptive language outcomes. Children between 12 and 15 months were randomly assigned to view *Baby Wordsworth*, a DVD highlighting words around the house marketed for children beginning at 12 months of age. Viewings took place in home settings over 6 weeks. After every 2 weeks and five exposures to the DVD, children were assessed on expressive and receptive communication measures. Results indicated there was no increased growth on either outcome for children who had viewed the DVD as compared to children in the control group, even after multiple exposures. After controlling for age, gender, cognitive developmental level, income, and parent education, the most significant predictor of vocabulary comprehension and production scores was the amount of time children were read to.

Targeting children as young as 1 month old, a growing number of videos and DVDs are available and marketed to children in the first 2 years of life, including *Baby Einstein*, *Brainy Superstar*, *Brainy Baby*, *Jumpstart*, and *T.V. Teach Me* (Garrison & Christakis, 2005). In 2006, BabyFirstTV, a 24-hour channel featuring programmes targeted to infants, premiered on cable and satellite providers. As of 2005, the Baby Einstein brand alone sold over $200 million worth of products with indications that the market would continue to rise (Bronson & Merryman, 2006). Currently, children under 2 are estimated to spend 1–2 hours a day viewing television (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Rideout, Hamel, & Kaiser Family Foundation, 2006; Rideout, Vandewater, Wartella, & Kaiser Family Foundation, 2003). Although there have been a small number of reports and studies exploring the effect of this screen time on development (e.g. Anderson & Pempek, 2005; Rideout *et al.*, 2003, 2006), there is no clear understanding of potential links between media exposure at this early age and developmental outcomes, especially with regards to content produced specifically for children under 2.

Given the rapid proliferation of media directed to children in the beginning years, parents are often caught in the middle of conflicting advice. Some academics and groups

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like the American Academy of Pediatrics (1999) favour very restricted or zero exposure to television for very young children. The concern is that these hours would otherwise be spent in the kinds of social interaction and high-quality activities critical for brain development.

In contrast, media producers market their products as having developmental benefits for young viewers. Despite the slim body of research on learning effects from infant-directed television and DVDs, teaching appears to be an implicit goal of many media producers. Garrison and Christakis (2005) found that 76 out of the top 100 best-selling baby DVDs on Amazon.com made educational claims. However, attempts to demonstrate learning from television and videos in children under 2 have yielded mixed results. With this discrepancy in mind, a closer examination of learning effects in very young children is appropriate. This paper specifically addresses how (or if) children under 2 are able to utilize information from screen media and, specifically, how screen media might impact children's language development.

Because television and DVDs are significant environmental inputs for young children, they might have an impact on children's language learning. Both areas of language development, expressive and receptive, are relevant to this concern. Receptive language pertains to the comprehension of spoken language, whereas expressive language pertains to communicative behaviours, including vocalization, gestures, and word production (McCarthy, 1960; Owens, 1996). Research has demonstrated that word comprehension generally precedes word production (Owens, 1996). Although children may not be able to articulate a particular word, they can often demonstrate their understanding of the referent word. For example, a 13-month-old who does not yet say the word 'dog' may still point or direct their attention to the family dog when a parent uses the word. Learning a word indicates that a child has retained its sound pattern and meaning and is able to link the two in a contextually appropriate manner. Whereas first spoken words typically begin around a child's first birthday, a child's receptive vocabulary may include far more words. The MacArthur communicative development inventories (CDIs) are often used to demonstrate the growth of language from infancy through toddlerhood and show vocabulary comprehension scores of 20–26 words for the average 12-month-old child (Fenson *et al.*, 2000). Other estimates for children at 12 months approach 50 words (Golinkoff & Hirsh-Pasek, 1999).

Although language development is considered to be a fairly resilient process in early childhood, vocabulary acquisition appears to be less resilient and more influenced by the environment than other language skills. Deviations in the environment can affect the quantity and quality of linguistic input children receive. For example, the amount of talk mothers direct to their children is strongly related to children's vocabulary growth (Hart & Risley, 1995). Related to young children's exposure to screen media, it is unclear whether television and DVDs can provide a similar level of environmental support as interactions with live caregivers, especially in light of parents' generally favourable opinions about the educational uses of screen media (Rideout *et al.*, 2003).

Learning from books

The benefits of joint book reading for language development have been well-documented. Although storybook reading is often used primarily as source of enjoyment for parents and children, it is also important in children's developing vocabularies and acquisition of word knowledge (Sénéchal & LeFevre, 2001; Sénéchal, LeFevre, Thomas,

& Daley, 1998). Storybook reading often involves language that is richer and more varied than other contexts for language interaction, such as dressing or mealtime (Hoff-Ginsberg, 1991). It also provides a context in which children can imitate verbal behaviours that are demonstrated by the parent (Snow & Goldfield, 1983). Interaction with very young children often involves the parents drawing attention to and labelling pictures on a page (Sénéchal, Cornell, & Broda, 1995). These behaviours may be repeated as parents read books multiple times. The joint attention interaction in book reading emerges as the parent or caregiver asks the infant questions such 'What is this?' or 'Where is the (desired referent object)?' or by simply drawing attention to certain pictures (Ninio, 1983). In doing so, the parent provides a context in which the child can demonstrate recognition of a word or to produce the word.

