ARTICLE

# Effect of Block Play on Language Acquisition and Attention in Toddlers

## *A Pilot Randomized Controlled Trial*

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**Objective:** To test the hypotheses that block play improves language acquisition and attention.

**Design:** Randomized controlled trial.

**Setting:** Pediatric clinic.

**Participants:** Children aged 1½ to 2½ years.

**Intervention:** Distribution of 2 sets of building blocks.

**Main Outcome Measures:** Scores on the MacArthur-Bates Communicative Development Inventories, television viewing based on diary data, and the hyperactivity domain of the Child Behavior Checklist.

**Results:** Of 220 families approached in the clinic waiting room, 175 (80%) agreed to participate in the study. At least 1 diary was returned from 92 of the 175 families (53%). A total of 140 families (80%) completed exit interviews. Of the children in the intervention group, 52 (59%) had block play reported in their diaries compared with 11 (13%) in the control group ($P<.01$). The linear regression results for language acquisition were as follows: entire sample—raw score, 7.52 ($P=.07$); percentile, 8.4 ($P=.15$); low-income sample—raw score, 12.40 ($P=.01$); percentile, 14.94 ($P=.03$). For attention the results were as follows: entire sample—odds ratio, 0.49 ($P=.29$); low-income sample—odds ratio, 0.48 ($P=.26$) There were no statistically significant differences with respect to hyperactivity scores.

**Conclusions:** Distribution of blocks can lead to improved language development in middle- and low-income children. Further research is warranted.

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EARLY CHILDHOOD REPRESENTS a critical period in the development of young minds. The newborn brain triples in size between birth and 2 years of age. The long-standing presumption has been that certain activities during this period promote optimal development and that others may hinder it.[1] The American Academy of Pediatrics' recent report emphasizes the importance of free play in young children's development.[2] Although the lay press and many experts[2] recommend certain interactive activities (eg, reading, singing, and playing) as the best ways to foster healthy development during the first 3 years of life, there are few robust population-based studies that demonstrate how to promote such activities. This lack of data exists at a time when an increasing number of media-based products are making unsubstantiated claims that they can make children smarter, more literate, and more musical.[3] Parental reliance on media at this age (1) may reflect a mistaken belief that media viewing can adequately replace a child's interaction with his or her environment and (2) may be due to their availability and convenience. Media use as a default activity may, in part, explain consistent nonadherence with the American Academy of Pediatrics' recommendation that television viewing be discouraged before age 2 years.[1,4,5] Watching television in early childhood has been associated with language and attentional problems and with cognitive delay.[6-9]

One theory that may explain associations between early television exposure and subsequent cognitive and linguistic outcomes is based on the development of mental schemes akin to what Vygotsky and Kozulin referred to as "scaffolding."[10] Mental schemes are internal models of the world that a child uses to understand and master his or her environment. They are the precursors of thought and language. Through play, that is, unstructured manipulation of objects, the child begins to develop a men-

tal picture of and cognitive categories about the objects around him or her.[11-13] These mental schemes underlie an understanding of object permanence, the development of memory, and the roots of impulse control and language.[12-14] It has been shown that children acquire these mental schemes through imaginative play.[14] As children manipulate objects they begin to understand more about their qualities. Older children begin to make up stories or scripts for these objects, which underlie further understanding of them. An important leap in understanding occurs when the child learns to substitute and combine mental categories internally. For example, a toy truck is like a real truck, but it can be manipulated by the child. A toy truck can be driven along a chair and, before long, the chair can therefore be a road. Such development is essential for executive function: it is what facilitates children's ability to direct their own activity and is, therefore, important for sustaining attention.[15] Furthermore, this development is important in impulse control because children may use a mental image of an object to satisfy themselves while they wait for the real object. Accordingly, children who play more imaginatively have been shown to have better impulse control.[14]

Limited empirical data from nonlaboratory studies have tested this theoretical framework. This pilot study was designed to test the hypotheses that playing with blocks (as an example of an interactive type of play) promotes language and attention development.

## METHODS

We conducted a randomized controlled trial in a community sample recruited from a pediatric clinic in Seattle. Enrollment occurred between October 1, 2005, and March 31, 2006. A research assistant sat in the clinic waiting room and enrolled patients. The study protocol was approved by the Children's Hospital and Regional Medical Center institutional review board.

### PARTICIPANTS

Children aged 1½ to 2½ years were eligible. Children were excluded if their primary caretaker did not speak English or if they had been diagnosed as having developmental delay. After enrollment, participants were randomly assigned to the intervention arm or the control arm in blocks of 4 using a computer-generated randomization scheme.

