CHILD DEVELOPMENT

Child Development, xxxx 2017, Volume 00, Number 0, Pages 1–14

The title for this Special Section is **Bringing Developmental Science into the World**, edited by Roberta Michnick Golinkoff, Kathy Hirsh-Pasek, Rachel Grob, and Mark Schlesinger

When Cultural Norms Discourage Talking to Babies: Effectiveness of a Parenting Program in Rural Senegal

Ann Weber and Anne Fernald
Stanford University

Yatma Diop
Michigan State University

In some areas of rural Africa, long-standing cultural traditions and beliefs may discourage parents from verbally engaging with their young children. This study assessed the effectiveness of a parenting program designed to encourage verbal engagement between caregivers and infants in Wolof-speaking villages in rural Senegal. Caregivers (n = 443) and their 4- to 31-month-old children were observed at baseline in 2013 and 1 year later at follow-up. Results showed that caregivers in program villages nearly doubled the amount of child-directed speech during a play session compared to baseline, whereas caregivers in matched comparison villages showed no change. After 1 year, children in program villages produced more utterances, and showed greater improvement in vocabulary and other language outcomes compared to children in comparison villages.

The importance of rich verbal communication with infants is well documented in western cultures where the use of child-directed speech is a widespread norm. However, in certain agrarian societies in low-income countries, verbal engagement with infants is much less common (e.g., Richman, Miller, & LeVine, 1992), and some caregivers believe that talking to babies is pointless and may even have negative consequences (LeVine et al., 1996). Although some educators and researchers have argued that such variation in traditional parenting practices should not be questioned by outsiders (e.g., Dudley-Marling & Lucas, 2009; Valencia, 1997), there is increasing concern that low levels of verbal engagement with infants can be costly to the child, as more scientific evidence confirms that language and cognitive stimulation starting at birth are critical for brain development (Nelson, 2015). Here we report the results of a large-scale parent–child engagement intervention in West Africa designed to encourage verbal interaction between Wolof-speaking caregivers and infants living in subsistence-level rural villages in Senegal.

Research in western, industrialized countries has documented that infants who hear more rich and varied speech from caregivers become more efficient at processing language (Weisleder & Fernald, 2013), learn vocabulary more quickly (Rowe, 2012), and develop stronger language skills (Hirsh-Pasek et al., 2015; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010). The quantity and quality of speech to children vary widely as a function of family socioeconomic status (Hart & Risley, 1995) and cultural heritage (Tamis-LeMonda, Song,

This work would not have been possible without the hard work and many contributions of the team members in Dakar: Serginho Donatien Badji, Abdoulaye Bousso, Mourtada Dem, Magor Dia, Sidy Giroux, Abdoulaye Kasse, Ibrahima Samba, Mamadou Thiam, and Anna Vandekooy, as well as Shamsi Soltani, Virginia Marchman, Karl Pope, Kat Adams, Melanie Ashland, Ricardo Bion, Kyle MacDonald, and research assistants in the Language Learning Lab at Stanford University. We also gratefully acknowledge the generous support of all those who made this research possible, including Molly Melching and the Tostan staff; Madji Sock and her staff at Dalberg Global Development Advisors; the William and Flora Hewlett Foundation; and the caregivers, children, and other community members in Kaolack, Senegal.

Correspondence concerning this article should be addressed to Ann Weber, School of Medicine, Stanford University, Stanford, CA 94305. Electronic mail may be sent to annweber@stanford.edu.

 0009-3920/2017/xxxx-xxxx
DOI: 10.1111/cdev.12882

Leavell, Kahana-Kalman, & Yoshikawa, 2012). Interventions have emerged in the United States to encourage parents to provide more verbal stimulation to their children, with the aim of narrowing achievement gaps at school between children from more and less advantaged families (e.g., Suskind et al., 2015). Although such programs are viewed by some as undervaluing cultural differences in childrearing (Dudley-Marling & Lucas, 2009; Avineri et al., 2015), others emphasize the importance of sharing the scientific evidence with caregivers, encouraging them to explore new ways of engaging with their children (Fernald & Weisleder, 2015; Hoff, 2013).

The debate becomes more complex when discussing interventions in non-western, low-income areas of the world where less is known about how parenting practices influence children's learning. Research on parent–child interaction in many agrarian societies shows that western-based forms of communicating with young infants are often discouraged or avoided (LeVine et al., 1996; Shneidman & Goldin-Meadow, 2012). In settings where child mortality is high, valued practices such as prolonged breastfeeding and nonverbal soothing may serve to enhance children's survival, but cognitive stimulation is typically not a strong priority (Richman et al., 1992). Over the first 2 years of a child's life, caregivers' focus tends to shift from ensuring the infant's survival to encouraging the toddler's contributions to tasks important to family and community (Kagitcibasi, 2007). In addition, mothers may rely increasingly on siblings as caregivers when another baby comes along. Thus, as the child becomes more vocal and able to engage with caregivers, parents' direct engagement with the child frequently declines (LeVine et al., 1996).

Although it is clear that different styles of parent–child interaction can be adaptive in different cultural contexts (Keller, 2007), there is growing concern that low levels of parent–infant engagement are costly not only to growing children but to the economic future of the countries where they live (Cunha, Heckman, Lochner, & Masterov, 2006). In a seminal 2007 article in *The Lancet*, inadequate learning opportunities through parental engagement were identified as a key factor contributing to the failure of millions of children to achieve their developmental potential (Engle et al., 2007). As global child mortality rates drop and agrarian societies experience pressures of modernization, children living in low-income settings increasingly require more of the cognitive and school-based skills necessary for them to thrive in a global economy (Greenfield, 2009). Moreover, if a child's future vocational success now requires new kinds of learning in the public school system, then parents who never received a formal education will need new knowledge and skills to help their children succeed in school and later life. Effective parent education interventions in developing countries, such as the Jamaica Study (Walker, Powell, Grantham-McGregor, Himes, & Chang, 1991), have inspired other parenting programs around the world. The Jamaica Study demonstrated not only improvements in children's early cognitive outcomes but also gains in adult outcomes 20 years later (Walker, Chang, Vera-Hernández, & Grantham-McGregor, 2011).