Learning from television and DVDs

Given these findings, it is interesting to note that at the beginning of the *Baby Wordsworth* DVD, the founder of *Baby Einstein* encourages parents to use the DVD like a book. As with storybook reading, the literature on older children's ability to learn language from television is substantial, especially regarding high-quality educational programmes such as *Sesame Street*, which has been associated with many positive educational benefits, including increased school readiness (Fisch & Truglio, 2001; Wright & Huston, 1995; Wright *et al.*, 2001). *Sesame Street* viewing was a significant predictor of vocabulary scores at age 5 for children who viewed starting at 3- to $3\frac{1}{2}$-years-old, even after controlling for parental education, gender, family size, and parental attitudes towards television. The relationship was also found without parental co-viewing, meaning children could learn without parents viewing with them (Rice, Huston, Truglio, & Wright, 1990). Other research suggests children older than 2 can readily acquire vocabulary from television (Rice *et al.*, 1990).

Rice and Woodsmall (1988) looked at 3- to 5-year-olds' ability to learn novel words from television. In their experiment, children watched a 15-minute television programme containing 20 novel words. After viewing, children were given a comprehension test to assess learning. Four pictures were arrayed on a page, and children were asked to point to the picture depicting a target word from the programme. Although the experimental groups performed better than the control groups, there were significant age differences. The 5-year-olds were more accurate than the 3-year-olds in identifying the correct words. Rice and Woodsmall concluded that children have the ability to 'fast map' new words from television; in other words, children were able to gain an understanding of a word after a single exposure to the televised stimulus. In a compelling anecdotal study, Sachs, Bard, and Johnson (1981) reported a case study of two hearing children raised by deaf parents who apparently learned spoken language from television viewing, providing additional evidence that television could be a useful input for vocabulary development.

Although compelling, these results do not necessarily inform discussions about the impact of media on younger children's language development because this past research has focused on programmes targeted to children in the preschool years. In contrast, critics' concerns with infant-directed media reflect an assumption that media exposure in the first 2 years of life might detract from quality adult interactions that support normal linguistic development. A reasonable hypothesis might be that children who frequently watch infant DVDs spend less time in play and thus do not have as many play-related language learning possibilities. At least one recent study suggests that infants

who watch more baby videos and DVDs have fewer words, regardless of whether a parent was viewing with the child (Zimmerman, Christakis, & Meltzoff, 2007).

Some research has compared young children's ability to learn from a televised model to their ability to learn from a live model. The limited research available for children younger than 3 suggests evidence of a video deficit, or a lag between teaching with a live model and a televised model (Anderson & Pempek, 2005). Although the video deficit model has traditionally been used in research on imitation (Barr, Chavez, Fujimoto, Garcia, & Muentener, 2007; Muentener, Price, Garcia, & Barr, 2004), it may apply to the language domain as well, reflecting developmental difficulties in learning language from screen media. Krcmar, Grela, and Lin (2007) conducted a study examining the fast mapping abilities of young children. The authors presented words to 15- to 24-month-old children with a live adult model, an adult model on television, and through a clip from *Teletubbies*. Much higher gains were found with a live model as compared to the video of the adult or the *Teletubbies* clip, although the ability to learn from video improved as children approached 24 months. Infants under 2 seemed to struggle with fast mapping from the televised stimulus, especially in comparison to a live stimulus, leading the authors to conclude that children are more likely to learn the meanings of new words when instructed by a live adult and are less likely to learn them via television. Although compelling, these kinds of experiments have generally been conducted outside of young children's natural viewing experience.

Other data suggest there may be some linguistic benefit to watching content-specific programming. Using a survey approach, Linebarger and Walker (2005) found that differences in expressive language production were related to the specific programmes viewed. Viewing *Barney and Friends*, *Clifford*, *Arthur*, *Dragon Tales*, *Blue's Clues*, and *Dora the Explorer* were all related to higher expressive language scores, whereas viewing *Sesame Street* and *Teletubbies* were related to smaller expressive language skills. The authors speculated that the higher scores might be attributed to the narrative or storybook-like natures of the programmes, which afford opportunities for vocabulary words to be heard, visualized, and embedded in character interactions.

In order to explore whether children learn from viewing the videos produced for them, the study reported in this paper focuses on a DVD produced by the Baby Einstein Company called *Baby Wordsworth*. The DVD highlights 30 vocabulary words and combines short puppet skits with live footage of children and parents playing and interacting around the house. One of the most important factors to consider about children's potential word learning from *Baby Wordsworth* is that although words are paired with pictures of the named object, they are not embedded in a narrative or within spoken sentences, which may not be an ideal screen environment (Linebarger & Walker, 2005).