### INTERVENTION

Children in the treatment arm received 2 sets of molded plastic, interlocking building blocks via the US mail, 1 set a week after enrollment and 1 set approximately 2 months later. The blocks were large and were designed specifically for children in the targeted age range. The initial block distribution consisted of a pack of 80 blocks; the second consisted of a smaller pack of approximately 25 specialty blocks (eg, cars and people). In addition, intervention parents received 2 newsletters with "blocktivities," which were suggestions of things that they could do with their child and the blocks (sort them by color, see how big a stack they could make, etc). Children in the control arm received the same number of blocks at the conclusion of the study. Parents were told only that they were participating in a study of child time use. They were not informed of the central hypotheses of the study. Each participant was enrolled for 6 months.

### DATA COLLECTION

At enrollment, all the parents completed a baseline questionnaire that included basic demographic information. In addition, during the trial, on 2 randomly selected weekdays and 2 randomly selected weekend days, intervention and control parents were asked to complete time diaries derived from the Panel Study of Income Dynamics.[16] These forms asked them to track all the activities for the index child during a 24-hour period and to detail all the activities that their child engaged in during the day, including block play, other types of play, and television viewing. Such diaries have been used extensively and have been shown to have a high degree of validity.[17]

At the conclusion of the study period, parents in both groups completed a follow-up questionnaire that included assessments of language and attention. The questionnaires were administered via telephone 6 months after enrollment by a research assistant masked to group assignment. Diaries and questionnaires are available from the authors on request.

### OUTCOMES

#### Language Acquisition

We used the MacArthur-Bates Communicative Development Inventories. This instrument was developed by psycholinguists to measure the relation between children's language and experimental tests of neural, cognitive, and social development.[18] The Communicative Development Inventories is a triad of reliable, valid, and broadly adopted measures of linguistic and communicative development, with excellent internal and test-retest reliability.[19] The Communicative Development Inventories is available in a level I for infants (ages 8-16 months), level II for toddlers (ages > 16 to 30 months, and level III for preschoolers (ages > 30 to 37 months).[18,20] It is a parental report measure composed of the following 3 parts: (1) a 100-item vocabulary checklist, (2) a set of 12 sentence pairs assessing grammatical development, and (3) 12 yes/no questions about the use of syntax, semantics, and comprehension, although not all levels have all parts.[20] A general score can be computed by averaging the proportion correct across the 3 parts. Reference ranges are available for each part separately and for the total.[20] In addition, percentiles are available corresponding to the population- and sex-based norms.

#### Attention

We used the hyperactivity subdomain of the Child Behavior Checklist for ages 1½ to 5 years.[21] The term *hyperactive* is somewhat dated in this context given that the questions related to attention, impulse control, and hyperactivity. This instrument has been shown in many studies[21,22] to have excellent psychometric properties, including good construct, convergent, predictive, and discriminative validities for several common behavioral problems. Note that this instrument is not sufficient for diagnosing attention-deficit/hyperactivity disorder. Consistent with previous studies,[6] for analytic purposes we dichotomized scores in the 90th percentile or higher as having attentional problems.

### STATISTICAL ANALYSIS

We tested the following specific hypotheses: (1) children in the intervention arm would have increased language acquisition and (2) children in the intervention arm would be less likely to have attentional problems. For each hypothesis we performed a subanalysis limited to the lower-income portion of the sample (defined as families with annual incomes < $75 000).

We did this because we believed a priori that the effects of the intervention would be more pronounced for this less affluent subpopulation.

Multivariate regression was used to adjust for potential confounding variables, including day care attendance (yes/no), race/ethnicity, being an only child, parental education, sex, and age. This was appropriate despite the experimental nature of this trial given the relatively small sample size. Linear regression models were used for the Communicative Development Inventories raw score and percentile analyses, and logistic regression was used for attentional problems.

Because the hypotheses do not target any particular dimension of language acquisition, we analyzed only the total scores and not the language subdomains individually. We analyzed the raw scores and the percentile scores, and both sets of results are reported.

## RESULTS

Of 220 families approached in the clinic waiting room and asked to participate in the study, 175 (80%) agreed to do so. Data on parents who refused to participate were not available. Demographic data on enrolled individuals are given in **Table 1**. Of the 175 enrollees, at least 1 diary was returned from 92 (53%). A total of 140 participants (80%) completed follow-up surveys. Fifty-two of the 88 children in the intervention group (59%) had block play reported in their diaries compared with 11 of the 87 children (13%) in the control group ($P<.01$). Stratified unadjusted data are given in **Table 2**. There was no difference in follow-up rates of diary completion between study arms. The linear regression results for language acquisition were as follows: entire sample—raw score, 7.52 ($P=.07$); percentile, 8.4 ($P=.15$); low-income sample—raw score, 12.40 ($P=.01$); percentile, 14.94 ($P=.03$). For attention the results were are follows: entire sample—odds ratio, 0.49 ($P=.29$); low-income sample—odds ratio, 0.48 ($P=.26$). These results are summarized in **Table 3**.