Here we present an evaluation study of a parenting program conducted by Tostan, a widely respected NGO founded in Senegal in 1991 and now operating in six West African countries. Over 2,000 rural communities have participated in Tostan's Community Empowerment Program (CEP; Gillespie & Melching, 2010), a 3-year human rights based education program that engages communities to set a vision for their future while learning about democracy, human rights, hygiene, health, literacy, and project management. Participants also engage in discussions about how traditional practices can help or hinder their well-being. In 2011, Tostan interviewed caregivers in remote Senegalese villages who reported that they avoided making eye contact or talking with their infants for fear that the baby might then be possessed by evil spirits, a dire outcome thought to have fatal consequences (Zeitlin, 2011). Parents also reported that an adult might be called "crazy" if they talk to a baby, because "nobody is there." Concerned that such traditional beliefs might conceivably be related to low achievement in Senegalese elementary schools, Tostan developed the Reinforcement of Parental Practices (RPP) program, an early childhood development curriculum designed to build on their 3-year CEP program. Drawing on scientific discoveries about the crucial role of early language experience in cognitive development and later school achievement, the initial goals of the RPP program were to enable caregivers to engage more effectively in verbal interactions with their infants, providing richer cognitive stimulation, and thus to build a stronger foundation for their children's school learning.

With a focus on caregiving for children from 0 to 6 years, the RPP program comprised 43 group sessions and bimonthly home visits over a 9- to 10-month period, conducted by a Tostan facilitator who lived in the community. Topics in early

sessions included the human rights of the child, brain development in infancy, and scientific evidence on how parenting practices influence children's language and cognitive growth. Because most participants had no experience reading to children, Tostan developed 15 colorful children's books in three national languages and showed caregivers how to share them with children. Later sessions focused on how parents could help their children succeed in school—for example, by talking to them, telling stories, and teaching them numbers, as well as engaging with teachers and monitoring children's school progress. During the sessions, participants joined in games, role play, and other group activities. They also reflected on both the beneficial and potentially harmful aspects of traditional childcare practices. During home visits, the Tostan facilitator reinforced what was taught in class, coaching caregivers as they practiced new activities with their children. Participants were also encouraged to share their new knowledge with siblings, other relatives, neighbors, and surrounding villages through Tostan's model of "organized diffusion," with the goal of increasing the impact of the RPP program and reducing the potential for negative sanctions by others.

As funders of Tostan, the Hewlett Foundation invited us to design and conduct a rigorous and independent "proof-of-concept" evaluation of the RPP intervention. A central goal of this evaluation study was to test whether caregivers' behavior—in particular their tendency to engage in verbal interactions with their young children—actually changed as a result of participation in the program, and if so, whether these changes actually influenced children's language learning. Answering such questions about the effectiveness of an intervention is inherently difficult, even with participants who speak languages like English or Spanish in which valid assessment instruments are readily available. But conducting an evaluation study under field conditions in a developing country presents many additional challenges. For example, although Tostan offered the RPP program in 3 of the 11 national languages spoken in different regions of Senegal, we had to focus on just one—Wolof, the most widely spoken language. Given the substantial demands of translating and validating measures specifically designed to assess parents' language production and children's language learning in Wolof—it was not feasible to develop comparable materials in other languages at the same time. Moreover, our goal was to assess both caregivers' behaviors and children's developing language skills using reliable fine-grained measures that are standard in laboratory research but are not widely used under the arduous conditions of field research. Thus, in addition to adapting the standard questionnaire and interview measures commonly used in evaluation research, we included direct observations of caregiver–child interactions in a video-recorded play session, as well as all-day audio recordings of language heard in daily interactions, using the LENA™ speech recording and analysis technology (Ford, Baer, Xu, Yapanel, & Gray, 2008). These measures generated extensive samples of caregivers' and children's speech in Wolof.

To collect and analyze these diverse types of data, nine native Wolof-speaking university graduates familiar with Wolof culture were recruited as research assistants by an independent consulting firm, Dalberg Global Development Advisors in Dakar, Senegal. Over the 2-year period of the study, this team received extensive training in data collection and analysis from Stanford researchers, as well as supervision from Dalberg professionals. To assess the program impact on parenting practices and children's language outcomes, the team gathered extensive data at baseline in 2013, before the RPP program was implemented, and 1 year later at follow-up in 2014, both in villages that received the program and in comparison villages that did not.

Two overarching questions motivated this research: Did the RPP program result in change in caregiving behaviors? If so, did these changes influence children's early language development? These questions were addressed in a series of four analyses. First, to verify that our two groups of participants were not systematically different at baseline across key variables potentially related to early language development, we performed statistical tests of independence of child, caregiver, household, and village characteristics by program status. Second, to test our main hypotheses regarding change in both caregivers and children, we estimated average effects of the program, defined as the difference in mean outcomes obtained at follow-up between the RPP program group and comparison group. Using parametric linear regression, we asked whether differences at follow-up were statistically significant after adjusting for potential confounders. Third, because the pathway for change in children's language proficiency was expected to occur primarily through change in caregivers' behavior, we performed a mediation analysis to estimate the percentage of change in child language outcomes that could be explained by caregivers' knowledge of

child development and their observed verbal engagement with their child. Fourth, because caregivers in the RPP villages had varying levels of participation in the program, we explored possible dose–response effects by dividing RPP caregivers into low- and high-participation subgroups, to test whether higher frequency of participation resulted in larger program effects.

Method

Participants

Because Tostan's preparations for launching the RPP program in 200 Wolof-, Pulaar-, and Mandinka-speaking villages in five regions of Senegal were well underway before the evaluation study was designed, random assignment of the program to villages was not possible. Faced with this constraint, we designed our sampling strategy to minimize initial differences between the RPP and comparison groups. First, we limited the evaluation to the Kaolack region of Senegal in which Wolof is the primary language spoken and in which 90 communities had received Tostan's CEP. Only those villages that had participated earlier in the CEP program were considered eligible to host the RPP. Forty of these communities had already been selected by Tostan to receive the RPP, and the remaining 50 communities were eligible to receive the RPP at a later date. Using data from Tostan in combination with GPS data on the size and location of these villages, we restricted the sampling frame to 20 of the 40 program sites and 17 of the 50 delayed-intervention sites. All of these villages were similarly isolated, large enough to meet our within-village sample size requirements and estimated to have more than 90% Wolof-speaking households. We then performed systematic random sampling ordered by village size to select 12 program and 12 comparison sites for a total of 24 villages to be included in the evaluation study. During fieldwork, two program sites were replaced with the next largest village in the list, one because the predominant language spoken was Bambara and the other because the field team was unable to find an adequate testing space. Two comparison sites were also replaced, one because the village leaders refused to participate, and the other because the village had extremely unreliable age information for the children (e.g., date of birth was missing on most health cards).