However, there is evidence that children are effectively able to learn words presented in isolation. In a study on mothers and their 9-month-old infants, Brent and Siskind (2001) reported that an average of 9% of maternal utterances consisted of isolated words. Additionally, the frequency with which a child heard a word in isolation was a significant predictor of whether the child had acquired that word at 12 and 15 months. Bird and Chapman (1998) investigated whether children 13- to 16-months old could fast map a word after four or eight exposures to an object with an unfamiliar label. Results showed that children as young as 13 months could fast map a new word after as few as four exposures. Thus, it may be possible that repeated exposure to words heard in isolation, even on DVD, could contribute to infants' receptive language.

The present study examines the impact of viewing a *Baby Wordsworth* DVD on 12- to 15-month-olds' expressive and receptive language skills. Learning was compared between a group of children who viewed the DVD over multiple time points and a group of children who were not instructed to view a particular DVD at all. Although giving the control group a different DVD to view may also have been an appropriate comparison group, the goal of this study was to compare children who viewed our target DVD with children who went about their daily routines uninterrupted. Given the design of the experiment, which ensured that children would be exposed to the DVD multiple times in order to counteract the potential video deficit effect, it was believed that children who viewed the DVD would understand and produce more words than the control group. In order to enhance the ecological validity of the experiment, all viewings of the DVD occurred in children's homes.

Method

Participants

Participants were 45 infants ($M = 59.38$ weeks at first visit, $SD = 5.44$ weeks) and their parents from Riverside County and surrounding communities in southern California. All infants were between 12 and 15 months old. There were 26 male and 19 female infants, representing Caucasian/White (60.00%), Latino/Hispanic (20.00%), African-American (8.89%), Asian-American (2.22%), and other multi-ethnic/unknown groups (8.89%). Participants were recruited through direct mailings, local advertisements, and referrals from local pediatrician's offices. All participants were compensated $25 for each visit to the laboratory and were given a free DVD at the conclusion of their participation.

Measures

Demographic questionnaire

All parents filled out a questionnaire about their ethnic background, income, and education level.

Media survey

All parents completed a survey regarding their household's media environment, attitudes towards media, and media habits. The survey was derived from a previous version of a media survey utilized in an earlier study assessing home media environments of children ages 0–6 (Rideout *et al.*, 2003). Parents were asked to reflect on their own media exposure and habits for their last 'typical' day. An example question included: 'How long, on a typical day, is your child exposed to television or a DVD that is on in the background?' The survey also asked how many minutes their child spent watching television and DVDs and how many minutes they were read to.

Bayley Scales of Infant and Toddler Development, 3rd edition

The Bayley Scales of Infant and Toddler Development, 3rd edition (BSID-III; Bayley, 2005) is used to assess physical, motor, cognitive, language, and social-emotional development for children. In this study, only the cognitive subtest was used, which incorporates play tasks, memory items, problem-solving tasks, and measures of information-processing speed. Internal consistency reliability estimates for 12- to

15-month-old children range from $r = .83$ to .89. The BSID-III was administered only during the first testing session.

Vocabulary questionnaire

All parents were given a list of 30 words that were featured in the *Baby Wordsworth* DVD, such as 'ball', 'puzzle', and 'couch.' For each word, parents were asked to indicate whether they believed their child understood the word and whether their child could say the word. Parents were instructed to mark that their child could say a word if it was recognizable and phonetically similar to the actual world. For example, saying 'dah' for 'dog' would be accepted, but 'woof–woof' would not. The total number of words understood (WU) and words said (WS) at each time point were used in the analysis. This method of parental report is similar to the widely used MacArthur CDIs (Fenson *et al.*, 1993). A full list of words can be found in the Appendix A. The vocabulary questionnaire was filled out by parents during each visit.

Materials

Baby Wordsworth: First words around the house DVD

Part of the *Baby Einstein* series of programmes, *Baby Wordsworth* is a 39-minute DVD advertised for children 12 months and older. Set to classical music, the DVD highlights 30 target words of objects and rooms found inside the house. As demonstrated in Figure 1, the text for each word is displayed with a picture of the item, simultaneously with an adult woman or female child demonstrating the American Sign Language gesture for the word. Interspersed with the target words are short skits featuring puppets and musical montages that incorporate the vocabulary words, for example a child playing on a toy *piano* or a child stacking *cups* (italicized words are highlighted in the DVD).

Procedure

Upon arriving for the first testing session, parents and their infants were brought into the laboratory, where parents signed the consent form and were informed about the purpose of the study. All parents were told that the purpose of the study was to investigate the impact of baby DVDs on very young children. Parents were not informed about any specific outcome measures. After the consent form was signed, the parent, child, and experimenter sat on the floor together with toys and played for a few minutes to help the child warm up to the experimenter. During this time, parents filled out consent forms, questionnaires, and survey information. When the child seemed comfortable in the new setting, he or she was tested with the BSID-III.