**Table 1. Descriptive Data on the Study Participants**

| | Control Arm (n=87)[a] | Intervention Arm (n=88)[a] | Total (N=175)[a] |
|---|---|---|---|
| Male | 42 (48) | 52 (59) | **94** (54) |
| Age, mean, mo | 21.3 | 21.6 | 21.4 |
| Race/ethnicity | | | |
| Non-Hispanic white | 14 (16) | 14 (16) | **28** (16) |
| Hispanic | 9 (10) | 12 (14) | **21** (12) |
| Black | 56 (64) | 54 (61) | **110** (63) |
| Asian | 8 (9) | 8 (9) | **16** (9) |
| Parental education[b] | | | |
| Did not complete high school | 4 (5) | 6 (7) | **10** (6) |
| High school diploma | 20 (23) | 17 (19) | **37** (21) |
| Some college or vocational school | 24 (28) | 32 (36) | **56** (32) |
| College degree | 18 (21) | 22 (25) | **40** (23) |
| Graduate or professional degree | 21 (24) | 11 (12) | **32** (18) |
| Parental income, $ | | | |
| <10 000 | 22 (25) | 20 (23) | **42** (24) |
| 10 000-24 999 | 18 (21) | 24 (27) | **42** (24) |
| 25 000-49 999 | 28 (32) | 32 (36) | **60** (34) |
| 50 000-74 999 | 14 (16) | 6 (7) | **20** (11) |
| ≥75 000 | 5 (6) | 6 (7) | **11** (6) |
| Only child | 37 (43) | 42 (48) | **79** (45) |
| Child in day care | 57 (66) | 51 (58) | **108** (62) |

[a] Data are presented as number (percentage) unless otherwise indicated. Because of rounding, percentages may not total 100.
[b] Based on the parent with the highest level of education.

## COMMENT

In this pilot study, we found that distributing blocks was associated with significantly higher language scores in a sample of middle- and low-income children. Previous studies of Reach Out and Read programs have documented that distribution of books in a clinical setting can promote reading and literacy.[23,24] This study suggests that a "reach out and play" program to distribute blocks may also have efficacy in promoting development.

This study did not attempt to identify mediating factors that would explain the mechanism of action of block distribution on developmental outcomes. There are 2 related possibilities. One is that the block distribution resulted in more block playtime (as seems to be the case based on diary data) and that this additional block playtime displaced other forms of time use that were not as conducive to language development. The second is that the specific alternative time use displaced was television time. Infants are born with a drive to interact with their environments—including their caregivers and manipulable objects. This interaction is believed to foster cognitive development because the self-direction possible with interaction enables the developing brain to conduct experiments that provide information relevant to exactly the kind of learning that the child is trying to consolidate. Early environmental exposures, including opportunities to be engaged in socially and cognitively enriched environments, are critical to children's intellectual and linguistic development.[25,26] In this context it is not

**Table 2. Unadjusted Descriptive Comparisons Between the Intervention and Control Arms Stratified by Income**

| | Family Income ≥$75 000 | | Family Income <$75 000 | |
|---|---|---|---|---|
| | Control Arm (n=6) | Intervention Arm (n=5) | Control Arm (n=82) | Intervention Arm (n=83) |
| CDI, mean (SD) | | | | |
| Raw score | 72 (6.47) | 66.6 (15.34) | 57.21 (4.07) | 60.34 (4.11) |
| Percentile | 59 (11) | 44 (11) | 42 (4.25) | 55 (3.89) |
| Attentional problem, % | 0 | 0 | 14 | 9 |

Abbreviation: CDI, Communicative Development Inventories.