In each village, we enrolled a median of 21 caregiver–child pairs (range = 12–30 pairs) from a list provided by village leaders of age-eligible children in two cohorts: children 4–19 months who were mostly preverbal and children 20–31 months who were expected to be talking. All children on the village list in the older cohort were selected for enrollment. As the list of younger children was longer, systematic random sampling was performed to meet our target of 10 children per cohort per village. Seventy caregivers approached for enrollment across the 24 villages were unable to participate in the evaluation: 41 were travelling, 6 refused, and 23 could not attend the testing sessions. Children were excluded if they were reported by the caregiver to be bilingual (i.e., were spoken to more than 10% of the time in a language other than Wolof) or to have a serious developmental delay or a hearing, speech, or vision impairment. If a mother had twins, only one was included. Households typically consisted of large extended, often polygynous, families living together in small buildings set around a central compound with a communal kitchen. Caregiver-child pairs living in the same household were eligible to participate, although no caregiver could be represented twice. We chose as primary caregiver the individual who spent the most daylight hours responsible for the child and thus had the greatest opportunity to influence the child's language development. Almost all primary caregivers (93.9%) were the target child's mother.

At baseline in 2013, we collected data for 506 caregiver–child pairs in 423 households. One year after baseline, when the children were 16–43 months, 469 (92.7%) of these caregiver–child pairs were tested again (29 had moved away, 7 declined, and 1 child was deceased). We excluded one child with a developmental delay and 25 children whose primary caregiver had changed between the two study periods. The final analytic sample size varied by outcome based on the availability of data at both baseline and follow-up, with a maximum of 443 caregiver–child pairs included in our analyses (Table 1). Most primary caregivers (84.7%) had no formal education in French or French–Arabic schools, 11.5% had some primary education, and < 4% had any secondary or higher education. Because 66% of heads of household were in polygynous marriages, households were large, averaging 16.1 members and 4.1 children under the age of 5 years. Less than half of the villages had a functional health center and only three had electricity (see Table S1 for more details).

Data Collection

Extensive survey, video, and audio data were collected for all participants by two field teams

Table 1
Unadjusted and Adjusted RPP Program Effect Estimates for Key Outcome Measures

	Unadjusted regression		Adjusted regression[a]		
	N	Effect estimate β (*p*)	*N*	Effect estimate β (*p*)	*SD* units[b]
Caregiver outcomes[c]					
Play session: Caregiver words to child	441	181 (< .001)	433	176 (< .001)	1.55
Play session: Caregiver MLU	441	0.69 (< .001)	430	0.70 (< .001)	1.24
All-day recording: Female adult words/hr	183	−3.10 (.94)	179	−27.0 (.66)	−0.12
Caregiver knowledge of child development	443	8.7 (< .001)	435	7.7 (< .001)	1.59
Child outcomes[d]					
Play session: Child utterances	434	14.1 (.001)	433	15.3 (< .001)	0.45
Child language milestones	435	3.4 (.004)	431	2.3 (< .001)	0.34
CDI: expressive vocabulary	206	6.8 (.026)	203	4.8 (.047)	0.27
All-day recording: Child vocalizations/hr	178	36.9 (.057)	178	22.5 (.20)	0.23
All-day recording: Conversational turns/hr	178	8.3 (.046)	178	5.0 (.31)	0.24

Note. RPP = Reinforcement of Parental Practices; MLU = mean length of utterance; CDI = Communicative Development Inventory; CEP = Community Empowerment Program. [a]Covariates are the lagged dependent variables plus characteristics of the child (age, change in age, age squared, gender, length for age, birth size), caregiver (age, relation to child, education, literacy, attended earlier Tostan CEP, children < 5 years in her care, lost a child, depressive symptoms), household (polygynous head of household, members who attended earlier Tostan CEP, mean age, median years of education, children < 5 years, crowding, wealth), and village (population, households, midwives, and marabouts; has health clinic, primary school, day-care; time to market and to get water; electricity, operational NGOs, flooding in 2013). [b]Standard deviation (*SD*) units are calculated as the covariate-adjusted effect estimate divided by the *SD* of the raw data in the comparison group at follow-up. [c]Caregiver–child play session: caregiver words to child, MLU; all-day recording using LENA™: female adult words to child; Caregiver report questionnaire data: caregiver knowledge of child development. [d]Caregiver–child play session: child utterances; Caregiver report questionnaire data: child language milestones, MacArthur-Bates CDI adapted "understands and says": expressive vocabulary; all-day recording using LENA™: child vocalizations, conversational turns.

who kept to a demanding 10-week schedule of work and travel at both baseline and follow-up. Although the teams received generous hospitality from community members in the villages, they also faced many challenges, including exposure to extreme heat, absence of electricity and clean water, poor sanitation, and the need to reschedule data collection around unpredictable events. In each village, the teams set up a common testing space with adequate natural light for video recordings but removed from excessive noise and curious onlookers. The electronic equipment selected for these conditions operated on batteries, which were recharged with a gas-powered generator every night. The teams remained in each village for 5–6 days, sleeping in tents with mosquito netting on the floor of a space provided by village leaders, before traveling on to the next village. Data were transferred on USB keys to a Dalberg liaison on travel days to avoid loss from theft or other misfortune.

In order to improve the reliability of data collection, all questionnaires were translated and transcribed into Wolof—a significant change from common practice in survey research in Senegal. Wolof is a primarily oral language not used in written form in school. Because most Senegalese adults are not literate in their native language, we first needed to teach the team members to read and write fluently in Wolof. We also worked with Senegalese mothers and other Wolof language experts to verify that our assessment tools were culturally and linguistically appropriate for the dialect used in Kaolack. These survey tools are available upon request in both French and Wolof.

Data for three broad categories of measures were collected to evaluate the effectiveness of the Tostan RPP intervention: (a) measures of caregivers' parenting skills, including direct observations of caregiver–child interaction in video-recorded play sessions and all-day audio recordings of children's language environment using the LENA™ speech and analysis technology, as well as questionnaire data on caregivers' knowledge of child development; (b) measures of children's language proficiency, including direct measures of children's speech production from the video and audio recordings, as well as caregiver report questionnaires on milestones in language growth and expressive vocabulary size; and (c) extensive survey data on potential confounding variables related to child, caregiver, household, and village characteristics.

Measures of Caregivers' Parenting Skills

Caregiver's Speech to the Child in a Structured Play Session

To assess change in the amount caregivers spoke to their children, we analyzed naturalistic samples of their speech from video-recorded play sessions, in RPP and comparison groups, before and after the program. In each village, the play sessions took place in a single testing locale, to provide a standardized observational context. Caregiver and child sat on a floor mat with simple toys provided, such as a plastic bucket, shovel, car, book, and a few other items. A microphone was attached to the caregiver's clothing and a video camera was set up about 2 m from the pair. The caregiver was asked to interact with her child as she would at home and then left undisturbed for 15 min at baseline and 8 min at follow-up. Native Wolof speakers transcribed the middle 5 min of each video at baseline and the last 5 min at follow-up. These transcripts were then processed using the software package CLAN (Brian, 2000) to obtain two measures of caregiver speech directed to the child in 5 min: total number of caregiver words and the mean length of caregiver utterances (MLU), calculated as the total number of words divided by the number of utterances. MLU is used here as a proxy for the complexity of caregiver speech to the child.