At the conclusion of the first session, a randomly selected subset of the participants ($M = 60.00$ weeks, $SD = 5.36$, $N = 20$) received a *Baby Wordsworth* DVD to take

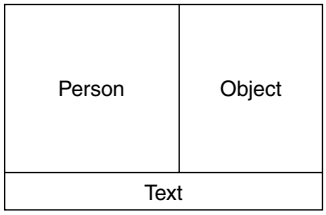

Figure 1. Sample display of vocabulary word on *Baby Wordsworth* DVD.

home with them and a time diary to keep track of their viewing. The viewing group included 9 female and 11 male infants. Five participants whose parents had indicated that their child had previously seen the *Baby Wordsworth* DVD were placed in this group to avoid contaminating the results. Parents were instructed to have their infant watch the DVD five times every 2 weeks for the next 6 weeks. Parent viewings were verified with a time diary that they kept indicating their viewing times. All other participants ($M = 58.88$ weeks, $SD = 5.57$, $N = 25$) were not given specific instructions, other than to follow their typical routines. The non-viewing group included 10 female and 15 male infants. Every 2 weeks for 6 weeks, all parents and children returned to the laboratory for follow-up testing sessions. At each of the remaining three testing sessions, parents filled out the vocabulary questionnaire.

Results

Average means and standard deviation at each time point can be seen in Table 1. Examination of *t* tests revealed no significant differences between the DVD and control groups on WU or WS scores at any of the time points. Although there were no significant differences in scores at the group level, the effect of the DVD may have contributed to individual differences in learning curves over time.

Table 1. Means and standard deviations by group

	Words understood				Words said			
DVD	T1	T2	T3	T4	T1	T2	T3	T4
No								
Mean	11.16	12.27	14.20	17.21	1.05	1.55	1.35	1.95
N	19	22	20	19	19	22	20	19
SD	6.78	8.03	8.02	7.88	1.39	1.73	1.42	1.61
Yes								
Mean	10.50	12.53	14.50	17.27	1.08	0.88	1.75	3.93
N	12	17	16	15	12	17	16	15
SD	6.05	6.73	7.37	7.17	1.56	1.05	2.08	4.11
Total								
Mean	10.90	12.38	14.33	17.24	1.06	1.26	1.53	2.82
N	31	39	36	34	31	39	36	34
SD	6.41	7.40	7.63	7.46	1.44	1.50	1.73	3.010

In order to take advantage of the longitudinal nature of the data, multi-level modelling was employed for analysis. Although often used to examine nested organizations (e.g. students within schools, etc.), multi-level modelling is also useful for examining longitudinal data, which has time points nested within individuals (Singer, 1998). A significant advantage to this approach is the ability to study multiple levels of analysis without violating the independence assumptions of linear multiple regression (Tabachnick & Fidell, 2007).

Before analysis, square root transformations were performed on the word understanding (WU), words spoken (WS), and income variables to adjust for extreme skew and kurtosis. In order to minimize potential third variable associations and to ensure

that the effects of predictors of interest were reflected appropriately in the outcomes, controls for age, cognitive developmental level, parent education, and income were included in all analyses. Additionally, as there was an unequal gender breakdown in our groups and because gender differences in word learning are sometimes found in children under 2, gender was also included as a control (Bauer, Goldfield, & Reznick, 2002; Fenson *et al.*, 1994; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991). All models included three Level-2 predictors: minutes read to; combined minutes viewing television and videos/DVDs; and exposure to background television, which is defined as the amount of time the television was on, even if no one was watching.

Impact of DVD

Analysis technique

Two-level hierarchical models were used to assess the effects of the *Baby Wordsworth* DVD on expressive language (as measured by the WU section of the vocabulary questionnaire) and receptive language (as measured by the WS section of the vocabulary questionnaire). Level-1 is a linear individual growth model (the 'within-person' model), and Level-2 expresses variations in the Level-1 model as random effects (the 'between-person' model). To begin, unconditional linear growth models examining variation in WS and WU were fitted and compared against models specifying no growth. In both analyses, a Level-1 predictor, *age*, was included, indicating each child's score was related to his or her age. In addition to a random effect representing variation within persons, random effects for the intercept and in the slopes for age were also included. Assuming significant variation was found in the intercepts and slopes, investigation would continue to examine covariates impacting intercept and slope. In all analyses, the variable *age* was centred to make the results more interpretable, so that the intercept would represent the average score for a child across the full sample controlling for age.

Expressive language

The unconditional linear growth model for WS provided a significantly better fit than a model specifying no growth ($\Delta\chi^2[3] = 231.9 - 207.7 = 24.2$, $p < .0001$) (see Table 2). The unconditional linear growth model revealed that at 59.38 weeks, the average child could say 2.04 words (out of 30) and gained about 0.14 words per week. Although there was significant variation in the intercept, there was no significant variance in the slope, meaning that Level-2 (between-person) covariates could only be used to explain intercept (i.e. mean score) variation and not slope. With no slope variation to explain, no analyses on the impact of the *Baby Wordsworth* DVD were valid. Thus, analysis shifted to examining Level-2 covariates affecting the intercept (see Table 3).