**Table 3. Regression Results[a]**

| Variable | Overall Sample | | | Middle- and Low-Income Sample | | |
|---|---|---|---|---|---|---|
| | CDI Raw Score, β (95% CI) | CDI Percentile, β (95% CI) | Attentional Problem, OR (95% CI) | CDI Raw Score, β (95% CI) | CDI Percentile, β (95%CI) | Attentional Problem, OR (95% CI) |
| Intervention group | 7.52 (–0.66 to 15.7)[b] | 8.40 (–3.00 to 19.90) | 0.49 (0.13 to 1.81) | 12.40 (3.00 to 21.80)[c] | 14.94 (1.37 to 27.60)[c] | 0.48 (0.12 to 1.83) |
| Day care attendance | 0.02 (–8.17 to 8.21) | –1.34 (–12.80 to 10.14) | 1.04 (0.30 to 3.60) | 3.86 (–5.10 to 12.94) | 4.23 (–8.49 to 16.90) | 1.16 (0.33 to 4.10) |
| Only child | 2.43 (–5.37 to 10.24) | 4.03 (–6.90 to 14.98) | 1.12 (0.33 to 3.71) | 1.50 (–7.00 to 10.06) | 1.07 (–10.90 to 13.02) | 1.27 (0.38 to 4.30) |
| At least a high school education in parent | 10.9 (–0.01 to 21.8)[b] | 16.55 (1.24 to 31.80)[c] | 1.15 (0.22 to 6.00) | 12.55 (0.55 to 24.00)[c] | 19.3 (2.63 to 36.10)[c] | 1.49 (0.29 to 7.68) |
| Male | –3.14 (–11.10 to 4.84) | 10.02 (–1.16 to 21.21)[b] | 1.11 (0.31 to 3.97) | –5.69 (–14.66 to 3.28) | 8.26 (–4.20 to 20.78) | 1.09 (0.30 to 3.96) |
| Age | 4.38 (1.16 to 7.69)[c] | –1.25 (–5.70 to 3.21) | 1.0 (0.60 to 1.73) | 4.90 (1.41 to 8.39) | –0.50 (–5.37 to 4.36) | 1.02 (0.60 to 1.75) |

Abbreviations: CDI, Communicative Development Inventories; CI, confidence interval; OR, odds ratio.
[a] All the results are also adjusted for race/ethnicity.
[b] $P < .10$.
[c] $P < .05$.

surprising that the largest effect in this study occurred in low-income children, whose parents may be constrained by their circumstances from providing their children with the adequate time and financial resources to ensure a rich, cognitively stimulating environment.

As provocative as these results are they must be interpreted in light of the following limitations. First, this study was performed in a single clinically derived population and must, therefore, be generalized conservatively. Second, similar to all behavioral interventions, this one was only single-blinded because blinding participating parents was not possible. Although parents were not, per se, aware of the hypotheses being tested, those who were in the intervention arm may have had incentive to report better language acquisition. At a minimum, as a result of block play they may have been more attuned to their child's linguistic abilities. Third, although we used a validated measure of language development in the way it was intended (parental report), laboratory-based measures of executive function of cognitive development would have strengthened the findings. Finally, we did not determine the marginal benefits of reading the blocktivities vs simply distributing the blocks themselves. It is possible that either alone may have been sufficient to achieve the effect we found, although the blocktivities, perforce, rely on the presence of blocks. We did not give any additional instructions to parents, which may have further enhanced the results. We did this because we were specifically trying to conduct an effectiveness trial mimicking the situation where a family obtains (or is gifted) a set of blocks. Based on these results, the blocktivities we tested are now included in this brand of building blocks.

Despite these limitations this study has important implications. The results suggest that there may be practical and actionable strategies that can be used at a population level to increase language acquisition and perhaps to decrease television viewing during a critical period of child development. Further study (including laboratory assessments) to corroborate these findings and to explore whether attentional capacity could be significantly improved given a larger sample is warranted.

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**Author Contributions:** The data were collected, stored, and analyzed by a team under the direct supervision of Dr Christakis. *Study concept and design:* Christakis and Zimmerman. *Acquisition of data:* Christakis. *Analysis and interpretation of data:* Christakis, Zimmerman, and Garrison. *Drafting of the manuscript:* Christakis and Zimmerman. *Critical revision of the manuscript for important intellectual content:* Christakis, Zimmerman, and Garrison. *Statistical analysis:* Christakis, Zimmerman, and Garrison. *Obtained funding:* Christakis. *Administrative, technical, and material support:* Christakis and Zimmerman. *Study supervision:* Christakis.
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***Announcement***

**Submissions.** The Editors welcome contributions to Picture of the Month. Submissions should describe common problems presenting uncommonly, rather than total zebras. Cases should be of interest to practicing pediatricians, highlighting problems that they are likely to at least occasionally encounter in the office or hospital setting. High-quality clinical images (in either 35-mm slide or electronic format) along with parent or patient permission to use these images must accompany the submission. The entire discussion should comprise no more than 750 words. Articles and photographs accepted for publication will bear the contributor's name. There is no charge for reproduction and printing of color illustrations. For details regarding electronic submission, please see: http://archpedi.ama-assn.org.