LENA™ Audio Recordings of Children's Language Environment

In addition to the naturalistic language samples obtained in the play sessions, we used the LENA™ audio and speech analysis technology to assess changes in the amount of language heard by children in the RPP and comparison groups. While video recordings from the play session captured interactions between each caregiver and child when they were alone with no distractions, the LENA™ digital recorder captured the language heard by each child from many different adults and other children over the course of a typical day. The LENA™ device was worn by the child in specially designed clothing, recording 8–10 hr of the audio environment within a 1.2- to 1.8-m radius of the child. Eight children in each village were selected to wear the LENA™ device, with priority given to children from the older cohort (20–31 months). The audio data were processed with LENA™ analysis software, which incorporates speech recognition algorithms to differentiate speech-related sounds from environmental background noise (Ford et al., 2008). This software yields automated measures of adult word counts (AWC), which is the number of words a child hears from men or women during the recording. Although the AWC does not distinguish child-directed from adult-directed speech, the software provides a breakdown of speech by "vocalization activity blocks." Each block represents periods of speech separated by silence, categorized by who initiated the speech (e.g., woman, man, target child, or other child). To assess possible caregiver speech to the child, we used female AWC from blocks categorized as "adult female-initiated speech to target child," because all primary caregivers were female. Because length of recordings varied, total counts were converted to counts per hour.

Caregivers' Knowledge of Child Development

To assess what caregivers' in the RPP and comparison groups had learned about child development between baseline and follow-up, we used a set of 15 statements read aloud to caregivers, who were asked if they strongly agreed, agreed, disagreed, or strongly disagreed with each statement. These statements were designed to assess participant understanding of key concepts which were taught in the RPP program, such as "A baby's brain starts to develop during pregnancy." Responses to each item were scored on a 0- to 3-point scale and summed to create a knowledge score for a maximum of 45 points.

Measures of Children's Language Proficiency

Observed Measures of Children's Vocalizations

To compare changes in amount of child vocalization between baseline and follow-up in the RPP and comparison groups, we used the same play session transcripts and all-day LENA™ audio recordings described for caregivers. Because accurate assessment of the number of words in children's speech was impossible due to difficulty of transcribing specific words for the younger children, the measure of child language production in the play session was the total number of utterances produced in 5 min. From the LENA™ recordings, we obtained automated estimates of child vocalizations and conversational turns. A child vocalization was counted when child speech of any length was surrounded by > 300 ms of silence or other sound that was not child speech. A conversational turn was counted when a child vocalized and an adult responded within 5 s—or an adult spoke and a

child responded. As with AWC, total child vocalization and conversational turn counts were converted to counts per hour.

Parents' Report of Children's Language Proficiency

To assess how children's communication skills developed from baseline to follow-up in the RPP and comparison groups, we used a language milestone checklist consisting of 38 questions asked to the caregiver regarding increasingly more advanced language skills in infants and young children. The checklist was translated into Wolof and adapted for use in the local context with the help of Senegalese experts in child development. The items were tested in a pilot study and refined by rewording or dropping items that were problematic for the caregivers. For example, the question "Does your child bring toys or objects to his/her mouth?" was dropped because respondents thought we wanted to know whether their children put "dirty" things in their mouths—so they said no, their child does not do that. Because all children had aged by a year at follow-up, we dropped the earliest milestones (e.g., "Child babbles or turns head to the sound of their mother's voice") and added more advanced items (e.g., "Child can describe two things about a named object") for a total of 40 items. The same starting item was used for all children, and a stopping rule of six consecutive responses of "no" was applied. Language milestones achieved are reported as the raw total score of administered questions to which caregivers responded "yes."

We also compared expressive vocabulary over time in the older cohort of children and between groups, using the MacArthur-Bates Communicative Development Inventory (CDI; Fenson et al., 2007). The CDI was adapted for use in the Wolof language and culture in a multiphase process approved by the CDI Advisory Board (Weber & Marchman, 2013). First, a pilot list of 130 words was constructed based on a CDI adapted for Krobo, Ewe, and Twi, all West African languages (Prado, 2016). In consultation with Wolof-speaking colleagues, we examined each word for cultural and linguistic relevance, substituting words that differed across dialects or were inappropriate to Wolof. Second, 30 Wolof-speaking mothers reported whether their child "understands and says" each pilot word, also providing additional words they had heard their child say. At baseline, a final Wolof language CDI was generated consisting of a list of 105 Wolof words likely to be familiar to children 20–30 months. For words in the list that caregivers reported their child understood and said, caregivers were frequently asked to give specific examples of when their child used the word, to verify their understanding of instructions. At follow-up, the list was modified by replacing the easiest words (e.g., *milk*) with a set of harder words (e.g., *before*) for a total of 110 words. Expressive vocabulary is reported as the total number of words from the list that the caregiver reported the child could understand and produce.

Measures of Confounding Variables

Extensive survey questionnaires were developed to verify that participants in the RPP and comparison groups did not differ systematically at baseline in terms of potentially confounding factors. These included village size and infrastructure, family demographics and wealth, caregiver characteristics (e.g., age and education), child characteristics (e.g., gender and birth size), and child nutritional status, which was obtained by measuring their height and weight, converted into age-adjusted *z*-scores using WHO growth standards and software (World Health Organization, 2011). We also included baseline measures of parenting practices and child language skill as potential confounders and refer to these as "lagged dependent variables" (i.e., occurring before the dependent variables used as outcome measures in our analyses). To minimize loss of statistical power, missing covariate data were imputed. For example, 5% of missing baseline height-for-age *z*-scores were replaced with children's height-for-age *z*-scores from follow-up (see Supporting Information for more information on confounding variables).

Results

Comparison of RPP Versus Comparison Groups at Baseline

The goal of the first analysis was to determine whether caregiver–child pairs in RPP and comparison villages were comparable across potential confounders, indicating that the villages were appropriately matched. Balance between the two groups was tested statistically with either a *t*-test (continuous variables) or chi-square test (dichotomous or categorical variables), adjusting the standard error to account for the correlated nature of our data at the village level. No significant differences were found between groups for child age, caregiver education, and relationship with the child, or for household size and wealth. However, children in the program villages were more likely to be male (59.8% vs. 49.3%) and to have a primary

caregiver who was slightly older (29 years vs. 27 years) than were children in the comparison villages. The number of caregivers who had completed Tostan's foundational CEP was also higher in program villages (54.9% vs. 30.6%) because the CEP had been held in many (but not all) of the RPP villages more recently than in the comparison villages (Table S1). There were no statistically significant differences between the two groups for any of the key caregiver behavior and child language measures assessed at baseline (Table S2).