A final model of the WS score, with all controls present in the model, indicated that the children in the sample had a parent-reported vocabulary of 0.59 words (out of a possible 30) that they could say. Although time spent viewing television and videos/DVDs was not a significant individual predictor, the model fit was significantly improved beyond a controls-only model by keeping this variable in the model ($\Delta\chi^2[3] = 114.5 - 102.8 = 11.7$, $p < .01$). There was a significant positive relationship between time being read to and average WS such that for every 15 minutes a child was read to on a typical day, the child's average score increased by 0.61 words. There was also a very small, but significant positive relationship between exposure to background television and WS such that for every 30 minutes of television exposure in the background, the child's average score increased by

Table 2. Estimates of multi-level model fixed effects and random effects variances

	Parameter estimates							
	Random effects				Fixed effects		Fit statistics	
Model	τ_{00} variance in means	τ_{01} covariance between means	τ_{11} variance in slopes	Residual	γ_{00} intercept	γ_{01} average slope	$\Delta\chi^2(df)$	p
WU – Unconditional means model[a]	0.76			0.34	3.65			
WU – Unconditional growth model[a]	0.70	0.0043	0	0.25	3.38	0.10	34.2 (3)	$<.0001$
WS – Unconditional means model[a]	0.18			0.20	1.55			
WS – Unconditional growth model[a]	0.12	0.0055	0	0.17	1.43	0.046	24.2 (3)	$<.0001$

[a] Values based on square root transformation.

Table 3. Fixed effects models

	Fixed effect estimates									Fit statistics	
	Intercept[a]	Age[b]	Gender[b]	BSID[b]	Parent education[b]	Income[a,b]	Minutes viewed	Background TV exposure	Minutes read to	−2LL	$\Delta\chi^2(df)$
Words understood – controls only	3.50 (0.16)***	0.091 (0.018)***	0.12 (0.32)	0.020 (0.076)	−0.053 (0.17)	0.0031 (0.0040)				191.1	
Words understood – final model	2.29 (0.53)***	0.097 (0.017)***	0.61 (0.32)	0.012 (0.066)	0.15 (0.19)	0.0074 (0.0037)	−0.0039 (0.0048)	0.0028 (0.0014)*	0.038 (0.12)**	181.8	9.3 (3)*
Words said – control only	1.41 (0.082)***	0.047 (0.011)***	−0.16 (0.16)	0.017 (0.38)	−0.026 (0.085)	−0.0012 (0.0020)				114.5	
Words said – final model	0.77 (0.26)**	0.053 (0.010)***	0.12 (0.16)	0.011 (0.032)	0.13 (0.098)	0.0012 (0.0018)	−0.0028 (0.0024)	0.0015 (0.00070)*	0.022 (0.0062)**	102.8	11.7 (3)**

Note. Standard deviations in parentheses. *$p < .05$; **$p < .01$; ***$p < .001$.

[a] Square-root transformed.

[b] Centred.

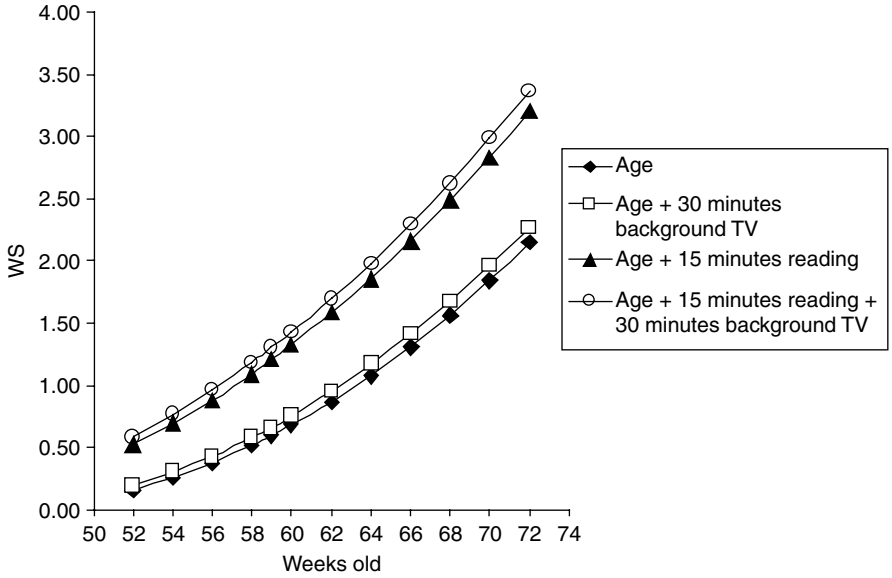

Figure 2. Growth curve predicting words said as a function of age, minutes of exposure to television in the background, and minutes read to.

0.069 words (see Figure 2). This model accounted for approximately 59% of the total explainable variation in the intercept, compared to the controls-only model, which accounted for about 34% of the variation.