Program Impact at Follow-Up

The first main hypothesis motivating this evaluation study was that caregivers who had participated in the RPP program would show significantly greater improvement in parenting practices and in knowledge about child development than would caregivers in the comparison group. The second main hypothesis was that children of participants in the RPP program would show significantly greater gains in language outcomes than would children in the comparison group. To test these hypotheses, we estimated differences in mean outcomes by program status at follow-up, and tested whether these differences were reliably different from zero. Given that the groups were reasonably balanced at baseline, we first estimated the program effect with linear regression, unadjusted for any confounding variables. We then repeated the regressions, adjusting for the potential confounding variables, and estimated the program impact from the difference in marginal means by program group. The resulting unadjusted and covariate-adjusted RPP effect estimates are shown in Table 1, with the list of covariates included in the adjusted regression. Effect estimates are given using the original metric (e.g., number of words) as well as standard deviation (*SD*) units. Standard errors of estimates are adjusted for correlation at the village level.

Changes in Caregivers' Behavior and Knowledge of Child Development

To assess the impact of the RPP on caregivers, we evaluated the direct measures of caregiver speech from the play sessions and speech initiated by adult females from the all-day LENA™ recordings, as well as the questionnaire data on caregiver knowledge of child development. At baseline, caregivers in all 24 villages spoke on average about the same amount to their child during the 5-min session: with a mean of 228 words (*SD* = 151, range = 0–701) in the RPP group and 226 words (*SD* = 131, range = 1–629) in the comparison group (Table S2). It is interesting to note that the quantity of child-directed speech by Senegalese caregivers at baseline was comparable to that observed in Spanish-speaking caregivers of same-age children from low-income Latino families (*M* = 254 words, *SD* = 91) observed in a similar play session in the United States (Hurtado, Marchman, & Fernald, 2008). At follow-up, we found large changes in caregivers' verbal engagement with their young children during the play session in the RPP villages, as compared to caregivers in comparison villages (Figure 1A). One year after the baseline study, caregivers in RPP villages had increased the amount of talk to their child by 78% compared to baseline, addressing 405 words to the child in 5 min, on average (*SD* = 158, range = 34–838). In contrast, caregivers in comparison villages showed no change in amount of child-directed talk over the year (*M* = 224, *SD* = 114, range = 2–518), as shown in Figure 1A. This substantial program effect remains nearly the same when adjusted statistically for key factors that could bias the results, including amount of caregiver speech at baseline (Table 1). Caregivers in the RPP group also used more complex language at follow-up, increasing their MLU from 2.55 to 3.41 words per utterance, with no change in the comparison group. In addition, although both groups of caregivers showed increased knowledge of child development when interviewed 1 year later, caregivers in RPP villages improved significantly more. However, the word count for adult female-initiated speech in the all-day LENA™ recordings decreased from baseline to follow-up in both groups, with no significant difference between the two groups (see Table S2 for raw data and Table 1 for impact estimates).

Changes in Children's Language Proficiency

To assess the impact of the RPP program on children's language proficiency, we evaluated the directly observed measures of children's vocalizations in both the play sessions and the all-day LENA™ recordings, as well as the parent-reported measures of children's language milestones and expressive vocabulary. Children of caregivers in the RPP group showed impressive gains in how much language they produced during the play session (Figure 1B). Although children in both groups increased the number of utterances they produced in 5 min at follow-up compared to baseline—an

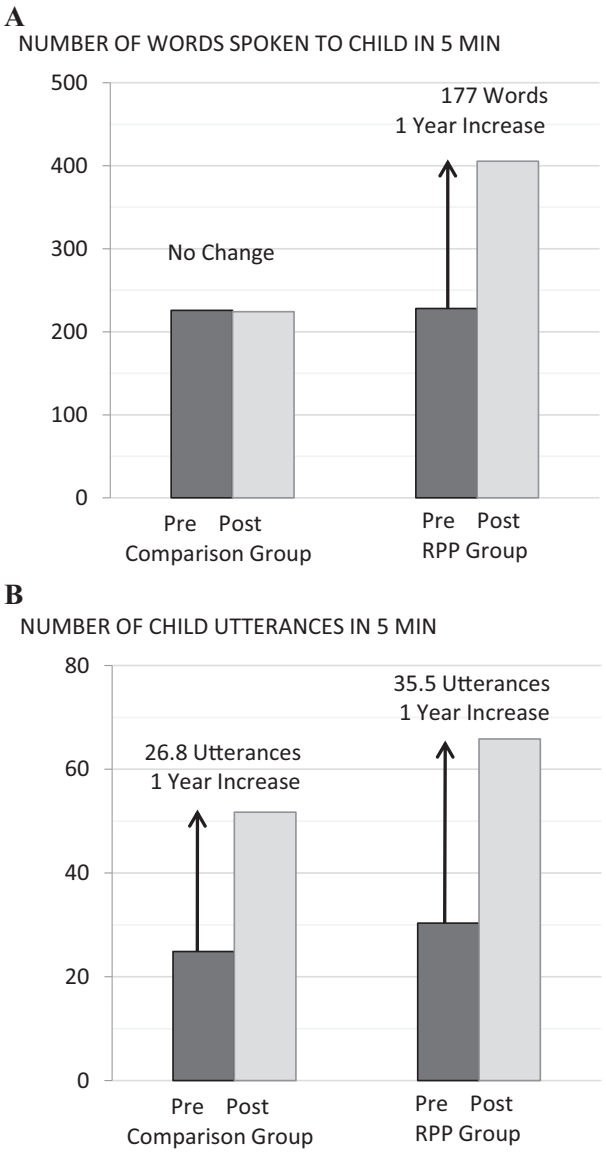

Figure 1. The bar graphs represent (A) the raw mean number of caregiver words and (B) child utterances observed in 5 min play sessions by comparison and Reinforcement of Parental Practices (RPP) groups, pre (baseline), and post the RPP program (follow-up). The unadjusted differences are significant after adjusting for confounders.

unsurprising change since they had all aged by 1 year—the increase was 32% greater for children in the RPP group compared to those in the comparison group. The estimated effect of the RPP on amount of child talk remained about the same after adjusting for key child factors, including age, gender, nutritional status, and baseline vocalizations. We also found significantly greater gains in language milestones and expressive vocabulary for children in the RPP villages than for children in the comparison villages, although effect sizes were smaller for these outcomes (Table 1). Finally, the estimated effect of the RPP program on number of child vocalizations and conversational turns per hour obtained from the all-day LENA™ audio recordings was small and not statistically significant when adjusted for possible confounders.

Since the LENA™ technology cannot identify who is speaking to the child, the small improvement in the all-day measures of AWC is not necessarily inconsistent with our finding that RPP caregivers substantially increased their child-directed speech during the play session. Ethnographers have reported that it is common for children in rural African villages to transition from being under direct care of their mother during infancy to being cared for by an older sibling or other female by the end of the 2nd year (LeVine et al., 1996). Thus, it is quite possible that the primary caregiver was spending less and less time with the child over the intervening year. To explore this possibility further, we looked for trends at baseline in children's language environment as a function of age (4–31 months), to determine whether children were in fact spending less time in the care of adult females and relatively more time with other children as they grew older. Specifically, we used three vocalization activity blocks obtained from the LENA™ software: adult female-initiated speech to target child, target child-initiated speech, and other child-initiated speech to target child. For each child, we summed the number of hours for a given block type and divided by the total number of hours recorded during the day, to obtain a proportion of total recording time by block type. We then plotted these proportions as a function of child age, and highlighted a change in all three slopes at about 14 months (Figure 2). The data suggest that talk initiated by adult females near the target child decreased as children got older, while talk initiated by other children near the target child increased, consistent with a transition in caregivers over time as children became older and more mobile.

Mediation of Change in Children by Change in the Caregivers

To test the pathway for change in children's language proficiency through change in caregivers' behavior, we performed a mediation analysis of the percentage of program impact on child language outcomes explained by two caregiver mediators: quantity of caregiver speech in the play session and knowledge of child development. We used the

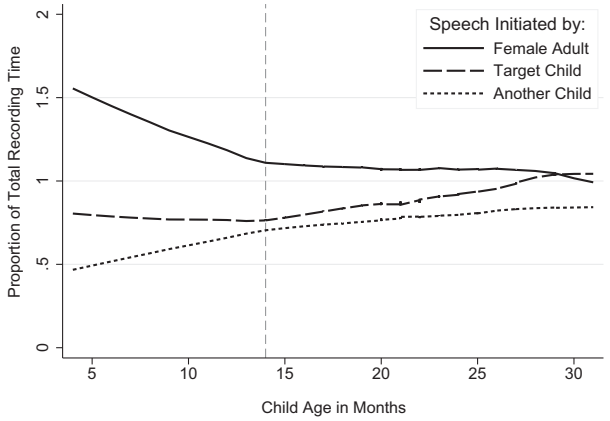

Figure 2. Proportion of total recording time that speech is initiated by an adult female to the target child, by the target child, or by another child to the target child as a function of the age of the target child, based on LENA™ all-day recordings.

methodology developed by Preacher and Hayes (2008) for multiple mediators, adapted for the statistical software package, Stata/SE version 13.1, and available on the UCLA: Statistical Consulting Group website (UCLA: Statistical Consulting Group, n.d.). Bootstrap standard errors were obtained by resampling participants 5,000 times with replacement, stratified by treatment status. The mediation analysis was performed for three child outcomes: child utterances in the play session, language milestones, and expressive vocabulary. From this analysis, we find that about 76% of the estimated RPP impact on number of child utterances and 47% of the impact on language milestones were accounted for by combined indirect effects through quantity of caregiver speech in the play session and caregiver knowledge of child development. Moreover, 100% of the estimated impact on children's expressive vocabulary was accounted for by these two mediators. The proportion of impact that remained unexplained may be due to changes in caregivers that we did not measure. More detailed mediation results are presented in Table S3.

Program Impact With Increased Participation

In this final analysis, we asked whether higher frequency of participation resulted in larger program effects, by splitting participants in the RPP villages into low- and high-participation subgroups based on the numbers of group sessions attended and home visits received. Although some caregivers in the RPP villages attended all of the classes and received regular home visits, others participated much less often. Thus, our inclusion of all caregivers in the RPP villages as "treated" represents a conservative estimate of the RPP effect. Participants categorized in the high-participation subgroup (n = 107) included those who reported attending more than half of the classes and receiving seven or more home visits (the median number of visits between the two study periods). Participants categorized in the low-participation subgroup (n = 117) included all remaining caregivers in the RPP villages, a few of whom did not participate at all in the program (n = 26). Program effect estimates were obtained with linear regression using two indicator variables for participation, and comparing the marginal means for each subgroup both to the comparison group and to each other (high vs. low participation). The estimates trended positively across all key outcomes: Caregivers who reported higher attendance in classes and more frequent home visits showed larger effects than did caregivers with lower attendance and fewer home visits. The quantity of caregiver speech in the play session was the only variable on which the low- and high-participation subgroups were significantly different, as shown in Table 2. However, the consistency of the trend across outcomes, including the LENA™ measures, suggests that the program was more effective with increasing program exposure.

Discussion

This evaluation study of Tostan's parent education program with 443 caregiver-child dyads in rural Senegal yielded four main findings: First, we found that caregivers who had participated in the RPP program significantly increased the amount of verbal engagement with their children when observed 1 year later. When interacting with their child in a play session, caregivers in the RPP group nearly doubled the quantity of child-directed speech compared to baseline, while caregivers in the comparison group showed no change over the same period. Second, children of caregivers in the RPP program showed significantly greater gains in language development, producing more utterances, and improving more in vocabulary and other language outcomes. Third, the impact of the RPP on children's later language outcomes was mediated by change in caregivers' observed verbal engagement with their children as well as by their knowledge of child development. And fourth, those caregivers in the RPP group who participated more regularly showed greater gains in the quantity of

Table 2
Effect Estimates by Low and High Participation Subgroups in the RPP Program

	Low participation in RPP[a]		High participation in RPP[a]		High versus low[b] difference estimate β (*p*)
	N	Effect estimate β (*p*)[c]	*N*	Effect estimate β (*p*)[c]	
Caregiver outcomes[d]					
Play session: Caregiver words to child	112	148 (< .001)	106	204 (< .001)	55.5 (.02)
Play session: Caregiver MLU	112	0.63 (< .001)	103	0.77 (< .001)	0.14 (.12)
All-day recording: Female adult words/hr	54	−73.1 (.26)	42	38.8 (.58)	112 (.10)
Caregiver knowledge of child development	112	7.26 (< .001)	106	8.04 (< .001)	0.77 (.30)
Child outcomes[e]					
Play session: Child utterances	112	12.8 (.001)	106	17.8 (< .001)	4.97 (.14)
Child language milestones	110	1.99 (.003)	105	2.67 (< .001)	0.68 (.38)
CDI: expressive vocabulary	56	4.42 (.17)	49	5.31 (.10)	0.89 (.85)
All-day recording: Child vocalizations/hr	54	17.1 (.36)	42	30.2 (.24)	13.1 (.60)
All-day recording: Conversational turns/hr	54	1.16 (.83)	42	10.5 (.14)	9.29 (.18)