Receptive language

The unconditional linear growth model for WU provided a significantly better fit than a no-growth unconditional means model ($\Delta\chi^2[3] = 337.8 - 303.6 = 34.2$, $p < .0001$). The unconditional linear growth model revealed that at 59.38 weeks, the average child could understand 11.42 words (out of 30) and gained about 0.69 words per week. Although there was significant variation in the intercept, there was no variance in the slope, meaning that Level-2 (between-person) covariates could only be used to explain intercept variation and not slope. Again, with no slope variation to explain, no analyses on the impact of the *Baby Wordsworth* DVD were valid. Analysis shifted to examining Level-2 covariates affecting the intercept (see Table 2).

A final model of the WU score, with all controls present, indicated that the children in the sample had a parent-reported receptive vocabulary of 5.24 words (out of a possible 30). Again, time spent viewing television and videos/DVDs was not a uniquely significant predictor, but the model fit was significantly improved beyond a controls-only model by keeping this variable in the model ($\Delta\chi^2[3] = 191.1 - 181.8 = 9.3$, $p < .05$). There was a significant positive relationship between time being read to and average WU such that for every 15 minutes a child was read to on a typical day, the child's average score increased by 3.01 words. There was also a small, but significant positive relationship between exposure to background television and WU such that for every 30 minutes of television exposure in the background, the child's average score increased by 0.40 words (see Figure 3). This model accounted for approximately 33% of the total explainable variation in the intercept, compared to the controls-only model, which accounted for about 6% of the variation.

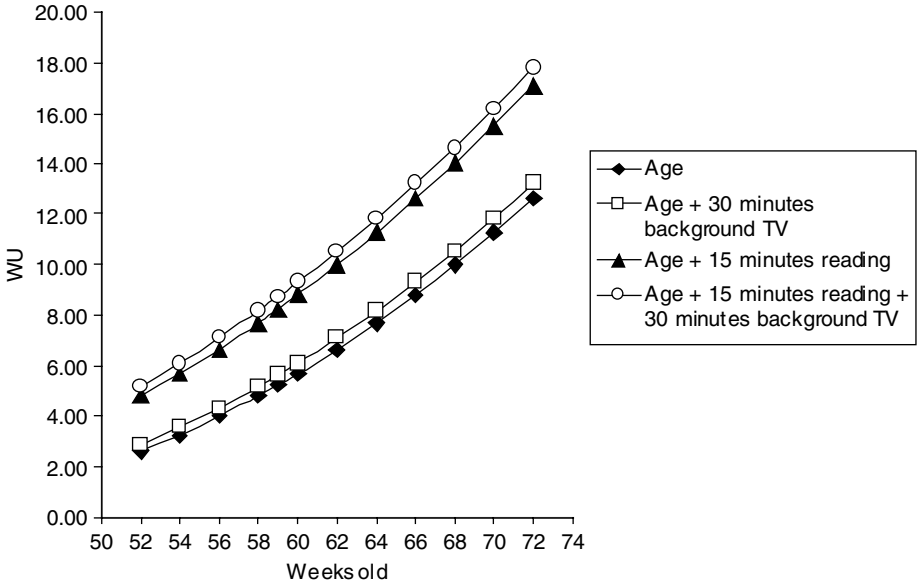

Figure 3. Growth curve predicting words understood as a function of age, minutes of exposure to television in the background, and minutes read to.

To summarize, results indicated that participants in the viewing group and the control group increased at the same rate on WU and WS. However, there were differences in what variables predicted participants' average scores on the measures. There were significant relationships between the amount of time a child was read to and outcome scores. Additionally, there were small, but significant relationships between outcome scores and having television exposure in the background.

Discussion

This experiment examined potential word learning from viewing a DVD produced with an emphasis on teaching specific words to children 12 months and older. Although this study is not meant to be a product evaluation, part of its strength lies in the utilization of professionally produced stimuli reflecting real-world use. Given past research suggesting young children can learn words from television after repeated exposures (Krcmar *et al.*, 2007), it was hypothesized that multiple exposures to the DVD could have a measurable impact on children's receptive and expressive vocabulary growth.

In contrast to the hypothesis, this experiment found no relationship between viewing an infant-directed DVD and increases on parent-reported scores of receptive and expressive knowledge of words highlighted in the DVD. Multilevel modelling revealed no significant variation in the slopes of the 12- to 15-month-old participants; in other words, there was no differential growth in any of the outcome measures for those participants who watched the DVD. Slopes across individuals increased at the same rate, regardless of condition; the only significant variation occurred in the participants' average scores (the intercepts), a finding that will be discussed below.

Although the findings suggest that children at this young age cannot learn words from a DVD of this nature, it is possible that this particular DVD was not well-suited to

teaching words. The structure of the DVD was such that a picture of target word was displayed on-screen in conjunction with a female voice saying the word, the text of the word, and an adult female signing the word. This was re-emphasized later with the same picture, but a child's voice saying the word and a female child signing it. This presentation does not mimic the situations in which infants are most likely to learn words. In particular, infants demonstrate the ability to learn new words and object labels in joint attention scenarios, where parents establish joint attention on an object with the infant and produce the desired word (Woodward & Hoyne, 1999). This DVD may not provide an appropriate context for joint attention learning in two respects: parents may not watch the DVD with their children and the on-screen adult does not look at the target object in the DVD.