Note. RPP = Reinforcement of Parental Practices; MLU = mean length of utterance; CDI = Communicative Development Inventory; CEP = Community Empowerment Program. [a]Effect estimates represent a comparison of the marginal means of the comparison group to either low or high level of participation in the RPP program. Participants categorized in the high participation subgroup include those who reported attending more than half of the classes and receiving seven or more home visits. Participants categorized in the low participation subgroup include all other participants in the RPP villages. [b]Difference in the program subgroup effect estimates (high minus low participation). [c]Effects are covariate adjusted for the lagged dependent variables plus characteristics of the child (age, change in age, age squared, gender, length for age *z* score, estimated birth size, baseline language milestones score), caregiver (age, relation to child, education, literacy, attended earlier Tostan CEP, children under 5 years in her care, lost a child, depressive symptoms), household (polygynous head of household, members who attended earlier Tostan CEP, mean age, median years of education in French or French–Arabic schools, children under 5 years, crowding, and wealth), and village (population, number of households, midwives, and marabouts; has health clinic, primary school, and day care; time to travel to market and to get drinking water; access to electricity, number of operational NGO programs, impacted by flooding in 2013).[d]Caregiver–child play session: caregiver words to child, MLU; all-day recording using LENA™: Female adult words to child; Caregiver report questionnaire data: caregiver knowledge of child development. [e]Caregiver–child play session: child utterances; Caregiver report questionnaire data: child language milestones, MacArthur-Bates CDI adapted "understands and says": expressive vocabulary; all-day recording using LENA™: child vocalizations, conversational turns.

their child-directed speech than did caregivers who participated less regularly.

The large increase in child-directed speech among caregivers in the RPP group shows that Tostan was successful in encouraging parents to change their traditional practices by talking more to young children. The 78% increase in caregiver talk from baseline to follow-up in RPP villages was not simply a matter of children becoming more verbal over the intervening year and thus eliciting more talk from adults. In fact, caregivers in the comparison group showed no change over the same period in the quantity of child-directed speech. Yet, while the RPP program led to dramatic changes in caregiver–child interactions during one-on-one play sessions, the LENA™ recordings of children's interactions with many different adults across an entire day showed no overall increase in child-directed speech. However, such null results do not invalidate our finding of significant change in caregivers' speech to their children observed in the play sessions, when considered in the cultural context in which Tostan works. Our survey data and transcripts from all-day recordings revealed that many toddlers were cared for by other adults in addition to the primary caregiver, as has often been reported in African villages. We also found that talk initiated by adult females near the target child decreased as children got older, while talk initiated by other children increased. These results are consistent with the conclusion that Tostan brought about significant change in the behavior of primary caregivers, but that interactions with the one individual who had learned about the importance of child-directed speech in the RPP program may have been limited to a small portion of the day. Thus, a considerable challenge remains for Tostan in providing RPP training to all of the child's caregivers and in disseminating information about child development more broadly in the community, with the goal of enriching children's daily interactions with other adults and older children as well.

This research provides the first detailed quantitative analyses of the amount of caregivers'

speech in relation to children's early language development in a large sample of families in rural African villages. However, this study has several limitations, which should be addressed in further research. While the Tostan RPP intervention was conducted in 200 villages across five regions of Senegal which differed in language and cultural traditions, our evaluation was limited to 24 Wolof villages in the Kaolack region. Thus we do not know if our positive findings on the effect of the RPP on amount of verbal engagement with young children can be generalized to the other language and cultural groups in which the program was conducted. And because Tostan had preselected villages to receive the RPP program, random assignment was not possible. Thus, we carefully matched comparison villages with RPP villages and adjusted statistically for measured confounders. Although caregivers may have differed on unobserved characteristics, the comparability of the relevant measures at baseline across the two groups was reassuring.

An additional limitation is that although we went to great lengths to use direct measures of both caregivers' and children's behaviors, we also relied on standard parent-report measures that are inherently subject to over-reporting bias. To address this concern, interviewers frequently requested examples of when the child was reported to say a word or do an activity. We also found positive correlations between these parent-report measures with direct measures of child vocalizations from the all-day recordings, providing evidence of validity. Note that even direct observations in the caregiver–child play session are also potentially subject to bias. For example, caregivers in the RPP group might have talked more to their child at follow-up if they were aware of Tostan's goals or were more at ease with the research team. But since the research team was not involved at all in the Tostan program and spent equal amounts of time as welcome guests in both the RPP and comparison villages, it is unlikely that their observations a year later were influenced by these factors. Moreover, the substantial increase in caregiver talk from baseline to follow-up in the RPP villages was accompanied by a 32% increase in children's language production in the play session, a large effect that cannot be explained by demand characteristics of the observation.

Despite these limitations, the results of the RPP evaluation represent an impressive achievement for Tostan. Senegalese mothers with no formal education, living in subsistence-level rural villages, were motivated to learn new ways of interacting with their young children, parenting practices which were often inconsistent with prevailing social norms and traditional beliefs. Focus groups and interviews conducted by our team confirmed that caregivers in this study did profess convictions about how to protect their infants from the dangers of evil spirits – for example, by placing a knife under babies' pillows or amulets on their arms. In addition, they considered certain caregiving behaviors risky in ways that are at odds with western views of best practices, such as looking deeply into a child's eyes. Tostan's approach was never to challenge such traditional beliefs directly, but rather to provide participants with alternative explanations, by sharing scientific evidence about the timing of brain development, and the ways in which children benefit from a cognitively stimulating environment. In this way, Tostan aimed to remove the social stigmas associated with talking to and engaging with babies. By carefully adapting sensitive assessments of caregivers' and children's language—measures typically used under controlled conditions in developmental laboratories—we were able to provide evidence for the effectiveness of this innovative Senegalese intervention, while working under challenging field conditions. In the process, this evaluation study also confirmed a finding that has been robustly demonstrated in studies with families in the United States—that caregivers' verbal engagement with young children can nurture their early language skills—extending this important result to children growing up in rural African villages.

References

Avineri, N., Blum, S., Johnson, E., Zentella, A. C., Briceheath, S., Mccarty, T., . . . Kremer-Sadlik, T. (2015). Invited forum: Bridging the "language gap." *Journal of Linguistic Anthropology*, *25*, 66–86. http://dx.doi.org/10.1111/jola.12071

Brian, M. (2000). *The CHILDES Project: Tools for analyzing talk*. Mahwah, NJ: Erlbaum.

Cunha, F., Heckman, J. J., Lochner, L., & Masterov, D. V. (2006). Interpreting the evidence on life cycles skill formation. In E. Hanushek & F. Welch (Eds.), *Handbook of the economics of education* (Vol. *1*, pp. 697–812). Amsterdam, The Netherlands: Elsevier. https://doi.org/10.1016/s1574-0692(06)01012-9

Dudley-Marling, C., & Lucas, K. (2009). Pathologizing the language and culture of poor children. *Language Arts*, *86*, 362–371.

Engle, P. L., Black, M. M., Behrman, J. R., Cabral de Mello, M., Gertler, P. J., Kapiriri, L., . . . Young, M. E. (2007). Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *The Lancet*, *369*, 229–242. https://doi.org/10.1016/s0140-6736(07), 60112-3.

Fenson, L., Marchman, V. A., Thal, D. J., Dale, P. S., Reznick, S. J., & Bates, E. (2007). *MacArthur–Bates Communicative Development Inventories: User's guide and technical manual* (2nd ed.). Baltimore, MD: Brookes.

Fernald, A., & Weisleder, A. (2015). Twenty years after "meaningful differences," it's time to reframe the "deficit" debate about the importance of children's early language experience. *Human Development*, *58*, 1–4. https://doi.org/10.1159/000375515

Ford, M., Baer, C. T., Xu, D., Yapanel, U., & Gray, S. (2008). *The LENA™ language environment analysis system: Audio specifications of the DLP-0121*. Boulder, CO: Lena Foundation.

Gillespie, D., & Melching, M. (2010). The transformative power of democracy and human rights in nonformal education: The case of Tostan. *Adult Education Quarterly*, *60*, 477–498. https://doi.org/10.1177/0741713610363017

Greenfield, P. M. (2009). Linking social change and developmental change: Shifting pathways of human development. *Developmental Psychology*, *45*, 401–418. https://doi.org/10.1037/a0014726

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Paul H Brookes.

Hirsh-Pasek, K., Adamson, L. B., Bakeman, R., Owen, M. T., Golinkoff, R. M., Pace, A., . . . Suma, K. (2015). The contribution of early communication quality to low-income children's language success. *Psychological Science*, *26*, 1071–1083. https://doi.org/10.1177/0956797615581493

Hoff, E. (2013). Interpreting the early language trajectories of children from low-SES and language minority homes: Implications for closing achievement gaps. *Developmental Psychology*, *49*, 4–14. https://doi.org/10.1037/a0027238

Hurtado, N., Marchman, V. A., & Fernald, A. (2008). Does input influence uptake? Links between maternal talk, processing speed and vocabulary size in Spanish-learning children. *Developmental Science*, *11*, F31–F39. https://doi.org/10.1111/j.1467-7687.2008.00768.x

Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., & Hedges, L. V. (2010). Sources of variability in children's language growth. *Cognitive Psychology*, *61*, 343–365. https://doi.org/10.1016/j.cogpsych.2010.08.002.sources

Kagitcibasi, C. (2007). *Family, self, and human development across cultures: Theory and applications*. London, UK: Routledge.

Keller, H. (2007). *Cultures of infancy*. Mahwah, NJ: Erlbaum.

LeVine, R. A., Dixon, S., Levine, S., Richman, A., Keefer, C. H., Brazelton, T. B., & Leiderman, P. H. (1996). *Child care and culture: Lessons from Africa*. New York, NY: Cambridge University Press.

UCLA: Statistical Consulting Group. (n.d.). How can I analyze multiple mediators in Stata?: Stata FAQ. Retrieved from https://stats.idre.ucla.edu/stata/faq/how-can-i-analyze-multiple-mediators-in-stata/

Nelson, C. A. (2015). An international approach to research on brain development. *Trends in Cognitive Sciences*, *19*, 424–426. https://doi.org/10.1016/j.tics.2015.05.008

Prado, E. L., Adu-Afarwuah, S., Lartey, A., Ocansey, M., Ashorn, P., Vosti, S. A., & Dewey, K. G. (2016). Effects of pre- and post-natal lipid-based nutrient supplements on infant development in a randomized trial in Ghana. *Early Human Development*, *99*, 43–51. http://dx.doi.org/10.1016/j.earlhumdev.2016.05.011

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*, 879–891. https://doi.org/10.3758/brm.40.3.879

Richman, A. L., Miller, P. M., & LeVine, R. A. (1992). Cultural and educational variations in maternal responsiveness. *Developmental Psychology*, *28*, 614–621. https://doi.org/10.1037/0012-1649.28.4.614

Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech vocabulary development. *Child Development*, *83*, 1762–1774. https://doi.org/10.1111/j.1467-8624.2012.01805.x

Shneidman, L. A., & Goldin-Meadow, S. (2012). Language input and acquisition in a Mayan village: How important is directed speech? *Developmental Science*, *15*, 659–673. https://doi.org/10.1111/j.1467-7687.2012.01168.x

Suskind, D. L., Leffel, K. R., Graf, E., Hernandez, M. W., Gunderson, E. A., Sapolich, S. G., . . . Levine, S. C. (2015). A parent-directed language intervention for children of low socioeconomic status: A randomized controlled pilot study. *Journal of Child Language*, *43*, 366–406. https://doi.org/10.1017/S0305000915000033

Tamis-LeMonda, C. S., Song, L., Leavell, A. S., Kahana-Kalman, R., & Yoshikawa, H. (2012). Ethnic differences in mother-infant language and gestural communications are associated with specific skills in infants. *Developmental Science*, *15*, 384–397. https://doi.org/10.1111/j.1467-7687.2012.01136.x

Valencia, R. R. (1997). *The evolution of deficit thinking: Educational thought and practice*. Hove, UK: Psychology Press.

Walker, S. P., Chang, S. M., Vera-Hernández, M., & Grantham-McGregor, S. (2011). Early childhood stimulation benefits adult competence and reduces violent behavior. *Pediatrics*, *127*, 849–857. https://doi.org/10.1542/peds.2010-2231

Walker, S. P., Powell, C. A., Grantham-McGregor, S. M., Himes, J. H., & Chang, S. M. (1991). Nutritional supplementation, psychosocial stimulation, and growth of stunted children: The Jamaican Study. *American Journal of Clinical Nutrition*, *54*, 642–648. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/0140673691900016

Weber, A., & Marchman, V. (2013). *MacArthur-Bates CDI: An adaptation in Wolof*. Information available from https://mb-cdi.stanford.edu/adaptations.html

Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science*, *24*, 2143–2152. https://doi.org/10.1177/0956797613488145

World Health Organization. (2011). *WHO Anthro for PC*. (Version 3.2.2) [Software]. Available from http://www.who.int/childgrowth/software/en/

Zeitlin, M. (2011). *New information on West African traditional education and approaches to its modernization*. Dakar, Senegal: Tostan.

Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's website:

Table S1. Baseline Demographics of Child, Caregiver, Household, and Village by Program Status

Table S2. Unadjusted, Descriptive Statistics for the Outcome Measures by Program Status and Survey Year

Table S3. Mediation of the Reinforcement of Parental Practices Effect on Child Outcomes Through Caregiver Behavior and Knowledge

Appendix S1. Additional Measurement Information