Another possibility is that the *Baby Wordsworth* DVD did not attract infants' attention. For example, the written text and adult signer may have been too distracting, providing too many things to attend to at once. In addition after each word, there were multiple examples of the object in use, for example a child playing with a toy *telephone* or tapping on keys on his mother's *computer*. It could be that there was too much information on the screen and the child did not attend to parts that would increase the likelihood of remembering the word.

Given the importance that attention plays in learning, some research has found high levels of looking by children 12- to 15-months old when watching videos specifically for babies, in this case the video *Baby Mozart* (Barr, Zack, Muentener, & Garcia, in press). Presumably, videos for this age group maintain a simple enough structure to promote comprehensibility to very young children and make adequate use of formal features that are attractive to this age group. However, the *Baby Mozart* video is marketed to 1-month-old children, whereas *Baby Wordsworth* is marketed to children at 12-months. Barr and her colleagues may have been able to elicit high levels of looking because their video was more comprehensible to the children in their sample, a view supported by Anderson and Lorch's (1983) idea that attention is driven by understanding. *Baby Wordsworth*, with its frequent breaks to highlight words, might be too difficult to follow and thus less likely to be attended to.

A third reasonable possibility may be that televised exposure is not sufficient to teach words. In a related argument, Schmitt and Anderson (2002) suggested there may be too many informational-processing issues involved for children to adequately use television as a source of information. They believe that the television's representation of 3-D space is too degraded to give children the kinds of perceptually salient information needed for encoding certain types of information. Considering the assumption of limited cognitive resources, the tasks of understanding what is on the television, identifying the objects, and perceiving the nature of televised space may utilize cognitive processes that might otherwise be used to learn new words.

Lastly, the DVD is marketed to children 12 months and older. Children's first words are often simple, monosyllabic words that are well-related to their everyday environments and interactions. In other words, a child may have a lot of contact with a ball, hear the word 'ball', and get to manipulate a ball, contributing to the learning of that word. Although many of the words highlighted in the DVD fit this categorization, several others were more complex polysyllabic words that may have been encountered less frequently by young children, such as 'refrigerator' and 'living-room'. It seems less likely that a parent would use the word 'refrigerator' frequently when speaking to a 12-month-old child. More age-appropriate vocabulary choices may facilitate word learning, although follow-up research could help determine

whether children who did hear complex words on the DVD acquired them earlier than those who were not exposed.

Although some may find it discouraging that the DVD had no impact on language learning even after 15 exposures, the finding corroborates other research on infant-directed media demonstrating very young children's difficulty in learning from televised stimuli (Barr & Hayne, 1999; Krcmar *et al.*, 2007; Schmitt & Anderson, 2002; Troseth & DeLoache, 1998). However, other findings from this study could be used to guide future research. First, reading matters. Children in families who were read to for longer periods of time had higher reports of words they could understand and say, even after controlling for age, gender, income, parent education, and cognitive development level. Given the research pointing to the positive academic outcomes of children with larger vocabularies and language skills, this is still a valuable (though not surprising) reminder that reading remains one of the most useful and beneficial practices available to parents from the very beginning (Neuman, 1999; Shonkoff & Phillips, 2000). A wide literature indicates how reading to children provides the type of joint-referent, interactive structure that is critical for learning new words and object labels (Lemish & Rice, 1986; Ninio, 1983; Ninio & Bruner, 1978).

In this sense, the findings of this research mirror other findings suggesting DVD talk is not equivalent to parent-talk for children in this age range, a phenomenon most strongly demonstrated in research testing infants' phonemic discrimination. In contrast to older children and adults, new-born infants have the ability to discriminate all phonemes in all languages, regardless of the language being spoken around them, until about 8 months of age, at which time they can only discriminate the phonemes that occur within their native tongue (Eilers, Gavin, & Wilson, 1979; Werker, Gilbert, Humphrey, & Tess, 1981). Research has demonstrated that repeated exposure to a non-native language through a book-reading interaction increases the length of time for which infants can continue to distinguish particular non-native phonemes (Kuhl, Tsao, & Liu, 2003). This effect was not found when the exposure was through a DVD.

Contrary to what was expected, children in households where the television was on in the background for longer periods of time had higher reported scores on both receptive and productive vocabulary measures. Follow-up analyses showed that parents who believed television was more helpful to children's learning tended to live in homes with more background television, perhaps reflecting parents' positive attitudes about television. Follow-up also showed a significant negative correlation between time being read to and background television, a finding supported by Vandewater and colleagues (2005). Given that there is less time reading, which was already linked to increased scores, it is unclear why background television might positively influence words learned. It is possible that the background television variable is serving as a proxy for another variable, such as having older siblings, which might increase the amount of television viewed in the household. The presence of siblings might provide additional environmental opportunities for children to hear and use language with a live, interactive model (Dunn & Kendrick, 1982; Oshima-Takane, Goodz, & Derevensky, 1996; Sachs & Devin, 1976). However, follow-up analyses did not reveal any differences in receptive or productive vocabulary between children with older siblings and those without. It is also possible that children who hear television speech in the background have greater linguistic input and thus may have larger vocabularies, but this is a tenuous explanation and requires additional investigation. Since the added benefit to language was small, it would be irresponsible to recommend leaving the television on as a useful strategy for developing language, especially considering background television's role in

displacing other potentially valuable activities and disrupting children's play (Anderson & Pempek, 2005; Vandewater *et al.*, 2005).

It is also interesting to note that total time spent viewing television and DVDs was not a significant unique predictor in any model. Research in media often uses total media exposure as a predictor of outcomes from aggression to academic outcomes to attention problems (Anderson & Hanson, 2007). As Anderson and Hanson argue, this can be a misleading strategy. They liken television exposure to a diet – what is eaten is ultimately more important than how much; in other words, the kinds of media that children are exposed to will have a far greater impact than the amount viewed. As in Linebarger and Walker's (2005) work, examining a breakdown of the shows children watch may lead to a more revealing trend.

A final interesting finding to note is that gender, which has been found to contribute to language differences in other studies, was not a significant predictor in any of the models. This is somewhat surprising considering research showing that girls have slightly higher receptive and productive language than boys of the same age (Bauer *et al.*, 2002; Fenson *et al.*, 1994). However, as Fenson and colleagues (1994) note, gender accounts for only a very small portion of the variance in early language, especially compared to the much greater variability that exists within gender.

Several limitations of this study should be considered. Considering the incredible diversity in infants' individual differences and rates of growth (Shonkoff & Phillips, 2000), examining language development up to 2 years of age and beyond would provide valuable insight into the differing role of infant DVDs at different ages. However, as *Baby Wordsworth* is marketed to children starting at 12 months, it was an appropriate starting time point for this study.

Additionally, in a traditional causal experiment, scientists have full control of the environment in which the experiment takes place to reduce the possibility of external interference and unwanted variance that could lead to incorrect or misunderstood conclusions (Cook, Campbell, & Day, 1979). However, in this study, infants viewed the DVDs in their own homes in a manner that was similar to how to they usually watch in order to enhance the ecological validity of the findings. The benefit of this approach is that this study provides results suggesting that these types of DVDs may not be effective in the ways they are naturally used or for the audience to whom they are targeted. Closer examination of home factors, such as co-viewing behaviours, will be helpful in determining if there are differential outcomes for children in diverse home environments, as has been shown to be the case in other studies of television effects (Desmond, Singer, Singer, Calam, & Colimore, 1985; Dorr, Kovaric, & Doubleday, 1989; Rice *et al.*, 1990; Singer & Singer, 1998).

A final potential limitation lies in the way vocabulary scores were measured. As stated before, the vocabulary questionnaire is similar in nature to the widely used CDIs (Fenson *et al.*, 1993); and there is reason to believe that there is a significant correspondence between parental reports of child language and child performance (Ring & Fenson, 2000), but there is still a potential for a social desirability bias. Such a bias could inflate scores. One might expect that parents who had the DVD in their homes and viewed it 15 times (or at least were partially exposed to it) would be more likely to believe that their child had learned some of the words highlighted in the DVD. But this is not what occurred – there was no vocabulary gain associated with watching the DVD. Although this does not rule out that there was a social desirability bias in score reporting, it does not seem likely that it played an important role in this study.

In conclusion, there is no evidence to support implicit claims that *Baby Wordsworth*, or infant media generally, can teach children between 12- to 15-months-old to understand or speak more words solely from viewing in their homes. Although time being read to and background television exposure were significant predictors of children's average scores, the added gains were very small, leading to questions about their overall meaningfulness. How much can be generalized from results from one DVD is open to debate; however, in the absence of other research supporting this type of learning, and considering the many developmental difficulties young children face in learning from televised stimuli, there is still no evidence that children at this young age learn language effectively from viewing a DVD. Future research examining alternative televised presentations of vocabulary words, such as embedding them in narratives and using them in sentences, would be useful in determining whether this limitation is a result of media production choices or is reflective of more general cognitive limitations.

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Appendix A

Baby Wordsworth vocabulary items

Kitchen
Refrigerator
Bowl
Cup
Chair
Table
Playroom
Telephone
Computer
Puzzle
Blocks
Book
Yard
Dog
Ball
Tree
Flower
Swing
Living room
Cat
Window
Couch
Lamp
Piano
Bedroom
Bear
Clock
Mirror
Blanket
Bed

Author Queries

JOB NUMBER: 440

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Q1 The same acronyms 'WU and WS' have been provided for two different expansions 'words understood and words said' and 'word understanding and words spoken'. Please check and confirm the appropriate acronyms.

Q2 Please update the references Anderson and Hanson (2007) and Barr, Zack, Muentener, and Garcia (in press).

Q3 Reference Bjorklund (2005) is provided in the list but not cited in the text. Please supply citation details or delete the reference from the reference list.

Q4 Please supply page range for Singer and Singer (1998).

Q5 We have inserted page range for this reference Fenson et al. (1994). Please check and approve.